2015

Annotated Bibliography of

PUBLICATIONS ON RAMIN AND KARAS (1927 - 2015)

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ANNOTATED BIBLIOGRAFY OF PUBLICATIONS ON RAMIN AND KARAS (1927 – 2015)

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PUBLICATIONS –RAMIN-

(*Gonystylus bancanus*)

Title:	Preliminary Findings on Impact of Logging on Plant Structure and Potential Indicator on Gap Opening in Peat Swamp Forest
Author:	Mohd Ghazali, H., Marryanna, L., Ismail, P., Abd Rahman, K., Abdul Razak, O., Salleh, M. & Saiful, I.K.
Types:	Journal **Year :** 2013
Publisher :	International Journal of Chemical, Environmental & Biological Sciences (IJCEBS)
Source/ link :	http://www.isaet.org/images/extraimages/P413013.pdf

Abstract:

Various parameters may have cause changing of plant structure especially in peat swamp forest (PSF). One major cause of plant structure changes in the PSF might be logging activities to extract valuable timbers out of the area. The logging activities will create gap opening that minimize competition among the plants for nutrients, moisture and sunlight. Some of the plants will eventually dominate and vigorously growth compared to other species. Just after the logging, pioneer plant species grow vigorously due to lower stand density and abundance of sunlight. Therefore the presence of these species can be attributed to the changes on soil properties and water quality of the area. This study is aimed to find possible indicators contributing to this phenomenon. These were done by setting plots in areas with different years after the logging. Preliminary observation showed that Kelubi (*Eleiodoxa coferta*) is possibly as an indicator species for changes in gap opening in the PSF, at least in early years after the logging completed.

Title	:	Regeneration Status and Population Profiles of Peat Swamp Forest in Pekan Forest Reserve, Pahang		
Author	:	Ismail, P., Nizam, M. S. & Sadali, S.		
Types	:	Journal	**Year :**	2012
Publisher	:	Forestry Department Peninsular Malaysia		
Source/ link	:	http://www.itto.int/		

Abstract:

Natural regeneration is the common way of ensuring species existence in a particular area. Their status could explain preferable site of certain species. Meanwhile, population profile is useful to understand population pattern and can be used to determine trees of different species being structured naturally. The objectives of this study were to determine status of natural regeneration of some main peat swamp forest (PSF) species and to identify the population profiles based on different subtype classification at Sungai Bebar in Pekan Forest Reserve, Pahang. The subtypes are Riverine, Kempas-Ramin-Bintangor and Kempas-Kedondong-Durian. There are three different categories of natural regeneration for nine main PSF species in Sungai Bebar. Natural regeneration status of *Callophylum ferrugineum, Dialium indum var. indum* and *Madhuca motleyana* are categorized as high, *Durio carinatus* and *Koompassia malaccensis* are categorized as moderate while *Gonjstylus bancanus, Eophopetalum multinervium, Shorea platycarpa* and *Tetramerista glabra* are under low category. Three population profiles based on each subtype has been developed. Population profiles for the subtypes are relatively different in term of species dominance, structure and composition. Characteristics of the areas in term of hydrology such as influence of river flow and ground water table, and physical aspects such as soil type and peat depth might be among the main factors affecting their natural regeneration and the population profiles.

Title	:	Measurement of The Surface Roughness of Wood Based Materials Used in Furniture Manufacture		
Author	:	Z.W. Zhong, Salim Hiziroglu & C.T.M. Chan		
Types	:	Journal	**Year :**	2012
Publisher:		Elsevier		
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0263224112004629#		

Abstract:

The objective of this work was to evaluate surface quality of wood based materials used to manufacture furniture units in Singapore. Various type commercially produced composite panels including particleboard, medium density fibreboard (MDF), plywood in addition to ten different solid wood species which are commonly used in furniture production were considered for the experiments. A stylus type profilometer and 3D image analyzer were employed to determine surface roughness of the samples. Medium density fibreboard (MDF) samples resulted in the smoothest surface with an across the sandmark average roughness (R_a) value of 5.07 lm, while corresponding value for plywood specimens was 8.09 μm among the composite panel samples. In the case of solid wood samples, measurements taken along and across the sandmark from the surface of the specimens measured by the stylus type profilometer, balau had the roughest surface with an R_a value of 9.85 μm across the sandmark followed by beech and walnut. Pine specimens along with ash, cherry and nyatoh resulted in relatively smooth surface values. Correlation between measurements taken by two different methods, namely stylus and 3D scanning showed a good agreement with each other. Based on the findings in this work it appears that both methods can be successfully used to evaluate and to get objective numerical values on surface quality of these samples so that such initial data can be used as quality control tool to have more effective further manufacturing steps in furniture production.

Title	:	Extractives in Some Tropical Woods

Author :	Ayben Kilic & Peter Niemz		
Types :	Journal	**Year :**	2012
Publisher :	Springer-Verlag: European Journal of Wood and Wood Products, Volume 70, Issue 1-3, pp 79-83		
Source/ link :	http://link.springer.com/article/10.1007/s00107-010-0489-8		

Abstract:

Total amount and composition of extractives from 12 different tropical wood species were determined by sequential extraction followed by silylation and GC, GC/MS analysis. Hexane and then acetone/water (5:1) mixture was used successively for the extraction. Generally, very low amounts of lipophilics were found (0.05–0.38 mg/g) and the constituent consisted of fatty acids. Hydrophilics were composed of phenolic acids, flavonoids, sterols, stilbenes and a lignan. The highest amount of hydrophilics was found in Afzelia (36.1 mg/g), while the lowest in Wenge and Opepe (0.30 mg/g). Also, cold-hot water, 1% NaOH and some solvent (acetone, dichloromethane) solubilities were determined. The solubility values of tropical woods except for Canalete were found to increase in the order of solvent, cold water, hot water and 1% NaOH.

Title	**:**	Penelitian Berbagai Jenis Kayu Limbah Pengolahan Untuk Pemilihan Bahan Baku Briket Arang		
Author	**:**	Usman Malik		
Types	**:**	Journal	**Year :**	2012
Publisher	**:**	Jurnal Ilmiah Edu Research Vol. I No.2 Desember 2012		
Source/ link	**:**	http://103.10.169.96/xmlui/handle/123456789/5966?show=full		

Abstract:

The waste of timber industry can be utilized to produce some valuable products. A research had been conducted to study such possibility. The research was to study the conversion of wood into charcoal briquetting using adhesive or heating process. Result showed that the heating value of charcoal briquetting made from kempas wood (*koompassia malaccensis maing*), meranti (*shorea spp.*) and pulai (*alstonia spp*) increases significantly compared to that of raw material. The product made from kempas wood (*koompassia malaccensis maing.*) was formed to have the highest energy per cc (density) followed by those of made of meranti (*shorea spp.*), ramin (*gonystylus bancanus kurz.*). However, raw material availability must be consideret in establishing charcoal briquetting industry

Title	:	Effects of Light and Soil Flooding on The Growth and Photosynthesis of Ramin (*Gonystylus bancanus*) Seedlings in Malaysia		
Author	:	WWP Jans, L Dibor, C Verwer, B Kruijt, S Tan & PJ van der Meer		
Types	:	Journal	**Year :**	2011
Publisher	:	Journal of Tropical Forest Science		
Source/ link	:	http://www.cabdirect.org/abstracts/20123049068.html;jsessionid=71B45CEF658D2534F39EEC8A7BCDFE5E		

Abstract:

We studied the ecophysiology of ramin (*Gonystylus bancanus*) seedlings in an experimental set up at the Forest Research Centre in Kuching, Sarawak, Malaysia. Ramin seedlings were grown on flooded and drained peat soil under 100, 76, 46 and 23% sunlight, thus simulating effects of different light conditions (canopy gap size) and drainage that occur in natural ramin populations. Seedling growth was highest in partial sunlight (76%) and reduced with reducing light levels. Aboveground productivity and fine root development were significantly higher in seedlings grown on flooded soil compared with those on drained soil. In contrast, investment in coarse root biomass was significantly higher in seedlings grown on drained soil. It appeared that the aboveground growth benefits in flooded conditions were the result of more advantageous conditions for allocation of carbon to leaves, thus enhancing overall relative growth rates through higher light interception rates despite lower photosynthetic capacity. The results of this experiment suggested that drainage of peat swamp forests would seriously hamper natural regeneration of ramin by limiting the growth of seedlings. It is also suggested that selective logging operations which produce medium-size canopy gaps improve ramin regeneration in hydrologically undisturbed mixed swamp forests.

Title	:	Phenology of *Gonystylus bancanus* in Pahang, Peninsular Malaysia
Author	:	P Ismail, MS Nizam, A Latiff, I Faridah Hanum & I Shamsudin
Types	:	Journal **Year :** 2011
Publisher	:	Journal of Tropical Forest Science 2011 Vol. 23 No. 2 pp. 143-151
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

A study on the phenology of *Gonystylus bancanus* (ramin melawis) was conducted in Pekan Forest Reserve, Pahang, Peninsular Malaysia, which covers areas of virgin and logged-over forests. Observations revealed that the flowering of *G. bancanus* was supra-annual. The smallest *G. bancanus* tree to flower was 29 cm in diameter at breast height (dbh) and was located in a logged-over site. Most trees that flowered had larger dbh of more than 40 cm and were found in logged-over and virgin forests. A total of 71-86 days was recorded for full development from the budding stage to mature fruit formation. The budding phase was quite long, extending for more than a month. However, it took only about two weeks for the flowers to become fruits. The flowers of *G. bancanus* were pollinated by thrips (*Heterothripts sp.*) and stingless bees (Trigona canifrons and T. laeviceps), while aphids (*Aphis sp.*), Prevost's squirrels (Callosciurus prevostii) and plantain squirrels (*C. notatus*) were identified as predators of *G. bancanus* flowers and fruits. *Gonystylus bancanus* seeds were mainly dispersed by gravity but the Malayan flying fox (*Pteropus vampyrus*) was also observed to disperse the fruits. Other fruit bats, namely, *Cynopterus sphinx, Megaerops ecaudatus* and *Penthetor lucasi* were also identified as potential seed dispersal agents of *G. bancanus*.

Title	:	Detection of Genetic Structure Among Ramin (*Gonystylus bancanus (Miq.) Kurz*) Populations in Peninsular Malaysia Using a Rapid DNA Fingerprinting Technique
Author	:	Fatma, N.A.H., Wickneswari, R. & Cannon, C.H.
Types	:	Journal **Year :** 2011
Publisher	:	Malays. Appl. Biol. (G20E1N1E) T4I0C(2S)T: R4U3–C5T0URE
Source/ link	:	http://www.mabjournal.com/index.php?option=com_content&view=article&id=403&catid=59:current-view&Itemid=56

Abstract:

Here, we demonstrate the power of DNA fingerprints, generated by Direct Amplification of Length Polymorphism (DALP) analysis to understand the genetic structure and variation of five natural populations of ramin (*Gonystylus bancanus*) in Peninsular Malaysia. Six primer sets generated 309 distinct fragments ranging from 100-1200 bp among 156 individuals. These loci were highly polymorphic (83%) and no two individuals shared the exact same fingerprint. Most of the genetic variation was found within populations (only 13% among population variance) although cluster analysis indicated that most individuals could be correctly assigned to their original population. Genetic similarity among populations was not correlated with geographic distance, possibly due to environmental differences among the sampled peat forests. The DNA fingerprinting approach presented here would be highly effective for tracking individual logs from forest to market and detecting illegal smuggling. These DNA fingerprints could also be applied for correct deployment of seedlings in enrichment planting schemes to avoid breakdown of co-adapted complexes for survival and growth in the extreme peat swamp environment.

Title	**:**	How Precise Can Wood Identification Be? Wood Anatomy's Role in Support of The Legal Timber Trade, Especially Cites		
Author	**:**	Peter Gasson		
Types	**:**	Journal	**Year :**	2011
Publisher	**:**	IAWA Journal, Vol. 32 (2), 2011: 137-154		
Source/ link	**:**	http://iawa-website.org/		

Abstract:

Traditional wood identification techniques using light microscopy are usually sufficient to identify a wood sample to the genus level. In some cases CITES legislation requires identification to species level, which is difficult or impossible using traditional light microscopy. This paper concentrates mainly on the identification challenges posed by CITES, particularly with ramin (*Gonystylus spp.*), Brazilian Rosewood (*Dalbergia nigra*) and Agarwood (*Aquilaria* and *Gyrinops* species). All the other CITES listed timbers and some other taxa that are traded or confused with protected species and might in the future be protected by legislation are also discussed. There are several new non-anatomical techniques being tried to make more accurate identifications and these are mentioned where appropriate. There is a mismatch between legislation and the natural world, and the limitations of the identification process need to be better appreciated by enquirers, especially in relation to CITES enquiries, since species and genus concepts vary among biologists, and can be ambiguous.

Title	:	Assembly Free Comparative Genomics of Short-Read Sequence Data Discovers The Needles in The Haystack		
Author	:	Charles H. Cannon, Chai-Shian Kua, D. Zhang & J.R. Harting		
Types	:	Journal	**Year :**	2011
Publisher	:	Molecular Ecology (2010), 19 (Suppl. 1), 147–161		
Source/ link	:	http://onlinelibrary.wiley.com/doi/10.1111/j.1365-294X.2009.04484.x/full		

Abstract:

Most comparative genomic analyses of short-read sequence (SRS) data rely upon the prior assembly of a reference sequence. Here, we present an assembly free analysis of SRS data that discovers sequence variants among focal genomes by tabulating the presence and frequency of 'complex' fragments in the data. Using data from nine tree species, we compare genomic diversity from populations to families. As a control, we simulated SRS data for three known plant genomes. The results provide insight into the quality and distributional bias of the sequencing reaction. Three main types of informative complexmers were identified, each possessing unique statistical properties. Type I complexmers are unique to a genome but suffer from a high false positive rate, being highly dependent on read coverage and distribution. Type II complexmers are shared between two genomes and can highlight potential copy-number differences. Type III complexmers are exclusive to a subset of genomes and can be useful for associating genetic differences with phenotypic or geographic variation. At the population level in an endangered timber species, numerous markers were identified that could potentially determine geographic origin of individuals and regulate international trade. We observed that the genomic data for the four fig species were more divergent than for stone oak species, possibly due to their complex pollination syndrome and high rates of gene flow. Our approach greatly enhances the application of SRS technology to the study of non-model organisms and directly identifies the most informative genetic elements for more detailed study and assembly.

Title	:	Effects of Light and Soil Flooding on The Growth and Photosynthesis of Ramin (*Gonystylus bancanus*) Seedlings in Malaysia		
Author	:	WWP Jans, L Dibor, C Verwer, B Kruijt, S Tan & PJ van der Meer		
Types	:	Journal	**Year :**	2011
Publisher	:	Journal of Tropical Forest Science 24(1): 54–63 (2012)		
Source/ link	:	http://www.cabdirect.org/		

Abstract:

We studied the ecophysiology of ramin (*Gonystylus bancanus*) seedlings in an experimental set up at the Forest Research Centre in Kuching, Sarawak, Malaysia. Ramin seedlings were grown on flooded and drained peat soil under 100, 76, 46 and 23% sunlight, thus simulating effects of different light conditions (canopy gap size) and drainage that occur in natural ramin populations. Seedling growth was highest in partial sunlight (76%) and reduced with reducing light levels. Aboveground productivity and fine root development were significantly higher in seedlings grown on flooded soil compared with those on drained soil. In contrast, investment in coarse root biomass was significantly higher in seedlings grown on drained soil. It appeared that the aboveground growth benefits in flooded conditions were the result of more advantageous conditions for allocation of carbon to leaves, thus enhancing overall relative growth rates through higher light interception rates despite lower photosynthetic capacity. The results of this experiment suggested that drainage of peat swamp forests would seriously hamper natural regeneration of ramin by limiting the growth of seedlings. It is also suggested that selective logging operations which produce medium-size canopy gaps improve ramin regeneration in hydrologically undisturbed mixed swamp forests.

Title	**:**	Analysis of Drying Three Kinds of Wood to DepreciationVolumetric Sortimen Board and Squares		
Author	**:**	Henni Aryati		
Types	**:**	Journal	**Year :**	2011
Publisher	**:**	Jurnal Hutan Tropis Volume 12 No. 32		
Source/ link	**:**	http://ejournal.unlam.ac.id/index.php/jht/article/ view/352/310		

Abstract:

Volumetric shrinkage sortimen boards and squares to ramin's smallest obtained at harike 5 i.e. the drying time of 9.49% and day 7 of 12.95% whereas squares day 5 of 6,29% and day 7 is 11,65%. Likewise, for keruing time dried the smallest and the biggest. meranti merah everythinglooks smaller than meranti and keruing . Drying of timber day to six of each type of wood are among the time of day and drying 5 to 7. The time of drying 5 days of shrinkage kayu has stabilized means kayu 's been in field of shrinkage the outside to the inside of wood, so the longer time drying used the percentage of shrinkage tending to be high . Shrinkage volumetris the largest for that is kind of wood boards sortimen keruing, as for sortimens squares on kinds of wood with long ramin drying 7 days.

Title	:	Effect of Cutting Positions and Growth Regulators on Rooting Ability of *Gonystylus bancanus*
Author	:	A. S. Nor Aini1, V. S. Guanih & P. Ismail
Types	:	Journal **Year :** 2010
Publisher	:	African Journal of Plant Science
Source/ link	:	http://www.academicjournals.org/article/article1380121786_Aini%20et%20al.pdf

Abstract:

The effect of cutting positions and growth regulators on rooting ability of *Gonystylus bancanus* were studied. This study, aims to determine the effects of cutting positions (top, middle, and bottom) and hormonal treatments (control, Seradix 3, Planton 3000, IBA 100 µg and IBA 150 µg) on the rooting ability of *G. bancanus*. The top position recorded the highest survival percentage of 90.7% followed by the middle and bottom with values of 86.0 and 74.7%, respectively. Hormonal treatments also showed significant differences ($p \leq 0.05$) in which the untreated cuttings survived the highest (93.3%) followed by Planton 3000 (88.9%) and Seradix (83.3%). Top cutting showed the highest rooting percentage of 78.0 followed by middle and bottom positions with percentages of 76.7 and 65.3, respectively. There was no significant difference observed in the rooting ability in terms of hormonal application. However, results in terms of root development based on the number of roots and vigour showed otherwise (significant at $p \leq 0.05$), whereby, cuttings from bottom positions treated with IBA 150 µg produced large number of roots which were thicker and healthier.

Title	:	Genetic Diversity of Ramin [*Gonystylus bancanus* (*Miq.*) *Kurz*] from Riau Province Based onRandom Amplified Polymorphic DNA Fingerprint		
Author	:	Yulita Kusumadewi, Yuyu S. Poerba, & Tukirin Partomihardjo		
Types	:	Journal	**Year :**	2010
Publisher	:	Jurnal Biologi Indonesia 6(2): 173-183 (2010)		
Source/ link	:	http://biologi.or.id/Journal%20Biologi/6%282%292010.pdf#page=26		

Abstract:

Gonystylus bancanus is a commercial timber found only on peat swamp forests, scatteredly distributed in Sumatra and Kalimantan. Their existence is now under severe threat due to habitat conversion. One of the remaining natural populations of ramin was in Riau Province, Sumatra. This study aimed to assess genetic diversity of this species within their natural populations in Riau Province using Random Amplified Polymorphic DNA (RAPD). RAPD profiles were obtained by performing PCR amplification using five arbitrary primers. One hundred and eleven putative loci of RAPD were scored and analysed using Popgene and NTSYS software. Eleven of RAPD bands were commonly found in all populations and 16 bands were distinctively found in certain populations. These unique bands may serve as population diagnostic marker for such populations. The average genetic diversity within population (0.1606) was lower than that of among populations (0.1894). Genetic differentiation (Gst) indicated that 95.56% of total genetic diversity in ramin was attributed to the differences among populations. The highest genetic diversity was found in population 3 (He:0.1858) and 3 (I:0.2864), while the lowest genetic variation was observed in population 1 (He: 0.1438) and 2 (I: 0.2201). Total genetic diversity for all population (Ht) was 0.1982 with an average value of genetic diversity within populations (Hs) was 0.1606. The low level of genetic diversity found in ramin with high population differentiation may suggest that these remaining populations was undergoing genetic bottleneck resulted from severe habitat fragmentation.

Title	**:**	Modelling Above- and Below-Ground Mass Loss and N Dynamics in Wooden Dowels (LIDET) Placed Across North and Central America Biomes at The Decadal Time Scale		
Author	**:**	Amanda C. Smith, Jagtar S. Bhatti, Hua Chen, Mark E. Harmon & Paul A. Arp		
Types	**:**	Journal	**Year :**	2010
Publisher :		Ecological Modelling (Volume 222, Issue 14, 24 July 2011, Pages 2276–2290)		
Source/ link	**:**	http://www.sciencedirect.com/science/article/pii/S0304380010004898		

Abstract:

This article focuses on modelling above and below-ground mass loss and nitrogen (N) dynamics based on the wooden dowels (*Gonystylus bancanus [Miq.] Kurz*) of the decadal Long-term Intersite Decomposition Experiment (LIDET) data. These dowels were placed at 27 locations across North and Central America, involving tropical, temperate and boreal forests, grasslands, wetlands and the tundra. The dowel, inserted vertically into the soil with one half remaining exposed to the air, revealed fast mass and N losses under warm to humid conditions, and slow losses under wet as well as cold to dry conditions. The model formulation, referred to as the Wood Decomposition Model, or WDM, related these losses to (i) mean annual precipitation, mean monthly January and July air temperatures, and (ii) mean annual actual evapotranspiration (AET) at each location. The resulting calibrations conformed well to the time-in-field averages for mass remaining by location: R^2 = 0.83 and 0.90 for the lower and upper parts, respectively. These values dropped, respectively, to 0.41 and 0.55 for the N concentrations, and to 0.28 and 0.43 for N remaining. These reductions likely refer to error propagation and to as yet unresolved variations in N transference into and out of the wood specific to each individual dowel location. Recalibrating the model parameters by ecosystem type reduced the R^2 values for actual versus best-fitted mass loss by about 0.15. Doing the same without location- or ecosystem-specific adjustments reduced the R^2 values further, by about 0.3.

Title	:	Microsatellite Markers of *Gonystylus bancanus* (*Thymelaeaceae*) for Population Genetic Studies and DNA Fingerprinting
Author	:	Kevin Kit Siong Ng, Soon Leong Lee, Chin Hong Ng, Lee Hong Tnah, Chai Ting Lee & Naoki Tani
Types	:	Journal **Year :** 2009
Publisher	:	Conservation Genetic Resources. Vol. 1, p. 153-157
Source/ link	:	http://link.springer.com/article/10.1007/s12686-009-9037-4

Abstract:

This paper reports 10 polymorphic microsatellite markers for a valuable peat swamp timber species, *Gonystylus bancanus* (*Thymelaeaceae*). The primers were designed from a genomic library enriched with dinucleotide (CT) repeats and screened on 24 samples from a natural population. The number of alleles detected per locus ranged from two to nine while the observed and expected heterozygosities ranged from 0.455 to 0.864 and from 0.476 to 0.863, respectively. No significant deviation from Hardy–Weinberg equilibrium ($P < 0.05$) was detected in all the 10 loci. These markers are currently being applied on population genetic studies and DNA fingerprinting databases establishment for individual identification of *G. bancanus* in Malaysia.

Title	:	Vegetation Assessment of Peat Swamp Forest Using Remote Sensing
Author	:	Seca Gandaseca, John Sabang, Osumanu H. Ahmed & Nik M.A. Majid
Types	:	Journal **Year :** 2009
Publisher	:	American Journal of Agricultural and Biological Sciences 4 (2): 167-172, 2009
Source/ link	:	http://thescipub.com/abstract/10.3844/ajabssp.2009.167.172

Abstract:

Problem statement: Peat covers 1.6 million ha (13%) of the 12.4 million ha land area of Sarawak and some of peat swamp forests have been logged. The objective of this study was to assess the impact of logging operation on peat swamp forest in this area. Approach: The study used a remote sensing technique to assess vegetation cover in a peat swamp forest areas in Sarawak as result of logging practice and land clearing activities for oil palm plantation. Vegetation Index was used to assess impact of timber harvesting system and land clearing activities on remaining peat swamp forest in two sites which were logged previously and the possible relationship of change in hydrology. Results: The timber harvesting system was a combination of rail system for log transportation and excavator crawler for log skidding. Drainage work was probably carried out prior to logging activities which was followed up by land preparation for the establishment of the oil palm plantations. There was a general decrease in the level of greenness from 2002-2007. Between the two sites, the level of greenness was relatively lower in the West Site. The high green level of both sites was reduced remarkably in 2007 especially for the West Site and this corresponded to increase in the percentage of medium green level. The changed in the level of greenness in the remnant peat swamp forest could suggest that soil and other conditions such as vegetation structure and floristic composition are unfavorable for the expected rate of forest regeneration. Conclusion: The remnant logged peat swamp forest of the area declined due to a poor state of growth as shown by the dramatically decrease in the level of greenness. The peat swamp forest types strongly related to the hydrological conditions and the associated flow of nutrients and mineral elements. The surrounding hydrology was presumed to have influence the physical and chemical characteristics of the peat.

Title	:	Ecological Characteristics of A*Gonystylus bancanus*-rich Area in Pekan Forest Reserve, Pahang, Malaysia		
Author	:	Khali Aziz Hamzah, Parlan Ismail, Abd Rahman Kassim, Che Hashim Hassan, Grippin Akeng & Nizam Mohd Said		
Types	:	Journal	**Year :**	2009
Publisher	:	Tropical Life Sciences Research		
Source/ link	:	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819060/		

Abstract:

Tropical peat swamp forest (PSF) is a unique wetland ecosystem with distinct vegetation types. Due to the waterlogged environment, the stand characteristics in this ecosystem are different from those of other inland forests. This paper highlights stand characteristics of a PSF based on our investigation of a 1 ha ecological plot established in a Virgin Jungle Reserve (VJR) at Compartment 100, Pekan Forest Reserve, Pahang, Malaysia. This site is considered a *Gonystylus bancanus*-rich area. From the inventory, we recorded a total of 49 tree species from 38 genera and 25 families among all trees of ≥ 10 cm in diameter at breast height. C*alophyllum ferrugineum var. ferrugineum* was the most abundant species, followed by *G. bancanus*. The forest appeared healthy, as all tree characteristics (crown shape, log grade and climber infestation) generally fell within Classes 1 and 2 (good and moderate categories), with the exception of crown illumination which majority of the trees were rated as class 3 (received less sunlight). The latter finding indicates that most of the trees living under the canopy received minimal illumination. In terms of total tree biomass, we estimated that about 414.6 tonnes exist in this 1 ha area; this tree biomass is higher than in some PSF areas of Sumatra, Indonesia.

Title	:	Drying Conditions for 11 Potential Ramin Substitutes		
Author	:	E Basri, Saefudin, S Rulliaty & K Yuniarti		
Types	:	Journal	**Year :**	2009
Publisher	:	Forest Research Institute Malaysia		
Source/ link	:	http://www.cabdirect.org/		

Abstract:

This study was aimed at obtaining data on drying conditions for 11 potential ramin substitutes. Several characteristics of the woods were observed and compared. Research on drying properties at high temperature was carried out to design drying conditions for the substituting-woods. From the 11 species studied, 8 species had better drying properties than ramin and can be dried further under more severe condition.

Title	:	Adsorption and Desorption Measurements on Selected Exotic Wood Species. Analysis with the Hailwood-Horrobin Model to Describe the Sorption Hysteresis
Author	:	Rudolf Popper, Peter Niemz & Stéphane Croptier
Types	:	Journal **Year :** 2009
Publisher	:	Wood Research
Source/ link	:	http://www.woodresearch.sk/articles/1-29-090831_WR_4_2009%2005%20Popper%20final.pdf

Abstract:

Our preceding investigations showed that the Hailwood Horrobin model is suitable for the description of water vapour sorption of wood. The goal of the submitted study at select exotic wood species is to describe the phenomenon sorption hysteresis with help of this model. Additionally it was tried the wood species due to the hysteresis loop to diff erentiate from each other.

Title	:	On Some Aspects of A Relation between Density and Mechanical Properties of Wood in Longitudinal Direction		
Author	:	Andrzej Krauss		
Types	:	Journal	**Year :**	2009
Publisher	:	Silvarum Colendarum Ratio et Industria Lignaria 8(1) 2009		
Source/ link	:	http://www.forestry.actapol.net/pub/7_1_2009.pdf		

Abstract:

A comprehensive analysis has been made of the mechanical properties and density of 100 timber species. The correlation between the mechanical properties and wood density has been approximated by a power function type $y = a\rho^n$. No functional relation has been found between the parameters describing mechanical properties of the cell wall and the wood density. The values of these parameters show great scatter of about ±50% relative to the mean value. An attempt has been made to identify other wood characteristics determining the mechanical properties of wood. The species characterised by extremely high values of the parameters describing mechanical properties of wood have been singled out. The greatest differentiation in the values has been noted for the tensile strength. Among the coniferous species of similar density the differences have reached 113% on average, while among the deciduous species – 143%, at the differences in density being only of 15%.

Title	:	Development of Microsatellite Markers in *Gonystylus bancanus* (Ramin) Useful for Tracing and Tracking of Wood of This Protected Species		
Author	:	M. J. M. Smulders, W. P. C. Van 'T Westende, B. Diway, G. D. Esselink, P. J. Van Der Meer & W. J. M Koopman		
Types	:	Journal	**Year :**	2008
Publisher	:	Willey		
Source/ link	:	http://onlinelibrary.wiley.com/		

Abstract:

Ten polymorphic microsatellite markers have been developed for *Gonystylus bancanus* (Ramin), a protected tree species of peat swamp forests in Malaysia and Indonesia. Eight markers were also shown to be polymorphic in other *Gonystylus* species. The markers will enable assessing the amount of genetic variation within and among populations and the degree of population differentiation, such that donor populations can be selected for reforestation projects. They may be used for tracing and tracking of wood in the production chain, so that legal trade in this Convention on International Trade in Endangered Species of Wild Fauna and Flora-protected timber species, derived from specifically described origins, can be distinguished from illegally logged timber.

Title	:	SNP-Based Method For The Genetic Identification of Ramin *Gonystylus spp.* Timber and Products: Applied Research Meeting CITES Enforcement Needs
Author	:	Rob Ogden, H. Noel McGough, Robyn S. Cowan, Lilian Chua, Madeleine Groves & Ross McEwing
Types	:	Journal **Year :** 2008
Publisher	:	Inter-Research Science Center
Source/ link	:	http://www.int-res.com/articles/esr2008/theme/Forensic/forensicpp4.pdf

Abstract:

We describe the development of a genetic assay for the identification of the tropical hardwood ramin *Gonystylus spp.*, a CITES-listed genus subject to illegal international trade. Samples representing different ramin species, confamilial genera and morphologically similar taxa were obtained. DNA extraction from leaf material and wood products was achieved using commercially available kits. Five chloroplast genes were examined for Single Nucleotide Polymorphism (SNP) loci capable of discriminating ramin. A locus within the matK gene was selected and a TaqMan® assay designed for sample genotyping. The assay was validated against different species to demonstrate its specificity and reproducibility. The final assay provides a robust, cost-effective, transferable method for identifying processed ramin. The research represents a feasibility study, addressing each of the steps required to develop a genetic identification assay for enforcement use; however, it should be noted that further work is required to produce a fully validated forensic identification tool.

Title	:	Design of an Intelligent Wood Species Recognition System		
Author	:	Marzuki Khalid, Eileen Lew Yi Lee, Rubiyah Yusof & Miniappan Nadaraj		
Types	:	Journal	**Year :**	2008
Publisher	:	IJSSST, Vol. 9, No. 3, September 2008		
Source/ link	:	http://www.researchgate.net/		

Abstract:

Tropical rainforest has more than 3,000 different types of timber species. According to the Forest Research Institute of Malaysia, out of these about 200 species are being used by the timber industry. Among the major timber consumers are housing developers, wood fabricators and furniture manufacturers where the need for recognition of wood species is necessary. Automatic wood recognition has not yet been well established mainly due to lack of research in this area and the difficulty in obtaining the wood database. In this paper, an automatic wood recognition system based on image processing, feature extraction and artificial neural networks was designed. The proto-type PC-based wood recognition system is capable of classifying 30 different tropical Malaysian woods according to their species based on the macroscopic wood anatomy. Image processing is carried out using our newly developed in-house image processing library referred to as "Visual System Development Platform". The textural wood features are extracted using a co-occurrence matrix approach, known as grey-level co-occurrence matrix. A multi-layered neural network based on the popular back-propagation algorithm is trained to learn the wood samples for the classification purposes. The system can provide wood identification within seconds, eliminating the need for laborious human recognition. The results obtained show a high rate of recognition accuracy proving that the techniques used is suitable to be implemented for commercial purposes.

Title	**:**	Development of Microsatellite Markers in *Gonystylus bancanus* (Ramin) Useful for Tracing and Tracking of Wood of This Protected Species		
Author	**:**	M. J. M. Smulders, W. P. C. Van 'T Westende, B. Diway, G. D. Esselink, P. J. Van Der Meer & W. J. M Koopman		
Types	**:**	Journal	**Year :**	2008
Publisher	**:**	Willey		
Source/ link	**:**	http://onlinelibrary.wiley.com/		

Abstract:

Ten polymorphic microsatellite markers have been developed for *Gonystylus bancanus* (Ramin), a protected tree species of peat swamp forests in Malaysia and Indonesia. Eight markers were also shown to be polymorphic in other *Gonystylus* species. The markers will enable assessing the amount of genetic variation within and among populations and the degree of population differentiation, such that donor populations can be selected for reforestation projects. They may be used for tracing and tracking of wood in the production chain, so that legal trade in this Convention on International Trade in Endangered Species of Wild Fauna and Flora-protected timber species, derived from specifically described origins, can be distinguished from illegally logged timber.

Title	**:**	Tropical Peat Swamp Forest Ecosystem and Floristic Diversity in Pahang, Malaysia		
Author	**:**	Kamaruzaman Jusoff, Che Hashim Hassan & Khali Aziz Hamzah		
Types	**:**	Journal	**Year :**	2007
Publisher	**:**	International Journal of Systems Applications, Engineering & Development		
Source/ link	**:**	http://www.universitypress.org.uk/journals/saed/saed-6.pdf		

Abstract:

Peat swamp forests are highly significant globally, both for their diverse and threatened species and as representative unique ecosystems. Apart from its critical role in providing habitat for wildlife, the tropical peat swamp forest also acts as a gene bank that harbours potentially useful varieties of plant species. Malaysia's peat swamp forests also provide crucial benefits and services for the sustainable development of human communities. The objective of the study is therefore to assess the status of the remaining peat swamp forest ecosystem and floristic biodiverstity in Pahang towards the efforts in establishing guidelines for its sustainable management and conservation. This collaborative study was undertaken by the Pahang Forestry Department, United Nation Development Programme/Global Environment Facility (UNDP/GEF)

Title	:	CITES as A Tool in Combating Illegal Logging		
Author	:	Chen Hin Keong		
Types	:	Journal	**Year :**	2007
Publisher	:	Commonwealth Forestry Association		
Source/ link	:	http://www.bioone.org/doi/abs/10.1505/ifor.9.3.805?journalCode=ifre		

Abstract:

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) controls international trade in species listed in its three Appendices. While timber species have been listed under its three appendices since its inception in 1975, CITES has not been considered as widely used for controlling timber species in trade as it has been for other wildlife species. Even so, there are a number of provisions within CITES that apply equally to timber species, in terms of management, and throughout its value chain up to the points of export, import and, uniquely to CITES, re-export. However, the capacity of CITES to combat illegal logging in particular, and to manage native timber species for conservation and economic benefit in general, is not used to its full potential. CITES can fulfill this role if all parties work together and do not perceive CITES as merely a trade ban, or a Convention only about restricting timber trade, but more as a useful tool to complement management of this important natural resource.

Title	:	Planting of *Gonystylus bancanus* in Non-Peat Swamp Area
Author	:	P. Ismail, I. Shamsudin, K. Abdul Rahman, W. S. Hashim & H. Ismail
Types	:	Journal **Year :** 2007
Publisher	:	Journal of Tropical Forest Science 19(1): 50–56 (2007)
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v19n1/50-56.pdf

Abstract:

Planting of *Gonystylus bancanus* in non-peat swamp area. *Gonystylus bancanus* is the most valuable timber species in peat swamp forests. It has high potential as plantation species since planting material can be raised easily either through seeds or vegetative propagation. However, establishment of forest plantations in peat swamp forest has many problems mainly due to poor accessibility and low soil productivity. Therefore, plantations may not be successful ventures without intensive management with high capital inputs. Establishment of *G. bancanus* plantations outside peat swamp areas would be a better solution. This study was conducted to investigate the potential of using *G. bancanus* as a plantation species in a non-peat swamp area. This paper reports on an 11-year planting trial conducted at the Forest Research Institute Malaysia whereby *G.bancanus* seedlings were planted in a non-peat swamp area. Survival was 52%, with an average of 816 cm total height and 9.1 cm diameter at breast height. Average yearly increments for total height and diameter at breast height were 69 and 0.95 cm year–1 respectively. In terms of wood strength, 11-year-old *G. bancanus* showed acceptable strength property and is useful for certain wood-based products. Based on physical and mechanical properties, this timber may be used for furniture manufacturing, internal joinery, holders and wooden toys. The limiting factors on utilization were the relatively small diameter and length of log.

Title	:	Light Intensity Preferences of Some Commercial Peat Swamp Forest Species		
Author	:	Ismail, P. & Abdul Razak, O.		
Types	:	Journal	**Year :**	2007
Publisher	:	Journal of Tropical Plant Physiology 2 (2007): 1-5		
Source/ link	:	http://mspp.org.my/files/JTPP_VolNo_02_2007.pdf		

Abstract:

P. rotundifolia is a medicinal plant that is used in Peninsular Malaysia. The leaves and roots are used to treat malaria, fever in children and after child-birth to give strength to mothers. This perennial herb is common in the lowland forest. A study was conducted to document the growth requirement of the plant. The physiological growth and leaf development in different light conditions was studied. It was noted that when grown under very low light intensities, the leaf size was larger. The leaf size reduced significantly when planted under partial shades. Besides, light, moist condition is preferred. This paper would prescribe the optimum growth conditions for large scale planting.

Title	:	Capturing Genomic Signatures of DNA Sequence Variation Using A Standard Anonymous Microarray Platform
Author	:	C. H. Cannon, C. S. Kua, E. K. Lobenhofer & P. Hurban
Types	:	Journal **Year :** 2006
Publisher	:	Nucleic Acids Research, 2006, Vol. 34, No. 18 e121
Source/ link	:	http://nar.oxfordjournals.org/content/34/18/e121.short

Abstract:

Comparative genomics, using the model organism approach, has provided powerful insights into the structure and evolution of whole genomes. Unfortunately, only a small fraction of Earth's biodiversity will have its genome sequenced in the foreseeable future. Most wild organisms have radically different life histories and evolutionary genomics than current model systems. A novel technique is needed to expand comparative genomics to a wider range of organisms. Here, we describe a novel approach using an anonymous DNA microarray platform that gathers genomic samples of sequence variation from any organism. Oligonucleotide probe sequences placed on a custom 44 K array were 25 bp long and designed using a simple set of criteria to maximize their complexity and dispersion in sequence probability space. Using whole genomic samples from three known genomes (mouse, rat and human) and one unknown (*Gonystylus bancanus*), we demonstrate and validate its power, reliability, transitivity and sensitivity. Using two separate statistical analyses, a large numbers of genomic 'indicator' probes were discovered. The construction of a genomic signature database based upon this technique would allow virtual comparisons and simple queries could generate optimal subsets of markers to be used in large-scale assays, using simple downstream techniques. Biologists from a wide range of fields, studying almost any organism, could efficiently perform genomic comparisons, at potentially any phylogenetic level after performing a small number of standardized DNA microarray hybridizations. Possibilities for refining and expanding the approach are discussed.

Title	:	Sensitivity To Ramin Wood		
Author	:	Derk P. Bruynzeel & Peter de Haan		
Types	:	Journal	**Year :**	2006
Publisher	:	Willey		
Source/ link	:	http://onlinelibrary.wiley.com/		

Abstract:

Contact dermatits from tropical woods is not uncommon Reviews on the subject by Woods & Calnan (1) and Hausen (2) indicate the importance of and interest in "wood-dermatitis". On some species, the reports are sparse und no more than case reports, as efforts to isolate and identify the allergen(s) were in vain. This applies to ramin wood; it was the cause of contact dermatitis in our patient

Title	:	Ekologi dan Potensi Ramin (*Gonystylus bancanus Kurz.*) di Kelompok Hutan Sungai Tuan-Sungai Suruk, Kalimantan Barat		
Author	:	N.M. Heriyanto & R. Garsetiasih		
Types	:	Journal	**Year :**	2006
Publisher	:	Buletin Plasma Nutfah Vol.12 No.1 Th.2006		
Source/ link	:	http://www.indoplasma.or.id/publikasi/buletin_pn/pdf/buletin_pn_12_1_2006_24-29_heriyanto.pdf		

Abstract:

Ecological and potential study of ramin was conducted in September 2002. Sampling plot of 20 meters x 1,000 meters with distance between plots was 1 km with total transect of three. Observation within the transect were on stage of tree, pole, sapling and seedling measured. Predominant species were *Gluta renghas*, *Kingiodendron sp.*, and *Shorea spp.* The tree stages of ramin was 1.48 tree/ha, poles stage 33.75 individual/ha, sapling stage 125 individual/ha, and seedling stage 468.75 individual/ha. Ramin was closely related to *Kingiodendron sp., G. renghas*, and *Mezzettia parviflora*. However, this species did not associate with *Litsea sp., Dryobalanops abnormis*, and *Canarium caudatum*. The habitat of ramin was peat swamp forest with the depth of more than 3 m and influenced by tide but the water remain unsalted.

Title	:	Occupational Asthma Caused By African Maple (Obeche) and Ramin: Evidence of Cross Reactivity Between These Two Woods		
Author	:	M. Hinojosa, E. Losada, I. Moneo, J. Dominguez, Teresa Carrillo & M. Sanchez-Cano		
Types	:	Journal	**Year :**	2006
Publisher	:	Willey		
Source/ link	:	http://onlinelibrary.wiley.com/		

Abstract:

Four patients with occupational asthma were studied. All patients were exposed to African maple dust and two of them were also exposed to Ramin dust. Skin tests and bronchial provocation tests with African maple extracts revealed an immediate response in all patients, and the same tests performed with Ramin extracts again revealed an immediate reaction in either exposed or non-exposed patients to Ramin wood dust. Specific IgE antibodies against African maple extracts were demonstrated in all patients as measured by a reverse enzyme immunoassay. Cross reactivity between both woods was demonstrated by a reverse enzyme immunoassay inhibition study. Unexposed persons and exposed asymptomatic workers did not exhibit reactivity to both woods in any of the tests listed above. To the best of our knowledge, this is the first article in which occupational asthma due to Ramin is defined, and cross sensitivity between two different woods is demonstrated.

Title	:	Seed Germination and Seedling Growth of Ramin (*Gonystylus bancanus Miq*.) onVarious Growing Media		
Author	:	Ning Wikan Utami, Witjaksono & Djadja Siti Hazar Hoesen		
Types	:	Journal	**Year :**	2006
Publisher	:	Jurusan Biologi FMIPA UNS Surakarta		
Source/ link	:	http://biodiversitas.mipa.uns.ac.id/D/D0703/D070300aaALL.pdf#page=66		

Abstract:

A study on seed germination and seedling growth of ramin (*Gonystylus bancanus Miq.*) was conducted at a green house, Treub Laboratory,Botany Department, Research Center for Biology- LIPI, Bogor. This study was to know the effect of growth media on the germination andgrowth of ramin. A Completely Randomized Designed with 13 treatments and 4 replications was used in this study. Thirteen compositionsof growth media used were soil, compost, cocopeat, mixture of soil and compost (1:1; 1:3), soil, compost and cocopeat (1:1:1); soil,compost, cocopeat and goat manure (1:1:1:1); soil and cocopeat (1:1; 1:2; 1:3); compost and cocopeat (1:1; 1:2; 1:3); compost and husk ofrice. The result showed that the highest germination percentage was 95% obtained on the cocopeat media, while on control (soil) was 55%.The highest germination value was 6.67 obtained from the mixture media of soil+compost = 1:3 and the lowest was 1.87 from the control.There was variation of leaf shape observed until 60 days after planting. Some compositions of suggested media for seed germination andseedling growth of ramin were cocopeat, mixture of compost+cocopeat (1:1; 1:2 and 1:3), compost and the mixture of soi+compost (1:2and 1:3) respectively. Generally, germination and growth of ramin seem not to be restricted on growth media with special pH.

Title	:	Study on Arbuscular Mycorrhizal Fungi and Light Intensity to The Natural Regeneration of Ramin (*Gonystylus bancanus (Miq.) Kurz*)		
Author	:	Abdurrani Muin, Yadi Setiadi, Sri Wilarso Budi, Irdika Mansur, Endang Suhendang & Supiandi Sabiham		
Types	:	Journal	**Year :**	2006
Publisher	:	No information		
Source/ link	:	http://202.124.205.111/index.php/jmht/article/viewArticle/2890		

Abstract:

The objective of this research is to find out the early information of optimum light intensity and highest mycorrhizal colonization on natural Ramin seedling which it includes in semitolerant plant. The research was conducted in Ramin Natural Forest of Sungai Pelunjung Labai, Sanggau District, West Kalimantan for a year. The results of the research show that there are correlations between light intensity with mycorrhizal colonization. Ramin seedling which grown under the light intensity 3190 – 9500 lux have high mycorrhizal colonization and their growth better than the other treatment. Meanwhile Ramin seedling which grown in closed area or in open area with light intensity less than 1670 lux and more than 10840 lux respectively have lower mycorrhizal colonization and their growth was lower.

Title	:	DNA Extraction From Processed Wood: A Case Study for The Identification of An Endangered Timber Species (*Gonystylus bancanus*)		
Author	:	M. J. Asif & Charles H. Cannon		
Types	:	Journal	**Year :**	2005
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1007/BF02772709		

Abstract:

We applied human forensic techniques to the extraction of whole genomic DNA from processed wood samples to explore the possibility of identifying an endangered tropical timber species by using DNA sequencing technology. High-yield and high-quality DNA samples were obtained from 2 commercial wood and 3 herbarium samples. Large PCR fragments ranging from 500–800 bp were successfully amplified from 2 chloroplast and 1 mitochondrial regions in all 5 samples, indicating limited degradation of the cytoplasmic genomes. DNA extraction from stem wood taken from herbarium specimens appeared superior to that from stem wood with bark intact or from leaf samples. DNA sequences from thetrn regions allowed for easy identification of the focal species based on GenBank Blast search. Little sequence variation was observed in the 3 regions, with the mitochondrialcox3 region completely conserved. Extraction of high-quality and large intact DNA fragments makes dry wood materials amenable to various DNA marker-based applications, including fingerprinting and historical approaches. By sampling stemwood, the wealth of historical information housed in international herbaria can be explored with minimal damage to taxonomically important features.

Title	:	Identification of An Obeche (*Triplochiton Scleroxylon*) Wood Allergen as A Class I Chitinase		
Author	:	S. Kespohl, I. Sander, R. Merget, A. Petersen, H. E. Meyer, A. Sickmann, T. Bruening & M. Raulf-Heimsoth		
Types	:	Journal	**Year :**	2005
Publisher	:	Willey		
Source/ link	:	http://onlinelibrary.wiley.com/doi/10.1111/j.1398-9995.2005.00794.x/pdf		

Abstract:

Wood dust is known to cause allergic occupational asthma and obeche (*Triplochiton scleroxylon*) is a prominent exponent in this field. However, the knowledge about wood allergens is still limited. The aim of this study was to identify and characterize obeche wood allergens.

Title	**:**	Bending Moment Capacity of Round Mortise and Tenon Furniture Joints		
Author	**:**	C. Eckelman, E. Haviarova, Y. Erdil, A. Tankut, H. Akcay & N. Denizli		
Types	**:**	Journal	**Year :**	2004
Publisher	**:**	Forest Products Journal Vol. 54, No. 12		
Source/ link	**:**	http://www.agriculture.purdue.edu/fnr/faculty/eckelman/pdf/fpj54%2812%29192-197.pdf		

Abstract:

Tests were conducted to determine the effect of cross pinning the tenons of roundmortise and tenon joints on the bending moment capacity of the joints. Tenon diametersranged from a nominal 0.6 to 1.0 inches. Cross-pins were about one-half the diameter ofthe tenons. Bothwood and steel cross-pins were included. Cross pinningwas found to reducethe bendingmomentcapacity of red oak joints by 33 percent and the capacity of yellow-poplar joints by 38 percent. Smaller cross-pins had less effect than larger cross-pins,and offsetting the pins toward the tip of the tenon also caused less reduction in bendingmoment capacity. Results also tend to indicate that the form factor for round beams, i.e.,1.18, should be incorporated into the flexure formula when estimating the bending momentcapacity of round tenons. Finally, the results indicate that the shoulders on tenonssignificantly increase the bending moment capacity of a joint when the shoulders of thetenon fit firmly against the side of the member in which the tenon is inserted.

Title	:	Measurement of Thermal Diffusivity of Malaysian Wood Using Photoflash and Photoacoustic Techniques
Author	:	Chia Pei Fung, W. Mahmood Mat Yunus, Zaidan Abdul Wahab & Paridah Mohd Tahir
Types	:	Journal **Year :** 2003
Publisher	:	Solid State Science and Technology, Vol. 11, No.1 (2003) 51-58
Source/ link	:	http://journal.masshp.net/wp-content/uploads/Journal/2003/Chia%20Pei%20Fung%2051-58.pdf

Abstract:

Two experimental arrangements have been used to measure the thermal diffusivity at room temperature for ten species of Malaysian wood using photoflash and photoacoustic (PA) techniques. Both use circular disc samples with thickness 1 to 2 mm and 100 to 200 μm respectively. In the photoflash experiment, a flash pulse is irradiated onto the front surface of the sample. The time dependence of the temperature response at the back surface of the sample is measured using a K-type thermocouple. On the other hand, the PA experimental configuration uses a closed photoacoustic (PA) cell that serves as a pressure sensor as well as an acoustic chamber. It is based upon the measurement of the acoustic signal as a function of the modulation frequency in the region where the sample is thermally thick. Both experimental data are then used to calculate thermal diffusivity using appropriate analytical expressions. Scanning electron microscopy (SEM) observation has also been done on both radial and tangential surface of the samples. The results are in good agreement within experimental error, hence validating the experimental measurements.

Title	:	Raising Planting Materials of Peat Swamp Forest Species		
Author	:	Ismail, P. & Shamsudin, I.		
Types	:	Journal	**Year :**	2003
Publisher :		Journal of Tropical Forest Science 15 (1): 237-240 (2003)		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The availability of adequate high quality planting material of peat swamp forest (PSF) species is one of the main constraints in rehabilitating degraded PSF. Planting materials of PSF species are currently difficult to get because planting in PSF has never been included in rehabilitation programmes in the past (Shamsudin & Aziah 1992). Therefore, due to the low priority given to PSF, there had been no attempt made to raise planting materials of PSF species. In addition, there is not much information on how to raise the planting materials. As the physical and chemical properties of peat soil are different from other forest types, it is not certain if normal techniques of raising planting materials and nursery management practices applied to inland forest species will be suitable for the PSF species. The aim of this study was to investigate suitable techniques of raising planting materials of some PSF species. Three techniques were tried out, namely, seeds, wildings and vegetative propagation by stem cutting.

Anisoptera marginata and *Gonystylus bancanus* were used for the germination test because their seeds were available during the study period. The test was based on procedure established by Aminah *et al.* (1997). Pure river sand with a proportion of approximately 60 and 40% particles < 2 mm and > 2 mm diameter respectively were mixed and put in germination trays (60 X 35 cm). The trays were placed in a germination house with light intensity ranging between 30 and 40%. Seeds selected for the germination test were in good condition and mature. The seeds were sown at an interval of 2 cm along the row and 4 cm between rows. The narrow or pointed end of the seed was pushed into the sowing media,

leaving the blunt end of the seed exposed. After sowing, the seeds were covered with a thin layer of paddy husk for moisture retention.

Watering was done twice a day, in the morning and afternoon, until the seeds germinated. Percentages of germination obtained were 90 and 95% for *A. marginata* and *G. bancanus* respectively. After about three weeks in the seedbeds the seedlings (about 5 cm height) were transferred into polybags (flat size 24 X 16 cm) that contained a mixture of 3:1 top soil and river sand. The seedlings were then placed under shade with 50% light intensity for a period of six to nine months. Both species had more than 90% survival.

In the experiment using wildings, water gel was used to collect the PSF wildings (Ismail & Shamsudin 1999). The PSF species collected were *G. bancanus, Madhuca motleyana, A.marginata, Stemonurus secundiflorus, Calophyllum* spp., *Durio carinatus, Santiria* spp. and *Pometia pinnata.* Collection was conducted in the morning (about 7.00 a.m.) to minimize water loss from seedlings through transpiration. The area was surveyed one day before collection to locate and assess the amount of wildings present. Small-sized wildings, approximately 4 to 12 cm high, and preferably at two-leaf stage, were collected by pulling the wildings out carefully from the ground. The wildings were then placed in plastic bags containing gel and water at a ratio of 1:150.

From experience, the wildings can be stored in this condition for more than a week. However, it is better that wildings be transplanted immediately into polybags at the nursery to ensure better growth conditions. Therefore, before collecting the wildings, polybags filled with planting media must be ready in the nursery. The planting media used was a combination of top soil and river sand at a ratio of 3:1. After being transplanted at the nursery, the wildings were then watered. In cases where the collection of wildings was done far from the permanent nursery, a temporary nursery was established. In this study, a mean of 60% survival was recorded for all species that were collected using water gel.

Method of raising planting materials by stem cutting in this experiment was based on the technique used by Aminah (1991) and Mohamad Lokmal *et al.* (1992). The species used for this technique were G. *bancanus, A. marginata, D. carinatus* and *Shorea platycarpa.* Stem cuttings of these species were obtained from stock plants which were raised in the nursery.

The preparation of cutting materials was done in the morning between 8.00 and 11.00 a.m. A commercial rooting hormone, Seradix-3, was applied to improve rooting percentage of the stem cuttings. Each cutting, with at least one node and one leaf, had a length of 2 to 3 cm.

The cutting bed was prepared in a greenhouse with 30% light intensity and humidity ranging between 85 and 95%. The rooting medium was made up of pure river sand. The stem cuttings and rooting medium were kept moist by an automatic mist sprinkler system operated at hourly interval; the duration of each spray was one minute. In addition, the cutting bed was covered with clear plastic sheet supported by wooden frame to maintain high humidity around the cuttings. Rooting percentage after six weeks were 51, 41, 20 and 32% for G. *bancanus, A. marginata, D. carinatus* and S. *platycarpa* respectively. Even though the root percentages were low, this study showed that vegetative propagation by stem cuttings can be an alternative technique to raise PSF species. More comprehensive study is needed in order to obtain good rooting percentage in this regard.

The rooted stem cuttings were transferred into polybags (flat size 24 X 16 cm) containing potting media of 3:1 top soil and river sand. The polybags were then placed under shade with 50% light intensity and watered regularly. One gram of commercial fertiliser nitrophoska blue (12N:12P:17K) was applied to each plant at the ages of two and five months to boost the development of roots and leaves. It was observed that the potted rooted cuttings grew well and can then be treated like other planting stocks in the nursery.

From this study, we conclude that PSF species can be raised using normal procedures applied to other inland forest species. Even the collection and vegetative propagation by stem cutting, both of which are considered less common techniques compared with technique using seeds, were also found feasible for plant production. Furthermore, it was also observed that management aspects of the PSF species in the nursery were also similar to other inland forest species. These findings suggest that adequate supply of planting materials to rehabilitate degraded PSF can be produced without much constraint.

Title	:	*Arbuscular Mycorrhizal* Colonization of Tree Species Grown in Peat Swamp Forests of Central Kalimantan, Indonesia
Author	:	K. Tawaraya, Y. Takaya, M. Turjaman, S.J. Tuah, S.H. Limin, Y. Tamai, J.Y. Cha, T. Wagatsuma & M. Osaki
Types	:	Journal **Year :** 2003
Publisher	:	Forest Ecology and Management (Volume 182, Issues 1–3, 3 September 2003, Pages 381–386)
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0378112703000860

Abstract:

Arbuscular mycorrhizas improve the growth and nutrient uptake of plants and are formed in 80% of all land plants. Little information is available on the status of *arbuscular mycorrhizas* in tropical soils. The objective of this study was to clarify mycorrhizal colonization of tree species grown in tropical peat soils. Seedlings of 22 tree species in 14 families grown in a peat swamp forest of Central Kalimantan, Indonesia were collected in 2000 and 2001. Roots were stained with 0.05% aniline blue and arbuscules, vesicles and internal hyphae were observed under a compound microscope. Seventeen of 22 species showed *arbuscular mycorrhizal* colonization. *Arbuscular mycorrhizal* colonization was observed for the first time in roots of *Shorea teysmanniana, Shorea balangeran, Shorea uliginosa (Dipterocarpaceae), Calophyllum sclerophyllum, Calophyllum soulattri (Guttiferae), Cratoxylum arborescens (Guttiferae), Tetramerista glabra (Tetrameristaceae), Palaquium gutta (Sapotaceae), Melastoma melabathricum (Melastomataceae), Gonystylus bancanus (Thymelaeaceae), Hevea brasiliensis (Euphorbiaceae)* and *Campnosperma auriculatum (Anacardiaceae). C. soulattri, C. arborescens, G. bancanus, Acacia mangium, M. melabathricum* and *H. brasiliensis* showed a percentage *mycorrhiza*l colonization of 50% or higher. No *arbuscular mycorrhizal* colonization was found in *Hopea mengarawan* (*Dipterocarpaceae*), *Koompassia malacensis (Caesalpiniaceae), Tristaniopsis whiteana (Myrtaceae), Combretocapus rotundatus (Rhizophoraceae)* and *Dyera costulata (Apocynaceae).* It is suggested that inoculation of arbuscular mycorrhizal fungi can improve the early growth of some tree species grown in peat swamp forests and this will be expected as a key technology to rehabilitate disturbed peatlands.

Title	**:**	The Role of Selected Animals in Pollination and Dispersal of Trees in The Forest: Implications for Conservation and Management		
Author	**:**	S. S. Lee, Norsham Suhaina Yaakob, K. S. Boon & L. S. L. Chua		
Types	**:**	Journal	**Year :**	2002
Publisher	**:**	Journal of Tropical Forest Science 14(2): 234-263 (2002)		
Source/ link	**:**	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v14n2/234-263.pdf		

Abstract:

The current state of knowledge of the role of some plant-animal interactions in forest regeneration and conservation in PeninsularMalaysia is discussed. In particular, we focused on selected insect pollinators and animals which act as seed dispersers, for example, bats, primates, squirrels and birds. Tree species, including timber trees and endemic tree species utilised by bats, primates, squirrels, birds and selected insect pollinators are listed by their scientific as well as local names. The forest types where such species can be found are also identified. Some of the shortcomings of the currently available data are highlightedand means to overcome the situation are suggested.

Title	:	Peat swamp Ecology and Sustainable Development in Borneo		
Author	:	Victor D. Phillips		
Types	:	Journal	**Year :**	1998
Publisher	:	Kluwer Academic Publishers		
Source/ link	:	http://link.springer.com/article/10.1023/A%3A1008808519096		

Abstract:

While tropical lowland peatswamp ecosystems are well-represented among the major forest formations of Borneo, they are rare outside South-East Asia. They are richly endowed with biological diversity, including the crocodile (*Crocodylus porosus*), which is a threatened species, and are characterized by their organic (histosol) soils that have developed recently, approximately within the past 5000 years. Their unique ecological features, as well as logistical difficulties in accessing and utilizing peatswamps, have not, however, deterred exploitation. Some of the tallest, most commercially desirable timber species, such as ramin (*Gonystylus bancanus*) have been harvested routinely in the peatswamp forests of Sarawak. Also, due to its primary location in coastal lowlands in close proximity to human activity, drained and reclaimed peatswamp land is desirable for development of highways, housing, and industrial and plantation estates. Ecological information is needed urgently by decision-makers and land-owners, who may be contemplating conversion of natural peatswamp ecosystems to other land uses, to undergird conservation policy and best management practices for the wise stewardship and sustainable development of this ecosystem. The paper provides an overview of peatswamp ecology with recommendations for avoiding or reducing potential ecological impacts associated with peatswamp development in Borneo, which include a moratorium on further development until a Borneo peatswamp survey and inventory as well as a holistic, multi-sectoral, integrated environmental assessment and planning procedure are completed; gazetting of pristine peatswamp forest parcels as totally protected areas; implementing highly restricted multiple-use policy that allows development only in degraded areas, and insuring protection of the critical hydrological role of peatswamps in providing fresh water supply for human use as an overriding criterion in assessing any development scheme.

Title	:	Seedling Development of *Gonostylus bancanus* (Ramin Melawis) in Response To Light Intensity and Spectral Quality		
Author	:	David W. Lee, B. Krishnapillay, M. Haris, M. Marzalina & S. K. Yap		
Types	:	Journal	**Year :**	1996
Publisher	:	Journal of Tropical Forest Science 8(4): 520 - 531 (1996)		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v8n4/520-531.pdf		

Abstract:

We studied seedling development of *Gonostylus bancanus* (ramin melawis, *Thymeliaceae*) in response to shade conditions, to learn about the tree's functional ecology. Shadelight comprises reductions in solar irradiance (photosynthetic photon flux density, 400-700 nm, or PFD) and changes in spectral quality, as reductions in the red: far-red ratio (or R:FR). We studied the separate and interactive effects of PFD and R: FR on seedling development by growing them under six different replicated shadehouse treatment conditions. Seedlings grew least at low light levels and full sunlight. Seedling branching was not strongly affected by the light treatments, but stem robustness was promoted by PFD, and leaf area/stem length was decreased by low R:FR. Photosynthate allocation to leaves was low, and was primarily reduced by increasing PFD. Most of the effects on development were influenced by PFD; only internode length and leaf area/stem length were more influenced by R:FR. Seedlings of ramin malawis are intolerant of extreme shade and direct sunlight, growing most rapidly in partial shade, with daily percentages of 40 % and more of full sunlight. Such seedlings are probably only at a competitive advantage in the inundatedsoils of their natural distribution.

Title	:	*Gonystylus bancanus*: Some Observations on Its Flowering, Fruiting, Seed Predation and Germination
Author	:	Shamsudin Ibrahim
Types	:	Journal **Year :** 1996
Publisher	:	Journal of Tropical Forest Science 2011 Vol. 23 No. 2 pp. 143-152
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v8n3/424-426.pdf

Abstract:

Gonystylus bancanus, commonly known as ramin, belongs to the family *Thymelaeaceae* (Whitmore 1972). It is one of seven species of this genus recorded in Peninsular Malaysia and is the only one found in peat swamp forests. A commercially important timber species, it can attain a height and diameter at breast height exceeding 30 m and 70 cm respectively. A detailed description of its anatomy and wood properties is given by Whitmore (1972) while Sim (1983) describes the different uses of the wood which include cabinets and interior paneling. Peat swamp forests are the major sources of ramin timber. This is in comparison to ramin obtained from the other *Gonystylus spp.* which are from dryland forests. Wyatt-Smith (1959) reports that it was abundant in the peat swamps of Perak, Selangor, Johore and Pahang. Most of these areas have now been converted to agriculture with significant areas remaining only in Selangor and Pahang. In peat swamps in Pahang, *G. bancanus* accounted for 10.6 m3 ha-1 and this represented 17% of the total timber produced from those sites. A 4-ha study plot was established in the primary peat swamp forest at Pekan Pahang. A total of 48 individuals of *G. bancanus* of 25 cm dbh were enumerated of which more than half were less than 10 cm dbh. It was noted that individuals in this size class (between 5 cm and 10 cm dbh) tended to be grouped near mother trees. Seedling regeneration on the forest floor was poor. This was attributed to high predation on immature fruits on the trees by bats and squirrels. In addition seeds on the forest floor are highly susceptible to insect and fungal attack. Flowering and fruiting also appear to be infrequent.

Title	**:**	Enrichment Plantings in The Tropical Rainforest of Sumatra - A Silvicultural Challenge		
Author	**:**	Muuss, U.		
Types	**:**	Journal	**Year :**	1996
Publisher	**:**	Forstarchiv 1996 Vol. 67 No. 2 pp. 65-70		
Source/ link	**:**	http://www.cabdirect.org/abstracts/19960605601.html		

Abstract:

In coastal peat swamp forests of eastern Sumatra, Indonesia, selective logging has removed commercially valuable timber species, and the area is under threat of transformation into non-forest land uses including cultivation. Enrichment planting is seen as one possibility to increase the commercial potential of these forests. Research was conducted in order to demonstrate the need for enrichment planting (a stand structural analysis), and some techniques for line planting were developed, based on measurements of light and growth rates of seedlings of jelutong (*Dyera lowii*), ramin (*Gonystylus bancanus*), labu (*Endospermum diadenum*) and pulai (*Alstonia scholaris*) over a 10-month period.

Title	**:**	Wood Energy Efficiency in Timber Drying		
Author	**:**	Nurhayati, T.		
Types	**:**	Journal	**Year :**	1993
Publisher	**:**	Jurnal Penelitian Hasil Hutan 1993 Vol. 11 No. 6 pp. 228-231		
Source/ link	**:**	http://www.cabdirect.org/abstracts/19950619596.html		

Abstract:

The efficiency of wood waste utilization as an energy source was investigated at big and medium scale mills processing sengon (*Paraserianthes falcataria*) and a small scale mill processing ramin (*Gonystylus bancanus*) in Indonesia.

Title	:	Withdrawal and Bending Strengths of Dowels From Three Malaysian Timbers		
Author	:	Said Ahmad, Ashaari Haji Amin, Roslan Ali & Hilmi Md. Tahir		
Types	:	Journal	**Year :**	1992
Publisher	:	Journal of Tropical Forest Science 6(1): 74-80		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v6n1/74-80.pdf		

Abstract:

The factors influencing the performance of dowel joints using three Malaysian timbers, nyatoh (species of *Sapotaceae*), ramin (*Gonystylus sp.*) and rubberwood (*Hevea brasiliensis*) were assessed. The effects on withdrawal and bending strengths on dowel species, dowel patterns and depths of dowel insertion were determined on testing blocks made from nyatoh. Species differences were not detected. Spiral-grooved dowels provided higher withdrawal strength while straight-grooved dowels performed better in bending. Both withdrawal and bending strengths increased with an increase in depth of insertion. In terms of application, dowels made from rubberwood are recommended.

Title	:	Rubberwood as A Substitute 'Tropical Whitewood' for Ramin in Asia
Author	:	Smith, P. M., Eastin, I. L. & Jen, I. A.
Types	:	Journal **Year :** 1990
Publisher	:	Forest Products Industries 1990 Vol. 9 No. 2 pp. 71-85
Source/ link	:	http://www.cabdirect.org/abstracts/19930672382.html#

Abstract:

A comparison of the resources, uses, treatment and properties of rubberwood (*Hevea brasiliensis*) from Malaysia, Indonesia and Thailand, and ramin (*Gonystylus bancanus*)from Indonesia, Sarawak and Malaysia, with a view to substituting rubberwood for ramin, especially in the Asian furniture industry.

Title	:	Moulding Properties of Some Malaysian Timbers		
Author	:	K.S. Ho & Said Ahmad		
Types	:	Journal	**Year :**	1990
Publisher	:	Journal of Tropical Forest Science3(4): 361 - 366		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v3n4/361-366.pdf		

Abstract:

Moulding properties of rubberwood,light red meranti, ramin and nyatoh were investigated with seven cutting angles starting from 150 to 45°. The surface quality and the occurrences of machining defects for each cutting angle are presented. The best cutting angle for each species is also determined.

Title	:	Location of Extractives and Decay Resistance in Some Malaysian Hardwood Species		
Author	:	K. Yamamoto & L.T. Hong		
Types	:	Journal	**Year :**	1990
Publisher	:	Journal of Tropical Forest Science 2(1): 61 - 70		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v2n1/61-70.pdf		

Abstract:

The durability' of 24 Malaysian hardwoods has been assessed by a modified ASTM D2017 soil-block method using the white rot fungus, Coriolus versicolor. Using cluster analysis, the 24 timbers have been classified into four groups, viz durable, durable but not after extraction, moderately durable, and non-durable. In general, timbers of the durable group (e.g. chengal, giam, rengas) contain more extractives than the non-durable group (perupok, jelutong, ramin, rubberwood). The extractives are predominantly present in the parenchyma cells with some in the adjacent fibre cells. A higher proportion of extractives exist in parenchyma cells in the durable group. The extractives located in the cell lumina are easier to extract from the durable group than the moderately durable group.

Title	**:**	The Application of Spent Liquor in Wood Colouring		
Author	**:**	Wang, H. & Perng, H. Y.		
Types	**:**	Journal	**Year :**	1990
Publisher	**:**	Forest Products Industries 1990 Vol. 9 No. 3 pp. 38-47		
Source/ link	**:**	http://www.cabdirect.org/abstracts/19930672530.html		

Abstract:

Colouring effect, depth of penetration, water resistance and static bending were determined after using spent liquor to treat ramin [*Gonystylus bancanus*], Taiwan acacia (*Acacia confusa*), red and white lauan [*Shorea spp.*], and rubberwood [*Hevea brasiliensis*]. The light coloured woods such as ramin and rubberwood became a black or brown walnut-like colour.

Title	:	Contribution of Extractives to Wood Characteristics		
Author	:	H. Imamura		
Types	:	Journal	**Year :**	1989
Publisher	:	Springer Berlin Heidelberg		
Source/ link	:	http://link.springer.com/chapter/10.1007/978-3-642-74075-6_21		

Abstract:

The major components of wood are cellulose, hemicelluloses, and lignin, and many of the properties of wood are a function of this lignocellulosic network. Although extractives are a minor component, often constituting less than 10% of the wood, they contribute disproportionately to the characteristics of wood. It is extractives that give wood its color, its odor, and, to some extent, its physical properties. Extractives can have a significant influence on how wood is used.

Title	:	Possibility of Predicting Mechanical Strength Properties of Malaysian Timbers
Author	:	S. H. Ong
Types	:	Journal **Year :** 1988
Publisher	:	Journal of Tropical Forest Science1(4): 318-326
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v1n4/318-326.pdf

Abstract:

Regression equations for predicting the mechanical strength properties from wood density and moisture content of Malaysian timbers are given in this paper. The high R^2 values show that regression equations are reliable for small clear samples.

Title	:	Malaysian Timbers for Wooden Tool Handles		
Author	:	S.C. Lim		
Types	:	Journal	**Year :**	1988
Publisher	:	Journal of Tropical Forest Science 1(1) : 16 - 25		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v1n1/16-25.pdf		

Abstract:

Current trends and usage of wooden tool handles in Malaysia are discussed here. The performance and property requirements of various tool handles, whether for heavy impact, low impact or nonimpact purposes are indicated. Criteria for the selection of timbers for the three classes of tool handles based on the factors that are found to influence the properties are formulated. Malaysian timbers suitable for the three classes of tool handles are indicated.

Title	:	A Preliminary Study on The Thermal Conductivity and Flammability of WPC Based on Some Tropical Woods		
Author	:	L.H.L. Chia, P.H. Chua & E.E.N. Lee		
Types	:	Journal	**Year :**	1985
Publisher	:	Elsevier		
Source/ link	:	http://www.sciencedirect.com/science/article/pii/0146572485902304		

Abstract:

Selected local woods and their wood-polymer combinations or composites (WPC) were tested for their thermal conductivity and their fire resistance. WPC were prepared by polymerizing monomers "in situ" in oven dried woods by gamma radiation. The monomers included acrylonitrile (AN), 60% styrene-40% acrylonitrile (STAN), methyl methacrylate (MMA), 95% methyl methacrylate —5% dioxane (MD), and vinylidene chloride (VDC). A reduction in thermal conductivity was exhibited by all the composites prepared. W-PAN showed the greatest reduction in thermal conductivity and W-PSTAN in general showed the least. An explanation is suggested for this behaviour. The polymers PMMA and PMD were found to enhance flammability of the woods while PVDC, PAN, and PSTAN imparted fire resistance to the woods. Of the six local woods studied, Ramin-and-Keruing-polymer composites showed the highest flammable tendencies obtained. The correlation of thermal conductivity to flammability is discussed.

