UREA-FORMALDEHYDE PARTICLEBOARD FROM YEMANE *(GMELINA ARBOREA)*

L.T. Chew, C.L. Ong

Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia.

&

Suhaimi Muhammad

Mara Institute of Technology, Shah Alam, Selangor Darul Ehsan, Malaysia.

Received April 1988, accepted July 1988.

CHEW, L.T., ONG, C.L. & SUHAIMI MUHAMMAD. 1988. **Urea-formaldehyde particleboard from yemane** *(Gmelina arborea).* Yemane, one of the species of the Compensatory Forest Plantation Programme, provides a source of suitable raw material for the manufacture of medium density urea-formaldehyde particleboards. This study indicates that yemane can be successfully blended with flakes of other species to produce urea-formaldehyde particleboards to meet the requirements of Type 1 Standard Board. The good strength properties of urea-formaldehyde particleboards comprising the flakes of yemane, batai *(Albizia falcataria)* and *Acacia mangium* indicate that these species are potential raw material for urea-formaldehyde particleboard manufacture.

Key words : Yemane – urea-formaldehyde – particleboard.

Introduction

Yemane (*Gmelina arborea*), a fast growing tropical plantation tree species, has been selected as one of the species for the industrial tree plantation programme in Malaysia. It holds great promise as a potential source of timber for pulp and other purposes (Wong & Khoo 1980). The timber has excellent working properties. Although it has been tried for furniture, panelling and matches manufacture, no work has apparently been reported to date on its use for urea-formaldehyde particleboard (U-F board) manufacture. In this paper, we examine the potential of yemane as a source of raw material in the manufacture of medium density U-F board.

Materials and methods

Raw material

Samples from two 12-year old yemane trees were collected from the plantations in

Kepong. The raw material used for boardmaking trials was from those sections of the logs that were not used for peeling trials. Most of the samples were in the form of billets of short lengths, *c.* 30 *cm*. Density measurements on the wood samples were carried out.

The billets were initially cut into 3 *cm*—thick discs and further processed into chips of approximately 30 x 20 x 66 *cm*. These chips were then fed into a knife-ring flaker, with knives set to produce 0.6 *mm* thick flakes. As the flakes obtained from the knife-ring flaker were found to be of suitable dimensions for board-making, no further processing by the disintegrator was necessary. The flakes were dried to less than 5% moisture content before sieving to separate the fines from the flakes. Sieve analysis and bulk densities of the flakes were made.

Board-making

Single-layer UF-boards

Measured quantities of flakes and fines sufficient for the production of 19 *mm* thick UF-boards of varying densities were sprayed in a Drais mixer with a resin mix containing urea formaldehyde (UF), hardener and water. The sprayed particles and fines with a controlled moisture content of 12% were laid in a wooden mould and pre-pressed at 3.5 kg/cm^2. The consolidated mat was finally pressed between two stainless steel caul plates in an electrically heated hydraulic press maintained at 160°C for 8 *min*. Different sets of single-layer homogeneous UF-boards comprising yemane flakes and an equal amount of separately oil palm (*Elaeis guineensis*), keruing (*Dipterocarpus* spp.), industrial wood wastes and rubberwood (*Hevea brasiliensis*) were produced. In addition, a set of homogeneous UF-boards comprising equal amounts of flakes of yemane, mangium and batai (*A. falcataria*) was produces.

Three-layer UF-boards

For three-layer UF-boards, the surface layers consisted of yemane flakes which accounted for 50% by weight of the material used for making each piece of UF-board. Different sets of UF-boards were made with the core layer comprising flakes from one of the following: oil palm, keruing, industrial wood wastes and rubberwood. The conditions of manufacture for the three-layer UF-boards were the same as that for the single-layer UF-boards. All the UF-boards were cut into test pieces and conditioned in a constant temperature and humidity room (20°C and 65% relative humidity). Strength and dimensional stability tests were carried out according to B.S. 5669 : 1979 "Specification of wood-chipboard and methods of test for particleboards" (Anonymous 1979).

Results and discussion

The particle classification of the flakes is as follows:

Sieve size (*mm*)	<0.25	>0.25	>0.5	>1.0	>1.4	>2.0	>2.8	>3.4	>5.6
Weight (%)	2.2	2.8	8.5	9.9	12.3	12.9	7.2	22.8	21.4

The average bulk density of the yemane flakes was 69.2 *g/l* at 5% moisture content while the average density of the green wood of yemane was 430.0 *g/l.*

Single-layer UF-boards

Single-layer UF-boards of densities 481, 561 and 641 kg/m^3 were produced. UF-boards of densities around 700 kg/m^3 gave blowing problems. This was also observed in the study of similar low density tropical hardwood species from Papua New Guinea (Iwashita 1980). Moslemi (1974) attributed the blowing problems to the interaction between mat moisture content and board and the particle densities during hot pressing. The quantity of particles in a certain volume of particle mat would increase with a decrease in the specific density of the raw material resulting in smaller openings for the steam flow within the particle mat during hot pressing. Consequently, a build-up of steam pressure occurs within the board and leads to blowing as steam is not sufficiently vented from the board. Hence it was not possible to produce UF-boards of density 700 kg/m^3 and above from wood species with densities lower than 0.5 *g/ml*. As a few UF-boards of density 700 kg/m^3 produced from yemane showed similar blowing problems, no UF-boards of such density were available for evaluation. Previous studies of particleboards from batai (Wong & Ong, unpublished) and mangium (Chew & Jaaffar 1986) showed that their average wood densities are 0.24 and 0.41 *g/ml*, respectively. In the above studies, there were also blowing problems during particle-board making.

