DRYING CONDITIONS FOR 11 POTENTIAL RAMIN SUBSTITUTES

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BASRI E, SAEFUDIN, RULLIATY S & YUNIARTI K. 2009. Drying conditions for 11 potential ramin substitutes. 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.

Keywords: High temperature drying, defects, drying properties

BASRI E, SAEFUDIN, RULLIATY S & YUNIARTI K. 2009. Keadaan pengeringan bagi 11 kayu yang berpotensi mengganti ramin. Kajian ini bertujuan mendapatkan data tentang keadaan pengeringan 11 kayu yang berpotensi menjadi pengganti ramin. Beberapa ciri kayu dicerap dan dibandingkan. Penyelidikan tentang sifat pengeringan pada suhu tinggi dijalankan untuk menetapkan keadaan pengeringan bagi kayu yang dipilih bagi mengganti ramin. Daripada 11 spesies yang dikaji, lapan didapati menunjukkan sifat pengeringan yang lebih baik berbanding dengan ramin dan boleh dilanjutkan pengeringannya pada suhu yang lebih tinggi.

INTRODUCTION

Ramin wood (*Gonystylus bancanus*) belongs to the Thymelaeceae family. It grows naturally in peat-swamp forests in Peninsular Malaysia, Indonesia and up to Solomon Island and Fiji in the Pacific. There are 27 species of ramin in the forests of Borneo, seven in Peninsular Malaysia, seven in Sumatra and two in the Philippines (Anonymous 2008).

Ramin has become popular in Asian and European markets, particularly in Japan. Therefore, it is included as one of the highly valuable species for export purposes since 1980. The high demand for ramin is due to its excellent wood colour and texture (Martawijaya *et al.* 2005a). Ramin wood has a white-yellowish colour, straight (sometimes interlocked) grain direction, quite fine and even texture, smooth surface and is quite glossy. Its specific gravity ranges from 0.48 to 0.84. In addition, it is also strong and has a wide variety of uses (Kartasujana & Martawijaya 1979).

Currently, ramin wood is included in Appendix III of the list of endangered species of CITES (Mihradi 2008). This ensued from serious exploitation of the species because wood industries recognize only ramin as the most suitable wood for various purposes.

There are about 4000 wood species in the Indonesian forests (Martawijaya *et al.* 2005a). This estimation was based on the number of wood samples collected by the Forest Products Research and Development Center in Bogor. Of these, three species have been used in industries to substitute ramin wood, namely, rubberwood (*Hevea brasiliensis*), perupuk (*Lophopetalum* sp.) and jelutung (*Dyera* spp.). Of the 4000 wood species, 24 species have been reported to have colour, grain direction, texture and lustre similar to those of ramin wood (Rulliaty 2005). However, these species have different anatomical structures and due to these there are differences in the processing steps of each species, especially in the drying process. Wood drying is necessary to reduce the moisture content of wood and to produce final products with better dimensional stability. The drying process is not easy to conduct. Poor drying procedures will not only result in reduced quality but will also increase the production cost. About 80% of the total energy spent by wood processing industries is in the drying

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process (Reeb 2007). A proper drying schedule is an important factor in determining the success of the drying process. Commonly, the schedule used by industries is based on the change in moisture content of wood.

This is a follow-up study from that reported by Rulliaty (2005). However, due to limited samples and budget, we could not investigate the 24 species recommended and limited our study to only 11 species. This paper reports the results obtained in the investigation of drying conditions for these selected woods. The information obtained will be useful to users of ramin who are looking for alternative woods to substitute ramin.

MATERIALS AND METHOD

The woods studied in this paper were based on the list of ramin substitutes proposed by Rulliaty (2005) (Appendix). Of these, 11 wood species (Table 1) which have similar appearance to ramin were observed for defect characteristics due to drying at high temperature.