Title	:	World Forestry: Forestry in Malaysia		
Author	:	Nor, Salleh Mohd		
Types	:	Journal	**Year :**	1983
Publisher	:	Journal of Forestry, Volume 81, Number 3, 1 March 1983 , pp. 164-187(24)		
Source/ link	:	http://www.ingentaconnect.com/content/saf/jof/1983/00000081/00000003/art00015		

Abstract:

Tropical forests of great botanical complexity occupy two-thirds of Malaysia's total land area of 33.2 million hectares. Dipterocarp species are the most numerous. Logs of high quality have been abundant and have supported a sizable export trade. Now the supply of such timber is dwindling, and planting has been started to avoid a shortfall. The 14 Malaysian states own and administer nearly all of the forest, but a national policy for Peninsular Malaysia calling for a system of permanent forests is nearing acceptance. While the lowland dipterocarp stands have long been managed with considerable success, many are being cleared for agriculture and the silviculture developed for them requires adjustment to the hill forests. On the whole, forest management and silviculture are in a state of flux. A Forest Research Institute has been active at Kepong since 1929, and two states have smaller research units. The Faculty of Forestry, at the Agricultural University, Serdang, offers four-year and three-year courses of instruction.

Title	:	Malaysian Timbers - Ramin		
Author	:	Sim, H. C.		
Types	:	Journal	**Year :**	1983
Publisher	:	Trade Leaflet, Malaysian Forest Service 1983 No. 74 pp. 8 pp.		
Source/ link	:	http://www.cabdirect.org/abstracts/19860607611.html		

Abstract:

Ramin (*Gonystylus*) is a very white, medium-wt. timber popular for furniture, easily worked and treated. *G. bancanus* is the common species of Sarawak and Peninsular Malaysia; 6 other species found in Peninsular Malaysia are listed, and more occur in Sarawak.

Title	:	Ramin - Some Possible Alternatives		
Author	:	Gower, A.		
Types	:	Journal	**Year :**	1980
Publisher :		No information		
Source/ link	:	http://www.cabdirect.org/abstracts/19800663451.html;jsessionid=EFECB1DDE1D40C914DA7F85ED2D57926		

Abstract:

A note on timbers which in terms of strength and colour are very similar to ramin (*Gonystylus bancanus*). Strength properties, density, colour, grain, texture, movement, seasoning, working properties and availability of 7 substitute timbers are briefly indicated.

Title	:	Intensity and Rate of Ambrosia Beetle Infestation on Ramin (*Gonystylus bancanus Kurz*)		
Author	:	Supriana, N., Tarumingkeng, R., Wardojo, S. & Turngadi, A.		
Types	:	Journal	**Year :**	1978
Publisher	:	No information		
Source/ link	:	http://www.cabdirect.org/abstracts/19800570359.html;jsessionid=34AD307B6FDA2DDB2D54260C26796CF2		

Abstract:

A study was carried out in West Kalimantan, Indonesia, on the intensity and rate of infestation of ramin wood (*Gonystylus bancanus*) by *Treptoplatypus trepanatus* (Chap.), *Crossotarsus wallacei* (Thoms.), *Platypus insularis Strohm., P. cupulatus Chap., P. cavus Strohm., P. pseudocupulatus Schedl* and *Xyleborus perforans* (Woll.). Results showed that logs without bark were more susceptible to ambrosia beetle infestation than those with bark. No correlation was found between the intensity and rate of infestation and the basal, middle and apical log sections or the location of logging. However, a significant correlation was found between the size of logs and the intensity and rate of infestation.

Title	**:**	Pulmonary Hypersensitivity to Ramin (*Gonystylus bancanus*)		
Author	**:**	A D Howie, G Boyd & F Moran		
Types	**:**	Journal	**Year :**	1976
Publisher	**:**	BMJ Open Respiratory Research		
Source/ link	**:**	http://thorax.bmj.com/content/31/5/585.abstract		

Abstract:

Transient airways obstruction associated with reduction in the transfer factor (diffusing capacity) of the lungs is reported in a patient with a clinical syndrome in keeping with extrinsic allergic alveolitis after exposure to Ramin dust (*Gonystylas bancanus*). The alterations in pulmonary function were consistently demonstrated on testing the patient in his working environment and were reproduced in the laboratory after inhalational challenge. The importance of the temporal relationship of changes in pulmonary function to contact with suspected allergenic material is emphasized.

Title	:	New or Noteworthy Species of *Gonystylus* (*Thymelaeaceae*), Principally from Borneo		
Author	:	H. K. Airy Shaw		
Types	:	Journal	**Year :**	1964
Publisher	:	Royal Botanic Gardens, Kews : Vol. 17, No. 3 (1964), pp. 447-458		
Source/ link	:	http://www.jstor.org/		

Abstract:

During the ten years that have elapsed since the publication of my revision of the genus *Gonystylus* in the Flora Malesiana, ser. 1, 4(4): 350-361 (1953), additional material has steadily accumulated, chiefly through the activity of Drs. J.A.R. Anderson (Sarawak), P.S. Ashton (Brunei), A.J.G.H. Kostermans (E. Indonesian Borneo) and W. Meijer (North Borneo)). Dr Anderson, especially, and his staff at Kuching have taken much interest in the genus and have given some attention to the ecology of the different species in their area. The more interesting results of this activity are detailed below, including descriptions of six new species. Descriptions of two further pobably new species, represented by incomplete material, are held over pending the receipt of supplementary collections. It is evident that the genus *Gonystylus* contains a considerable number of species, which, though often finely drawn, nevertheless exhibit remarkable constancy of characters and, it seems, distintness in ecological preferences. Certain groups are still 'difficult', and certain areas, such as the Philipines and Eastern Malaysia (from Celebes eastward), are only known in the most sketchy manner as regards this genus. I now think it probable that the concept of *G. macrophyllus (Miq.) Air Shaw* adopted in the "Flora Malesiana' was too wide, and that much of the material from the arcas just mentioned should be excluded, but without a greater range of good material fom these regions it is scarcely yet possible to present a more satisfactory treatment. It is a please to express to Messrs. Anderson, Ashton and Meijer my appreciation of their interest and co-operation in this work.

Title	:	Density Variation in The Timber of Ramin, *Gonystylus bancanus (Miq.) Baill*.		
Author	:	Murthy, L. S. V.		
Types	:	Journal	**Year :**	1960
Publisher :		Empire Forestry Review 1960 Vol. 39 No. 3 pp. 324-9		
Source/ link	:	http://cabdirect.org/abstracts/19600602370.html;jsessionid=8071ACC5CAA8C07018D4746676AA57B3		

Abstract:

Material was drawn from three sites, the padang forest, the deltaic swamp, and the coastal swamp. Tables illustrate variations outwards, and at various distances, from the pith. Graphs are then drawn to illustrate variations in basic density, and a diagram, followed by a table, deals with %s of different tissues at different distances from the pith. The most striking difference observed was, unexpectedly, the higher proportion of fibres in the wood of the coastal swamp.

Title	:	Effects of Wood Species and Thermal Modification on The Sorption Isotherm Properties
Author	:	J Zaihan, WS Hashim, R Rafeadah, J Khairul Azmi & T Siti Nor Ain
Types	:	Proceeding **Year :** 2013
Publisher	:	No information
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

The physical and mechanical behaviour of wood as a hygroscopic material needs to be fully understood in order to improve its utilisation. Wood adsorbs moisture in high humidity environments and desorb moisture in low humidity environments. The adsorption/desorption properties of cellulosic and lignocellulosic materials are characterised by the sigmoidal (IUPAC type II) shape of the isotherm and hysteresis developed between the sorption and desorption loops. The sorption value extrapolated at 100% RH is often interpreted as the projection fibre saturation point (p-FSP) of the material. The Hailwood-Horrobin (HH) model has been regularly used to explain the sigmoid sorption isotherm observed with the sorption of water vapour on polymers, specifically for wood (Hailwood & Horrobin 1946). It has proven to be useful although it has been criticised for some of the assumptions used in its derivation. This study was undertaken in order to determine the sorption properties of six tropical hardwoods and two thermally modified woods (*Acacia mangium* and *Endospermum malaccense*). The EMC was determined over a range of RH values in order to produce sorption isotherms. The H-H model was used as an analysis tool for sorption behaviour. The effect of cell-wall stiffness upon the sorption hysteresis behaviour was examined.

Title	:	Induksi Pembungaan Pohon Ramin (*Gonystylus bancanus* (*Miq.*) *Kurz*) Menggunakan Paclobutrazol Sebagai Upaya Konservasi
Author	:	Eny Dwi Pujawati & Hj. Normela Rahmawati
Types	:	Proceeding **Year :** 2013
Publisher	:	Prosiding Seminar Nasional 2013
Source/ link	:	http://eprintpasca.unlam.ac.id/996/

Abstract:

Ramin (*Gonystylus bancanus (Miq.) Kurz.*) adalah salah satu jenis pohon yang tumbuh di hutan alam rawa. Sejak tahun 1998 aktivitas Illegal logging telah teridentifikasi menjadi semakin marak dan kayu ramin menjadi salah satu kayu terpopuler yang menjadi incaran para penebang di Sumatera dan Kalimantan. Karena semakin langka keberadaannya di hutan, sejak tahun 2004 berdasarkan konferensi CITES di Bangkok Thailand, kayu ramin sudah dimasukkan ke dalam appendix II. Penelitian ini bertujuan untuk memacu pembungaan pada pohon ramin menggunakan senyawa Paclobutrazol. Hasil penelitian ini diharapkan dapat memberikan informasi ilmiah tentang teknik mempercepat pembungaan guna menunjang konservasi ramin. Sampai penelitian pemberian Paclobutrazol belum berhasil memacu pembungaan pada pohon ramin, namun ada 1 pohon yang memunculkan tunas-tunas baru yang kemungkinan dapat menjadi kuncup reproduktif. Belum berhasilnya pemacuan pembungaan pada pohon ramin mungkin terjadi karena pemberian Paclobutrazol yang masih kurang, waktu pengamatan yang kurang lama dan perlu dikombinasi dengan pemupukan.

Title	:	Species Selection Trial in Burnt Peat Swamp Vegetation in Southwest Coast of Sabah, Malaysia
Author	:	Reuben Nilus, Lee Ying Fah & Alexander Hastie
Types	:	Proceeding **Year :** 2011
Publisher	:	No information
Source/ link	:	www.academia.edu/download/30924448/abstract54.pdf

Abstract:

Peat swamp forests in Sabah, Malaysia, are an endangeredecosystem. Forest fires, log extraction activities, urban and agricultural activitieshave reduced the area of natural peat swamp vegetation of Sabah. In the KliasPeninsula, Malaysia forest fires in 1997–98 have destroyed about 100 ha of peatswamp vegetation. In March 2005, Sabah Forestry Department established ademonstration plot for the rehabilitation of burnt peat swamp vegetation. Eight (8) tree species, namely *Nauclea subdita, Dyera polyphylla, Dryobalanops beccarrii, Lophopetalum multinervium, Alstonia spatulata, Gonystylus bancanus, Hopea pentanervia*, and *Mitragyna speciosa* were selected based on the availability ofplanting materials. High density planting of seedlings was practised, with a totalof 4,469 seedlings planted on a 4 ha plot of burnt area in March 2005. During theassessment in July 2010, about 48% of the total seedlings planted survived. Thisis equivalent to 538 seedlings that had survived per hectare. Thus far, based onthe growth and survivorship, *Alstonia spatulata, Dryobalanops beccarii, Hopea pentanervia* and *Lophopetalum multinervium* demonstrated encouragingperformance. The availability of sufficient light is still the most important factorthat influences the growth and mortality of seedlings. Several issues related tothe rehabilitation activities carried out are discussed.

Title	:	Operational Peat Swamp Spatial Sensitivity Model Development
Author	:	Hasham, M.N.A, Asmat, A. & Mansor, S.B
Types	:	Proceeding **Year :** 2010
Publisher	:	Science and Social Research (CSSR), 2010 International Conference on 5-7 Dec 2010
Source/ link	:	http://ieeexplore.ieee.org/

Abstract:

Large-scale patterns of peat swamp forest (PSF) biodiversity have until now been obscured by a sparse and scattered inventory record. Known as edaphic forest, it existed in highly acidic soil and waterlogged condition. PSF had been degraded due to various anthropogenic purposes and the impact is largely affected on species level. This fragile forest is facing constant threats at alarming rate and the need of sensitivity study at landscape level is crucial in order to reduce the disturbance impact in PSF area. Here we present the first comprehensive sensitivity spatial model based on disturbance level of tree compositions for PSF in Pekan, Pahang. Data from the hyperspectral imaging will be integrated with ground measurement data to delineate tree PSF zoning and determine PSF the sensitivity levels. PSF spatial sensitivity model is simulated on combination parameters which derive from land cover/land use mapping, physical factors, and tree species composition based on spatial ecology software with integrated GIS features. Using spatial ecology modeling, the PSF spatial sensitivity zoning will be linked into geographic database. Initial sampling design decisions in PSF sensitivity studies using observational field assessment influence the ability to detect and accurately estimate the impacts. As the fragile PSF is high in sensitivity and any slight disturbance natural elements may cause it vulnerable to vast destruction areas. Sensitivity modeling on entire ecosystem is important to investigate the sensitivity level of ecosystem due to changes nearby. The model developed can be used to assess the fragility of PSF ecosystem due to physical changes and surrounding. Later, model can be used as indicator for forest conservation and help in preventing and monitoring vulnerable area of PSF.

Title	:	Development of Local Volume Table for Peat Swamp in Pekan Forest Reserve, Pahang, With Special Reference To *Gonystylus bancanus* (Ramin Melawis)		
Author	:	Ismail Parlan, Abd Rahman Kassim, Wan Mohd Shukri Wan Ahmad, Samsudin Musa & Harfendy Osman		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gonystylus bancanus locally known as ramin melawis is not only the main species of *Gonystylus* (Soerianegara & Lemmens 1994), but also the main timber of peat swamp forests (PSF). The species is also amongst the main commercial timbers produced from the forests of Malaysia and Indonesia (Soerianegara & Lemmens 1994, Abdullah et al. 2004, MTIB 2004). *Gonystylus spp.* was officially listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) effective from 12 January 2005. This requires that traded *Gonystylus spp.* timbers meet the requirements of sustainable production. *Gonystylus bancanus* represents the major source of ramin timber compared with other *Gonystylus spp.* from dry inland forests. Therefore, sufficient information on *G. bancanus* is important in preparing the non-detrimental findings (NDF) that should be conducted by the scientific authority (SA) toset the annual quota for the trade. This study was aimed to develop a local volume table (LVT) specifically for *G. bancanus* in Pekan FR, Pahang.

Title	:	Non-Detrimental Findings Report on *Gonystylus bancanus*: A Qualitative Assessment of *G. bancanus* in Two Selected Permanent Forests of Sarawak		
Author	:	Malcom Demies, Mohd. Shahbudin Sabki, Lucy Chong & Ernest Chai		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gonystylus bancanus or locally known in Sarawak as ramin telur or ramin was assessed in two areas of peat swamp forests in the Permanent Forest Estate of Sarawak namely, Kayangeran Forest Reserve (FR) and Saribas Lupar Protected Forest (PF). Thirty eight (38) and nine (9) transects were established in Kayangeran FR and Saribas Lupar PF, respectively. A total of 1,154 ramin stems were recorded in transects covering an area of 22.05 ha in Kayangan FR and Saribas Lupar PF. Four ramin trees with stem diameter at breast height (dbh) > = 10 cm were recorded. The seedlings and saplings density in Saribas Lupar PF was 144.26 and 165.25 ha-1 respectively while the density of ramin seedlings and saplings in Kayangeran FR was 3.4 and 7.2 ha-1 respectively. About 54% of the seedlings were less than 1.3 m in height while 46% of seedlings were taller than 1.3 m but less than 1.0 cm in dbh. 97% of the saplings were from the diameter group of 1.0 to 5.0 cm and another 3% were from the diameter class of 5.1 to 9.9 cm. The stocking of ramin trees in the studied areas was 0.15 and 0.33 trees ha-1 in Kayangeran FR and Saribas Lupar PF, respectively. The mean ramin volume is estimated at 0.33 m3 ha-1 for the two sites. With such a low volume, harvesting of ramin in Kayangeran FR and Saribas Lupar PF is not recommended.

Title	:	The Distribution of Dry and Wet Inland *Gonystylus spp.* (Ramin), *Aquilaria spp.* (Karas) and *Intsia spp.* (Merbau) in Peninsular Malaysia
Author	:	Samsu Anuar Nawi, Ihsan Sabri Kamarazaman, M. Zarin Ramlan & Muhamad Azmi
Types	:	Proceeding **Year :** 2010
Publisher	:	No information
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

There is a widespread concern on the distribution of *Gonystylus spp.* (ramin), *Aquilaria spp.* (karas) and *Intsia spp.* (merbau) due to the existing rate of exploitation and extraction in Peninsular Malaysia. Assessments on distribution of the three species were carried on 59 sampling units (SU) using NFI-4 data and consequently ten permanent sample plots (PSPs) were established for periodic monitoring on the growth, mortality and recruitment of *Gonystylus spp.* Enumeration on the 59 SU showed that only two species of *Aquilaria* were found, totalling 3.96 stems ha-1 and 92.08% concentrated in diameter classes 1.5m<10cm and 10 < 30cm. *Aquilaria hirta* and *Aquilaria malaccensis* recorded 2.8 and 1.16 stems ha-1 respectively. As for *Intsia spp*., the total number of stems per ha for *I. bijuga* and *I. palembanica* was 0.013 and 0.034 respectively. Six *Gonystylus spp*. were recorded in the enumeration namely *G. bancanus, G. affinis, G. macrophyllus, G. brunnescens, G. confusus* and *G. maingayi* with estimated 19.51 stems ha-1. for all diameter classes. However, based on the diameter class 10cm dbh and above, the difference on the number of stems ha-1 is lessened to 3.5 stems ha-1. For dry *Gonystylus*, it was 1.8 stems ha-1 and wet inland *Gonystylus* (*G. bancanus*), 1.73 stems ha-1. Result on wet inland *Gonystylus* is comparable to the result on the enumeration of ten PSPs which recorded 1.6 stems ha-1 of *G. bancanus* but lesser number of stems ha-1 for dry *Gonystylus* or 0.9 stems ha-1. Other results on *Gonystylus spp.Aquilaria spp.* and *Intsia spp.* enumerated in the 59 SU, ten PSPs and NFI-4 are presented and discussed in this paper.

Title	:	Generation of Spatial Distribution Maps of *Gonystylus bancanus* (Ramin) Using Hyperspectral Technology		
Author	:	Khali Aziz Hamzah, Mohd Azahari Faidi, Tan Sek Aun & Hamdan Omar		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Peat swamp forest (PSF) is the largest of the wetland forest in Malaysia and consist of some of Malaysia's endangered tree species. Ramin (*Gonystylus bancanus*) which grows in the PSF is one of the species that has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Due to lack of spatial distribution of this species, in addition to high market demand, the species population is now decreasing very rapidly and threatened in some areas. Development of airborne hyperspectral remote sensing technique has provided new opportunities on mapping the individual tree species in a landscape scale such as the PSF. The main objective of this paper is to present the findings of a study to generate spatial distribution maps of ramin using the Spectral Angle (SAM) sub-pixel classification method in analysis of airborne hyperspectral imaging at the canopy level. HySpex VNIR-1600 airborne hyperspectral data with the spatial resolution of 0.5 meter and spectral range of 400 nm to 1000 nm were used in this study. About 6.25 ha of the PSF at Pekan Forest Reserve, Pahang was selected as the study plot. Sampling plots with the size of 30 x 30 m were established in the study area and all ramin with the diameter 20 cm and above were inventoried. The inventory data were used as a sampling point to generate a spectral signature of ramin using the SAM processing technique. It was found that the density of ramin within the study area is about 21 trees ha-1. All of these trees were able to be mapped using the hyperspectral data with an error of about ± 4 trees ha-1. Verification on the ground indicated that the map accuracy is about 86%. The results showed that by combining individual ramin signature sampling from HySpex data in SAM appears to have a high accuracy for discriminating individual ramin canopy in the PSF. It was also found that the HySpex airborne hyperspectral data have good capability to discriminate individual canopy layer tree species in mix peat swamp forest. The availability of accurate information on ramin population from this study can be used to assist in designing rehabilitation and conservation programs in order to conserve and sustainably manage the ramin population in the PSF.

Title	:	The Development of DNA Database for *Gonystylus bancanus* in Sarawak		
Author	:	Bibian Diway, Nurul Farhana Zakaria, Suliana Charles, Kevin Ng & Lucy Chong		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The government of Malaysia and CITES control measure on ramin could not guarantee no illegal trading of ramin. The current project was developed to probe the use of DNA for tracing and tracking of ramin timber origin and species verification in order to combat illegal trading. The DNA was extracted from leaves and bark samples that were collected from nine populations throughout Sarawak using cetyltrimethyl ammonium bromide (CTAB) with modification. Eighteen microsatellite markers were selected to amplify the DNA and thus used to generate alleles frequencies for database. From the database, a total of 67 unique alleles were detected providing useful information for tracing the population origin of ramin. The genetic diversity measured was generally high for most populations except for Kayangeran Forest Reserve and Loagan Bunut National Park. Cluster analysis based on Nei's genetic distance revealed that the populations were clustered into two geographical regions. In order to determine if the populations were significantly distinguishable from one to another, a pair wise comparison of populations test was conducted. The results based on Fs values showed that most populations were significantly differentiated except for populations located at the tributaries of Batang Lupar (Lupar River). This indicated that most likely gene flow has occurred along waterway. Unique alleles detected and cluster analysis indicated the ability and usefulness of microsatellite markers selected for tracking and tracing of ramin populations. However for effective and accurate use of microsatellite markers, application should be based on many loci and complete database covering all ramin populations throughout other states and neighbouring countries.

Title	:	Genetic Diversity Study of *Gonystylus bancanus* and Genetic Relationship Between *Gonystylus spp*		
Author	:	Anthonius YPBC Widyatmoko		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gonystylus bancanus (ramin) is the most valuable timber species in peat swamp forests. It has high potential as plantation species since planting material can be raised easily either through seeds or vegetative propagation. Over harvesting and illegal logging had decreased the potential of the species. Thus conservation of the species becomes a very crucial activity to be carried out. In order to conserve the species effectively and efficiently, information on genetic diversity, distribution and genetic relationship between populations are very important. In this study, 72 loci from 18 RAPD primers were used to investigate genetic diversity of ramin using ten populations distributed in Kalimantan and Sumatera. Mean genetic diversity of ten populations of *G. bancanus* was 0.329 and mean genetic distance between populations of *G. bancanus* was 0.061. Distribution of genetic diversity within population was higher (94%) than between populations (6%). Based on cluster analysis, ten populations of *G. bancanus* were divided into two groups: Sumatera populations and Kalimantan populations. Ex-situ and in-situ conservation of *G. bancanus* should be based on that information. Genetic relationship of ramin (*Gonystylus spp.*), a CITES-listed genus subject to illegal international trade, was examined using ITS rDNA (ITS3) and three chloroplast non-coding regions samples representing nine different ramin species. No variation within species was recognised among the nine species, including three unidentified *Gonystylus spp.* Based on ITS3 sequence, the nine species were divided into three clades. The first clade was *G. bancanus*, the second clade consisted of five species, *G. brunnescens, G. velutinus* and three unidentified *Gonystylus spp.,* and the third clade consisted of three species, *G. consangineus, G. Keithii* and *G. Macrophyllus*. However, using combination of ITS3 and three chloroplast non-coding regions, the nine species were divided into four groups. The first group was *G. bancanus* and *G. macrophyllus*; the second group was *G brunescens, G. consangineus, G. velutinus* (two samples) and one unidentified *Gonystylus spp.,* the third group consisted of *G. velutinus* (two samples) and two unidentified *Gonystylus spp.,* and the final group, *G. keithii*.

Title	:	The Development of *Gonystylus spp.* (Ramin) Timber Monitoring System Using Radio Frequency Identification (RFID) in Peninsular M'sia		
Author	:	Harry Young & Abdul Jalil Ahmad Tabon		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Ramin (*Gonystylus spp.*) is one of the most important peat swamp forest tree species currently being utilised in Malaysia. There are widespread concerns about the harvesting rate of this species due to increasing demand from the timber industries, both local and international. There are also concerns that the ramin trees are under considerable threats from illegal logging and tax evasion that cause the government to lose lucrative forest revenues. Tree marking is one of the measures carried out by Forestry Department Peninsular Malaysia to address these problems. It also serves to regulate the harvestable number and volume of trees as well as to monitor incompliance of forest operation such as the felling of mother trees, buffer zone and protection trees from logging areas. The project embarked on the use of radio frequency identification (RFID) technology instead of the manual timber tagging activities in the harvesting of peat swamp forest area, in particular ramin species. It aims to develop a customised cost-effective *Gonystylus spp.* (ramin) timber monitoring system using radio frequency identification (RFID) in Peninsular Malaysia. This project is very essential to promote sustainable utilisation towards the conservation of ramin in production forests of Malaysia.

Title	:	Survey and Inventory of *Gonystylus spp.* in East Kalimantan		
Author	:	Muhammad Mansur, Teguh Triono, Kade Sidiyasa, Ismail & Zaenal Arifin		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Field survey and inventory for *Gonystylus spp.* in East Kalimantan were conducted from June until December 2009 at five locations: Malinau Research Forest of PT. Inhutani II Concessions, Sungai Wain Protection Forest (HL-SW), Bukit Bangkirai and Samboja Research Forest-Balikpapan, PT. ITCI Concession areas and Gunung Lumut Protection Forest-Paser District. Results of the survey showed that from the above five locations, six *Gonystylus* spp. were found: *G. affinis, G. brunnescens, G. consanguineus*, *G. forbesii, G. keithii* and *G. velutinus.* The species grow naturally in primary forest with flat to hilly topography, with altitude ranges from 20 to 500 m above sea level, on sand clay soil type with pH between 6.1-6.8, and soil moisture between 20% - 75%. Among those five species, only *G.brunnescens* was found in abundance and with better natural regeneration, especially in Sungai Wain Protection Forest, Bukit Bangkirai and PT. ITCI concession area. The other five species were found in small population ranging from one to five individuals.

Title	:	Sawn Timber and Plywood Recovery Study of Ramin (*Gonystylus bancanus*) in Peninsular Malaysia		
Author	:	Harry Young, Rosaizan Haryani Rosli & Abdul Jalil Ahmad Tabon		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Malaysia is one of the largest exporter of logs and sawn timber and a major exporter of other products, such as plywood and other wood-based panels, wooden furniture, builders' carpentry and joinery (BCJ), and mouldings. The sawmilling sector is the largest and oldest wood processing industry in Malaysia. The government has expected a further reduction in output from the natural forest by 2020 and substitutes from forest plantation is planned, thus affecting the nature of the wood-based industries in Malaysia. However, ITTO (1997) has forecasted that Malaysia, principally, Peninsular Malaysia, is already an importer of hardwood logs. This trade will grow over time with most of the processing are for meeting domestic consumption or for further processing into value-added products. As resource scarcity becomes more and more severe, the sawmills, especially in Peninsular Malaysia, will have to undergo restructuring to compete with composite board plants, such as those involved in the manufacturing of medium-density fibreboard (MDF) and chipboard. There is a need for sawmills to maximise their processing recovery rates as the size of timber for the next decade will also be reduce. The objectives of the proposed activities are (i) to determine the recovery rate of ramin logs for the manufacture of sawn timber, and (ii) to develop a technique for quantifying wood waste from sawmilling production. The expected outputs from the proposed activities are (i) improved recovery rate and maximised utilisation of ramin timber; and (ii) calculation of the quantum of wood waste for estimating the recovery rate of ramin log in the production of sawn timber.

Title	:	Conservation and Establishment of Ramin (*Gonystylus bancanus*) Genepool
Author	:	Endang Savitri, Tajudin Edy Komar & Rusmana
Types	:	Proceeding **Year :** 2010
Publisher	:	No information
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Ramin (*Gonystylus bancanus*) - one of the more than 30 *Gonystylus* species - with a vulnerable status is facing a high risk of extinction in the wild. Its natural habitat is peat swamp forest areas in Sumatera (eastern coast of Riau, Jambi and South Sumatera) and Kalimantan (West and Central Kalimantan). Due to its critical status and problems in artificial regeneration, Forest Research Institute (FRI) Banjarbaru with ITTO Project carried out two studies: plantation trials since 2008 under ITTO project and the establishment of gene pool in 2010 under ITTO-CITES Project. The research sites are in Tumbang Nusa Forest Research Station, Central Kalimantan. For the plantation trials, different strip planting methods were used to study the response of ramin to light intensity (shade intensity). The result showed that seedlings were very sensitive to light intensity (shade). With a four-meter-wide strip, the seedlings tended not to survive (high mortality) compared to those planted in a two-meter-wide strip. This indicated that too strong an intensity was not suitable for ramin planting in this site. The gene activity was developed to conserve ramin genetic resources and to support the provision of stem cutting for propagation of planting materials. The flowering and fruiting seasons are unreliable and difficult to predict, therefore vegetative propagation is the best solution. The materials for genepool were collected in the form of wildings in the vicinity of Teluk Umpan and Lahei, Central Kalimantan. The wildings were separated according to the source. The wildings were planted from May to July 2010 and data collection is still in progress. FRI Banjarbaru will continue with the studies and records data for analysis.

Title	:	Population Genetic Structure of *Gonystylus bancanus* Throughout Malaysia: Preliminary Result
Author	:	Nurul Farhanah Zakaria, Soon-Leong Lee, Kevin Kit-Siong Ng, Lee-Hong Tnah, Chai-Ting Lee, Bibian Diway, Lucy Chong & Ismanizan Ismail
Types	:	Proceeding **Year :** 2009
Publisher	:	Proceedings of the 8th Malaysia Congress on Genetics, 4-6 August 2009, Genting Highlands, Malaysia
Source/ link	:	http://www.persatuangenetikmalaysia.com/files/mgc8/poster/PA22.pdf

Abstract:

Gonystylus bancanus is a valuable timber tree native to the peat-swamp forests of Malaysia and Indonesia. The decline in peat swamp area has caused this species to be vulnerable to extinction in the wild. Genetic diversity provides the fundamental basis for the evolution of forest tree species and for their adaptation to environmental changes. It is also essential for selection and breeding to meet present and future human needs. Therefore, in order to prevent irreversible loss of genetic diversity, a robust understanding of underlying genetic processes as well as the variation within and between populations of this species need to be addressed urgently. Ten polymorphic microsatellite markers developed for *G. bancanus* were used to study the population genetic structure of this species. We report the preliminary results based on four populations throughout Malaysia. From the data, the average number of alleles per locus was 11.43. The expected heterozygosity ranged from 0.68 to 0.82 with a mean of 0.76, while the mean allelic richness was 10.59. The estimated R_{st} was 0.097, implying that the majority of the genetic diversity was distributed within population. Further analysis using more populations and utilization of additional microsatellites will generate more comprehensive information in strategizing conservation program for *G. bancanus*.

Title	:	Tinjauan Ekologi dan Persyaratan Tapak: Uji Coba Penanaman Ramin		
Author	:	Prof. Dr. Abdurrani Muin		
Types	:	Proceeding	**Year :**	2009
Publisher	:	Prosiding Lokakarya Nasional 2009		
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/		

Abstract:

Present decreasing of ramin (*Gonystylus bancanus (Miq.) Kurz*) population in nature should be overcome by planting ramin in its natural habitats in Peat Swamp Forest, including by enrichment planting. However, to carry out the plantation, it is critical to obtain information on site ecology and characteristics required for better growing. One of the environment factors is light intensity that supports plant growth. Ramin is semi-tolerant type species which requires certain level of light intensity in its developmental stage. To test site requirement for ramin growth, plantation trials need to be carried out. One of the trial was carried out in a logged over forest with several treatments including infestation with mycorrizha. The trials using mycorrhizal inoculated seedlings were planted under the canopy with several levels of shade intensity: closed, medium, open area. Trial results indicated that ramin seedlings that inoculated with mycorrhizas shown a faster growth with 100% survival. The trial also showed that ramin grew better in open area. Seedlings inoculated with mycorrhiza also showed faster growth than noninoculated seedlings. The overall results of this trial suggested that for better growth, ramin seedlings require the presence of mycorrhiza and sufficient light intensity.

Title	:	Strategi Konservasi, Persyaratan Legal Dan Administratif		
Author	:	Prof. Dr. Herujono Hadisuparto		
Types	:	Proceeding	**Year :**	2009
Publisher	:	Prosiding Lokakarya Nasional 2009		
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/		

Abstract:

It is an urgent need to formulate a conservation strategy for ramin forest in Indonesia, since peat swamp forest as ramin habitat is currently under serious threat due to various disturbance. Ramin forest has been degraded by both legal and illegal logging since late sixties up to the presence. The degradation has been worsened by forest conversion to other uses primarily for oil-palm estates and other commodities and settlement. The illegal logging is taking place not only in production forest but also in the protection and conservation forests. Restoration activity and management of the existing logged-over peat swamp forests with natural regeneration of ramin may have become alternative solutions to the recovery of peat swamp forest and its ecosystem including ramin population.

Title	:	Statistik Perdagangan Kayu Ramin dan Sistem Monitoringnya		
Author	:	Ir. Zulfikar Adil		
Types	:	Proceeding	**Year :**	2009
Publisher	:	Prosiding Lokakarya Nasional 2009		
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/		

Abstract:

According to regulation by Ministry of Trade No. 20/M-DAG/PER/5/2008 and Decree of Ministry of Trade No. 405/M-DAG/KEP/7/2008, Central Government has given the authority to BRIK (Agency for Revitalization of Forest Industry) to provide endorsement for the export of timber products categorized in certain HS Code. Based on the export data under the HS Code in 2007 the export of woodworking approximately 431,000 cu meters with the value of US $ 1.25 billion. The export of panel in 2008 was estimated 2.6 million m3 with the value of US $ 1.2 billion and woodworking 1.6 million m3 with the value US $ 1.1 billion. The above figures were not specific to ramin. Ramin export in 2005 was 2.698 m3 and decrease yearly and for 2007 only 1.480m3 with the value only US $ 1.1 million. Until now, the main exported products of ramin are moulding, laminated wood and louvre doors. Product trade monitoring of ramin is still difficult to be executed since HS Code for ramin is still mixed with other species. In the future it is recommended that the special HS Code of ramin be developed.

Title	:	Kajian Kebijakan Pengelolaan Hutan Rawa Gambut: Studi Kasus Pengelolaan Dan Pemanfaatan Ramin (*Gonystylus bancanus*)
Author	:	Dr. Retno Maryani, Dr. Titiek Setyawati & Ir.Tajudin Edy Komar
Types	:	Proceeding **Year :** 2009
Publisher	:	Prosiding Lokakarya Nasional 2009
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/

Abstract:

Peat swamp forest is a type of national forest areas in Indonesia where ramin is naturally found. Peat swamp forests in Indonesia distributes in production forests, conservation and protected forests where ramin is naturally growing. Conditions of the forests have been reported to be severely degraded at the alarming rate causing ramin, an economically valuable species, is facing serious threat to extinction. Illegal logging and conversion of forest areas into non-forest areas are suspected to worsen this degraded condition. Decentralization of forest management is said to have given contribution to mismanagement of state forests caused by the emergence of various conflicts between different actors. This paper aims to understand on how far the changes of forest condition and forest management could contribute to the achievement of SFM and conservation of ramin by analyzing existing policies on the management of peat swamp forests and ramin. This paper focuses on legal status of the forests and their functions, system of silviculture, organization and institutions involved in the preservation of ramin woods as well as to maintain its production. The paper proposes to put restoration of peat swamp forest as priority action in orderto save ramin, followed by various efforts to enhance regeneration of ramin population in its habitat. The effort should involve various interest parties, especially in field level.

Title	:	Tinjauan Aspek Silvikultur Dan Pemanenan Ramin		
Author	:	Dr. Istomo		
Types	:	Proceeding	**Year :**	2009
Publisher :		Prosiding Lokakarya Nasional 2009		
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/		

Abstract:

In the beginning, the exploitation of peat swamp forest in Indonesia was due to the presence of ramin (*G bancanus*), which later become the most popular species and having high economic value. This species grows naturally only in peat swamp forest ecosystem in Sumatra and Kalimantan. Ramin was exploited applying Indonesia Selective Cutting (TPI) silvicultural system with diameter limit since 1970s. In 1972, the system changed to Indonesian Selective Cutting and Planting system (Tebang Pilih Tanam Indonesia-TPTI). Later, 1989 and 1996, the system was improved further in terms of diameter limit and cutting cycle. Using the assumption that diameter increment of 0.5 cm per year, diameter limit for cutting changed to a minimum of 40 cm at dbh with cutting cycle of 40 years. Using this diameter limit and cutting cycle, it is expected that pre-selected residual mother trees (core trees) with diameter of 20-39 cm will have become more than 40 cm and therefore ready to be harvested in the next cutting cycle. However, other important aspects that influence the sustainable management of ramin, in addition to the silvicultural system and harvesting method, is the implementation of the rules and regulation and the practice of the system. Weak of government supervision, handling of illegal logging and international trade (smuggling) have contributed to over-exploitation of ramin and damage of the habitats, which will result in unsustainable forest management.

Title	:	Potensi Dan Sebaran Kayu Ramin (*Gonystylus spp*) Berdasarkan Data TSP/PSP		
Author	:	Dr. Ir. Hermawan Indrabudi		
Types	:	Proceeding	**Year :**	2009
Publisher	:	Prosiding Lokakarya Nasional 2009		
Source/ link	:	http://www.dephut.go.id/uploads/files/ITTO_ramin/		

Abstract:

Natural Forest Inventory (NFI) has been conducted between 1989 – 1996 with the assistance of World Bank and FAO. The inventory was carried out by observing the existing temporary and permanent sample plots established in every grid with the distance between grid of 20 x 20 km throughout Indonesia. The number of TSP/PSP observed 2,735 clusters. The primary results of the inventory were the baseline data of forest resources in Indonesia. The inventory results were made based on the analysis of digital landsat photography, geographical information system and field data system analysis. Following the termination of the NFI in 1996, MoF continues collecting data from some of the TSP/PSPs. Potency of ramin not only *G. bancanus* but also *G. velutinus* and *G. macrophylla* has been recorded, especially based on the observation of the PSPs (1996-2004) in Riau, Jambi, West Sumatra, South Sumatra and Lampung (Sumatra) and all Province of Kalimantan. However, from the inventory and data collection, it is still difficult to obtain more accurate estimate of ramin potency. This is primarily due to the difficulty in obtaining the actual and current area of ramin habitats as a result of over exploitation, conversion, encroachment and forest fire.

Title	:	Alternatives to Ramin (*Gonystylus spp.)*		
Author	:	Norini Haron, Abdul Razak Mohd Ali & Lim Seng Choon		
Types	:	Proceeding	**Year :**	2007
Publisher	:	Conference on Forestry and Forest Products Research (CFFPR) : Balancing Economic and Ecological Needs, The Legend Hotel, Kuala Lumpur, 27-29 November 2007		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Because ramin (*Gonystylus spp*) has been heavily exploited in Southeast Asia and the Pacific Islands especially Indonesia, the international trade of ramin, the most highly sought-after species for the production of picture frames, is strictly monitored. The genus *Gonystylus* was first included under the Convention on International Trade in Endangered Species of Wild Flora and Fauna Appendix III by Indonesia back in 2001. Nonetheless, inclusion of the genus in Convention on International Trade in Endangered Species of Wild Flora and Fauna did not stop unscrupulous loggers from further exploiting the already threatened survival of that species in its natural state. To ensure the continued existence of ramin, a decision was made at the 13th meeting of the Conference of the Parties to Convention on International Trade in Endangered Species of Wild Flora and Fauna to uplift the genus status from Appendix III to Appendix II. With the uplifting from Appendix III to Appendix II and depleting availability of ramin from the natural forests, the need to seek other alternative species is inevitable. Therefore, to better appreciate the situation at hand, this paper not only sheds light on the supply and demand of ramin in Peninsular Malaysia, but also discusses alternative species from the perspective of colour, texture, density, treatability, and other timber properties.

Title	:	Volume Equation for Ramin (*Gonystylus bancanus*) in Pekan Peat Swamp Forest, Pahang, Malaysia		
Author	:	Nur Hajar Zamah Shari, Wan Mohd Shukri Wan Ahmad, Ismail Parlan & Ismail Harun		
Types	:	Proceeding	**Year :**	2007
Publisher	:	Conference on Forestry and Forest Products Research (CFFPR) : Balancing Economic and Ecological Needs, The Legend Hotel, Kuala Lumpur, 27-29 November 2007		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:
Peat Swamp Forests (PSFs) are the largest of the wetland forests in Malaysia and of the 0.30 million ha in Peninsular Malaysia, the PSF of Pahang is the most extensive in terms of size (ca. 200,000 ha). These forests have been providing useful source of high quality timbers to the forestry sector. One of them is Ramin (*Gonystylusbancanus*), which is one of the most valuable timber species. A Ramin-Bintangor subtype forest in Compartment 77, Pekan Forest Reserve provided an opportunity to develop volume equation for Ramin since none existed previously for this particular area or any other Ramin-Bintangor subtype forests. Even though there are numerous volume equations that have been developed for the other forest types or species, these equations are applicable to a specific area or forest ecosystem only and these might be biased when used to estimate the volume of ramin in peat swamp forests. The measurements of parameters were done on 140 individual ramin standing trees using laser criterion. The first stage of analysis involved computing the volume for each section and then summing up for the whole tree. The second stage involved regression analysis i.e. to fit the data to the selected equations in order to seek the best volume equation. Fifteen volume (over bark) equations were fitted with volume data from which the best fit equation based on Furnival Index criteria was selected. This paper will highlight the procedure in calculating the ramin tree volume (overbark) and selection of the best ramin volume equation.

Title	:	Ecosystem and Floristic Diversity of Tropical Peat Swamp Forest, Pahang, Malaysia
Author	:	Che Hashim Hassan, Mohamed Zin Yusop, Grippin Akeng, Khali Aziz Hamzah & Kamaruzaman Jusoff
Types	:	Proceeding **Year :** 2007
Publisher	:	Proc. of the 3rd IASME/WSEAS Int. Conf. on Energy, Environment, Ecosystems and Sustainable Development, Agios Nikolaos, Greece, July 24-26, 2007
Source/ link	:	http://www.wseas.us/e-library/conferences/2007creteeeesd/papers/562-233.pdf

Abstract:

Peat swamp forests are highly significant globally, both for their diverse and threatened species and as representative unique ecosystems. Apart from its critical role in providing habitat for wildlife, the tropical peat swamp forest also acts as a gene bank that harbours potentially useful varieties of plant species. Malaysia's peat swamp forests also provide crucial benefits and services for the sustainable development of human communities. The objective of the study is therefore to assess the status of the remaining peat swamp forest ecosystem and floristic biodiverstity in Pahang towards the efforts in establishing guidelines for its sustainable management and conservation. This collaborative study was undertaken by the Pahang Forestry Department, United Nation Development Programme/Global Environment Facility (UNDP/GEF) and DANIDA focusing on the South East Pahang Peat Swamp Forest (SEPPSF), Pahang, Malaysia. The UNDP/GEF component emphasized on the ecosystem and floristic diversity of the peat swamp forest. The final output from the collaborative efforts was used by the state authority, in particular the Pahang Forestry Department as a guide to manage the remaining peat swamp forest in the state for both ecosystem and floristic diversity conservation and sustainable use of the forest resources. Results indicated that the SEPPSF is very rich in ecosystem and floristic diversity and an integrated management plan is proposed to ensure biodiversity conservation of Peat Swamp Forest in Pahang.

Title	:	Current Growing Stock of Ramin in Indonesia
Author	:	M. Bismark, Ari Wibowo, Titi Kalima & Reny Sawitri
Types	:	Proceeding **Year :** 2006
Publisher	:	No information
Source/ link	:	http://www.forda-mof.org/files/Current_Growing_Stock.pdf

Abstract:

Ramin is a trade name of tropical wood or trees belonging to genus *Gonystylus*, family of*Thymeleaceae*. The number of species within the genus *Gonystylus* is 30 species.However in this study, ramin refers to *Gonystylus bancanus Miq. Kurtz*, a species that hasnatural distribution in peat swamp forest. Indonesia is natural habitat of ramin. Fiveprovinces in Indonesia namely Riau, Jambi, South Sumatera, Central Kalimantan andWest Kalimantan are known as ramin main producers. Results of this study showed thatpotency of ramin with diameter of 20 – 39 cm in five provinces varied from 0.02 – 5.08trees/ha with volume of 0.08 – 10.48 m^3/ha, or average of 4.3 trees/ha with volume of 5.3m^3/ha. total potency of ramin in five provinces was 14,757,221 m^3 or 11.3 % from potencyreported in 1983. Habitat degradation reached 46.4 % from total area in 1983. 31.1% oframin habitat was on conservation areas, with potency 27.1% of all estimated raminpotency. Although some conservation efforts have been done, there have been raminhabitat degradation and reduction of ramin potency, mainly due to forest conversion,illegal logging and trade, in-appropriate system of forest concession and forest fires.

Title	**:**	Populasi Ramin (*Gonystylus Bancanus (Miq.) Kurz*) Di Hutan Alam: Regenerasi,Pertumbuhan Dan Produksi)		
Author	**:**	Tukirin Partomihardjo		
Types	**:**	Proceeding	**Year :**	2006
Publisher :		Workshop Nasional "Policy Option On The Conservation And Utilization Of Ramin",Bogor, 22 Pebruari 2006		
Source/ link	**:**	http://www.forda-mof.org/files/Populasi_Ramin.pdf		

Abstract:

Ramin (*Gonystylus bancanus (Miq.) Kurz*) has been known as a one of main trees ofpeat swamp forest. The natural population and distribution of ramin associated with thedepth and distribution of peat. Field surveys by Ramin Team in 2005 at loggingconcession area of PT Diamond Raya Timber reported that population of ramin beforelogged was relatively high. However, the density of this species drastically decreasedafter logged. Distribution pattern of diameter classes of ramin compared with commontrees is different. The regeneration of ramin could be broadly categories as shadetolerant or shade demanding as shown by the seedling establishment beneath closedcanopy or under different mother trees. Studies in more detail were suggested to improvethe understanding of biology of ramin for supporting the sustainable management of this species.

Title	:	Potensi, Pertumbuhan dan Regenerasi Ramin (*Gonystylus spp*) di Hutan Alam di Indonesia		
Author	:	Dr. Machfudh & Rinaldi, S.Hut		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/files/Alternatif_Kebijakan _Dalam_Pelestarian_dan_Pemanfaatan_Ramin.pdf		

Abstract:

Ramin (*Gonystylus spp*) merupakan salah satu jenis pohon penting di Indonesia yangtumbuh di hutan rawa, khususnya rawa gambut. Sebelum mengalami eksploitasi yangbesar-besaran, penyebaran jenis ramin di Indonesia hampir terdapat di hutan-hutanrawa/gambut di seluruh kepulauan Indonesia. Saat ini penyebaran ramin dalam skalabesar hanya ditermui di daerah Sumatera (Riau, Jambi, Selat Karimata, SumateraSelatan) dan Kalimantan (Kalimantan Tengah, Kalimantan Barat, Kalimantan Selatan). Di daerah-daerah tersebut pun tegakan ramin yang relatif masih rapat dengan diameterpohon yang relatif besar kebanyakan hanya ditemui di kawasan-kawasan konservasi.Potensi ramin di Indonesia saat ini diperkirakan sebanyak 6.925.041 m^3 yang tersebardi daerah sumatra sekitar 1.602.334 m^3 (3.732 m^3/ha) dengan riap diameter 0.42 cm/tahun, dan di daerah Kalimantan sekitar 4.091.730 m^3 (3.842 m^3/ha) dengan riapdiameter 0.53 cm/tahun. Keadaan diameter pohon di Kalimantan rata-rata lebih besardibandingkan dengan diameter pohon di Sumatra. Riap tertinggi untuk jenis raminterdapat pada kisaran diameter 40 – 50 cm untuk lokasi Sumatra dan 30 – 40 cm untuklokasi Kalimantan.

Title	**:**	Evaluasi dan Penyesuaian Praktek/Sistem Silvikultur Hutan Rawa Gambut di Indonesia Khususnya Untuk Jenis Ramin		
Author	**:**	Dr. Istomo		
Types	**:**	Proceeding	**Year :**	2006
Publisher	**:**	Prosiding Semiloka Nasional 2005		
Source/ link	**:**	http://www.forda-mof.org/files/Evaluasi_dan_Penyesuaian.pdf		

Abstract:

Indonesia ranks as the fourth largest in the world in terms of possession of tropical peatland. Originally, most of the peat land was in the form of production forest, managedunder forest concession system (HPH) or which is now referred to as IUPHHK (permit forutilization of wood forest product). Peat swamp forest is famous and their wood isexploited due to existence of one commercial tree species, namely ramin (*Gonystylusbancanus (Miq.) Kurz.*). Silvicultural systems used in utilization of peat swamp forestwere Indonesian selective cutting (TPI) (year 1972), Indonesian selective cutting andplanting (TPTI) (year 1989), and improved silvicultural system in year 1996. However,inconsistence in the application of silvicultural system, over exploitation, weaksupervision by the government, lack of concern by the forest concession company insustainable forest management, illegal logging, forest conversion and forest fire, makesmost peat swamp forest in Indonesia become degraded forest. Degradation of peatswamp forest causes not only the reduction of productivity and function, social functionand environmental function. Even, each year, such degraded forest become sources ofdisaster in the form of forest fire (smoke) and flood (destruction of hydrology system).Therefore, for maintaining the existing forest and rehabilitating the degraded forest, thereis a need for appropriate silvicultural system and practices, particularly for salvaging andcultivating ramin species (*Gonystylus bancanus (Miq.) Kurz.)*to prevent extinction.Rehabilitation of such degraded peat swamp forest should become a part of strategy andaction plan for Peat Land Sustainable Management, which is now under preparation.

Title	:	Kebijakan Pengelolaan dan Pemanfaatan Ramin		
Author	:	Ir. Lasmin		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Ramin is a tropical hardwood which only found in Indonesia and Malaysia, and now is threatened to extinct. Ramin (*G. bancanus*) grows best in wetland area such as deep swamp. Estimated standing stock of Ramin in Kalteng Province is about 23,11 million m^3, comes from primary swamp forest 8,90 million m^3 and from secondary swamp forest 14,21 million m^3. In Riau Province, estimated standing stock volume or Ramin is about 8,17 million m^3 which is come from primary swamp forest 2,80 million m^3 and from secondary swamp forest 5,37 million m^3. Total area of swamp forest in Sumatera Island is 7.201.301 Ha and total swamp forest area in Kalimantan is 5.769.246 Ha. Based on the above information and combined with inventory data from BAPLAN, it found that potential of Ramin in Riau Province is 5,6 million m^3 and in Kalimantan Tengah is 1,4million m^3 for tree with Ø 20 cm up. Policy of forest utilization including for Ramin production has been regulated through the Ministerial Decree number 4795/Kpts-II/2002 about Criteria and Indicator of Sustainable Forest Management at forest unit management level (Ministry of Forestry Mandatory Scheme) which is mandating of every unit management to manage their forest area in sustainable way. To whom have been achieved sustainable forest management certificate, will be granting incentive such self approval of their annual plan and get AAC based on their real potential stock; e.g. PT. Diamond Raya Timber in Riau Province, is one of concessionaires who have achieve certificate of SFM and the only one forest management unit allowed to cut Ramin for their production under control of CITES. To monitor data and information of Ramin growth and standing stock, it is necessary to conduct forest inventory regularly and thoroughly. For this activity, the Ministry of Forestry has launched regulation for doing the Inventory of production forest at Forest management unit level. Since Ramin is specifically grows in swamp forest, they need specific silvicultural system which is different with the system in dry land area. For silviculture system in Wet Land/Swamp Forest, the Ministry of Forestry has established Ministrial Regulation number P.30/Menhut-II/2005 dated 13 October 2005 which is about System Standard of Silviculture for Dry Land and Wet Land/Swamp forest area.

Title	:	Kebijakan Yang Perlu Diambil Dalam Upaya Pelestarian dan Pemanfaatan Ramin (*Gonystylus spp*)		
Author	:	Prof. Dr. Herujono Hadisuparto		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

It has been for decades and primarily since decentralisation era forest destruction due to illegal logging and encroachment has become intense, including in the peat swamp forest. According to the recent source there is only 30% of the peat swamp forest left in West Kalimantan consisting of peat swamp production forest and non forest areas. Nowadays illegal logging is still going on using primarily bicycle type of hauling and transporting system along the forest tracks. Forest management primarily forest patrol and supervision was not strong enough to overcome the problem. Beside the inclusion of ramin in the appendix II of CITES have not also been well implemented in the field. Efforts for conservation and utilization of ramin (*Gonystylus spp.*) being discussed have to be formulated in the implementation of development of ramin stands in Indonesia. Conservation of ramin may be conducted by means of both in-situ and ex-situ regrowth. In the case of Kalimantan, several ramin habitats may still be found to promote in-situ ramin forest succession, whereas existing secondary peat swamp forests may be planted such as for ex-situ ramin forest growth. Regulations to be implemented should include primarily redetermination of forest landuse for ramin habitat, silvicultural practices for natural ramin seedlings and regeneration, promoting ramin plantation in degraded peat swamp, moratorium of ramin logging, rehabilitation of degraded peat swamp as ramin habitat, and protecting national park and conservation forest as ramin habitat.

Title	:	Pengaruh Cendawan Mikoriza Arbuskula (CMA) dan Intensitas Naungan Terhadap Pertumbuhan Ramin(*Gonystylus bancanus (Miq.) Kurz*) di Areal Bekas Tebangan		
Author	:	Dr. Abdurrani Muin		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Ramin (*Gonystylus bancanus (Miq.) Kurz*) that has been rare need to save through the replanting on the log over area and ramin forest establishment. The research aims tofind technology that can create the high capability seedlings while planted in log over area. In order to reach it, we need to find: (1) effective mycorrhizae genus that has tobe inoculated to ramin seedlings, (2) the suitable shade intensity for the best ramin growth. The result shows that ramin growth in which innoculated by arbuscular mycorrhizal fungi (AMF) has better than uninoculated and survival is 100 %. The result also shows that *Glomus sp* and *Acaulospora sp* are effective genus for ramin planting in log over area. Althout ramin characteristized is semitolerant, but ramin had been inoculated by VAM could be fast growth on opened area.

Title	:	Integrated Policy for Ramin: Toward Ecological and Social Sustainability and Fair Distribution of Ramin Benefits		
Author	:	Dr. Taufiq Alimi		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Ramin (*Gonystylus spp*) is a hardwood grows in tropical areas. Its uniquefeature makes it a good material for furniture. It has the strength of hard-wood, with the texture and hardness that fit furniture, moulding, and finewood products. Ramin usually grows at peat areas. Indonesia and Malaysiaare home for ramin. There are about 30 species of ramin, of which*Gonystylus bancanus* is the most heavily harvested. The feature and beauty of ramin have attracted people and lead to overharvesting of it. In 1970, only 1.5 million meter cubic of ramin was logged.As the source for ramin declines, the harvest also shrinks. Nowadays only137,512 meter cubic ramin was logged in Malaysia and 131,307 m^3washarvested in Indonesia. The demand for ramin remains high. Only theinclusion of ramin in the CITES appendix that slows the demand and tradeof ramin.

Species Survival Network noted that over the time, ramin has become increasingly threatened. Excessive logging and destruction of peat swamps have led to commercial extinction in much of Peninsular Malaysia. Populations have also been reduced in Sarawak in Malaysian Borneo, as evidenced by declining timber production levels. Ramin production in Sarawak fell from 521,000 m^3 in 1990 to 67.000 m^3 in 2000. By the mid-1990s, most of Malaysia's peat forests had been logged at least once. Because ramin is naturally slow to regenerate, Malaysian populations have yet to recover. Populations throughout Indonesia have also declined due to over-exploitation (Soehartono and Mardiastuti 2002). This decline is evident inIndonesia's annual ramin production, which fell from more than 665,000 m^3in 1994 to just 131,000 m^3 in 2000 - a decline of more than 80% in 6 years.Even at these levels, Indonesia's ramin harvest in 2000 far

exceeded theannual allowable cut of 24,000 m^3 authorized by the Ministry of Forestry. Inresponse to such threat IUCN have classified 15 species of *Gonystylus* (including *G. bancanus*) as Vulnerable and these 15 Species have beenincluded in the IUCN Red List of Threatened Species since the year 2000.

Being an endangered species, ramin was listed in CITES Appendix. Thelisting of ramin in CITES Appendix is to regulate the trade of it, so that it willnot endanger the species. Moreover it is also to protect the environmentwhere ramin inhabited, the peat swamps forest. Therefore, the listing oframin in CITES and the regulation of its trade following after will be instrumental for safeguarding the environment at large. Problem with ramin is actually the reflection on more precise the iceberg of larger problem in forest management. Decline in production is not only unique for ramin. Almost every single species in tropical forests is-defacto-threatened and endangered. Some of them may not as scarce as ramin, but they are all equally threatened if more than 3 million hectares of forests are cleared annually. Ramin suffers from over harvesting – some are legal and more are illegal one - and illegal trades of it; and so are other species in the forests.

Title	**:**	Pilihan Kebijakan untuk Penyelamatan Ramin di Indonesia		
Author	**:**	Dr. Slamet R. Gadas		
Types	**:**	Proceeding	**Year :**	2006
Publisher	**:**	Prosiding Semiloka Nasional 2005		
Source/ link	**:**	http://www.forda-mof.org/		

Abstract:

Ramin adalah nama dagang salah satu jenis kayu dari Indonesia yang banyak diperdagangkan di dunia. Pohon ramin berasal dari genus *Gonystylus*, yang diperkirakan terdiri dari 20 — 30 jenis (species) akan tetapi hanya sekitar 10 jenis yang menghasilkan kayu dengan sebutan ramin. Di Indonesia jenis pohon ramin yang paling banyak dipanen dan diperdagangkan adalah dari jenis *Gonystylus bancanus* (Kade Sidiyasa, 2005; Tukirin Partomihardjo 2005). Di Indonesia pohon ramin jenis *Gonystylusbancanus* banyak tumbuh padahutan rawa gambut di Sumatera dan Kalimantan. Di pulau Sumatera ramin banyak dijumpai pada hutan rawa gambut di Provinsi Riau, Jambi, dan Sumatera Selatan, sedangkan di Kalimantan banyak ditemukan di provinsiKalimantan Barat dan Kalimantan Tengah.

Kayu ramin mempunyai warna yang cerah, dengan tekstur agak halus dan merata serta mudah pengerjaannya, sehingga banyak digunakan untuk pembuatan furniture, komponen perumahan dan konstruksi ringan. Karena harga jual yang tinggi dan banyak diminati oleh industri pengolahan kayu di dunia, maka kayu ramin banyak dipanen. Akan tetapi pemanenannya dilakukan tanpa memperhatikan kaidah penyelamatan atau pelestariannya. Upaya peremajaan tegakan ramin melalui tanaman perkayaan juga belum dilakukan dengan baik. Akibatnya keberadaan pohon ramin di hutan produksi semakin langka. Ancaman terhadap kelestarian tegakan ramin semakin meningkat denganmaraknya kegiatan pembalakan liar (*illegal logging*) dan alih guna kawasan hutan yang tak terkendali setelah era refromasi tahun 1998. Penebangansecara liar kayu ramin tidak hanya terjadi di hutan produksi, tetapi sudah merambah ke

hutan lindung dan kawasan pelestarian, seperti yang terjadi di taman nasional Berbak (Jambi), Tanjung Puting (Kalimantan Tengah), Gunung Palung dan Danau Sentarum (Kalimantan Barat).

Berbagai upaya telah dilakukan untuk menyelamatkan tegakan ramin, mulai dari pengendalian pembalakan, operasi pemberantasan pembalakan liar dan penyelundupan kayu, pengembangan teknik budidaya, serta pengendalian perdagangan antar bangsa dengan memasukkan ramin sebagai mata dagang yang dilindungi dalam Convention on International Trade of Endangered Species (CITES) Appendix Il, namun upaya tersebut belum menampakkan hasil yang memuaskan. Sampai saat ini, penebangan tegakan ramin di kawasan hutan masih berlanjut, termasuk di kawasan penyelamatan. Makalah ini akan mencoba untuk menguraikan secara ringkas beberapa pilihan kebijakan yang perlu diambil oleh pemerintah, terutama Departemen Kehutanan, untuk menyelamatkan keberadaan tegakan jenis ramin di Indonesia.

Title	:	Potensi Permudaan Alam di Areal Tegakan Tinggal Hutan Alam Ramin Campuran		
Author	:	Dr. Harun Alrasyid		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Prosiding Semiloka Nasional 2005		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Menurut berbagai ahli silvikultur seperti Warsopranoto (1974) menyatakan bahwa sustained management hutan bertalian erat dengan prinsip – prinsip silvikultur yang mantap dimana persoalannya berkisar pada dua prinsip yaitu prinsip kekekalan hasil dan ekonomi. Adapun yang menjadi kunci kekekalan hasil adalah berhasilnya permudaan hutan.

Permudaan alam hutan adalah peremajaan hutan secara alami yang komponennya terdiri dari tingkat semai, pancang dan tiang. Proses permudaan alam hutan merupakan aspek ekologi yang cukup besar peranannya terhadap pembentukan struktur tegakan hutan. Penyebaran dari permudaan hutan suatu jenis pohon berkolerasi dengan kemampuannya bertoleransi dengan kondisi lingkungan. Jenis tumbuhan yang dominan merupakan jenis yang mempunyai toleransi tinggi terhadap perubahan lingkungan yang mempengaruhi perkembangannya dengan perkataan lain jenis tumbuhan tersebut mampu beradaptasi dengan kondisi lingkungan yang beragam.

Penebangan hutan akan merubah komposisi jenis dan struktur hutan berikut habitatnya. Sejalan dengan waktu, proses perubahan ini dapat mengarah terbentuknya hutan semula atau terbentuknya hutan yang berbeda dengan hutan yang semula. Kecenderungan proses perubahan komunitas tumbuhan tersebut dapat diduga dari kondisi hutan yang ada. Hal seperti tersebut diatas yang melatar belakangi patut dikajinya kondisi dari permudaan hutan alam ramin campuran di areal bekas penebangan.

Title	:	Evaluasi Penanaman Ramin (*Gonystylus spp*) Di Indonesia: Kendala Dan Program Kegiatan Dalam Pembangunan Hutan Tanaman Ramin
Author	:	Istomo
Types	:	Proceeding **Year :** 2005
Publisher	:	Proceedings of Bogor Agricultural University's seminars
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/51639

Abstract:

Production of ramin woods which was progressivety decreasing and the rampant illegal logging activity, has forced Ministry of forestry since 2001 to ban ramin logging. At the same time, ramin was included in Appendix III of CITES, and in the year 2004 the status was elevated into Appendix II CITES. Therefore in the future, attention toward ramin should be focused on the aspect of conservation and planting. Ramin planting activities have been conducted by HPH through enrichment planting, but there had been no information concerning the growth and rate of success. On the other hand, successful ramin planting activities which have been evaluated are those ramin plants within research scale, either in Sumatera or Kalimantan with considerably high growth percentage. Research activities to product ramin planting stock have been frequently conducted and successful. However, the characteristic of ramin trees which do not fruit every year, have recalcitrant seed and slow growth are an internnal constraints for large csale raming planting. Other constraints are raise as external factors, such as land tenure uncertainly, weak law enforcement, rampant conversion of forest land, forest fire, and financial and environment feasibility study for ramin plantation forest development which have never been conducted. therefore, for salvation and planting of ramin, as series of research and development for ramin plantation, should be conducted and comprise other things: determination of ramin planting, technology of environmentally friendly land preparation, technology of growth acceleration (fertilizer and mycorrhiza application), financial feasibility study, study on environmental impact of ramin planting and establishment of representative demonstration plots of ramin planting.

Title	:	Evaluasi Dan Penyesuaian Sistem Silvikultur Hutan Rawa Gambut, Khususnya Jenis Ramin (*Gonystylus bancanus (Miq.) Kurz.*) Di Indonesia
Author	:	Istomo
Types	:	Proceeding **Year :** 2005
Publisher	:	Proceedings of Bogor Agricultural University's seminars
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/51636

Abstract:

Indonesia ranks as the fourth largest in the world in terms of possession of tropical peat land. Originally, most of the peat land was in the form of production forest, managed under forest concession system (HPH) or which is now referred to as IUPHHK (permit for utilization of wood forest product). Peat swamp forest is famous and their wood is exploited due to existence of one commercial tree species, namely ramin (*Gonystylus bancanus (Mig.) Kurz.*). Silvicultural systems used in utilization of peat swamp forest were Indonesian selective cutting (TPI) (year 1972), Indonesian Selective cutting and planting (TPTI)(year 1989), and improved silvicultural system, over exploitation, weak supervision by the application of silvicultural system, over exploitation, weak supervision by the government, lack of concern by the forest concession company in sustainable forest management, illegal logging, forest conservation and forest fire, make most peat swamp forest couses not only the reduction of productivity and function, social function and environmental function. Even, each year, such degraded forest become source of disaster in the form of forest fire (smoke) and flood (destructtion of hydrology system). Therefore, for maintaining the existing forest and rehabilitating the degraded forest, there is a need for appropriate silvicultural system and practices, particularly for salvaging and cultivating ramin species (*Gonystylus bancanus (Miq.) Kurz.*) to prevent extinction. Rehabilitation of such degraded peat swamp forest should become a part of strategy and action plan for Peat Land Sustainable Management, which is now under preparation.

Title	:	Effects of Dimensional Stabilization Treatment on Wood Gluability and Bond Durability		
Author	:	Lin ChengJung & Huang YawFu		
Types	:	Proceeding	**Year :**	1998
Publisher	:	Taiwan Forestry Research Institute		
Source/ link	:	http://www.cabdirect.org/abstracts/19990611650.html		

Abstract:

This study investigated the effects of dimensional stabilization treatment (DST) and various chemical surface extraction methods on the wettability, gluability, and bond durability of three wood species (red oak (*Quercus sp.*), Ramin (*Gonystylus bancanus*), and rubber wood (*Hevea brasiliensis*)). Results indicated that epoxy adhesive was the best one, both in gluability and wettability for the wood treated with linseed oil, oil-based sealer, nitrocellulose lacquer wood sealer, or PEG1000. Meanwhile, it is inevitable that some adhesion difficulties still will be encountered after DSTs. Most of them can be improved by the chemical surface extraction method. The study also found that good wettability is a necessary but not sufficient condition for obtaining good bond quality for specimens after treating with dimensional stabilizing agents. The other result demonstrated that bonded members with epoxy adhesive cannot endure the soaking treatment in linseed oil solution, and those with water-based adhesives, like Titebond 50 and powdered urea formaldehyde, cannot endure the soaking treatment in PEG1000 aqueous solution. And after the bond durability test, results indicated that only the bond strength retention of vinylurethane-bonded members was higher than the control. Therefore, DSTs on this adherent were beneficial to its bond durability.

Title	**:**	The Effects of Timber Harvesting and Forest Conversion on Peat Swamp Forest Dynamics and Environment in West Kalimantan		
Author	**:**	Herujono Hadisuparto		
Types	**:**	Proceeding	**Year :**	1996
Publisher	**:**	Springer Netherlands		
Source/ link	**:**	http://link.springer.com/chapter/10.1007/978-94-009-1685-2_40		

Abstract:

The peat swamp forests of Kalimantan, formerly covering 6.3 million hectares, are found primarily along the western and southern parts of Indonesian Borneo and are separated by the Sunda shelf from those of Sumatra's east coast. Studies conducted on production forests in West Kalimantan indicate that the presence of natural regeneration stages favour continued sustainability. Silvicultural practices ensure sustainability when the residual trees left after logging are adequate and there is protection of the resource from unplanned relogging and forest conversion.

Title	:	Production of *Gonystylus bancanus* Planting Materials Via Stem Cuttings		
Author	:	Mohamad Lokmal Ngah, Shamsudin Ibrahim, Darus Ahmad & Mohd Noor Mahat		
Types	:	Proceeding	**Year :**	1992
Publisher	:	Proceedings of the Regional Symposium on Recent Advances in Mass Clonal Multiplication of Forest Trees for Plantation Programmes,Cisarua, Bogor, Indonesia, 1-8 December 1992. p. 213-217		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The percentage of rooting of *Gonystylus bancanus* stem cuttings treated by commercial rooting hormone Seradix-3 was very high, i.e., 83 percent. Survival rate of these rooted cuttings at five months after potting was also very high, i.e., 98 percent. There is tremendous opportunity to mass produce planting stock of *Gonystylus bancanus* via single node stem cuttings.

Title	:	Kajian Terhadap Pengumpulan Data, Monitoring dan Kontrol Perdagangan Ramin		
Author	:	Puja Utama		
Types	:	Report	**Year :**	2011
Publisher :		No information		
Source/ link	:	http://www.itto.int/files/user/cites/indonesia/Tinjauan%20Terhadap%20Pengumpulan%20Data%20-%20Technical%20Report%20Act%203.1_Bahasa-1.pdf		

Abstract:

Ramin is a trade name for several species of trees of the genus *Gonystylus Thymeleaceae* family members. Abundance of habitat, had made Ramin (*Gonystylus bancanus*) as one of the wild plant species or traded timber and has a high economic value. Ramin wood is traded in various forms of products from logs to finished product. Requests from international demand to exports Ramin wood and its products had led to exploitation of Ramin on a large scale. In year 2001 the government of the Republic Indonesia issued a policy of suspension (moratorium) logging and trade in Ramin through the Minister of Forestry Decree No. 127/Kpts-V/201 April 11, 2001. The main consideration of this policy due to the greatly reduced population of Ramin and Ramin rampant illegal logging that has penetrated down to the conservation areas.

Since Ramin had considered starting rare and its international trade in high enough, then in 2001 the species of *Gonystylus bancanus* listed in Appendix III of CITES, so trade of this species was controlled through the CITES mechanism. Along the lines of the decreasing of Ramin potential in field and the need for international trade on this timber, control these species need to develop including data collection of Ramin timber trade. Therefore, study on data collection of Ramin timber trade, the information monitoring and control of trade are necessary.

The purpose of this review was to obtain data and information on the timber trade on Ramin, the information system of monitoring and supervision of timber trade on Ramin. The aims of the review mainly to determine Ramin wood trade data collection, and efficiency monitoring and control systems of trade on Ramin. Data and information that collected in this study was consists of Ramin wood trade data, in particular with data of actual exports, information on monitoring and control its trade.

From the review, the discrepancy data of actual export presented from the CITES Management Authority compare with BRIK's data were happened due to several reasons such as CITES permit issued by CITES Management Authority was not fully realized by the industry. CITES Management Authority did not receive the report on the actual export from the company; Other reason the decrease of the actual Ramin wood exports, particularly since Ramin wood processing yield amounted to 50-60%.

Title	**:**	Asian Workshop of The ITTO-CITES Project on Ensuring International Trade in CITES-Listed Timber Species Is Consistent With Their Sustainable Management and Conservation: *Gonystylus spp.* (Ramin)		
Author	**:**	Tajudin Edy Komar & Hesti Lestari Tata		
Types	**:**	Proceeding	**Year :**	2010
Publisher	**:**	Bogor : Forestry Research and Development Agency, 2010		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

Ramin (*Gonystylus spp*), consisting of 31 species with one variety of tall trees and some shrubs, is a valuable genus of tree species found in the tropical forests of Southeast Asia and the Pacific islands. The most valuable species, *Gonystylus bancanus*, is found in the peat swamp forests of the region. Ramin has been heavily exploited in the region, in particular Indonesia where illegal loggers have encroached into the national parks where the species occurs. Indonesia included the genus *Gonystylus* in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix III with annotation #1 with effect from 6 April 2001. At the 13th Meeting of the Conference of the Parties to CITES held in Bangkok, Thailand, from 2 to 14 October 2004, the Parties voted to uplist the genus to Appendix II, which entered into force on 12 January 2005. This means„that Ramin to be exported has to be accompanied by a CITES export permit, which requires that the wood to be exported was legally acquired and its export will not be detrimental to the survival of the species in the wild. The Appendix-II listing ensures that international trade in Ramin is stringently monitored and controlled. The listing also has helped obtain greater technical assistance to ensure the species can be harvested and traded sustainably.

The International Tropical Timber Organization (ITTO) has undertaken a number of activities relevant to the CITES Appendix-II listing of timber species, the most recent being the convening of this Expert Meeting

pursuant to ITTC Decision 2(XXXVII) on Enhanced Cooperation between ITTO and CITES for Ramin and Mahogany.

