

MACHINING PROPERTIES OF *KHAYA IVORENSIS* AND *KHAYA SENEGALENSIS*

A Khairul, K Roszaini, M Khairul & A Siti Zaliha

Introduction

Machining properties of wood is very important in the production of high-quality wood-based products such as premium furniture. Knowing the machining properties helps manufacturers to plan for factory's operating and maintenance costs. Among the normal activities carried out in wood processing factory include planing, sanding, turning, boring, mortising and shaping. To obtain a smooth surface, wood needs to be planed and ripped before cross cutting it to the required dimensions. To produce the required shape or profile, certain wood might need to be moulded, shaped or turned. Others might need to be machined for jointing or for producing tenon and mortise for hardware fixtures. The knowledge regarding machining properties of any wood species would help in deciding the appropriate type of cutting tools, cutting or feeding speed and pressure needed during fabrication or finishing of products.

A study was carried out to determine the wood machining quality of two planted mahogany species (*Khaya ivorensis* and *Khaya senegalensis*). Mahogany is one of the most widely planted timber species targeted to produce general utility timber (Abdul Rasip et al. 2004). Other species such as *Acacia mangium*, teak (*Tectona grandis*), sentang (*Azadirachta excelsa*) and rubber wood (*Hevea brasiliensis*) are also highlighted by the government as plantation species meant for the wood industries. *Khaya* was selected due to its high growth rates equivalent to those of fast growing species such as *A. mangium*, sesenduk (*Endospermum malaccense*) and merawan siput jantan (*Hopea odorata*) (Lok & Ong 2002).

K. ivorensis is classified as a moderately durable hardwood timber, possesses fairly regular grain, easy to work but difficult to impregnate with wood preservative. The timber was determined by Lamprecht (1989) to possess an average density of about 560 kg/m³ and 580–690 kg/m³ as determined by Khairul et al. (2006). *K. senegalensis* is a hardwood species of high quality, moderately soft and light wood material (Hashim 2005). The weight (air dry) of this species varies between 560–660 kg/m³ (Khairul et al. 2006). Both species are important material for furniture, indoor decoration (solid or veneer), high quality joinery for staircases, paneling and domestic flooring, boat planking and cabins, banisters and handrails. *K. senegalensis* is said to have the best surface finishing as compared to other African mahoganies. It is a popular timber in east Africa for lorry bodies, construction work and boats decking apart from the normal uses as furniture etc. (Lemmens 2008).

Wood properties

Table 1 and 2 list the basic physical and mechanical properties of two *Khaya* species.

Table 1 Physical properties of two *Khaya* species

Species	<i>K. ivorensis</i>	<i>K. senegalensis</i>
a. Classification	Light hardwood	Light hardwood
b. Density	580–690 kg/m ³	560–660 kg/m ³
c. Age of timber	(14–16 year-old)	(15 year-old)
d. Moisture content		
i. Green	62%	59.9%
ii. Air dry	14%	15.5%

Source: Khairul A. et al. 2006

Table 2 Mechanical properties of two *Khaya* species

Species	<i>K. ivorensis</i>	<i>K. senegalensis</i>
a) Modulus of rupture (N/mm ²)	71–126 ^b	66 ^a
b) Modulus of elasticity (N/mm ²)	8700–10800 ^b	6210 ^a
c) Compression parallel to grain (N/mm ²)	37–48 ^b	36 ^a
d) Shear parallel to grain (tangential) (N/mm ²)	8–12 ^b	17 ^a

Source: Khairul A. et al. (2006)^a, Lemmens (2008)^b



K. ivorensis

Source: Nordahlia et al. (2013)



K. senegalensis

Source: Khairul A et al. (2006)

Figure 1 Cross sections of *K. ivorensis* and *K. senegalensis* in green condition

Sawing and wood machining properties

Based on ASTM D 1666-87: 2004, it was observed that both *Khaya* species were hard to rip in green condition due to the existence of interlocked grain. In terms of sawing, both species were moderately easy to saw, almost similar to other tropical timber species.

(a) Planing and sanding

The sanding property was expressed in percentage of fuzzy grains or scratching on the specimen surface after sanding. The qualitative assessment for planing test based on five rating scale for *Khaya* is as shown in Table 3.

Table 3 Classification of planing and sanding quality

Rating	Remarks
1	Excellent
2	Good
3	Fair
4	Poor
5	Very poor

(b) Turning

Turning test was done by visual assessment or touch on the wood surface. The turning property was assessed as being easy, difficult or very difficult.