The method used in this experiment was the quick drying test at 100 °C (Terazawa 1965). Ten defect-free wood samples (2 × 10 × 20 cm) were taken from the green flat-sawn lumber of each species and measured for their weights. The samples were then dried in an oven at 100 °C until an average moisture content of 1% was reached. They were then half-cut to expose defects, namely, initial checks, deformation and honeycomb (internal checks). The criteria in assessing these three types of defects were size and number of defects on the surface of the dried lumber. A scale of 1 to 8 was used for initial checks and deformation, and from 1 to 6 for honeycomb—the highest score given to the worst defect (Terazawa 1965). According to this method, even if only 1 of the 10 samples observed has the worst defect, the score should be based on this sample.

Initial and final temperatures as well as the wet bulb depression (drying condition) for the drying process of each species were set based on the highest scale of defect. Table 2 shows the values of the initial and final temperatures and wet bulb depression that can be derived based on the drying defects observed.

RESULTS AND DISCUSSION

Poor drying process caused ramin wood to develop end split, surface check and severe deformation (Table 3). Based on the quick drying test results, ramin wood could be dried at temperatures ranging from 50 to 77 °C and initial wet bulb depression of 4 °C. However, considering its high shrinkage and tangential/radial ratio of > 2 (Table 3), the maximum temperature for drying ramin was around 70 °C. The difficulty in drying ramin at this low temperature is due to its small pores, very thin ray cells and the existence of crystals inside its cells (Martawijaya *et al.* 2005b). Structures like these (small pores, very thin ray cells and the existence of crystals) will hamper the transportation of water molecules inside the wood (Panshin & de Zeeuw 1969).

Table 1 The 11 wood species used in the experiment

Species	Common names
Diplodiscus sp., Tiliaceae	Balobo
Vitex sp., Verbenaceae	Bitti
Gironniera subasqualis, Ulmaceae	Kibulu
Evodia aromatica, Rutaceae	Kisampang
Mastixia trichotoma, Cornaceae	Nyaling
Lophopetalum sp., Celastraceae	Perupuk
Sterculia foetida, Sterculiaceae	Pimping
Hevea brasiliensis, Euphorbiaceae	Rubber
Turpinia sphaerocarpa, Staphyleaceae	Saribanaek/kibancet
Pouteria duclitan, Sapotaceae	Segoe
Endospermum malaccense, Euphorbiaceae	Sendok-sendok

Table 2 Drying condition based on degree of defects

Types of defects	Drying conditions (°C)	Degree of defects							
		1	2	3	4	5	6	7	8
Surface check	Initial temperature	70	65	60	55	53	50	47	45
	Wet bulb depression	6	5.5	4	4	3	2	2	2
	Final temperature	95	90	85	83	82	81	80	79
Deformation	Initial temperature	70	66	58	54	50	49	48	47
	Wet bulb depression	6	6	4.5	4	4	3	3	2
	Final temperature	95	88	83	80	77	75	73	70
Honeycombing	Initial temperature	70	55	50	49	48	45	-	-
	Wet bulb depression	6	4.5	4	3	3	2.5	-	-
	Final temperature	95	83	77	73	71	70	-	-

Table 3 Types of defects and drying conditions of 11 ramin substitutes investigated in this study

Species	Initial moisture content (%)	T/R ratio	Types of defects			Drying conditions (°C)		
			I	II	III	Initial temperature	WB	Final temperature
Bitti	56–67	2.43	3-4	2	3	50	4.0	77
Pimping	78–86	2.55	4–5	4–5	1	50	4.0	77
Nyaling	54–60	-	1–2	2–3	1	58	4.5	83
Segoe	53–60	2.22	2–3	3–4	1	54	4.0	80
Kisampang	60–70	2.69[1]	4	4–6	1	49	3.0	75
Perupuk	51–62	2.00[2]	2–3	2	1	60	4.0	85
Kibulu	112–143	2.30	1–3	2	1	60	4.0	85
Saribanaek	90–105	2.23	2–3	2–3	1	58	4.5	83
Rubber	75–87	1.68	1–2	1–2	1	66	6.0	88
Sendok-sendok	65–72	2.24	1–3	3–4	1	54	4.0	80
Balobo	60–70	2.10	2–3	2	1	60	4.0	85
Ramin	40–51	2.50[2]	3–4	5	3	50	4.0	77