The ITTO Expert Meeting on the Effective Implementation of the Inclusion of Ramin (Gonystylus spp) in Appendix II of CITES was held from 16 to 19 May 2006 in Kuala Lumpur, Malaysia. The Expert Meeting was hosted by the Ministry of Natural Resources and Environment (NRE) and organized jointly by the Forest Research Institute Malaysia (FRIM), the Forestry Department Peninsular Malaysia (FDPM) and the Malaysian Timber Industry Board (MTIB) in collaboration with TRAFFIC. The Meeting gathered some 50 participants from 15 countries representing forestry, customs, timber trade regulating agencies, civil societies and international organizations.

The four objectives of the ITTO Expert Meeting were to: (i) exchange experiences in the implementation of the inclusion of Ramin (*Gonystylus spp*) in Appendix II of CITES including undertaking Non-Detriment Findings (NDFs) as well as training on identification and relevant CITES procedures; (ii) review recent trade figures and data submitted to CITES, experiences in tracking a full range of products and measurement and reporting issues; (iii) identify and examine problems and issues relating to the implementation of the inclusion of Ramin in Appendix II of CITES; and (iv) recommend follow-up actions for countries, CITES and ITTO to improve the implementation of the inclusion of Ramin in Appendix II of CITES.

The ITTO Expert Meeting was opened by His Excellency Dato' Suboh Mohd. Yassin, Secretary-General of the NRE, Malaysia. The agenda included 17 papers and presentations. CITES Secretariat and TRAFFIC provided the overview of CITES provisions, implementation issues and challenges with regard to Ramin. The key range countries' reports from Malaysia and Indonesia highlighted the commitment of the governments to improving the management, trade and enforcement of Ramin ranging from policy to legal and administrative developments. This was complemented by presentations by participants from some importing countries including Canada, the US, the Netherlands, China and Hong Kong SAR, as well as presentations by those representing the private sector and civil societies. These papers and presentations were aimed at providing background information, illustrating case studies and initiating points for discussion and deliberation during the Meeting.

The ITTO Expert Meeting brought together participants from exporting and importing countries, civil societies and international agencies. Participants were divided into four working groups to discuss the following topics: i) ecological and management status of Ramin (Gonystylus spp); ii) review of market and international trade in Ramin; iii) capacity building for meeting the requirements of CITES Appendix-II listing of Ramin; iv) coordination and cooperation for the effective implementation of the inclusion of Ramin in Appendix II of CITES.

Title	:	Asian Workshop of The ITTO-CITES Project on Ensuring International Trade in CITES-Listed Timber Species Is Consistent With Their Sustainable Management and Conservation: *Gonystylus spp.* (Ramin)
Author	:	Tajudin Edy Komar & Hesti Lestari Tata
Types	:	Report **Year :** 2010
Publisher	:	Bogor : Forestry Research and Development Agency, 2010
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Ramin, a commercial name of *Gonystylus spp.*, distributes naturally in South East Asia and some species distributes in Solomon and Fiji. The number of species within the genus remains unclear, however, it has been predicted to be 30 species or more depending on their taxonomic interpretation. Some of *Gonystylus spp.* are woody plant and others are small tree and shrubs. Among the woody species, only *Gonystylus bancanus* has been commercially harvested and traded. Other species, may have been harvested and traded as member of mixed light hardwood (MLH).

The harvest of ramin, especially *G. bancanus*, has been started since early 1970's along the harvest of tropical forest in this region and the species is still being harvested until today. The harvest methods used, along with other change of forest condition due to various factors, have made some tropical species undergo population decrease, depletion and even extinction. This includes *Gonystylus spp*.

According to the assessment by World Conservation and Monitoring Center (WCMC) using 1994 IUCN Red list categories and criteria (Version 2.3), 15 species of Gonystylus are at the status of "vulnerable" and facing a high risk of extinction in the wild in the medium-term future. Results of recent studies and observation, especially for *G. bancanus*, have confirmed the concern, especially in some geographical ranges, like Indonesia. Various efforts to further prevent the rate of population depletion have

been put in place through various means, such as regulation in its international trade, regional cooperation and national initiatives. ITTO-CITES Project on ensuring CITES- timber listed species is consistent with their sustainable management and conservation- is one of the international commitments to assist in the SFM and conservation of ramin.

The main objectives of the workshop are: (1) To introduce current ITTO-CITES programme for implementing CITES listing of tropical timber species, specific to ramin (Gonystylus spp.). This ITTO-CITES project has been officially started in this region in 2008 and several activities are being implemented by Indonesia and Malaysia, (2) To assess and evaluate the progress achieved for each activity in both Indonesia and Malaysia and to ensure effective implementation of the findings and (3) To review on the progress and actions taken to implement the recommendation of the previous ITTO Expert Meeting on the Effective Implementation of the Inclusion of ramin (*Gonystylus spp.*) in Appendix II of CITES, held in Kuala Lumpur, 2006.

Title	:	Manual of Ramin Inventory in Peat Swamp Forest		
Author	:	Nengah Surati Jaya, Samsuri, Tien Lastini & Edwin Setia Purnama		
Types	:	Report	**Year :**	2010
Publisher :		Indonesia's Work Programme for 2008 ITTO CITES Project, Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Badan Litbang Kehutanan, Kementerian Kehutanan, Indonesia		
Source/ link	:	http://dephut.net/uploads/files/ITTO_ramin/		

Abstract:

Dalam perencanaan hutan, kegiatan inventarisasi hutan merupakan kegiatan vital yang sangat menentukan kualitas perencanaan hutan yang akan dihasilkan. Hasil inventarisasi hutan yang baik, yaitu yang memiliki keakuratan dan kecermatan yang baik sangat bergantung pada metode yang dipergunakan, alat alat ukur yang dipergunakan serta keterampilan dan pengetahuan dari pelaksana (enumerator atau surveyor). Oleh karena itu, diperlukan persiapan pelaksanaan inventarisasi hutan yang mantap, yang mencakup:

(a) Rancangan pengambilan contoh (*sampling design*),
(b) Rencana organisasi pelaksana survei,
(c) Rencana peralatan dan perlengkapan survei yang dibutuhkan,
(d) Rencana pengambilan data,
(e) Rencana pengolahan dan analisis data,
(f) Rencana tata waktu pelaksanaan.

Sejalan dengan kebutuhan tersebut, agar pelaksanaan inventarisasi hutan dapat dilaksanakan sesuai dengan prosedur yang diperlukan, cermat dan efisien maka perlu adanya sebuah panduan pelaksanaan inventarisasi hutan. Sebagaimana diketahui, ramin merupakan salah satu jenis dilindungi dan telah masuk ke dalam Appendix II CITES, karena termasuk tumbuhan dalam kategori kritis (c*ritically endangered*) atau sudah mulai terancam punah (*International Union for Conservation of Nature and Natural Resources*, IUCN 1994). Ramin termasuk marga (genus) *Gonystylus* dari suku (famili) Thymelaeaceae yang banyak tumbuh di daerah rawa

gambut dalam hutan alam. Pada saat ini, sejalan dengan semakin pentingnya informasi tentang ramin, maka perlu disusun panduan pelaksanaan inventarisasi ramin sehingga dapat diperoleh data dan informasi yang handal, cepat dan murah.

Pada panduan ini disajikan panduan inventarisasi ramin secara ringkas, tetapi jelas dan mudah dipahami sehingga dapat dilaksanakan oleh para pihak yang berkaitan langsung dengan penyediaan data tegakan ramin khususnya dan di hutan rawa gambut pada umumnya.

Title	**:**	Produksi Dan Perdagangan Ramin Di Indonesia		
Author	**:**	Listya Mustika Dewi & Tajudin Edy Komar		
Types	**:**	Report	**Year :**	2008
Publisher :		ITTO PROJECT PD 426/06 Rev. 1 (F)		
Source/ link	**:**	http://www.itto.int/files/user/pdf/publications/PD%20426%2006/pd426-06-15%20rev1%28F%29%20e.pdf		

Abstract:

Ramin *(GonystyJus bancanus)* adalah nama jenis kayu perdagangan yang tumbuh alami di habitat rawa gambut. Jenis ramin yang paling umum di dunia perdagangan adalah *Gonystylus bancanus.* Jenis ini tumbuh di hutan rawa gambut Sumatra dan Kalimantan. Sejak tahun 1990an, jenis ini mulai sang at diminati terutama oleh pasar Eropa, Amerika dan Jepang. Tingginya nilai kayu dan nilai komersial dari jenis ini telah menyebabkan terjadinya penurunan yang sangat tajam dari populasi ramin yang ada di hutan rawa gambut tropis Indonesia. Oleh karena itu untuk menanggulangi hal tersebut, pada tanggal 11 April 2001 Departemen Kehutanan mengeluarkan Keputusan Menteri Kehutanan No. 127/Kpts-V/2001 tentang Moratorium Kegiatan Penebangan dan Perdagangan Ramin. Selanjutnya pada tanggal 12 Juni 2001 Departemen Kehutanan mengeluarkan Keputusan Menteri Kehutanan No. 168/Kpts-IVl2001 yang mengatur tentang pemanfaatan dan peredaran kayu ramin, memperbolehkan IUPHHK yang mendapatkan sertifikat PHAPL untuk melakukan penebangan dan perdagangan kayu Ramin berdasarkan rekomendasi Lembaga IImu Pengetahuan Indonesia (L1PI). Sejak pemberlakuan Keputusan Menteri Kehutanan tersebut, satu-satunya konsesi HPH yang mendapat ijin produksi kayu ramin adalah PT. Diamond Raya Timber. Kayu ini kemudian diolah dan diekspor oleh industri PT. Uniseraya. Dalam rangka melindungi populasi ramin, maka Pemerintah Indonesia juga memasukkan ramin ke dalam *Convention on International Trade in Endangered Species* of *Wild Flora and Fauna* (CITES) Appendix 11\ dengan anotasi #1 sejak 2001. Setelah Ramin masuk ke dalam Appendix 11\ CITES, perdagangan internasional ramin diatur sesuai dengan peraturan CITES. Kemudian pada *Conference* of *the Parties* (CoP) CITES ke-

13 di Bangkok ditingkatkan menjadi Appendix 11, yang berlaku mulai 12 Januari 2005. Perdagangan internasional jenis yang masuk Appendix 11 CITES mempunyai prasyarat yang lebih ketat agar perdagangan tetap pada level *sustainable: non-detriment finding* (NDF) dan *permitting* system. Dalam implementasi CITES Ramin di Indonesia melibatkan banyak *stakeholders* antara lain Ditjen PHKA sebagai *Management Authority* dan L1PI sebagai *Scientific Authority. Stakeholders* lain yang terlibat adalah BRIK (Badan Revitalisasi Industri Kehutanan), Direktorat Jenderal Bea Cukai, Balai Karantina, BKSDA, Departemen Perdagangan, Departemen Perindustrian, ·Kepolisian, danlain-Iain. Dalam implementasi CITES ini diperlukan kerjasama antar *stakeholders* yang bersangkutan agar pelaksanaan implementasi CITES dapat berjalan dengan baik. Namun, fakta yang terjadi di lapangan banyak menunjukkan adanya kelemahan-kelemahan dalam pelaksanaan implementasi CITES khususnya untuk kayu ramin. Makalah ini mencoba menyajikan dan membahas data-data mengenai produksi dan perdagangan ramin.

Title	:	Vegetative Propagation Trial of Ramin (*Gonystylus Bancanus*) by Shoot Cutting Using Hedge Orchard as Source in Green House With KOFFCO System		
Author	:	Evalin Sumbayak & Tajudin E. Komar		
Types	:	Report	**Year :**	2008
Publisher	:	No information		
Source/ link	:	http://www.itto.int/files/itto_project_db_input/2589 /Technical/pd426-06-13%20in%20Bahasa.pdf		

Abstract:

Ramin *(Gonystylus bancanus)* is known as one of commercial wood species from peat swamp forest which has been rare in its natural distribution. Ramin is one of slow growing species, the seeds are recalcitrant and the harvest time is not yearly. This become a problem in species regeneration. Some previous research showed that the artificial of ram in can be made with vegetative propagation by shoot cutting. The advantage of using vegetative is, the seedlings can be produced. The genetic will be similar with the mother tree. Ramin vegetative trial (shoot cutting) is from a hedge orchard established using natural seedlings. The shoot cutting was obtained from hedge orchard is garden prepared to produce orthotrop's bud as cuttings materials. Seedlings for hedge orchard are planted in shed directly in organics soil. 64 shoots from hedge orchard were planted in tray, the shoot size 12 cm of length and 0,6 mm of diameter.

Mixure of sand that previously sterilizied in 120°C for 4 hours with local peat (2: 1) were used as media in trials. Rootone F is used as stimulation of rooting's cutting. Shoot cutting is stacked in 90° humidity propagation cover. Green house with KOFFCO system, An ideal space conditon in green house with humidity (~900C), temperature « 30°C) and light intensity (5000-20.0000 lux) is good for shoot cutting to row well.

Root measure is on the 8th and 11· week. The result showed that on the 8th, shoot cutting had 88,9 % of rooting and on the 11 th had 96,8 % of rooting. This trial showed that vegetative propagation of ram in by shoot cutting in green house with KOFFCO system is indicate a sufficient of vegetative growth and root growth.

Title	**:**	Review and Current Status of Ramin Plantation Activities		
Author	**:**	Murniati, T. Rostiwati, Hendromono & Istomo		
Types	**:**	Report	**Year :**	2005
Publisher	**:**	Technical Report ITTO Pre-Project PPD 87/03 Rev, 2 (F). Identification of Gonystylus spp (Ramin), Potency, Distribution, Conservation and Plantation Barrier. Forestry Reseacrh and Development Agency, Ministry of Forestry		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

Ramin is a trade name of timber from a group of species, which belong to *Gonystylus* genus. Although it has 30 species, there are only 7 species, which are known as large trees. One of those species is Ramin (*Gonystylus bancanus (Miq) Kurz.*). Ramin is well-known and very popular in terms of both its timber quality and (its) value. Besides, a ramin tree is ecologically and morphologically easy to be recognized in forest. A freshwater swamp or peat-swamp forest habitat appears to be almost unique in the genus.

The ramin population decreased sharply and the species tend to be nearly extinct because of an over exploitation of ramin trees whichhas been occurred since last two decades. Ramin plantation efforts to achieve sustainable management of peat-swamp forests should be done. Therefore, data collection on ramin plantation efforts and activities is very crucial as a point to start in establishing and developing of ramin plantations in large scale.

The objective of the ITTO Pre-Project PPD 87/03 Rev.2 (F) (Identification of ramin plantation activities and plantation barriers) is to provide sufficient data on ramin plantation activities and plantation barriers that was carried out from February to April 2005 by means of literature review and field survey. A direct investigations including interviews to experts were conducted in four provinces, where peat-swamp forests and ramin species occurred, i.e. Riau, Jambi, West Kalimantan and Central

Kalimantan. From literature review, it is found that ramin flowering and seed production do not occur every year, and the seed is categorized as recalcitrant. To overcome this problem, therefore, ramin propagation is conducted by shoot tip cutting from wild seedlings and hedge-orchard. Propagation with tissue culture has been conducted, but it has not been successful yet.

Ramin is a very slow growth tree species that grows better on a deep peat soil and under moderate shading (during early growth). Planting activities of ramin species had been conducting by various stakeholders, either as enrichment planting or as rehabilitation effort of degraded peat soil. Ramin planting activities conducted by active HPH concessionaires to fulfill the requirement of TPTI guideline were difficult to evaluate in terms of its succes due to limited access to the areas.

Field survey to obtain data and information concerning ramin plantation activities has been carried out at eight sites in four provinces (Riau, Jambi, Central Kalimantan and West Kalimantan). The visited ramin plantation that established by HPH concessionaires, state forest enterprise, universities or research institutes and non-government organization were still within research scale. The age of the visited ramin plantations ranged between 1-7 years. The survival rate and growth increment also varied among them. The highest survival rate (100%) and the highest height increment (43.87 cm/ year) occurred in Sei Bakau, West Kalimantan. While, the highest diameter increment (0.73 cm/ year) found in PT. DRT, Riau.

To support and guarantee continuous ramin plantation activity, it is" suggested to keep and save existing seed stands and to establish seed orchard, either seedling seed orchard or clonally seed orchard.

Title	**:**	Population and Natural Regeneration of Ramin		
Author	**:**	Komar, T.E., B. Yafid & A. Suryamin		
Types	**:**	Report	**Year :**	2005
Publisher	**:**	Technical Repot No.12. ITTOPPD.7/03.Rev.2 (F). Ramin. Bogor: Forest and Nature Research and Development Center		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

The exploitation of ramin forests in Indonesia was started since 1970, almost in the same time as that of other Indonesian Tropical Forests. Based on collected data and information, it is indicated that the natural regeneration of ramin is poor, silvicultural system applied to ramin forest is not fully implemented and efforts to rehabilitate or restore ramin forest is still insignificant. These all have contributed to the great degradation of ramin forests throughout Sumatra and Kalimantan as primary ramin habitats in Indonesia.

Data and information on ramin populations and growing stock have been previously compiled by various agencies, such as government, state-owned and private companies and even Non- Government 0rganization, such as WWFand Telapak. However, recent data on the population and growing stocks are now limited to those areas with relatively higher accessibility, such as active forest concessions. Whereas from other areas, such as forest concessions which have been closed down since last several years ago and forest concessions which are not allowed to harvest ramin, recent data and information are almost impossible to obtain.

Data and information presented in this Technical Reports are complementary to the data and information obtained in Activity 1.1.1 of the Pre- Project (PPD87/03 Rev.2 (F)). Data and information in this technical report are obtained from a brief field survey carried out in two separate locations: Berbak National Park, in the province of Jambi, Sumatra which represents a primary (virgin) forests and Sebangau National Park, in the province ofCentral Kalimantan, Kalimantan which represents logged

over area (Secondary Forest). Additional data on ramin population and natural regeneration were also collected from other sources. Data and information presented in this report are expected to represent an overall situation in population and natural regeneration of ramin in Indonesia.

Based on the above collected data, it is indicated that ramin population and regeneration vary depending on the site and condition of forests. Results of this survey are described as follow: ramin in Berbak National Park, which represent primary and mature forest was dominant and the population was dominated by large and mature ramin trees. Ramin was in the first rank out of 36 forest tree species based on its value of the important value index calculated from overall species recorded. On the contrary, ramin was relatively rare in Sebangau National Park which represent a secondary (logged over area). In this forest, ramin was in the tenth rank out of 31 recorded forest tree species based on its value of the important value index and ramin trees were relatively small.

Natural regeneration indicated by the presence of seedlings and saplings was extremely poor in both site (Berbak National Park and Sebangau National park). The number of seedlings and saplings recorded from all plots was less than two. This poor natural regeneration is one of the primary threats to extinction of ramin species, even though earlier studies in other forests indicated rich of ramin natural regeneration. Otherthreats, especially to the remaining population are illegal logging, habitat degradation or conversion to other uses and frequent forest fires.

Title	:	Emission of Chemical Substances From Products Made of Exotic Wood		
Author	:	Thomas Witterseh		
Types	:	Report	**Year :**	2005
Publisher	:	The Danish Environmental Protection Agency		
Source/ link	:	http://www2.mst.dk/udgiv/publications/2005/87-7614-775-4/pdf/87-7614-776-2.pdf		

Abstract:

The purpose of this project is to analyse the emission of chemical compounds and to determine whether there are health risks connected with consumer products made of exotic wood when used at home. The main stress has been laid on the emission of volatile chemical compounds to the indoor air and to a less extent to the ingredients and compounds emitted from the products by migration into artificial saliva. The emitted compounds have been evaluated in relation to LCI-values and indoor-relevant time-values. It was also evaluated, whether the examined wood species can cause allergic reactions.

Title	:	Penggunaan Kaedah Dinamik Ultrasonik Bagi Menentukan Pemalar Kenyal Kayu Tropika		
Author	:	Abd. Aziz, Sidek and Shaari, Abdul Halim & Chow, Sai Pew		
Types	:	Report	**Year :**	1995
Publisher	:	Universiti Putra Malaysia Press		
Source/ link	:	http://psasir.upm.edu.my/3836/		

Abstract:

Kertas ini melaporkan penentuan pemalar kenyal 56 spesis kayu-kayan tropika menggunakan teknik dinamik ultrasonik. Gelombang membujur (45 kHz) digunakan untuk mengukur halaju pada arah ketakisotropan jejarian (R), tangen (T) dan longitud (L) bagi setiap sampel kayu. Pemalar kenyal bagi setiap spesis kayu ditentukan dengan menggunakan nilai halaju ultrasonik dan ketumpatan menerusi persamaart Christoffel. Hasil k~ian menunjukkan terdapat satu korelasi yang linear diantara pemalar kenyal dan ketumpatan kayu bagi arah L, R dan T. Perbandingan hasil pengukuran ulrasonik kepada hasil pengukuran statik menunjukkan teknik ultrasonik juga mampu digunakan untuk menilai kualiti sampel-sampel kayu tropika jenis sederhana dan keras.

Title	:	Technical Information on Optimum Harvesting Regimes of Peat Swamp Forests in Peninsular Malaysia		
Author	:	Ismail Parlan & Ismail Harun		
Types	:	Review	**Year :**	2011
Publisher	:	No information		
Source/ link	:	http://www.itto.int/files/user/cites/malaysia/		

Abstract:

Under the Forestry Act, the South East Pahang Peat Swamp Forest (SEPPSF) was gazetted as a permanent reserve forest (PRF) to be managed as a production forest. This allows logging activities to be carried out in the area but on a sustainable basis. The fact that there was still a lack of proper management system for the production peat swamp forest (PSF) prompted the Forest Research Institute Malaysia (FRIM) to undertake a specific study to develop an appropriate optimum harvesting system for the PSF. FRIM was allocated about RM790,000 by the Malaysian Government under the Levy Fund to determine the harvesting regimes for PSF in Peninsular Malaysia. In line with the objective of the UNDP/GEF funded project, the so-called "Harvesting regime study" has contributed to the Integrated Management Plan (IMP) and Forest Management Plan for Pekan Forest Reserve (FR), Pahang, particularly on the aspect of forest harvesting in the forest reserve.

In this study, Compartment 77 in Pekan FR was selected as the study site. The area is a productive rich forest of Ramin-Bintangor subtype located northeast of the forest reserve. The Ramin-Bintangor subtype represents about 20% (~ 10,000 ha) of the whole Pekan FR. An area of 100 ha in Compartment 77 was allocated for this study to present actual harvesting practices on the ground. The study area was divided into four blocks of 25 ha each for the testing of different cutting options developed by the project. Four sets of cutting regimes were developed based on primary and secondary data collected. The cutting regimes were prepared by taking into account species dominance in the area, volumes of timber to be taken out

and numbers of residual trees and main species to be retained as future crops.

The cutting regimes were tested using the Rimbaka timber harvester (RTH) or simply called as Rimbaka. The machine is employed in one type of reduced impact logging (RIL) method. After the harvestings, post-harvest assessments were conducted to determine the impacts of each cutting option on the forest stands. In the assessments, actual damage on the residual trees from the different cutting regimes due to the harvesting operations was assessed. Besides the physical and ecological assessments, financial evaluation was also conducted. These assessments were used to determine the final harvesting regime considered the most suitable for the PSF.

Based on the damage assessments, there were 2,396 trees >15 cm dbh in the 100 sampling plots of 50 x 20 m. Out of this number, 2,055 trees (86%) survived and another 341 trees (14%) died. Out of the trees that survived, 1,520 (63%) trees showed no damage at all while 535 (22%) had some damage. Meanwhile, of the trees that died, 396 trees (11%) died due to felling activity and another 67trees (3%) died because of extraction by the Rimbaka. Nonetheless, focus was given to the damage on trees with dbh > 30 cm as these are trees considered as residual stands. All together there were 848 trees > 30 cm dbh in the sample plots, in which 755 (89%) survived and the remaining 93 trees (11%) died. Out of the 755 trees that survived, 546 trees had no damage at all while 209 trees showed some damage on their crowns, stems, roots or their combinations. Interestingly, there were 106 trees of *Callophyllum* spp. (bintangor) and 87 trees of *Gonystylus bancanus* (ramin melawis) that were not damaged at all. Both species are the main commercial timber species of the residual stands. Among those trees that had some kind of damage, 91 trees (44%) had light, 49 trees (23%) medium and 70 trees (33%) serious damage respectively. Trees in the light and medium categories of damage are expected to survive at least for a certain number of years, while those having serious damage are expected to die within a short time.

Based on the assessments, in general tree survival using RIL was high at 86% and 89% for categories of trees with dbh of >10 cm and >30 cm respectively. Moreover, a high number of trees that had no damage at all was recorded. In addition, in the case of residual stands (trees >30 cm), of trees with some kind of damage only about 33% had serious damage that

may lead to their mortality. Apart from that, felling was found to be the main reason for mortality at 11% compared to extraction at only 3%. Therefore, it can be concluded that the RIL causes minimum impact on the residual stands and timber extraction contributes only a small portion of trees that die during the harvesting operation.

A yield projection model called Growth and Yield Model for Tropical Peat Swamp Forest (GYMTPSF) is being developed as another output of this study. The GYMTPSF was originally developed for dry inland forest. Calibration has been made on the original software to suit the PSF data and environment. Among others, the GYMTPSF can be used to project stand tables of stocking, basal area, volume and mean annual increments (MAIs). Based on these studies, volume mean MAIs and optimum cutting cycles are projected. The volume MAI for each block is not far different from the next, in the range of 1.75–1.88 m^3ha^{-1} yr^{-1}, while the optimum cutting cycle varies in the range of 35–40 years depending on the block.

In terms of timber production, the total timber production in the study area of 100 ha was 8,698.9 m3. Apparently, due to the lower cutting regime, Block 1 had the highest timber production, followed by Blocks 2, 3 and 4 at 110.5, 106.1, 80.1 and 51.2 m^3ha^{-1} respectively. The total cost of timber harvesting in the study site was RM22,476.70 ha^{-1}. The cost of felling consumed the largest portion of 51.42% followed by administration and pre-felling costs at 46.44 and 2.16% respectively. Based on the financial evaluation, the analysis gave positive net present value (NPV) for timber harvesting in Blocks 1 to 3 but negative value in Block 4. Therefore timber harvesting is viable in Blocks 1, 2 and 3, but not in Block 4. The productivity of the main activities and machinery used in the harvesting operation employing RIL such as felling and haulage was also examined in this study. The hydrological response to road construction and forest logging is also discussed and reported. Last but not least, a local volume table (LVT) was produced to be used for more accurate estimation of *G. bancanus* logs in Pekan FR.

As conclusion, this study has produced outputs that can contribute to optimum harvesting of PSF, in particular for Pekan FR. In terms of cutting limits, this study suggests the cutting limits of Block 3 to be used in the Ramin-Bintangor subtype. The cutting limits are 60 cm for *G. bancanus* and dipterocarps, 50 cmfor *Calophyllum* spp. and 45 cm for other species. For cutting cycle, the 40-yr cycle is recommended. Encouragingly, the cutting

limits and cycle are being used in the Forest Management Plan for Pekan Forest Reserve prepared by the UNDP/GEF PSF Project. It is hoped that the outputs of this project can be used and contribute to better understanding of the PSF ecosystem in Peninsular Malaysia, mainly for the sustainable utilization of timber resources.

Title	**:**	Review on Trade Data Collection Monitoring and Trade Control		
Author	**:**	Puja Utama		
Types	**:**	Review	**Year :**	2011
Publisher	**:**	No information		
Source/ link	**:**	http://www.itto.int/files/user/cites/indonesia/		

Abstract:

Ramin adalah nama perdagangan untuk beberapa jenis pohon dari marga Gonystyus anggota suku *Thymeleaceae*. Kelimpahan habitat telah menjadikan Ramin sebagai salah satu jenis tumbuhan liar atau kayu yang diperdagangkan dan memiliki nilai ekonomi tinggi. Kayu Ramin ini diperdagangkan dalam berbagai bentuk produk mulai log hingga finished product. Permintaan dunia internasional terhadap ekspor kayu Ramin dan produk-produknya telah menyebabkan eksploitasi Ramin secara besar-besaran. Pada tahun 2001 pemerintah mengeluarkan kebijakan penghentian sementara penebangan dan perdagangan Ramin melalui Keputusan Menteri kehutanan No. 127/Kpts-V/201 tanggal 11 April 2001. Pertimbangan utama kebijakan ini dikarenakan populasi Ramin yang sangat menurun serta maraknya penebangan kayu Ramin secara liar yang telah merambah hingga ke kawasan konservasi. Karena Ramin sudah dianggap mulai langka dan perdagangan internasionalnya cukup tinggi, maka pada tahun 2001 jenis *Gonystylus* spp. dimasukkan kedalam daftar Appekdiks III CITES, sehingga perdagangannya dikontrol melalui mekanisme CITES. Sejalan dengan makin langkanya potensi kayu Ramin di alam dan adanya kebutuhan perdagangan internasional akan kayu tersebut, perlu diambil langkah-langkah untuk pengendalian jenis tersebut termasuk perbaikan koleksi data perdagangan kayu Ramin. Untuk itu perlu dilakukan kajian pada koleksi data perdagangan kayu Ramin yang ada saat ini, informasi monitoring dan kontrol perdagangan. Maksud penulisan kajian ini adalah untuk memperoleh data dan informasi tentang perdagangan kayu Ramin, informasi sistem monitoring dan pengawasan perdagangan kayu Ramin. Tulisan ini bertujuan mengetahui koleksi data perdagangan kayu Ramin, dan efekstivitas serta efisiensi sistem monitoring dan kontrol perdaganga kayu Ramin. Data yang dikumpulkan dalam kajian

ini yaitu data perdagangan kayu Ramin, khususnya data ekspor, informasi monitoring dan kontrol perdagangannya. Data perdagangan kayu Ramin yang dikumpulkan dari beberapa instansi yang menangani peredaran kayu Ramin yaitu Otorita Pengelola CITES dan Badan Revitalisasi Industri Kehutanan (BRIK) serta dari pihak industri. Kegiatan kontrol ini menyangkut beberapa measurement yaitu peraturan perundangan yang berlaku, ketersedian dokumen yang sah dan petugas yang melakukan monitoring dan kontrol perdagangan kayu Ramin serta alat monitoring kontrol khususnya pemberlakuan HS code. Secara keseluruhan mekanisme kontrol mulai dari hulu hingga hilir yaitu yang dimulai dari pemanenan hingga di pelabuhan dianggap cukup terpadu dan efektif. Dari hasil kajian, data realisasi eksport yang bersumber dari Otorita Pengelola CITES dengan BRIK terjadi perbedaan hal ini disebabkan oleh beberapa hal diantaranya : Dokumen SATS-LN atau CITES permit yang diterbitkan Otorita Pengelola CITES tidak seluruhnya direalisasikan oleh pihak industri demikian pula Otorita Pengelola CITES tidak menerima hasil laporan realisasi ekspor dari perusahaan; penyebab lain rendahnya realisasi ekspor kayu Ramin, khususnya terkait rendemen kayu Ramin, menurut Haygreen (1996) dalam Arif Nuryawan (2008) dan Julius Zakson Sigiro (2010), bahwa besarnya rendemen untuk mengubah kayu bulat (log) menjadi lumber di kilang penggergajian bervariasi antara 30-70% dengan limbah berupa serbuk gergaji, slabs, trimming, atau chip. Sedangkan menurut Tim Terpadu Ramin (2005) rendemen kayu olahan Ramin adalah sebesar 50-60%. Dari hasil kajian dapat disimpulkan bahwa perlu studi yang lebih luas mengenai potensi Ramin Indonesia apakah ada perusahaan lain yang kemungkinan dapat memanen Ramin juga; data pemanfaatan Ramin di dalam negeri belum tercatat dengan baik, sehingga untuk kedepannya perlu diciptakan mekanisme pencatatan data pemanfaatan dalam negeri ; data terkait realisasi ekspor antara Otorita Pengelola CITES selaku penerbit SATS-LN dan BRIK selaku penerbit endorsement masih terjadi discrepancy sehingga perlu digali penyebab perbedaan data dimaksud; Mekanisme kontrol saat ini dianggap efektif baik di hulu maupun di hilir, pemantauan harus senantiasan dilakukan secara berkala di lokasi penebangan Ramin untuk memeriksa kesesuaian volume penebangan dengan kouta tebang yang telah ditetapkan dan perlu meningkatkan koordinasi yang lebih terarah terarah antara Dinas Kehutanan, BKSDA, dan Bea dan Cukai dalam meningkatkan penegakan hukum.

Title	:	Evaluation on Antioxidant Activity, Antifungal Activity and Total Phenols of 11 Selected Commercial Malaysian Timber Species
Author	:	Fumio Kawamura, Nurul Atiqah Shaharuddin, Othman Sulaiman, Rokiah Hashim & Seiji Ohara
Types	:	Review **Year :** 2010
Publisher	:	No information
Source/ link	:	https://www.jircas.affrc.go.jp/english/publication/jarq/44-3/44-03-12.pdf

Abstract:

Antioxidant activity [1,1-diphenyl-2-picrylhydrazyl (DPPH) assay], antifungal activity against *Gloeophyllum trabeum* (brown-rot) and *Pycnoporus sanguineus* (white-rot), and total phenol content (Folin-Ciocalteu method) of 11 selected commercial Malaysian timbers were investigated. The extracts from Neem bark showed the highest yield, 25.59%. Kelat gelam bark showed the highest antioxidant activity, followed by Kelat jambu air bark. The extracts that showed the four highest antioxidant activities were all taken from bark samples. These extracts also showed high yields of methanol extracts and high total phenol content, suggesting that they have great potential as a source of antioxidant material. The highest total phenol content was found in Neem bark, while the lowest was in Ramin melawis bark. The methanol extracts from the heartwood of Neem showed the highest antifungal activity against *G. trabeum*. The methanol extracts from the sapwood and the heartwood of Neem, and the heartwood of Kulim showed the highest antifungal activity against *P. sanguineus*. The antifungal activities of these methanol extracts were higher than those of the positive control, glycyrrhizic acid dipotassium salt. Almost all wood species showed antifungal activity against either brown- or white-rot fungus. However, methanol extracts from the heartwood of Neem showed strong antifungal activity against brown- and white-rot fungi, *G. trabeum* and *P. sanguineus*, suggesting that they have great potential as a source of fungistats.

Title	:	Improving Inventory Design to Estimate Growing Stock of Ramin (Gonystylus bancanus) in Indonesia		
Author	:	Hilman Affandi, Suwarno Sutarahardja, Siti Nurjanah & Dian Tita Rosita		
Types	:	Review	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Efforts to improve management practices of *Gonystylus bancanus* in Indonesia have been taken through various activities. This includes efforts by the Ministry of Forestry to issue various policies on ramin, especially those related to logging activities. Since 2001, the logging moratorium on ramin has been imposed to provide space and time for ramin, especially in logged-over areas to recover. In the same year, ramin was also listed in CITES Appendix III, meaning that the harvest of ramin should received a prior harvest permit from a Management Authority of CITES, which is the Ministry of Forestry- Both the logging moratorium and listing of ramin in the CITES Appendix are aimed to assist the control of both domestic and international trade in ramin.

Obtaining accurate and reliable data is always a difficult problem in forest management. For specific forest ecosystem like the peat swamp forests (PSF), there are some limitations in obtaining the data not only on the availability to utilize current modern technology, but also the readiness of human resource in forestry to capture and utilize the technology for collecting field data. The unavailability of accurate data frequently causes misleading information and mismanagement of the PSF. For example, ITTO PPD8T/03 Rev. 2 — Identification of *Gonystylus spp.* (Ramin), Potency, Distribution, Conservation and Plantation Barrier has made- estimation on the standing stock of ramin in 2005 where the data may be under-estimated or over-estimated due to limited access to use more reliable technology. The estimation was mostly based on the results of pre-inventory cruising carried out by each company. Additional data were the result of interpolation from growth data from other sources. These data, however, bear some fundamental weaknesses primarily due to lack of appropriate inventory methods, extremely low sampling intensity, poor

supervision and lack of cross-checks. The estimation by utilizing satellite images (technology) is predicted to be more cost-effective and able to obtain more accurate data for peat swamp forests with specific characteristics of poor accessibility.

The objective of the project is to develop an inventory design for ramin in peat swamp forest areas in Sumatra and Kalimantan for estimating the standing stock of ramin. Peat swamp forest is a unique ecosystem characterized by vegetation, peat and excess of water for long period of time causing poor accessibility in most parts of the area. This poor accessibility has caused the pre-harvest inventory carried out by forest concession companies to be least optimal and this has led to, perhaps, under- or over-estimates of the standing stock. For CITES-listed species like ramin, this will influence harvest quota and the non-detrimental findings (NDF). Selection of stems to be cut and core trees in this area take more time than that in dry land forests, such as in the lowland forest areas. The project is, therefore, aimed to develop an inventory design by utilizing satellite technology to obtain relatively more accurate data and information on the standing stock of ramin.

Ramin (*G. bancanus*) is found growing in peat swamp forests in Sumatra and Kalimantan. The habitat is characterized by relatively poor accessibility compared to the dry land forests, such as lowland forests and even hill forest habitats. Before logging, under the current silvicultural system, the Selective Cutting with Enrichment Planting (TPTI), it Is required to carry out a pre-harvest inventory (cruising) to estimate the standing stock, not only for ramin but also for the other species found growing in the forest. The critical problem in carrying out the inventory in PSF, not only for harvest but also to estimate the overall standing stock, is the accessibility, which is mostly poor as described earlier. This poor accessibility has caused inventory in PSF to be costly and laborious. Large amount of resources spent for field inventory has resulted, in practice, only small portion (very small sampling intensity) of the target area being sampled. Collection of data from very low sampling intensity will produce less accurate and/or unreliable data, either under-estimated or over-estimated standing stock. For ramin, this condition is more critical, since ramin is growing in scattered clumps and not homogenously distributed in the forest area. The project is expected to produce an acceptable inventory design (method) to estimate standing stock for ramin (*G. bancanus*) growing in PSF in Sumatra and Kalimantan. By reviewing all the existing

methods for inventory (pre-harvest inventory), stakeholder consultation and exploration of technology (satellite imagery or remote sensing), the relatively low cost and more accurate method or design will be obtained. The project is also expected to produce relatively more accurate estimation of the current standing stock of ramin in most of the production forest areas in Sumatra and Kalimantan.

The inventory design (method) and its related technology are also expected to be useful for estimating the standing stock of the other species having relatively similar botanical characteristics with ramin. Forest concessionaire, whose working areas are in peat swamp forest, is expected to gain the benefit from this inventory design.

Title	:	Sustainable Management of Peat Swamp Forest of Sarawak With Special Reference to Ramin (*Gonystylus bancanus*) : Development of A Monitoring System		
Author	:	Wijdeven, S.M.J., Meer, P.J. van der, Chai, F.Y.C., Tan, S., Mohizah, M. & Liam, D.		
Types	:	Review	**Year :**	2004
Publisher	:	Wageningen : Alterra		
Source/ link	:	http://library.wur.nl/WebQuery/clc/1751046		

Abstract:

Peat swamp forests in Sarawak are valuable in terms of timber and biodiversity, but heavily degraded. In order to assess the current status, potential developments and possible management interventions, an adequate monitoring system is necessary. In this study a new monitoring system is proposed, based on an evaluation of the current system combined with the identification of present PSF values. Adjustments include the monitoring of all woody species in all size classes, the monitoring of standing and fallen dead wood and the monitoring of environmental factors such as hydrology and peat depth. Moreover, the protection and monitoring of primary, undisturbed PSF is of paramount importance in the light of conservation of biodiversity and the design and evaluation of management interventions.

Title	:	The Massive Exploitation of Peat Swamp Forest Potentiality Has Not Successfully Increased The Local People's Prosperity In Central Kalimantan		
Author	:	Suwido Limin & Patricia Erosa Putir		
Types	:	Review	**Year :**	1999
Publisher	:	No information		
Source/ link	:	http://www.splu.nl/strapeat/download/9%20massive%20exploitation.pdf		

Abstract:

The total area of forest in Central Kalimantan is approximately 15,356,400 ha (or 90% of the total area of Central Kalimantan). 2651,724 ha, or 17,27% of the area above is still covered by peat soil, and also as the habitat of various forests which are having high economic values. Some of them are Ramin (*Gonystylus bancanus Kurtz*), Jelutung (*Dyera costulata*), Meranti Rawa (*Shorea spp*), dan Gemor (*Alseodaphne spp*). It is true that timber is the leading commodity of Central Kalimantan within the last three decades, as it has contributed the largest portion of Indonesian foreign exchange after oil and gas. The management of forest potentiality has been carried out by the owners of forest concession, which is legally arranged under the law of forestry along with its implementation guidelines. The decree of minister of Forestry number 485 /KPTS – II/ 1989, stated that the management of productive forest can be worked out by sylvi-culture system, as known by "Tebang Pilih Tanam Indonesia (TPTI), selective cutting system. This method must be executed by every forest concession owner, which is clearly stated in the "Rencana Karya Lima Tahun" (RKLT) the five years work planning as well as in the "Rencana Karya Tahunan (RKT), the annual work planning. The formulation of RKLT and the RKT is based on the survey finding in the field is aimed at regulating the cutting cycle within every forest concession. In this way, it is hoped that within a certain period of time (cutting cycle 35 years), the tree will have reached cutting criteria and could be exploited. The establishment of various acts as well as their guide-lines is aimed at maintaining sustainable production of forest. However, the application of those acts in the field seems to be inconsistent. The inconsistency of the law mentioned above is clearly proven. In many cases, the forest concession owners have broken the law

as they exceeded the cutting limit as stated in the effective forest acts. The condition of forest management as mentioned above has been going on for a long time and it will be going on and on in the future. This is due to the vested interest of the decision- makers. Consequently, illegal logging has proliferated all over Indonesia. Although illegal logging activities have been tolerated as what is going on up to the present, it is proven that illegal logging activities have not been successfully increased the prosperity of the local people.

Title	:	Quality Increase of Colour of Several Wood Species Using Perhydrol as Substitutes of Ramin (*Gonystylus bancanus* Wood)		
Author	:	Iskandar & Toto, B.M		
Types	:	Review	**Year :**	1994
Publisher	:	No information		
Source/ link	:	http://agris.fao.org/aos/records/ID9700098		

Abstract:

This paper proposed an experiment of increase quality color some kinds wood with perhydrol for substitute ramin (*Gonystylus bancanus*) wood. The purpose research is increasing quality color rubber (*Hevea brasilliensis*), sungkai (*Peronema canescens*) and meranti (*Shorea sp*) wood to can be resemble or as substitute ramin wood. The result shown that color rubber, sungkai and meranti wood can be increase will as substitute ramin wood after treatment a soaking perhydrol in consentration at 0,5 percent, 1 percent and 1,5 percent

Title	:	A Note on A Laboratory Method for Estimating Durability of Some Tropical Hardwoods		
Author	:	L. T. Hong & K. Yamamoto		
Types	:	Review	**Year :**	1989
Publisher	:	Journal of Tropical Forest Science 2(2)		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v2n2/167-170.pdf		

Abstract:

The natural durability of timbers is determined from data obtained through field trials by long term exposure of the timbers to biodegrading organisms in the field (Jackson 1957). The Forest Research Institute Malaysia has used this procedure for classifying natural durability of timbers and a revision of the durability classification of some Malaysian timbers has been published (Mohd. Dahlan & Tam 1985). Such tests give good estimates of the natural durability because the timbers are exposed to both types of biodeteriorating agents, but a long time is needed to obtain meaningful data. Standard laboratory testing procedures for estimating fungal decay and insect resistance have been established (Anonymous 1980, Anonymous 1985). In a tropical environment the natural durability obtained by field trials is further complicated by the presence of termites. Very often susceptible timbers are completely destroyed by termites between three to six months of exposure. Therefore it becomes more difficult to relate laboratory data to field data for durability assessment. It is with this consideration in mind that a laboratory decay assessment was carried out on 17 timbers and the data obtained were compared with field data for evaluation. A summary of the study is presented here.

Title	:	High Resolution Airborne Hyperspectral Data for Mapping of Ramin Distribution in Peat Swamp Forest		
Author	:	Mohd Azahari Faidi, Khali Aziz Hamzah & Hamdan Omar		
Types	:	Bulletin	**Year :**	2011
Publisher	:	FRIM-ITTO-CITES Publication		
Source/ link	:	Forest Research Institute Malaysia		

Abstract:

Peat swamp forest (PSF) is the largest of the wetland forests in Malaysia and consists of some of Malaysia's endangered tree species such as *Gonystylusbancanus*. This species has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and as such needs better management and control. Among others, spatial distribution information on the species in the natural environments need to be identified and mapped. The developments of airborne hyperspectral remote sensing have provided new opportunities for mapping this tree species at a landscape scale. A recently concluded study in Malaysia's tropical peat swamp forest exhibited a promising use of airborne hyperspectral data for mapping *G. bancanus* distribution. The study was conducted in Pekan Forest Reserve, Pahang, using HySpex VNIR -1600 airborne hyperspectral data with the spatial resolution of 0.5 meter and spectral range of 400 nm to 1000 nm. It was found that the HySpex airborne hyperspectral data have good capability to discriminate individual canopy layer tree species in mixed peat swamp forest. The distribution of *G. bancanus* in the natural peat swamp forest could be mapped with an accuracy of 86%. It is anticipated that with the availability of accurate information on the *G. bancanus* population derived from airborne hyperspectral data, better management of the species for both conservation and sustainable use can be undertaken.

Title	**:**	Implementing Ramin's CITES Listing		
Author	**:**	Chen Hin Keong		
Types	**:**	Bulletin	**Year :**	2007
Publisher	**:**	ITTO Tropical Forest Update 17: 3–6		
Source/ link	**:**	www.itto.int/direct/topics/		

Abstract:

Ramin is a timber trade name encompassing 31 species of the genus *Gonystylus* (*Thymelaeaceae*). The genus occurs in the tropical forests of Southeast Asia and the Pacific islands and it produces a whitish timber which is highly prized and popular for decorative uses. The most valuable species, *Gonystylus bancanus*, is found in the peat swamp forests of the region. Due to the timber's wide acceptability and use, ramin has been heavily exploited in the countries of origin. In the attempt to curb detrimental population loss, Indonesia included the genus *Gonystylus* in the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) Appendix III with annotation #1 with effect from 6 April 2001. Annotation #1 states that all trade in ramin parts and derivatives, with a few exceptions like seeds, seedlings and tissue culture, have to be accompanied by a CITES permit or certificate. At the 13th Meeting of the Conference of the Parties to CITES held in Bangkok, Thailand, from 2 to 14 October 2004, the genus was uplisted to Appendix II, with the listing entering into force on 12 January 2005.

Title	:	Durability of Timbers for Indoor Applications in Malaysia		
Author	:	S. Ani, S. Salamah, M.J. Dahlan, U. Salmiah, & K. Roszaini		
Types	:	Bulletin	**Year :**	2005
Publisher	:	Forest Research Institute Malaysia, 52109 Kepong, Selangor Darul Ehsan		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The durability of timber is defined as the degree of resistance to deterioration by the whole range of biological, chemical, mechanical and physical wood-destroying agents; or simply as the number of years the timber can last under a particular service condition, against wood destroying organisms and the elements of the weather (Willeitner & Liese 1992; Zabel & Morell 1992; Eaton & Hale 1993). The natural durability of timber, however, usually refers only to its degree of resistance to attack by biological agents. Resistance of wood to fungal and insect attack varies enormously from one species of timber to another. No wood is completely and permanently resistant to all forms of biodeterioration. However, some woods such as Chengal *(Neobalanocarpus heimii)* and Balau *(Shorea maxwelliana)* will endure fungal and insect attack for many years while others such as Jelutong *(Dyera costulata)* and Rubberwood *(Hevea brasiliensis)* are highly susceptible to decay (Jackson 1957; Dahlan & Tam 1985, 1987). Factors affecting durability are diverse of which some are related to conditions within the wood itself while others are due to circumstances pertaining to its use. The durability classification of timbers is usually based on the results of field trials, where assessments are made on the actual performance of each individual species against fungal and termite attacks. The first scries of field tests for Malaysian timbers were started in 1918 at a site within the Weld Hill Forest Reserve, Kuala Lumpur and the results were published by Foxworthy & Woolly (1930). Tests were continued but at new sites in the Forest Research Institute Malaysia (FRIM), Kepong. Durability results reported by Jackson (1957) were based on data from the new test sites at Kepong after inspection in July 1956.

Subsequently, two more reports on the durability of Malaysian timbers were published, summarizing the durability rating of more than 200 timber species from Peninsular Malaysia (Dahlan & Tam 1985, 1987). These limbers were grouped into four durability classes ranging from nondurable to very durable, depending on their years of service life. The graveyard tests were conducted under extreme environmental conditions, where the situations were favourable to the wood attacking organisms but not to the timber samples.

The main purpose of the field trials is to provide general comparison of the relative natural durability of various timber species at particular service conditions. When the same timbers are used under a more favourable environment, they are expected to give a much better performance in terms of service life. Service life of limber refers to the usefulness of the timber in its finished form while in usage before it is destroyed by fungi or termites. The length of service life of timbers resulting from the graveyard test has been misconstrued as being similar to other uses in milder and less severe conditions. This is a very common misconception in the durability rating, even among experienced timber users. Timbers that are supposed to be rated on their durability for usage outdoor was indiscriminately used to rate timbers intended for indoor applications. This resulted in incorrect assessment of timber durability when the intended application is dissimilar. To date, there is no published data on the serviceability of timbers for indoor applications in Malaysia. This article presents the estimated service life of timbers for indoor applications derived from observations made on wood samples kept above ground and under shelter over a long period of time. This estimate is useful for approximating the durability of these timbers under indoor applications.

Title	**:**	Shrinkage Allowance of Some Malaysian Timbers		
Author	**:**	K. T. Choo, H. S. Sik, S. C. Lim & K. S. Gan		
Types	**:**	Bulletin	**Year :**	2005
Publisher	**:**	Forest Research Institute Malaysia, 52109 Kepong Selangor Darul Ehsan		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

The shrinkage of wood normally occurs when the moisture content (mc) dips below the fibre-saturation point (FSP), which in most cases, ranges from 25% to 30%. The magnitude of shrinkage of a piece of timber is not equal in all directions, but is significantly different across the grain in both the radial and tangential directions. While the relation of radial to tangential shrinkage varies considerably in different woods, the average tangential shrinkage for all woods is approximately twice the radial shrinkage. For the purpose of comparison, the usual method of measuring shrinkage is to determine the total contraction undergone in shrinking from the fully 'expanded' condition at saturation to the oven-dry condition. Grewal (1979) reported that the average radial shrinkage of Malaysian woods (from green to oven-dry) ranges from 1.6% in meranti bakau *(Shorea uliginosa)* to 7.3% in penaga *(Mesua ferrea).* The average tangential shrinkage ranges from 4.4% in meranti bakau *(Shorea uliginosa)* to 13.5% in keruing merah *(Dipterocarpus verrucosus).* The slight longitudinal shrinkage may be disregarded in practice, as its total amount is minimal when compared to the total length of the board, except for woods which contain a large amount of juvenile or tension wood e.g. rubberwood (*Hevea brasiliensis)* (Lim & Ani 1979).

This article attempts to present to the timber processors a relatively quick and practical way of estimating the shrinkage allowances at 3 common mc levels of 10%, 15% and 20% which approximately correspond to ⅔, ½ and ⅓ respectively of the total shrinkage at oven-dry condition.

Title	**:**	A study of Site Suitability of *Gonystylus sp.* in Jambi Province		
Author	**:**	Butarbutar T, Harahap RMS & Sunarto		
Types	**:**	Bulletin	**Year :**	2000
Publisher	**:**	Balai Penelitian Pematang (BPK) Siantar, Bul. 15 (2) : 59-72		
Source/ link	**:**	Balai Penelitian Pematang (BPK) Siantar		

Abstract:

A preliminary study was made of the planting suitability (silvicultural characteristics) of *Gonystylus sp.* in the forest concession at PT Putra Duta Indah Wood in Jambi Province, North Sumatra. The planting areas were logged-over, or a burned area which was previously occupied by ground vegetation. The strip planting system was used. Growth data presented at 9 yr old show that the soil and climate in this research area were suitable for planting ramin.

Title	:	Kalimantan Ramin and Agathis, Where Do You Come From and How Are You Harvested?		
Author	:	Laurent, D.		
Types	:	Bulletin	**Year :**	1986
Publisher	:	No information		
Source/ link	:	No information		

Abstract:

Ramin especially, Agathis are the main harvested in Swamp forests. The economic importance of this resource is briefly dealt with in the introduction. The author first gives the natural context and the potential of the swamp forest, then he describes at length the modes of forest harvesting: the companies, their organization, structure, importance, methods and techniques. These entirely manual techniques are unique. We know of no other such example, at an industrial level, in the tropical world. A chapter is devoted to the river transportation of Ramin and of poorly-floating species logged in this forest. Harvesting and floating then analyzed from the yield and cost point of view in another chapter. So as to widen the scope beyond the swamp forest, the conclusion brings some basic data about the Indonesian economy and thus show the development in progress; it ponders over the participation of some foreign partners in the process.

Title	:	100 Malaysian Timbers 2010 Edition		
Author	:	Malaysian Timber Industry Board (MTIB)		
Types	:	Book	**Year :**	2010
Publisher	:	Malaysian Timber Industry Board (MTIB)		
Source/ link	:	MTIB Library		

Abstract:

Contains a comprehensive technical description on 122 species of Malaysia timbers of commercial value. Each entry covers a particular timber's Standard and Botanical name including its Family group, its distribution, general description, its properties and its uses. Every timber type is illustrated in colour, allowing for easy identification.

Title	:	CITES & Timber: Ramin		
Author	:	Garrett, L., H.N. McGough, M. Groves & G. Clarke		
Types	:	Books	**Year :**	2010
Publisher	:	Royal Botanic Gardens, Kew		
Source/ link	:	No information		

Abstract:

Ramin (*Gonystylus spp.*) is a light tropical hardwood tree genus. There are some 30 species of Ramin, all of which are native to the peat swamp forests of Southeast Asia, including Brunei Darussalam, Fiji, Indonesia, Malaysia, Singapore, the Solomon Islands and the Republic of the Philippines. Of those species found in commercial trade, *Gonystylus bancanus* is the most heavily exploited. This paper describes Ramin trade, the Ramin parts and derivatives frequently seen in trade and those which are regulated, and methods for identifying and differentiating Ramin wood.

Title	**:**	Timber Trees: Major Commercial Timbers		
Author	**:**	Soerianegara, I. & Lemmens, R.H.M.J.		
Types	**:**	Books	**Year :**	1993
Publisher	**:**	Prosea Foundation, Bogor, Indonesia & Wageningen, Netherlands: Pudoc Scientific Publishers		
Source/ link	**:**	No information		

Abstract:

An introductory chapter is presented on definitions, the role of timber trees, grouping of timbers, botany, ecology, properties, processing, forest management, silviculture, harvesting, agroforestry and urban forestry, forest and timber policy, biodiversity, conservation and breeding, forestry research in South East Asia and prospects. This is followed by information on individual timbers (listed alphabetically by genus) with regard to nomenclature, distribution, uses, and the various aspects covered in the introduction. Tables are presented on the physical and mechanical properties of selected species. Also included are a bibliography, a glossary and indexes of scientific and vernacular names.

Title	:	Seasoning and Handling of Ramin		
Author	:	John M. McMillen		
Types	:	Books	**Year :**	1967
Publisher :		U.S. Forest Services Research Note FPL, Volume 172		
Source/ link	:	No information		

Abstract:

One of the imported woods that is finding increasing use for specific purposes is ramin (*Gonystylus spp.*). It originates in the Southwest Pacific and has seasoning properties somewhat like oak. Many importers, custom dryers, and users are not aware of the special seasoning and handling requirements of this wood. As a result, some firms have experienced heavy losses. This note brings Suggestions that should greatly reduce or eliminate these losses.

Title	:	Phenology, Habitat Specialization and Reduced Impact Logging of *Gonystylus (Miq.) Kurz* in Pekan Forest Reserve. Pahang
Author	:	Ismail Parlan
Types	:	Thesis (PhD) **Year :** 2009
Publisher	:	Universiti Kebangsaan Malaysia (UKM)
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Relevant studies need to be conducted on *Gonystylus bancanus (Miq.) Kurz* or locally known as Ramin melawis to obtain sufficient data and information of the species. Hence, there were three general objectives of this work and therefore three main studies; i.e. phenology, habitat specialization and harvesting impacts of *G. bancanus* were conducted. All of these studies were conducted in Pekan Forest Reserve, Pahang. It was found that the flowering type for *G. bancanus* is supra-annual. Based on this study, one important factor that possibly triggers *G. bancanus* to flower was period of flooding. It was found the species flowered in a situation of prolonged flooding due to the longer monsoon season. The smallest *G. bancanus* tree observed to flower was 29.0 cm in diameter located in a logged-over site. Nonetheless, most of trees that flowered were those having larger diameter of more than 40.0 cm, either in logged-over or virgin forests. A total of 71-86 days was recorded for full development from bud to matured fruit formation. The budding developing phase was fairly long, more than a month; however, it took a relatively short period for the flower to become fruit of only about two weeks. Flowers of *G. bancanus* were pollinated by thrips (*Heterothripts sp.*) and stingless bees (*Trigona canifrons* and *T. laeviceps*). Identified predators of the G. bancanus flowers and fruits are aphids (*Aphis sp.*), Prevost's squirrel (*Callosciurus prevostii*) and Plantain squirrel (*C. notatus*). *Gonystylus bancanus* seed is dispersed naturally by normal gravity. In addition, Malayan flying fox (*Pteropus vampyrus*) was identified as the animal species that disperses the fruits. Some fruit bats, namely *Cynopterus sphinx, Megaerops ecaudatus* and *Penthetor lucasi* were also identified as the potential seed dispersal agents of *G. bancanus*. Factors for the specialization of *G. bancanus* in certain

habitats in the peat swamp forest (PSF) were analyzed using canonical correspondence analysis (CCA). Areas with deep peat depth, preferably more than 6 m were found to have more *G. bancanus* stands. In terms of nutrients, it was found that *G. bancanus* was closely associated with macronutrients of magnesium and nitrogen. The species was also found to dominate areas with relatively high water-table and high organic matter content. The cluster analysis revealed that only *Syzygium inophyllum* was found to be associated strongly with *G. bancanus*. Based on the damage assessment survey, percentage of survival of *G. bancanus* trees after the harvesting operation using reduced impact logging (RIL) method of Rimbaka was considerably high, between 84.6 and 94.7 percent. Most of the survived *G. bancanus* trees were recorded in diameter classes of 30.0 - 44.9 cm and 45.0-59.9 cm. The survey showed that all species including *G. bancanus* recorded damage on the crown as the main damage, followed by stem and root damage. Most of the survived *G. bancanus* trees that were suffered damages were under the light damage category, and therefore the trees were expected to continue to survive as good residual stands. The average damaged and dead residual stands of all species including *G. bancanus* in this study area amounted to about 36.5 percent in which total heavy damaged and dead trees contributed to aboud 11.4 and 14.3 percent, respectively. As for *G. bancanus* alone, average percentage of damaged and dead trees was at 25.0 percent of total surveyed *G. bancanus* stands in which the heavy damaged and dead trees represented with 4.1 and 10.6 percent, respectively. An average of 90.2 percent of damaged and 81.5 percent of dead trees of all species resulted from the felling operation. Thus, the extraction operation was much less destructive, causing only about 9.8 percent of the all damage and 18.5 percent of the dead trees. It showed that the RIL method had successfully produced relatively low damage and mortality of the residual stands and therefore should be encouraged to be used in timber harvesting at the PSF areas.

Title	:	Keanekaragaman Genetik Ramin (*Gonystylus bancanus Miq. Kurz*) Di Cagar Biosfer Giam Siak Kecil-Bukit Batu Kabupaten Bengkalis Provinsi Riau Berdasarkan Pola Pita Isozim		
Author	:	Meilian Syafitri, Ninik Nihayatul Wahibah & Siti Fatonah		
Types	:	Thesis	**Year :**	2013
Publisher	:	No information		
Source/ link	:	http://jom.unri.ac.id/index.php/JOMFMIPA/article/viewFile/2503/2437		

Abstract:

Ramin merupakan tumbuhan hutan yang banyak diminati industri meubel karena memiliki tekstur kayu dan serat halus. Harga jual dan kebutuhan pasar yang tinggi menyebabkan meningkatnya kegiatan penebangan liar, akibatnya populasi ramin terancam punah. Diperlukan adanya penelitian tentang keanekaragaman genetik dengan menggunakan penanda biokimia sebagai salah satu upaya konservasi ramin. Penelitian ini bertujuan untuk menganalisis keanekaragaman genetik ramin (*Gonystylus bancanus Miq. Kurz*) yang terdapat di cagar biosfer Giam Siak Kecil-Bukit Batu Kabupaten Bengkalis berdasarkan pola pita isozim. Analisis isozim dilakukan dengan menggunakan metode elektroforesis gel pati model horizontal. Sebanyak 50 sampel individu ramin di ekstrak kemudian di elektroforesis untuk analisis keanekaragaman pola pita isozim dengan menggunakan enzim peroksidase (PER). Hasil penelitian menunjukkan pola pita yang jelas. Enzim PER menghasilkan sebanyak dua belas pola pita dan bermigrasi ke kutub anoda (positif) dan katoda (negatif). Analisis pengelompokkan berdasarkan fungsi SAHN menggunakan metode UPGMA memperlihatkan bahwa semua individu ramin mengelompok pada koefisien kemiripan 38% dan memisah menjadi dua kelompok (I dan II). Keseluruhan individu pada kelompok I mengelompok di koefisien kemiripan 61% sedangkan keseluruhan individu pada kelompok II mengelompok di koefisien kemiripan 55%. Data penelitian ini menunjukkan bahwa keanekaragaman genetik ramin di cagar biosfer Giam Siak Kecil-Bukit Batu Kabupaten Bengkalis Provinsi Riau relatif tinggi.

Title	:	Change of Enviromental Conditions and Growth of Ramin (*Gonystylus bancanus (Miq.) Kurz*) Seedlings Due Land Clearance on Peat Swamp Forest IUPHHK PT. Diamond Raya Timber, Riau Province
Author	:	Rusvadilla, Ifani
Types	:	Thesis **Year :** 2012
Publisher	:	No information
Source/ link	:	http://mobile.repository.ipb.ac.id/handle/123456789/60327

Abstract:

Peat swamp forests is one of the forest type that has a specific and fragile ecosystem with the land that is rich in organic materials, so it needed proper management to achieve production and ecological sustainability. This research was purpose to measure the area of peat swamp forest that are open due to harvesting activity, analyze the factors that influenced by the openness of the area include the growth of ramin, physical properties if soils, water table, temperature, humidity and analyze the factors that influence the growth of ramin (*Gonystylus bancanus (Miq.) Kurz*) such as physical properties of soil, peat depth, temperature and humidity. The openness of land due to harvesting is expected to recover by making efforts to replant the area. Data analysis was carried out trough the descriptive and statistic analysis. Descriptive analysis by doing reading tables and images while statistic analysis using microsoft office excel 2007 software, Statistical Analysis Software (SAS) 9.1 trough Multivariate Analysis of Variance (MANOVA) and Minitab 15 by principal component analysis (RKU). PT. Diamond raya timber has exercised the harvesting of a forest to the principle of sustainability, one applies the theory of forest opening at the beginning stages of harvesting. The Purpose is to decrease high levels of openness to the harvesting, besides that PWH can also reduce the damage to the forest live and the reduce cost of harvesting. Harvesting activities can cause openess of the area, that means logging trees, building a skid road and seling road, and the road making TPn and manufacture of road transport of wood. The openness of the total harvesting is due to 3.728,75 m^2/ha. Openness area in manual plots is 1.712, 90 m^2/ha, in mechanical plots 1.415,85 m^2/ha, and road transport of wood 600 m2/ha.

Openess the area in mechanical plots can be higher if take into account the openess of area due to maneuver logfisher equal to 1000 m^2/ha or as much as 70,6 %. Hutan rawa gambut merupakan salah satu tipe hutan yang memiliki ekosistem spesifik dan rapuh dengan habitat lahan yang kaya akan bahan organik, sehingga diperlukan pengelolaan yang baik dan hati-hati untuk mencapai kelestarian produksi dan ekologi. Penelitian ini bertujuan untuk mengukur luas hutan rawa gambut yang terbuka akibat kegiatan pemanenan, menganalisis faktor-faktor yang dipengaruhi oleh keterbukaan areal meliputi pertumbuhan semai ramin, sifat fisik tanah, tinggi muka air (TMA) serta suhu dan kelembaban dan menganalisis faktor yang mempengaruhi pertumbuhan semai ramin (*Gonystylus bancanus (Miq.) Kurz*) antara lain sifat fisik tanah, ketebalan gambut, serta suhu dan kelembaban. Keterbukaan lahan akibat pemanenan diharapkan pulih kembali dengan melakukan upaya penanaman kembali lahan tersebut. Analisis data dilakukan melalui analisis deskriptif dan analisis statistik. Analisis deskriptif dengan melakukan pembacaan tabel dan gambar sedangkan analisis statistik dengan menggunakan Microsoft office excel 2007, software Statistical Analysis Software (SAS) 9.1 melalui metode Multivariate Analysis of Variance (MANOVA) dan Minitab 15 dengan analisis Komponen Utama (RKU). PT. Diamond Raya Timber telah melaksanakan pemanenan hutan yang sesuai dengan prinsip kelestarian hutan, salah satunya menerapkan teori Pembukaan Wilayah Hutan (PWH) pada bagian awal tahap pemanenan. Kegiatan pemanenan dapat menimbulkan keterbukaan areal, dalam hal ini meliputi penebangan pohon, pembuatan jalan sarad dan jalan seling, pembuatan TPn dan pembuatan jalan angkutan kayu. Keterbukaan areal total akibat pemanenan adalah 3.728,75 m^2/ha, keterbukaan di petak manual 1.712, 90 m^2/ha, di petak mekanis 1.415,85 m^2/ha dan jalan angkut 600 m^2/ha. Luas keterbukaan areal pada petak mekanis dapat lebih tinggi jika memperhitungkan keterbukaan areal akibat manuver logfisher sebesar 1000 m^2/ha atau sebesar 70,6%.

Title	:	Struktur Tegakan dan Sebaran Jenis Ramin dan Meranti di Hutan Rawa Rambut (Studi Kasus PT. Diamond Raya Timber dan PT. Riau Andalan Pulp and Paper, Provinsi Riau)		
Author	:	Mohfar, Rizki		
Types	:	Thesis (Undergraduates)	**Year :**	2012
Publisher	:	No information		
Source/ link	:	http://mobile.repository.ipb.ac.id/handle/123456789/61716		

Abstract:

Ramin and meranti are recognized as main tree species in peat swamp forest. This study was aimed to determine stand structure and distribution of ramin and meranti, and to determine the existence and growth indicators of ramin and meranti in their natural habitat. The research was conducted in June 2010 at IUPHHK PT Diamond Raya Timber and PT Riau Andalan Pulp and Paper, Riau Province. Stem diameter of trees 10 cm up was recorded using vegetation analysis method in sampling plots size of 100 m x 100 m which was divided into sub plot of 25 m x 25 m. The result shows that the total number of tree species is 26 species at IUPHHK PT Diamond Raya Timber and 45 species at PT Riau Andalan Pulp and Paper. However, the abundance of ramin and meranti species is less than 12% from the tree total number growing in the peat swamp forest either at PT Diamond Raya Timber or PT Riau Andalan Pulp and Paper. Both ramin and meranti grow in the uniform pattern in which the distribution patterns of their stand structure did not follow usual form.

Title	:	Kajian Komposisi Dan Struktur Tegakan Serta Pertumbuhan Jenis-Jenis Komersial, Khususnya Jenis Ramin (*Gonystylus bancanus (Miq.) Kurz.*) di Hutan Rawa Gambut IUPHHK PT Diamond Raya Timber, Propinsi Riau		
Author	:	Prasetyo, Danu		
Types	:	Thesis (Undergraduates)	**Year :**	2006
Publisher	:	No information		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/46065		

Abstract:

Dewasa ini, berbagai kegiatan pengelolaan hutan rawa gambut telah dilakukan untuk meningkatkan pemanfaatan hasil hutan dan ekosistemnya. Namun, karena intensitas pemanfaatan hasil hutan yang semakin meningkat, menyebabkan produktivitas hutan dan ekosistemnya semakin menurun, khususnya untuk jenis-jenis komersial yang diusahakan. Salah satu jenis spesifik hutan rawa gambut yang populasinya terus menurun adalah jenis ramin (*Gonystylus bancanus (Miq.) Kurz.*) yang sejak tahun 2004 telah masuk dalam Appendix II CITES. Oleh karena itu perlu dilakukan penelitian mengenai aspek pertumbuhan untuk memperoleh informasi dasar sehingga dapat meminimalisasi penurunan produktivitas hutan yang mungkin terjadi pada masa yang akan datang, khususnya pada areal IUPHHK PT. Diamond Raya Timber, Propinsi Riau. Salah satu aspek pertumbuhan yang dapat diteliti adalah kajian mengenai komposisi dan pertumbuhan riap dalam suatu habitat tertentu. Penelitian ini bertujuan untuk mengkaji komposisi dan struktur hutan rawa gambut serta pertumbuhan dari jenis komersial, khususnya jenis ramin (*Gonystylus bancanus (Miq.) Kurz*) hutan rawa gambut PT. Diamond Raya Timber, Propinsi Riau.

Title	:	Kebutuhan Intensitas Nuangan dan Cendawan mikoriza Permudaan Alam dan Bibit Ramin (*Gonystylus bancanus (Miq.) Kurz*)		
Author	:	Muin, Abdurrani; Setiadi, Yadi; Budi, Sri Wilarso; Mansur, Irdika & Suhendang, Endang		
Types	:	Thesis (Undergraduates)	**Year :**	2006
Publisher :		No information		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/30978		

Abstract:

The objective of this research is to find out the early information of optimum light intensity and highest mycorrhizal colonization on natural Ramin seedling which it includes in semitolerant plant. The research was conducted in Ramin Natural Forest of Sungai Pelunjung Labai, Sanggau District, West Kalimantan for a year. The results of the research show that there are correlations between light intensity with mycorrhizal colonization. Ramin seedling which grown under the light intensity 3190 – 9500 lux have high mycorrhizal colonization and their growth better than the other treatment. Meanwhile Ramin seedling which grown in closed area or in open area with light intensity less than 1670 lux and more than 10840 lux respectively have lower mycorrhizal colonization and their growth was lower.

Title	:	Pertumbuhan Anakan Ramin (*Gonystylus bancanus (Miq.) Kurz*) dengan Inokulasi Cendawan Mikoriza Arbuskula (CMA) pada Berbagai Intensitas Cahaya dan Dosis Fosfat Alam		
Author	:	Muin, Abdurrani		
Types	:	Thesis (Undergraduates)	**Year :**	2003
Publisher	:	No information		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/845		

Abstract:

Tujuan utama penelitiin ini adalah ingin menemukan suatu teknolcgi pengadaan anakan ramin dengan kualis yang tinggi. Untuk mendapatkan tujuan ini, tiga sasaran penelitian yang prlu ditentukan dan dikaji yakni : (1) Menentukan intensitas cahaya ommal bagi anakan ramin yang terkolonisasi cendawan mikoriza arbuskula (CMA) di lapangan dan di persemaian. (2) Mengkaji pertumbuhan anakan ramin yang diinokulasi CMA di persemaian dan tingkat ketergantungannya terhadap CMA, dan (3) Menentukan dosis fosfat alam yang ophmal untuk meningkatkan pertumbuhan anakan ramin yang terkolonisasi CMA di persemaian.

Title	:	Bionomi Kumbang *Ambrosia Platypus trepanatus* (Chapman) (*Coleoptera : Platypodidae*) Pada Dolok Ramin (*Gonystylus bancanus Kurz.*)		
Author	:	Nandika, Dodi		
Types	:	Thesis (Undergraduates)	**Year :**	1991
Publisher	:	IPB (Bogor Agricultural University)		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/1136		

Abstract:

Kumbang *ambrosia Platypcs trepanatus* (*Chapman (Coleoptwa*: *Platypodidae*) merupakan hama yang sangat penting karena sepanjang tahun mampu merusak sejenis kayu yang tinggi nilai ekonominya yaitu ramin (*Gonystylus bancanus Kurz*). Dalan waktu singkat, bebrapa jam atau beberapa hari setelah pohon ramin ditebang, dolok ramin telah mengandung puluhan bahkan ratusan liang gerek akibat serangga tersebut.