(c) Boring, mortising and moulding

Boring property was assessed on the holes for crushing, tear outs, fuzziness and general smoothness on a scale of five similar to turning. Figure 2(a) shows the samples used during assessment. The quality of mortises was graded based on the same scale. The defects to be considered while grading mortises were crushing, tearing and general smoothness of cut as shown in Figure 2(b). The samples were cut across the holes and examined.

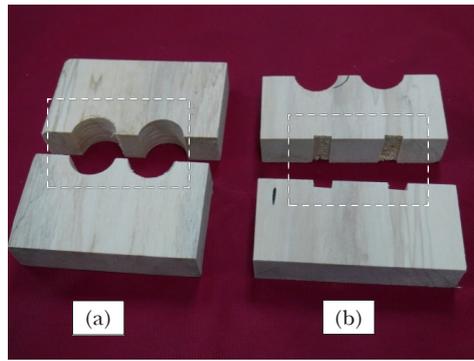


Figure 2 (a) Boring and (b) mortising samples

In moulding process, both *Khaya* species showed only fair quality. All properties were also discussed by Lemmens (2008) who reported that both *Khaya* species were easy to work with (sawing, turning, boring and sanding) and very good in holding of nail and screws, as well as having good gluing properties. Figure 3–8 show the machining of *Khaya* species for properties assessment.



Figure 3 Sawing in green condition



Figure 4 Surface observation after planing



Figure 5 Sanding using 60 and 180 grit



Figure 6 Bored (top) and mortised (bottom) wood



Figure 7 Wood moulded using selected profile



Figure 8 Turning process

Table 4 Summary of properties of two *Khaya* species based on six machining tests conducted

Machining test	<i>K. ivorensis</i>			<i>K. senegalensis</i>		
	Fair	Good	Excellent	Fair	Good	Excellent
1) Turning	████████████████████			████████████████████		
2) Mortising	████████████████			████████████████████		
3) Planing	████████████████			██████████████████		
4) Sanding	████████████████			██████████████████		
5) Boring	████████████████			██████████████████		
6) Moulding	██████████			██████████		

Summary

Based on density test conducted, both *Khaya* species can be considered as light hardwood. From the machining properties both species have the potential to be used for light to moderate furniture, high quality joinery works, souvenir items, paneling veneers and flooring.

References

- ASTM-D 1666-87. 2004. Standard test methods for conducting machining tests of wood and wood based materials.
- ABDUL RASIP AG, AHMAD ZUHAIYI Y, MOHD ZAKI A, ROSDI K, MOHD NOOR M, MOHD FARID M & MOHD FAUZI MS. 2004. Matrix—Selected plantation species. Forest Research Institute Malaysia, Kepong.
- LOK EH & ONG TH. 2002. *Khaya ivorensis*. Pp 215–229 in Krisnapillay B (Ed): A manual for forest plantation establishment in Malaysia. *Malayan Forest Records No. 45*. Forest Research Institute Malaysia, Kepong.
- HASHIM MN & ROSDI K. 2005. Planting and managing trees for high quality timber production. *In Conference Forestry and Forest Products Research*, FRIM, Pan Pacific Hotel 22–24 November 2005.
- KHAIRUL A, AB RASIP AG, ONG TH TAMIZI M, MOHD ZAKI A & ZAMANI WY. 2006. Machining Properties of *Khaya Senegalensis* from the urban roadside tree. *In Conference on Natural Resources in The Tropics: Development and Commercialization of Tropical Natural Resources; 291–293*.
- LAMPRECHT H. 1989. *Khaya ivorensis*. Tree species-possibilities and methods for their long term utilization. Silviculture in the tropics. German agency for technical cooperation (GTZ). Eschborn: 296.
- LEMMENS RHMJ. 2008. *Khaya ivorensis* A. Chev. In Louppe D, Oteng-Amoako AA & Brink M (Eds) Prota 7(1): *Timbers/Bois d'oeuvre I*. PROTA, Wageningen. (CD).
- NORDAHLIA AS, HAMDAN H & ANWAR UMK. 2013. Wood properties of selected plantation species: *Khaya ivorensis* (African mahogany), *Azadirachta excelsa* (sentang), *Endospermum malaccense* (sesendok) and *Acacia mangium*. *Timber Technology Bulletin* FRIM No 51:1–8

© Forest Research Institute Malaysia 2017

Series Editor : MK Mohamad Omar
 Managing Editor : S Vimala
 Typesetter : Y Rohayu

Set in NewBaskerville 11

MS ISO 9001:2008



Printed by Publications Branch, Forest Research Institute Malaysia
 52109 Kepong, Selangor