[1]Hadjib (2004b); [2]Martawijaya *et al.* (2005b); T = tangential; R = radial; I = surface check; II = deformation; III = honeycomb defect; 1 = very good; 2 = good; 3 = rather good; 4 = fair; 5 = rather poor; 6 = poor; 7 = very poor; WB = wet bulb depression

Results of the quick-drying test at 100 °C for the 11 wood species are presented in Table 3. Results obtained indicated that woods with similar appearances like ramin do not always have similar drying conditions. From the 11 ramin substitutes investigated, only bitti (*Vitex* spp.) and pimping (*Sterculia foetida*) had similar drying conditions as ramin. Bitti wood tends to develop surface check and honeycomb during drying. Therefore, the determination of drying conditions for bitti should consider the occurrence of honeycomb and not only check. According to the Terazawa Standard (Terazawa 1965), the determination of drying conditions for woods that have honeycomb defect criterion 3 is similar to woods that have deformation defect criterion 5 (as can be seen from Table 2) because honeycomb substantially affects wood strength and other physical properties. Internal stress that occurs within the wood and exceeds the grain strength at perpendicular direction will lead to the formation of honeycomb (Wang *et al.*

1994). Severe case hardening at the start of the drying process will also lead to the occurrence of honeycomb (Bramhall & Wellwood 1976). Therefore, it is suggested that the drying process for woods that have a high tendency to develop honeycomb as in the case of bitti, should use low temperature and high humidity at the starting phase, especially if the moisture content is still above the fibre saturation point (Bramhall & Wellwood 1976, Basri *et al.* 1998). Pre-steaming bitti wood for 2 hours could further accelerate the drying process (Oetomo 1999). Steaming enhances fluid transportation inside the wood, thus, making it easier for moisture to evaporate during the drying process.

Pimping had end splits and was deformed during drying. However, unlike other species from the genus *Sterculia* (Anonymous 1999), pimping wood in this study did not collapse during the drying process. Similar to pimping, sendok-sendok was also deformed during drying. Kisampang had the worst drying property among the 11 species investigated due to the highest degree of defect the species obtained (defect degree for check was 4, and 4–6 for deformation) (Table 3). However, the ratio between tangential and radial shrinkage (T/R) of kisampang wood was very high, i.e. 2.69 (Hadjib 2004a). This indicates that the wood has less dimensional stability and needs to be dried carefully.

Among the 11 ramin substitutes investigated, rubberwood has the best drying properties. The drying condition for rubberwood is at a dry bulb temperature range of 66–88 °C and initial wet bulb depression of 6 °C. The tendency for rubberwood to develop split-check and deformation during drying process was lower compared with the rest of the samples. Its structure and physical properties contributed to better drying properties. Rubberwood had the lowest shrinkage level and, with a T/R ratio of < 2, the wood was stable. However, if the drying process of rubberwood uses a very high initial temperature while the wood itself is still in a green condition, the wood colour will darken. Therefore, the initial drying temperature for rubberwood should be below 60 °C, preferably 55 °C. Besides rubberwood, there were also seven species that had better drying properties than ramin. These are nyaling, segoe, perupuk, sendok-sendok, saribanaek, balobo and kibulu. Based on their drying properties and conditions, these eight wood species are considered as potential ramin substitutes. These eight species are also easy to work with. Planing will give the wood a smooth and shiny (glossy) appearance and the finishing process will be easy to carry out.

CONCLUSIONS

Among the 11 species investigated for their drying properties, bitti and pimping wood had similar drying conditions to that of ramin. However, it is rubberwood that showed the best drying properties and low tendency to develop defects. Rubberwood can be dried at a temperature range of 66–88 °C and wet bulb depression 6 °C. Seven other species, namely, nyaling, segoe, perupuk, sendok-sendok, saribanaek, balobo and kibulu also had better drying properties than ramin and could be dried using higher temperature than that used for ramin.