1.2 List of Other Publications (Without Abstract)

No	Title	Types	Year published
1	Timber Characteristics and Utilisation of Ramin	Books	2010
2	Seedling Distribution of Ramin (*Gonystylus bancanus*) and Seed Dispersal in Sarawak, Malaysia	Books	2005
3	Findings on *Gonystylus spp* in Malaysia	Books	2004
4	*Gonystylus Teijsm. & Binnend*	Books	1994
5	Potency and Distribution of Commercial Wood in Indonesia. Ramin Book 3.	Books	1983
6	Hutan Ramin (*Gonystylus Sp*) di Kalimantan	Books	1975
7	Degradasi Sumberdaya Genetik Jenis Ramin Dan Upaya Penyelamatannya	Bulletin	2007
8	Ramin, Endangered Idol Forest Tree Species	Bulletin	2007

9	Intensitas Cahaya Untuk Pemeliharaanpermudaan Alam Dan Penanaman Ramin (*Gonystylus Bancanus(Miq.) Kurz*) Pada Areal Bekas Tebangan Eks HPH PT	Bulletin	2002
10	Pengaruh Manipulasi Kondisi Lingkungan Terhadap Proses Berakar Stek Ramin (*Gonystylus bancanus*)	Bulletin	1999
11	The Distribution of Ramin (*Gonystylus bancanus Kurtz.*) in The Peat Forest (Case study in PT Inhutani III. Central Kalimantan)	Bulletin	1998
12	Simple Storage Technology for Recalcitrant Seeds of An Endangered Species: Ramin *(Gonystylus bancanus)*	Bulletin	1998
13	Teknik Penyimpanan Sederhana Benih Tanaman Langka: Ramin (*Gonystylus bancanus Kurz*)	Bulletin	1998
14	Penanaman Ramin (*Gonystylus bancanus Kurz*) Pada Tiga Lebar Jalur Di Hutan Rawa Gambut Sekunder Bekas Tebangan	Bulletin	1998
15	Penyebaran Pertumbuhan Pohon Ramin (*Gonystylus bancanus (Miq.) Kurz.*) Di Hutan Rawa Gambut: Studi Kasus Di HPHPT	Bulletin	1998

16	Kemungkinan Pembiakan Vegetatif Ramin (*Gonystylus bancanus)* secara Stek Dalam Rangka Penyediaan Material Tegakan Hutan	Bulletin	1995
17	Petunjuk Teknis Penanaman Ramin (*Gonystylus bancanus Kurz*)	Bulletin	1983
18	Keterangan-Keterangan Tentang Ramin (*Gonystylus bancanus*) Di Negara Serawak	Bulletin	1963
19	Malaysian Timbers - Ramin	Bulletin	
20	Results on 11-Year of Planting Trial of *Gonystylus bancanus (Miq) Kurz* in Non-Peat Swamp Area	Journal	2008
21	Sifat Toleransi Anakan Ramin (*Gonystylus bancanus (Miq.) Kurz*) Terhadap Naungan Melalui Pendekatan Karakter Morfologi Dan Anatomi Daun	Journal	2005
22	Studi Pembiakan Stek Batang Anakan Ramin (*Gonystylus bancanus*) Dengan Menggunakan Zat Pengatur Tumbuh Rootone-F pada Berbagai Media Perakaran	Journal	1997
23	Efisiensi Energi Kayu Pada Proses Pengeringan Papan	Journal	1993

24	Exploitation Factor for Ramin (*Gonystylus bancanus*)	Journal	1984
25	Trial Enrichment Planting of Residual Ramin (*Gonystylus Bancanus*) Forest, in The Telukbelanga Forest Complex, West Kalimantan	Journal	1978
26	Hyperspectral Imaging for Mapping of Endangered Peat Swamp Forest Species in Malaysia: A Case Study	Poster	2011
27	Effect of Different BAP Concentrations on Ramin Melawis (*Gonystylus bancanus*) in-Vitro Shoot Cultures	Poster	2005
28	Genetics Conservation of A Vulnerable Peat Swamp *Gonystylus bancanus* (*Thymelaeaceae*)	Proceeding	2014
29	Population Genetic Study of A Threaten Timber Species *Gonystylus bancanus* (*Thymelaeaceae*) and Its Implication for Conservation	Proceeding	2012
30	Estimation of Standing Timber Volume of *Gonystylus bancanus* Using Hyperspectral Data	Proceeding	2011
31	Genetic Diversity Assessment of Ramin Melawis (*Gonystylus bancanus*) Throughout Malaysia Using Microsatellite Markers	Proceeding	2011

32	Potential of DNA Profiling Technique for Timber Tracking : Using *Neobalanocarpus Heimii* and *Gonystylus bancanus* as Case Study	Proceeding	2011
33	Forensic DNA Profiling of A CITES Listed Timber Species *Gonystylus bancanus* in Malaysia	Proceeding	2010
34	Geographical Traceability of A CITES Listed Timber Species *Gonystylus bancanus* in Malaysia	Proceeding	2010
35	Ramin Identification and Look-Alike Species	Proceeding	2010
36	Ecological and Management Status of Ramin (*Gonystylus spp.*) in Malaysia	Proceeding	2009
37	Review on CITES Implementation and Trade in Ramin	Proceeding	2009
38	Long-term Strategy for The Sustainable Management and Conservation of Ramin Forest Resources	Proceeding	2009
39	Searching for Meaningful DNA Markers of Endangered Species Using Next-Gen Sequencing: A Case Study of Ramin (*Gonystylus bancanus*)	Proceeding	2008
40	Natural Habitat Specialization of *Gonystylus bancanus* and Its Association	Proceeding	2008

41	Ramin (*Gonystylus bancanus*) Regeneration and Growth in Sarawak's Peat Swamp Forests	Proceeding	2008
42	Pemanfaatan Berkelanjutan Ramin & Aturan Pengelolaannya Pada Tingkat Unit Pengelolaan Lahan	Proceeding	2007
43	Pre-Harvesting Planning Is A Tool for Sustainable Harvest of Ramin in Peat Swamp Forest in Peninsular Malaysia	Proceeding	2006
44	Potensi Botani, Ekonomi dan Ekologi Ramin (*Gonystylus spp.*)	Proceeding	2005
45	Several Alternative Woods to Substitute Ramin Wood	Proceeding	2005
46	Praktek Pengelolaan Dan Pelestarian Ramin (*Gonystylus bancanus (Miq.) Kurz*) Di PT. Diamon Raya Timber	Proceeding	2005
47	Kajian Ekologi Dan Silvikultur Ramin Di Sumatera Selatan Dan Jambi	Proceeding	2005

48	Unravelling The Regeneration of Ramin (*Gonystylus bancanus*) to Promote Wise Use of Peat Swamp Forests in Sarawak	Proceeding	2004
49	Ekologi Dan Pengelolaan Ramin Di Indonesia	Proceeding	2004
50	Pembiakan Tampang Spesis Jelutong Dan Ramin	Proceeding	2001
51	A Planting Trial of G*onystylus bancanus* "In An Non-Peat Swamp Area in Peninsular Malaysia	Proceeding	1999
52	Population Structure and Distribution Pattern of *Gonystylus bancanus* in Primary Peat Swamp Forest at Pekan, Pahang	Proceeding	1995
53	Trade in Plants Specimen of Ramin *Gonistylus bancanus*	Proceeding	1994
54	A Preliminary Guide for Planting Ramin	Proceeding	1976
55	DNA Timber Tracking System of A CITES Listed Species *Gonystylus bancanus*	Reports	2012
56	Population Dynamics and Optimum Harvest of *Gonystylus bancanus* in Production Forest of Peninsular Malaysia	Reports	2010

57	Ecological and Management Status of Ramin (*Gonystylus spp.*) in Malaysia	Reports	2010
58	Generation of Spatial Distribution Maps of *Gonystylus bancanus* (Ramin) Using Hyperspectral Technology and Determination of Sustainable Level of Harvest of Ramin in Production Forests	Reports	2009
59	Pedoman Identifikasi Kayu Ramin dan Kayu Mirip Ramin	Reports	2008
60	Assessment on the Status and Distribution of Ramin Telur (*Gonystylus bancanus*) in the Peat Swamp Forest in Sedilu Forest Reserve and Sebuyau Protected Forest, Sarawak	Reports	2008
61	Expert Meeting on the Effective Implementation of Inclusion of Ramin (*Gonystylus spp.*) in Appendix II of CITES - Report of the Expert Meeting	Reports	2007
62	Report of The ITTO Expert Meeting on The Effective Implementation of The Inclusion of Ramin (*Gonystylus spp.*) in Appendix II of CITES	Reports	2007
63	ITTO Expert Meeting on The Effective Implementation of The Inclusion of Ramin in	Reports	2007

	Appendix II of CITES : Report of The Expert Meeting, 16-19 May 2006, Kuala Lumpur, Malaysia		
64	Phenology of *Gonystylus bancanus* in Logged Over Peat Swamp Forest in Sarawak	Reports	2005
65	Laporan Hasil Kajian Lapangan Potensi Ramin (*Gonystylus bancanus (Miq.) Kursz.*) Pada Areal HPH PT. Diamond Raya Timber Propinsi Riau	Reports	2005
66	Potency, Distribution and Conservation of Ramin in Indonesia	Reports	2005
67	Leaf Properties, Photosynthetic Rates and Growth Strategies of Ramin	Reports	2004
68	Reducing Unsustainable Harvest and Trade of The Commercial Timber Species, Ramin *Gonystylus spp*	Reports	2004
69	Penanaman Ramin (*Gonystylus bancanus (Miq.) Kurz*) Pada Areal Bekas Tebangan Dengan Inokulasi Cendawan Mikoriza Arbuskula Dan Pemupukan Fosfat Alam Terhadap Anakan Di Persemaian	Reports	2004
70	Framing the Picture: An Assessment of Ramin Trade in Indonesia, Malaysia and Singapore	Reports	2004

71	Report on The Result of Field Assessment of Ramin Potency (*Gonystylus bancanus Kurz.*) in Forest Concession (HPH) of PT Diamond Raya Timber for 2004 Annual Work Plan (RKT)	Reports	2004
72	Report on The Result of Field Assessment of Ramin Potency (*Gonystylus bancanus Kurz.*) in Forest Concession(HPH) of PT Diamond Raya Timber for 2003 Annual Work Plan (RKT)	Reports	2003
73	Insect Infestation on Ramin Trees in Trial Plot Near Kroh River, Kg Jawa, FRIM, Kepong	Reports	2002
74	The Sustainable Management of Peat Swamp Forests With Specific Reference to Ramin; Interim Report on Status of Peat Swamp Forests in Sarawak	Reports	2002
75	Laporan Hasil Penelitian Pemilihan Pohon Plus dan Peremajaan Ramin (*Gonystylus bancanus Miq. Kurz*) Ditinjau Dari Aspek Lingkungan Mikro dan Mikroba Tanah	Reports	2001
76	Hubungan Antara Komposisi, Struktur Dan Penyebaran Ramin (*Gonystylus bancanus (Miq.) Kurz*) Dengan Sifat-Sifat Tanah Gambut, (Studi	Reports	1999

	Kasus Di Areal HPH PT. Inhutani III Kalimantan Tengah)		
77	Regeneration of Ramin (*Gonystylus bancanus) (Miq.) Kurz* and Selected Commercial Species in Logged-Over Mixed Swamp Forests, 20 or More Years After Logging	Reports	1998
78	Evaluasi Dan Penentuan Sistem Pengelolaan Hutan Ramin Yang Berasaskan Kelestarian	Reports	1995
79	Masalah Dan Teknik Prersemaian pengembangan Ramin (*Gonystylus bancanus*)	Reports	1994
80	Pedoman Sementara Penanaman Kayu Ramin	Reports	1976
81	Permudaan Ramin Di Kalimantan Barat	Reports	1972
82	Application of Hyperspectral Technology in Discriminating *Gonystylus bancanus* in Malaysia	Review	2013
83	*Gonystylus spp.* (Ramin) : Population Status, Genetics and Gene Conservation	Review	2010
84	Ramin (*Gonystylus bancanus*)	Review	2008
85	*Gonystylus bancanus (Miq.) Kurz*	Review	2002
86	Evaluation and Determination of Ramin Forest Management System Based on Sustainability	Review	1996

87	Some Wood Varieties Which Can Be Utilized as Ramin (*Gonystylus bancanus (Miq.) Kurz*) Substitutes	Review	1988
88	Commercial Timber Trees of The Malay Peninsula	Review	1927
89	Population Genetics Study of *Gonystylus bancanus* (Ramin melawis) Using Microsatellite Markers	Thesis (Masters)	2014
90	Study of Regeneration Patterns of Five Emergent Species in Peat Swamp Forest, Pahang	Thesis (Masters)	2003
91	Keanekaragaman Genetik Plasma Nutfah Ramin di Hutan Rawa Gambut Kabupaten Rokan Hilir Riau Berdasarkan Metode Isozim	Thesis (Undergraduates)	2007
92	Pengaruh Campuran Media Tumbuh Dan Rootone F terhadap Pertumbuhan Anakan Ramin (*Gonystylus bancanus Kurtz*)	Thesis (Undergraduates)	1998

PUBLICATIONS –KARAS-

(Aquilaria malaccensis)

Title	:	Evaluation of Comprehensive Two-Dimensional Gas Chromatography With Accurate Mass Time-of-Flight Mass Spectrometry for The Metabolic Profiling of Plant–Fungus Interaction in *Aquilaria malaccensis*
Author	:	Yong Foo Wong, Sung-Tong Chin, Patrick Perlmutter & Philip J. Marriott
Types	:	Journal **Year :** 2015
Publisher	:	Journal of Chromatography A (Volume 1387, 27 March 2015, Pages 104–115)
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0021967315002095

Abstract:

To explore the possible obligate interactions between the phytopathogenic fungus and *Aquilaria malaccensis* which result in generation of a complex array of secondary metabolites, we describe a comprehensive two-dimensional gas chromatography (GC × GC) method, coupled to accurate mass time-of-flight mass spectrometry (TOFMS) for the untargeted and comprehensive metabolic profiling of essential oils from naturally infected *A. malaccensis* trees. A polar/non-polar column configuration was employed, offering an improved separation pattern of components when compared to other column sets. Four different grades of the oils displayed quite different metabolic patterns, suggesting the evolution of a signalling relationship between the host tree (emergence of various phytoalexins) and fungi (activation of biotransformation). In total, ca. 550 peaks/metabolites were detected, of which tentative identification of 155 of these compounds was reported, representing between 20.1% and 53.0% of the total ion count. These are distributed over the chemical families of monoterpenic and sesquiterpenic hydrocarbons, oxygenated monoterpenes and sesquiterpenes (comprised of ketone, aldehyde, oxide, alcohol, lactone, keto-alcohol and diol), norterpenoids, diterpenoids, short chain glycols, carboxylic acids and others. The large number of metabolites detected, combined with the ease with which they are located in the 2D separation space, emphasises the importance of a comprehensive analytical approach for the phytochemical analysis of plant metabolomes. Furthermore, the potential of this methodology in grading agarwood oils

by comparing the obtained metabolic profiles (pattern recognition for unique metabolite chemical families) is discussed. The phytocomplexity of the agarwood oils signified the production of a multitude of plant–fungus mediated secondary metabolites as chemical signals for natural ecological communication. To the best of our knowledge, this is the most complete information available so far about essential oils of *A. malaccensis*, which represents a valuable extension to available data for advanced studies on microbial-mediated biotransformation of terpenes, and offers promise for potential discovery of unanticipated phytochemicals, and biotechnological exploitation.

Title	**:**	Development and Characterization of Polymorphic Microsatellites Markers in Endangered *Aquilaria malaccensis*		
Author	**:**	Pradeep Singh, Himanshu Sharma, Akshay Nag, Brijmohan Singh Bhau & Ram Kumar Sharma		
Types	**:**	Journal	**Year :**	2015
Publisher	**:**	Conservation Genetics Resources (Volume 7, Issue 1 , pp 61-63)		
Source/ link	**:**	http://link.springer.com/article/10.1007/s12686-014-0287-4		

Abstract:

Aquilaria malaccensis is a critically endangered species in Asia because of its overexploitation to obtain high valued agarwood, used in medicine, perfume, and incense production. Its genetic improvement faces serious problem due to lack of genomic resources. In this study, eighteen novel highly polymorphic microsatellite markers derived from enriched genomic libraries were characterized using 45 individuals of three populations, would be an asset to its non-existing marker recourse. Allelic variations per locus ranged from 2 to 6 with mean allele number was 3.28. The average observed and expected heterozygosity varied from 0.811 and 0.597, respectively. Reproducibility rate, polymorphic potential and ability to detect heterozygosity, novel microsatellites markers would contribute in evaluation of genetic diversity and population structure, and selection of elite germplasm for conservation of genetic resources and commercial utilization.

Title	:	A Review Study of Agarwood Oil and Its Quality Analysis		
Author	:	Nurlaila Ismail, Nor Azah Mohd Ali, Mailina Jamil, Mohd Hezri Fazalul Rahiman, Saiful Nizam Tajuddin & Mohd Nasir Taib		
Types	:	Journal	**Year :**	2014
Publisher	:	UTM Press, Universiti Teknologi Malaysia		
Source/ link	:	http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/2419		

Abstract:

This paper presents an overview of analysis agarwood oil and its quality grading. The review suggested agarwood oil can be graded according to their chemical properties and so that there is a common standard recognized worldwide on grading the agarwood oil. Analysis based on chemical profiles is required to ensure that agarwood oil can be classified based on their respective classes or grades where the accurate results can be measured. Conventionally, the grading of agarwood oil is performed by trained human graders (sensory panels) depends on its physical appearance such as color, odor, high fixative and consumer perception. However, this method is limited due to human nose cannot accept many samples in one time and easily get fatigues especially when dealing with continuous production. The human sensory panel also limited in terms of subjectivity, poor reproducibility, time consumption and large labour expense. These are constraining factors in increasing agarwood oil trade and market penetration.

Title	:	Chemometric Study of Selected Agarwood Oils by Gas Chromatography–Mass Spectrometry
Author	:	MA Nor Azah, N Ismail, J Mailina, MN Taib, MHF Rahiman & Z Muhd Hafizi
Types	:	Journal **Year :** 2014
Publisher	:	Journal of Tropical Forest Science
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v26n3/382-388.pdf

Abstract:

Chemometric study of selected agarwood oils by gas chromatography–mass spectrometry. Agarwood oils are concentrated volatile aromatic compounds mainly produced by the distillation of agarwood (*Aquilaria spp.*). Currently, grading of agarwood oil is done by trained personnel based on colour and odour. This technique is done manually and limited to sample repeatability. In this study, the chemical compositions of several selected agarwood oil samples were analysed by gas chromatography and gas chromatography–mass spectrometry. Their pattern recognition profiles were examined by chemometric analysis using principal component analysis (PCA). The samples were categorised into two groups according to their quality: group A (high quality) and group B (unknown quality). At least 43 chemical compounds were identified from both groups. From PCA, six significant compounds were obtained, i.e. 4-phenyl-2-butanone, α-guaiene, ar-curcumene, 10-epi-g-eudesmol, β-dihydroagarofuran and valencene. Correlation analysis revealed significant and high correlation between groups A and B. This is due to samples from group B showing similarity to major compounds found in group A.

Title	:	In Vitro Antioxidant Activity and Phytochemical Screening of *Aquilaria malaccensis* Leaf Extracts
Author	:	Nik Noor Asma Nik Wil, Nor Adila Mhd Omar, Noorhuda Awang@Ibrahim & Saiful Nizam Tajuddin
Types	:	Journal **Year :** 2014
Publisher	:	Journal of Chemical and Pharmaceutical Research, 2014, 6(12):688-693
Source/ link	:	http://jocpr.com/vol6-iss12-2014/JCPR-2014-6-12-688-693.pdf

Abstract:

The present study investigated water extraction (WE) and methanol extraction (ME) of *A. malaccensis* dried leaves (DL) and fresh leaves (FL) for its in vitro antioxidant activity that may contribute to their pharmacological effects. Total phenolic content (TPC) of this plant was determined by Folin-Ciaocalteu assay, while antioxidant potential were evaluated by TAC, CUPRAC and DPPH method. Tests for steroids, triterpenoids, flavonoids, saponins, tannins and alkaloids were positive in both water and methanol extracts. WEDL showed the highest inhibition of the DPPH radical (48.07 ± 0.68 %) at concentration 1000 ug/ml and IC50 value was found to be 1.091 mg/ml, relative to ascorbic acid, having an IC50 of 0.219 mg/ml. It also showed the highest CUPRAC value (3.32 ± 0.01µg/ml) as well as the highest TPC and TAC (181.11 ± 0.61 and 398.74 ± 0.66 gallic acid equivalent (GAE) mg/g) at a concentration of 1000 µg/ml) as compared to the other studied extracts. In conclusion, the results of this study clearly indicated that the extracts of *A. malaccensis* possess significant antioxidant activities and could be used as a potential source of natural antioxidant agents that may be due to the presence of phytochemicals.

Title	:	Effects of Plant Growth Regulators, Carbon Sources and Ph Values on Callus Induction in *Aquilaria malaccensis* Leaf Explants and Characteristics of The Resultant Calli		
Author	:	Shashita Jayaraman, Nurul Hazwani Daud, Rasmina Halis & Rozi Mohamed		
Types	:	Journal	**Year :**	2014
Publisher	:	Northeast Forestry University		
Source/ link	:	http://link.springer.com/article/10.1007/s11676-014-0492-8		

Abstract:

The endangered tropical tree, *Aquilaria malaccensis*, produces agarwood for use in fragrance and medicines. Efforts are currently underway to produce valuable agarwood compoundsn tissue culture. The purpose of this study was to develop an optimal growth medium, specifically, the best hormone combination for callus suspension culture. Using nursery-grown *A. malaccensis*, sterilized leaf explants were first incubated on basic Murashige and Skoog (MS) gel medium containing 15g/L sucrose and at pH 5.7. Different auxin types including 1-naphthaleneacetic acid (NAA), 2,4-dichlorophenoxyacetic acid (2,4-D), and indole-3-butyric acid (IBA), were tested at various concentrations (0.55, 1.1 and 1.65 μM) using the basic medium. Leaf explants were incubated for 30 days in the dark. Callus induced by 1.1 μM NAA had the highest biomass dry weight (DW) of 17.3 mg; however the callus was of a compact type. This auxin concentration was then combined with either 6-benzylaminopurine (BAP) or kinetin at 0.55, 1.1, 2.2 or 3.3 μM to induce growth of friable callus. The 1.1μM NAA + 2.2μM BAP combination produced friable callus with the highest biomass (93.3mg DW). When testing the different carbon sources and pHs, sucrose at 15g/L and pH at 5.7 yielded highest biomasses at 87.7mg and 83mg DW, respectively. Microscopic observations revealed the arrangement of the friable cells as loosely packed with relatively large cells, while for the compact callus, the cells were small and densely packed. We concluded that MS medium containing 15 g/L sucrose, 1.1 μM NAA + 2.2 μM BAP hormone combination, and a pH of 5.7 was highly effective for inducing friable callus from leaf explants of *A. malaccensis* for the purpose of establishing cell suspension culture.

Title	:	Succession Patterns of Fungi Associated to Wound-Induced Agarwood in Wild *Aquilaria malaccensis* Revealed From Quantitative PCR Assay		
Author	:	Rozi Mohamed, Phai Lee Jong & Ismail Nurul Irdayu		
Types	:	Journal	**Year :**	2014
Publisher	:	Springer Netherlands		
Source/ link	:	http://link.springer.com/article/10.1007/s11274-014-1668-2		

Abstract:

Aquilaria malaccensis produces agarwood in response to wounding and fungal attack. However, information is limited regarding *Aquilaria*'s interaction with its diverse fungal community. In this study, time-related changes of three natural fungal colonizers in two wounded wild *A. malaccensis* were tracked, beginning a few hours after wounding up to 12 months. Using species-specific primers derived from their nrITS sequences in quantitative real-time PCR (qPCR), we quantified the amount of Cunninghamella bainieri, Fusarium solani and Lasiodiplodia theobromae. Because time is a major factor affecting agarwood quantity and quality, 14 wood samples were collected at different time points, i.e., 0–18 h, 2–13 days, 2–18 weeks, and 6–12 months after wounding. qPCR data revealed that the abundance of the three species decreased over time. The fungi were detected in high numbers during the first few hours and days after wounding (40- to 25,000-fold higher levels compared with initial counts) and in low numbers (<1- to 3,200-fold higher than initially) many months later. Consistent with its role in defense response, the accumulation of secondary metabolites at the wounding site could have caused the decline in fungal abundance. Succession patterns of the two trees were not identical, indicating that fungal populations may have been affected by tree environment and wound microclimate. Our results are important for understanding the diversity of microbial community in wild *Aquilaria* species and their association to wound-induced agarwood formation. Fungi could be secondary triggers to agarwood production in situations where trees are wounded in attempt to induce agarwood.

Title	:	Analysis of Chemical Compounds of Agarwood Oil from Different Species by Gas Chromatography Mass Spectrometry (GCMS)		
Author	:	Yumi Z.H-Y. Hashim, N.I. Ismail & P. Abbas		
Types	:	Journal	**Year :**	2014
Publisher	:	IIUM Engineering Journal, Vol. 15, No. 1, 2014		
Source/ link	:	http://journals.iium.edu.my/ejournal/index.php/iiumej/article/viewFile/469/398		

Abstract:

Agarwood oil is a highly prized type of oil due to its unique aroma. The oil is extracted from the fragrant resin found in the agarwood tree (trunk). The unique aroma and quality of agarwood resin and oil are contributed by the presence of certain chemical compounds. In this work, analysis and comparison of the chemical compounds of agarwood oil from *A. malaccensis, A. sub-integra* and a mixture of both were conducted. The essential oils were diluted in hexane (5%) prior to gas chromatography mass spectrometry (GCMS) analysis performed using Agilent GCMS 7890A coupled with MSD quadrupole detector 5975 C. Separation of analytes by gas chromatography was carried out using a Hewlett Packard HP-5MS silica capillary column (30 m X 0.25 mm X 0.25 mm). A total of 107 compounds were identified from the three samples of agarwood oils. Fifty-five (55) components were identified in *A. malaccensis* sample which contributes to the largest portion of the total compounds. About 20% of the compounds identified were aromatic and sesquiterpenes which have been revealed to be the main active compounds of agarwood oils which also give the aroma and pleasant odour of agarwood. Different compositions or profile of chemical components were found in agarwood oils from the two different species. Two compounds were commonly identified in all three samples namely 3-phenyl-2-butanone and alpha-cubebene. Further studies are needed to refine the results which later can be used to assist detection and authentication of agarwood as well as its scientific-based grading.

Title	:	Gas Chromatography-Mass Spectrometry Analysis of Agarwood Extracts From Mature and Juvenile *Aquilaria malaccensis*
Author	:	Phai Lee Jong, Pascale Tsan & Rozi Mohamed
Types	:	Journal **Year :** 2014
Publisher	:	No information
Source/ link	:	http://www.fspublishers.org/published_papers/2825_..pdf

Abstract:

Chemical composition of crude extracts from infected woods of *Aquilaria malaccensis* were compared to that of healthy wood and commercial agarwood. Infected woods were collected six months after drilling of wild mature trees or after fungal inoculation into the stem of 4-year-old trees. Agarwood substances were extracted in methanol and were subjected to GC-MS analyses. The major compounds were chromone derivative, aromatic compounds, sesquiterpenes, monoterpenes, sterols and fatty acid methyl ester. Aromatic compounds constituted of aldehyde, phenol, ether and ketone groups. In the agarwood extract of the juvenile fungal-elicited tree but not in the healthy wood, some major compounds found were 2-(2-phenylethyl) chromone derivative, 4-phenyl-2-butanone, (1S,4S,7R)-1,4-dimethyl-7- (prop-1-en-2-yl) -1,2,3,4,5,6,7,8-octahydroazulene [guaiene], 1,1,4,7-tetramethyl-2,3,4,5,6,7,7a,7b-octahydro-1aH-cyclopropa[h]azulen-4a-ol [palustrol], and 4-(4- methoxyphenyl) butan-2-one [anisylacetone]. These were also found from agarwood of different grades and agarwood collected from the wild mature tree, in addition to agarospirol, alloaromadendre oxide (2), _-elemol, _-eudesmol, and guaiol. This work demonstrated that in young *A. malaccensis* trees, fungi may be associated to the formation of important agarwood compounds and can be detected as early as six months after inoculation.

Title	:	Ecological Features of Cultivated Stands of *Aquilaria malaccensis Lam.* (*Thymelaeaceae*), a Vulnerable Tropical Tree Species in Assamese Homegardens		
Author	:	P. Saikia & M. L. Khan		
Types	:	Journal	**Year :**	2014
Publisher	:	No information		
Source/ link	:	http://www.hindawi.com/journals/ijfr/2014/140926/		

Abstract:

Research was conducted in twenty-seven selected villages located in Jorhat and Golaghat districts of upper Assam, northeast India, for population estimation, quantitative ecological analysis, and evaluation of *Aquilaria malaccensis* (*Thymelaeaceae*). Vegetation sampling was done by quadrat method and A. malaccensis is the most dominant tree species in all twenty-seven different study sites of upper Assam contributing 10–54% of the total tree density with a mean of . Density of the species varied from 6,236 individuals ha−1 to 429 individuals ha−1 with a mean of 1,609 individuals , whereas frequency of occurrence is very high ranging from 93% to 100% with a mean of in different study sites. Distribution of *A. malaccensis* is found contagious in all twenty-six study sites on the basis of abundance to frequency ratio except in KBG, Golaghat, where its distribution is random with 0.04 abundance to frequency ratio. The widespread cultivation of *A. malaccensis* in upper Assam, northeast India, offers a potential ex situ reservoir for the future conservation and management of this threatened tree.

Title	**:**	Distribution and Population Status of Critically Endangered *Aquilaria Malaccensis Lamk.* in The Forests of Arunachal Pradesh and Assam, India		
Author	**:**	Tasso Tabin & Karuna Shrivastava		
Types	**:**	Journal	**Year :**	2014
Publisher	**:**	No information		
Source/ link	**:**	http://www.ijirset.com/upload/2014/november/70_DISTRIBUTION_.pdf		

Abstract:

*Aquilaria malaccensis Lamk.*is an endangered but highly demanded tree species of sub-tropical rain forests of northeastern India. It has profound impact on socio-economic status of rural people owing to its highly priced resinous wood and wood oil valued for medicinal & aromatic properties. The species has come to the risk of extinction due to pressures for utilization. As a result, it has been included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and considered „critically endangered, in India. Population ecology of this important species was investigated as a basis for its conservation. This paper presents results of survey conducted at thirty nine *Aquilaria* growing sites of Arunachal Pradesh and Assam. The present study records the existence of natural populations of *A. malaccensis Lamk.*but in very less numbers with alarming current population density. The species is mainly surviving in plantations. Urgent biotechnological interventions may be employed to conserve remaining natural genetic pool of *Aquilaria malaccensis* in natural state in this north eastern most state of India.

Title	:	Fungal Inoculation Induces Agarwood in Young *Aquilaria malaccensis* Trees in The Nursery		
Author	:	Rozi Mohamed, Phai Lee Jong, & Abd Kudus Kamziah		
Types	:	Journal	**Year :**	2013
Publisher	:	Springer Berlin Heidelberg		
Source/ link	:	http://link.springer.com/article/10.1007/s11676-013-0395-0		

Abstract:

Fungi are often used to induce agarwood in *Aquilaria* trees. This study was conducted to evaluate the effect of several fungi on agarwood formation over time in young *Aquilaria malaccensis (Lam.)* trees. Typical changes in the length and light intensity of the resulting discoloration were observed after three and six month periods following inoculation. Wood samples were observed microscopically and classified into several light intensity groups. The discoloration length was measured longitudinally. The duration after inoculation affected the mean of discoloration length: the 6-month old sample (1.70 cm) had a wider discoloration zone when compared to the 3-month old sample (1.17 cm). When measuring the discoloration intensity, a positive relationship with time was perceived. Digital images, captured using a camera-equipped microscope, revealed that wood samples collected after six months appeared to be 1.8-times darker than after three months. We concluded that time, not the species of any of the tested fungi, had significant effect on discoloration length and intensity. Gas chromatography/mass spectrometry (GCMS) analysis of the 6-month old sample yielded some important agarwood compounds such as benzylacetone, anisylacetone, guaiene and palustrol. This demonstrates that the tested fungi have the ability to induce agarwood formation in nursery *A. malaccensis* trees.

Title	:	Characterization of Wound Responsive Genes in *Aquilaria malaccensis*		
Author	:	Mun Theng Wong, Chai Har Siah, Qamaruz Zaman Faridah & Rozi Mohamed		
Types	:	Journal	**Year :**	2013
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1007/s13562-012-0144-z		

Abstract:

We report on the isolation and characterization of several genes responsive to wounding in the tropical endangered tree *Aquilaria malaccensis*. Wounding triggers the formation of a fragrant substance inside the tree stem. Deduced amino acid of the cloned sequences exhibited sequence similarities to their respective homologs: transcription factors of the WRKY gene family (AmWRKY) and β-1,3-glucanase (AmGLU). A homolog to phenylalanine ammonia-lyase (AmPAL) from previous work was also included. All cDNA sequences were of partial lengths. We studied their expression profiles in a wounding-stress experiment. Mechanical wounding induces AmWRKY in an early response to wounding (3 h), and elevates AmPAL and AmGLU expressions after 16 h. It is possible that AmWRKY mediates early wounding response while AmPAL mediates response to fungal infection by co-inducing AmGLU. Their homologs in other plants are known to inhibit fungal growth. Our data provide the first insight into the mechanisms of wounding responses in *Aquilaria*.

Title	:	Magnetic Induction Tomography: A Review on The Potential Application in Agricultural Industry of Malaysia
Author	:	Z. Zakaria, M.S.B. Mansor, R.A. Rahim, I. Balkhis, M.H.F. Rahima[1], H. A. Rahim & S.Yaacob
Types	:	Journal **Year :** 2013
Publisher	:	Canadian Center of Science and Education: Journal of Agricultural Science; Vol. 5, No. 9; 2013
Source/ link	:	http://www.ccsenet.org/journal/index.php/jas/article/view/27667

Abstract:

Agriculture is the foundation of Malaysia's economy in addition to other government-focused industries. The trend of its contribution to the gross domestic product (GDP) has fluctuated from year to year. The highest value was 28.8% in 1970; this reduced to 7.5% in 2007, rose slightly to 7.7% in 2009, and then decreased to 7.3% in 2010. However, the value is still high compared with other developed countries, the value of which is typically only within the range of 1% to 3%. This fluctuating trend is related to several factors both globally and locally, such as disease and diminishing resources. Despite the constraints and challenges faced by the agricultural industry, the quality of the produce has to be maintained, while solutions to the current problems are sought. Thus, this article discusses the possibility of using the technique of Magnetic Induction Tomography (MIT) in the agricultural industry for application in a fruit-grading system, the early detection of basal stem rot disease in palm oil trees, and resin identification inside a karas (gaharu) tree.

Title	:	Assessment of Heavy Metals Uptake and Translocation by *Aquilaria malaccensis* Planted in Soils Containing Sewage Sludge		
Author	:	Keeren Sundara Rajoo, Arifin Abdu, Hazandy Abdul-Hamid, Daljit Singh Karam, Shamshuddin Jusop, Aiza-Shaliha Jamaluddin & Wong Wan Zhen		
Types	:	Journal	**Year :**	2013
Publisher	:	American Journal of Applied Sciences		
Source/ link	:	http://thescipub.com/abstract/10.3844/ajassp.2013.952.964		

Abstract:

Increase in human population has resulted in an enormous growth in the volume of wastewater. The conventional methods of sewage sludge disposal, that is the by-product of wastewater treatment, are costly and not environment-friendly. An ideal way for sewage sludge management is by using it as a soil amendment in agricultural land due to sewage sludge's high organic matter content. However, sewage sludge contains high levels of heavy metals that can be harmful to both plants and the environment. Hence, these metals need to be removed before the sewage sludge is to be used as a soil amendment. The objective of this study was to assess the potential of *Aquilaria malaccensis* to uptake and translocate heavy metals found in sewage sludge. *A.malaccensis* seedlings were planted on six different planting media: T0/Control (100% soil), T1 (80% soil and 20% sewage sludge), T2 (60% soil and 40% sewage sludge), T3 (40% soil and 60% sewage sludge), T4 (20% soil and 80% sewage sludge) and T5 (100% sewage sludge) for the duration of 16 weeks. The growth performance of height and basal diameter was measured using diameter tape and venier caliper every two weeks, respectively. The average dry weight biomass of *A.malaccensis* was measured using destructive sampling at 16 weeks after planting. Plant samples were collected after harvest and soil samples were collected before planting and after harvesting. Atomic Absorbtion Spectrophotometer (AAS) was used to determine the concentration of heavy metals in the planting media and the plant parts (leaves, stem and roots). The highest growth of *A.malaccensis* was recorded for the T5

growth media. The highest concentration of Fe in the roots of the *A.malaccensis* plant was in the T5 growth media (2770.75 ppm). The highest accumulation of Zn (95.62 ppm) was recorded in the roots of *A.malaccensis* in the T5 growth media, whereas the stem of the *A.malaccensis* in T5 recorded the highest Cd accumulation (3.75 ppm). The highest Pb uptake was recorded in the roots of *A.malaccensis* in T5 (39.79 ppm), while the lowest accumulation of Pb was noted in the leaves of the *A.malaccensis* in control (16.08 ppm). The highest Translocation Factor (TF) (2.00) for Cd was recorded in T5. The lowest Bioconcentration Factor (BCF) for Cu was recorded at T5 (0.18). The highest TF for Pb was recorded in control (1.50), while the lowest was in T5 (1.23). The BCF for Zn was lowest in T5 (0.64). The *A.malaccensis* plant was found to be suitable for taking up heavy metals from sewage sludge especially Cd and Cu. The roots of *A.malaccensis* are ideal in uptaking and storing Fe, while the stem of the *A.malaccensis* plant is ideal for the uptake and accumulation of Cd. More studies need to be conducted, especially in field conditions, to optimize the potential of the *A.malaccensis* plant as a phytoremediator.

Title	**:**	Classification of Agarwood (Gaharu) by Resin Content		
Author	**:**	MA Nor Azah, S Saidatul Husni, J Mailina, L Sahrim, J Abdul Majid & Z Mohd Faridz		
Types	**:**	Journal	**Year :**	2013
Publisher :		Journal of Tropical Forest Science 25(2): 213–219 (2013)		
Source/ link	**:**	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v25n2/213-219.pdf		

Abstract:

Agarwood or gaharu is a fragrant resinous heartwood that can develop in diseased trees from the genus *Aquilaria* (*Thymelaeaceae*). The wood is often classified into various grades according to the colour, density, gaharu formation and scent. These parameters are very subjective and depend on individual perception. In this study, several grades of gaharu wood from natural sources and inoculated materials were evaluated for resin content and the data classified using Z-score transformation technique. The results demonstrated that resin content could be used as a guide for the classification of gaharu, thus assisting the industry to reduce bias judgement among traders.

Title	**:**	Agarwood Production - A Multidisciplinary Field to Be Explored in Bangladesh		
Author	**:**	Selina Akter, Md. Tanvir Islam, Mohd Zulkefeli & Sirajul Islam Khan		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	International Journal of Pharmaceutical and Life Sciences		
Source/ link	**:**	http://www.ijlsbd.com/010403.pdf		

Abstract:

'Agarwood' or 'eaglewood' ('Aguru' in Bengali) is the most expensive wood in the world, which is an occasional product of a few genera of *Aquilaria* and *Gyrinops* in the plant family *Thymelaeaceae*. Agar is a scented product, oleoresin, obtained from pathological conditions of the wood of live trees containing many aromatic substances. Various bacteria and fungi have been found to be associated with Agarwood formation, although it is still not absolutely clear which are important or even necessary. The quality of agar mostly depends on the plant species and the fungal species involved, as well as, certain other unknown factors. The issues are now to explore the new sources of agarwood to protect the endangered plant species, to ensure agar formation in 100% of the planted trees, upgrade in quality and most possibly quantity of agar yield per tree simultaneously minimizing the maturation time. Both physical and chemical stresses like mechanical wound and induction have long been practiced to enhance agarwood yield as well as fungal inoculation. Specificity of fungal infection is a minor criterion of agarwood formation rather than the plant's physiological state, immune responses and presence of inducer. The agarwood production could be a multifaceted field of prospects in Bangladesh. The cultivation of new *Aquilaria* and *Gyrinops* plants and selection of appropriate inocula and inducers should be the priority objective. A multidisciplinary approach could be initiated with the experts of forestry, mycology, biochemistry and microbiology to achieve the goal

Title	:	Analysis of High Quality Agarwood Oil Chemical Compounds By Means of SPME/GC -MS And Z-Score Technique
Author	:	Nurlaila Ismail, Mohd Ali Nor Azah, Mailina Jamil, Mohd Hezri Fazalul Rahiman, Saiful Nizam Tajuddin & Mohd Nasir Taib
Types	:	Journal **Year :** 2013
Publisher	:	Malaysian Journal of Analytical Sciences, Vol 17 No 3(2013): 403 -413
Source/ link	:	https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=45100622

Abstract:

Currently, the grading of the agar wood oil to the high and low quality is done using manually such as human trained grader. It was performed based on the agar wood oil physical properties such as human experience and perception and the oil colour, odor and long lasting aroma. Several researchers found that chemical profiles of the oil should be utilized to overcome the problem facing by manual techniques for example human nose cannot tolerate with the many oils at the same time, so that accurate result can be obtained in grading the agar wood oil. The analysis involved of SPME/ GC-MS and Z-score techniques have been proposed in this study to analyze the chemical compounds especially from the high quality samples of agar wood oil (*Aquilariamalaccensis*) from Malaysia. Two SPME fibers were used such as divinylbenzene-carbogen-polydimethylsiloxane (DVB-CAR-PDMS) and polydimethylsiloxane (PDMS) in extracting the oils compound under three different sampling temperature conditions such as 40, 60 and 80 degree Celsius. The chemical compounds extracted by SPME/ GC-MS were analyzed. The chemical compounds as identified by Z-score as significant compounds were discussed before the conclusion is made. It was found that 10-epi-γ-eudesmol, aromadendrene, β-agar ofuran, α-agar ofuran and γ-eudesmol were highlighted as significant for high quality agar wood oil and can be used as a marker compounds in classifying the agar wood oil

Title	**:**	Characterization of Methanolic Extracts of Agarwood Leaves		
Author	**:**	Khalil, A. S., Rahim, A. A., Taha, K. K. &Abdallah, K. B.		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	Journal of Applied and Industrial Sciences, 2013, 1 (3): 78-88, ISSN: 2328-4595 (PRINT), ISSN: 2328-4609 (ONLINE)		
Source/ link	**:**	http://researchpub.org/journal/jais/number/vol1-no3/vol1-no3-9.pdf		

Abstract:

Tropical Agarwood (*Aquilaria*) is in danger of extinction in the wild due to illegal logging. It's resin (Gaharu) is used for the production of highly valued incense throughout Asia. The methanolic crude extracts of Agarwood leaves before and after inoculation process extracted by using maceration into methanol as solvent were screened for Phytoconstituents, the extracts revealed the presence of alkaloids, tannins, saponins, flavonoids and terpenoids. Gas chromatography-mass spectrometry (GC-MS) analysis of the plant extracts led to the identification of 14 components from the two types of Agarwood leaves extracts. It is interesting to see here that all the identified compounds from agarwood leaves Methanolic extracts contained oxygen and/or π-electrons in their molecules. Hexadecanoic acid was found to be one of the major compounds in Agarwood leaves methanolic extracts. Infrared spectroscopic analysis of the extracts of Agarwood revealed the presence of O-H, C=O, C-H, C-N, C-O, -CH2 and – CH3 bond stretching. The present study has proved the usefulness of agarwood tree for medicinal and anti corrosive purposes. The presence of phytochemicals indicates its potential as a source of useful drugs.

Title	:	Differentiating Agarwood Oil Quality Using Artificial Neural Network
Author	:	Nurlaila, I., Nor Azah, M.A.., Mailina, J., Mohd Hezri, F.R., Saiful Nizam, T. & Mohd Nasir, T.
Types	:	Journal **Year :** 2013
Publisher	:	Malaysian Journal of Analytical Sciences 17(3): 490–498
Source/ link	:	http://www.ukm.my/mjas/v17_n3/Nor%20Azah.pdf

Abstract:

Agarwood oil is well known as expensive oil extracted from the resinous of fragrant heartwood. The oil is getting high demand in the market especially from the Middle East countries, China and Japan because of its unique odor. As part of an on-going research in grading the agarwood oil quality, the application of Artificial Neural Network (ANN) is proposed in this study to analyze agarwood oil quality using its chemical profiles. The work involves of selected agarwood oil from low and high quality, the extraction of chemical compounds using GC-MS and Z-score to identify of the significant compounds as input to the network. The ANN programming algorithm was developed and computed automatically via Matlab software version R2010a. Back-propagation training algorithm and sigmoid transfer function were used to optimize the parameters in the training network. The result obtained showed the capability of ANN in analyzing the agarwood oil quality hence beneficial for the further application such as grading and classification for agarwood oil.

Title	**:**	Characterization of The Chemical Constituents of Agarwood Oils From Malaysia by Comprehensive Two-Dimensional Gas Chromatography–Time-of-Flight Mass Spectrometry		
Author	**:**	Saiful Nizam Tajuddin, Norfatirah S. Muhamad, Mohd A. Yarmo & Mashitah M. Yusoff		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	Elsevier B.V.		
Source/ link	**:**	http://www.sciencedirect.com/science/article/pii/S0959943613000205		

Abstract:

4-Phenyl-2-butanone, a-bulnesene, a-guaiene, agarospirol, ledene oxide-(II), elemol and g-eudesmol were identified as the major chemical constituents of Malaysian agarwood oils.

Title	:	Fungi Inoculation Induced Agarwood Formation in Young *Aquilaria malaccensis* Trees in The Nursery		
Author	:	Mohamed R., Jong P.L. & A.K. Kamziah		
Types	:	Journal	**Year :**	2013
Publisher	:	Journal of Forestry Research. In print		
Source/ link	:	Forest Biotech Laboratory, Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia		

Abstract:

Fungi are often used to induce agarwood in *Aquilaria* trees.This study was conducted to evaluate the effect of several fungi on agarwood formation over time in young *Aquilaria malaccensis*(*Lam.*)trees.Typical changes in the length and light intensity of the resulting discoloration were observed after three and six month periods following inoculation.Wood samples were observed microscopically and classified into several light intensity groups.The discoloration length was measured longitudinally.The duration after inoculation affected the mean of discoloration length:the 6-month old sample(1.70 cm)had a wider discoloration zone when compared to the 3-month old sample(1.17 cm).When measuring the discoloration intensity,a positive relationship with time was perceived.Digital images,captured using a camera-equipped microscope,revealed that wood samples collected after six months appeared to be 1.8-times darker than after three months.We concluded that time,not the species of any of the tested fungi,had significant effect on discoloration length and intensity.Gas chromatography/mass spectrometry(GCMS)analysis of the 6-month old sample yielded some important agarwood compounds such as benzylacetone,anisylacetone,guaiene and palustrol.This demonstrates that the tested fungi have the ability to induce agarwood formation in nursery *A.malaccensis* trees.

Title	:	Microscopic Observation of 'Gaharu' Wood From *Aquilaria malaccensis*		
Author	:	Mohamed R., Wong M.T & R. Halis		
Types	:	Journal	**Year :**	2013
Publisher	:	Pertanika Journal of Technology and Science 36 (1):43-50		
Source/ link	:	Forest Biotech Laboratory, Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia		

Abstract:

Aquilaria produces fragrant wood known as 'gaharu' in its stem and branches, often in mature and damaged trees. In this study, anatomical characteristics in juvenile and mature trees were investigated by comparing their anatomical structures after various staining methods and direct observations under a light microscope. Juvenile and mature wood share similar anatomical structures. No major differences were observed other than the percentage of area covered by included phloem in juvenile was 2.16 times more than that of the mature wood. Microscopic observation revealed that in mature resinous wood, brownish bodies were found in ray and axial parenchyma, included phloem, xylem vessels and fibres, and this finding indicates that these are important elements for 'gaharu' depositing. Thus, it was concluded that juvenile tree possess the anatomical features of that of mature wood in producing 'gaharu'.

Title	:	Vegetative Description of Three *Aquilaria* (*Thymelaeaceae*) Saplings in Malaysia
Author	:	Rozi Mohamed, Faridah Hanum Ibrahim & Lee, S. Y.
Types	:	Journal **Year :** 2013
Publisher	:	UPM KM Portal
Source/ link	:	Forest Biotech Laboratory, Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia

Abstract:

Plants' reproductive parts are most important for species identification. However, trees such as *Aquilaria* species take many years to mature and produce flowers and fruits. Inconsistent and infrequent flowering periods may cause additional hindrance to classical identification. In this study, descriptions were made based on vegetative parts such as leaf, branch and bark for saplings of three *Aquilaria* species found in Malaysia. It was found that *A. hirta* sapling can be recognized through the densely hairy twigs, young shoots and axillary buds, undersurface of leaf, margin, petiole and midrib besides the strongly raised midrib, and usually unbranched habit; *A. malaccensis* through the many branches and white spots along main axis, entire leaf margin, slightly hairy leaf undersurface and midrib, and glabrous petiole; *Aquilaria sp.1* from the lower branches that are nearly perpendicular to the stem and wavy leaf margin. These vegetative characters can serve as a basis for the correct identification of *Aquilaria* saplings when growers need to confirm their planting materials.

Title	**:**	Pyrolysis of Waste Biomass: Investigation of Fast Pyrolysis and Slow Pyrolysis Process Conditions on Product Yield and Gas Composition		
Author	**:**	Q M K Waheed, M A Nahil & P T Williams		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	Journal of the Energy Institute		
Source/ link	**:**	http://www.maneyonline.com/doi/abs/10.1179/1743967113Z.00000000067		

Abstract:

High temperature fast pyrolysis of wood, rice husk and forestry wood residue was carried out in a laboratory scale fixed bed reactor. The results were compared with pyrolysis of the biomass samples in a different reactor under slow pyrolysis conditions. There was a marked difference in product yield depending on heating rate, for example the gas yield from slow pyrolysis was 24•7 wt-% for wood, 24•06 wt-% for rice husks and 24•01 wt-% for forestry residue; however, for fast pyrolysis, the gas yields were 78•63, 66•61 and 73•91 wt-% respectively. There were correspondingly significantly lower yields of oil and char from fast pyrolysis, whereas for slow pyrolysis, oil and char yields were higher. The composition of the product gases was also influenced by the heating rate. In additional experiments, the influence of pyrolysis temperature was investigated under fast pyrolysis conditions from 750 to 1050°C. It was found that the increase in temperature increased overall gas yield and also increased hydrogen gas concentration with a decrease in CH_4, CO_2 and C_2–C_4 hydrocarbons. High gas yields of ~90 wt-% conversion of the biomass to gas was obtained during the pyrolysis of biomass at 1050°C. Steam was also added to the fast pyrolysis system to enhance the hydrogen production. The amount of hydrogen produced was found to significantly increase in the presence of added steam.

Title	:	Population Structure and Regeneration Status of *Aquilaria malaccensis Lam.* in Homegardens of Upper Assam, Northeast India
Author	:	P. Saikia, & M. L. Khan
Types	:	Journal **Year :** 2013
Publisher	:	International Society for Tropical Ecology
Source/ link	:	http://www.tropecol.com/pdf/open/PDF_54_1/1-Saikia.pdf

Abstract:

Aquilaria malaccensis, a critically endangered tree species of India, is cultivated in homegardens of Assam. We studied the population structure and regeneration status of this species in homegardens of Upper Assam, northeast India. Population structure of the species was studied in 135 homegardens and regeneration status was studied in eight selected homegardens of Jorhat and Golaghat districts of Upper Assam. In the studied homegardens, population density (individuals ha-1) of *A. malaccensis* was 1,443, 4,060 and 33,917 for trees (> 3.18 cm diameter at breast height = DBH), saplings and seedlings, respectively. This pattern of density distribution (seedlings > saplings > trees) indicates good regeneration status of the species in homegardens. On the other hand, out of the eight selected homegardens, seven showed good regeneration status, whereas, one showed fair regeneration status for the species. Seasonal survival rate of *A. malaccensis* saplings was significantly different among the eight selected homegardens during all the four seasons (each season of three months) of the year but that of seedlings and trees did not differ significantly. Average seasonal growth rate of *A. malaccensis* (in terms of collar diameter for seedlings and saplings, and DBH for trees) varied significantly among the eight selected homegardens as well as between the four seasons. The findings of the present study suggest that homegardens can save the species from the risk of extinction.

Title	**:**	Effect of Culture Media and Growth Hormones on Callus Induction in *Aquilaria malaccensis Lam.*, a Medicinally and Commercially Important Tree Species of North East India		
Author	**:**	Moitreyee Saikia, Karuna Shrivastava & S. Sureshkumar Singh		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	Asian Journal of Biological Sciences		
Source/ link	**:**	http://scialert.net/fulltext/?doi=ajbs.2013.96.105		

Abstract:

The use of in vitro culture technique has growing significance in conservation of plant germplasm and in securing valuable products of medicinal and commercial importance. *Aquilaria malaccensis Lam.*, an economically important tree species of North East India is valued for its highly prized wood and agar oil. Callus induction was investigated using young leaf and nodal explants of this species on modified Murashige and Skoog (MS) and Woody Plant Medium (WPM) supplemented with different growth hormones. We found MS medium more suitable for induction and maintenance of callus when supplemented with growth hormones at high auxin and low cytokinin ratio. The hormonal combination of 2,4 dichlorophenoxyacetic acid (2,4D)+kinetin was recorded as most appropriate for high percentage of callus induction (70-73%), fast growth rate of viable and healthy callus. Rhizogenesis and embryogenesis from callus tissues of *Aquilaria malaccensis* could be accomplished. In laboratory conditions, large scale and rapid callus production protocol has been established which may be utilized for in-vitro biosynthesis of biochemical principles of commercial importance. This may help in reducing uncontrolled overexploitation of this endangered tree species while giving an important opportunity to conserve the natural population in the wild habitats of the region in particular and other habitats in general.

Title	**:**	Analysis of Different Grades of Agarwood (*Aquilaria malaccensis Lamk.*) Oil Through GC-MS		
Author	**:**	K Jayachandran, I Sekar, K T Parthiban, D Amirtham & K K Suresh		
Types	**:**	Journal	**Year :**	2013
Publisher :		Indian Journal of Natural Products and Resources		
Source/ link	**:**	http://nopr.niscair.res.in/bitstream/123456789/27475/1/IJNPR%205%281%29%2044-47.pdf		

Abstract:

The study was carried to find out differences in the composition of Agarwood oil obtained from highly infected (Grade 1), moderately infected (Grade 2), less infected (Grade 3) and healthy wood (Grade 4) by using gas chromatography mass spectrometry analysis (GC-MS). Highly infected wood oil (G1) contains aromadendrene2 (24.76%), valencene2 (17.53%), + calarene (9.63%), 1(5), 6-Guaiadiene (8.76%), etc. Moderately infected wood oil (G2) contains Tau-cadinol (16.90%), valencene2 (1.73%), aromadendrene2 (1.73%), etc. Less infected wood oil (G3) contains 1-Methyl-1-caprolactone (39.10%), 7(Hydroxymethyl)-2-methoxy-xanthone (32.06%), aromadendrene2 (1.58%), valencene2 (1.58%), etc. Healthy wood oil (G4) contains 3-Carbethoxy-3-butenyl Crotonate (29.12%), Methyl 5, 5-dimethoxy-4, 4-dimethyl-3-hydroxy-2-vinylpentanoate (24.68%), etc. Since the the presence of aromadendrene and valencene plays an important role in grading of Agarwood oil, quantity of these two compounds in the above mentioned four grades of wood are in the following order G1>G2>G3 and absent in G4 grade wood oil.

Title	:	Molecular Phylogenetic Identification of Endophytic Fungi Isolated From Resinous and Healthy Wood of *Aquilaria malaccensis*, A Red Listed and Highly Exploited Medicinal Tree
Author	:	K. Premalatha & A. Kalra
Types	:	Journal **Year :** 2013
Publisher	:	Fungal Ecology (Volume 6, Issue 3, June 2013, Pages 205–211)
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S1754504813000068

Abstract:

Aquilaria malaccensis is a fast-growing, tropical tree belonging to the family *Thymelaeaceae* and is locally known as Agar. Agarwood formation takes place in the stem or main branches of the tree where an injury has occurred. It is believed that the tree is first attacked by a pathogenic fungus, which causes it to weaken. Most fungal diversity studies have previously been based on morphological examination and cultivation methods. In this study, we used both culture-dependent and culture-independent approaches (metagenomic) to study the endophytic fungi on wood chips of *A. malaccensis*. The culture-based approach revealed *Alternaria, Cladosporium, Curvularia, Fusarium, Phaeoacremonium* and *Trichoderma* as members of the agarwood community. Also analysis of ITS sequencing of these culture isolates provided further verification of the identity of the cultured groups. Analysis of community DNA (metagenome) extracted from both infected and healthy wood samples revealed that the majority of fungi present had highest sequence similarity to members of *Dothideomycetes*, followed by *Sordariomycetes* and *Saccharomycetes*. Thus, morphological and genetic characteristics showed that most isolates from agarwood belong to *phylum Ascomycota*. A neighbour-joining tree showed the relationships between the isolates sequence data and the closest identified relatives from GenBank.

Title	**:**	An Efficient Procedure for The Preparation of Natural Products Bearing The 2-(2-Phenylethyl) Chromone Skeleton		
Author	**:**	Dwight A. Williams, Cameron Smith & Yan Zhang		
Types	**:**	Journal	**Year :**	2013
Publisher	**:**	Tetrahedron Letters (Volume 54, Issue 32, 7 August 2013, Pages 4292–4295)		
Source/ link	**:**	http://www.sciencedirect.com/science/article/pii/S0040403913009507		

Abstract:

Several 2-(2-phenylethyl)chromones have been shown to possess neuroprotective activity. However, limited synthetic methods have been disclosed to construct the 2-(2-phenylethyl)chromone skeleton. Herein, we report a straightforward 3-step preparation of five naturally occurring 2-(2-phenylethyl)chromones utilizing the Claisen condensation as the key step.

Title	**:**	Analysis of Agarwood Oil (*Aquilaria malaccensis*) Based on GCMS in Signal Processing and Its Application (CSPA)		
Author	**:**	Ali, N.A.M., Ismail, & N. Taib, M.N.		
Types	**:**	Journal	**Year :**	2012
Publisher	**:**	Signal Processing and its Applications (CSPA), 2012 IEEE 8th International Colloquium		
Source/ link	**:**	Forest Research Institute Malaysia		

Abstract:

Agarwood oil has been widely used especially in fragrance, incense, prayers and traditional medicinal. In the Middle East, the market demand for Agarwood oil is very high. Agarwood oil is traded based on high grade and low grade, corresponding to expensive price and cheap price, respectively. Currently, the grading of Agarwood oil, specifically *Aquilaria malaccensis*, depends on its physical appearance such as color and odour. This paper presents the analysis of *Aquilaria malaccensis* based on GC-MS data. The work involves of statistical technique such as boxplot and PCA. The analysis part was done on 64 chemical compounds on 7 samples of agarwood oil obtained by Forest Research Institute Malaysia (FRIM). It was done via MATLAB ver. R2010a. The result shows that the distribution of chemical compounds in Agarwood oil is not normal and five componets is identified from 64 variables Agarwood oil samples, gathered by boxplot and PCA, individually.

Title	:	Isolation and Characterization of Microsatellite Markers for An Important Tropical Tree, *Aquilaria malaccensis* (*Thymelaeaceae*)
Author	:	Lee Hong Tnah, Chai Ting Lee, Soon Leong Lee, Kevin Kit Siong Ng, Chin Hong Ng, Zakaria Nurul-Farhanah, Kah Hoo Lau & Lillian Swee Lian Chua
Types	:	Journal **Year :** 2012
Publisher	:	American Journal of Botany: e431–e433. 2012.
Source/ link	:	http://www.amjbot.org/content/99/11/e431.short

Abstract:

Premise of the study: Aggressive collections and trade activities in recent decades have resulted in heavy pressure on the natural stands of *Aquilaria malaccensis* and concerns over its long-term survival potential. To aid DNA profiling and assessment of its genetic diversity, microsatellite markers were developed for the species. Methods and Results: Seventeen polymorphic microsatellite markers were developed for *A. malaccensis* using an enrichment protocol. The markers were screened on 24 samples from a natural population. The number of alleles ranged from two to 11, and the observed heterozygosity ranged from 0.042 to 0.957. No significant deviation from Hardy–Weinberg equilibrium was detected after conservative Bonferroni correction. Conclusions: This is the first report on the development of microsatellite markers in *A. malaccensis*. The markers will be used to establish a DNA profiling database and to estimate the genetic diversity and population genetic structure of the species

Title	**:**	Methods Paper: An Improved Surface Sterilization Technique for Introducing Leaf, Nodal and Seed Explants of *Aquilaria malaccensis* From Field Sources into Tissue Culture		
Author	**:**	Nurul Hazwani Daud, Shashita Jayaraman & Rozi Mohamed		
Types	**:**	Journal	**Year :**	2012
Publisher	**:**	Asia Pacific Journal for Molecular Biology and Biotechnology (APJMBB)		
Source/ link	**:**	http://www.msmbb.org.my/apjmbb/html202/202c.pdf		

Abstract:

A critical stage in the introduction of plants into tissue culture is to obtain cultures free from microbial contamination.This study investigated different sterilization regimes for leaf and nodal explants from *Aquilaria malaccensis* grown in the shadehouse under natural environmental conditions, and for seeds from wild mature trees. We found that pre-sterilization using 0.2%Benomyl for 15 minutes improved the number of 'clean and alive' individuals of all types of explants, especially when followed bysurface sterilization using mercury chloride ($HgCl_2$). Treatment with 0.1 % $HgCl_2$ for 15 and 30 seconds yielded the best resultsfor leaf and nodal explants, respectively. Maximum percentage of 'clean and alive' seeds was observed when using 0.2 % $HgCl_2$for 12 minutes. Treatment with Clorox® bleach (5.25% sodium hypochlorite as the active ingredient) even at high concentration(50% Clorox®) alone was not sufficient to control fungal and bacterial contamination in the explants. We conclude that $HgCl_2$coupled with Benomyl pre-treatment produced a highly efficient sterilization method producing 83 – 90% 'clean' leaf, nodal andseed explants of *A. malaccensis* from natural sources after fourteen days in culture.

Title	:	Effects of Soaking on Yield and Quality of Agarwood Oil		
Author	:	K Nor Fazila & KH Ku Halim		
Types	:	Journal	**Year :**	2012
Publisher	:	Journal of Tropical Forest Science 24(4): 557–564 (2012)		
Source/ link	:	http://www.frim.gov.my/v1/JTFSOnline/jtfs/v24n4/557-564.pdf		

Abstract:

The aims of this study were to investigate vaporisation temperature of agarwood oil, determine enlargement of wood pore size, analyse chemical components in soaking solvents and examine the chemical composition of agarwood oil extracted from soaked and unsoaked agarwood. Agarwood chips were soaked in two different acids, namely, sulphuric and lactic acids for 168 hours at room temperature (25 °C). Effects of soaking were determined using thermogravimetric analysis (TGA), scanning electron microscope (SEM) and gas chromatography-mass spectrum analysis. With regard to TGA curve, a small portion of weight loss was observed between 110 and 200 °C for agarwood soaked in lactic acid. SEM micrograph showed that the lactic acid-soaked agarwood demonstrated larger pore size. High quality agarwood oil was obtained from soaked agarwood. In conclusion, agarwood soaked in lactic acid with concentration of 0.1 M had the potential to reduce the vaporisation temperature of agarwood oil and enlarge the pore size of wood, hence, improving the yield and quality of agarwood oil.

Title	**:**	Classification of Agarwood Using ANN		
Author	**:**	M. S. Najib, N. A. Mohd Ali, M. N. Mat Arip, M. Abd Jalil & M. N. Taib		
Types	**:**	Journal	**Year :**	2012
Publisher	**:**	International Journal Of Electrical And Electronic Systems Research, Vol.5 June 2012		
Source/ link	**:**			

Abstract:

An artifical neural network (ANN) has been modeled for the classification of Agarwood region. The target regions were from Melaka, Pagoh, Super Pagoh, Ulu Tembeling and Indonesia. The data analysis using Principal Component Analysis (PCA) was done to find significant input selection from 32 sensors of the E-nose and to recognize pattern variations from different number of Agarwood samples as inputs to ANN training. The network developed based on three layers feed forward network and the back propagation learning algorithm was used in executing the network training. Five input neurons, two hidden layer sizes and one output neurons were found to be the optimized combination for the network. The experimental results reveal that the proposed method is effective and significant to the classification of Agarwood region

Title	:	Comparisons of Different RNA Extraction Methods on Woody Tissues of The Tropical Tree, *Aquilaria malaccensis*		
Author	:	Chai Har Siah, Parameswari Namasivayam & Rozi Mohamed		
Types	:	Journal	**Year :**	2012
Publisher	:	AsPac J. Mol. Biol. Biotechnol. 2012		
Source/ link	:	http://www.msmbb.org.my/apjmbb/html203/203e.pdf		

Abstract:

Aquilaria malaccensis (karas) produces oleoresin in its wood (known as agarwood) when responding to wounding and microbial infection. Wood tissues are known to contain high levels of polysaccharides, polyphenolics and secondary metabolites, which make RNA extraction challenging. In this work, six different methods for extracting RNA from wood tissues of *A. malaccensis* were compared. RNA yield, purity, and integrity number, were used as parameters to evaluate the efficiency of each method. Conventional methods yielded RNA with good purity but the RNA integrity was poor. The commercial RNeasy Plant Mini kit protocol was modified by means of scaling-up the reaction and combining all aliquots in the same RNeasy spin column, and yielded the highest yield while maintaining the integrity of the RNA. We found that this kit with some modifications was most suitable for extracting RNA from healthy wood and agarwood. This study is essential for future molecular studies on agarwood.

Title	:	Histology of *Aquilariamalaccensis* and Agarwood Resin Formation Under Light Microscopy		
Author	:	Chong Saw Peng, Osman, M. F., Khairuddin Abdul Rahim & Mat Rasol Awang		
Types	:	Journal	**Year :**	2012
Publisher	:	Journal of Agrobiotechnology		
Source/ link	:	No information		

Abstract:

A histology study was conducted in the investigation of the anatomy of *Aquilaria malaccensis* cell structures and the organelles existing in the plant system to seek for the correlation between the cell structure and the response of resin secretion and accumulation in the plant cell system. Light microscopy was used in the study due to its simplicity in the sample preparation and the power of visualization gave a clear image of the cell structure. The xylem cell structure was investigated under light microscope to seek for the answer of the agarwood resin formation and accumulation in the *A. malaccensis* caused by the responses of the cells towards the defense system trigged by an injury or the invasion of microbes.

Title	:	A Real-Time PCR Method For The Detection of Trnl-Trnf Sequence in Agarwood and Products From *Aquilaria* (*Thymelaeaceae*)		
Author	:	Mohamed R., H.Y. Tan & C.H. Siah		
Types	:	Journal	**Year :**	2012
Publisher	:	Conservation Genetics Resources 4 (3): 803-806		
Source/ link	:	No information		

Abstract:

The trnL-trnF intergenic spacer is used in phylogenetic studies of many plant species including *Thymelaeaceae*. Members of this family are endangered tropical tree species. *Aquilaria* produces agarwood that is prized for its fragrance when used directly as incense or processed into essential oil. The goal of the project was to detect DNA sequences from processed samples of *Aquilariamalaccensis* using real-time PCR (RT-PCR). When using regular PCR, only fresh wood sample yielded a specific band of 465 bp. Samples consisted of fresh wood, different grades of agarwood chips, samples taken at various stages during essential oil processing, and its by-product. Our results revealed lower levels of intact trnL-trnF sequence in samples that had undergone treatments (threshold cycle, Ct ≥ 20) when compared to fresh wood (Ct = 16 and 18). We demonstrated RT-PCR sensitivity and usefulness in detecting DNA presence in agarwood and processed products derived from agarwood.

Title	:	Effect of Seed Abortion and Seed Storage on Germination and Seedling Growth in *Aquilaria malaccensis Lamk.* (*Thymelaeaceae*)		
Author	:	Uma Shankar		
Types	:	Journal	**Year :**	2012
Publisher	:	Current Science, Vol. 102, No. 4, 25 February 2012		
Source/ link	:	http://www.currentscience.ac.in/Volumes/102/04/0596.pdf		

Abstract:

The fruit of *Aquilaria malaccensis* is a bilocular dehiscent capsule, with each locule harbouring a single seed. If this species aborts a developing seed within a fruit, does the remaining seed benefit in terms of enhanced seed weight, and do heavier seeds confer germination and growth advantages over lighter seeds? As seeds mature in the middle of the rainy season when moisture is abundant in the soil, does desiccation in the storage of seeds reduce germination success? To test these predictions, 821 fruits were examined, including two-thirds fruits that were oneseeded and one-third fruits two-seeded. Fresh seeds varied nearly fivefold in weight, from 28.8 to 134.8 mg. However, the mean seed weight did not vary significantly between the seeds from one- and two-seeded fruits. On storage at room temperature (28 ± 2°C), the seeds lost 40 ± 1.2% moisture by the 5th day and 55 ± 1.5% by the 14th day. Yet, the difference in mean seed weight was not significant between the seeds from one- and two-seeded fruits. Germination percentage of fresh seeds increased with increase in seed weight: seeds < 40 mg failed to germinate, those between 40 and 80 mg resulted in 10.5% germination and those > 80 mg germinated vigorously (54.8%). This trend was steady when seeds stored for 5 and 14 days were sown. Germination percentage of all seeds declined drastically with storage time: from 31 for seeds without storage to 25 for 5 days of storage and only 1% for 14 days of storage. Germination was epigeous and it was completed within 40 days from sowing. Time to germination was lesser for heavier than lighter seeds. Survival of seedlings and their growth from heavier seeds was significantly greater than those from lighter seeds. The study shows that the abortion of one of the two seeds does not enhance the weight of the remaining seed. Yet greater seed weight (> 80 mg) is advantageous for better germination and seedling growth in *A. malaccensis.*

Title	**:**	*Aquilaria malaccensis Lam.*, A Red-Listed and Highly Exploited Tree Species in The Assamese Home Garden		
Author	**:**	Saikia, P. & Khan, M.L.		
Types	**:**	Journal	**Year :**	2012
Publisher	**:**	Current Science (00113891);Feb2012, Vol. 102 Issue 4, p546		
Source/ link	**:**	http://connection.ebscohost.com/c/articles/73832391/aquilaria-malaccensis-lam-red-listed-highly-exploited-tree-species-assamese-home-garden		

Abstract:

The article discusses the advantages and disadvantages of *Aquilaria malaccensis lam.*, a tree species, largely found in Southeast Asia. As mentioned, *Aquilaria* produces a resin which helps in defense mechanism of the tree and is also used for making perfumes and traditional medicine. It further informs that large scale harvesting of *Aquilaria* species causes depletion of species in the natural habitat of the tree as it requires huge amount of nutritional compounds for its growth.

Title	:	An Efficient Protocol for Callus Induction in *Aquilaria malaccensis Lam.* Using Leaf Explants at Varied Concentrations of Sucroce
Author	:	Moitreyee Saikia, Karuna Shrivastava & S. Sureshkumar Singh
Types	:	Journal **Year :** 2012
Publisher	:	Scientific & Academic Publishing
Source/ link	:	http://article.sapub.org/10.5923.j.plant.20120206.03.html

Abstract:

Aquilaria malaccensis Lam. (Family: *Thymelaeaceae*), commonly known as agarwood, eagle wood or Gaharu is a commercially important tree species of northeast India. The *Aquilaria* tree is categorised as critically endangered in India. This species is being continuously exploited due to its precious heartwood which is the source of expensive agar oil used in the production of high grade perfumes as well as in traditional medicines. The main aim of this study was to establish a speedy callus production protocol from *Aquilaria malaccensis* which may serve as an important option for direct extraction of agar oil. For this purpose, large scale production of callus tissue is needed. An efficient callus regeneration protocol was established through leaf proliferation in *Aquilaria malaccensis Lam.* using Murashige and Skoog medium supplemented with least amount of plant growth hormones (2,4 D, NAA, Kinetin & BAP) at varied concentrations of sucrose (2-5%). Callus could be initiated in all the treatments of hormones and sugar levels; however, the best callus growth was obtained in the MS medium supplemented with BAP (0.5 mg/l) + NAA (3mg/l) giving the highest fresh (7.368g) and dry cell biomass (2.170g) at the optimum sucrose concentration (4%) after 45-60 days of incubation.

Title	:	Seedling Survival and Growth of *Aquilaria malaccensis* in Different Microclimatic Conditions of Northeast India		
Author	:	P. Saikia & M. L. Khan		
Types	:	Journal	**Year :**	2012
Publisher	:	Northeast Forestry University		
Source/ link	:	http://link.springer.com/article/10.1007/s11676-012-0296-7		

Abstract:

We studied seedling survival and growth of *Aquilaria malaccensis* in three different environmental conditions (homegardens, green house and in different canopy conditions) of northeast India. Results show that mean seasonal survival was highest in green house (95.53%±2.33), followed by homegardens (89.3%±1.89) and different canopy conditions (77.62%±6.73); the highest values were found during February to April for both the homegardens (96%±1.68) and green house (98% ± 0.88) and lowest during November to January (78%±2.99) in homegardens and May to July (90%±4.53) in green house. In case of transplanted seedlings in different canopy conditions, mean seasonal survival was highest during May to July (98%±1.92) and lowest during August to October (66%±12.81). However, mean seasonal growth of collar diameter was highest in different canopy conditions (23.99%±1.76 compared to green house (21.52%±2.70) and homegardens (12.44%±1.33) and it was highest during rainy season (May to July) and lowest during dry winter (November to January) in all the three experimental sites. These variations may be due to the different microclimatic conditions as well as nutrient status of the soil in all the three experimental sites. Although, seedling quality plays a great role in their survival and growth, based on the result of green house experiment, it can be concluded that maintenance of seedlings in green house conditions during their early growth period may improve both the survival and growth for large scale plantation of the species. Thus, the species can be reintroduced in its natural forest range to compensate the loss of natural population of this precious species in northeast India.

Title	:	Growth and Mineral Nutrition of *Aquilaria malaccensis* (Karas) in Two Habitats as Affected by Different Cultural Practices		
Author	:	Nashriyah Mat, Shamsiah Abd Rahman, Norhayati Ngah, Khairil Mahmud, Nurrul Akmar Rosni & Khairuddin Abdul Rahim		
Types	:	Journal	**Year :**	2011
Publisher	:	Journal of Nuclear and Related Technologies, Volume 8, No. 2, December, 2011		
Source/ link	:	http://www.nuklearmalaysia.org/nuklearmalaysia_org/media/JNRT2012-9-1-02.pdf		

Abstract:

Effects of cultural practice under different habitats, of well-managed monoculture plantation and growing wild under rubber trees, were studied in *Aquilaria malaccensis* (Karas) leaves. This study was carried out on Karas growing in these two habitats each from Lipis, Pahang and Sepang, Selangor areas in Malaysia; under the control and induced treatments. The parameters studied include wet and dry weight of 50 matured leaves, iron and zinc elemental contents in leaf, iron and zinc uptakes from soil, and leaf and soil moisture contents. Iron and zinc were analysed in Karas leaves and soil by using Instrumental Neutron Activation Analysis (INAA) technique.

Title	:	Genetic Variation and Molecular Authentication of Selected *Aquilaria* Species From Natural Populations in Malaysia Using RAPD and SCAR Marker
Author	:	Lee , Shiou Yih, Weber, Jean S. & Mohamed, Rozi
Types	:	Journal **Year :** 2011
Publisher	:	Asian Journal of Plant Sciences, 10 (3). pp. 202-211
Source/ link	:	http://scialert.net/abstract/?doi=ajps.2011.202.211

Abstract:

Aquilaria (*Thymelaeaceae*) is an endangered agarwood-producing tropical tree that is endemic to the Indomalesia region. Molecular information on genetic diversity of *Aquilaria* is limited. The aims of this research were to study genetic diversity among three *Aquilaria* species, growing in natural and distant populations in Malaysia using RAPD markers and to develop SCAR markers for easy identification of *A. malaccensis*, the major agarwood producer. By analyzing 23 RAPD primers, a total of 368 bands were scored. Multi-populations Descriptive statistics revealed that 333 (90.49%) polymorphic bands were found at species level, where *A. malaccensis* had 107 (29.08%) bands, *A. hirta* had 56 (15.22%) and *Aquilaria sp.1* had 11 (2.99%), for the percentage of polymorphic loci in a single population/species. Nei's unbiased measurement indicated moderate similarities among populations/species. Out of the 23 RAPD primers, three were found specific *to A. hirta* and one was specific to each *A. malaccensis* and *Aquilaria sp.1*. RAPD-based SCAR markers generated a total of five species-specific amplicons: three for *A. hirta*, one each for *A. malaccensis* and *Aquilaria sp.1.* SCAR markers for *A. malaccensis* were used to distinguish five other different *A. malaccensis* populations in Malaysia. SCAR markers for *A. malaccensis* tested in five other different *A. malaccensis* populations in Malaysia yielded positive and consistent results. The DNA fingerprints identified for each *Aquilaria sp.* will be useful for *Aquilaria* identification in natural population, young plantation and even at seedling and seed stages in the nursery, as it is rapid and cost-effective and does not rely on morphology.

Title	:	Separation and Fractionation of *Aquilaria malaccensis* Oil Using Supercritical Fluid Extraction and The Cytotoxic Properties of The Extracted Oil
Author	:	A.H. Ibrahim, S.S. Al-Rawi, A.M.S. Abdul Majid, N.N. Ab. Rahman, K.M. Abo- Salah & M.O. Ab Kadir
Types	:	Journal **Year :** 2011
Publisher	:	11th International Congress on Engineering and Food (ICEF11)
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S2211601X11002884

Abstract:

Most cancer chemotherapy procedure employs cytotoxic drugs that target tumor cell. Some natural product contains cytotoxic compound but in low concentration. However, fractionation method can significantly increase the concentration of the cytotoxic compound present, resulting in more effectiveness, which can easily achieve using Supercritical extraction. Therefore, this study aims to extract and fraction *Aquilaria malaccensis* oil using supercritical fluid extraction, and investigate the cytotoxic properties of the extracted and fractioned oil. *Aquilaria malaccensis* oil was extracted using supercritical extractor at temperature of 40-50 °C, pressure of 20.7, 27.6 and 34.5 MPa and extraction dynamic time 30 min. The extract with the highest extraction yield was then fractionated using the best obtained operating condition to extract the most active fraction. Both samples and fractions were tested for anticancer activity by employing MTT assay on human colon (HCT116) cancer cell line. The result of this study shows that the highest amount of extracted oil was obtained at 50 °C, applied pressure of 34.5 MPa within 30 min extraction time, using CO2 flow rate of 1 ml/min. The most cytotoxic fraction was obtained at the first ten minutes at operating temperature of 50 °C, pressure 34.5 MPa. The cytotoxicity result of the tested cell showed a significant cell growth inhibition of 99% for using the whole sample and 94% for using the fraction and IC50 values against the tested cell was 4 µg/ml. These finding reveals that the supercritical extraction oil of Aquilaria Malaccensis has strong anticancer activity towards human colon cancer cells and hence can be a good candidate for treating cancer.

Title	:	Feasibility Study of Business In Agarwood Inoculation at Different Stem Diameters and Inoculation Periods		
Author	:	Sri Suharti , Pratiwi , Erdy Santosa & Maman Turjaman		
Types	:	Journal	**Year :**	2011
Publisher	:	Journal of Forestry Research Vol. 8 No. 2, 2011: 114 - 129		
Source/ link	:	http://forda-mof.org/files/3.Sri_Suharti,_Pratiwi,_Erdy_Santosa_and_Maman_Turjaman.pdf		

Abstract:

Indonesia signifies as the biggest agarwood producer country in the world. Its demand and price tend to increase and have brought about over exploitation of agarwood. Consequently, its population in nature has decreased significantly. To overcome the situation, since 1995, agarwood has been included in the CITES Appendix II. However, illegal exploitation remains persistent and reaches an excessive level. In order to deal with it, agarwood cultivation and its artificial production have been undertaken at several provinces in Indonesia. Some supporting factors for agarwood cultivation and artificial production are the availability of potential land for extensive cultivation, appropriate agro climate condition, simple cultivation technique and already being well adopted by farmers, the availability of necessary pathogen for agarwood inoculation, and the increasing demand with relatively high price. The research aims to analyze the feasibility study of agarwood inoculation business at several stem diameters (15 - 25 cm; 26-35 cm and 36 - 40 cm) and periods of inoculation (1 - 5 years). Data were collected through field observation and literature study. The results showed that inoculation on agarwood producer tree stands at 12.5% interest rate afforded positive net present value (NPV), internal rate of return (IRR) is much higher than market interest and benefit cost (B/C) ratio >2 for those three diameter classes. Furthermore, if agarwood harvesting is delayed until five years after inoculation, NPV, IRR and B/C ratio would be much higher. It can be concluded that inoculation on agarwood producer tree stands (at appropriate age for inoculation) is feasible to be developed.

Title	**:**	The Volatile and Semi-Volatile Constituents of Agarwood, The Infected Heartwood of *Aquilaria* Species : A Review		
Author	**:**	Regula Naef		
Types	**:**	Journal	**Year :**	2011
Publisher	**:**	Flavour and Fragrance Journal		
Source/ link	**:**	http://onlinelibrary.wiley.com/doi/10.1002/ffj.2034/abstract		

Abstract:

A compilation of the volatile and semi-volatile constituents of agarwood, the infected fragrant heartwood of some *Aquilaria* species, mainly *A. malaccensis, A. sinensis* and *A. crassna*, is presented. This high-priced wood has a long tradition in religious ceremonies as incense and its essential oil is well appreciated in fine perfumery. More than 150 compounds have been identified so far, mostly sesquiterpenoids, chromones and volatile aromatic compounds. The scarce knowledge of their organoleptic properties is summarized. Studies on the chemistry of agarwood smoke are discussed. Emphasis is given to structural and analytical aspects.

Title	:	Identification of Odor-Active Components of Agarwood Essential Oils From Thailand by Solid Phase Microextraction - GC/MS and GC-O
Author	:	Patcharee Pripdeevecha, Weeraya Khummueng & Seung-Kook Park
Types	:	Journal **Year :** 2011
Publisher	:	Journal of Essential Oil Research
Source/ link	:	http://www.frim.gov.my/v1/Library/

Abstract:

Volatile components from the essential oils of *Aquilaria malaccensis*, *A. subintegra* and *A. crassna* were investigated by gas chromatography (GC), gas chromatography-mass spectrometry (GC/MS), and gas chromatography-olfactometry (GC-O). A total of 31 volatile constituents were identified from the three agarwood oils. A subset of 18 out of the 31 components was identified from the essential oil of *A. malaccensis* with the major components being isoamyl dodecanoate, guaia-1(10),11-dien-15-ol, karanone, cyclocolorenone and jinkoheremol. *Aquilaria subintegra* oil yielded 28 identified compounds with the most abundant components being isoamyl dodecanoate, kusunol, jinkoh-eremol, epoxybulnesene and β-agarofuran, while 30 volatile compounds from *A. crassna* were identified, with isoamyl dodecanoate, β-agarofuran, kusunol, dehydrojinkoh-eremol and 9,11-eremophiladien-8-one as the main constituents. The aroma-active compounds of the three samples were analyzed by HS-SPME-GC-O. A total of 74 odor-active components were characterized by using the GC-O technique. The major components responsible for the aroma included β-agarofuran, 4-phenyl-2-butanone, furfural and benzaldehyde, while the minor aroma notes were attributed to (E)-α-bergamotene, α-humulene, α-bulnesene, α-agarofuran, nor-ketoagarofuran, epoxybulnesene, agarospirol, jinkoh-eremol, kusunol, acorenone B, selina-3,11-dien-14-al and 9,11-eremophiladien-8-one, considered to be the most important aroma impact compounds for the characteristic aroma of agarwood essential oils.

Title	:	Biochemical Plasma Profile of Male Rats Exposed to Smoke of Agarwood (*Aquilaria spp.*)		
Author	:	Isaac Karimi, Lora A. Becker, Abdolali Chalechale & Ali Ghashghaii		
Types	:	Journal	**Year :**	2011
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1007/s00580-011-1227-2		

Abstract:

In oriental regions, the resinous agarwood from *Aquilaria* trees is used during daily Asian religious practices and/or ceremonies either alone or as a part of incense burning. This study was undertaken to investigate the effect agarwood stick smoke on certain biochemical parameters. Ten male adult rats were divided into two groups (n = 5 each): Smoke-treated animals were exposed to agarwood smoke in a smoking apparatus for four sessions (1 h/day) per week and control animals exposed only to compressed air in a smoking apparatus similar to the smoke-exposed group. Blood samples were collected on the 28th day of the experiment to determine levels of a number of biochemical parameters: lactate dehydrogenase, aspartate transaminase, alanine transaminase, creatine phosphokinase, alkaline phosphatase, total protein, globulin, albumin, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglyceride, cortisol, and testosterone. The changes in body weight and biochemical parameters were not statistically significant after exposure to agarwood smoke with respect to the control group. The only significant decrease was in plasma testosterone level and was observed in the smoking group in comparison to the control group which led us to consider agarwood as an endocrine disruptor.

Title	:	Analysis of Gaharu Oils From Artificially Induced *Aquilaria* Species
Author	:	Nor Azah Mohd Ali, Abd Majid Jalil, Mailina Jamil, Saidatul Husni S, Chang Yu Shyun, Nik Yasmin Nik Yahya & Mohd Faridz Zolpatah
Types	:	Journal **Year :** 2010
Publisher	:	Malaysian Journal of Pharmaceutical Sciences Supplement (1) : 73, 2010
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Agarwood or gaharu is the result of a defence process of the karas (*Aquilaria*) tree against injury. High quality gaharu wood chips are sold directly to the Middle East and Japan as they are more favourable for religious purposes and as incense. The low quality grades are distilled to produce essential oils which are highly valued as perfumery ingredient. Currently, the suppliers of gaharu chips and oil are from Indonesia, Malaysia, India, Thailand and Vietnam where species such as *Aquilaria malaccensis, A. crassna* and *A. filaria* are being traded. All *Aquilaria* species are currently listed in Appendix II of the convention on trade in endangered species of wild fauna and flora (CITES) which means the trade of gaharu and its products is controlled and monitored by the relevant agencies for each producing country. In future the market will depend for supply from Aquilaria plantations in order to minimise the depletion of forest species. Thailand, Laos, Vietnam and Malaysia have already started planting trees in acreage. They have also developed their own inoculation technology and have already started using them on their-plantation on a large scale.

Title	:	Fungal Diversity in Wounded Stems of *Aquilaria malaccensis*		
Author	:	R. Mohamed, P. L. Jong & M. S. Zali		
Types	:	Journal	**Year :**	2010
Publisher	:	Springer Netherlands: Fungal Diversity (2010) 43:67-74		
Source/ link	:	http://link.springer.com/article/10.1007/s13225-010-0039-z		

Abstract:

Aquilaria malaccensis is a tropical tree which produces agarwood in its trunk often after being wounded and attacked by pathogens or insects. Fungi are generally viewed as the main microbial component responsible for agarwood formation. In this study, isolation of fungi from agarwood in damaged trees was carried out. Culture morphology and microscopic characteristics plus PCR amplification of the internal transcribed spacer (ITS) region from the fungal isolates as well as wood samples, were used to identify the fungal community composition of wounded *A. malaccensis* trees from a natural forest in West Malaysia. Conventional culture methodology revealed *Cunninghamella*, *Curvularia*, *Fusarium* and *Trichoderma* species as members of the agarwood community. Analysis of genomic DNA confirmed the identifications. When wood samples were used directly in PCR, an additional Lasiodiplodia species was identified. Neighbor-joining trees were constructed to examine the relationships between the isolates sequence data and reference sequences in GenBank. Five distinct clades resulted, supported with high bootstrap values, indicating the presence of five distinct taxa. The wounded trunks of *A. malaccensis* in the natural environment harbor multiple fungal taxa that exist in a complex system as a whole or in succession leading to agarwood production in the tree trunk.

Title	:	Costs and Benefits Analysis of *Aquilaria* Species on Plantation for Agarwood Production in Malaysia		
Author	:	Mohd Parid Mamat, Mohd Rusli Y, Lim Hin Fui & Alias R		
Types	:	Journal	**Year :**	2010
Publisher	:			
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The establishment of *Aquilaria* plantation for agarwood production has been regarded by the planters as a green 'gold mine' of the future. This study examines the costs and benefits of planting *Aquilaria spp.* for agarwood production. The analysis shows that whether planting *Aquilaria spp.* integration with banana (*Musa spp.*) or planting *Aquilaria spp.* as a single crop for agarwood production, both options are viable. An investment return for planting *Aquilaria spp.* integrated with banana (*Musa spp.*) on 1,000 hectares of land is higher with an internal rate of return (IRR) of 54.85% compared with 38.49% for a single crop *Aquilaria* plantation. The Net present value (NPV) of investment at a 10% discount for 1,000 hectares integrated planting is RM185.6 million (1 RM=USD0.32 in 2008) while the option involving single crop *Aquilaria* plantation for agarwood production is RM153.6 million.

Title	**:**	Classification of Agarwood Oil Using an Electronic Nose		
Author	**:**	Wahyu Hidayat, Ali Yeon Md. Shakaff , Mohd Noor Ahmad & Abdul Hamid Adom		
Types	**:**	Journal	**Year :**	2010
Publisher	**:**	Sensors 2010, 10(5), 4675-4685		
Source/ link	**:**	http://www.mdpi.com/1424-8220/10/5/4675/htm		

Abstract:

Presently, the quality assurance of agarwood oil is performed by sensory panels which has significant drawbacks in terms of objectivity and repeatability. In this paper, it is shown how an electronic nose (e-nose) may be successfully utilised for the classification of agarwood oil. Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA), were used to classify different types of oil. The HCA produced a dendrogram showing the separation of e-nose data into three different groups of oils. The PCA scatter plot revealed a distinct separation between the three groups. An Artificial Neural Network (ANN) was used for a better prediction of unknown samples.

Title	:	Chemical Composition of Volatile Oils of *Aquilaria malaccensis* (*Thymelaeaceae*) From Malaysia
Author	:	Tajuddin SN & Yusoff MM
Types	:	Journal **Year :** 2010
Publisher	:	Europe PubMed Central
Source/ link	:	http://europepmc.org/abstract/MED/21299133

Abstract:

Volatile oils of *Aquilaria malaccensis Benth. (Thymelaeaceae)* from Malaysia were obtained by hydrodistillation and subjected to detailed GC-FID and GC/MS analyses to determine possible similarities and differences in their chemical composition in comparison with the commercial oil. A total of thirty-one compounds were identified compared with twenty-nine identified in the commercial oil. The major compounds identified were 4-phenyl-2-butanone (32.1%), jinkoh-eremol (6.5%) and alpha-guaiene (5.8%), while the major compounds in the commercial oil were alpha-guaiene (10.3%), caryophellene oxide (8.6%), and eudesmol (3.2%). The results of the present study showed that more than nine sesquiterpene hydrocarbons were present, which is more than previously reported. Analysis also showed that the number of oxygenated sesquiterpenes in this study were much less than previously reported. Among the compounds detected were alpha-guaiene, beta-agarofuran, alpha-bulnesene, jinkoh-eremol, kusunol, selina-3,11-dien-9-one, oxo-agarospirol and guaia-1 (10), 11-dien-15,2-olide.

Title	:	Airborne Hyperspectral Sensor for Individual Species Counting and Mapping of Karas (*Aquilaria malaccensis*) in Bukit Nanas F.R, Malaysia
Author	:	Kamaruzaman Jusoff
Types	:	Journal **Year :** 2009
Publisher	:	IDOSI Publications: World Applied Sciences Journal 7 (10): 1246-1251, 2009
Source/ link	:	http://www.idosi.org/wasj/wasj7%2810%29/6.pdf

Abstract:

Karas (*Aquilaria malaccensis*) is well known for producing gaharu, a fragrant material which is extremely valuable for cosmetic products manufacturing. Due to its un-permitted harvesting, there is an alarming depletion in the natural forests, which requires some forms of quick monitoring in near real time. A study on the spatial distribution of Karas trees in Bukit Nanas F.R., Federal Territory (FT) was therefore conducted to identify, quantify and map its geospatial distribution using an airborne hyperspectral sensor. Using a Sobel filter and Spectral Angle Mapper (SAM) processing techniques, a digital geospatial distribution map with an accuracy of 89.47% showing 38 individual Karas trees was developed. This study demonstrated that individual Karas trees can be easily counted and mapped with an airborne hyperspectral sensor which may lead to possible estimation of gaharu production for its future sustainable management and conservation efforts in FT, Malaysia.

Title	:	Cloning of Phenylalanine Ammonia-Lyase (PAL) Gene Fragment From *Aquilaria malaccensis Lam.* (Karas)		
Author	:	Wong, M. T. & Mohamed, R.		
Types	:	Journal	**Year :**	2009
Publisher	:	The Malaysian Forester 72(1)		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Current practice of indiscriminate and illegal felling of 'karas' trees (*Aquilaria malaccensis*) to extract 'gaharu' in the wild have caused the population to dwindle drastically. 'Gaharu' formed as a result of natural defense mechanism in trees, which unfortunately happens over a long period of time. To better understand natural processes of gaharu-making, we sought to study the roles of defense genes in 'karas' by cloning a gene that synthesizes secondary compounds. The phenylalanine ammonia-lyase (PAL) gene encodes an enzyme in the metabolism of phenylpropanoid compounds, which are produced in response to stress, such as damage by wounding and pathogen attack. We report a cloned PAL gene fragment from *A. malaccensis* using the polymerase chain reaction (PCR) technique. The fragment was amplified from genomic DNA of a wounded 2-year old tree and cloned into the pGEM-T Easy Vector. The cloned fragment had a length of 610bp and an uninterrupted open reading frame of 201 amino acids. When searched against the Genebank database using BLAST tools, the cloned fragment shared 92% sequence similarity at amino acid level to known PAL proteins. This work will serve as a foundation in identifying important genes for triggering 'gaharu' synthesis.

Title	**:**	Antioxidant Activity of *Aquilaria malaccensis* (*Thymelaeaceae*) Leaves		
Author	**:**	A.W.N Huda, M.A.S Munira, SD Fitrya & M Salmah		
Types	**:**	Journal	**Year :**	2009
Publisher	**:**	No information		
Source/ link	**:**	http://www.phcogres.com/article.asp?issn=0974-8490;year=2009;volume=1;issue=5;spage=270;epage=273;aulast=Huda		

Abstract:

The phytochemical and antioxidant activity of *Aquilaria malaccensis* leaves were investigated. The sequential maceration extraction methods utilizing solvents with different polarities namely hexane, ethyl acetate and methanol yielded the corresponding crude extract. The extracts were subjected to preliminary phytochemical screening and revealed the presence of alkaloids, flavanoids, triterpenoids, steroids and saponins. The phytochemical screening suggests that flavanoids present in this species might provide a great value of antioxidant activity. Preliminary screenings of the free radical scavenging activity on the extracts of the plants with 2, 2-Diphenyl-1-picrylhydrazyl (DPPH) were tested and showed positive result. Quarcetine was used as reference standard. The extracts exhibited strong antioxidant activity radical scavenging activity with IC 50 value of 8.0 X 10 2 µg/ml, 1.6 X 10 2 µg/ml, 1.4 X 10 2 µg/ml, 30.0 µg/ml and 3.33 µg/ ml for hexane, DCM, ethyl acetate, methanol and quarcetine respectively.

Title	:	Comparison of Chemical Profiles of Selected Gaharu Oils From Peninsular Malaysia		
Author	:	Nor Azah M.A, Chang Y.S., Mailina J., Abu Said A , Abd. Majid J. Saidatul Husni S., Nor Hasnida H. & Nik Yasmin Y.		
Types	:	Journal	**Year :**	2008
Publisher	:	The Malaysian Journal of Analytical Sciences, Vol 12, No 2 (2008): 338 - 340		
Source/ link	:	http://gaharuku.com/docs/Comparison-of-Chemical-Profiles-of-Selected-GAHARU.PDF		

Abstract:

Gaharu (agarwood) is a fragrant wood that is usually derived from the diseased timber of the genus *Aquilaria* (*Thymelaeceae*) and often occurs as dark coloured patches or streaks in the tree. Due to its strong, unique scent and medicinal properties, gaharu oil is greatly valued as perfumery ingredient and incense. Gaharu may be classified into various grades; Grade A, B, C and D and they are often graded according to the physical properties, gaharu formation and its unique scent. The lower grades such as Grade C are often distilled to obtain gaharu oils. As part of an on-going research on the chemical profiling of some Malaysian gaharu oils and evaluation of their potential beneficial properties; gaharu oils obtained from different sources were analysed and compared by GC and GC-MS. Identification of the chemical components was based on comparison of calculated retention indices and mass spectral data with literature values. Examination of the oils showed some variations and differences in terms of GC profiles, concentration and chemical components. Majority of the essential oil profiles were complex and made up of sesquiterpenoids and their oxygenated derivatives. However, common occurrences of chemical compounds such as 3-phenyl-butanone, á-guaiene, â-agarofuran, á-agarofuran, agarospirol and jinkoh-eremol were detected.

Title	:	CO2 Production From Degraded Woods Via A Novel Integrated Pyrolysis-Combustion Process
Author	:	N. Othman, S.K. Kamarudin, M.N. Md. Yunus, S.R.S. Abdullah & Z. Yaakob
Types	:	Journal **Year :** 2008
Publisher	:	Elsevier B.V.
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0165237008001356

Abstract:

The process of combustion produces minimal amounts of CO2 for conventional radiocarbon dating, making it difficult to estimate the age of the archaeological wood. Thus, the objective of this paper is to introduce a novel integrated pyrolysis-combustion process that will maximize the production of CO2. Degraded wood samples were assumed to be archaeological samples for this study, namely Karas (*Aquilaria malaccensis*), Meranti (*Shorea acuminate*) and Setumpol (*Hydnocarpus spp.*) were used for this process. The process of CO2 production was optimized by the application of design of experiment (DOE) and response surface method. The mathematical model was examined using the analysis of variance (ANOVA) at 5% level of significance. The temperature during the pyrolysis process, retention time and flow rates for the carrier gas (argon) were found to have a positive influence on the production of CO2. A second-order model was obtained to predict the production of CO2 as a function of temperature, retention time and flow rate. Optimum conditions for the production of CO2 were obtained at a pyrolysis temperature of 300 °C, 20 min retention and 980, 984 and 987.6 ml/min argon flow rate for Karas, Meranti and Setumpol, respectively. The optimized yields of carbon dioxide produced were 82.57, 79.7 and 84% for Karas, Meranti and Setumpol, respectively. The different yields of carbon dioxide were due to the carbon content in the individual samples.

Title	:	Some Ecological Aspect, Tree Population, and Natural Regeneration of Agarwood Tree of Karas Groups (*Aquilaria spp.*) in Jambi Province Region)
Author	:	Yana Sumarna
Types	:	Journal **Year :** 2008
Publisher	:	Journal Penelitian Hutan dan Konservasi Alam, Vol. V No. 1 : 93-99, 2008
Source/ link	:	http://litbang.dephut.go.id/files/9_Yana_2_klm.pdf

Abstract:

Indonesia has the highest resources potency of the agarwood tree producer in the world. Naturally they grow at various condition of ecosystem and forest type. At the beginning people collected agarwood from the died tree, but due to the increased demand in the market and naturally selling price turned higher, people started hunting and cutting living tree. This activity endangers the agarwood natural population. Since year 2004, the genus of *Aquilaria spp.* and *Gyrinops sp.* have been put in the Appendix II CITES (Convention on International Trade on Endangered Species of Wild Flora and Fauna). In order to support the conservation effort, ecological study of agarwood tree producer is needed. The research was conducted through field survey in 3 sites namely site at <100 m, 200 m, and >200 m above sea level. Each observation was replicated 3 times. The location of the study was in Tabir Ulu subdistrict on Sorolangun regency on Jambi Province. The results showed that air temperature range from 20-33º C, humidity range from 78-81%, light intensity range from 56-75% with rainfall range from 1,200-1,500 mm/year. Tree *Aquilaria spp.* population in forest area according to altitude mean only 7 tree, the population potency of seedling nature average from each mother tree of the *Aquilaria malaccensis Lamk* mean amount to 287 seedling (20,3 m^2 crown canopy) and for the type *Aquilaria microcarpa Bail* amount to 331 seedling (24,5 m^2 crown canopy).

Title	:	The Effects of Seed Maturity Condition and Media Type on Growth of Agarwood Seedlings of Karas Trees
Author	:	Yana Sumarna
Types	:	Journal **Year :** 2008
Publisher	:	Journal Penelitian Hutan dan Konservasi Alam, Vol. V No. 2 : 129-135, 2008
Source/ link	:	http://baru.forda-mof.org/files/2_Yana_1_klm%28edited%29.pdf

Abstract:

Agarwood is categorized as a non-timber forest product which has complex use values, not only for perfume and cosmetics, but also for medicinal industrial materials. The products were initially taken from the dead trees, but people nowadays tend to cut down the trees to obtain agarwood which could lead to the depletion of the resource. Since 2004 the species of *Aquilaria sp.* and *Gyrinops sp.* have been listed as endangered species in the Appendix II by the Commission of CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna). A number of reservation efforts to maintain sustainable production of the agarwood could be done through cultivation. Based on the biological nature of the plants, the agarwood seedlings can be cultivated either from the seeds which fall from the tree or from the seeds taken from the mature fruit. Technically, growth of the seeds in yielding good quality and optimal number of seedlings will be influenced by germination media type used. Through examination on seeds fall from the trees (A) and seeds taken from mature fruits (B) germinated by three media types, i.e. (a) soil, (b) soil + organic compost (1:1) and (c) soil + zeolith sand (1:1), it can be suggested that growth percentage of seeds fall from the tree (A) was about 82.88% while that of seeds taken from mature fruit was only 70.33% after three months. The good germination media was indicated by the media treatment of soil combined with organic compost (b).

Title	:	The Effects of Media Types and Nitrogen, Phosphor, and Kalium (NPK) Fertilizers on Growth of Agarwood Seedlings of Karas Trees
Author	:	Yana Sumarna
Types	:	Journal **Year :** 2008
Publisher	:	Journal Penelitian Hutan dan Konservasi Alam, Vol. V No. 2 : 193-199, 2008
Source/ link	:	http://baru.forda-mof.org/files/7_Yana_2_klm%28edited%29.pdf

Abstract:

Agarwood is classified as one of the non-timber forest products which possess a high commercial value. Product of agarwood can be obtained by picking it up from the trees which died naturally. Due to the difficulty in getting dead trees as well as market demand with higher price, people now look for agarwood by cutting down the trees and chopping up the stems to find parts of the wood that contain agarwood. The high exploitation of trees in some areas results in the depletion of the wild resource. One of the conservation efforts to maintain sustainable production of agarwood for the future is through cultivation conducted in various central production areas and suitable sites. The success of cultivation is mainly influenced by the availability of good quality of plants. Hence, the study on seedling maintenance in the nursery done by split plot design with the media as the main plot and NPK fertilizer dose treatment as sub plot can be expected to gain technical information on fertilization for good quality of seedlings. Observation on growth of karas (*Aquilaria malaccensis Lamk.*) seedlings with four media type treatments (A: soil, B: soil + compost (1:1), C: soil + sand (1:1), and D : soil + compost +sand (1:1:1)), and three NPK fertilizer dose treatments (a : 0gram, b : two gram, and c: four gram), suggested that media B (mixture soil + compost (1:1)) and D (mixture soil + compost + sand (1:1:1)) with induction of two grams NPK fertilizer produced optimal percentage of growth and quick to reach age ready for planting.

Title	**:**	Agarwood - Saving A Precious and Threatened Resource		
Author	**:**	Joachim Gratzfeld & Bian Tan		
Types	**:**	Journal	**Year :**	2008
Publisher	**:**	Botanic Gardens Conservation International (BGCI), Volume 5 Number 1 - January 2008		
Source/ link	**:**	http://www.bgci.org/resources/article/0576/		

Abstract:

There are many names for the resinous, fragrant heartwood produced primarily by trees in the genus *Aquilaria*. The commoner names include agarwood, aloeswood, eaglewood, gaharu or oudh, and it is also mentioned in the Old Testament as 'aloe' or 'ahaloth'. This valuable and highly fragrant wood has been used in many ways for over two thousand years, especially as incense in Buddhist, Hindu, and Islamic traditional ceremonies, and as a significant component of traditional Ayurvedic, Tibetan and Far Eastern medicine and Middle Eastern perfumes. The genus *Aquilaria* of the *Thymelaeaceae* (*Daphne* family) consists of generally fast-growing trees found in lowland tropical forests. It occurs naturally in South and Southeast Asia, from the foothills of the Himalayas (Bhutan) and northern India, through Myanmar, IndoChina (Lao PDR, Cambodia, Vietnam), Thailand, Malaysia, the Philippines and Indonesia to Papua New Guinea. Seedlings of most species establish best in shady, moist conditions, but large adult trees sometimes become emergent in the forest and can withstand full sun. Some species can be found growing on steep, rocky, exposed slopes, and in regions that experience a hot, dry season. Wherever they occur naturally, they provide an important source of livelihood for local communities who harvest the fragrant agarwood to sell. Other genera in the family of the *Thymelaeaceae* known to produce agarwood include*Gonystylus*, *Gyrinops*, *Aetoxylon*, *Enkleia*, *Wikstroemia* and *Phaleria*. However, it is still unclear which species within these taxa produce agarwood and in what quantities. The taxonomy ofAquilaria is in need of review. A new species, *A. rugosa L.C. Kiet* & K*essler*, was described in 2005 from central Vietnam and northern Thailand, and a possible new species has been reported from Lao PDR (Sourioudong Sundara, pers. com.).

Title	:	Performance of 45 Native Tree Species on Degraded Lands in Singapore		
Author	:	K. Shono, S. J. Davies & Y. K. Chua		
Types	:	Journal	**Year :**	2007
Publisher	:	Journal of Tropical Forest Science 19(1): 25–34 (2007)		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The performance of 45 native tree species, which encompassed a range of early successional to primary forest species, was evaluated in a reforestation planting trial on degraded lands in Singapore. Growth data was obtained from 1640 saplings planted between 1999 and 2004 on seven reforestation plots. Survival rates were greater than 90% across most species. Growth rates of planted saplings were significantly affected by species, site and interaction between species and site. A number of primary forest species performed well in this study. In comparison, many of the secondary forest species had slow to medium growth rates. Of the 45 species tested, 19 had diameter growth exceeding 1 cm year-1 while seven had growth rates below 0.5 cm year-^{1}. This study showed that many primary forest species can grow well in open conditions of deforested sites. The results also emphasized the importance of site-species matching and the region-specific nature of species performance. The approach of interplanting fast-growing native species with primary forest species was shown to be a viable forest restoration method. Continued monitoring will reveal more information on the long-term performance of these planted saplings and native forest development in the restored forests.

Title	:	TrnL-trnF Sequence Data Imply Paraphyly of *Aquilaria* and *Gyrinops* (*Thymelaeaceae*) and Provide New Perspectives for Agarwood Identification
Author	:	M. C. M. Eurlings & B. Gravendeel
Types	:	Journal **Year :** 2005
Publisher	:	Springer-Verlag
Source/ link	:	http://link.springer.com/article/10.1007/s00606-005-0312-x

Abstract:

The genera *Aquilaria* and *Gyrinops* (*Thymelaeaceae, Malvales*) are well known for the production of agarwood which is a highly wanted forest product of substantial economic value. The taxonomic status of *Aquilaria* and *Gyrinops* as separate genera is doubted as they are only distinguished by the number of stamens. We investigated their status by conducting phylogenetic analyses of DNA sequences from the plastid trnL-trnF spacer. Control of international trade of agarwood is currently hampered by the failure of traditional methods such as microscopy to identify samples to species level. We therefore evaluated the potential of molecular identification of agarwood by searching for species- and region-specific plastid DNA polymorphisms. DNA sequences were obtained from 31 *Thymelaeaceae* accessions encompassing 20 different species in six genera. *Aquilaria* and *Gyrinops* appear to be paraphyletic. Success in sequencing wood samples demonstrates that molecular markers provide new perspectives for agarwood identification.

Title	:	In Vitro Germination and Micropropagation of Agarwood
Author	:	Mia Kosmiatin, Ali Husni & Ika Mariska
Types	:	Journal **Year :** 2005
Publisher	:	Jurnal Agro Biogen 1(2):62-67
Source/ link	:	http://biogen.litbang.pertanian.go.id/wp/wp-content/uploads/downloads/2012/05/agrobiogen_1_2_2005_62-67.pdf

Abstract:

Agarwood (*Aquilaria malaccensis Lank*) is one of the forest wood that are continously exploited. Currently, the Indonesian export of agarwood is decreasing because its population is endangered by excessive logging. Agarwood propagations need technology for reproduction of agarwood seedlings and their fungal inoculum. In vitro technique for germination of recalsitrant seeds and micropropagation are technologies that can be used for propagation of agarwood seedlings. An experiment was done to develop techniques for in vitro germination and micropropagation of agarwood. The in vitro germination was done using two different techniques. Firstly, sterile seeds were germinated on an MS medium + 50 mg/l PVP, 50 mg/l GA, and 1 mg/l BA or kinetin. Secondly, sterile seeds were germinated on basal medium of MS, ½ MS medium, MS medium without vitamins, as well as on MS medium without pyridoxine, nicotinic acid and WPM. Shoot initiations and multiplications were done on MS and ½ MS media containing 1, 3, or 5 mg/l BA. The explants used were cotyledone nodes, terminal shoots, single node with leaf, and sinle node without leaf. The results showed that the seed germination rate on the different media ranged from 7,14 to 50%. The seed germination rate on the MS medium without vitamis was the highest. The best explants for shoot induction and multiplication was single node with leaf which was cultured on MS + 1 mg/l BA.

Title	:	Learning From Traditional Knowledge of Non-timber Forest Products: Penan Benalui and The Autecology of *Aquilaria* in Indonesian Borneo
Author	:	D.G. Donovan & R.K. Puri
Types	:	Journal **Year :** 2004
Publisher	:	Ecology and Society 9(3):3
Source/ link	:	http://www.ecologyandsociety.org/vol9/iss3/art3/

Abstract:

Traditional knowledge, promoted to make conservation and development more relevant and socially acceptable, is shown to have an important role in identifying critical research needs in tropical ecology. Botanists, foresters, and phytochemists, among others, from many countries have sought for decades to understand the process of resin formation in the genus *Aquilaria*, a tropical forest tree of South and Southeast Asia. Not every tree develops the resin and, despite extensive scientific research, this process remains poorly understood. Attempts at cultivating the valuable aromatic resin, gaharu, have been uneven at best. Thus, gaharu remains largely a natural forest product, increasingly under threat as the trees are overexploited and forest is cleared. In this paper, we compare scientific knowledge and traditional knowledge of the Penan Benalui and other forest product collectors of Indonesian Borneo. Although limited management of wildlings failed to bring the resin-producing species under cultivation, we found that the Penan recognize the complex ecology of resin formation involving two, or maybe three, living organisms—the tree, one or more fungi, and possibly an insect intermediary. Developing a sustainable production system for this resource will require a clear understanding of how these various natural elements function, separately and synergistically. Traditional knowledge can help fill gaps in our information base and identify promising areas for future research. Both correspondence and gaps in knowledge support the call for a greater role for ethnobiological research and interdisciplinary cooperation, especially between ethnobiologists and foresters, in developing sustainable management systems for this traditional resource and its natural habitat.

Title	:	A Survey on Agarwood in Vietnam
Author	:	Quan Le Tran, Qui Kim Tran, Kyoji Kouda, Nhan Trung Nguyen, Yukiko Maruyama,Ikuo Saiki & Shigetoshi Kadota
Types	:	Journal **Year :** 2003
Publisher	:	Journal of Traditional Medicine 20(3):124–131
Source/ link	:	http://ci.nii.ac.jp/els/110001846595.pdf?id=ART0002009999&type=pdf&lang=en&host=cinii&order_no=&ppv_type=0&lang_sw=&no=1416817455&cp=

Abstract:

Agarwood is a one of the most valuable minor forest products of the Southeast Asian tropical forests. In Vietnam agarwood is produced from the heartwood of rarely available natural *Aquilariacrassna* trees (*Thymelaeaceae*). In our field work in Vietnam, a natural *A. crassna* was found in Khanh Hoa Province. Information on agarwood exploitation and production were also gathered by interviewing the local people. The result showed that part of the local people earn their living by dealing with agarwood, but due to over exploitation the natural resource for this valuable plant has declined dramatically in the past decades, while the demand for the resource remains constant or even increases. The cultivation of *A. crassna* has been started in several places in the country as an initiative for conserving this endangered but economically important plant species.

Title	**:**	The Role of Selected Animals In Pollination and Dispersal of Trees In The Forest: Implications for Conservation and Management		
Author	**:**	S. S. Lee, Norsham Suhaina Yaakob, K. S. Boon & L. S. L. Chua		
Types	**:**	Journal	**Year :**	2002
Publisher	**:**	Journal of Tropical Forest Science 14(2): 234-263 (2002)		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

The current state of knowledge of the role of some plant-animal interactions in forest regeneration and conservation in PeninsularMalaysia is discussed. In particular, we focused on selected insect pollinators and animals which act as seed dispersers, for example, bats, primates, squirrels and birds. Tree species, including timber trees and endemic tree species utilised by bats,primates, squirrels, birds and selected insect pollinators are listed by their scientific as well as local names. The forest types where such species can be found are also identified. Some of the shortcomings of the currently available data are highlightedand means to overcome the situation are suggested.

Title	:	The Gaharu Trade in Indonesia: Is It Sustainable?		
Author	:	Tonny Soehartono & Adrian C. Newton		
Types	:	Journal	**Year :**	2002
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1663/0013-0001%282002%29056%5B0271:TGTIII%5D2.0.CO%3B2		

Abstract:

When subjected to fungal attack, *Aquilaria spp.* (*Thymelaeaceae*) produces a fragrant resin that is traded internationally as gaharu. Socioeconomic aspects of the gaharu trade were investigated via interviews with collectors and local and international traders. In addition, the extent of local and international trade was evaluated by reference to official government statistics. Evidence that gaharu resources are declining was obtained from the personal experience of gaharu collectors, and official statistics relating to the declining number of gaharu export companies in operation. Traders also reported that the main source of gaharu has recently switched from Sumatra and Kalimantan to sources in eastern Indonesia (Maluku and Irian Jaya), a finding supported by official statistics. Disparities recorded between official figures for the price and volume of gaharu in local and international trade, supported by comments made by export traders, indicate that a high proportion of the more valuable, high-grade gaharu is traded illegally by personal transaction. Interviews with gaharu collectors indicated that traditional approaches to harvesting are declining, as more nonlocal people become involved in collection, leading to more intensive harvesting practices. Together, these findings suggest that the current Indonesian trade in gaharu is not sustainable.

Title	:	Factors Influencing The Survival and Growth of *Aquilaria malaccensis* Seedlings in Indonesia		
Author	:	Soehartono, T., Newton, A. C. & Mardiastuti, A.		
Types	:	Journal	**Year :**	2002
Publisher	:	Journal of Tropical Forest Science 14(3): 364-378 (2002)		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Aquilaria malaccensis (*Thymelaeaceae*) is the principal source of gaharu, one of the most valuable tropical forest products in international trade. Despite its economic importance, the autecology of this species is virtually unknown. Seedling growth and survival of *A. malaccensis* was monitored over a 15-month period in natural forest in West Kalimantan. Mean height growth rate was 21.2 + 2.3 cm year1, and was positively related to light availability (i^= 0.79, p < 0.001), but unrelated to distance to the nearest mature tree or seedling density. By the end of the observation period, fewer than 20% of seedlings surveyed initially were still alive, trampling and cutting being one of the main causes of mortality. A nursery experiment examined the influence of soil (two treatments), light availability (four treatments) and seedling density (four treatments) on growth. Although a decrease in irradiance was associated with significantly (p < 0.01, t - test) lower values for height and stem diameter, seedlings were able to survive under the low light treatment. Lower height growth rates and leaf increment were observed with higher seedling densities on the more fertile soil; no such effects of density were observed on the relatively infertile soil. The implications of these results for the sustainable management of *A. malaccensis* are discussed.

Title	:	*Heortia vitessoides Moore* (*Lepidoptera: Pyralidae*): A Serious Pest of Agarwood Plant (*Aquilaria malaccensis Lamk.*)
Author	:	Kalita J, Bhattacharyya PR & Nath SC.
Types	:	Journal **Year :** 2002
Publisher	:	Geobios 29: 13–16.
Source/ link	:	http://cat.inist.fr/?aModele=afficheN&cpsidt=13492670

Abstract:

The field and laboratory investigations were carried out on the biology of Heortia vitessoides in the Agarwood plantations during 1998. The pest being active from March to mid-November, has seven to eight overlapping generations in year. There are five larval instars and total larval duration was 23.50′0.49 days. Pupation takes place below soil surface and pupal duration was 8.17′0.64 days. The adult lives for 4.17′0.51 days. The female lays eggs in masses of 350-550 under surface of the leaf after one to two days of mating. The incubation period is 10.50′0.75 days and the life cycle is completed in 46.34′0.45 days. In severe infestation, the pest completely denuded the leaves.

Title	**:**	Indigenous Knowledge on Utility and Utilitarian Aspects of *Aquilaria malaccensis Lamk.* in Northeast India		
Author	**:**	Subhan C Nath & Nabin Saikia		
Types	**:**	Journal	**Year :**	2002
Publisher	**:**	Indian Journal of Traditional Knowledge		
Source/ link	**:**	http://nopr.niscair.res.in/bitstream/123456789/19376/1/IJTK%201%281%29%2047-58.pdf		

Abstract:

Indigenous knowledge associated with the utility and utilitarian aspects of *Aquilaria malaccensis Lamk*. in Northeast India since ancient time to present have been explored. The plant was the raw material for preparing a writing paper called "Sanchi pat" for writing religious script in the past, while agar, a fragrant resinous dark co loured wood and its product called agar oil obtained from the diseased wood of the tree, which is associated with the cultural heritage of people in Northeast India since ancient time, has gained importance in the perfumery world in recent years due to its potentiality as perfume retainer for mixing best grade scent s. The present communication provides an account on utility of the plant with a particular emphasis to the local people's knowledge associated with the utilitarian or technological aspects of agar trade i.e. the detection of agar bearing plants; collection, processing, extraction and marketing of agarwood products; artificial stimulation leading to the development of agar within the tree and conservation strategies of the species in the region for sustainable use.

Title	:	Diversity, Diameter Structure and Spatial Pattern of Trees in A Semi-Evergreen Rain Forest on Langkawi Island, Malaysia		
Author	:	M. Kohira, I. Ninomiya, Ahmed Zainudin Ibrahim & Abdul Latiff		
Types	:	Journal	**Year :**	2001
Publisher	:	Journal of Tropical Forest Science 13(3): 460-476 (2001)		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Species diversity, diameter structure and the spatial pattern of trees were studied in a 2.4-ha plot of the semi-evergreen rain forest at Machinchang Forest Reserve, Langkawi Island, Malaysia. The 3518 trees > 5 cm dbh studied comprised 208 species from 45 families, including 156 species in 41 families for 1484 trees > 10 cm dbh. Number of species per area was higher in trees 5 - < 10 cm dbh than in trees > 10 cm dbh. The plot was dominated by *Anacardiaceae*, particularly *Swintonia floribunda*, which was the most frequent (11.1%) and displayed the greatest basal area (12.8%) of all trees. *Swintonia floribunda* was consistently dominant in all five dbh classes defined from the M-w relationship. Among 64 common species examined for spatial pattern, 2, 42 and 20 species exhibited uniform, random and clumped distribution respectively. The plot was characterised by lack of family dominance by *Dipterocarpaceae*.

Title	:	Reproductive Ecology of *Aquilaria spp.* in Indonesia		
Author	:	Tonny Soehartono & Adrian C. Newton		
Types	:	Journal	**Year :**	2001
Publisher :		Science Direct		
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0378112700006101		

Abstract:

Aquilaria spp. (Thymelaeaceae) are the principal source of Gaharu, a valuable resin, yet information about their reproductive ecology is almost entirely lacking. Individuals of six species (*A. beccariana, A. crasna, A. filaria, A. hirta, A. malaccensis* and *A. microcarpa*) in cultivation in Indonesia were investigated to assess reproductive phenology, pollination, seed production and germination. Seed production and seedling dispersion were also assessed in natural populations of *A. beccariana, A. malaccensis* and *A. microcarpa* in Kalimantan. Most of the selected trees flowered during the dry season, fruits requiring between 36 and 72 days to develop, depending on the species. Twenty different species of insect were recorded visiting flowering trees. The probability of flowers developing into fruit varied between species from 0.04 to 0.43, although flowers from which pollinators were excluded never produced fruit. Seed production of *A. malaccensis* and *A. microcarpa* peaked at a dbh of approximately 40 and 50 cm, respectively, individual trees producing up to 19,000 seeds in a single season. Germination under nursery conditions was initiated 7–15 days after sowing; seeds of *A. crasna* had the highest probability of germination success (92%) whereas those of *A. filaria* had the lowest (53%). In natural forest, most seedlings (>65%) occurred within 5 m of an adult tree, suggesting limited dispersal. These results indicate that *Aquilaria spp.* have high reproductive potential, but suggest that seed dispersal might be limited in natural forests. The implications of these results for the management of *Aquilaria spp.* are discussed.

Title	:	An Ecological and Economic Assessment of The Non-Timber Forest Product Gaharu Wood in Gunung Palung National Park, West Kalimantan, Indonesia
Author	:	Gary D. Paoli, David R. Peart, Mark Leighton & Ismayadi Samsoedin
Types	:	Journal **Year :** 2001
Publisher	:	Ecology and Economics of Gaharu Wood
Source/ link	:	http://deepblue.lib.umich.edu/handle/2027.42/74107

Abstract:

Ecological and economic data are essential to the identification of tropical nontimber forest products with the potential for sustainable and profitable extraction in a managed system. We studied the demographic effect and economic returns of harvesting aromatic gaharu wood from fungus-infected trees of *Aquilaria malaccensis Lam.* at Gunung Palung National Park, Indonesia, to evaluate the management potential of gaharu wood. *Aquilaria malaccensis* trees openface> 20 cm in diameter occurred at low preharvest densities (0.16-0.32 ha) but were distributed across five of six forest types surveyed. During a recent harvest, 75 of trees were felled, with harvest intensities ranging from 50% to 100% among forest types. Overall, 50% of trees contained gaharu wood, but trees at higher elevations contained gaharu wood more frequently (73%) than trees at lower elevation (27%). The mean density of regeneration (juveniles> 15 cm in height) near adult trees (3-7 m away) was 0.2/m^2, 200 times greater than at random in the forest (10/ha), but long-term data on growth and survivorship are needed to determine whether regeneration is sufficient for population recovery. Gaharu wood extraction from Gunung Palung was very profitable for collectors, generating an estimated gross financial return per day of US $8.80, triple the mean village wage. Yet, the estimated sustainable harvest of gaharu wood at natural tree densities generates a mean net present value of only $10.83/ha, much lower than that of commercial timber harvesting, the dominant forest use in Kalimantan. Returns per unit area could be improved substantially, however, by implementing known silvicultural methods to increase tree densities, increase the proportion of trees that produce gaharu wood, and shorten the time interval between successive harvests. The economic potential of gaharu wood is unusual among nontimber forest products and justifies experimental trials to develop small-scale cultivation methods.

Title	:	Incentives For Collecting Gaharu (Fungal Infected Wood of *Aquilaria spp.; Thymelaeaceae*) in East Kalimantan		
Author	:	Eva K. Wollenberg		
Types	:	Journal	**Year :**	2001
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1007/BF02866565		

Abstract:

The economic importance of Gaharu is assessed in three villages on the Bahau River in north-central Borneo to gain insights about the incentives for harvesting and management of valuable non-timber forest product. Three indicators of economic value-level and proportion of income, returns to labor, and proportion of Gaharu collecting households per village – are used to demonstrate the multiple incentives that NTFP income can generate. The concept of incentives logic is developed as an analytical technique to show how economic values can be linked to incentives for different types of management actions. The article discusses how incentives from Gaharu income were most likely linked to the stake local people had in the resource, their preferences about which forest which forest product to harvest, and their willingness to engage in collective action. These incentives contributed to sustainability to the extent they induced actions that reduce threats to the resource. The article suggests that an understanding of the influence of economic incentives on people's resource management can be improved by recognizing three factors: the multiple incentives created by an income, the logical link of those incentives to a management action, and the influence of other socio-cultural and biophysical factors on management

Title	**:**	Sesquiterpenoids in Two Different Kinds of Agarwood		
Author	**:**	Kaisuke Yoneda, Etsuko Yamagata, Tsutomu Nakanishi, Tsukasa Nagashima, Ichiro Kawasaki, Toshio Yoshida, Hideo Mori & Iwao Miura		
Types	**:**	Journal	**Year :**	2001
Publisher	**:**	Phytochemistry (Volume 23, Issue 9, 21 August 1984, Pages 2068–2069)		
Source/ link	**:**	http://www.sciencedirect.com/science/article/pii/S0031942200849766		

Abstract:

Sesquiterpenoids of an agarwood originating from *Aquilaria agallocha* and of the other kind of agarwood (*Aquilaria sp.*; probably *Aquilaria malaccensis*) were investigated by a combination of GLC and GC/MS. The differences in sesquiterpene composition between the two kinds of agarwood are discussed.

Title	**:**	Prospect of Agar (*Aquilaria malaccensis*) Planting in Denuded Hilly Areas of Chittagong		
Author	**:**	Siddiqi N.A., Ara R. & Merry S.R.		
Types	**:**	Journal	**Year :**	2001
Publisher	**:**	No information		
Source/ link	**:**	http://www.frim.gov.my/v1/Library/		

Abstract:

Experimental planting with *Aquilaria malaccensis Lamk.*was undertaken to assess its suitability on denuded hilly areas of Cittagong, Bangladesh. Germination of the species was 70 percent, and the seedlings attained a height of 40-60 cm in the nursery at the age of one year. Average survival of the out-planted seedlings in four locations was 34.7 percent with 1.85m mean eight and 1.92 cm mean diameter after three years. Survival and seedling increment decreased with increasing height of hill slope, apparently because of gradual low soil moister content. Strong and direct sunshine seem to have adverse effect on seedling survival. The prospect of *Aquilaria malaccensis* appeared to be uncertain for the denuded areas. However, further investigation needs to be undertaken.

Title	:	Volatile Constituents from The Infected Wood of *Aquilaria malaccensis Benth*		
Author	:	Karim B. Yaacob & Daniel Joulain		
Types	:	Journal	**Year :**	2000
Publisher	:	Sains Malaysiana, 29 . pp. 197-200		
Source/ link	:	Unversiti Kebangsaan Malaysia (UKM) Library		

Abstract:

Upon hydrodistillation of Malaysian 'gaharu' (agarwood), an essential oil is obtained in 0.8% yield. The odour of the oil can be described as warm, diffusive, strongly woody and characteristic. It was found to contain at least 61% sesquiterpene alcohols, with 10-epi γ - eudesmol (23%) and valerianol (12.3%) predominating. The remaining part of the oils is made of sesquiterpene oxides (α - agarofurane : 7.5% major) and a number of non terpenic aromatic compounds (benzylacetone: major). These findings and other considerations conform the identity of the starting material is *Aquilaria malaccensis Benth*.

Title	:	Conservation and Sustainable Use of Tropical Trees in The Genus *Aquilaria* I. Status and Distribution in Indonesia		
Author	:	Tonny Soehartono & Adrian C Newton		
Types	:	Journal	**Year :**	2000
Publisher :		Elsevier: Volume 96, Issue 1, November 2000, Pages 83–94		
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0006320700000550		

Abstract:

Tropical trees in the genus *Aquilaria Lam.* are the principal source of gaharu, one of the most valuable forest products traded internationally. Although these species are the focus of increasing conservation concern, information on their status and distribution is lacking. Information from herbarium accessions, a national forest inventory (NFI), field surveys and gaharu traders was used to assess the distribution of *Aquilaria* species in Indonesia, indicating population concentrations in Sumatra and eastern Kalimantan. Analysis of NFI data indicated that population densities are relatively low, with values generally <1.2 individuals ha^{-1}; mean values recorded in field surveys were <0.6 individuals ha^{-1}. Analysis of probability distributions emphasized the rarity of *Aquilaria* species, with a probability of encountering one or more individuals of *Aquilaria* in 1 ha being less than 0.2 in field assessments. Calculation of Morisita's index of dispersion indicated that the species are generally clumped, with Ip typically <0.6. Analysis of stand structure suggested continuous recruitment in some areas, but a general absence of larger individuals. Given current deforestation rates, these data suggest that all *Aquilaria* species in Indonesia classify as Vulnerable according to the IUCN Red List criteria.

Title	:	Conservation and Sustainable Use of Tropical Trees in The Genus *Aquilaria* II. Impact of The Gaharu Harvest in Indonesia		
Author	:	Soehartono, T. & Newton, A. C.		
Types	:	Journal	**Year :**	2000
Publisher	:	Biol. Conserv. 83-94		
Source/ link	:	http://www.sciencedirect.com/science/article/pii/S0006320700000896		

Abstract:

Aquilaria spp. are the main source of gaharu, one of the most valuable non-timber products harvested from tropical forests. In order to assess the impact of gaharu harvesting on populations of *Aquilaria spp.* in Indonesia, the activities of gaharu collectors were assessed by accompanying them on collecting expeditions. Gaharu harvesting generally involved felling the tree, with 31–92% of trees encountered being felled. The quantity of gaharu obtained from each felling was extremely low, mean values ranging from 0.10–0.18 kg tree $^{-1}$ to 0.19–2.13 kg tree^{-1} for high and low grade gaharu respectively. A combination of these values with gaharu trade figures for the early 1990s enabled the number of *Aquilaria spp.* trees harvested annually in Indonesia to be estimated. Values ranged from less than 30,000 to more than 100,000 trees felled, depending on the year. Field assessments of two populations of *Aquilaria spp.* were used to parameterize a matrix model, which was used to predict the impact of different harvesting regimes on population dynamics of the species. Values of the dominant latent root (λ) were 1.22 and 1.20 for *A. malaccensis* in West Kalimantan and *A microcarpa* in East Kalimantan respectively, indicating that both populations are self-sustaining in the absence of harvesting. Analysis of λ under different harvesting scenarios indicated that for *A. malaccensis*, population expansion will continue if harvesting is set at a minimum diameter at breast height (dbh) of above 10 cm, but for *A. microcarpa*, a population decline will occur if trees with a dbh of less than 30 cm are harvested. Given current harvesting practices, it is, therefore, unlikely that gaharu is being sustainably harvested at present. These results suggest that the gaharu trade may have had a substantial impact on the population size of *Aquilaria spp.* in Indonesia, and their implications are discussed in the context of setting harvest quotas for regulation of trade, as required by CITES.

Title	:	Early Survival and Growth in Field Trials of *Aquilaria malaccensis* (Karas) and *Azadirachta excelsa* (Sentang)		
Author	:	Lok Eng Hai, Chang Yu Shyun & Aziah Mohd Yusoff		
Types	:	Journal	**Year :**	1999
Publisher	:	Journal of Tropical Forest Science 11(4): 852-854 (1999)		
Source/ link	:	http://www.frim.gov.my/v1/Library/		

Abstract:

Trial plots of karas and sentang were established to assess their survival and height growth at Bukit Lagong. The preliminary result suggested that karas can be interplanted with sentang. Shade can be provided at the early stage for karas to ensure good survival rate.

Title	:	A Review on Agar (Gaharu) Producing *Aquilaria* Species		
Author	:	Ng. L.T., Chang Y.S. & Azizol Abdul Kadir		
Types	:	Journal	**Year :**	1997
Publisher	:	No information		
Source/ link	:	http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu, a fragrant wood, is derived from the diseased timber of *Aquilaria spp.* of the family *Thymelaeaceae*. Eight tree species of *Aquilaria* are found distributed throughout India, China, Southeast Asia and the East Indies. Although several studies on the biology and chemistry of gaharu have been conducted, the exact mechanism(s) of gaharu formation remains unclear. The objective of this paper is to review previous investigations and results, and discuss the potential for developing techniques for commercial induction of gaharu formation in *Aquilaria spp.* Economic aspects are also addressed.

Title	:	The Growth Performance of Plantation Grown *Aquilaria malaccensis* in Peninsular Malaysia		
Author	:	Lok Eng Hai & Ahmad Zuhaidi Yahya		
Types	:	Journal	**Year :**	1996
Publisher	:	Journal of Tropical Forest Science 8(4): 573 - 575 (1996)		
Source/ link	:	Forest Research Institute Malaysia (FRIM)		

Abstract:

Growth data (height, diameter, basal area, volume, stand density) were collected in 1995 from the 28 available standing trees in a 0.9 ha research plot established in 1928 on a cleared secondary forest site at the Bukit Lagong Forest Reserve. The stand was originally planted at 833 trees/ha, but competition and mortality have reduced this to 31 stems/ha over 67 yr. Data are presented showing the diameter class distribution, which was very wide (17.8-55.9 cm). A height estimation equation was determined from the data based on log diameter. The species is viewed as promising.

Title	:	Effects of Jinkoh-Eremol and Agarospirol From Agarwood on The Central Nervous Systems in Mice		
Author	:	Okugawa H, Ueda R, Matsumoto K, Kawanishi K & Kato A.		
Types	:	Journal	**Year :**	1996
Publisher	:	Planta Med 1996; 62(1): 2-6		
Source/ link	:	https://www.thieme-connect.com/DOI/DOI?10.1055/s-2006-957784		

Abstract:

Agarwood (Jinkoh in Japanese), one of the Oriental medicines, is used as a sedative. The benzene extract of this medicine showed a prolonged effect on the hexobarbital-induced sleeping time, and hypothermic effects in terms of rectal temperature, a suppressive effect on acetic acid-writhing, and a reduction of the spontaneous motility in mice. By repeated fractionation, oral administration in mice, and pharmacological screening, the active principles, jinkoh-eremol and agarospirol, were obtained from the benzene extract. They also gave positive effects on the central nervous system by peritoneal and intracerebroventricular administration. They decreased both methamphetamine- and apomorphine-induced spontaneous motility. The level of homovanillic acid in the brain was increased by them, while the levels of monoamines and other metabolites were unchanged. Similar results were seen in chlorpromazine-administered mice. Therefore, jinkoh-eremol and agarospirol can be considered to be neuroleptic.

Title	:	Aloeswood Forest and The Maritime World		
Author	:	Yamada, Isamu		
Types	:	Journal	**Year :**	1995
Publisher	:	Southeast Asian Studies 33(3), 181-186		
Source/ link	:	http://repository.kulib.kyoto-u.ac.jp/dspace/handle/2433/56559		

Abstract:

Aloes wood, one of the most valuable forest products of the Southeast Asian forest, is a chemical reaction to fungi or to wounds by various species of *Aquilaria*, most notably *Aquilaria malaccensis*. The author, who has done a great deal of research in Borneo, has collected all sorts of information about the harvesting and trading of this commodity. The Penan and Dayaks sell their harvest to Chinese traders, who then sell it to merchants from Arabia, Bangladesh, and China. Although the bulk comes from Indonesia and is shipped out through Jakarta, Singapore is the main international center of this trade (Rosemary L. Robson-McKillop).

Title	:	Population Dynamics of Some Tropical Trees That Yield Non-Timber Forest Products		
Author	:	James V. Lafrankie		
Types	:	Journal	**Year :**	1994
Publisher	:	Springer-Verlag		
Source/ link	:	http://link.springer.com/article/10.1007/BF02862331		

Abstract:

The population biology of *Aquilaria malaccensis*, one source of gharu, and *Cinnamomum mollissimum*, one source of wild cinnamon, was studied in a 50 ha permanent plot of primary rain forest in Malaysia. Median diameter growth rates of 0.22 cm yr^{-1} and 0.1 cm yr^{-1} should not be prohibitive of economic exploitation, and suggest that the trees could be grown commercially. However, the natural densities were between 2 and 3 trees over 1 cm d.b.h. per ha, which is roughly the median for all trees in the plot, would preclude economic exploitation of these natural populations. The economics of harvesting natural populations is considered in a preliminary fashion by allowing favorable assumptions of quantity and quality of production. The price likely to be fetched from either a first time extraction (on the order of US$10.00 per ha) or from sustained production (on the order of US$0.10 per ha per yr), are too small to be of interest as single-product schemes, and are negligible compared to the extraction of multi-species crops of timber. However, it is possible that by combining multiple products under a "High Diversity Forestry" scheme, one could increase the density of harvestable products, reduce the unit cost of labor and improve the economic portrait.

Title	:	Possibility of Predicting Mechanical Strength Properties of Malaysian Timbers		
Author	:	S. H. Ong		
Types	:	Journal	**Year :**	1988
Publisher	:	Journal of Tropical Forest Science1(4): 318-326		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Regression equations for predicting the mechanical strength properties from wood density and moisture content of Malaysian timbers are given in this paper. The high R^2 values show that regression equations are reliable for small clear samples.

Title	**:**	Three Fragrant Sesquiterpenes of Agarwood		
Author	**:**	Tsutomu Nakanishi, Etsuko Yamagata, Kaisuke Yoneda, Tsukasa Nagashima, Ichiro Kawasaki, Toshio Yoshida, Hideo Mori, Iwao Miura		
Types	**:**	Journal	**Year :**	1984
Publisher	**:**	Phytochemistry (Volume 23, Issue 9, 21 August 1984, Pages 2066–2067)		
Source/ link	**:**	http://www.sciencedirect.com/science/article/pii/S0031942200849754		

Abstract:

Three fragrant sesquiterpenes have been isolated as major constituents from the wood of *Aquilaria malaccensis* and identified as α-agarofuran, (−)-10-epi-γ-eudesmol and oxo-agarospirol.

Title	:	Plant Anticancer Agents. XIX Constituents of *Aquilaria malaccensis*
Author	:	Sarath P. Gunasekera , A. Douglas Kinghorn , Geoffrey A. Cordell & Norman R. Farnsworth
Types	:	Journal **Year :** 1981
Publisher	:	Journal of Natural Products, 1981, 44 (5), pp 569–572
Source/ link	:	http://pubs.acs.org/doi/abs/10.1021/np50017a010

Abstract:

The stem bark of the Thai tree *Aquilaria malaccensis* (*Thymelaeaceae*) has afforded 1,3-dibehenyl-2-ferulyl glyceride (3), which is novel, and 12-O-n-deca- 2, 4, 6-trienoylphorbol-13-acetate (4). The structures of these cytotoxic compounds were elucidated by their spectral and chemical parameters.

Title	:	Pest and Disease Survey of *Aquilaria sp.* (Karas) Plantations in Peninsular Malaysia		
Author	:	SP Ong, A Mohd Farid & SS Lee		
Types	:	Proceeding	**Year :**	2014
Publisher	:	No information		
Source/ link	:	Forest Reseach Institute Malaysia (FRIM)		

Abstract:

Gaharu plantations are gaining popularity due to the high economic value of the trees and depletion of wild resources. The resin produced by the tree as a response to an injury, known as gaharu, is processed into perfume oil and incense. As the planted area increases due to high demand of gaharu, the pests and diseases associated with the trees may become more prevalent in large-scale monocultures. Therefore, this survey was conducted to determine the types of pests and diseases and the extent of damage caused by them.

Title	:	Application of ANN in Agarwood Oil Grade Classification
Author	:	Nurlaila Ismail, Mohd Hezri Fazalul Rahiman, Mohd Nasir Taib, Nor Azah Mohd Ali, Mailina Jamil, Saiful Nizam Tajuddin
Types	:	Proceeding **Year :** 2014
Publisher	:	Signal Processing & its Applications (CSPA), 2014 IEEE 10th International Colloquium
Source/ link	:	http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6805751&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6805751

Abstract:

This paper presents the application of Artificial Neural Network (ANN) in agarwood oil grade classification. The work involved of the extraction of chemical compounds by GC-MS, identification the significant chemical compounds using Z-score, generating the synthetic data using a dedicated formulae and application of ANN classification. The ANN classification is performed and its performance is measured using accuracy, sensitivity and specificity. The result showed that the performance of ANN classification for original GC-MS data is increasing when the data is added with synthetic data. This study showed that the ANN application in this study required a large number of sample size for it to have high accuracy in classification.

Title	:	Perladangan Karas di Malaysia		
Author	:	Ismail Muhammad		
Types	:	Proceeding	**Year :**	2014
Publisher	:	No information		
Source/ link	:	Universiti Putra Malaysia (UPM)		

Abstract:

Gaharu, karas, depu atau *Aquilaria sp.* saban tahun mula menjadi kegilaan ramai pemain gaharu di seluruh dunia termasuk Malaysia. Penglibatan pada peringkat awal bermula sebagai pencari dan pengumpul gaharu sehingga memiliki ladang persendirian adalah menjadi matlamat banyak pihak seperti di India, Thailand, Kemboja, Malaysia, China dan Indonesia. Perladangan gaharu bermula di Assam, India dipercayai bermula sejak tahun 1970-an, Thailand dan Kemboja pada tahun 1980-an manakala Malaysia seawal tahun 2000. Menjelang tahun 2007, perladangan gaharu juga telah berkembang sehingga ke Barat Australia yang kini dilaporkan sebanyak 5,000 ekar telah ditanam secara komersial sepertimana Santalum album L (cendana merah). Perladangan karas di Malaysia dilaporkan seluas 232.8 ha (575 ekar) telah diwujudkan di Malaysia sejak awal tahun 2000-2005 yang melibatkan agensi kerajaan seperti Jabatan Perhutanan Negeri manakala syarikat persendirian dianggarkan sebanyak 1,062.8 ha (2,625 ekar) dengan anggaran pokok masing-masing sebanyak 256,080 dan 1,169,028 pokok. Bancian yang terkini 2014 mendapati bilangan pokok karas yang telah ditanam di Malaysia adalah mencecah 1,571,100 pokok dengan keluasan sebanyak 1,119 ha atau 2,763.9 ekar. Anggaran ekonomi ke atas ladang karas ini adalah berjumlah RM 785,550, 000 berbanding tahun 2010 sebanyak RM 128, 040, 000. Perladangan karas adalah sangat penting dalam memastikan kelestarian dan sumber gaharu yang berkekalan pada masa hadapan. Untuk memastikan pengurusan perladangan yang tepat sememangnya industry gaharu memerlukan satu manual atau panduan yang merangkumi kaedah-keadah penanaman, penyelenggaraan, kawalan penyakit, pemilihan spesies dan baja. Perladangan gaharu juga terikat kepada polisi dan undang-undang Negara seperti Dasar Perhutanan Negara 1978 (Pindaan 1992), Akta CITES, Akta 686 dan sebagainya.

Title	:	Analysis of Chemical Compounds of Agarwood Oil Based on Headspace-Solid Phase Microextraction Combined With Gas Chromatography Mass-Spectrometry
Author	:	Ismail, N., Rahiman, M.H.F., Taib, M.N., Ali, N.A.M., Jamil, M., Tajuddin, S.N.
Types	:	Proceeding **Year :** 2013
Publisher	:	Signal Processing and its Applications (CSPA), 2013 IEEE 9th International Colloquium
Source/ link	:	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=6530044&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6530044

Abstract:

The quality of the agarwood oils plays an important role as it reflects the price of the oil in the market. High quality agarwood oil is traded extensively. In order to obtain good quality agarwood oil, temperature condition during the extraction is one of the important parameter instead of type and time of extraction. An analysis of chemical compounds of agarwood oil involves of three different temperature conditions such as 40°C, 60°C and 80°C has been carried out in this study. The analytical work involves HS-SPME combined with GC-MS analysis to extract and identify the chemical compounds composition in agarwood oil. The zscore technique was introduced to identify the significant compounds that contribute to the aroma of agarwood oil. The result shows that five compounds were identified and they were aromadendrane, β-agarofuran, α-agarofuran, 10-epi-ϒ-eudesmol and ϒ-Eudesmol. These compounds were found to have similar pattern of plot but different in chemical composition due to the different chemical properties of the oils.