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Appendix The properties of ramin wood and its substitutes

Species	Specific gravity[1]	Colour	Grain	Texture	Wood lustre	Strength class[3]	Durability	Distribution areas[9]
Ramin (*Gonystylus bancanus*, Thymelaeceae	0.63 (0.48–0.84)	White yellowish/ yellow/yellow brownish	Straight, sometimes interlocked	Quite fine and even	Quite shiny and smooth	II – III[3]	II – IV[3]	Java, Sumatra, Borneo
Ki jeruk (*Acronychia pedunculata*), Rutaceae[2]	0.65 (0.49–0.83)	Yellow brownish/ cream	Straight and a little bit interlocked	Fine and even	Quite shiny and quite smooth	II–III[3]	V[3]	Borneo, Timor, Molluccas, Sumatra
Ki bonteng (*Casearia tuberculata*), Flacourtiaceae[2]	0.68 (0.68–0.71)	White to pale yellow	Straight	Fine and even	Quite shiny and quite smooth	II	V[3]	Java, Sumatra
Mempulut (*Chrysophyllum roxburghii*), Sapotaceae[2]	0.71 (0.54–0.88)	White yellowish/ yellow brownish	Straight, sometimes interlocked	Fine and even	Quite shiny and smooth	II–III[3]	V[3]	Borneo, Molluccas, Sumatra
Jenitri (*Elaeocarpus sphaericus*), Tiliaceae[2]	0.49 (0.30–0.60)	White yellowish	Straight, sometimes interlocked	Quite rough and uneven	Quite rough and dull	III–IV[3]	V[3]	Borneo, Molluccas, Sumatra
Sendok-sendok (*Endospermum malaccense*), Euphorbiaceae[2]	0.45 (0.30–0.61)	White yellowish/ yellow brownish	Straight	Rough and uneven	Rough and quite dull	III[3]	V	Borneo, Riau
Kisampang (*Evodia aromatica*), Rutaceae[2]	0.41–0.57[3]	White yellowish/ Yellow brownish	Straight, sometimes interlocked	Fine and even	Quite rough and quite dull	II[3]	IV[3]	Sumatra
Kasap (*Gironiera nervosa*), Ulmaceae[2]	0.56 (0.46–0.75)	White yellowish	Straight	Fine and even	Quite shiny	II–III[3]	IV–V[3]	Sumatra, Borneo
Rubber (*Hevea brasiliensis*), Euphorbiaceae[2]	0.61 (0.55–0.70)	White yellowish	Straight, sometimes interlocked	Rough and even	Rough and quite dull	II–III[3]	V[3]	Sumatra, Borneo
Mensira gunung (*Ilex pleiobrachiata*), Aquifoliaceae[2]	0.61 (0.49–0.68)	White yellowish/ yellow brownish	Straight, sometimes interlocked	Fine and even	Quite shiny and smooth	II–III[3]	V[3]	Borneo, Celebes, Sumatra
Empaga (*Kibatalia villosa*), Apocynaceae[2]	0.56–0.70	White	Straight	Fine and even	Quite rough and dull	-	-	Celebes, Borneo, Sumatra
Perupuk (*Lophopetalum* sp.), Celastraceae[2]	0.45–0.69[4]	Bright yellow/ yellow brownish	Straight	Quite fine and even	Quite shiny	III – IV[4]	V[4]	Java, Sumatra, Celebes

(continued)

Appendix (continued)