Title	:	*Aquilaria* Leaf Extract Compositions and Their Biological Activities		
Author	:	Nor Azah MA, Siti Humeirah AG, Saidatul Husni S, Mailina J, Vimala S, Nik Musaadah NY, Tan HP, Azrina A, Mohd Jemain MR, Azrina A & Mohd Faridz Z		
Types	:	Proceeding	**Year :**	2013
Publisher	:			
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Aquilaria is a genus in the family *Thymelaceae* and is well known for its gaharu resin. About 16 species of *Aquilaria* had been documented and the best known species that produce the gaharu resin are *A. malacensis* and *A. crassna* (Hoang 2000). Besides its uses as perfumery ingredient, the leaves are used as remedies for the treatment of trauma diseases (Zhou 2008). The leaves of this tree are infused with hot water and drunk as the same way as green tea. Realizing the potential of *Aquilaria* species as herbal health care product, this project was undertaken to carry out on the chemical profiling and biological properties (antioxidant, microbial enumeration, toxicity profile and proximate test) of aqueous leaf extracts from *A. malaccensis*. Based on this finding, the leaves could be developed as potential health care product such as nutraceutical, or personal care products.

Title	:	Agarwood Aroma Profiling by Chromatographic and Sensor Applications		
Author	:	Nor Azah, M.A., Mailina, J., Sahrim, L., Saidatul Husni, S., Mohd Faridz, Z., Abd. Majid, J., Muhd Hafizi, Z. & Mohd Nasir, M.A.		
Types	:	Proceeding	**Year :**	2013
Publisher	:	Prosiding Seminar Agri-Dana 2013: "R&D Perhutanan: Sumber Kekayaan Baharu", 10–11 September 2013, Shah Alam		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu (agarwood) is obtained from the fragrant and resinous heartwood from the genus *Aquilaria*. It is highly valued for its unique strong aroma when burned. The aroma of gaharu may be directly influenced by the presence of complex chemical components that may be present in agarwood and oils produced. Agarwood is often "graded according to the physical properties, resin content and aroma and thus have its disadvantages in terms of repeatability. Therefore in this, project, we focused on the chemical profiles and fingerprint profiling of selected gaharu oils and wood chips using gas chromatography (GC), gas chromatography-mass spectrometer (GC-MS) coupled to head space microextraction technique and electronic nose which we called the Gaharu Sense technology. This technique is a combination of many analytical methods and sample pattern recognition processes such as Principal Component Analysis (PCA) and k Nearest Neighbour with k-fold (K-NN kfold) for classifying agarwood. The information obtained will be valuable towards establishing quality control for gaharu as there are no clear classification standards for gaharu in the Malaysian market.

Title	**:**	Classification of The Quality of Agarwood Oils From Malaysia Using Z-Score Technique		
Author	**:**	Ismail, Nurlaila, Rahiman, Mohd Hezri Fazalul, Taib, Mohd Nasir, Ali, Nor Azah Mohd, Jamil, Mailina, Tajuddin & Saiful Nizam		
Types	**:**	Proceeding	**Year :**	2013
Publisher :		System Engineering and Technology (ICSET), 2013 IEEE 3rd International Conference		
Source/ link	**:**	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=6650147&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6650147		

Abstract:

This paper presents classification of the quality of agarwood oils from Malaysia using Z-score technique. Six agarwood oil samples named as MU, MUS, MN, MNS, R5 and HD are analyzed by GC-MS to examine their chemical profiles. The extraction showed that at least forty three volatile compounds are found. The Z-score technique is proposed to identify the significant chemical compounds of the agarwood oils. It is found that six chemical compounds are recognized. They are ß-agarofuran, β-agarofuran, 10-epi-ϒ-eudesmol, ϒ-eudesmol, dihydrocollumellarin and ϒ-eudesmol. These volatile compounds have different abundances pattern responsible to the different qualities of agarwood oil such as high and low. The Z-score applied in this study give a promising result in discriminating agarwood oil to high and low quality. It is important and useful in solving the grading agarwood oil system which is currently done manually.

Title	:	Some Silvicultural Considerations in *Aquilaria* Cultivation for Agarwood and Oil Production
Author	:	Lok Eng Hai & Ahmad Zuhaidi Yahya
Types	:	Proceeding **Year :** 2013
Publisher	:	Conference on Forestry and Forest Products Research 2013 "Forestry R, D & C: Meeting National and Global Needs", 11–12 November 2013, Kuala Lumpur
Source/ link	:	Forest Research Institute Malaysia (FRIM)

Abstract:

Similar to forest plantation establishment, silviculture understanding of *Aquilaria* cultivation is important in ensuring success of the forest plantation of this species in Malaysia. There are about 3,500 ha of *Aquilaria* or karas plants planted and over half a million of *Aquilaria* trees are expected by 2015 (FAO 2012). The product that currently affords high economic returns is gaharu or agarwood. In Malaysia, agarwood producing species are derived from five genera, namely *Aetoxylon*, *Gonystalus*, *Wikstroemia* and the other two commonly traded *Aquilaria* and *Gyrinops* in the family *Thymelaeaceae*. Local names like chandan, gaharu, kalambak, oud and chen-hsiang are commonly known. The valuable part of these trees is the aromatic resin which is found in a small percentage of trees mainly harvested from the species *Aquilaria* and *Gyrinops* (Ding Hou 1960, Wiriadinata 1995, Mulyaningsih et al. 2006). However, agarwood cannot produce aromatic resin in healthy wood tissue but needs to be induced and stimulated by wounding due to herbivory, wind chill, lightning or fire damage and importantly by subsequent opportunistic infection by facultative fungal pathogens (Burkill 1966, Ng et al. 1997). Scientifically, the first process of oleo-resin production is taken up in cells of the included phloem, rays, parenchyma para-trachea and trachea. It is the tree's response to injury, its first line of defence formation of phloem callus tissue over the injury (Itoh et al. 2002, Mulyaningsih & Sumarjan 2002, Gunn et al. 2003). Age and size of the trees may also significantly affect the yield and quality of the agarwood produced. For instance, it was suggested that only 10% of mature trees above 20 cm diameter at breast height produce agarwood. It is believed that the lowest grade of any species of natural

agarwood could fetch a price of USD19/kg in the Middle East while the top grade agarwood is valued at over USD10,000–27,000/kg in end-use markets (Barden et al.2000). In Southeast Asian countries like Indonesia, Malaysia, Thailand, Cambodia and Vietnam, collection of agarwood is reportedly becoming scarcer with the number of wild mature trees starting to dwindle. Concerns over the effects of logging and trade in this non-wood product have led to the genus being listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2004). It is envisaged that agarwood produced from cultivated *Aquilaria*/ *Gyrinops* will match the quality desired and play an important role in the future for ensuring sustainable supply and demand as they take less time to mature, from about four to seven years. However, there is an urgent need for effective artificial induction and stimulation of agarwood formation on these cultivated trees in order to offer high economic returns.

Title	:	The Grading of Agarwood Oil Quality Using k-Nearest Neighbor (k-NN)
Author	:	Ismail, N, Rahiman, M.H.F., Taib, M.N., Ali, N.A.M. more authors
Types	:	Proceeding **Year :** 2013
Publisher	:	Systems, Process & Control (ICSPC), 2013 IEEE Conference
Source/ link	:	http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6735092&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6735092

Abstract:

This paper presents the application of k-Nearest Neighbor (k-NN) in grading the quality agarwood oil. Six agarwood oil samples obtained at Forest Research Institute Malaysia (FRIM) were extracted and their chemical compounds were examined by GC-MS. The work is followed by the grading system using the proposed k-NN. The study shows that there are 10 significant chemical compounds of agarwood oils. They are β-agarofuran, α-agarofuran, 10-epi-Y-eudesmol, Y-eudesmol, longifolol, oxo-agarospirol, hexadecanol and eudesmol. These compounds are used as inputs to the k-NN algorithm for grading them. The performance of the k-NN is measured and the highest accuracy obtained by k-NN which is above 83.3% shows that k-NN is a reliable classifier in grading the agarwood oil quality.

Title	:	Extraction of Essential Oil From Biologically Inoculated Agarwood
Author	:	Fadzil, A.H.M., Hamid, K.H.K., Rodhi, M.N.M. & Mohd Kamaruddin, L.
Types	:	Proceeding **Year :** 2013
Publisher	:	Business Engineering and Industrial Applications Colloquium (BEIAC), 2013 IEEE
Source/ link	:	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6560264

Abstract:

Agarwood becomes one of the valuable forest products compared to others due to its quality which makes the wood is in high demand. High yield of agarwood is used as a medicinal product and this has been recorded in the Sahih Muslim, which dates back to approximately the eighth century, and in the Ayurvedic medicinal text known as Susruta Samhita. Agarwood oil and its incense are used for their fragrant properties. Therefore, it is commonly used as perfumes and has been recorded in the Old Testament. Biologically inoculated agarwood is new to research due to the development of bio based inoculants. Chemical based extracted oil and hydrosol claims resulting low quality of resin formation, thus produce low quality of essential oil. Replacement for bio resin formation will ensure the safety of end product used for medicine, perfumery and food industry. Agarwood's essential oil production has been lacking in terms of maintaining the high grading and the yield due to the loss of major volatile component that effect the aroma.

Title	:	Antidiabetic Activities of Malaysian Agarwood (*Aquilaria SPP*) Leaves Extract
Author	:	Zulkifle Nur Liyana, Mhd Omar Nor Adila, Tajuddin Saiful Nizam & Shaari Mohd Rosly
Types	:	Proceeding **Year :** 2013
Publisher	:	National Conference On Industry-Acamedia Initiative in Biotechnology (CIA:BIOTECH 2013), 5 - 7 December 2013, Equatorial Cameron Highlands, Pahang
Source/ link	:	http://umpir.ump.edu.my/5602/

Abstract:

Aquilaria spp. or agarwood were reported to have pharmacological activities. There was a report of one diabetic patient who drank water infusion of agarwood leaf was found to have blood sugar return to normal. However, still, there is no evidence or systemic clinical study to confirm the activities of antidiabetic agents. This study is undertaken to evaluate the effects of methanol and aqueous crude extracts of agarwood leaf in streptozotocin-induced diabetic rats with 20% glucose water consumption for 6 weeks. *Aquilaria spp.* crude methanolic and aqueous extracts was administered orally (250 and 500 mg/kg) to the respective treatment groups and compared to metformin (0.25 mg/kg). The blood glucose level, body weight, glycosylated hemoglobin, muscle and liver glycogen, lipid profile status were measured and histopathology of pancreas was performed after 6 weeks of treatment and compared to the control. In in vitro experiment, the effects of the methanol and aqueous crude extract at the construction of 100µg/mL to 1000µg/mL are subjected to α-amylase inhibitory activity. For comparable, Acarbose is used at the same concentration as a standard. The expected result suggest that Malaysian *Aquilaria spp.* leaves extract will represent potential dietary supplements that may be useful for allowing flexibility in meal planning and automatically will reduce the number of diabetic patients in worldwide population.

Title	:	Generation of High Income Through Compatible Combinations of Forest Trees and Agricultural Crops Under Agroforestry Ecosystem		
Author	:	Hashim Md Noor, Rosdi Koter, Abd Razak Othman, Lok Eng Hai & Ahmad Zuhaidi Yahya		
Types	:	Proceeding	**Year :**	2012
Publisher :		Paper prepared for 3rd IPICEX 2012, 5-7 November 2012, Kota Kinabalu, Sabah, Malaysia		
Source/ link	:	http://www.ipicex.com/docs/2012/		

Abstract:

In Malaysia, due to rapid increase in population, industrial mono-cropping, and urban development, availability of suitable land for forest farming and small scale agricultural food production has shrink significantly. Since independence, extensive and intensive clearance of forestland for agricultural development in both Peninsula and Sabah and Sarawak has proceeded at the expense of environmental degradation and loss of timber resources and indigenous flora and fauna biodiversity. A hybrid land use practice known as agroforestry have been forwarded as a harmonious solution to land use conflict in the tropics. Agroforestry encompasses a spectrum of land use systems in which trees as dominant components are intentionally combined, spatially or temporally, with agricultural crops and/or animals to maximize land production. As an anchor component, trees in the agroforestry system provides various beneficial impacts including reduction of soil erosion; maintenance of soil organic matter; improves biological nitrogen fixation; enhancement of physical soil properties and moisture retention; and enhanced efficiency of nutrient use by crops. By ingenious combinations of compatible high value tree species and marketable agricultural crops and/or animals under agroforestry ecosystem, farmers can generate sustainable high income, producing both agricultural and forest produces from a same farming unit. In this paper we discuss some agroforestry models that can be adopted by smallholders as an option to improve land productivity and financial return.

Title	:	Incorporating Agroforestry Practices in Karas (*Aquilaria Malaccensis*) Plantations in Malaysia
Author	:	Rahman, N.A.N., Suratman, M.N., Ghani, A.R.A. & Tsan Fui Ying
Types	:	Proceeding **Year :** 2012
Publisher	:	Business, Engineering and Industrial Applications (ISBEIA), 2012 IEEE Symposium
Source/ link	:	http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6422864&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6422864

Abstract:

Analysis on tree growth data and survival rate from a 6-year old Karas agroforestry plantations in Rembau, Negeri Sembilan, Malaysia is reported in this paper. Three agroforestry components involved in this study include: (1) Karas monoculture, (2) Karas intercropped with lemongrass, and (3) Karas intercropped with guava. Three replicative plots measuring at 6 rows × 5 column of trees were established for each component. The diameter at breast height (DBH) of each component was measured within four time intervals while height was measured within two time intervals which produced three sets and one set of growth, respectively. From the field measurements, the DBH growth were 0.65, 0.71 and 0.95 cm respectively while the height growth were 6.82 and 12.21 m respectively. The means of DBH of Karas for the three components ranged from 1.94 to 2.90 cm with means of height ranged from 3.96 to 7.59 m. These translated into the Periodic Anual Increment (PAI) of diameter and height which were ranged from 1.74 to 2.43 cm/year and 3.47 to 6.65 m /year, respectively. From the analysis of variance (ANOVA), it was found that there is a significant difference in the means DBH and height of Karas among different components and growth interval ($P \geq 0.05$). From t-test analysis, there is a significant difference between the first and the second height growth measurements ($P \geq 0.05$). However, there is no significant difference in the survival rate among all components ($P \geq 0.05$). This concludes that there appear to be intercropping effects in the growth of a 6-year old Karas agroforestry system. The results from this study will be used for subsequent investigation in the assessments of growth performance of Karas under different intercropping components.

Title	:	Flora Sampling in The Vicinity of Gamma Greenhouse: As A Flora Sampling Model for Supporting The National Nuclear Power Program (NPP)		
Author	:	Affrida Abu Hassan, Zaiton Ahmad, Ros Anita Ahmad Ramli, Shakinah Salleh, Norazlina Noordin, Salmah Moosa, Sakinah Ariffin, Salahbiah Abdul Majid, Nur Humaira Lau Abdullah, Mohd Zaidan Kandar & Abdul Rahim Harun		
Types	:	Proceeding	**Year :**	2012
Publisher	:	International Atomic Energy Agency (IAEA)		
Source/ link	:	http://inis.iaea.org/search/search.aspx?orig_q=RN:44096838		

Abstract:

Gamma Green House was used as a model to study radiation effects on flora and ecosystems in supporting the National Nuclear Power Programme (NPP). A task force was formed in BAB which consists of 3 main groups of flora, fauna and microorganisms. For the flora group, two sampling expeditions have been carried out on July 7, 2011 and March 2, 2012 with the assistant of experts from University Putra Malaysia. From these expeditions, a preliminary data on the types and distribution of plants in selected quadrants close to the Gamma Greenhouse has been successfully observed and the collected plant samples have been preserved as part of the herbarium collection. This paper will describe on the sampling activities and sample preservation. Knowledge gained from this study will be very useful as model for flora distribution baseline data at plant site

Title	**:**	A Case-Based Reasoning Approach Based on E-nose		
Author	**:**	Najib, M.S., Ahmad, M.U., Funk, P., Taib, M.N. & Ali, N.A.M.		
Types	**:**	Proceeding	**Year :**	2012
Publisher	**:**	Signal Processing and its Applications (CSPA), 2012 IEEE 8th International Colloquium		
Source/ link	**:**	http://ieeexplore.ieee.org/		

Abstract:

Using an array of sensors (E-nose) to classify Agarwood has proven to be successful and produced performance close to an expert level (90% of expert level performance) but it has proven difficult to eliminate misclassifications without over-fitting. In our effort to improve our result we explored a self-improving Case-Based Reasoning approach and reached 100% correct classification. Case-Based Reasoning is an approach that will learn from every new classified case and hence the risk for misclassification is reduced. Also when new cases have to be classified that have never occurred before the system will avoid misclassification (similarity measurement is low). The approach also enables indeterminism; in reality a sample may be both close to a good case and a bad case and need further exploration by experts. The approach also handles natural variants in the wood samples well; both low-quality and high-quality samples may spread considerably in the context of E-nose readings and there is no model available of low or high quality.

Title	:	Agarwood Classification: A Case-Based Reasoning Approach Based on E-Nose		
Author	:	M. S. Najib, M. U. Ahmad, P. Funk, M. N. Taib & N. A. M. Ali		
Types	:	Proceeding	**Year :**	2012
Publisher	:	2012 IEEE 8th International Colloquium on Signal Processing and its Applications (CSPA). 120–126		
Source/ link	:	http://ieeexplore.ieee.org/		

Abstract:

Using an array of sensors (E-nose) to classify Agarwood has proven to be successful and produced performance close to an expert level (90% of expert level performance) but it has proven difficult to eliminate misclassifications without over-fitting. In our effort to improve our result we explored a self-improving Case-Based Reasoning approach and reached 100% correct classification. Case-Based Reasoning is an approach that will learn from every new classified case and hence the risk for misclassification is reduced. Also when new cases have to be classified that have never occurred before the system will avoid misclassification (similarity measurement is low). The approach also enables indeterminism; in reality a sample may be both close to a good case and a bad case and need further exploration by experts. The approach also handles natural variants in the wood samples well; both low-quality and high-quality samples may spread considerably in the context of E-nose readings and there is no model available of low or high quality.

Title	:	Overview of The Agarwood Oil Industry		
Author	:	Dr. Pakamas Chetpattananondh		
Types	:	Proceeding	**Year :**	2012
Publisher	:	IFEAT International Conference in Singapore, 4-8 November 2012' Essential Asia'		
Source/ link	:	http://www.ifeat.org/wp-content/uploads/2012/12/Pakamas-Agarwood.pdf		

Abstract:

Agarwood is a resinous, fragrant and highly valuable heartwood. The scientific name is *Aquilaria*. It is also known as aloeswood, eaglewood, krissana in Thailand, gaharu in Malaysia and Indonesia, Oudh in the Middle East, chen-xiang in Chinese and jin-koh in Japan. Healthy agarwood is relatively light and pale coloured. When the wood is infected by a disease in the wild, the infection process produces a dark aromatic resin in response to the attack. This results in a very dense, dark, resin embedded hardwood. This resin is highly prized and commands an exceptionally high value because of its distinctive fragrance and medicinal benefits. The international trade in agarwood involves wood, wood chips, powder and oil. Agarwood oil is also known as Oudh oil or Oud oil. The oil is conventionally obtained by the water distillation process. Agarwood oil can be applied directly to the skin. Pure agarwood oil has a slow release effect lasting at least 8 hours. A small amount of agarwood oil can be added to other oils to give a rich and complex depth and to fix the aroma of middle or top notes in perfume blending. Pure agarwood oil is also burned as incense, especially in Japan. It is used in spiritual ceremonies or holy occasions as a temple offering in the Muslim, Hindu and Buddhist traditions.

Title	:	Effects on Growth Performance of 13 Years Old *Aquilaria malaccensis* (Karas) Interplanted With *Azadirachta excelsa* (Sentang)		
Author	:	Lok, E.H. & Ahmad Zuhaidi, Y.		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Trans. Malaysian Soc. Plant Physiol. 19		
Source/ link	:	http://www.mspp.org.my/files/FullPapers_TransactionMSPPVol19.pdf#page=30		

Abstract:

Karas or *Aquilaria/Gyrinops* tree produces one of the most after sought and valued fragrant non-wood product-so called gaharu or agarwood (Lim et al., 2008). Currently, these species generate a lot of interests and a significant development in the establishment of relatively large ex-situ cultivation of *Aquilaria* (Karas tree) as a forest plantation or farm crop (Lok and Ahmad Zuhaidi, 2009). Due to indiscriminate felling and illegal collection of gaharu or agarwood, all *Aquilaria/Gyrinops* species are now classified in Appendix II which are endangered under Convention on International Trade of Threatened, Endangered Species of Wild Fauna and Flora (CITES) (Oldfield et al., 1998). Concurrently, the strong global demand has also supported the planting of *Aquilaria/Gyrinops*, as this had been recognised as an integral part of sustainable forest management, conservation and complementary to natural forest protection. At present, over 1,500 hectares of *Aquilaria* plantation have been established throughout Malaysia, all aiming towards the production of agarwood, oil and other high value added products for healthcare, pharmaceutical and cosmetic purposes (Burkill, 1966; Dawend et al., 2005; Lok and Ahmad Zuhaidi, 2010). The expected rotation cycle would be between 4 to 8 years old depending on the species management, growth, site suitability and effective inducement technique applications. In Malaysia, the main gaharu producing species of *Aquilaria* comprises of *A. malaccensis*, *A. hirta*, *A. beccariana*, *A microcarpa* and *A. rostrata*. (Barden et al., 2000; Burkill, 1966). These trees description and timber uses are as described by Wyatt-Smith (1952), Ng and Tang (1974), Corner (1988) and Noraini (1997).

Title	:	Diameter Patterns of 5-Year Old Karas (*Aquilaria malaccensis*) Agroforestry Stands		
Author	:	Rahman, N.A.N., Suratman, Mohd Nazip, Ghani, A.R.A. & Tsan Fui Ying		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Business, Engineering and Industrial Applications (ISBEIA), 2011 IEEE Symposium		
Source/ link	:	http://ieeexplore.ieee.org/		

Abstract:

The work conducted in this study is based on a preliminary data collection for assessing a soil status in a 5-year old Karas agroforestry plantations in Rembau, Negeri Sembilan, Malaysia. Three agroforestry components involved in this study include (1) Karas (*Aquilaria malaccensis*) monoculture, (2) Karas intercropped with lemongrass, and (3) Karas intercropped with guava. Three replicative plots measuring at 6 m × 5 m were established for each component. Each plot consists of a total of 90 Karas trees. The diameter at breast height (DBH) of Karas trees was measured in each plot. From the field measurements, the means of tree DBH in all three plots are 5.74 cm, 4.23 cm and 6.65 cm, respectively. Analysis of variance (ANOVA) revealed that there is a significant difference in the mean DBH of Karas tree between components ($P \leq 0.05$). Karas intercropped with guava recorded a significantly greater DBH than the other two components ($P \leq 0.05$). This could be due to the intercropping effects of Karas with different components of agroforestry system. The results from this study will be used for subsequent investigation in the assessments of growth performance of Karas under different intercropping components.

Title	:	Conservation of *Aquilaria* (*Thymelaeaceae*) in Peninsular Malaysia. Multinational and Transboundary Conservation of Valuable and Endangered Forest Tree Species		
Author	:	Lau K.H. & Chua L.S.L.		
Types	:	Proceeding	**Year :**	2011
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu, a valuable resin, is mainly sourced from the genus *Aquilaria* (*Thymelaeaceae*). Driven by lucrative trade demand, the unsustainable harvesting of *Aquilaria* trees in the wild is dangerously decimating the populations and this has become a global concern. While efforts have been taken to establish *Aquilaria* plantations worldwide, trees are still being harvested from the wild, both legally and illegally. To regulate its trade, *Aquilaria* was listed in the Appendix II of CITES (CITES 2011). There are five species of *Aquilaria* in the rainforests of Peninsular Malaysia (Turner 1995) and these are *A. beccariana Tiegh.*,*A hirta Ridl.*, *A. malaccensis Lam.*, *A. microcarpa Baill.*and*A. rostrata Ridl*. Before a sustainable source of gaharu can be established, one needs to understand the reproductive and regeneration patterns of indigenous *Aquilaria*. In this respect, a project was initiated recently to study the reproductive ecology of the most sought-after species, *A. malaccensis*. The research data will be used to develop both in situ and ex situ conservation measures. In addition, conservation assessment based on IUCN will be conducted on all *Aquilaria* species from Peninsular Malaysia.

Title	:	Classification of Agarwood Grades using ANN		
Author	:	M. S. Najib, M. N. Taib, N. A. M. Ali, M. N. M. Arip & A. M. Jalil		
Types	:	Proceeding	**Year :**	2011
Publisher	:	International Conference on Electrical, Control and Computer Engineering		
Source/ link	:	http://ieeexplore.ieee.org/		

Abstract:

Agarwood is an important agricultural product widely used in fragrance industries. It can be found in various parts of ASEAN countries. The price of the Agarwood is determined according to its quality, which is generally decided based on certain grade. This paper proposes an intelligent grading technique for the wood using advanced signal processing of E-nose measurements. Agarwoods from Malaysia and Indonesia are classified into either high or low grade using artificial neural network. Thirty two sensor readings of the E-nose are used as the inputs of the artificial neural network. The experimental results show that the proposed technique, employing feed forward artificial neural network defined by 32-8-1 architecture and trained via Levenberg-Marquardt back propagation (LMBP) algorithm, successfully grade the Agarwood with a 100% classification rate.

Title	**:**	Development of Eaglewood (Gaharu) in Bengkulu, Sumatera		
Author	**:**	Mucharromah		
Types	**:**	Proceeding	**Year :**	2011
Publisher	**:**	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	**:**	http://arkn-fpd.org/index.php/download/getdirect/product/Proceeding_of_Gaharu_DEVELOPMENT_OF_GAHARU.pdf		

Abstract:

Gaharu is a resin product which is produced by particular trees and has a certain high comercial value. This paper presents an insight of gaharu development in Bengkulu province, Sumatera. Indonesia has high diversity of gaharu-producing trees, but the gaharu found in nature is threatened to extinction due to uncontrolled exploitation. Therefore, there is a need to conserve gaharu in nature while maintaining well-managed gaharu production. The community who lives near the forest has long known gaharu and how to harvest them, but the knowledge of gaharu-forming and gaharu induction technology is still limited. Technology transfer and the community's capability development will mantain the perpetuation of natural gaharu and increase the community income by gaharu artificial induction. The gaharu development needs a certain capital and investment. Therefore interference by several parties will fasten the achievement of the development, for instance the government, privates, research and development institutions, and the forest community. Certain organization who facilitates the whole process of gaharu development is necessary in gaharu center region. In this paper, we also include the calculation needed to start gaharu business.

Title	:	Gaharu-Producing Tree Induction Technology		
Author	:	Erdy Santoso, Ragil Setio Budi Irianto, Maman Turjaman, Irnayuli R. Sitepu, Sugeng Santosa, Najmulah, Ahmad Yani & Aryanto		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://arkn-fpd.org/index.php/		

Abstract:

Gaharu is formed as an gaharu producing-tree responsed to particular factors which are the plant physiology and fungal infection. Fungi isolates which are potential to induce gaharu-forming have been isolated from various regions. This activity was carried in order to provide information about the diversity of isolates that have been collected. Wood samples were taken from several locations, from cultivated plants as well as nature (Java, Sumatera, Kalimantan, Sulawesi, and Maluku). Isolation, purification, and cultivation were done with adding standard medium, while qualification was carried with observing *Aquilaria malaccensis* and *A. microcarpa* characteristics. Cultured isolates on (Potato Dextrose Agar) PDA medium were incubated in room temperature for seven days. Isoalates that have been collected include *Fusarium solani* (Mart), Appell and Walenw, *F. sambunicum*, and *F. tricinctum*. Inoculation of four isolates of *Fusarium* to *Aquilariamicrocarpa* was carried in KHDTK Carita, Banten. Inoculation of Gorontalo-originated Fusarium to *Aquilariamicrocarpa* stems caused the largest and fastest infection compared to *Fusarium* originated from West Sumatera, West Kalimantan, or Jambi in 2-6 months.

Title	:	Trial for Generative and Vegetative Production of Gaharu (Eaglewood) Planting Stocks		
Author	:	Atok Subiakto, Erdy Santoso & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://arkn-fpd.org/index.php/		

Abstract:

Gaharu is one of the reliable and superior trees, particularly for development of people plantation forest. R & D Centre for Forest Conservation and Rehabilitation, with the support of Project of ITTO PD 256 prepared science and technology needed for the aspect of planting stocks production and fungi injection for gaharu stimulation. In the development of science and technology for gaharu planting stocks production, research had been conducted concerning the effect of storage duration on seed germination, which was related to the recalcitrant seed property. Research on gaharu cutting was also conducted to learn the ideal condition for gaharu propagation with cutting, in relation with program of gaharu clonal development. Duration and condition seed storage were influential on gaharu seed germination. Gaharu seed germination decreased from 82% in the initial germination to 42% after 8 weeks storage in room temperature condition. Storage of gaharu seed in refrigerator decreased germination percentage of seeds which had been stored for 8 weeks to 24%. Propagation by cutting on media comprising mixture of coconut rind powder and rice husk with ratio of 1:1, and twice a week watering, produced the best growth percentage of 69%.

Title	:	Application of Phytohormone-Producing Rhizobacteria to Improve The Growth of *Aquilaria sp.* Seedlings in The Nursery		
Author	:	Irnayuli R. Sitepu, Aryanto, Yasuyuki Hashidoko & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://arkn-fpd.org/index.php/		

Abstract:

Gaharu or aloewood or agarwood is resinous wood found mainly in the genus of *Aquilaria*. Gaharu is formed through a unique pathological process initiated with infection of fungi on the wood tissue. Gaharu has many uses, i.e. incense in religious ceremony, perfume additive, medicine, and cultural activities. In response to overexploitation of gaharu-producing trees that has threatened their existence, genera or *Aquilaria* and *Gyrinops* have been enlisted in Appendix II since October 2004. It is therefore crucial to sustain the existence of gaharu-producing species and to accelerate regeneration of gaharu-producing trees for commercial use. This study was aimed at investigating the effect of plant growth promoting rhizobacteria (PGPR) in accelerating the growth of gaharu-producing seedlings in the nursery. The PGPR have been previously tested in vitro for their phytohormone production from which nine isolates along with one additional isolate of interest were selected for this study. Inoculation accelerated height growth of seedlings up to 5 months after inoculation. *Burkholderia sp.* CK28 and *Chromobacterium sp.* CK8 gave consistent effect on height growth acceleration. Percentage of height increase over non-inoculated control seedlings ranges from 12,2 to 38, 7%, five months after inoculation. No significant effect was observed for the following months and after seedlings were transplanted in the field. Height was the most inoculation-affected parameter which made it reliable for observation of inoculation effect. No significant difference was observed for diameter, total dry weight, shoot/root ratio, and seed quality index. Dual inoculation with mycorhizal fungi may extent the effectiveness of microbial effect on growth.

Title	:	Application of Arbuscular Mycorrhizal Fungi in Four Species of *Aquilaria*		
Author	:	Maman Turjaman, Erdy Santoso, Irnayuli R. Sitepu, Mitsuru Osaki & Keitaro Tawaraya		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://arkn-fpd.org/index.php/		

Abstract:

The scarcity of natural gaharu (agarwood) production is due to excessive exploitation in Indonesian tropical natural forest. The sustainability of mother trees which produce gaharu is disturbed due to many activities of felling the trees, so that there is a threat of extinction, particularly for species of *Aquilaria*. Afterwards, the availability of natural regeneration seeds which produce gaharu, become also limited. The main problems addressed in this research is the slow growth of *Aquilaria*, either in the nursery or in the field, due to acid soil condition and nutrient deficiency. The use of *arbuscular mycorrhizal* (AM) fungi is possible to help the initial growth of *Aquilaria* species in the acid soils. The objective of this research was determining the effect of several AM fungi species on *Aquilaria* species, either in the nursery or in the field. Species of *Aquilaria* used in this reserach were *Aquilaria malaccensis*, *A. crassna*, *A. microcarpa* and *A. beccariana*. Species of AM fungi being used in this study were *Entrophospora sp., Gigaspora decipiens, Glomus clarum, Glomus sp. ZEA*, and *Glomus sp. ACA*. This research used completely randomized experimental design with 30 replications. Parameters observed in this research were AM fungi colonization, heigth, diameter, dry weight, fresh weight, seedling survival rate, and absorption of N and P in plant tissue. Research results showed that AM fungi colonization was formed in the root of *Aquilaria* species, after six months being inoculated in greenhouse condition. The use of AM fungi could increase all growth parameters and nutrient absorption in species of *Aquilaria*. Species *Entrophospora sp.* was very effective to be used for increasing the growth and nutrient absorption in species of *A.*

malaccensis, A. crassna and *A. microcarpa. A. beccariana* prefer to have partner and is very effective with *G. clarum* to increase growth and nutirent absorption of N and P. According to the results of this researh, the use of AM fungi could help the regeneration of *Aquilaria* species, either at seedling stage or at the field. The use of effective AM fungi is recommended for accelerating the growth of *Aquilaria* species, starting from nursery condition. Availability of AM fungi inoculum at the user level, and socialization for its use, should be pursued so that AM fungi utilization become effective and efficient.

Title	**:**	Pests That Attack Gaharu-Yielding Plants		
Author	**:**	Ragil SB Irianto, Erdy Santoso, Maman Turjaman & Irnayuli R Sitepu		
Types	**:**	Proceeding	**Year :**	2011
Publisher	**:**	Proceedings of Gaharu Workshop: Development of Gaharu Production Technology: A Forest Community-based Empowerment.		
Source/ link	**:**	http://arkn-fpd.org/index.php/		

Abstract:

Gaharu or eaglewood or agarwood is non-wood forest product. There are about 27 tree species that can produce gaharu in Indonesia, i.e. *Aquilaria spp., Gyrinops spp., Aetoxylon spp.,* and *Gonystylus spp.* These species exist in the forests in Sumatra, Kalimantan, and Papua, but they are threatened due to overexploitation. Thus, farrmers begin to plant them in monoculture is a small or a big-scale and outside their natural habitat. However, monoculture is generally susceptible to pest and disease attack. Pest has been found attacking gaharu plantations in several locations in Indonesia, included of leaf eater *Heortia vitessoides*. This pest has become increasingly important as it can cause severe damage and kill plants. Several control measures were investigated: a) short term controls with a mechanical measure by a routine collection of the larvae or eggs of the pest from infested plants and; a chemical measure using contact or systemic insecticides that contains natural enemies, parasite or predator, e.g. entomopathogenic microorganism (e,g. *Beavureia bassiana* or *Bacillus thuringiensis*); and silviculture techniques. Our recent study also showed that *Oecophylla smaradgina* may be used as a potential predator for protecting plants against pest attack.

Title	**:**	The Environmental Characteristics of Kandangan Site for Gaharu Plantation Project		
Author	**:**	Erry Purnomo & Maman Turjaman		
Types	**:**	Proceeding	**Year :**	2011
Publisher	**:**	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	**:**	http://arkn-fpd.org/index.php/		

Abstract:

A field study to characterized the site for growing and inoculation gaharu has been carried out. The characterization included location, climate, soil properties and plant species. The selected sites were distributed in regencies, namely, Hulu Sungai Selatan and Hulu Sungai Tengah. The annual total rainfall in the area under study was 2361 mm. The rainy season began in October and ease in June. In general, the soil in each site was considered very poor. The number plant species were varied from site to site. It is recommended that application of compost is needed to get good growth of eagle wood.

Title	:	Soil Physical and Chemical Properties of the Gaharu (*Aquilaria spp.*) Stands Habitat in West Java
Author	:	Pratiwi, Erdy Santoso & Maman Turjaman
Types	:	Proceeding **Year :** 2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)
Source/ link	:	http://arkn-fpd.org/index.php/

Abstract:

The research aims to collect data and information of gaharu habitat characteristics in forest plantation for support gaharu plantation development in Indonesia. The research was carried out in Carita (Banten), Darmaga (Bogor) and Sukabumi. The observed characteristics include: topography, climate, physical, and chemical characteristics of the soils. Beside that, the underground vegetation were analysed, in order to know the relationship between soil characteristics and underground vegetation composition. Result indicates that gaharu could develop quite favourably in flat to rolling landscape, low to high temperature (20-32°C) , and high rainfall (> 1500 mm/year), hard soil texture (clay), fast drainage, pH about 4,5-5,1, very low to high base saturation (1,2%-78,84%) and low toxic element. The dominant and co-dominant underground species in Carita are jampang (*Panicum disachyum*) and selaginela (*Selaginella plana*), while in Darmaga are pakis (*Dictyopteris irregularis*) and seuseureuhan (*Piper aduncum*) and in Sukabumi are jampang (*Panicum disachyum*) and rumput pait (*Panicum barbatum*).

Title	:	Community Based Forest Management (CBFM) Using Profit Sharing System in Gaharu Plantation Establishment		
Author	:	Sri Suharti		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:			

Abstract:

Forestry sector has an important role in development program in Indonesia. However, during its development, forestry program always deals with several problems both technical and non technical including social community conflicts. The situation gives an indication that community's right and interest in forestry development process besed on sustainable principles need to be taken into consideration shrewdly. One alternative solution that could be done to accommodate rehabilitation of forest function in one hand and fulfilling local community's needs on the other hand especially in areas prone to land encroachment and illegal logging is by promoting participatory forest rehabilitation through Community Forest Based Management (CBFM) approach. CBFM is deemed to be the suitable approach in such areas since CBFM is implemented by involving forest surrounding community in forest management. Forest management would be successful if all stakeholders involved are willing to cooperate and allocate space, time, benefit, right and obligation based on powering, promoting and benefiting each other principles. Collaboration research of gaharu trees plantation establishment through profit sharing system in KHDTK Carita is intended to implement forest land rehabilitaion by increasing land productivity through growing trees with high economic value hence it could inrease people's income as well. Gaharu trees are selected as it has high economic value beside it still could grow well under tree stands with limited light intensity (< 70%). The research was done by using field observation, informal discussion with related stakeholders (Perhutani state owned forest, Banten Forestry Service, personnel of KHDTK Carita, gaharu trader, etc) and followed by Focus Group

Discussion/FGD with the people who are going to involve in the research collaboration (40 people). The result of the research shows that in general people's response towards plan of research collaboration with gaharu plantation in the area is very positive. Candidates of participants try to understand every item of the collaboration principles written down in draft of understanding including its risks and consequences. Main principles written down in the understanding draft of collaboration research are sustainability and its economic feasibility during period of contract (mutualistic advanteges based on inputs contributed by each stakeholder in order to achieve collaborative objectives i.e social, economic and ecology). After having several in depth discussions with all stakeholders involved especially candidates of participants, draft of collaboration memorandum successfully formulated including right and obligation, reward and punishment and profit sharing system when gaharu trees already produce. Formulation of memory of understanding (MOU) is written down in the document draft.

Title	**:**	The Developing of Database Regarding The Potency of Gaharu-Yielding Trees in Indonesia		
Author	**:**	Sulistyo A. Siran		
Types	**:**	Proceeding	**Year :**	2011
Publisher	**:**	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	**:**	http://www.forda-mof.org/		

Abstract:

Gaharu is a name of commodity of non timber forest products (NTFPs) which at present become the subject of discussion by many parties. Gaharu is actually a product in the form of solid lump with color ranging from blackish brown to black, and has fragrant smell occurring in the wood and roots of the host plants (for instance *Aquilaria spp.*) which have undergone physical and chemical change due to infection by a kind of fungi. Objective of this paper is to describe the database regarding the potency of gaharu-yielding trees in several regencies of Indonesia, and factors that affect potency increase of gaharu population.

Title	:	Chemical Composition of Gaharu Products That Result From Inducement		
Author	:	Totok K Waluyo, E. Novriyanti, Gustan Pari & E. Santoso		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Gaharu signifies as one of the non-timber forest products (NTFPs) commodities in Indonesia that exerts significant roles on acquiring the state earnings and a direct income from the community who reside in the vicinity of forests. The gaharu-yielding trees, which stand high and are hunted the most by the gaharu-seekers, belong to the genus *Aquilaria sp.* and *Gyrinops sp.* This is because such gaharu affords high quality as well as high commercial (selling) values. The hunting of gaharu with uncontrolled harvest capacity has brought about the situation that the potency of those two species tends to decrease, and as a result gaharu is listed in the list of the CITES' Appendix II. One of the solutions to deal with those inconvenient cases are to synthesize/produce gaharu products through inducement. In relevant, the chemical composition in gaharu products that result from the inducement, in their six-month age, contained 9 kinds of chemical compounds, while in their 20-year age present 150 kinds of compounds, where the latter can be categorized into 24 phenolic derivatives. The phenolic derivatives contained in the induced-gaharu products afford many benefits/uses, such as anti-fungal, anti-microbe, insecticide, coughing remedy, perfumes, cosmetics, etc.

Title	:	Standardization and Effectiveness of Bioinduction on Gaharu Development and Its Qualities		
Author	:	Erdy Santoso & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Gaharu signifies as one of the non timber forest products (NTFPs) commodities which affords high economy value in enhancing the state earnings. Gaharu presents a resin product that evolves fragrant smell occurring to the secondary metabolism reaction between the gaharu-yielding and particular fungi. In nature, the gaharu-yielding trees can be induced by fungi through the nature injury, but only with limited extent. Until this occasion, there are no fewer than 26 tree species that yield gaharu, two of which, namely *Aquilaria spp.* dan *Gyrinops spp.* still belong to the category regarded as scarce. The Forest Microbiology Laboratory, under the R&D Centre for Forest Conservation and Rehabilitation so far has collected particular fungi able to develop gaharu, called *Fusarium spp.* from Aceh until Papua, which in reached 54 fungi species. Meanwhile, 8 out of those 54 fungi species have been trial tested, comprising FORDA CC-00499 (from West Kalimantan), FORDA CC-00500 (Jambi), FORDA CC-00509 (FORDA CC-00509), FORDA CC-00501 (West Sumatera), FORDA CC-00512 (Papua), FORDA CC-00495 (South Kalimantan), FORDA CC-00497 (Central Kalimantan), and FORDA CC-00511. Further 3 out of those 8 species afforded their virulence consecutively FORDA CC-00509, Papua, and Kalimantan Tengah (as the highest virulence), followed in decreasing order by those from Jambi, West Nusa Tenggarta and Kalimantan Barat (as the medium virulence), and ultimately those from West Sumatera dan South Kalimantan Selatan (as the lowest). For the bio-inducement on gaharu development, it needs standardization and effectiveness toward such bio-inducement in order to develop gaharu with favorable qualities.

Title	:	Feasibility of Gaharu Inoculation Business at Different Stem Diameter and Period of Inoculation		
Author	:	Sri Suharti, Pratiwi, Erdy Santosa & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

Indonesia is the biggest gaharu producer country in the world. Its demand and price which tend to increase has resulted over exploitation of gaharu. Consequently, its population in nature has decreased significantly. To overcome the situation, since 1995, gaharu has been included in CITES Appendix II, however illegal exploitation remained occur until it reached excessive level. In order to conquer it, several efforts on gaharu cultivation and artificial gaharu production have been undertaken at several provinces of Indonesia. Several supporting factors for cultivation and artificial production of gaharu are availability of potential land for extensive gaharu cultivation, appropriate agro climate condition, cultivation technique which is relatively easy and has been well adopted by farmers, availability of necessary pathogen for gaharu inoculation and its demand that tends keep increasing with relatively high price. The research aims to analyze feasibility of gaharu inoculation business at several stem diameters (15 – 25 cm; 26 – 35 cm and 36 cm - 40 cm.) and period of inoculation (1 – 5 years). Data collection was done through field observation and literature study. The result showed that inoculation on gaharu producer tree stands at 12.5 % interest rate produced positive NPV value, IRR much higher than market interest and B/C ratio >2 for those three diameter class. Furthermore, if gaharu harvesting is delayed until five years after inoculation, NPV, IRR and B/C ratio would be much higher. It can be concluded that inoculation on gaharu producer tree stands (at appropriate age for inoculation) is feasible to be developed.

Title	:	Financial Analysis on Gaharu (Eaglewood) Plantation		
Author	:	Atok Subiakto, Erdy Santoso & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

There is a growing plantation area of gaharu (eaglewood), a potential non-timber forest products (NTFPs), planted either by government project or people initiative. The increasing gaharu planting trend is attributed mostly to the currently available of innoculant production and gaharu induction technology. ITTO PD425/06 Rev.1 (I) has planted 15.000 gaharu trees at Carita Banten and 30.000 trees at Kandangan-Barabai South Kalimantan. Planting gaharu is mostly done in mix planting with others commercial plants such as rubber trees and palm oil. This paper present gaharu planting cost calculation based on ITTO PD 425/06 Rev.1 (I) data on planting plot establishment at Carita, Banten and Kandangan-Barabai South Kalimantan. The planting cost calculation is presented in two planting schemes namely mono-culture and mix planting. Planting cost per hectare of gaharu in mono-culture at 3 x 3 and 4 x 4 meter spacing is Rp 12.452.000,- and Rp 8.460.500,- respectively. Planting cost per Hectare of gaharu in mix planting with palm oil at planting density of 278 trees per ha is Rp 9.303.000,-. Planting cost per hectare of gaharu in mix planting with rubber trees at planting density of 1.112 trees per ha is Rp 14.068.000,-.

Title	:	Nutrient and Economic Balances of Gaharu (Eaglewood) Grown in A Mix Farming System		
Author	:	Erry Purnomo, Dewi Wulandari, Anita Andayani, Aidil Fitriadi & Maman Turjaman		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

One of famers in Pulau Laut of Kotabaru Regency is growing gaharu with other plants (mix farming). Beside gaharu, this farmer also grows banana (*Musa sp.*), Jackfruit (*Artocarpus integra*), Rubber (*Hevea brassliensis*), Jati (*Tectona grandis*), Mahkota Dewa (*Phaleria papuana*), Cassava (*Manihot utilisima*), Durian (*Durio zibethinus*), and Langsat (*Lansium domesticum*). The advantage of growing Gaharu has never been evaluated. Using a NUTMON program, we take the opportunity to measure the economic performance of such system. The results showed that in the January to December 2009 period there were positive balances of nitrogen (N), phosphorus (P) and potassium (K) for the whole farm. In each commodity (compartment), there were positive and negative balances of nutrients. The positive balance occurred in compartments which has no yield yet. The negative balance occurred in the compartments that produced yield. It was also observed that the economic balance for the whole farm was positive. In each compartment, the positive balance of economy was noticed in the compartments that produced yield. On the other hand the negative economic balance was found in the compartments that had not produced yield. Over all, while waiting for the gaharu to produce, the farmer earned about 4.75 million rupiah per month from the mix farming system.

Title	:	Exit Strategy and Recommendation on Gaharu (Eaglewood) Development Following The ITTO PD 425/06 Rev.1 (I) Project		
Author	:	Maman Turjaman, Erdy Santoso, Ragil S.B. Irianto, Irnayuli R. Sitepu, Atok Subiakto, Bambang Wiyono, Pratiwi, Sri Suharti & Erry Purnomo		
Types	:	Proceeding	**Year :**	2011
Publisher	:	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	:	http://www.forda-mof.org/		

Abstract:

The development of gaharu products as addressed in ITTO PD 425/06 Rev.1 (I) Project, entitled "Production and Utilization Technology for Sustainable Development of Eaglewood (Gaharu) in Indonesia" has significantly contributed to development of bio-induced gaharu, gaharu inoculum products, and its implementation in the demonstration plot for the gaharu-yielding trees owned by the farmer group who reside around the forests. The problems as encountered while these activities proceed are among others the pests brought about by the larvae that attack the leaves of gaharu-yielding trees, which have taken place in several regions. Another problem is that gaharu qualities varied depending on the gaharu-yielding species as induced; and also still other problems cover tree-genetic variation, bio-physic environments, community perception toward the technology of bio-induced gaharu, government policies on gaharu products that result from cultivation, market institution, etc which so far are not yet established. Development activities on gaharu in Indonesia deserve continuation by determining exit strategy with regard to research and development framework directed by the Forestry Research and Development Agency in cooperation with the related stakeholders. The addressing of these highlights intends to discuss in depth the exit strategy and recommendation on gaharu development following the ITTO project designated as PD 425/06 Rev.1 (1).

Title	**:**	The Value of Agarwood. Reflections Upon Its Use and History in South Yemen		
Author	**:**	Jung, Dinah		
Types	**:**	Proceeding	**Year :**	2011
Publisher	**:**	Workshop "The Use of Herbs in Yemeni Healing Practices," Halle, September 25 – 26, 2009		
Source/ link	**:**	http://nbn-resolving.de/urn/resolver.pl?urn=urn:nbn:de:bsz:16-heidok-120390		

Abstract:

Agarwood is a scented heartwood produced by a number of mainly *Aquilaria* species. It has been highly valued among various populations of Asia. Specifically in South Yemen, agarwood presents the key material of the current perfumery arts; it is the ingredient of many products, and people take great care to have it on hand for the most special occasions. The paper discusses the factors which turned agarwood from an originally uncommon good of minor interest into such a significant and cherished one. The olfactory character and medicinal qualities of the resinous product do not yet provide a satisfactory explanation for this aesthetic development. A fruitful basis for the rising esteem of agarwood was given in the establishment of Islam, due to the general attention to perfumery matters in the holy literature. Specifically, agarwood became important in South Yemen with the expansion of the operating range of the coastal population. Experiencing the fragrance of agarwood supports an awareness of Islamic values and noble origin, as they were defined in the cultural exchange with the Eastern world of Islam and the Indian Ocean Rim over the course of the centuries. In order to maintain availability of this coveted good, sustainable management of the threatened natural resource is requisite.

Title	**:**	Classification of Malaysian and Indonesian Agarwood using k-NN		
Author	**:**	M. S. Najib, N. A. M. Ali, M. N. M. Arip, A. M. Jalil, M. N. Taib & N. Kasuan		
Types	**:**	Proceeding	**Year :**	2010
Publisher	**:**	International Sysmposium on Forestry and Forest Products 2010, Kuala Lumpur, 2010		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

This paper present an identification of Malaysian and Indonesian agarwood. The aim of this paper is to identify the regions of agarwood based on k Nearest Neighbor (k-NN) classification. The agarwood samples were segregated and prepared using the Forest Research Institute Malaysia (FRIM) chemical separation standard instrument. The agarwood regions were initially predetermined and the k-NN was employed with portable E-nose to classify the agarwood. The experimental results demonstrate that the k-NN is effective in the identification of agarwood regions.

Title	:	Propagation of *Aquilaria malaccensis* Seedlings Through Tissue Culture Techniques		
Author	:	Salahbiah Abdul Majid, Zaiton Ahmad, Mohd Rafaie Abdul Salam, Nurhayati Irwan, Affrida Abu Hassan & Rusli Ibrahim		
Types	:	Proceeding	**Year :**	2010
Publisher	:	International Atomic Energy Agency (IAEA)		
Source/ link	:	http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/43/035/43035293.pdf		

Abstract:

Aquilaria malaccensis or karas is the principal source of gaharu resin, which is used in many cultures for incense, perfumes and traditional medicines. The species is mainly propagated conventionally through seeds, cuttings and graftings. Propagation by seeds is usually a reliable method for other forest species, but for karas, this technique is inadequate to meet the current demand of seedling supplies. This is principally due to its low seed viability, low germination rate, delayed rooting of seedlings, long life-cycle and rare seed production. Tissue culture has several advantages over conventional propagation, especially for obtaining large number of uniform and high-yielding plantlets or clones. This paper presents the current progress on mass-propagation of *Aquilaria malaccensis* seedlings through tissue culture technique at Nuclear Malaysia.

Title	:	Establishment of *Aquilaria malaccensis* Callus, Cell Suspension and Adventitious Root Systems		
Author	:	Norazlina Noordin, Rusli Ibrahim, Norzulaani Khalid & Noorsaadah Abdul Rahman		
Types	:	Proceeding	**Year :**	2010
Publisher	:	International Atomic Energy Agency (IAEA)		
Source/ link	:	http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/43/035/43035330.pdf		

Abstract:

Aquilaria malaccensis is a tropical forest tree from the family *Thymelaeaceae*, an endangered forest species and was listed in CITES since 1995. Locally known as Pokok Karas, this tree produces agar wood or gaharu, a highly valuable, resinous and fragrant forest product. Karas has been highly recognized for its vast medicinal values and gaharu has been widely use for perfumery, incense and religious purposes. The phyto chemical studies of agar wood showed that Sesqui terpenoid and Phenyl ethy chromone derivatives are the principal compounds that have anti allergic and anti microbe activities. Cell and organ culture systems provide large scale production of biomass and offers feasibilities for the production of secondary metabolites. This paper describes the work done for establishing reproducible systems for callus initiation and production of cell suspension cultures as well as production of adventitious roots that will later be amenable for the production of secondary metabolites of *A. malaccensis*. Hence, further manipulation with Methyl Jasmonate, a chemical elicitor could be done to induce secondary metabolites using callus, cell suspension and adventitious roots systems.

Title	:	Farm Planting of Karas (*Aquilaria Spp.*) for Gaharu (Agarwood) and Oil Production in Malaysia. Addressing Global Concerns and Changing Societal Needs		
Author	:	Lok Eng Hai & Ahmad Zuhaidi Yahya		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu or agarwood is an important commodity. Its resinous heartwood is derived or formed in the matured *Aquilaria/Gyrinops* trees. This dark aromatic heartwood is then harvested and produced into various products: pure fragrant oil, incense, wood chips/chunks, perfume and health products such as green tea and body lotion. Gaharu is also used in many ancient Chinese, Muslim, Indian and Tibetan cultures for traditional medicine. Due to the high demand and price for high quality gaharu, wild trees of *Aquilaria* (karas) have almost been depleted, extinct and are now considered as endangered species. This paper highlights some silvicultural management practices used in the farm cultivation of *Aquilaria/Gyrinops*) leading to successful cultivation and performance of the species. It also describes some of the marketing aspects relating to grading, current inducement techniques and the need for sustainable production and development of the gaharu industry in Malaysia.

Title	:	The Distribution of Dry and Wet Inland *Gonystylus spp.* (Ramin), *Aquilaria spp.* (Karas) and *Intsia spp.* (Merbau) in Peninsular Malaysia		
Author	:	Samsu Anuar Nawi, Ihsan Sabri Kamarazaman, M. Zarin Ramlan & Muhamad Azmi		
Types	:	Proceeding	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

There is a widespread concern on the distribution of *Gonystylus spp.* (ramin), *Aquilaria spp.* (karas) and *Intsia spp.* (merbau) due to the existing rate of exploitation and extraction in Peninsular Malaysia. Assessments on distribution of the three species were carried on 59 sampling units (SU) using NFI-4 data and consequently ten permanent sample plots (PSPs) were established for periodic monitoring on the growth, mortality and recruitment of *Gonystylus spp.* Enumeration on the 59 SU showed that only two species of *Aquilaria* were found, totalling 3.96 stems ha-1 and 92.08% concentrated in diameter classes 1.5m<10cm and 10 < 30cm. *Aquilaria hirta* and *Aquilaria malaccensis* recorded 2.8 and 1.16 stems ha-1 respectively. As for *Intsia spp.,* the total number of stems per ha for *I. bijuga* and *I. palembanica* was 0.013 and 0.034 respectively. Six *Gonystylus spp.* were recorded in the enumeration namely *G. bancanus, G. affinis, G. macrophyllus, G. brunnescens, G. confusus* and *G. maingayi* with estimated 19.51 stems ha^{-1}. for all diameter classes. However, based on the diameter class 10cm dbh and above, the difference on the number of stems ha^{-1} is lessened to 3.5 stems ha^{-1}. For dry *Gonystylus*, it was 1.8 stems ha^{-1} and wet inland *Gonystylus* (*G. bancanus*), 1.73 stems ha^{-1}. Result on wet inland *Gonystylus* is comparable to the result on the enumeration of ten PSPs which recorded 1.6 stems ha^{-1} of *G. bancanus* but lesser number of stems ha^{-1} for dry *Gonystylus* or 0.9 stems ha^{-1}. Other results on *Gonystylus spp.Aquilaria spp.* and *Intsia spp.* enumerated in the 59 SU, ten PSPs and NFI-4 are presented and discussed in this paper.

Title	**:**	Classification of Agarwood Region Using ANN		
Author	**:**	M. S. Najib, N. A. M. Ali, M. N. M. Arip, A. M. Jalil & M. N. Taib		
Types	**:**	Proceeding	**Year :**	2010
Publisher	**:**	IEEE Control and System Graduate Research Colloquium (ICSGRC 2011). 7–13		
Source/ link	**:**	http://ieeexplore.ieee.org/		

Abstract:

An artifical neural network (ANN) has been modeled for the classification of Agarwood region. The target regions were from Melaka, Pagoh, Super Pagoh, Ulu Tembeling and Indonesia. The data analysis using Principal Component Analysis (PCA) was done to find significant input selection from 32 sensors of the E-nose and to recognize pattern variations from different number of Agarwood samples as inputs to ANN training. The network developed based on three layers feed forward network and the back propagation learning algorithm was used in executing the network training. Five input neurons, two hidden layer sizes and one output neurons were found to be the optimized combination for the network. The experimental results reveal that the proposed method is effective and significant to the classification of Agarwood region.

Title	:	Harga Dan Perdagangan Gaharu Di Semenanjung Malaysia		
Author	:	Lim Hin Fui., Mohd Parid Mamat & Chang Yu Shyun		
Types	:	Proceeding	**Year :**	2009
Publisher	:	Seminar Penanaman Karas dan Pengeluaran Gaharu, 14 Julai 2009, Miri, Sarawak		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Pokok karas yang boleh menghasilkan gaharu merupakan pokok spesis hutan yang hangat diperbincangkan di kalangan petani di seluruh Malaysia. Pokok karas ini berkemampuan untuk menghasilkan kayu gaharu yang bernilai tinggi di pasaran antarabangsa.

Di Semenanjung Malaysia, gaharu dicari di hutan semulajadi oleh Orang Asli, Malaysia dan orang keturuanan Thailand. Dalam tahun 2009, dianggarkan lebih kurang 3,500 orang pencari gaharu di dalam kawasan hutan di Semenanjung Malaysia.

Kayu gaharu yang terhasil akan dijual kepada pedagang tempatan. Di peringkat tempatan, harga kayu gaharu berbeza mengikut gred. Kayu bergred A mendatangkan hasil setinggi RM14,000 satu kilogram manakala kayu gred D cuma berharga RM5 satu kilogram. Di pasaran Timur Tengah dan Asia, gred kayu gaharu tertinggi dijual lebih USD10,000 atau RM35,000 bagi setiap kilogram di peringkat terakhir pasaran. Jenis kayu gred D ini biasanya digunakan untuk memproses minyak gaharu oleh industri kecil tempatan.

Semua pedagang tempatan akan menjual gaharu yang bergred tinggi kepada pedagang lain atau mengeksport kayu ini ke Singapura atau Negara timur tengah. Kayu-kayu yang bergred rendah akan diproses di Kelantan, Terengganu, Pahang, Selangor, Melaka dan Kedah sebelum dipasarkan. Pada 2009, harga minyak gaharu pula boleh dipasarkan pada USD 120 atau RM432 satu tola (12 ml).

Walaupun terdapatnya peningkatan dalam permintaan antarabangsa untuk barangan gaharu, penghasilan barangan menurun selepas pertengahan 1990-an. Menanam pokok karas bagi menghasilkan gaharu mungkin adalah salah satu langkah sekiranya Malaysia ingin menjadi penghasil produk gaharu terpenting didunia dalam jangka masa panjang. Impian ini boleh dicapai sekiranya kerajaan menerima cadangan untuk menubuhkan Lembaga Gaharu Malaysia.

Title	**:**	Modeling of Dynamic Response of Essential Oil Extraction Process		
Author	**:**	Ismail, N., Tajjudin, N., Rahiman, M.H.F. & Taib, M.N.		
Types	**:**	Proceeding	**Year :**	2009
Publisher	**:**	Signal Processing & Its Applications, 2009. CSPA 2009. 5th International Colloquium		
Source/ link	**:**	http://ieeexplore.ieee.org/		

Abstract:

This paper presents a model of dynamic response of essential oil extraction process using system identification approach. A collection of samples was collected from a pilot plant of essential oil extraction process using steam distillation technique. Input signal for the process is pseudo-random binary sequence (PRBS) and the output is temperature. The sample was separated into training and testing data by using interlacing technique. Based on Auto Regressive Exogenous Input (ARX) model validation, the results showed that partial data will produce adequate model to describe the full dynamic of essential oil extraction process.

Title	:	Identification of Fungal Communities in "Agarwood' From Wild *Aquilaria malaccensis* using rDNA Spacer Sequences
Author	:	Mohamed, Rozi and Phai, Lee Jong and Zali, Mohammed Syazwan & Husin, Halimah
Types	:	Proceeding **Year :** 2009
Publisher	:	International Conference on Plants, Environment and Pollution, 6 -11 July, 2009, Kayseri, Turkey
Source/ link	:	http://psasir.upm.edu.my/18141/

Abstract:

Aquilaria malaccensis is a medium-sized tropical tree from the family *Thymelaeaceae*, and is the main 'agarwood' producer in Peninsular Malaysia. 'Agarwood' is a valuable fragrant resin, produced in the tree trunks of *A. malaccensis*, often associated to pathological infections by fungi. In our attempt to understand the roles of fungi in 'agarwood' production, we isolated fungi from 'agarwood', collected from a wild *A. malaccensis* population in Peninsular Malaysia. The fungal isolates were from the genera *Fusarium*, *Trichoderma*, *Curvularia* and *Cunninghamella* (order *Mucorales*) based on culture characteristics on agar medium. To confirm the genera, we analyzed genomic DNA from pure cultures and wood samples from which they were first isolated., ' Using universal primers in PCR, we amplified the intemal transcribed spacer (ITS) within the ribosomal DNA (rONA) regions. Spacer sequences provided supporting evidence to the genera designation via the culture-based method. The method promised a rapid detection and identification of fungal communities directly from environmental and wood samples.

Title	**:**	Distribution and Ecology of *Aquilaria Lam.* in Malaysia		
Author	**:**	Mustapa, M.Z., Faridah-Hanum, I., Awang Noor, A.G. & Kamziah Abd Kudus		
Types	**:**	Proceeding	**Year :**	2009
Publisher	**:**	ATBC Conference, 23-26 April 2008, Kuching, Sarawak		
Source/ link	**:**	No information		

Abstract:

Gaharu is the resin produced from trees of the genus *Aquilaria Lam.* In Malaysia, there are five species of *Aquilaria*, *viz. A. beccariana Van Tiegh, A.hirta Ridl., A. malaccensis Lam., A. microcarpa Baill.*and*A. rostrata Ridl*. These species have been put by CITES in Appendix II which regulates trade in species that could potentially lead to extinction. A study was undertaken to re-examine the distribution and ecology of the different *Aquilaria* species in Malaysia. Besides generating data from field trips, additional data were obtained from the Fourth National Forest Inventory of Peninsular Malaysia (NFI 4). A total of 232 specimens had also been studied from the herbaria at Universiti Kebangsaan Malaysia (UKMB), Singapore Botanic Gardens (SING), University of Malaya (KLU), Forest Research Institute of Malaysia (KEP), Sarawak Forestry Department (SAR) and Sabah Forestry Department (SAN). The distribution of *A. malaccensis* which supplies the largest bulk of gaharu being traded locally and internationally is widespread in our Malaysian forests except the state of Perlis. The remaining species can be found from the primary lowland forest up to an altitude of 825 m a.s.l. in various habitats. Information obtained on the distribution and ecology of *Aquilaria* species in Malaysia will be valuable to the State Forestry Departments for the conservation and management of these resources in the wild and also plantations.

Title	:	Gaharu Harvesting and Trade in Malaysia		
Author	:	Lim Hin Fui, Mohd Parid Mamat. & Chang Yu Shyun		
Types	:	Proceeding	**Year :**	2008
Publisher	:	Third International Borneo Business Conference, 15 to 17 December 2008, Universiti Malaysia Sabah, Kota Kinabalu		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Malaysia and Indonesia are two important major countries producing gaharu, an important non-timber forest product traded internationally. The gaharu wood is harvested from the natural forests by the Orang Asli, Malays and Thai decendants in Peninsular Malaysia. In 2008, it was estimated that there are about 4,100 gaharu harvesters in the states in Peninsular Malaysia. Even though there is increasing international demand for gaharu products, the production has declined after mid-1990s. The main reason being the gaharu resources in the natural forest are getting scarce, especially with the intrusion of illegal harvesters from Thailand since the mid-1980s.

Our study in 2007 showed that income from gaharu forms a substantial proportion (28%) of average monthly household income (RM752) of 138 gaharu harvesters in Perak, Kelantan, Pahang and Terengganu. This showed that contribution of gaharu to household income of harvesters was important in 2007.

Gaharu wood produced is sold to local traders. These local traders then sell the high grade gaharu to other traders or export them to Singapore and Middle East. The low grade wood is processed into oil in Kelantan, Terengganu and Pahang before it is marketed. Trade has generally declined for local traders. In the case of Perak state, the trend value of gaharu wood sold to local traders and local oil processors was about RM330,000 (1990), RM666,667 (1997), RM1.5 million (2000), and RM1.1 million (2007). Planting of gaharu producing karas trees may be an option if Malaysia wishes to remain an important gaharu products producing area in the world in the long run.

Title	:	Gaharu Harvesting and Its Importance to Rural Households in Peninsular Malaysia		
Author	:	Lim Hin Fui, Mohd Parid Mamat, Chang Yu Shyun & Jean-Marc Roda		
Types	:	Proceeding	**Year :**	2007
Publisher	:	Persidangan Kebangsaan Ekonomi Malaysia 2007, 21 to 23 August, Century Mahkota Hotel, Bandar Hilir, Melaka		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu was traded in Peninsular Malaysia before 684 CE. Today, it is one of a few non- timber forest products popularly traded in the world market. It is mainly produced from the resinous, fragrant and highly prized heartwood of species of *Aquilaria* of the family *Thymelaeaceae*. The current grade A gaharu fetches about RM16.000 per kg in metropolitan Kuala Lumpur.

It is estimated that there are about 4,100 gaharu harvesters in Peninsular Malaysia. There are found in Perak, Kelantan, Kedah, Terengganu and Pahang. While some harvesters are full-time workers, other rural villagers depend on gaharu harvesting in supplementing household income, especially during rainy days where rubber tapping could not be carried out. Other than local harvesters (Orang Asli, Malay and Thai descendants), local villagers reported that foreigners (especially the Thai) are also harvesting gaharu from the forests. The resources are depleting.

Gaharu harvesting may not last long as a source of income. The planting of gaharu- producing trees may provide income to villagers and Malaysia in the long run. It is important for the government to encourage the planting of gaharu-producing trees among the villagers. Interested villagers need support from the government in many ways, from planting, maintenance to inducing the formation of gaharu in the trees. Forestry research, development and promotion activities in these areas would help in the

development of gaharu industry from planting to high-value processing to marketing of gaharu related products in Malaysia. It could yet be another income-generator for the country.

Title	:	Production, Use and Trade of Gaharu in Peninsular Malaysia		
Author	:	Lim Hin Fui, Mohd Parid Mamat & Chang Yu Shyun		
Types	:	Proceeding	**Year :**	2007
Publisher	:	Unpublished		
Source/ link	:	http://repo.uum.edu.my/2423/		

Abstract:

Gaharu, known as agarwood, aloeswood, eaglewood, oudh (Arabic), chen-xiang (Chinese) and jinkoh (Japanese), is the resin-impregnated deposits formed in some trees of the family *Thymelaeaceae*. The fragrant gaharu products are used by Muslims, Christians, Buddhists and Hindus. They are highly demanded in international market. The best grade of gaharu wood is sold as high as RM16,000 in Kuala Lumpur in October 2007. On the production side, there are about 4,100 gaharu harvesters in Peninsular Malaysia in 2007. Local harvesters, comprising Orang Asli, Malay and Thai descendants, practise responsible harvesting. However, since 1980s, with the encroachment of foreign harvesters (especially the Thai), the resources are depleting in our natural forests. Gaharu wood produced is sold to local traders. These local traders then sell the high grade gaharu to other middlemen or export them to Singapore and Middle East. The low grade wood is processed into oil in Kelantan and Terengganu before it is marketed. In some cases, the Arab traders come personally to purchase the wood and oil directly from the local middlemen. There is practically little use of gaharu by the Malaysian population. Processed oil of 12-ml is packed in small bottle and sold at about RM300, which is regarded expensive by many Malaysians. The use of gaharu products lies in the international market. While production of gaharu provides income to local harvesters and traders, it may not be a long term source of income as resources are depleting. There is international demand for gaharu products. It is recommended that the planting of gaharu-producing trees and the processing of gaharu products be encouraged and supported by government research and development. The industry is a potential income-generating activity for the country.

Title	:	Effect of Commercial Hormones on Rooting Cuttings of *Aquilaria malaccensis*
Author	:	Aminah Hamzah, Naimah C.L. & Noor Ratul Maleka S.
Types	:	Proceeding **Year :** 2007
Publisher	:	No information
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Experiment on rooting cuttings of *Aquilaria malaccensis* was carried in the nursery unit, Forest Research Institute Malaysia (FRIM) on 22.6.2006. Cuttings were taken from 9 months old potted stock plants raised in the nursery. The length of cuttings used was 5 cm long with 30 cm2 leaf area retained on each cutting. The base of these cuttings was cut at a right angle and treated with the following commercial hormones: 1) Plantone-R 500 (0.05% indole butyric acid-IBA+0.025% naphthalene acetic acid-NAA), 2) Plantone-R 1000 (0.1% IBA+0.05% NAA), 3) Plantone-R 2000 (0.2% IBA+0.1% NAA), 4) Plantone-R 3000 (0.3% IBA+0.15% NAA), 5) Seradix 1 (0.1% IBA), 6) Seradix 2 (0.3% IBA), 7) Seradix 3 (0.8% IBA) and 8) control (without hormone). Each treatment consisted of 40 cuttings and they were randomly arranged in four blocks. These cuttings were planted in an consisted mist propagation system in the media of cleaned river sand. The misting frequency was every hour with one minute duration of misting. Results 12 weeks after planting showed that there was no significant difference between rooting percentage and number of roots of *A. malaccensis* cuttings treated with various hormone concentrations. All treatments gave > 80% rooting except for cuttings treated with Plantone-R 2000. High rooting of 92.5% was obtained with cuttings treated with Plantone-R 500 and untreated cuttings. Highest number of roots (4.46) was obtained with cuttings treated with Plantone-R 3000.

Title	:	Agar Wood Grade Determination System Using Image Processing Technique		
Author	:	Azma Abdullah, Nik Kamariah Nik Ismail, Tuty Asmawaty Abdul Kadir, Jasni Md Zain, Nor Amizam Jusoh & Noorlin Mohd Ali		
Types	:	Proceeding	**Year :**	2007
Publisher	:	Proceedings of the International Conference on Electrical Engineering and Informatics		
Source/ link	:	http://publication.gunadarma.ac.id/		

Abstract:

The aim of this study is to develop a prototype of Agar wood grade determination system using image processing technique. Agar wood becomes one of the valuable forest products compared to others because of its quality that makes the wood is high in demand. It is also famous because of its special aroma and used for many purposes such as ingredients in perfume, medical and others. The raw Agar wood is sold in either as large pieces of block chips or powder form. Manually, the quality and price of Agar wood are determined by its shape, size, color and weight. There is no such modern way in determining the grade of Agar wood except by using the traditional or manual methods above. As a result, the process of Agar wood's grade determination consumes time and performed ineffectively. Besides, many experts and experienced employees are required to determine the grade of Agar wood. As a solution, we need a system that is able to detect the percentage of the density of black color by using grayscale images of Agar wood as well as determining the grade based on the percentage. The objective of this paper is to determine the appropriate image processing technique that is able to perform the detection and determination tasks. The detail outcome and result from the experiments of the technique are discussed in this paper.

Title	**:**	Ultrasonic goniometry measurement of *Aquilaria* (gaharu) wood		
Author	**:**	Mohamad Pauzi Ismail, Mat Rasol Awang, Mohd Noorul Ikhsan Ahmad, Amry Amin Abas & Mohd Fajri Osman		
Types	**:**	Proceeding	**Year :**	2007
Publisher :		Mohamad Pauzi Ismail, Mat Rasol Awang, Mohd Noorul Ikhsan Ahmad, Amry Amin Abas & Mohd Fajri Osman		
Source/ link	**:**	No information		

Abstract:

This paper describes the results of ultrasonic goniometry measurement in *Aquilaria* (gaharu) wood. Ultrasonic wave was transmitted into the surface of gaharu wood and the reflected amplitudes by corner reflection were measured. The measurements were performed on gaharu sample with dimension of about 3 mm×15 mm×25 mm by attaching to corner reflector goniometer made of mild steel. The measurement results are explained and discussed.

Title	:	Social Perspective on Gaharu Harvesting and Trade in Malaysia		
Author	:	Lim Hin Fui, Mohd Parid Mamat, Chang Yu Shyun & Woon Weng Chuen		
Types	:	Proceeding	**Year :**	2006
Publisher	:	Workshop on the Trade Dynamics of Agarwood in Malaysia		
Source/ link	:	Forest Research Institute of Malaysia (FRIM) Library		

Abstract:

This paper examines some socio-economic aspects of gaharu harvesting and trade in Malaysia. In Peninsular Malaysia, most of the gaharu harvesters are the Orang Asli and Malays. However, since the 1980s, foreigners, especially the Thais, have been encroaching the Malaysian forests searching for gaharu. Forest encroachment and competitive harvesting are threatening species survival. There is a need to further monitor the harvesting and trading of gaharu. The resources are observed to be depleting over the years. Its role in income generation may not last long. While natural forest may continue to be a source, the future of gaharu production and trade also lies in the development of gaharu plantations and the related industries.

Title	:	Growth Performance of *Aquilaria malaccensis* Planted at MINT Tech-Park
Author	:	Ahsanulkhaliqin Abdul Wahab, Mohd Fajri Osman, Shyful Azizi Abdul Rahman, Chong Saw Peng, Khairuddin Abdul Rahim & Mat Rasol Awang
Types	:	Proceeding **Year :** 2006
Publisher	:	International Atomic Energy Agency (IAEA)
Source/ link	:	http://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=38056848

Abstract:

Aquilaria malaccensis or karas seedlings were planted in 2003 in an open field at MINT-Tech-Park, Malaysian Institute of Nuclear Technology Research (MINT), Bangi, Selangor. The seedlings were of 0.5 - 1.0 m in height and planted in plantation manner at 1.0 m - 1.5 m intervals. The seedlings were allowed to grow naturally without adding any fertilizer and watering. The survival rate of *A. malaccensis* was calculated. The height and diameter of the plant were measured at a regular interval and growth performance was calculated. Although there is no available data on the survival rate and growth performance of *A. malaccensis* planted in this manner for comparison, the results showed that without fertilizer and watering, the *A. malaccensis* grown in planation system can survive and grew relatively well.

Title	:	Gaharu, From The Metabolomic Aspect
Author	:	Chong Saw Peng, Ahsanulkhaliqin Abdul Wahab, Mohd Fajri Osman, Shyful Azizi Abdul Rahman, Khairuddin Abdul Rahim & Mat Rasol Awang
Types	:	Proceeding **Year :** 2006
Publisher	:	International Atomic Energy Agency (IAEA)
Source/ link	:	http://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=38056858

Abstract:

Agarwood, one of the timber woody plant which has the similar response as grand fir toward external invasion and is able to produce oleoresin as the secondary metabolite from plant defense system to inhibit the invader and heal the wound. Species of agarwood found in Malaysia is known as *Aquilaria malaccensis*, and locally known as karas or depu. *A. malaccensis* is valuable due to its oleoresin (gaharu). Gaharu is a product produced in the secondary metabolic pathway known as terpenoid synthesis pathway. In order to switch on this pathway, the plant defense system need to be induced and lead to the octadecanoid pathway where the linolenic acid (LA) converts to jasmonic acid (JA). Jasmonic acid is the major key to switch the plant metabolic pathway from primary metabolic pathway to secondary metabolic pathway. To prove this hypothesis, some researches on molecular study such as gene expression and protein expression are conducted to identify key components, which will lead to the manipulation of the metabolic pathway.

Title	:	The Use of Photoluminescence Spectra of TiO2 Nanoparticles Coated With Porphyrin Dye Thin Film for Grading Agarwood Oil
Author	:	N. H. Yusoff, M. M. Salleh, M. Yahaya & M. R. Awang
Types	:	Proceeding **Year :** 2006
Publisher	:	Semiconductor Electronics, 2006. ICSE '06. IEEE International Conference
Source/ link	:	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=4266596

Abstract:

This paper explores the possibility using nanostructure thin film of TiO2 nanoparticles coated with porphyrin dye based on fluorescence technique to grade agarwood oil. The sensing material was prepared using synthesized of TiO^2 nanoparticles colloid is in a sol-gel form. Then the nanoparticles were coated with dye, Iron (III) meso tetraphenyl porphine chloride. The coated nanoparticles were deposited on quartz substrate using self- assembly through dip coating technique. The sensing properties of the thin film toward five grades of agarwood oil were studied using luminescence spectrometer. It was found that the thin film produced different emission spectra peaks for different grades of agarwood oil. Hence the thin film potentially be use as sensing material for grading agarwood oil and others nature product for the future.

Title	:	Kepentingan Gaharu Dalam Kehidupan Komuniti Orang Asli: Satu Kajian Kes		
Author	:	Lim Hin Fui, Mohd Parid Mamat. & Woon Weng Chuen		
Types	:	Proceeding	**Year :**	2005
Publisher	:	Seminar Kebangsaan Pengurusan Persekitaran 2005: Pengurusan Persekitaran, Bangi, Selangor, 4-5 Julai 2005, UKM		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Komuniti Orang Asli adalah salah satu kurnpulan yang termiskin di negara kita Walaupun negara kita telah mencapai kejayaan pembasmian kemiskinan yang memuaskan pada keseluruhannya, kemiskinan di kalangan Orang Asli masih perlu diberi perhatian yang lebih. Kadar kemiskinan di kalangan semua isirumah di Malaysia ialah 11% pada tahun 2002. Kajian kes di Kg. Sungai Banun di Hulu Gerik pula menunjukkan kadar kemiskinan setinggi 75% pada tahun 2003. Salah satu sebab kemiskinan di kalangan Orang Asli di Hulu Perak ialah pergantungan mereka kepada hasil bukan kayu iailu gaharu di mana sumbernya makin berkurangan. Di Kg. Sg. Banun di mana dari pendapatan isirumah sebulan berjumlah RM477, RM31 (7%) adalah dari hasil jualan gaharu pada tahun 2003. Pada dua dekad yang lalu, semakin ramai orang luar seperti dari Thailand juga telah memasuki hutan di Hulu Perak bagi tujuan mencari gaharu. Keadaan ini telah meyumbang kepada kekurangan hasil gaharu di hutan tropika negara kita. Realitinya ialah taraf sosio-ekonomi Orang Asli tidak boleh lagi bergantung kepada gaharu pada masa depan. Adalah penting bagi kerajaan pusat dan kerajaan negeri Perak memajukan projek pertanian secara komersil supaya taraf hidup Orang Asli dapat dipertingkatkan dan kemiskinan dikurangkan.

Title	:	Gaharu in Malaysian Forests: How Long Can The Orang Asli Community Depends on It?		
Author	:	Lim Hin Fui, Mohd Parid Mamat& Woon Weng Chuen		
Types	:	Proceeding	**Year :**	2005
Publisher	:	International Conference on Indigenous People 2005, Kuala Lumpur, 4-5 Julai 2005		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu, one of a few non-timber forest products popularly traded internationally, is produced from the resinous, fragrant and highly prized heartwood of species of *Aquilaria* of the family *Thymelaeaceae*. Our study in 2003 in Hulu Perak showed that of the 71 households surveyed in 7 Orang Asli villages, 57 households (80%) generated cash income from gaharu harvesting. The average monthly income derived from the sale of gaharu was RM69 or 20% of monthly household cash income. Of the 170 household members in employment, 29 members (17%) stated that their main occupation is hlarvesting gaharu. Even though gaharu harvesting generated cash income to Orang Asli households, their continued dependence on this non-timber forest product remains doubtful. The popular gaharu-producing tree, *Aquilaria malaccensis*, is listed in the Appendix II of the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES). In principle, a permit is needed to harvest gaharu but Orang Asli hardly applies such a permit. In view of foreign encroachment on Malaysian forests to search for gaharu resulting in resource depleting and the need to practice sustainable non-timber forest resource management, it means that the Orang Asli community needs to find alternative source of income in the future.

Title	:	A Protocol for in Vitro Propagation of *Aquilaria* Species. Forestry in Malaysia : Reinventing Human-Nature Relationships		
Author	:	Millicent Dominic		
Types	:	Proceeding	**Year :**	2005
Publisher	:	Proceedings of the 14th Malaysian Forestry Conference, September 12-16, 2005, Kota Kinabalu, Sabah, pp. 738-739		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Plant tissue culture which is also referred to as in vitro propagation is considered to be one of the important application tools in the Biotechnology world. *Aquilaria* species has been selected for this research due to high value of gaharu in recent times. This paper proposes a design for an in vitro protocol for the mass propagation of *Aquilaria* species through tissue culture. The proposed methodology covers the material collection process up to the weaning stages. The source of raw explants will be collected from seed production area (SPA). In the establishment culture media, the treated explants will go through different stages of development under optimum conditions. Through this effort, mass production of high quality *Aquilaria* planting materials can be obtained which can be utilized for field planting.

Title	:	The Production of Quality Gaharu From *Aquilaria* Tree Under Various Methods in Peninsular Malaysia : Issues and Challenges		
Author	:	Abdul Rahman Abdul Rahim, Mohd. Paiz Kamaruzaman & Zahari Ibrahim		
Types	:	Proceeding	**Year :**	2005
Publisher	:	Universiti Putra Malaysia		
Source/ link	:	http://www.agris.upm.edu.my:8080/dspace/handle/0/7917		

Abstract:

Gaharu, also known as agarwood, aloeswood or eaglewood is the resinous, fragrant and highly valuable heartwood produced from *Aquilaria* tree which has been widely recognized and used significantly by the aromatic industry. Large quantities of gaharu are currently traded in domestic and international market. Internationally, gaharu is widely traded to the Middle East, China, Taiwan and Japan in the form of solid wood to be used as incense for traditional and religious ceremonies, medicinal purposes, and in distilled pure resin form for perfume and perfume component. The traded price ranges from low to extremely high depending on the values and qualities of the gaharu produced. In Peninsular Malaysia, approximately 0.5 million kg of gaharu was exported from 1998 to 2003 which contributed an estimated amount of RM 36 million to the national economy. Gaharu can be produced through conventional and non-conventional methods. Conventionally, gaharu is produced by wounding parts of the *Aquilaria* tree involving slashing with parang or knife in order for the trees to be infected and begin to produce aromatic resin. On the contrary, non-conventional method for the production of large volumes of quality gaharu from *Aquilaria* tree is also available and continuously explored. This paper highlights and reviews these two methods as well as discusses several key issues and challenges in an endeavour for continuous production of high-grade valuable gaharu from *Aquilaria malaccensis Lam.* in the country.

Title	:	Aplikasi Bioteknologi Untuk Pengembangan Tanaman Gaharu (*Aquillaria spp.*) Di Indonesia		
Author	:	Isnaini, Y. & J. Situmorang		
Types	:	Proceeding	**Year :**	2005
Publisher	:	Prosiding Seminar Nasional Perhimpunan Bioteknologi Pertanian Indonesia		
Source/ link	:	No information		

Abstract:

Gaharu yang dalam perdagangan internasional dikenal dengan sebutan agarwood, eaglewood, dan aloeswood telah banyak dimanfaatkan sebagai bahan dasar industri parfum, obat-obatan, dan setanggi atau dupa. Banyaknya manfaat gaharu ini telah menjadikannya sebagai salah satu komoditi ekspor penting di Asia Tenggara, termasuk Indonesia. Permintaan ekspor dan harga gubal gaharu yang cukup tinggi telah memacu pesatnya perburuan dan penebangan pohon secara liar, sehingga eksploitasi hutan menjadi tidak terkendali. Akibatnya sumber genetik species *Aquilaria* sebagai penghasil gaharu di hutan alam semakin terkikis. Bahkan sejak tahun 1995 *Aquilaria malaccensis* telah dikategorikan sebagai tanaman terancam punah dalam apendix II CITES (Convension on International Trade in Endangered Species of Wild Fauna and Flora), sehingga perdagangannya di dunia diatur dan dibatasi oleh kuota. Untuk mempertahankan posisi Indonesia sebagai produsen gubal gaharu terbesar dalam perdagangan internasional, harus diupayakan produksi gubal gaharu secara berkelanjutan. SEAMEO BIOTROP telah melakukan berbagai upaya untuk melestarikan dan meningkatkan produksi gaharu melalui berbagai penelitian sejak tahun 1997. Untuk mengatasi masalah kelangkaan pohon induk sebagai sumber benih, aplikasi teknik kultur jaringan untuk pengadaan bibit gaharu telah dipelajari. Seleksi pohon gaharu juga telah dilakukan untuk mendapatkan sumber bibit yang berpotensi menghasilkan gubal gaharu. Seleksi dilakukan berdasarkan kemampuan pohon gaharu merespons kehadiran cendawan Acremonium dengan membentuk metabolit sekunder beraroma khas gaharu. Hasil penelitian ini menunjukkan bahwa teknik kultur jaringan dan aplikasinya sangat berpeluang untuk dijadikan alternatif teknik perbanyakan untuk menghasilkan bibit gaharu yang berpotensi. Selain itu, salah satu isolat cendawan Acremonium yang telah dikoleksi dan dipelajari melalui penelitian ini, berpotensi untuk dijadikan agens penginduksi gubal gaharu untuk pengembangan bank klon gaharu potensial dan produksi gubal gaharu secara komersial.

Title	:	Weaning of Tissue-Cultured Plantlets of Selected Forest Species With Commercial Potential (*Dyeracostulata*, *Aquilaria malaccensis*, and *Endospermum malaccense*)
Author	:	Kandasamy K.I.
Types	:	Proceeding **Year :** 2004
Publisher	:	Proceedings of the Seminar Hasil Kajian IRPA RMK-8 2004. Pp. 34-39
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Tissue-cultured plantlets are known for their superior quality; however, they require careful nursing for a period of time during the transition from culture conditions (in the laboratory) to the exposed environment (out in the nursery) and subsequently to the field. Although shoot multiplication methods for these selected species are well established, none is available to produce well-developed root systems for these micropropagated plantlets. Therefore to address this problem, various culture medium formulations were tried on three selected species, *Dyera costulata*, *Aquilaria malaccensis* and *Endospermum malaccense*, to determine one that optimized root induction. Then a suitable transplanting medium formulation was developed and finally environmental requirements (e.g. temperature, humidity and light levels) were established. As a consequence of this study, an award-winning "Tropicalized Weaning Chamber" was designed and constructed (which allows the control of temperature, humidity and light levels). Through this study, and with the use of the weaning chamber, acclimatization time was reduced to one week (compared with the four weeks required using conventional tunnel-shaped humid chamber), with success rates well over 90% (compared with less-than 20% using conventional tunnel-shaped humid chamber).

Title	**:**	Gaharu Harvesting and Forest Resource Management in Malaysia		
Author	**:**	Lim Hin Fui, Mohd Parid Mamat& Woon Weng Chuen		
Types	**:**	Proceeding	**Year :**	2003
Publisher	**:**	KUSTEM Second Annual Seminar on Sustainability, Science and Management (KUSTEM 2003), Terengganu		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu (a product ofkaras tree *Aquilaria malaccencis*) is highly demanded in the international market. It is used in Ayurvedic, Tibetan and East Asian medicinal practices, incense manufacturing (used in religious ceremonies by Buddhists, Hindus and Muslims), and as perfume and aromatic ingredients. In Peninsular Malaysia, the highest grade of gaharu can fetch as high as RM5.000 per kilogram at the local level. It is not surprising to find youths spending days in the forest looking for gaharu. Some locals have manufactured gaharu oil for sale to the Middle East markets.

The harvesting of gaharu by the local communities living near to the forest area poses a challenge in achieving sustainable forest management in Malaysia. Some ruralpeople in the remote areas have depended on gaharu harvesting as an impcrtant form of employment and a source of household income. In the northern states of Peninsular Malaysia, a minority of Thai has also crossed the border searching for gaharu. This brings the issue of depletion of gaharu producing trees.

A. malaccensis is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The listing obliges all CITES member countries exporting or re-exporting *A. malaccensis* parts and derivatives (e.g. wood, chips, oil) to issue CITES documents for those shipments exported. This means that to achieve good forest management practices of both timber and non-timber forest products (NTFP), amidst forest certification process, necessary action needs to be taken in monitoring gaharu harvesting.

Title	:	The Sustainability of Non-Timber Forest Products: The Case of Gaharu (*Aquilaria malaccensis*)		
Author	:	Mohd Parid Mamat & Lim Hin Fui		
Types	:	Proceeding	**Year :**	2003
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

The use of non-timber forest products (NTFPs) is as old as human civilization. They are the main sources of food, medicine, cosmetics and building materials. The present day agricultural and horticultural plants were also derived from these wild stocks from forest areas. The world tropic forests are rich in flora and fauna. As such, these areas are the main storehouse of a wide ranges of NTFPs, which are valuable to the economy of local communities. Gaharu is one of a few of the international NTFPs well known for its resinous, fragrant and highly valuable heartwood produced by the *Aquilaria spp*. of the family *Thymelaeaceae*. It is used in the manufacturing of incense and cosmetic products. The formation of the resinous within the tree is always associated with some external injury to the timber and is never produced in sound tree where no injury occurs. Eight tree species of *Aquilaria* are found distributed throughout India, China, Southeast Asia and East Indies. Today the introduction of new applications for gaharu materials in the cosmetic industry, manufacturing and other product has raised its demand. This paper examines the importance of gaharu harvesting to local household economy and highlights some socio-economic aspects of local communities dependent on utilisation of this resource. It provides information in terms of the status of these resources in the wild and examines the opportunities and incentives for better management of harvest and trade.

Title	:	Eaglewood in Papua New Guinea		
Author	:	Gunn B, Stervens, P, Singadan M, Sunari L & Chatterton P		
Types	:	Proceeding	**Year :**	2003
Publisher	:	Papers of the First International Agarwood Conference. November 1–15, 2003. Vietnam		
Source/ link	:	No information		

Abstract:

Papua New Guinea is arguably one of the last frontiers in the world where the exploitation of natural stands of eaglewood is possible. The trade in eaglewood first commenced in the late 1990s. Prior to the demand for export of eaglewood, the tree species had not been regarded as having any cultural or commercial importance. To date, only one species of eaglewood, Gyrinops ledermannii, is known to occur in Papua New Guinea. The lack of information and awareness of eaglewood is creating major problems exacerbated by the remoteness of producers and landowners who harvest the resin wood. There is an urgent need to develop a practical plan for scientifically-based biological conservation and management of eaglewood. This paper provides a general overview of eaglewood with specific reference to Papua New Guinea. Summary information on the recommendation contained in the strategy document on biological conservation and management of eaglewood is also presented.

Title	:	Informasi Awal Pembentukan Gaharu Pada Pohon Penghasil Gaharu (*Aquilaria Malaccensis Lamk*)		
Author	:	Ngatiman & Sulistyo A. Siran		
Types	:	Proceeding	**Year :**	2003
Publisher	:	No information		
Source/ link	:	http://www.diptero.or.id/prosiding/2003/Prosiding-2003.pdf		

Abstract:

Proses pembentukan gaharu pada pohon penghasil gaharu dapat terjadi secara alami maupun secara buatan. Secara buatan terdiri dari beberapa cara, salah satunya adalah dengan inokulasi. Inokulasi dengan Fusarium sp. pada pohon penghasil gaharu (*Aquilaria malaccensis*) telah dilakukan oleh Balitbang Kehutanan Kalimantan di Samarinda. Pohon penghasil gaharu yang diinokulasi tersebut berumur 9 tahun yang berlokasi di Arboretum Sempaja Samarinda. Hasil inokulasi menunjukkan bahwa pembentukan gaharu sudah terjadi 1 bulan setelah inokulasi. Selanjutnya setelah 4 bulan bagian kayu yang telah diinokulasi diambil dan dilakukan pembakaran, ternyata kayu yang dibakar tersebut memberikan bau aroma gaharu. Hal ini menunjukkan bahwa ada indikasi yang kuat terbentuknya gaharu. Pembentukan gaharu 5 bulan setelah diinokulasi masing-masing berukuran panjang berkisar 2,9 — 5,5 cm dan lebar berkisar 08 — 1,5 cm.

Title	:	International Gaharu Trade and Its Implication on Harvesting to The Local Communities		
Author	:	Mohd Parid Mamat. & Lim Hin Fui		
Types	:	Proceeding	**Year :**	2001
Publisher	:	Proceedings of the National Seminar on Science, Technology and Social Science, 27-28 May 2002, Kuantan, Pahang		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu is one of a few of the international non-timber forest products well known for its resinous, fragrant and highly valuable heartwood produced by the *Aquilaria spp.* of the family *Thymelaeaceae*. The formation of the resinous within the tree is always associated with some external injury to the timber and is never produced in sound tree where no injury occurs. Eight tree species of *Aquilaria* are found distributed throughtout India, China, Southeast Asia and the East Indies. There has been active trading and demand for gaharu with the introduction of new applications for gaharu materials in the cosmetical industry, manufacturing and other products. Because of the very high demand of this material, it has contributed to the national and household economy especially among gaharu collectors.

Gaharu contributed to the national income through export. The total net trade of gaharu in raw and semi- processed form (i.e. timber, chips and powder) was over 1,350 tonnes from 1995 to 1997. This trade data is only a fraction of the total world trade in gaharu, as demostrated by Customs import data from Taiwan which show imports totalling approximately 2,050 tonnes during the same period. Indonesia and Malaysia were reported to be the main exporters with the total export of approximately 923 tonnes and 341 tonnes, respectively from the year 1995 to 1997. These two countries are the primary suppliers of these material to international market. The major importer countries are Hong Kong, Taiwan, Japan, Singapore, Saudi Arabia, Yemen, Oman and UAE. In the global market there are many form of gaharu traded, ranging, from large sections of trunk to

finished products such as incense and perfumes. Generally the most common forms in trade are gaharu chips and flakes. Although the overall trade volumes of these materials may appear small in timber trade term but they are not small in monetary terms. Gaharu chips and flakess may sell for several hundred to several thousand US dollars per kilogramme. The price of oil distilled from gaharu is generally between five and ten thousand US dollars per kilogramme, but can be more than that espeacially for gaharu oil of exceptionally high quality.

The objective of this paper is to review the potential of gaharu in international trade and its importance to household economy. It provides information in terms of the status of these resources in the market and also provide better understanding of the value of the gaharu to the local communities. In 1999, our case study in Terengganu showed that the involvement of villagers in these activities generated a reasonable average level of income, comprising about 62% from the total household income. These materials were sold at prices varying from around RM8-4,000 per kilogramme depending on the grade. The classification (grading) of gaharu in the international market is depend on a complex set of factors related to the colour, species involved, size, fragrance and resin content of gaharu offered for sale.

Title	:	Multiplication of Shoots From in Vitro Germinated Seedlings of *Eurycoma Longifolia* and *Aquilaria malaccensis*
Author	:	Hasnida, H. N., Aziah, M. Y., Salbiah, M., Fadhilah, Z. & Haliza, I.
Types	:	Proceeding **Year :** 2001
Publisher	:	No information
Source/ link	:	Http://www.frim.gov.my/v1/Library/

Abstract:

Eurycoma longifolia, or locally known as tongkat ali, is a single stemmed slow growing understorey tree of the rain forests of Southeast Asia. It is used throughout the region as an herbal medicine and tonic. The active ingredients are concentrated in the root. The plant takes five years or more to reach reproductive age, and the fruit yield is usually low, hence the production of seeds cannot sustain the existing level of demands for plants, especially for the root. Tongkat ali is a medicinal plant whereas *Aquilaria malaccensis*, or Malay name is karas, is known widely as an aromatic plant. The trees are valuable for their aromatic pathological resin. The wood is called gaharu. Gaharu is a word of trade, and indicates the heavy fragrant wood. The scented wood is regarded as a stimulant, tonic and carminative medicine. Collection of these plants in forests has become very difficult and they are threatened with extinction due to their indiscriminate collection and over-exploitation and also as natural resources for commercial purposes. Tissue culture techniques would be beneficial in accelerating large-scale multiplication, improvement and conservation of these plants. In this study, multiplication of shoots from in vitro germinated seedlings of both species was carried out. The seeds of tongkat ali and karas were surface sterilized with 70% ethanol for 3 minutes followed by washing in 20% Chlorox plus Tween 20 for 30 minutes. They were finally rinsed five times in sterile distilled water. The seeds were germinated in vitro in basal MS media alone or with additions of 0.1 and 0.5 mg/litre BAP, MS+10-6 M 2, 4-D+10-5 M KIN (I11), MS+10-5 M 2, 4-D+10-6 M BAP (I4), and MS with different concentrations of NAA ranging from 10-4 M NAA to 10-6M NAA (E1M, E3M and E5M) and incubated in the light condition. For tongkat ali,

the highest mean number of shoots per explant was observed in MS basal medium (2.0±0) and MS supplemented with 0.1 mg/litre BAP (2.0±2.83). For karas, the seeds were only germinated in MS medium containing 0.1 mg/litre BAP and gave 5 shoots. Germinated seedlings were used as a source of explants for the multiplication of shoots. The multiplication of tongkat ali shoots was carried out in 3 treatments of BAP, and for karas 6 treatments of BAP. Each treatment consisted of basal MS with additions of 0.05, 0.1, 0.25, 0.5, 1.0 and 5.0 mg/litre BAP. For shoot multiplication of tongkat ali, the highest mean number of shoots was observed in MS medium with addition of 0.25 mg/litre BAP, and for karas in MS+0.1 mg/litre BAP.

Title	:	The Importance of Gaharu Harvesting To Household Economy		
Author	:	Mohd Parid, M. & Lim, H.F.		
Types	:	Proceeding	**Year :**	2001
Publisher	:	Seminar on Medicinal & Aromatic Plants: Towards Modernisation of Research Technology in Herbal Industry, FRIM, 24-25 July 2001		
Source/ link	:	Forest Research Institute Malaysia (FRIM)		

Abstract:

Gaharu is a fragrant wood, which is a resinous dark coloured wood that occurs as irregular patches in the light coloured wood of species of *Aquilaria* in the family *Thymelaeaceae*. The formation of the resin within the tree is always associated with some external injury and is never produced in sound trees where no injury occurs. Fifteen species of *Aquilaria* are found distributed from India to Southeast Asia. There is active trading and demand for gaharu. The introduction of new applications of gaharu in the cosmetic industry, manufacturing and other products has increased its demand. The very high demand for gaharu has affected the household economy especially among gaharu collectors. This paper examines the importance of gaharu harvesting to local household economy and to highlight some socio-economic aspects of local communities' dependence on the utilisation of this resource. A socio-economic survey was conducted on 28 respondent households in 1999, representing 57% of the total households that collected gaharu in two villages in Terengganu. The research findings showed that out of a total of 145 household members in these 28 households, 60 (or 41 %) were working members. Thus, on an average there were 2.1 working members per household. About 58% of the working members were engaged in gaharu harvesting. Involvement of villagers in various activities had generated a reasonable average level of income. The average household income was RM1,305 per month in two villages, out of which about RM860 (or 66%) was generated from forest related activities. Out of this RM860, RM809 (or 62%) was derived from gaharu.

Title	:	Role of in Vitro Techniques in The Conservation and Demostication of Medicinal and Aromatic Plants		
Author	:	Aziah Mohd Yusoff, Asiah Osman, Nor Hasnida Hassan, Halilah Khafidz, Haliza Ismail & Fadhilah Zainudin		
Types	:	Proceeding	**Year :**	1997
Publisher	:	Proceedings of the Symposium State-of-the -Art Strategies and Technology for Conservation of Med. and Aromatic Plants held under the Auspices of G-15 Gene Banks for Med. and Aromatic Plants; Kuala Lumpur; September 29-30,1997; p 79-87		
Source/ link	:	http://www.globinmed.com/		

Abstract:

The tropical rain forest of Malaysia is endowed with a di versity of higher plants, including plant of medicinal and aro matic values. Currently, these plants are collected from the wild. Over exploitation due to increase in demand will lead to extinction of this valuable resource. Efforts are geared towards conservation of this natural heritage. The import values of medicinal plants for pharmaceutical uses indicated an increase from RM54 billion in 1990 to RM64 million in 1995. There was a decline in the export of this resource between 1990 to 1992, when RM3.3 million in 1990 were exported as compared to RM1.4 million in 1992. The decrease in export value can be ascertain ing adequate and consistent supply to meet local demands. In vitro techniques can be attributed to the lack of supply. Among the in vitro techniques used are cryopreservation or cryostorage and slow growth storage. Demostication of plant with medicinal values can lead to large scale planting and adequate supply of plant can be obtained through tissue culture methods. Plant can be propagated by in vitro techniques via axillary shoots development, adventi tious shoots formation and through somatic embryogenesis. Micro propagation of *Aquilaria malaccensis* has been developed using nodal segment from in vitro germinated seedlings preliminary in vitro studies on callus development in *Eurycoma longifolia* has also been initiated. The prospects of in vitro techniques in propagation and conservation of plants with medicinal and aro matic values are wide.

Title	:	Development of Herbal Health Care Products From Gaharu and Selected Plants Extracts of *Aquilaria* Species		
Author	:	Nor Azah, M.A., Mailina, J., Saidatul Husni, S., Siti Humeirah, A.G., Vimala, S., Ling, S.K., Azrina, A., Zaridah, M.Z., Mohd Jemain, M.R., Shalini, M. & Fadzureena, J.		
Types	:	Report	**Year :**	2012
Publisher	:	Project Evaluation and Monitoring Seminar (PEM), 31 October–2 November 2012, Pahang		
Source/ link	:	Forest Research Institute Malaysia (FRIM)		

Abstract:

Aquilaria is a genus in the family *Thymelaceae*. The genus is well known for gaharu producing resin mainly used for perfumery and medicinal application. Reahzing the potential of *Aquilaria* species (karas) as herbal health care products, this project was undertaken to conduct the essential oil chemical profiling, to screen for phytochemical, and to evaluate the biological properties of gaharu and plant extracts for *Aquilaria-malaccensis*. Our findings suggested that some of the leaf crude extracts, fractions and essential oils showed high antioxidant and mosquito repellent properties but with moderate or low anti-inflammatory activities. These could be developed as potential health care products such as herbal infusion, nutraceutical or personal care products. Microemulsion formulations and antioxidant properties of *A malaccensis* extract are highlighted in this paper.

Title	:	Penanaman *Aquilaria* dan Penghasilan Gaharu di Malaysia		
Author	:	Lim Hin Fui, Abdul Rashid Ab Malik, Lee Su See, Ahmad Fauzi Puasa, Chang Yu Shyun, Ahmad Zuhaidi Yahya, Mohd Parid Mamat, Lok Eng Hai, Mohd Farid Ahmad & Nor Azah Mohd Ali		
Types	:	Report	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu merupakan satu sumber hutan bukan kayu yang bernilai tinggi di pasaran antarabangsa dan dijangka akan menjana hasil pendapatan yang lumayan. Ini disebabkan oleh permintaan antarabangsa terhadap hasil pengeluaran gaharu yang semakin meningkat sedangkan sumber yang diperolehi dari hutan asli semakin berkurangan. Kertas ini bertujuan memberi satu gambaran menyeluruh mengenai penanaman, pengeluaran dan perdagangan gaharu di Malaysia. Kebergantungan bekalan hasil hutan daripada sumber semula jadi tidak menjamin kualiti dan penawarannya malah akan menyebabkan sumber asli tersebut semakin pupus. Oleh yang demikian, penanaman pokok *Aquilaria* merupakan satu langkah wajar bagi menjamin penawaran kayu gaharu pada masa hadapan. Penanamannya juga boleh meningkatkan pendapatan sampingan kepada pengusaha terutama sewaktu harga komoditi utama menjadi tidak stabil. Kajian daya maju projek penanaman pokok *Aquilaria* secara komersial untuk pengeluaran gaharu di Semenanjung Malaysia di tanah seluas 10 hektar dijangka akan memberi pulangan masa kini (NPV) sebanyak RM719,351.50. Kadar Pulangan Dalam (IRR) sebanyak 22.84% dan Kadar Faedah Kos sebanyak 3.17. Perusahaan ini menguntungkan dan pelaburan dalam penanaman pokok *Aquilaria* untuk tujuan pengeluaran gaharu amat menggalakkan. Hasil kajian sensitiviti telah menunjukkan apabila berlakunya penurunan harga jualan melebihi 38.5% dan jumlah kos pengeluaran naik melebihi 62.8% barulah perusahaan ini tidak akan berdaya maju. Kedua-dua angkubah ini mengambil masa untuk naik atau turun ke paras tersebut, dan pengusaha boleh menyusun semula strategi

apabila paras tersebut dihampiri bagi mengelak kerugian. Memandangkan dirian *Aquilaria* di dalam hutan telah dicerobohi atau dirosakkan oleh penuai gaharu, aktiviti pengumpulan samada anak benih, anak pokok atau kayu resin mestilah dikawal ketat dan hanya peratusan tertentu sahaja dibenarkan dituai pada satu-satu masa. Oleh itu, dicadangkan agar diwujudkan satu inventori untuk menentukan limpahan atau taburan, dan ancaman ke atas regenerasi populasi spesies yang menghasilkan gaharu di Semenanjung Malaysia, Sabah dan Sarawak. Adalah wajar teknologi inokulasi gaharu yang mempunyai kos efektif dibangunkan untuk memastikan gaharu yang dihasilkan secara perladangan memenuhi kuantiti dan kualiti yang dikehendaki. Kajian untuk membangunkan sistem yang praktikal dan berkesan untuk pengredan gaharu juga adalah penting di samping keperluan untuk membangunkan data deoxyribonucleic acid (DNA) dalam aplikasi forensik perhutanan untuk mengesan sumber kayu gaharu yang dituai.

Title	**:**	The Trade and Use of Agarwood (Oudh) in The United Arab Emirates		
Author	**:**	Marina Antonopoulou, James Compton, Lisa S. Perry & Razan Al-Mubarak		
Types	**:**	Report	**Year :**	2010
Publisher	**:**	TRAFFIC Southeast Asia, Petaling Jaya, Selangor, Malaysia		
Source/ link	**:**	http://www.trafficj.org/publication/ 10_Trade _Use_ Agarwood.pdf		

Abstract:

The UAE is an important import, consumer and re-exporting country within the Middle East agarwood market, and is connected to other agarwood-consuming countries in the region including Saudi Arabia, Kuwait, Bahrain, and Qatar. The persistent and culturally embedded nature of demand for agarwood by end-consumers and commercial interests in the UAE, as well as concerns over the sustainability of supply, have led to the national CITES Authorities recognising the importance of a well-managed trade. In August 2002, at the CITES Asia Regional Meeting, the UAE Government called for producer consumer co-operation in managing the global agarwood trade, at the time when only one species *Aquilariamalaccensis*, was listed in CITES Appendix II. In 2004, when more species were listed under CITES, the UAE stated its public support for agarwood conservation and sustainable use, but also its concerns over information gaps regarding wild populations, and the need to consider personal effects exemptions. The UAE subsequently took out a CITES Reservation on *Aquilaria spp.* and *Gyrinops spp.* in January 2005. The research for this report was carried out under the auspices of CITES Decision 13.63 arising from the 13th Conference of the Parties to CITES, which recommended that: "Further field research should be conducted on trade dynamics, including in the major importing and re-exporting States and territories of Southeast Asia, East Asia and the Middle East." A deeper understanding of the cultural demand from the UAE, as an indicator for the broader Middle East market for agarwood, has been lacking up until now. It is hoped that this report will provide additional insights into how this trade can be better regulated and managed for the benefits of both consumers and producers.

Title	:	The Contribution of Gaharu Harvesting to Household Economy		
Author	:	Lim Hin Fui, Mohd Parid Mamat & Chang Yu Shyun		
Types	:	Report	**Year :**	2008
Publisher	:	Highlights of FRIM's MOSTI Projects 2007, 21 to 22 January 2008, Ayer Keroh, Melaka		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu is harvested for sale to generate income and it is generally not used by the harvesters in Peninsular Malaysia. In 2007, a total of 138 harvesters were interviewed & data analyzed, comprising 45 samples (33%) from Perak, 44 samples (32%) from Kelantan, 27 samples (19%) from Pahang and 22 samples (16%) from Terengganu. The 138 gaharu harvesters comprised various age groups, i.e. 10% less than 20 years old, 32% aged 20-29 years, 31% between 30-39 years, 15% 40-49 years and 12% aged 50 and above. Orang Asli forms 88% of harvesters while 12% are Malay harvesters. Most respondents are lowly educated as 30% had no schooling, 56% primary educated while 14% attained secondary education. Of the 138 respondents, 121 (88%) generated income from harvesting gaharu in 2007. A total of 69% of them began harvesting gaharu in the 1990s and 2000s, which was related to the increased demand for gaham in the 1990s and early 2000s. Average monthly household income of harvesters in the four states was RM752 in 2007. This income level was lower than that of RM1875 for all rural households in Malaysia in 2004. The average monthly household income received from gaharu was RM282 (38%) for harvesters in the four states. This showed that contribution of gaharu to household income of harvesters was important in 2007.

Title	:	Agarwood Plantation at BRAC Tea Estate: Introduction, Environmental Factors and Financial Analysis		
Author	:	Nasima Akter & Ananta Z Neelim		
Types	:	Report	**Year :**	2008
Publisher :		No information		
Source/ link	:	http://research.brac.net/reports/Agarwood_Plantation_BRAC.pdf		

Abstract:

The *Aquillaria malaccensis* (known as agar) produces agarwood which is used in perfumes, incense and medicines, and thus, can be extremely valuable. Excessive harvesting of agarwood has made this species threatened. Considering its conservation value and economic benefit BRAC has started agarwood plantation at Kaiyachara Tea Estate from July, 2007. At Kaiychara tea estate, a plantation of about 17 acres has been created, where 83,400 agar seedlings have been planted between August and October 2007. In addition, 700,000 agar seedlings have been planted in two nurseries, namely 'Kaiya' and 'Sirgasia', at Kaiyachara tea estate. The survival rate of young seedlings was around 95%, which can be considered impressive. Initially, the BRAC tea estate plans to plant 50 acres of land with agar plant, after which agarwood harvesting would take place after 12 years. Assuming 90% survival rate and 2 kg premium quality agarwood production per plant the estimated investment related to plantation would be Tk. 145,497,198 and total return would be Tk. 60,907,155,348 with the rate of return 41,861%. However, this high rate of return is an underestimate given the environmental benefits of this plantation would generate. The establishment of this plantation would also be significant in terms of the environmental conservation of this endangered species, as well as provide a carbon sink to reduce greenhouse gases. Furthermore, there are potential opportunities that would arise in the future for improving the livelihoods of poor people in the region by providing income generating means. This report was prepared after field investigation and laboratory analysis and contains suggestions regarding proper management of the plantation as well as further research.

Title	:	The Potential of Gaharu as A Plantation Species

Author	**:**	No information		
Types	**:**	Report	**Year :**	2006
Publisher	**:**	No information		
Source/ link	**:**	No information		

Abstract:

Gaharu (Malay word for agar wood) is the most expensive wood in the world. It is valued in many cultures for its distinctive fragrance, and used extensively in incense and perfumes. Gaharu is the occasional product of two to four genera in the family *Thymelaeaceae*, with *Aquilaria agallocha*, *Aquilariacrassna* and *Aquilariamalaccensis* being the three best known species. The name of the species is derived from the latin word "aquila" meaning eagle. Gaharu is known throughout many Asian countries and at least 15 species of *Aquilaria* trees are known to produce the much sought-after agar wood. The valuable wood has been traded for thousands of years throughout Asia. It used to be commonly found in many tropical countries, from India to Indonesia (Angela Barden et. al., 2000).

Title	:	The Use and Trade of Agarwood in Japan		
Author	:	James Compton & Akiko Ishihara		
Types	:	Report	**Year :**	2004
Publisher	:	No information		
Source/ link	:	http://www.cites.org/common/com/pc/15/X-PC15-06-Inf.pdf		

Abstract:

This report was compiled by TRAFFIC Southeast Asia and TRAFFIC East Asia-Japan, under funding from CITES Project S-206, to document the significance of the Japanese agarwood market, both in terms of the Japanese traditions of agarwood use, as well as within the context of the current global trade demand for agarwood, following CITES Decision 12.71. Agarwood use and trade have played an important historical role in Japanese culture, and yet at the same time retain an arcane sense of mystery for many Japanese people, let alone foreigners with an interest in one of Japan's high arts of long-standing tradition. Obtaining information on this trade, and the industry it supports, required the establishment of several trust-based relationships – and many of those would not have been possible for TRAFFIC to obtain without various personal introductions and connections, both inside and outside Japan.

Title	:	Plantation Studies for The Induction of Gaharu-Inoculation of Young Trees		
Author	:	Reader, S., Spiers,A., Chang Y.S., Nor Azah M.A., Abu Said, A., Lok, E.H. & Nor Hasnida, H.		
Types	:	Report	**Year :**	1999
Publisher	:	No information		
Source/ link	:	Forest Research Institute Malaysia (FRIM)		

Abstract:

The stem bark of the Thai tree *Aquilaria malaccensis* (*Thymelaeaceae*) has afforded 1,3-dibehenyl-2-ferulyl glyceride (3), which is novel, and 12-O-n-deca- 2, 4, 6-trienoylphorbol-13-acetate (4). The structures of these cytotoxic compounds were elucidated by their spectral and chemical parameters.

Title	:	The Trade and Use of Agarwood in Taiwan, Province of China
Author	:	TRAFFIC East Asia-Taipei & TRAFFIC Southeast Asia
Types	:	Report **Year :**
Publisher	:	TRAFFIC East Asia-Taipei & TRAFFIC Southeast Asia
Source/ link	:	http://www.cites.org/common/com/pc/15/X-PC15-07-Inf.pdf

Abstract:

The purpose of this study is to describe the nature and significance of the consumer market for agarwood in Taiwan (Province of China), in response to CITES Decision 12.71, and to report these findings to the CITES Plants Committee and the CITES Secretariat.

Title	**:**	Trade in Agarwood		
Author	**:**	Kalyan Chakrabarty, Ashok Kumar & Vivek Menon		
Types	**:**	Report	**Year :**	1994
Publisher	**:**	TRAFFIC-India		
Source/ link	**:**	www.traffic.org/forestry-reports/traffic_pub _forestry20.pdf		

Abstract:

This is the first market study of the valuable wood *Aquilaria malaccensis*, known in the trade as agarwood. The tree grows in the north-eastern states of India and in a number of countries of south-east Asia. The focus here is not on the timber that is yielded by the tree but on a brown, or very dark brown, pathological product formed by a fungal infestation of parts of the heartwood of certain trees of this species alone. It is this unique infested portion that contains a concentrated amount of oleoresin of high commercial value. In literature, as in trade, the words "agarwood" and "agar" are used interchangeably, causing confusion. Strictly speaking, "agarwood" is the uninfested timber of the species or the tree itself, and "agar" is the infested part of the wood. Yet, since the trade commonly uses either of the words without distinction, some of this confusion has inevitably crept into our report; however, the context makes clear whether the reference is to agarwood or agar. What is important to note is that the uninfested timber of this species has a poor commercial value, whereas agar is greatly coveted in trade circles. Here is a classic example of a natural resource, one that man has failed to duplicate so far, being extracted at unsustainable levels, thereby reducing the species to an endangered status—at least in India, The scarcity has led to a steady escalation in prices, but since the consumers can afford to pay the enhanced rate, unsustainable use continues recklessly. The efforts of state governments of north-eastern India to regulate the extraction have failed. Some state governments, therefore, decided to ban extraction altogether, but this step too has not succeeded in safeguarding the remaining trees against illegal felling. There is enough evidence to prove that the highly-prized Indian agarwood is, surreptitiously, still reaching consumers in the Middle East. Further, despite the ban on extraction, the distilleries in Assam are getting enough agar, partly from illegal extraction in India and partly by smuggling from Myanmar.

This, then, is the dilemma. If the government bans total utilisation of a product, the problem is merely swept under the carpet, forgotten, and the regulation of its use abandoned. On the other hand, a limited and controlled utilisation can obtain the cooperation of legal traders and bring about a control of the illegal trade. Such a paradigm has not so far worked in India; certainly it not worked in the trade in wild flora and fauna. There is altogether too much mistrust on all sides: the government is convinced of the malfeasance of the traders, and the traders know of innumerable ways of by-passing regulations. The government argues that when the import of African ivory was allowed with the purpose of reducing the pressure on Asian ivory, the traders continued to buy Indian ivory obtained from poached Asian elephants. Quite a number of legally-held 'African' ivory carvings in India are believed to be actually Indian ivory. The links between the people guilty of the killings, trapping, and extraction and the traders are so amorphous that, so far, no scheme of self-regulation seems workable.

The traders, driven quite naturally by personal profit, vie one with the other in gaining the last of the resource. The increasing scarcity of a precious resource is not a deterrent. In the short run, it could be an advantage: when the price soars, so does the profit margin per unit. Finally, when the resource runs out, the traders can easily switch to another resource or to a completely new business. Drawing up a strategy on these battle lines has not helped the survival of agarwood in India. It may prove beneficial to give some of the leading traders in agarwood limited harvesting rights in return for their traditional knowledge and their cooperation in curbing unsustainable extraction and in enhancement of the species. The distressing alternative is the extinction of agarwood in India, to begin with, and later in other south-eastern countries. Mankind would lose not only a mere item of perfumery, but would be deprived of both the key to a mystery of nature and a host of other current and potential uses of agarwood. Above all, the trade in agarwood shows that traditional knowledge passed down from one generation to another in this instance, worth more than $40 still has a marketable niche million annually.

Title	:	Local Gaharu Trade and Its Contribution to Household Economy of Harvesters		
Author	:	Lim Hin Fui, Mohd Parid Mamat & Chang Yu Shyun		
Types	:	Review	**Year :**	2010
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

This report examines the extent of local gaharu trade and how it contributes to the household economy of the harvesters. At the local level, the first level of trading of gaharu is done in the forest, in the village, at the jetty, in weekly market and in the nearby town. In some cases, the traders provide advances (food, cigarettes, petrol, cash) to the harvesters who are obliged to sell the gaharu wood to the traders. The local gaharu trade is generally on the decline over the years. In Kedah, Perak and Pahang, the number of traders fell from 51 in 1997 to 29 in 2008.

In 2007, a socio-economic survey was conducted on 138 harvesters, comprising 45 samples (33%) from Perak, 44 samples (32%) from Kelantan, 27 samples (19%) from Pahang and 22 samples (16%) from Terengganu. Average monthly household income of harvesters in the four states was RM752 in 2007. The average monthly household income received from gaharu was RM282 (38%) for harvesters in the four states. The contribution of gaharu to household income of harvesters was important in 2007.

Nevertheless, this monthly household income level was lower than that of RM187 5 for all rural households in Malaysia in 2004. In line with the goals of national development, it is important to have alternative employment (such as developing rubber and oil palm plantations) for the rural harvesters to eradicate poverty and to uplift their living standards in the long run.

Title	:	Wood For The Trees : A Review of The Agarwood (Gaharu) Trade in Malaysia		
Author	:	Lim Teck Wyn & Noorainie Awang Anak		
Types	:	Review	**Year :**	2010
Publisher	:	TRAFFIC Southeast Asia		
Source/ link	:	http://angkorfarm.org/files/documents/agarwood/ 10_wood_for_the_trees.pdf		

Abstract:

TRAFFIC has been monitoring the trade in agarwood since before the CITES listing (Chakrabarty et al., 1994). The TRAFFIC report Heart of the Matter (Barden et al., 2000) reviewed the state of knowledge of agarwood use and trade and CITES implementation for *Aquilaria malaccensis*. The report also provided individual country reports for the 10 countries known at that time to be either range States for *A. malaccensis* and hence likely to be engaged in harvest and trade in agarwood (Bangladesh, Bhutan, India, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand) as well as Viet Nam, a range state for *A. crassna* and possibly other species. Following concerns raised by Barden et al. (2000), the Conference of Parties to CITES decided that *A. malaccensis* warranted a formal "Review of Significant Trade" (*CITES Conf. 12.8*). TRAFFIC was contracted to carry out this research which reviewed the biological, trade and other relevant information on the species to identify problems and solutions concerning the implementation of CITES (Annex 2 of *CITES PC14 Doc. 9.2.2*).

The Review of Significant Trade came up with specific recommendations for a number of countries, including Malaysia, which were then further refined by the Plants Committee (*CITES PC14 WG 3.2 Doc1*) – including the need to hold a consultative workshop on agarwood trade, and establishing a cautious national quota for trade in agarwood. At the fifty-fourth meeting of the CITES Standing Committee at Geneva (Switzerland), 2-6 October 2006, it was reported that Malaysia had complied with most of the recommendations and steps had been taken to strengthen and improve the procedures for licensing the harvest of, trade in and processing of *Aquilaria spp.* However the CITES Secretariat had not been advised of the establishment of a cautious harvest and export quota for *A.malaccensis*. As

a result, the Secretariat proposed that the Standing Committee recommend that all Parties suspend trade in all specimens of *A. malaccensis* from Malaysia if Malaysia did not establish a cautious harvest and export quota (*SC54 Doc.42*). In response, the Malaysian delegation notified that it had established an export quota of 200 000 kg of powder and woodchips for 2007 (180,000kg for Peninsular Malaysia and Sabah and 20,000kg for Sarawak). However, there were concerns regarding the scientific basis for this quota and the Committee requested Malaysia to submit a report to the Secretariat explaining how it had established this quota, stating "If the Secretariat, after consulting with the Plants Committee, is not satisfied with the explanation, it will issue a Notification to the Parties recommending a suspension of trade in all specimens of *A.malaccensis* from Malaysia with effect from 1 January 2007" (*SC54 Sum. 8 (Rev. 1) (06/10/06)*). Subsequently on 7 December 2006 Malaysia submitted an explanation which was accepted by the Secretariat on 11 January 2007.

In support of Malaysia's response to the Review of Significant Trade and in furtherance of CITES decisions on the need for more research (*CITES Decision 12.71, 13.63*) TRAFFIC Southeast Asia was contracted by the CITES Secretariat to carry out further field research in the trade dynamics of agarwood in Malaysia, as a major agarwood exporter. This report documents the findings of this research, including the results of case studies carried out in the three administrative regions of the country: Peninsular Malaysia, Sabah and Sarawak.

Title	:	Notes on The Distribution and Ecology of *Aquilaria Lam.* (*Thymelaeaceae*) in Malaysia		
Author	:	Faridah-Hanum I, Mustapa MZ, Lepun P, Tuan Marina TI, Nazre M, Ribka Alan & Mohamed R		
Types	:	Review	**Year :**	2009
Publisher	:	No information		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Gaharu is the resin produced from trees of the genus *Aquilaria Lam.* In Malaysia, there are five species of *Aquilaria, viz. A. beccariana Van Tiegh, A. hirta Ridl., A. malaccensis Lam., A. microcarpa Baill.*and*A rostrata Ridl.* These species have been put by CITES in appendix II which regulates trade in species that could potentially lead to extinction. A study was undertaken to re-examine the distribution and ecology of the different *Aquilaria* species in Malaysia. Besides generating data from field trips, additional data were obtained from the Fourth National Forest Inventory of Peninsular Malaysia (NFI 4). A total of 232 specimens had also been studied from the herbaria at Universiti Kebangsaan Malaysia (UKMB), Singapore Botanic Gardens (SING), University of Malaya (KLU), Forest Research Institute of Malaysia (KEP), Sarawak Forestry Department (SAR) and Sabah Forestry Department (SAN). The distribution of *A. malaccensis* which supplies the largest bulk of gaharu being traded locally and internationally is widespread in our Malaysian forests except the state of Perlis. The remaining species can be found from the primary lowland forest up to an altitude of 825m a.s.l. in various habitats. Information obtained on the distribution and ecology of *Aquilaria* species in Malaysia will be valuable to the State Forestry Departments for the conservation and management of these resources in the wild and also plantations.

Title	**:**	CITES and The Conservation of Tree Species: The Case of *Aquilaria* in Indonesia		
Author	**:**	Newton Adrian C. & Soehartono Tonny		
Types	**:**	Review	**Year :**	2001
Publisher	**:**	No information		
Source/ link	**:**	Http://www.frim.gov.my/v1/Library/		

Abstract:

The Convention on International Trade in Endangered Species (CITES) provides a framework for the regulation of trade in species threatened as a result of international trade. *Aquilaria malaccensis Lamk* is one of the few tree species listed on CITES Appendix II, as a consequence of international trade in gaharu, a resinous wood product. Although inclusion of the species on CITES has improved information about the extent of the gaharu trade, listing has so far had little impact on its conservation status, as unsustainable harvesting and illegal exploitation are widespread. The reasons for the ineffectiveness of CITES in the case of *Aquilaria* are explored, by reference to trade data. It is suggested that for tree species such as *Aquilaria spp.,* research on population status, distribution and the impacts of harvesting is an essential prerequisite to the setting of meaningful harvest quotas, without which CITES will be ineffectual as a conservation tool.

Title	:	Microfungi Associated With Gaharu (*Aquilaria spp.*) From Indonesia		
Author	:	Rahayu, G., Isnaini, Y., Situmorang, J. & Umboh, M.I.J.		
Types	:	Review	**Year :**	1999
Publisher	:	No information		
Source/ link	:	http://agris.fao.org/agris-search/search.do?recordID=ID2002001230		

Abstract:

Some fungi have been known to be associated with gaharu from South Asia and Southeast Asia. In Indonesia, fungi such as *Fusarium* and *Papularia* have been reported to occur and induce gaharu formation in gaharu-tree (*Aquilaria spp.*) grown in Kalimantan and Lombok, respectively. Whilst, fungi associated with gaharu from Sumatra and Irian have not been known yet. So are the fungi associated with early symptom of gaharu formation, namely gaharu-eye, in naturally infected tree. Seven genera of fungi have been isolated from gaharu collected from Riau, Mataram, and Irian Jaya. *Acremonium* is recorded as most widely distributed fungi. *Diplodia, Fusarium, Libertella, Scytalidium*, and *Trichoderma* are only associated with gaharu from Riau, while *Thielaviopsis* was found only in gaharu-eye. Amongst all those, *Acremonium*, *Libertella*, *Scytalidium*, and *Thielaviopsis* are first recorded fungal genera associated with gaharu. The potential of this fungi to induce gaharu formation should be studied further

Title	:	The Gaharu Harvesting Method on Karas Trees (*Aquilaria malaccensis LAMK*) By Local Forest Community in Kutai District		
Author	:	Yusliansyah & Prabawa, S.B.		
Types	:	Review	**Year :**	1997
Publisher	:	No information		
Source/ link	:	http://agris.fao.org/agris-search/search/display.do?f=1999/ID/ID99001.xml;ID1999000414		

Abstract:

Gaharu is one of non timber forest products which has high economic value and can be found on karas trees (*Aquilaria malaccensis LAMK*). Usually the rural community around forest areas in Kutai Region, East Kalimantan use chopping method for harvesting gaharu. The method is not efficient because of wasting energy and time. Therefore, it is reasonable to study the method deeply and try to find new better method. Besides, it is recommended to make a standard of criteria or classification of gaharu qualities.

Title	**:**	Notes on Some Asiatic Species of *Aquilaria* (*Thymelaeaceae*)		
Author	**:**	Ding Hou		
Types	**:**	Review	**Year :**	1964
Publisher	**:**	Blumea 12(2):285–288		
Source/ link	**:**	http:// www.repository.naturalis.nl/		

Abstract:

In the course of my study of the *Thymelaeaceae* for the Flora Malesiana, it was surprising to find that the well known Asiatic species *Aquilaria agallocha Roxb*. is very similar to the *Malesian A. malaccensis Lamk,* and that the Chinese species *Ophiospermum sinense Lour*, was transferred to *Aquilaria* independently by Sprengel (1825), Gilg (1894), and Merrill (1920), with the specific epithet either '*chinensis*' or '*sinensis*'. In order to clarify the status and delimitation of the species concerned, the results of my investigations may follow here. Among the unnamed collections of Thailand *Thymelaeaceae* received for determination from the Kew Herbarium, two species of *Aquilaria* were found, a new one, *A. subintegra* Ding Hou, and a new record for the flora of that country, *A. crassna* Pierre ex H. Lec.

Title	:	Micropropagation of *Aquilaria malaccensis Lank.*and*Aquilaria microcarpa Baill.*		
Author	:	Zul Helmey Mohamad Sabdin, Sepiah Muid & Hamsawi Sani		
Types	:	Bulletin	**Year :**	2011
Publisher	:	No information		
Source/ link	:	http://www.frst.unimas.my/images/TAYMG/ResearchBulletin/frst%20bulletin%20vol%202%20oct2011_ver%202.0.pdf#page=3		

Abstract:

Aquilaria malaccensis Lamk., locally known as 'gaharu' or 'karas', is of economic importance as source of gaharu for cosmetic and medicinal purposes. Currently, the high value of gaharu stimulates illegal harvesting and as a result, *Aquilaria* trees are often cut down indiscriminately. Populations of this tree have declined and may lead to possible extinction in the near future. In addition to conserving the trees and ensuring sustainable supply of the gaharu, methods for propagation need to be developed. Tissue culture techniques would be beneficial in accelerating large-scale multiplication, improvement and conservation of these plants. The objective of this study is to develop an in vitro culture method for mass propagation of this species. In this study, shoot tip were cultured in modified MS medium with BAP at the concentrations rate 0, 0.25, 0.5, 1, 2 and 4 mg/l. The MS medium supplemented with 0.5 mg/L BAP was the most effective for multiple shoot formation in *A. malaccensis*, which is higher than other treatment. Both NAA and IBA were tested in the rooting experiments, IBA more effective in stimulate rooting. The highest rooting percentage was 80% in half MS medium containing 1.0 mg/L IBA for shoots derived from shoot tip. Rooted plantlets were acclimatized in potting mix consisted of peat, soil and sand (1:1:1). The plantlets showed 80% survival rate and good growth.

Title	:	Karakteristik Habitat Pohon Penghasil Gaharu Di Beberapa Hutan Tanaman Di Jawa Barat		
Author	:	Pratiwi, Erdy Santoso & Maman Turjaman		
Types	:	Bulletin	**Year :**	2010
Publisher	:	Info Hutan		
Source/ link	:	http://forda-mof.org/files/03_Pratiwi_klm_ok.pdf		

Abstract:

Penelitian ini bertujuan untuk mengetahui karakteristik habitat pohon penghasil gaharu di hutan tanaman untuk mendukung program pengembangan hutan tanaman pohon penghasil gaharu di Indonesia. Penelitian dilakukan di Carita (Banten), Dramaga (Bogor), dan Kampung Tugu (Sukabumi). Komponen habitat yang diamati meliputi: topografi, iklim, sifat-sifat fisik tanah, sifat-sifat kimia tanah, dan komposisi tumbuhan bawah yang ada di sekitar tanaman gaharu. Hasil penelitian ini menunjukkan bahwa gaharu dapat tumbuh dengan baik di areal dengan kelerengan datar sampai bergelombang, temperatur rendah sampai tinggi (20-32°C), dan curah hujan tinggi (> 1.500 mm/th), tekstur tanah berat (liat), drainase cepat, pH sekitar 4,5-5,1, kejenuhan basa dari sangat rendah sampai tinggi (1,2-78,8%), dan kandungan unsur-unsur toksik yang rendah. Jenis dominan dan ko-dominan dari tumbuhan bawah yang ditemui di Carita adalah jampang (*Panicum disachyum Linn.*) dan selaginela (*Selaginella plana Hiern.*) sedangkan di Dramaga adalah pakis (*Dictyopteris irregularis Presl.*) dan seserehan (*Piper aduncum Linn.*) serta di Kampung Tugu (*Sukabumi*) masing-masing jampang (*Panicum disachyum Linn.*) dan rumput pait (*Panicum barbatum Lamk*).

Title	:	Prospect of Gaharu Business Through Community Based Forest Management Model		
Author	:	Sri Suharti		
Types	:	Bulletin	**Year :**	2010
Publisher	:	No information		
Source/ link	:	http://www.forda-mof.org/files/04_Ni2k_klm_ok.pdf		

Abstract:

Agarwood is a fragrant resinous wood coming from trees belonging to the genera *Aquilaria*, *Gyrinops*, and *Gonystylus*. Due to habitat destruction and unsustainable harvesting many species of agarwood are nowadays potentially threatened to extinct. On the other hand, agarwood price tends to increase thas has induced cultivation of agarwood especially in South East Asia region. In Indonesia, agarwood has continued to become a very prospective business due to several supporting factors i.e its biological potency (wide variety of tree species producing agarwood are native to Indonesia), abundant suitable land for agarwood cultivation and technology for artificial induction is already available. Agarwood cultivation is feasible to be carried out based on financial analysis by using several criteria and could generate Net Present Value, Internal Rate of Return, and Benefit Cost Ratio of Rp 147.74 million/ha, 48.53%, and 3.32 respectively. However, since agarwood business is capital intensive, only few people with enough capital could afford this. In order to increase agarwood cultivation more widely, it is urged to develop a partnership model between capital owner and local community. One prospective partnership model that could be developed is Community Based Forest Management (CBFM). Through CBFM partnership model, it is expected that agarwood cultivation could be expanded widely, community income is significantly increased and people dependency toward forest could be decreased considerably. Main principles persist in agarwood cultivation by using CBFM partnership model are sustainable economic feasibility based on period of partnership contract, mutual advantage based on each contribution to achieve common social, economic and ecological objectives.

Title	:	*Aquilaria malacensis*		
Author	:	Syahida Emiza Suhaimi		
Types	:	Bulletin	**Year :**	2009
Publisher	:	Flora Peninsular Malaysia Online Newsletter, Volume 27/1, February 2009		
Source/ link	:	http://www.tfbc.frim.gov.my/Subscribe27.html		

Abstract:

Aquilaria malaccensis Lamk. is widely distributed throughout Malaysia, India, Myanmar, Sumatra, Singapore, Borneo and Philippines, and belongs to the family *Thymelaeaceae*. This species is locally known as karas and grows from lowlands to lower montane forest at altitudes to 750 m. *A. malacensis* is a highly valued forest tree species because of its resin-stained wood obtained from old and infected or diseased tree heartwood, called gaharu in Malay. A sweet fragrance is produced when the wood is burnt and it is therefore used as incense for ceremonial purposes in some religions. An essential oil that is distilled from a liquid extract of the wood has been used in luxury oriental perfumery. Karas is a medium to large tree up to 40 m tall and 60 cm in diameter. The bole is usually straight but sometimes fluted and the buttresses can reach up to 2 m tall. The bark is smooth and whitish grey in color. The leaves are usually elliptic oblong and broadly wedge-shaped at the base. The inflorescences are mainly axillary, usually branched with 2–3 umbels, with each umbel bearing about 10 flowers. The flowers are bell-shaped and tublar, about 5 mm long, coloured green, yellow or white. The flowers also produce an odour. Karas can be easily distinguished from other species in the genus by the size of its fruit. Karas fruit are larger, about 3–4 x 2.5 cm and very bluntly pear-shaped. Each fruit has only a single seed bearing a tail-like appendage. It takes 40 to 50 years for karas to mature enough to produce high quality gaharu. The rapid disappearance of karas from natural forests is an indication of the exorbitant price of gaharu on the international market.

Title	:	Propagation Techniques of Karas Plant (*Aquilaria malaccensis Lamk*) by Shoot Cutting		
Author	:	Yana Sumarna		
Types	:	Bulletin	**Year :**	2008
Publisher	:	Info Hutan Vol. V No. 1 : 79-87, 2008		
Source/ link	:	http://forda-mof.org/files/10_Yana_2_klm.pdf		

Abstract:

Increasing value of agarwood and its market demand at higher price has increased agarwood harvesting by falling the living tree. This condition made a strong call for conservation of karas (*Aquilaria malaccensis Lamk*) population, which has high commercial value. For the conservation effort and sustainable production to supply market demand, a plantation should be established. One important problem in plantation is seedling production. In order to solve the problem, vegetatively propagated seedling, which have similar genetic quality as its mother tree, and in the hight quality, need to be raised. Experiment on vegetative propagation of karas (*A. malaccensis*) were done using split plot design, with 4 kinds of media as treatmens (main plot). The media consists of : A (soil), B (soil + compost 1:1), C (soil + cocopit 1:1), and D (soil + compost + cocopit 1:1:1). The sub plot treatment was different dose of Rootone-F as root inducer, i.e : (a) 0 ppm, (b) 10 ppm, and (c) 20 ppm. Results showed that the effect of media and dose of hormone, and their interaction were significant on survival percentage of shoot cuttings. The best media for shoot cutting, which gave highest survival percentage was mixture of soil + compost organic (1:1). The optimum dose was 10 ppm. The optimum interaction between media and Rootone-F dose was combination of media cocopit + organic compost, with 10 ppm dose of Rootone-F.

Title	:	Teknik Perbanyakan Tumbuhan Karas (*Aquilaria malaccensis Lamk*) Dengan Stek Pucuk		
Author	:	Yana Sumarna		
Types	:	Bulletin	**Year :**	2008
Publisher	:	Info Hutan Vol. V No. 1 : 79-87, 2008		
Source/ link	:	http://forda-mof.org/files/10_Yana_2_klm.pdf		

Abstract:

Bertambahnya nilai guna gaharu dan meningkatnya permintaan pasar dengan harga jual yang semakin tinggi mendorong masyarakat untuk memburu produksi gaharu dengan cara menebang pohon hidup. Cara tersebut mengakibatkan populasi pohon dari jenis karas (*Aquilaria malaccensis Lamk*) yang tergolong sebagai tumbuhan penghasil bernilai komersial tinggi perlu dilestarikan. Upaya konservasi dan membina kelestarian produksi untuk mengantispasi permintaan pasar, dapat dilakukan melalui upaya pembudidayaan. Salah satu kendala dalam budidaya adalah upaya penyediaan bahan tanaman. Agar produksi gaharu dapat terbina sesuai harapan, bibit tanaman dikembangkan secara vegetatif, agar bibit memiliki nilai keunggulan kualitas dan kuantitas produksi sesuai sifat genetik pohon induknya. Percobaaan stek pucuk karas, yakni *A. malaccensis*, dilakukan menggunakan rancangan split plot. Sebagai perlakuan utama (main plot) adalah empat macam media yaitu (A) : tanah, (B) tanah + kompos (1:1); (C) tanah + cocopit (1:1), (D) tanah + kompos + cocopit (1:1:1), sedangkan tiga faktor perlakuan (sub plot) adalah dosis hormon perangsang akar rootone- F yaitu (a) 0 ppm, (b) 10 ppm, dan (c) 20 ppm. Sesuai hasil uji keragaman (Anova), menunjukkan bahwa pengaruh media, hormon, dan interaksi kedua perlakuan berpengaruh sangat nyata terhadap persen tumbuh stek pucuk pohon karas (*A. malaccensis*). Perlakuan media terbaik dalam menghasilkan persen tumbuh stek adalah media perlakuan B : campuran tanah + kompos organik (1 : 1), sedang dosis rootone- F yang optimal ditunjukan oleh perlakuan (b) : 10 ppm. Interaksi kedua perlakuan optimal ditunjukkan oleh kombinasi jenis media tanah dengan cocopit dan kompos organik dengan dosis 10 ppm hormon rootone- F.

Title	:	Agarwood: The Life of A Wounded Tree		
Author	:	Gerard A. Persoon		
Types	:	Bulletin	**Year :**	2007
Publisher	:	IIAS Newsletter # 45 Autumn 2007		
Source/ link	:	https://openaccess.leidenuniv.nl/bitstream/handle/1887/12820/iias_nl45_2425.pdf?sequence=1		

Abstract:

Agarwood is the infected wood of the *Aquilaria* tree. Called 'the wood of the Gods', its uses range from incense for religious ceremonies, perfume for the Arabic world, medicinal wine in Korea and ornamental functions in China. As a healthy tree the *Aquilaria* is worth next to nothing, but wounded its defence mechanisms produce agarwood and the tree becomes a valuable commodity. Gerard Persoon goes in search of the natural and social life of a wounded tree.

Title	:	Studies on The Agarwood (Jinko) I – Structures of 2-(2-Phenylethyl) Chromone Derivatives		
Author	:	Yasuo Shimada, Tominaga, T., Tenji Konishi & Shiu Kiyosawa		
Types	:	Bulletin	**Year :**	1982
Publisher	:	Chem. Pharm. Bull. 30 (10) 3791-3795.		
Source/ link	:	No information		

Abstract:

The structures of two compounds, AH1 and AH2, isolated from agalwood "Jinko" were studied. AH1 was obtained as needles having a melting point different from that of agarotetrol (powder) isolated and characterized by Yoshii et al. However, the carbon-13 nuclear magnetic resonance (13C-NMR) data and [α]D values of the two compounds were identical, and AH1 was concluded to have the same structure, including stereochemistry, as agarotetrol. The half-chair conformation of the hexenyl ring moiety assumed by Yoshii et al. was confirmed by detailed analyses of the proton nuclear magnetic resonance (1H-NMR) and 2D-COSY spectra.AH2 was assigned the structure (5S, 6R, 7R, 8S)-2-(2-phenylethyl)-5e', 6e, 7e, 8'e-tetrahydroxy-5, 6, 7, 8-tetrahydrochromone, a stereo-isomer of agarotetrol (7S, 8R), on the basis of the 1H-NMR, X-ray analysis and circular dichroism (CD) spectral data. It was named isoagarotetrol. The hexenyl ring moiety of isoagarotetrol was found to have a half-chair conformation identical to that of agarotetrol in the crystalline state as well as in solution.

Title	:	Karakteristik dan Cara Pengendalian Hama Ulat Pada Tanaman Penghasil Gaharu		
Author	:	Fajar Lestari, Beny Rahmanto & Edi Suryanto		
Types	:	Books	**Year :**	2013
Publisher	:	No information		
Source/ link	:	http://www.forda-mof.org/index.php/content/publikasi/post/228		

Abstract:

Bau harum yang dihasilkan resin gaharu pada saat dibakar mampu menempatkan gaharu sebagai komoditas hasil hutan bukan kayu (HHBK) yang bernilai ekonomi tinggi. Pemanfaatan tersebut pada dasarnya telah berlangsung cukup lama bahkan ratusan tahun yang lalu baik oleh kalangan elit kerajaan maupun masyarakat sebagai dupa dalam pelaksanaan upacara keagamaan, pengharum tubuh dan ruangan, bahan kosmetik dan obat – obatan sederhana (Irianto et al., 2010). Bertahun–tahun masyarakat melakukan pemungutan/ pengambilan gaharu tentu saja mengakibatkan penurunan populasinya di alam. Kegiatan eksploitasi jenis – jenis tanaman penghasil gaharu tanpa diiringi upaya pelestarian, penyebabkan tanaman tersebut masuk dalam Appendix II CITES dan ditetapkan sebagai salah satu jenis tanaman yang terancam punah serta melarang dan membatasi pemungutan gaharu alam. Oleh sebab itu tanaman penghasil gaharu saat ini memperoleh prioritas dalam pengembangannya selain Rotan, Bambu, Madu Lebah dan Sutera (Anonim, 2012). Dalam rangka mendukung kegiatan tersebut Kementrian Kehutanan mensosialisasikan gerakanan penanaman tanaman gaharu dan mendapatkan respon serta antusiasme yang cukup tinggi dari masyarakat. Masyarakat menanam gaharu disela – sela tanaman karet maupun secara monokultur, sehingga dalam perkembangannya beberapa permasalahan mulai bermunculan salah satunya adanya serangan hama. Berdasarkan hasil monitoring dan inventarisasi hama yang dianggap paling serius menyerang berasal dari jenis rama – rama yaitu jenis *Heortiavitessoides* dan *Pitama hermesalis* (*lepidoptera*). Hama ini menyerang pada stadia larva dengan memakan daging daun serta pucuk – pucuk muda tanaman. Akibat serangan ulat ini beberapa tanaman dilaporkan menjadi gundul dan mati.

Title	**:**	Rahsia Dan Keunikan Gaharu		
Author	**:**	Fatmawati Adam, Saiful Nizam Tajuddin & Joharizal Johari		
Types	**:**	Books	**Year :**	20
Publisher	**:**	Penerbit Universiti Malaysia Pahang		
Source/ link	**:**	http://equip.mtib.gov.my/elmu-mtib/index.jsp?module=webopac-d&action=fullDisplayRetriever.jsp		

Abstract:

Malaysia merupakan salah sebuah negara pengeksport komoditi Gaharu yang terpenting di Asia. Gaharu, khasnya *AquilariaMalaccensis*, adalah tergolong dalam genus *Aqularia* (*Thymelaeaceae*) yang begitu sinonim dikenali sabagai karas dalam kalangan masyarakat di Malaysia.