Balik angin (*Mallotus blumenaus*), Euphorbiaceae[2]	0.42–0.75	Yellow brownish	Straight	Quite fine, quite coarse and even	Quite shiny	II[3]	V[3]	Java, Sumatra, Celebes, Borneo, Molluccas
Kayu kundur (*Mastixia* sp.), Cornaceae[2]	0.42–0.70	Yellow brownish to yellow	Straight, sometimes interlocked	Fine and even	Quite shiny	II–III[3]	V[3]	Borneo, Papua, Celebes, Sumatra
Baniran (*Neoscortechinii kingii*), Euphorbiaceae[2]	0.66 (0.40–0.86)	Broken white	Straight, sometimes interlocked	Quite coarse and uneven	Quite rough and quite shiny	II–III[3]	V	Sumatra, Borneo
Rambai burung (*Osmelia maingayi*), Flacourtiaceae[2]	0.65–0.74	Pale yellow	Straight	Fine and even	Quite shiny	-	-	Sumatra, Borneo, Molluccas, Papua
Pelaju (*Pentaspadon motleyi*), Anacardiaceae[2]	0.48–0.74	White yellowish	Straight, sometimes interlocked	Quite fine and even	Quite shiny	II–III[3]	IV[3]	Java, Papua, Timor, Celebes, Molluccas
Ki Honje (*Pittosporum* sp.), Pittosporaceae[2]	060–0.72	White yellowish/ yellow brownish	Straight, sometimes interlocked	Fine and even	Quite smooth and shiny	II	IV	Timor, Molluccas, Sumatra
Segoe/nyatoh putih (*Pouteria duclitan*), Sapotaceae[2]	0.71 (0.60–0.78)[5]	White yellowish / yellow brownish	Straight	Fine and uneven	Quite rough and quite shiny	II[3]	IV–V[3]	Sumatra, Borneo, Celebes
Belimbing hutan (*Sarcotheca diversifolia*), Oxalidaceae[2]	0.65–0.84	Pale white yellowish	Straight	Quite fine and even	Quite shiny	II	IV	Borneo, Celebes, Molluccas
Pimping (*Sterculia foetida*), Sterculiaceae[2]	0.64 (0.54–0.76)	White yellowish	Straight	Quite fine and even	Quite shiny and quite smooth	II–III[3]	III[3]	Java, Sumatra, Borneo, Molluccas, Celebes
Ketimon (*Timonius timon*), Rubiaceae[2]	0.62–0.88	Yellow brownish	Straight	Quite fine and even	Quite shiny	II – III[3]	II–III[3]	Java, Celebes, Molluccas, Borneo, Papua
Bitti (*Vitex* sp.), Verbenaceae[2]	0.48–0.99	Pale yellow brownish	Straight, sometimes interlocked	Fine to quite fine and even	Quite shiny	II – III[3]	IV–V[3]	Bali, Lombok, Celebes, Riau

(continued)

Appendix (continued)

Bentawas (*Wrightia tomentosa*), Apocynaceae[2]	0.55 (0.49–0.64)	White yellowish / yellow brownish	Straight	Fine and even	Quite shiny	III–IV	IV–V	Bali, Lombok, Timor, Molluccas, Sumatra
Kayu tanah (*Zanthoxylum rhetsa*), Rutaceae[2]	0.51 (0.30–0.66)	White yellowish / yellow brownish	Straight	Fine and even	Quite smooth and quite dull	III – IV[3]	V[3]	Java, Celebes, Borneo
Balobo (*Diplodiscus* sp.), Tiliaceae	0.67–0.81[5]	White yellowish	Straight	Fine to quite fine	Smooth and quite dull	II[7]	III[8]	Java
Kibulu (*Gironniera subasqualis*), Ulmaceae	0.44–0.67[3]	White yellowish	Straight	Fine	Shiny and smooth	III – II[3]	IV–V[3]	Java, Sumatra, Borneo, Papua
Saribanaek/Kibancet (*Turpinia sphaerocarpa*), Staphyleaceae	0.47–0.63[6]	Pale yellow	Straight	Quite fine	Shiny and smooth	III – IV[3]	V[3]	Java, Sumatra
Nyaling (*Mastixia trichotoma*), Cornaceae	0.40–0.60[3]	Yellow brownish to yellow	Straight, sometimes interlocked	Fine and even	Quite shiny	III[3]	V[3]	Java, Sumatra, Celebes, Borneo, Molluccas

Data without superscript are original data; data with superscript are secondary data; [1]secondary data; [2]Rulliaty (2005); [3]Oey (1990); [4]Martawijaya *et al.* (2005b); [5]Hadjib (2005); [6]Hadjib (2006); [7]Hadjib (2004a); [8]Sumarni and Muslich (2004); [9]Lemmens *et al.* (1994, 1995, 1998)