Title	**:**	Fragrant Wood Gaharu: When The Wild Can No Longer Provide		
Author	**:**	Irnayuli R. Sitepu, Erdy Santoso, Sulistyo A. Siran & Maman Turjaman		
Types	**:**	Books	**Year :**	2011
Publisher	**:**	Indonesia's Work Programme for 2011 ITTO PD425/06 Rev.1 (I)		
Source/ link	**:**	http://www.forda-mof.org/files/FRAGRANT%20WOOD%20GAHARU.pdf		

Abstract:

The objective of this book is to give thorough information concerned with gaharu, and summarize the findings of the state-of-the-art research on gaharu (project: "Production and Utilization Technology for Sustainable Development of Eaglewood (Gaharu) in Indonesia"). A key message of this book is to stimulate an understanding that the future of gaharu relies solely on sustainable production of gaharu and habitat conservation, and that technology intervention plays a major role in the process.

Title	**:**	Tapping The Wealth From Karas (*AquilariaMalaccensis*) Tree		
Author	**:**	Abdul Rashid Abdul Malek & Ahmad Zuhaidi Yahya		
Types	**:**	Books	**Year :**	2011
Publisher	**:**	No information		
Source/ link	**:**	Forest Research Institute Malaysia (FRIM)		

Abstract:

This book covers comprehensive information from the historical background on the beginning of gaharu utilization and the conservation status, botanical and ecological characteristics of the species, procurement, seed handling, planting materials production and nursery practices.

Title	:	Professorial Lecture : Enhancing The World of Fragrance Through Malaysian Bio-Gaharu		
Author	:	Ku Halim Ku Hamid		
Types	:	Books	**Year :**	2011
Publisher	:	No information		
Source/ link	:	http://penerbit.uitm.edu.my/		

Abstract:

Gaharu is scientifically known as *Aqularia* and well known as Agarwood. Sometime it is called as Wood of the Gods. It is used as a raw material for incense, perfumes or fragrant and even alternative medicine. It is believe that the aromatic product of the tree is one of the most expensive in the World. There are few hadith that encourage Muslim to use Gaharu products in certain cases, including medicinal practices; and most of religions in the world are using Gaharu in their ceremony. Wild *Aquilaria* trees normally found in Malaysia and grow randomly and scatter in forest through natural seeding process. *Aquilariamalaccensis* is one the species that produce high quality of products, grow in various habitats, including those that are rocky, sandy or calcareous, well-drained slopes ridges and near swamps. Since wild Gaharu trees have been chopped for the resinous stems, there are efforts have been carried out to develop Gaharu farm in Southeast Asia countries and India. Integrated farming normally practices by combining with many types of commercial plants, where Gaharu seeding by tissue culture technique is getting popular in order to quicken the plantation activities. Gaharu product from plantation is harvested by using inoculation or inducement process, it is an artificial technique in producing of agar or resin in Gaharu trees. The method is accomplished by developing of wound. chemically, biologically or physically into xylem part of the trees stem. In Malaysia, most of inoculation process is performed by using imported inoculants from neighbor countries and mainly are chemical based, usually require 8 to 12 months to produce quality agar or resin in the trees.

Title	:	Growing 'The Wood of The Gods': Agarwood Production in Southeast Asia		
Author	:	G. A. Persoon & H. Heuveling van Beek		
Types	:	Books	**Year :**	2008
Publisher	:	Springer		
Source/ link	:	http://link.springer.com/chapter/10.1007%2F978-1-4020-8261-0_12#page-1		

Abstract:

Agarwood, also known as eaglewood or gaharu, is a valuable non-timber forest product which sometimes grows in *Aquilaria* species. The genus species occur mainly in South and Southeast Asia. As a result of a defense mechanism to fend off pathogenes, *Aquilaria* species develop agarwood which can be used for incense, perfume, and traditional medicines. The main markets for these products are in South and East Asia and the Middle East. The high prices demanded for agarwood has led to the rapid depletion of *Aquilaria* trees in natural forests. The search for agarwood has spread from one country to another. At present Indonesia and Papua New Guinea are the main supplies. Because of the rapid depletion of the agarwood in the wild, the species was put on the CITES Appendix II as endangered. Efforts have been undertaken to increase the production of the infected wood by deliberately wounding the trees. A variety of methods is used towards this end. Some recently developed techniques have proven to be most effective. This resulted in planting of *Aquilaria* trees by small holders as well as large industrial size plantations. In this chapter we shall discuss a particular agarwood project in Vietnam and some other locations elsewhere promoting growing of *Aquilaria* trees among small holders. The general approach of the project to stimulate the growing of the trees among local communities will be discussed against the background of the international demand for this highly valuable non-timber forest product. Finally some potential developments of the future will be described.

Title	:	Heart of The Matter Agarwood Use and Trade and CITES Implementation for *Aquilaria*		
Author	:	Barden, Angela		
Types	:	Books	**Year :**	2000
Publisher	:	No information		
Source/ link	:	Jabatan Perhutanan Semenanjung Malaysia (JPSMJ Library		

Abstract:

Agarwood, eaglewood, gaharu, aloeswood - these are just a few of the names for the resinous, fragrant and highly valuable heartwood produced by *Aquilaria malaccensis* and other species of the Indomalesian tree genus *Aquilaria*. The wealth of names for this dark and heavy wood (its Chinese name literally means 'wood that sinks') reflects its widespread and varied use over thousands of years. Agarwood's use as a medicinal product has been recorded in the Sahih Muslim, which dates back to approximately the eighth century, and in the Ayurvedic medicinal text the Susruta Samhita. Its use as a perfume has been recorded in the Old Testament. These and other uses continue today. Agarwood is used in Ayurvedic, Tibetan and traditional East Asian medical practices. Both agarwood oil and incense are used for their fragrant properties, notably in the Middle East. Agarwood incense is used in religious ceremonies by Buddhists, Hindus and Muslims, while a revival of the 'Koh doh' incense ceremony in Japan has rekindled interest in agarwood in that country. In Taiwan, agarwood is an aromatic ingredient in Chu-yeh Chingand Vo Ka Py wine. Although less common, agarwood may also be carved into sculptures, beads and boxes, these sometimes also being used for religious purposes. Accounts of international trade in agarwood date back as early as the thirteenth century, India being one of the earliest sources of agarwood for foreign markets. Agarwood is currently traded in large quantities. Over 700 t of agarwood from*Aquilariamalaccensis* were reported in international trade in 1997, with exports from Indonesia and Malaysia taking the lead among approximately 20 reported countries of export/re-export. Although overall trade volumes may appear small in 'timber trade' terms, they are not small in monetary terms. Agarwood chips and segments may sell for several hundred to several thousand US dollars per kilogramme. The price of oil

distilled from agarwood is generally between five and ten thousand US dollars per kilogramme, but can be significantly more for agarwood oil of exceptionally high quality. Unfortunately, the demand for agarwood currently far exceeds the available supply, which is naturally restricted owing to the nature of its formation - agarwood is only found in a small percentage of *Aquilaria* trees of those species known to produce it. Although research into the origins of agarwood are ongoing, it appears that the fragrant resin that permeates the heartwood of some *Aquilaria* trees is produced as a response to wounding and/or a fungal infection. It is this resinous wood, or 'agarwood', that is sought, the non-impregnated wood being considered too soft to be useful for construction. Agarwood is harvested by felling and then splitting trees open. External signs of the presence of agarwood are not always obvious. As a result, *Aquilaria* trees are often cut down indiscriminately in the search for those containing agarwood. The high value of agarwood products is also stimulating illegal harvest and trade in several range countries. Populations of eight *Aquilaria* species have already declined to the point where they are considered threatened according to IUCN Red List Categories. Of these, six species are considered at risk from overexploitation for agarwood. In view of evidence of unsustainable harvest and trade, inter-governmental action has been taken to bring the international trade in one of these species, *Aquilariamalaccensis*, within sustainable levels. *A. malaccensis* was listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) with effect from February 1995. This listing obliges all CITES member countries exporting or re-exporting *A. malaccensis* parts and derivatives (e.g. wood, chips, oil) to issue CITES documents for those shipments exported. In the case of exports from range States, the Convention stipulates that such permits should only be issued once the exporting government has confirmed that the agarwood to be exported was obtained both legally and in a manner not detrimental to the survival of the species. The CITES Plants Committee considered it a priority to review the implementation of the CITES listing for *Aquilaria malaccensis* during the 1998-2000 triennium. TRAFFIC was contracted by the CITES Secretariat to undertake such a review in 1998. TRAFFIC's research initially focused specifically on CITES implementation. However, as several different *Aquilaria* species are in trade and agarwood is extremely difficult to identify to the species level, TRAFFIC's research was broadened to encompass a more general review of agarwood use and trade. Information was gathered through interviews with government authorities, other agarwood researchers and traders; compilation and analysis of CITES and

Customs trade data; and a review of available legislation and literature. Market surveys and visits to harvest sites and processing centres were undertaken in several countries. The results of TRAFFIC's research are reported in the TRAFFIC Network report Heart of the Matter:Agarwood Use and Trade and CITES Implementation for *Aquilaria malaccensis*.

Title	:	*Heortia vitessoides*, an Agarwood (Karas) Defoliator		
Author	:	SP Ong et al.		
Types	:	Books	**Year :**	No information
Publisher	:	No information		
Source/ link	:	Forest Research Institute Malaysia (FRIM)		

Abstract:

One of the main insect pests of *Aquilaria* trees is the moth *Heortiavitessoides*. This paper provides information on the distribution, damage, life cycle and control of the moth.

Title	:	Karakteristik Usaha Gaharu Alam (*Aquilaria malaccensis*) Di Provinsi Bengkulu: Studi Kasus Kabupaten Bengkulu Selatan, Kabupaten Kaur, Dan Kabupaten Seluma		
Author	:	Maryani, Dwi		
Types	:	Thesis (PhD)	**Year :**	2011
Publisher	:	Departemen Manajemen Hutan, Fakultas Kehutanan, Institut Pertanian Bogor		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/47819		

Abstract:

Forest is a natural resource that can be used for the people walfare. One of forest product which has potential to be used is resin agarwood. Gaharu has high sold price with production qualification that consist of gubal, kemedangan and ash. Each of product containsOleo Chromone which are produce unique aroma, so that it often used in many industries such as parfum industry, cosmetic industry and religion ritual need. High demand of agarwood cause the demand of it increase more, so that influence to the decrease more, but the agarwood exertion process still do so that it is important to do investigation of natural agarwood characteristics nowdays. This Research aims to know the characteristic of the natural agarwood exertion in Bengkulu Province, that consist of the characteristic of agarwoodenterprenuer (finder small, collector seller and big collector seller), the process of agarwood exertion, kinds and quality characteristic, marketing system and also policy in agarwood exertion. The methodology of this research is qualitative by describing the characteristic of natural agarwood exertion and quantitative by counting the margin of profit. There are three groups of gaharuenterprenuer namely: agarwood finder, small collector and big collector. The group of agarwood finders do the gaharu exertion. On the process of agarwood exertion need the specific skill about the characteristic of tree that contain agarwood. The products then sell to collector seller of agarwoodthrough its selling channel. The selling of agarwood begun by determining the condition and price, where there are seven agreed quality. This quality class is so determining the price, better quality of agarwood higher the price and lower quality of agarwood lower

the price. The differences of price from each quality of agarwood can reach 3-15 times from the increasing each quality. Enterprenuer have role in determining namely big collector seller so that margin of highest price gotten by them is 1,4-2 multiple times with their income that they gottetn 28 times from income of agarwood finders group. In order to manage marketing of agarwood, government determines policy in the form of quota in a year, the license that is given to big collector seller in 5 year and the rate of dues determined based on gubal class Rp 20.000,-/kg and kemedanganRp 2.000,-/kg.

Title	:	Pengaruh Beberapa Media Tanam Terhadap Pertumbuhan Tanaman Gaharu (*Aquilaria beccariana van Tiegh.*)		
Author	:	Karyantara, Iteng Dayana		
Types	:	Thesis (PhD)	**Year :**	2009
Publisher	:	Departemen Manajemen Hutan, Fakultas Kehutanan, Institut Pertanian Bogor		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/20743		

Abstract:

Gaharu merupakan salah satu komoditas hasil hutan bukan kayu yang mempunyai peranan penting dalam peningkatan devisa negara. Saat ini tidak kurang 17 (tujuh belas) jenis tumbuhan yang dapat menghasilkan gaharu diantaranya adalah *Aquilaria beccariana*. Meningkatnya permintaan pasar dan harga jual gaharu yang cukup tinggi, menyebabkan usaha pencarian gaharu oleh masyarakat di hutan alam meningkat terlebih masyarakat tersebut lebih banyak yang salah tebang. Cara pemungutan seperti ini berdampak terancamnya kelestarian gaharu, tidak diimbangi dengan pembudidayaan dengan baik.

Title	**:**	Marketing of agarwood (*Aquilaria spp.*) oil in Thailand		
Author	**:**	Seri Nanta		
Types	**:**	Thesis (PhD)	**Year :**	2008
Publisher	**:**	Graduate School of Kasetsart University, Bangkok, Thailand		
Source/ link	**:**	https://www.academia.edu/3349053/ Marketing_of_agarwood_Aquilaria_spp._oil_in_Thailand		

Abstract:

Agarwood is an economical forest product of Thailand. It plays an important role in Thai economy because it is the principle raw material for agaroil production, this will create the agaroil industry to be a source of employment. In 1966, there were 8 agaroil factories in the whole country and this increased to 49 factories in 2006, and they distributed in the Central, North and South region in number of 43, 4 and 2 respectively (Industrial Factory Department, 2007). Moreover the price of agaroil that is the product of agaroil factory was quite high, it was 200,000 Baht/ litre (Siripattanadilok, 1982; Manimuang and Niranpakorn, 1999). However, there was no problem about the market for absorbing all of the produced agaroil, and almost all of the agaroil production was exported to the rest of the world which could earn a lot of foreign currencies in each year.

It is recognized that marketing system is very important for Thai economy development because it comprises a various relevant enterprises starting from plantation, timber transportation, agaroil integrated factories, retail, wholesale, exportation and importation of agarwood and agaroil. In addition, agaroil is multipurpose product, it could be used in many different forms such as medicine and cosmetic, this will create more source of employment in such integrated enterprise which used agaroil as their raw material as well as the ones who come to engaged in the relevant marketing activities of each enterprises, this will generate much more income to distribute in the Thai economy.

Nowadays agarwood shortage was become severe problem of agaroil industry and most of agarwood using for agaroil production was imported from the neighboring country, this loss a lot of foreign currencies in each

year. In order to mitigate this problem the agarwood plantation has been established, however the area of existing agarwood plantation is still less. In 1992 there was only about 1,000 rai of agarwood plantation in the country (Chaiwongkiat, 1994). Moreover, the information about the total demand for agarwood at full capacity, the quantity of available agarwood, and the quantity of agarwood shortage of the agaroil industry, sources of agarwood, agarwood and agaroil price, cost and benefits from agaroil production as well as the marketing system of agaroil were not available. Thus, in order to ensure the ones who were interested in the investment of agarwood plantation and agaroil distillation factories as well as the integrated agaroil industries to have the rational decision making, as well as the related agencies that govern such enterprise to have the necessary information for formulating the development plan for agaroil industry of Thailand. Thus, the study on the marketing of agaroil in Thailand will be needed.

The study was emphasized to determine the marketing system of agaroil in Thailand, this including in market structure, market conduct, market performance and marketing channel.

Title	:	Kajian Sterilisasi, Induksi, dan Elongasi Tunas Gaharu (*Aquilaria spp.*) Secara In Vitro		
Author	:	Wardoyo, Teguh		
Types	:	Thesis (PhD)	**Year :**	2004
Publisher	:	Departemen Manajemen Hutan, Fakultas Kehutanan, Institut Pertanian Bogor		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/20743		

Abstract:

Gaharu merupakan produk yang bernilai ekonomi tinggi. Eksploitasi besar-besaran menyebabkan *A. malaccensis* menjadi langka. Daya berbunga dan berbuah yang rendah menyebabkan tanaman ini sulit dikembangkan dengan cara generatif sedangkan pembiakan dengan cangkok dan stek membutuhkan bahan induk yang banyak. Kullur jaringan dapat dijadikan alternatif perbanyakan tanaman gaharu dengan cepat. Karena *A. malaceensis* mcmpunyai pertumbuhan lambat dan terbatasnya sumber eksplan jenis ini untuk mendapatkan klon baru, maka untuk sterilisasi dan induksi tunas digunakan *A. crassna* yang memiliki pertumbuhan cepat. Penelitian ini bertujuan untuk mengetahui pengaruh variasi klon *A. crassna* terhadap persentase hidup, jumlah tunas, persentase bertunas, dan waktu bertunas serta mengetahui pengaruh klon, media tumbuh serta interaksi keduanya terhadap pertambahan tinggi planlet *A. malaccensis*.

Title	:	Kajian Corak Regenerasi Lima Spesies Munculan Di Kawasan Hutan Paya Gambut, Pahang		
Author	:	Nurul Huda Hamzah		
Types	:	Thesis (PhD)	**Year :**	2003
Publisher	:	Universiti Kebangsaan Malaysia		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

This study attempts to assess the regeneration patterns of five taxa, nemely *Koompassia malaccensis* (Kempas), *Durio carinatus* (Durian), *Gonystylus bancanus* (Ramin), *Shorea platycarpa* (Meranti) and *Diallium indum var. indum* (Keranji) within a 5 ha study area in a peat swamp forest. The aims were to determine the distribution patterns and performance of seedlings in relation to their mother trees (ò 20 cm dbh), and the effect of habitat variation, in term of water availability. The methodology involved random selection of taxa and individuals around mother trees which were identified, measured, and mapped within the circular plot of 40 m radius where the mother tree was the center point of the plot. The plot was divided into 4 subplots with 10 m interval. For Linear Regression analysis and Polynomial Regression analysis pruposes, the plot was divided into 40 subplots with 1 m interval and for spatial distribution analysis it was divided into 64 subplots. Spatial distribution analysis was made and Index of Dispersion calculated were statitically compared with Poisson Distribution. The distribution of seedlings in different size structure (10 cm - 200 cm height) was categorized according to 20 classes at (10 cm class interval). The results indicated that 1993 seedlings were present around 50 adult trees (251 327.4 m^2 or 25 ha). Good regeneration of Keranji was represented by the greatest frequencies of 1083 seedldings while Meranti showed poor regeneration with the lowest frequencies of 70 seedlings. Keranji seedlings were found to have the highest mean density (215.46 ha^{-1}) while Meranti seedlings showed the lowest mean density (13.95 ha^{-1}). Linear Regression analysis showed that the densities of seedlings were correlated with the decrease of frequencies. Polynomial Regression Analysis showed that the mean density of Durian, Ramin and Keranji seedlings were highly concentrated in the vicinity of adult trees. In

contrast, the mean densities of Kempas and Meranti seedlings were dispersed out of vicinity of adults trees. These patterns suggested that limited seed dispersal for Durian, Ramin and Keranji had occured while those for Kempas and Meranti were widely dispersed by wind dispersal. Variation within population structure suggested the recruitment of seedlings may have occurred frequently and the numbers of seedlings rogressively decline to the larger size classes. Spatial Distribution analysis showed that seedlings were distributed either in clump or random patterns. The mean relative growth rate of young seedlings was highest in Kempas (0.77 cm cm^{-1} $year^{-1}$) followed by Meranti (0.66 cm cm^{-1} $year^{-1}$), Durian (0.64 cm cm^{-1} $year^{-1}$), Ramin (0.56 cm cm^{-1} $year^{-1}$) and Keranji (0.47 cm cm^{-1} $year^{-1}$). The mean realtive survival rate were between the range 0.52 $year^{-1}$ to 0.22 $year^{-1}$). The variation in water table level may have not a significant effect in relative mortality and growth rate, relative mortality rate and relative survival rate suggested the importance of a follow-up ecological studies. It is also important to examine the mechanistic basis such as water table and soil humidity that underline an relationship established within the fragile ecosystem such as peat swamp forest.

Title	:	Mikroperambatan *Shorea leprosula Miq.*dan*Aquilaria malaccensis Lamk.*		
Author	:	Nor Asmah Hassan		
Types	:	Thesis (PhD)	**Year :**	2000
Publisher	:	Universiti Kebangsaan Malaysia		
Source/ link	:	Http://www.frim.gov.my/v1/Library/		

Abstract:

Micropropagation studies were carried out on *Shorea leprosula* (meranti tembaga) and *Aquilaria malaccensis* (karas). For *S. leprosula*, shoot explants from 1 year old saplings; and shoot and cotyledonary node sections of in vitro seedlings were used. For *A. malaccensis*, shoot explants of in vitro seedlings were utilised. Explants from *S. leprosula* were cultured on Woody Plant Medium (WPM) while explants from *A. malaccensis*, were culture on Gresshoff & Doy (GD) medium. Explants from in vivo saplings of *S. leprosula* were used in the sterilization studies using boric acid (1 %), benlate (0.1%), streptomycin (200 mg/l) as pretreatment. The explants were then surface sterilized with ethanol (70%) and hypochlorite solution (40 percent). To avoid browning, the explants were soaked with antioxidants i.e. ascorbic acid (150 mg/l) or polyvinylpyrrolidone, PVP (0.7 percent) that were mixed with sucrose (2%). Despite the variety of sterilization techniques used, high percentage of browning and contamination occured. Mature *S. leprosula* seeds were sterilized with distilled water and Tween 20, soaked in benlate (0.1%) and washed with hypochlorite solution (50 %). They were then cultured on medium supplemented with various plant growth regulators for example 6-benzylaminopurine (BAP), kinetin (Kin) and 2,4-dichlorophenoxyacetic acid (2,4-D). The in vitro germinated seedlings were then used as the source of shoots and cotyledonary nodes for the multiplication study. In the multiplication study of both explants, multiplication study. In the multiplication study of both explants, multiplication of 0.44-2.2 shoot/explant/4 weeks was observed on 6-benzylaminopurine treatment with the concentration of 0-10.0 æM where the cotyledonary nodes gave the best overall shoot number (1.24 shoots) compared to the shoot explants. For the multiplication study using in vitro shoot explants, the

highest total number of shoots (3.20 shoots/explant/4 weeks) was obtained on 2.2 æM 6-benzylaminopurine whereas no response was observed with kinetin treatment. The highest elongation (11.50 mm) of in vitro *S. leprosula* shoots was obtained with the combination of 4.4 æM BAP and 0.29 æM gibberellin (GA3). Seed of *A. malaccensis* were germinated in vitro. The shoot sections of the in vitro seedlings were used as the source of explants for the multiplication and rooting studies. Highest multiplication rate (6.50 shoots/explant/4 weeks) was observed on GD medium supplemented with 0.1 æM 6-benzylaminopurine. A rooting percentage of 55.4 percent and a high number of roots (8.67 roots/shoot/7 weeks) were successfully obtained in vitro on a combined solid and liquid medium supplemented with 10 æM 3-indolebutyric acid. In vivo rooting using two types of commercial rooting power either Seradix 3 or Seradix 2 and three types of potting medium i.e. vermiculite, perlite and soil-sand (2:1), gave 2.00-29.50 percent rooting but indicate no significant difference between all the treatments used.

Title	:	Non-Detriment-Findings in CITES - *Thymelaeaceae*		
Author	:	Martin Rose		
Types	:	Thesis (Master)	**Year :**	2013
Publisher	:	University of Vienn		
Source/ link	:	http://othes.univie.ac.at/26827/		

Abstract:

Based on CITES and the Council Regulation (EG) No. 338/97 Non-Detriment-Findings (NDFs) are required for species in Annex II and accordingly Annex B in the EU for import or export. This survey was conducted for the listed genera of the family *Thymelaeaceae*. The genera *Aquilaria* and *Gyrinops* were included completely, while only the eleven species which have an economic value of the genus *Gonystylus* were considered. The evaluation sys-tem by Rosser and Haywood (2002) was used with little changes. *Aquilaria* and *Gyrinops* face different trade dynamics compared to other tropical wood. The main reasons are the great value of this non-timber forest product and the non-homogeneous character of the product. *Aquilariamalaccensis* used to be the most traded species, but has now been replaced by *A. filaria*. Legal frameworks for the protection of these species exist, but fail due to a lack of enforcement. A de facto open access combined with deficient re-sources for accurate monitoring result in great illegal trade. The deficiency is increased by a lack of information on several species, especially within the genus *Gyrinops*. Identifying the tree on species level is possible but the problem of determining which species are used for the products in trade remains. The current genus-based trade control bears the risk of extinction of certain species, especially *A. rostrata*. The promoted harvest of plantations could reduce the price and decrease the pressure on wild populations. Price reduction is important to fight the illegal harvest, because currently there is great profit with low risks. For the genus *Gonystylus* the premise is similar. The existence of a good legal framework is undermined by a great illegal harvest and trade. Good quality information on Gonystylus is available but often focusses only on *G. bancanus*. The legal and certified trade with selective and impact-reduced methods is qualified to reduce the negative impacts of the harvest. The EU aims for an enforced control of the illegal trade through the EUTR which will change the tropical wood market.

Title	:	Molecular DNA Studies of Three Aquilaria Species in Malaysia		
Author	:	Lee Shiou Yih		
Types	:	Thesis (Master)	**Year :**	2011
Publisher	:	School of Graduate Studies, Universiti Putra Malaysia		
Source/ link	:	http://psasir.upm.edu.my/27862/		

Abstract:

There are five *Aquilaria* species reported from Malaysia: *A. beccarania, A. hirta, A. malaccensis, A. microcarpa* and *A. rostrata*. Although *A. malaccensis* is the most well-known gaharu-producing species which supplies bulk trades domestically and internationally, its genetic information is lacking. Establishment of *Aquilaria* plantation and sustainable gaharu production can be seen as an effort to diversify the gaharu industry without threatening the conservation effort in nature. Hence, the understanding of genetic diversity and variation of the different species is essential for the establishment of effective conservation practices for *Aquilaria* species in Malaysia. In this study, Random Amplified Polymorphic DNA (RAPD) markers were used to measure genetic diversity of *A. hirta, A. malaccensis* and an incomplete known species, *Aquilaria sp.1*. Initially, 60 RAPD primers were analyzed, yielding 23 RAPD showing clear and reproducible polymorphism results. A total of 368 bands were scored. Multi-populations Descriptive Statistics revealed that 333 (90.49%) polymorphic bands were found at species level: *A. malaccensis* had 107 (29.08%)bands, *A. hirta* had 56 (15.22%), and *Aquilaria sp.1* had 11 (2.99%), for the percentage of polymorphic loci in a species. Nei's unbiased measurement indicates moderate similarities among species in this study. Out of the 23 RAPD primers,OPA02, OPA08 and OPB06 were found specific to *A. hirta*, OPA05 to *Aquilaria sp.1,* and OPA09 to *A. malaccensis*. PCR amplicons were cloned and sequenced to develop highly specific primers. Based on the sequence information, Sequence Characterized Amplified Region (SCAR) primers were designed. In *Aquilaria sp.1*, the SCAR marker OPA05AS yielded a 637 bp band. In *A. hirta*, OPA02AH yielded a 955 bp band, a SCAR marker named OPA08AH yielded a 866 bp band, and OPB06AH yielded a 826 bp

band. In *A. malaccensis*, OPA09AM yielded a 566 bp band. These results showed successful detection in genetic variation among *Aquilaria* species in Malaysia using RAPD markers. SCAR markers were also successfully developed to help in distinguishing these three *Aquilaria* species. In classical identification, reproductive parts are most important for species identification. However this is not easily done when examining their vegetative parts such as the leaf, branch and bark. In this study, general descriptions of three different *Aquilaria* species were recorded, crosschecked with previous literatures and botanical records: *A. hirta* through their heavily pubescent, large-sized leaves, *A. malaccensis* through elliptic-lanceolate shape leaves and *Aquilaria sp.*1 from the existence of strongly raised lateral veins below the leaves. In conclusion, the identification of *Aquilaria* species with higher level of confidence can be achieved by performing both botanical observations and molecular authentication with the aid of molecular markers. Molecular information can support species identification for *Aquilaria* species even with the absence of their reproductive parts. This will help in reducing the occurrence of species misidentification caused by phenotype changes due to environment factors. These results are useful information for conservation and molecular breeding purposes in the future.

Title	:	Optimised Application of The Microwave Extraction Technique of Essential Oils from *Aquilaria malaccensis Lamk* Wood and *Cymbopogon Nardus (L.) Rendle* Leaves
Author	:	Bibi Sabrina Binti Yahaya
Types	:	Thesis (Masters) **Year :** 2011
Publisher	:	School of Graduate Studies, University Putra Malaysia
Source/ link	:	http://psasir.upm.edu.my/19616/

Abstract:

In this study, the important process parameters such as microwave power, temperature and extraction time of MET are controlled to obtain the highest yield of extracted essential oil. The microwave extraction method for the essential oil from gaharu and citronella grass is compared with the conventional extraction technique (CET). In such a way to obtain the first droplet of distillation, it is necessary to heat up only 10 to 13 minutes with MET against 25 to 45 minutes with CET for *Aquilaria malaccensis* wood while for Cymbopogon nardus extraction, it requires 3 to 7 minutes for MET and about 12 to 20 minutes for CET to obtain the first droplet of oil. After 1 hour of extraction, MET gives higher percentage yield of oil with 0.016% for wet distillation for *Aquilaria malaccensis* and 1.21% for Cymbopogon nardus while the percentage yield of oil obtained by the CET is only 0.140% for *Aquilaria malaccensis* and 3.51% for Cymbopogon nardus after 8 hours of extraction. Another parameter is day of soaking for the samples. It plays an important role in the extraction where by the long time the sample was soaked, the more yield were collected. The highest yield was 0.116% which obtained in ten days of soaking. Identification of the chemical component was based on comparison of calculated retention indices and mass spectral data with literature values. The tested result of the oils showed some variation and differences in terms of GC profiles, concentration and chemical derivatives. In gaharu essential oil, the composition of oil isolated by the hydro distillation (MET) is dominated by dodecanoic acid, ethenyl ester, lauric acid, and vinyl ester yielding 12.75%. while in citronella essential oil, the composition is dominated by 6-octenal, 3,7-dimethyl and citronellal yielding 24.68%. This project is also looking for the various techniques of extraction process such as hydro (HD), dry (DD) and steam (SD) distillation techniques. The results from each technique were presented. The project has successfully proved that MET is more efficient than CET in terms of rapidity and the quantity of the yield.

Title	:	Characterization of Genes Associated With Gaharu Formation and Anatomical Changes in Stress-Induced *Aquilaria malaccensis Lam*		
Author	:	Wong Mun Theng		
Types	:	Thesis (Master)	**Year :**	2010
Publisher	:	Universiti Putra Malaysia		
Source/ link	:	http://psasir.upm.edu.my/19495/		

Abstract:

Aquilaria malaccensis (Karas) is a native tree that produces aromatic oleoresins (gaharu or agarwood) in response to external attack. Little is known about oleoresin synthesis in the wood. To understand this phenomenon, several candidate genes in oleoresin synthesis pathway were cloned and expression patterns determined at various time points after stress induction. Three genes were cloned in this study: two transcriptional factors from the WRKY family and a gene that encodes terpene synthase. A partial length cDNA of AmWRKY1 was isolated through RACE-PCR. The cDNA fragment was 871 bp and the deduced polypeptide consisted of 194 amino acids. The deduced protein sequence exhibited high sequence similarity (63-72%) to WRKY proteins from group I. The second WRKY gene which was designated as AmWRKY2 was 580 bp long. The translated sequence had poor similarity to other WRKY protein with only 36% similarity to Zinc-dependent activator protein-1 (Zap1) from Arabidopsis thaliana. The cloned terpene synthase fragment had a length of 344 bp and was designated as AmTPS1. The deduced protein exhibited 62-80% sequence similarity to known acyltransferases proteins. The expression profile of the three transcripts including phenylalanine ammonia-lyase (PAL) gene from a previous study in a 30 days cycle were investigated using real-time RT-PCR (qPCR). Expression of all the four transcripts was regulated differently from 3 hours to 30 days. AmWRKY1 and AmTPS1 showed immediate-early expression at 3 hours while AmWRKY2 and AmPAL were expressed later starting from 16 hours. In addition, the anatomical structures of juvenile and mature resinous wood were compared, and changes in the woody tissues were determined following mechanical wounding and electrical stimulation. There was no

difference between juvenile and mature wood except that the percentage of area covered by included phloem in juvenile wood was twice than that of mature wood. In juvenile wood, the content of starch grains decreased in inner sapwood when compared to outer sapwood. In resinous wood, brownish bodies were found in both ray and axial parenchyma, included phloems, xylem vessels and fibers. From unstained sections of 48 hours following wounding of juvenile tree, brownish substance was found in ray parenchyma cells, included phloem and fibers. Electrical stimulation on 3-year old trees was carried out by applying doses of high voltage currents. After 28 days of electrical stimulation, naked eye observation revealed that the outer sapwood was dehydrated, while the inner sapwood was carbonized. Included phloems were crushed and the vessels of the affected wood contained brownish bodies. In addition, fungal hyphae were observed inside the carbonized area. In conclusion, the results of gene expression indicate that AmWRKY1, AmWRKY2, AmTPS1 and AmPAL may be involved in 'gaharu' formation. It can be deduced that wounding, either by direct penetration into the stem or by indirect damage through electrical shock, is the primary cause to commence synthesizing of gaharu. Both juvenile and mature wood, have the ability to produce oleoresin as there was no major anatomical difference between them. In this study, juvenile tree as young as 3-year old can produce oleoresin when given proper treatment.

Title	:	Induced of Agarwood Production Using Fungal Inoculation and The Influence of Abiotic Factor		
Author	:	Isnaini, Yupi		
Types	:	Thesis (Master)	**Year :**	2004
Publisher	:	Bogor Agricultural University		
Source/ link	:	http://repository.ipb.ac.id/handle/123456789/9129? show=full		

Abstract:

The role of Acremonium isolates inoculation, abiotic factor and their interaction on the gaharu production of Aquilaria spp. has been studied in vitro and in vivo. In laboratory experiment, shoot culture of 13 clones of *Aquilaria spp.* (*A. crassna, A. filaria, A. malaccensis*, and *A. microcarpa*) and two isolate of Acremonium (F and M) were grown in dual culture on five different concentration or pH of modified MS basal media. The growth of Acremonium, the dead shoots, and the level of fragrance formation was evaluated. In the field condition, the effect of fungal isolate (ACEFI, F, and M), the abiotic factor (abcisic acid (ABA) and sterile water), and their interaction on the production of agarwood has been evaluated. The result indicated that different clones of *Aquilaria* showed different responses to Acremonium in the percentage of dead shoots and fragrance formation. *Aquilaria malaccensis* (Ama 7, Ama 13), and *A. nucrocarpa* (Ami 2064) are the potential clones to produce aromatic compounds. The lower of nutrient on the medium, cause the increasing of the percentage of dead shoots, as well as fragrance formation in *Aquilaria* shoots. Acremonium Isolate F alone or in combination with isolate ACEI was better than isolate M and control to induce agarwood formation in vivo. Morover, it will be needed the interaction of biotic factor (Acremonium isolate) and abiotic factor (ABA).

Title	:	In Vitro Culture of Agarwood Trees (*Aquilaria spp.*)		
Author	:	Pimol Tiengtum		
Types	:	Thesis (Master)	**Year :**	1995
Publisher	:	Graduate School of Kasetsart University, Bangkok, Thailand		
Source/ link	:	Kasetsart University, Bangkok, Thailand		

Abstract:

In vitro culture of various parts of *Aquilaria spp.* were studied at tissue culture laboratory, Department of Horticulture, Kasetsart University. Shoot tips and lateral buds from 2 species of agarwood trees (*Aquilaria crassna* and *A. malaccensis*) were cultured on Woody Plant Medium (WPM) and modified MS medium with half-strength of nitrate supplemented with BA, 2iP and kinetin at the concentrations rate 0, 0.25, 0.5, 1, 2 and 4 mg/l. Both media supplemented with cytokinin promoted growth and shoot proliferation. BA was the most effective for stimulating shoot multiplication, followed by kinetin. 2iP had no effect on shoot multiplication. Relatively low levels of BA (0.25, 0.5 mg/l) were effective in stimulating the multiplication and elongation of shoot tips and lateral buds. BA at high levels (1-4 mg/l) produced more number of shoots that did not elongate. Callus obtained by culturing young leaf discs on MS medium containing 0.5, 1, 1.5 and 2 mg/l 2,4-D and 2, 3 mg/l BA. But callus did not regenerate. Shoots of A. crassna produced roots on WPM medium with or without auxin. Both NAA and IBA were tested in the rooting experiments, IBA more effective in stimulate rooting. The highest rooting percentage was 65 percent in medium containing 0.5 mg/l IBA. Shoots of *A. malaccensis* failed to root. The survival rate of *A. crassna* plantlets was 90 percent when transplanted in nursery.

Title	:	Miscibility Study of Gaharu Essential Oil in Water and Organic Solvents		
Author	:	Latifah Binti Abu Bakar		
Types	:	Thesis (Undergraduates)	**Year :**	2012
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/4391/		

Abstract:

This research is a study about miscibility of gaharu essential oil in water and organicsolvents. The scope of this study is to compare polar and non-polar compound whichmiscible well in gaharu essential oil. Gaharu essential oil is very viscous, smelly, nonsticky and dark-brown oil. This essential oil has a highly market demand because of the value such as it used in incense, perfume and medicine. In this study, the miscibility of gaharu is studied by comparing the chemical components in gaharu essential oil in two different solvent, which is polar and non-polar. Miscibility of gaharu essential oil in water and organic solvents is actually a continuous research work to improve the extraction of gaharu hydro-distillation technique that using water as a solvent and to identify any recovery gaharu maker compound that dissolve in water for each stage of multistage extraction. To perform analysis, FTIR and GCMS are used to determine the chemical compound in gaharu essential oil. The main chemical component in gaharu essential oil is agarospirol, eudesma-4(14),7(11)-diene, _-guaiene, selina-4(15),7(11)-diene, and selinene. But, after gaharu essential oil mixed with water and let for one day, percentage of quality chemical components in gaharu essential oil is reduced. It shows that some of the chemical component tends to dissolve in the water. Furthermore, the smell of water itself just likes gaharu essential oil smell. It coincides with the theory that polar molecule will tend to dissolve anything polar molecule and non-polar molecule will tend to dissolve anything non-polar molecule.

Title	:	The Investigation of Different Extraction Techniques To Extract Gaharu Oil		
Author	:	Abdul Mudzil bin Mahamod		
Types	:	Thesis (Undergraduates)	**Year :**	2009
Publisher	:	Universiti Teknologi PETRONAS		
Source/ link	:	http://utpedia.utp.edu.my/9168/		

Abstract:

Gaharu or agarwood, scientifically known as *Aquilaria malaccensis*, is one of the most expensive woods in the world. Analysts have differentiated the quality of gaharu based on its commercial grade, at which it ranges from A Super, A, B and C. Due to it rarity and high demand, agarwood extract (gaharu oil) brings high prices. The price is around RM 30 000 per litre for lower grade and superior grades could be priced up to RM 60 000 per litre. It is anticipated that the prices of gaharu will remain high in the future because of the high demand for gaharu material in Arabic countries, introduction of new applications for gaharu materials in the cosmetic industry and the traditional users of gaharu in China, Japan and India for manufacturing joss-sticks and other. However, the process is less effective as the yield of oil is relatively small and it acquires high temperature. This project is mainly about investigating the alternatives to traditional hydro distillation to extract gaharu oil. Experiments are to be conducted to study the effectiveness of ultrasonic technology, microwave technology, solvent extraction and supercritical fluid extraction (SFE) in terms of oil yield and other related parameters. Proposed methodology is carried out to accomplish the aims of the project.Three extraction methods were selected, namely as solvent extraction and ultrasonic extraction, and steam distillation as control. The gaharu chips were initially grinded into small particles and mixed with different type of solvent for extraction. For solvent extraction, petroleum ether is not suitable used as solvent at specified temperature (35°C) due to its dissimilarity in polarity as the chemical compounds for the raw material obtained were mainly sesquiterpenes. For ultrasonic extraction, the highest oil yield recovery is 0.1% at 100% power output of ultrasonic bath with temperature of 50±2°C. Several modifications on the parameters experimented need to be done to produce higher oil yield recovery.

Title	:	Analysis of Agarwood Oil Composition Via Preparative Thin Layer Chromatography		
Author	:	Siti Faridah Bt Ab Rahman		
Types	:	Thesis (Undergraduates)	**Year :**	2009
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/806/		

Abstract:

Agarwood which is also known as *Aquilaria* is the most valuable wood in the world with higher prices and demands nowadays. The widely uses of agarwood in meditation field, essential oil production and etc makes agarwood one of the precious things on earth. The study was carried out to analysis compounds present in agarwood oil by using Preparative Thin Layer chromatography. In this study, used of *Aquilaria maleccencis* from Malaysia as the sample and it can be classified in grade C. After extraction, isolation was carrying out to isolate it complex component present and detected by UV irradiation to afford 4 spots. Each spots, i.e spots 1, 2, 3 and 4 numbered in order of increasing polarity and each separated spot was confirmed by GC-MS. Results from GC-MS was analyzed to confirm presented of sesquiterpenes as a mojor active compound in agarwood oil and comparison between sample was made between commercial sample, i.e. Maha and Kelantan samples. This study showed a marked similar compound presented in the oil compositions among the sample and commercial samples.

Title	:	Extraction of The Essential Oil of *Aquilaria malaccensis* (Gaharu) Using Hydro-Distillation ond Solvent Extraction Methods		
Author	:	Ashwin Charles Benedict		
Types	:	Thesis (Undergraduates)	**Year :**	2009
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/868/1/Ashwin_Charles_Benedict.PDF		

Abstract:

Agarwood oil is regarded as one of the most expensive natural products in the world due to the fragrance inducing compounds it contains. However, current studies on the chemical composition of agarwood essential oil are woefully lacking and this poses a threat to the agarwood industry. This research aims to identify the best extraction method for isolating gaharu essential oil and to create a list of compounds contained in a sample of grade C agarwood. In the present work, the composition of agarwood essential oil obtained through hydro-distillation and solvent extraction with acetone, dichloromethane and hexane as the solvents were analyzed for marker compound identification using gas chromatography-mass spectrometry (GC-MS). Studying another parameter of this experiment, the sample hydro-distillated in the lab was compared with industrial grade hydro-distillation to determine the difference in quality between industrial and lab scale hydro-distillation. Of the three solvents used, acetone eluted the highest number of compounds. The lab scale hydro-distillated sample eluted 34 compounds at a quality of 50% and above whereas the solvent extraction sample eluted 25 compounds. There was no significant difference found between lab scale and industrial scale hydro-distillation.

Title	:	Analysis Volatile Compound of Gaharu Oil Composition Via Solid Phase Micro Extraction (SPME)		
Author	:	Norsuzieana Bt Ab Latif		
Types	:	Thesis (Undergraduates)	**Year :**	2009
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/732/1/NORSUZIEANA_BT_AB_LATIF.pdf		

Abstract:

Gaharu (agarwood) is a fragrant wood that is usually derived from the diseased timber of the genus *AquilariaThymelaeceae* and often occurs as dark coloured patches or streaks in the tree. Due to its strong, unique scent and medicinal properties, gaharu oil is greatly valued as perfumery ingredient and incense. Gaharu may be classified into various grades; Grade A, B, C and D and they are often graded according to the physical properties, gaharu formation and its unique scent. The lower grades such as Grade C are often distilled to obtain gaharu oils. As part of an on-going research on the chemical profiling of some Malaysian gaharu oils and evaluation of their potential beneficial properties; gaharu oils obtained from different sources were analysed and compared by SPME and GCMS. Identification of the chemical components was based on comparison of the types of SPME fibers and chromatographic columns. The SPME device included a fused silica fiber coating partially cross-linked with 100µm Polydimethylsiloxane (PDMS), 75µm Carboxen/Polydimethylsiloxane (CAR/PDMS) and 65µm Polydimethylsiloxane /divinylbenzene (PDMS/DVB). The chromatographic column used were HP-5MS 5% Phenyl Methyl Siloxane and DB-WAX, 30 m x 250 µm i.d, film thickness 0.25 µm. Examination of the oils showed some variations and differences in terms of GCMS profiles, concentration and chemical components. Majority of the essential oil profiles were complex and made up of sesquiterpenoids and their oxygenated derivatives. However, common occurrences of chemical compounds such as benzaldehyde, 3-phenyl-butanone, alpha-guaiene and gamma- guaiene were detected.

Title	:	Study on Pretreatment of Gaharu Oil Extraction Process		
Author	:	Nor Ilia Anisa, Aris		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/599/		

Abstract:

Gaharu, the names for the resinous, fragrant and highly valuable heartwood produced by *Aquilaria malaccensis*. Gaharu is classified as one of the most valuable forest products traded internationally. Gaharu oil is widely use in religious ceremony, meditation, incense and perfume. Currently, local entrepreneur has adopted hydro distillation technique to complete the extraction process because the advantages of the hydro distillation are less steam usage, the cheapest and simplest process and this is the best method for the powder. However, the percentage of yield is very low and longer time required extracting gaharu oil. To overcome this problem, a study on pretreatment methods will be performed to increase the effectiveness of gaharu oil extracted using hydrodistillation. There were three pretreatment methods studied which are soaking, ultrasonic and ultrasonic with enzymatic. From three of pretreatment methods, hydro distillation process with the assistant of ultrasonic with enzymatic pretreatment contribute the highest efficiency and capacity of gaharu oil extraction which gave 0.12% percentage yield of gaharu oil. However, the further method of pretreatment the gaharu oil in this study was ultrasonic because the increasing percentage yields of ultrasonic was 0.023% compared to the increasing of ultrasonic with enzymatic only 0.009% while the lowest was soaking 0.016%. The percentage of yield with the ultrasonic pretreatment was increased when the duration was increased. The percentage of yield was proportional with time.9 hours of pretreatment time showed the highest percentage of yield rather than other durations (1, 3 and 6 hours). As the conclusion, the ultrasonic pretreatment method is very crucial to improve the extraction process of gaharu essential oil.

Title	:	Comparison of Agarwood Essential Oil & Water Soluble (Hydrosol)		
Author	:	Fairul Idzwan , Mohd		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/613/		

Abstract:

Gaharu which is also known as *Aquilaria* is the most valuable wood in the world with higher prices and demands nowadays. The widely uses of gaharu in meditation field, essential oil production and etc makes gaharu one of the precious things on earth. For last several years, many methods were founded to extract gaharu especially spesifically in distillation. Methods such as steam distillation and spinning band distillation were discovered but the most common methods which more precise and saving cost was hydrodistillation. In this study, we use *Aquilaria maleccencis* from Malaysia as the sample and it can be classified in grade C. This method requires temperature according to water boiling point which is 100 OC and gaharu sawdust size less than 1.0mm. After extraction, analysis was carrying out by using gas chromatography mass spectrometer to see the component in oil sample. To get the secondary oil, 2 different kind of solvent (ethyl acetate and hexane) were used to trap gaharu essential oil component by mix it with hydrosol which left in the flask. This step is carry out by going through several processes such as centrifuge, filtering and water termination. Then, primary oil and secondary oil is analysis to see compounds which contain in the sample. As the conclusion, we have founded several compounds in secondary oil which same as primary oil and this mean the water can be used to recycle in the next distillation process.

Title	:	Extraction of Gaharu Esential Oil Using Ultrasonic Assisted Hydrodistillation		
Author	:	Zubair Bin Mat Isa		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/794/		

Abstract:

Gaharu is one of the most highly valuable, non-timber products harvested from tropical forest that produces from the *Aquilaria* species trees naturally or mechanically. Its essential oil is used in varies industries as perfumes and also been used in religious occasion for centuries. The gaharu that was used in this research is grade C came from the peninsular of Malaysia and known as 'karas' among the locals. Recently, the gaharu essential oil traditionally extracted using hydro distillation. However, the method is not effective in producing the higher yield of oil and it is consumed a lot of time. The ultrasonic assisted hydro-distillation is introduced to enhance the process where the gaharu sample is put into an ultrasonic bath before distillate. The parameter that has been studied in this research are extraction time which are 1 hour, 3 hours, 6 hours and 9 hours, and the solid to solvent ratio which are from 1:8, 1:12, 1:16 and 1:20. Solvent been used in this research are water. From the result, it showed that the gaharu oil yield is increase along with the increase of extraction time and solid to solvent ratio and it is proved that this method are feasible to extract the gaharu oil. From the results, the highest oil yield percentage for solid to solvent ratio is for 1:20 which is 0.139 %. For extraction time, the highest percentage oil yield is for 9 hours which is 0.169 %.

Title	:	Extraction of Gaharu Essential Oil Using Ultrasonic Assisted Steam Distillation		
Author	:	Ahmad Junaidy Bin Jaapar		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/665/		

Abstract:

Aquilaria species from the family of *Thymelaeceae* are the main source of gaharu, which has been classified as one of the most highly valuable, non-timber products in the world market. Its distinctive fragrance has been valued in many cultures and it is widely used in religious ceremonies, medication, incense, perfume and toiletry products. Currently, the method used for extracting gaharu essential oil is by using hydrodistillation. However, this method is inefficient which it produced low yield of oil and longer time of extraction and thus increasing the production cost. To overcome those problems, this study will be conducted to improve existing method of extraction by using ultrasonic assisted steam distillation. Parameters involve in this study is pretreatment time and gaharu-to-water ratio and both are manipulated to gain high yield of oil with optimum and maximum. The results from this study is the gaharu essential oil yield is increasing with the increment of both pretreatment time and gaharu-to water ratio until it reached a condition where the yield of oil become constant. The best pretreatment time obtained is at 9 hours with oil yield of 0.1276% and the gaharu to water ratio of 1:20.which gave 0.1295% oil yield.

Title	:	Comparison Between Chemical Compounds in Gaharu Smoke (Burning) and Gaharu Oil (Hidrodistillation)		
Author	:	Surita Binti Sokima		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/671/		

Abstract:

Gaharu is known as one of the most expensive wood in the world. It is valued in many cultures for its distinctive fragrance, and used extensively in incense and perfumes. The gaharu that was used in this study is grade C gaharu from peninsular of Malysia or known as 'karas' among the locals. The objective of this study is to determine the different between chemical compounds exist in gaharu smoke and gaharu oil. For burning process, the smoke was trapped using sample bottles and then was analyzed using GC-MS. Meanwhile for extraction process, the gaharu was extracted using hidrodistillation method. Then, the oil formed was analyzed using GC-MS too. From the result, about 20 to 30 chemicals compounds found in gaharu smoke and about 80 to 90 chemical compounds found in gaharu oil. After make comparison, only 6 compounds exist in both condition of gaharu. Most of them are pulp wood pyrolysis product and aromatic compounds. There are also fragrant sesquiterpenes found in gaharu oil but not in gaharu smoke which are copaene and 7-methanoazulene.

Title :	Application of Solid Phase Microextraction in Gaharu Essential Oil Analysis		
Author :	Pravina Ashok Kumar		
Types :	Thesis (Undergraduates)	**Year :**	2008
Publisher :	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ : link	http://umpir.ump.edu.my/638/1/Pravina_Ashok_Kumar.pdf		

Abstract:

The gaharu essential oil is important for the evaluation of the important compounds that makes it valuable and quality of the wood. Extraction of oil, sample preparation, concentration and isolation of analytes, greatly influences the reliable and accurate analysis of food. Solid phase microextraction (SPME) is a new sample preparation technique using fused silica fiber that is coated on the outside with an appropriate stationary phase. In this work, a simple, rapid and sensitive method was developed for the determination of compounds in fragrant wood *Aquilaria* spp. from the family of *Thymelaeaceae*, which was based on headspace solid phase microextraction (HS-SPME) followed by gas chromatography-mass spectrometry (GC-MS). The gaharu essential oil was extracted by hydroditillation and prepared by two different fibers, CAR/PDMS and PDMS/DVB. The extraction parameters of fiber coating were systemically analyzed. Finally, GC-MS following HS-SPME was applied to determination of compounds in gaharu essential oil with two different fibers. The experiment results suggest that the proposed method provided an alternative and novel approach to the study of components in gaharu and SPME fibers.

Title	:	Comparison of Gaharu (*Aquilaria malaccensis*) Essential Oil Composition Between Each Countries		
Author	:	Nurdiyana Binti Abu Bakar Sidik		
Types	:	Thesis (Undergraduates)	**Year :**	2008
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/659/1/Nurdiyana_Abu_Bakar_Sidik.pdf		

Abstract:

Aquilaria is an evegreen tree growing up to 40 meters high and 60 centimetres in diameter. These trees frequently become infected with a fungus and begin to produce an aromatic resin commonly called Aloeswood, Agarwood and Oud. The resin is created in response to an attack from Phialophora parasitica, which is a parasite fungus or mold. The purpose of this project were to know the compounds in essential oil from gaharu that been produced by hydrodistillation, to analyse of the compound in the gaharu essential oil and to determine the quality, chemical compound and method use to extract the essential oil of gaharu between different origins. Chemical compound of an agarwood originating from agarwood *(Aquilaria sp.* probably *A. malaccensis*) were investigated by GC-MS. The differences in chemical composition between the agarwood in four difference countries are discussed. The samples are taken from gaharu production industry at Kelantan, China, India and Thailand. The extraction of gaharu essential oil also been done by using hydrodistillation. Firstly preparations of the sample were done by make the sample to the sawdust and after that soak it with water. Then setting the hydrodistillation set and heated up the sample that was soaked before. The temperature of the sample was maintained at 980C to 990C for three days. Collect the sample that diluted in solvent of ethyl acetate (EtOAc) and put it in sample bottle. Cleaned the sample from the water existed, before analyze it with GC-MS. The data from GC-MS were recorded in the understandable way. The compound between the four countries have large dissimilar, but it still some component is comparable between each country. The essential oil had been produced and been analyzed. If look from analysis result, component from oil sample of industry and laboratory were not identical.

Title	:	Extraction of Gaharu Essential Oil Using Spinning Band Distillation		
Author	:	Ahmad Fadzli Bin Zakaria		
Types	:	Thesis (Undergraduates)	**Year :**	2006
Publisher	:	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang		
Source/ link	:	http://umpir.ump.edu.my/573/		

Abstract:

Gaharu is known as one of the most expensive wood in the world. Its essential oil is used in many industries such as perfume and also toiletries. The gaharu that was used in this study is grade C gaharu from peninsular of Malysia (*Aquiliria malaccensis*) or known as 'karas' among the locals. Traditionally, gaharu oil is extracted by distilling the grinded gaharu sample in a copper still. However the process it is not effective and the yield of oil is relatively small and it acquire high temperature. The extraction of gaharu essential oil using spinning band distillation (batch distillation) and water as solvent at heating rate and temperature cut ranging from 20 – 40% and 25 - 100°C respectively was studied. The size of gaharu particle that will be used is <1.00mm. Result obtained after the experiment is 0% of oil yield in parameter stated. This extraction technique is not suitable to extract the gaharu essential oil at specified parameter. Some changes need to be done to make such objective achievable.

2.2 List of Other Publications (Without Abstract)

No	Title	Types	Year published
1	Panduan Penanaman Karas	Books	2012
2	Seed Procurement and Handling of Karas (*Aquilaria malaccensis*)	Books	2011
3	Botany and Ecology of Karas (*Aquilaria malaccensis*)	Books	2011
4	Establishment of Commercial Karas (*Aquilaria malaccensis*) Plantation	Books	2011
5	Nursery Techniques of Karas (*Aquilaria malaccensis*)	Books	2011
6	Inducement of Gaharu and Potentials of Gaharu Oils	Books	2011
7	Diseases of Karas (*Aquilaria malaccensis*)	Books	2011
8	Gaharu Trade in Peninsular Malaysia	Books	2011
9	Silviculture and Management of Karas (*Aquilaria malaccensis*) as Plantation Species	Books	2011

10	Gaharu Komoditi Khazanah	Books	2010
11	Koleksi Keratan Akhbar Wood Product/Wood Species (Gaharu)/Kenaf/Kayu Getah 2010	Books	2010
12	Gaharu : Wang Tumbuh Di Atas Pokok	Books	2009
13	Penanaman, Pengeluaran Dan Perdagangan Gaharu Di Malaysia	Books	2009
14	Investigation on *Aquilaria malaccensis* for The Production of Gaharu Oils	Books	2006
15	Budidaya Gaharu Dan Masalahnya	Books	2003
16	*Aquilaria malaccensis* (*Thymelaeceae*)	Books	1999
17	Potensi Spesies Karas	Books	
18	What is Gaharu Sense?	Bulletin	2011
19	Tree Farming for Karas	Bulletin	2010
20	The Grim Reaping of Gaharu-A Tale of Greed, Gold and Gored Trees	Bulletin	2010
21	*Aquilaria spp.*	Bulletin	2005
22	Teknik Pengembangan Bibit Tanaman Gaharu Melalui Kultur Jaringan	Bulletin	2005
23	Budidaya dan Rekayasa Pengembangan Produksi Gaharu	Bulletin	2004

24	Gaharu	Bulletin	2002
25	Anatomy of Eagle Wood (*Aquilaria Malaccensis*) and Several Related Species	Bulletin	2002
26	Laju Pertumbuhan Tegakan Gaharu (*Aquilaria malaccensis*) di Riau Yang Ditanam Dengan Intensitas Budidaya Tinggi Dan Manual	Bulletin	2000
27	Gaharu	Bulletin	1997
28	Agarwood Harvesting in Vietnam	Bulletin	1995
29	Eksplorasi Dan Studi Permudaan Jenis-Jenis Penghasil Gaharu Di Wilayah Hutan Kintap, Kalimantan Selatan	Bulletin	1986
30	Keanekaragaman Jenis Jamur Yang Potensial Dalam Pembentukan Gaharu dari Batang *Aquilaria spp.*	Journal	2006
31	Gaharu: A Prized Incense From Malaysia	Journal	2001
32	The Current Trade in Gaharu in West Kalimantan	Journal	1997
33	Jenis-jenis Gaharu Di Indonesia (Gaharu in Indonesia)	Journal	1986
34	Gaharu Wood	Journal	1981
35	Garu and Chandan	Journal	1901
36	Development of Antioxidant Nanoemulsion From *Aquilaria malaccensis*	Poster	2013

37	Antioxidant and Cytotoxic Effect of *Aquilaria malaccensis* Leaves From Malaysia	Poster	2013
38	Chromosome Number and Genome Size of *Aquilaria malaccensis*, An Endangered Agarwood Producing Species	Poster	2013
39	The Characterisation of Agarwood Using Gaharu Sense Technology	Poster	2013
40	Classification of Agarwood Oils Using k-NN k-Fold	Poster	2013
41	Classification of Aroma Profiles of Selected Agarwood Samples (*Aquilaria*) by Hs-SPME-GC-MS and Sensor Technology	Poster	2012
42	Protein Profiling of *Aquilaria malaccensis* Seeds - A Preliminary Study	Poster	2012
43	Antioxidant Nanoemulsion From *Aquilaria sp.*	Poster	2012
44	Analysis of Aroma Compounds From Gaharu Oil by Head-Space Solid Phase Microextraction & Gas Chromatography-Mass Spectrometry	Poster	2012
45	Determination of The Chemical Constituents of Selected Agarwood Oils by Gas Chromatograph-Mass Spectrometry and Chemometric Approach	Poster	2012

46	Antioxidant Activity From The Extract of *Aquilaria malaccensis* and Leea Indica by Using DPPH-TLC Chromatographic Assay	Poster	2011
47	Chemical Constituents of Essential Oils From The Genus *Aquilaria* (*Thymelaceae*)	Poster	2011
48	Development of Genetic Markers for *Aquilaria* Species Identification Using Amplified Fragment Length Polymorphism (AFLP) - A Preliminary Study	Poster	2010
49	Evaluation of Genetic Relatedness Between *Aquilaria* Species Using Allozyme Analysis	Poster	2010
50	Kultur Tisu Spesies Yang Menghasilkan Gaharu Untuk Tujuan Perladangan	Poster	2009
51	Studies on Malaysian Gaharu: *Aquilaria malaccensis*	Poster	2008
52	Profiles of Selected Supreme Agarwood Oils From Malaysia	Poster	2008
53	Can Karas/Gaharu (*Aquilaria malaccensis*) Plantation Be Established on Poor Marginal Soils in Malaysia?	Poster	2007
54	Production of *Aquilaria malaccensis* Plantlets Through Tissue Culture Technique for Plantation Purposes	Poster	2007
55	Breeding systems in *Aquilaria malaccensis*	Poster	2007

56	Comparison of Chemical Profiles of Some Malaysian Gaharu Oils	Poster	2007
57	Comparison of Chemical Profiles of Selected Gaharu Oils From Peninsular Malaysia	Poster	2007
58	Agarwood - Genetic Diversity of Its Sources	Poster	2007
59	Effect of Commercial Hormones on Ex-Vitro Rooting of Tissue Culture Derived Plants of *Aquilaria malaccensis*	Poster	2006
60	Rooting of Tissue-Culture-Derived *Aquilaria malaccensis* (Karas) and *Dyera costulata* (Jelutong) Shoot Cultures	Poster	2005
61	Shoot Multiplication and In Vitro Rooting of *Aquilaria malaccensis*	Poster	2003
62	Gaharu or Agarwood Research in Malaysia	Poster	2003
63	Investigation Into The Induction of Gaharu in Standing Karas (*Aquilaria malaccensis*)	Poster	2000
64	Reproductive and Genetic Studies Towards The Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia	Proceeding	2014

65	Development of Genetic Markers for *Aquilaria* Species Identification Using Direct Amplification Minisatellite DNA (DAMD)	Proceeding	2013
66	Genetic Diversity of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia	Proceeding	2013
67	*Aquilaria* in Peninsular Malaysia: Towards Its Conservation and Management	Proceeding	2013
68	Investigation Into The Induction of Agarwood in *Aquilaria* Trees and Their Quality Control Assessment	Proceeding	2013
69	Authentication of Important *Aquilaria* Species for Plantation in Malaysia Using Molecular Marker Technology	Proceeding	2013
70	Chromosome Doubling in *A. malaccensis* Through In Vitro Polyploidization	Proceeding	2013
71	Approaches for Enhancing Flavonoids Production From *Aquilaria malaccensis*	Proceeding	2013
72	De Novo Transcriptome Sequence Assembly in Callus Culture of *Aquilaria malaccensis*	Proceeding	2013
73	Microbial Genes Discovery in Wounded *Aquilaria malaccensis* Through EST Analysis	Proceeding	2013

74	Analysis of Agarwood Oil (*Aquilaria malaccensis*) Based on GC-MS Data	Proceeding	2012
75	Analisa Ekonomi Perladangan Karas Dan Penghasilan Gaharu	Proceeding	2012
76	Domestication of *Aquilaria* Tree Species for Agarwood and Oil Production: Reaping The Wealth	Proceeding	2012
77	Phytochemical Study on The Leaves of *Aquilaria malaccensis Lam.*	Proceeding	2012
78	Analisa Ekonomi Perusahaan Tanaman Karas Untuk Pengeluaran Produk Gaharu	Proceeding	2011
79	Diversity of Wood Inhabiting Fungi in *Aquilaria* Species	Proceeding	2011
80	Plantation Cultivation of Agarwood and Current Development in Malaysia	Proceeding	2011
81	Enhancement of Key Chemical Content of *Aquilaria malaccensis* (Karas) Through in Vitro Polyploidization	Proceeding	2010
82	Penanaman Dan Pengurusan Ladang Tanaman Karas Bagi Tujuan Pengeluaran Gaharu	Proceeding	2010
83	Silviculture and Management of *Aquilaria malaccensis* for Agarwood (Gaharu) Production	Proceeding	2009

84	Chemical Investigation on Selected *Aquilaria* Species and Their Essential Oil Composition	Proceeding	2009
85	Production of High Quality Planting Materials of *Aquilariasp.*	Proceeding	2009
86	Ex-Situ Cultivation of *Aquilaria malaccensis* (Karas) as A Potential Forest Plantation Species and Its Economic Importance	Proceeding	2009
87	Silviculture and Establishment Techniques of Karas Plantation for Gaharu Production in Malaysia	Proceeding	2009
88	Extraction Technology and Chemical Fingerprint Profiling of Gaharu Essential Oil and Resins	Proceeding	2009
89	Photochemical Efficiency of *Aquilaria malaccensis Lamk.* Planted at Two Different Sites	Proceeding	2009
90	Surface Sterilization of *Aquilaria malaccensis* Young Leaf and Nodal Segment Explants	Proceeding	2009
91	Analysis of Volatile Compounds of Gaharu by Headspace Solid Phase Microextraction Gas Chromatographic Mass Spectrometry	Proceeding	2009
92	Potensi Dan Silvikultur Pokok Karas Secara Perladangan Di Malaysia	Proceeding	2008

93	Cadangan, Potensi Dan Prospek Tanaman Pokok Karas Secara Perladangan Di Malaysia	Proceeding	2008
94	Inoculation Technique and Other Aspects of Gaharu (*Aquillaria malaccensis*) Research	Proceeding	2008
95	Penanaman Dan Penjagaan Tanaman Pokok Karas (*Aquilaria spp.*) Untuk Penghasilan Gaharu	Proceeding	2008
96	Potential of Gaharu Industry in Malaysia and at The Global Level	Proceeding	2008
97	Market Potential in Gaharu Products, Success Story and Challenges	Proceeding	2008
98	Teknik Tapak Semaian Karas (*Aquillaria malaccensis*)	Proceeding	2008
99	Hipotesa Mekanisme Pembentukan Gubal Gaharu	Proceeding	2008
100	Tingkat Akumulasi Resin Gaharu Akibat Inokulasi *Fusarium sp* Pada Berbagai Waktu Setelah Pengeboran Batang Aquilaria *malaccensis (Lamk.)*	Proceeding	2008
101	Potensi Tiga Isolat *Fusarium sp* Pada Dalam Menginduksi Akumulasi Resin Wangi Gaharu Pada Batang *Aquilaria malaccensis (Lamk.)*	Proceeding	2008
102	Cultivation and Management of *Aquilaria malaccensis* for Agarwood Production	Proceeding	2007

103	The Status of Gaharu Plantation in Sabah	Proceeding	2007
104	Trend and Prospek Perdagangan Gaharu Antarabangsa	Proceeding	2007
105	Penemuan Awal Inventori Pokok Karas Di Semenanjung Malaysia Berdasarkan Inventori Hutan Nasional Ke Empat	Proceeding	2007
106	Gaharu Research in FRIM: An Update	Proceeding	2007
107	Research Efforts on Gaharu-Producing Species in Malaysia	Proceeding	2006
108	Agarwood Grading Using an Electronic Nose and Artificial Neural Networks Based on Its Fragrance	Proceeding	2006
109	Gaharu Harvesting and Trade in Peninsular Malaysia	Proceeding	2006
110	Teknik Inokulasi & Produksi Gaharu	Proceeding	2006
111	Teknologi Budidaya Tanaman Gaharu Untuk Menuju Sistem Produksi Gubal Gaharu Secara Berkelanjutan	Proceeding	2006
112	Respon *Acremonium sp* Asal Gaharu Terhadap Alginate dan CaCl2	Proceeding	2005
113	Uji Coba Pembentukan Gaharu Dengan Cara Inokulasi	Proceeding	2005
114	Strategi Budidaya dan Pengembangan Produksi Gaharu	Proceeding	2005
115	Investigation on *Aquilaria malaccensis* For The Production of Gaharu Oils	Proceeding	2004

116	Artificial Seeds Production of *Aquilaria malaccensis* (Karas) – A Preliminary Result	Proceeding	2004
117	Tataniaga Perdagangan Gaharu Indonesia	Proceeding	2004
118	Preliminary Micropropagation Studies of *Aquilaria malaccensis Lamk*	Proceeding	2003
119	Development of *Aquilaria spp.* (gaharu) Plantation and Processing	Proceeding	2003
120	Legislation and Gaharu or Agarwood Harvesting in Peninsular Malaysia	Proceeding	2003
121	Tata Nama Dan Kelasifikasi Mutu Gaharu Di Daerah Sekitar Samarinda	Proceeding	2003
122	History and Ecology of Agarwood in Viet Nam	Proceeding	2003
123	Gaharu Harvesting and Trading: A Case Study in Terengganu	Proceeding	2001
124	Utilisation of Fungi and Their Secondary Metabolites: An Overview	Proceeding	2000
125	Prospek Pengembangan Komoditas Gaharu	Proceeding	1998
126	Potensi Jenis Pohon Penghasil Gaharu	Proceeding	1998
127	The History of Agarwood in Viet Nam	Proceeding	1996

128	*Aquilaria* Species Identification Using Chloroplast DNA Marker	Reports	2013
129	Establishment of Chemical and Aroma Profiles From Selected Gaharu Samples (*Aquilaria*) by Chromatographic Tools and Sensor Technology	Reports	2010
130	Proteome Profiling of *Aquilaria malaccensis* Upon Cold Stress Conditions	Reports	2010
131	Pemeriksaan Pokok Karas Berpenyakit di Getang, Telemong Dan Bukit Aceh, Paya Akob, Kuala Berang, Terengganu	Reports	2010
132	Quality Control Assessment of Herbal Raw Material-Agarwood	Reports	2010
133	Chemical Characterization and Fingerprint Pattern Profiling of Selected Gaharu Samples	Reports	2009
134	Contribution of Gaharu to Household Income of Harvesters in Peninsular Malaysia	Reports	2008
135	Studi Mekanisme Akumulasi Resin Wangi *Aquilaria malaccensis (Lamk.)* Merespon Pelukaan Dan Infeksi Cendawan	Reports	2008

136	The Final Frontier: Towards Sustainable Management of Papua New Guinea's Agarwood Resource	Reports	2001
137	Agarwood: Trade and CITES Implementation in Southeast Asia	Reports	1999
138	Agarwood: Trade and CITES Implementation in Malaysia	Reports	1999
139	Three Year Report on Gaharu Project	Reports	1999
140	Report on Gaharu Chemical Analysis for IRL/FRIM Collaboration Project	Reports	1999
141	Agarwood: Trade and CITES Implementation in Indonesia	Reports	1999
142	Gaharu Project - The Investigation of The Formation of Gaharu in *Aquilaria malaccensis* (Karas) Through Inoculation and Wounding	Reports	1998
143	Gaharu Project - The Investigation of The Formation of Gaharu in *Aquilaria malaccensis* (Karas) Through Inoculation and Wounding	Reports	1997
144	Pilot Scale Tree Inoculations - Results of Trial Set Up June 1997	Reports	1997
145	Overview of Trade in Gaharu in Indonesia	Reports	1997

146	Gaharu Project - The Investigation of The Formation of Gaharu in *Aquilaria malaccensis* (Karas) Through Inoculation and Wounding	Reports	1996
147	Pembentukan Gaharu Dengan Inokulasi	Reports	1996
148	Proses Pengolahan Pohon Gaharu Sampai Siap Diperdagangkan Dan Tata Cara Pembudidayaannya, Serta Proese Gaharu Pembentukan Gubal	Reports	1995
149	Gaharu (*Aquilaria spp.*) Pengembangan dan Pemanfaatan yang Berkelanjutan	Reports	1995
150	Gaharu Collecting in The Kayan Mentarang Nature Reserve: Problems and Prospects for Sustainable Community-Based Forest Management in East Kalimantan, Indonesia	Reports	1994
151	Report on Stem Borer (*Zeuzera Sp.*) Infestation in An *Aquilaria malaccensis* Plantation in Kuala Terengganu (Institutional Reports)	Reports	
152	Pembangunan Penanda Mikrosatelit DNA Ke Atas *Aquilaria malaccensis* (Karas)	Reports	

153	Laporan Awal Berkenaan Serangga Ulat Pengorek Batang Ke Atas *Aquilaria malaccensis* Di Projek Penanaman Karas UPEN, Empangan Jus, Melaka	Reports	
154	Budidaya Jenis Pohon Penghasil Gaharu	Review	2012
155	Agarwood: Towards Efficient Plantation and Industry Development in Malaysia	Review	2011
156	Kajian Daya Maju Projek Penanaman Karas Secara Komersial Untuk Pengeluaran Gaharu Di Semenanjung Malaysia	Review	2009
157	Penubuhan Dan Pengurusan Ladang Hutan Karas/Gaharu	Review	2009
158	Agarwood (*Aquilaria malaccensis*) in Malaysia	Review	2008
159	*Aquilaria malaccensis Lam.*	Review	2004
160	A Note on The Performance of Plantation Grown *Aquilaria malaccensis* in Peninsular Malaysia	Review	1996
161	Economic Ecology of Gaharu (*Aquilaria malaccensis*) in Gunung Palung National Park: Valuation of Extraction and Ecology of The Residual Population	Review	1994
162	De Novo Assembly, Annotation and Analysis of Transcriptome Sequences of Callus Culture *From Aquilaria malaccensis Lam.*	Thesis (Masters)	2014

163	Resolution of Complex Sesquiterpene Mixture in *Aqualaria malaccensis* (Gaharu) Volatile Oils Using Gas Chromatography Methods	Thesis (PhD)	2011