Table 1 gives some of the strength and dimensional stability properties of single layer UF-boards manufactured from the yemane flakes, while Table 2 gives similar properties of both the local and commercial particleboards as well as the mean quality levels of the different types of boards stipulated in British Standards B.S. 5669 : 1979 (Anonymous 1979).

All the experimental UF-boards with densities above 550 kg/m^3 and resin contents in the range of 6 to 12% met the bending strength (MOR) requirement of Type I boards as specified in the British Standards B.S, 5669 : 1979 (Table 2). For the Internal Bond (IB) requirement, a minimum resin content of 8% and density of 640 kg/m^3 for UF-boards are necessary; with a higher resin content of 10%, lower density UF-boards of slightly less than 600 kg/m^3 could satisfy the IB of the British Standards. Increased resin content and board density considerably improved all the

Table 1 . Strength and dimensional stability properties of single layer UF boards from yemane

(Press temperature : $160^{\circ}C$; Pressing time : 8 *min*)

Sample	Resin Contents (%)	Density (kg/m^3)	Bending Strength (MPa)	Internal Bond (MPa)	Screw Withdrawal (N)	Water Absorption (%)	Thickness Swelling (%)
A	6	497	13.9	0.15	318	22.0	11.1
B	6	559	18.3	0.19	416	22.6	10.1
C	6	642	18.6	0.17	463	10.4	7.2
D	8	498	13.3	0.12	379	14.6	5.8
E	8	567	18.7	0.22	476	10.7	3.7
F	8	639	22.9	0.49	516	6.3	2.5
G	10	509	13.3	0.32	497	16.5	7.3
H	10	589	17.9	0.66	607	13.5	4.4
J	10	654	24.7	0.75	691	7.4	3.4
K	12	502	12.5	0.50	549	20.7	7.4
L	12	590	23.1	0.71	635	8.1	3.7
M	12	646	27.0	0.77	681	5.0	2.8

Table 2 . Strength and dimensional stability properties of commercial particleboards and different types of particleboards stipulated in B.S. 5669 : 1979

	Density (kg/m^3)	Bending Strength (MPa)	Internal Bond (MPa)	Screw Withdrawal (N)	Water Absorption (%)	Thickness Swelling (%)
Malaysian commercial particleboard (a)	714	26.9	0.66	543	NA	6.9
British commercial particleboard (b)	610 – 640	14.0	0.35	360	9.0	NA
B.S. 5669 – 1979 (c) Type I*	NA	13.8	0.34	360	NA	12
Type II*	NA	17.0	0.50	NA	NA	10
Type III*	NA	19.0	0.50	NA	NA	8

(a) – Standard and Industrial Research Institute of Malaysia (1979)

(b) – Anonymous, 1969

(c) – British Standard Institution, 1979.
Type I* Standard
Type II* Flooring
Type III* Improved Moisture Resistance

NA – Not Available

thickness swellings and screw withdrawal values. All the UF-boards satisfied the screw withdrawal requirements and had thickness swelling values well below the stipulated maximum rate of 12% in the British Standards, with the exception of Sample A (board density 497 kg/m^3 and 6% resin content, Table 1). Thus, to satisfy all requirements of Type I Standard Board, UF-boards must have a minimum density of 640 kg/m^3 and 8% resin content.

Table 3 gives the strength and dimensional stability properties of single-layer UF-boards manufactured from equal amounts of yemane flakes and separately flakes from keruing, rubberwood, oil palm and industrial wood as well as from an admixture, comprising equal amounts of flakes of yemane, mangium and batai. All the experimental boards comprising flakes of yemane and other species met the requirements of Type I boards as specified in the British Standards. UF-boards comprising equal amounts of yemane, batai and mangium (Sample S) showed the highest strength values.

Three-layer UF-boards

Table 4 gives the properties of three layer UF-boards comprising flakes of yemane for the surface layers and flakes of other species for the core layer.

All the experimental three layer UF-boards satisfied the requirements of Type I board, as specified in the British Standards. It is difficult, however, to specify which sample had the best properties because no sample displayed maximum or minimum values in all the dimensional stability and strength properties. Sample U (comprising industrial wood wastes), for example, gave the best internal bond, water absorption and thickness swelling values but lost out to sample W (comprising oil palm flakes) in bending strength and screw withdrawal. On the other hand, Sample V (comprising rubberwood flakes) showed the weakest internal bond, screw withdrawal and water absorption properties but was superior to Sample T (comprising keruing flakes) in the bending strength and thickness swelling values.

Conclusions

Yemane was found to be a suitable wood species for the manufacture of medium density UF-boards because single layer UF-boards with at least 8% resin content and density 640 kg/m^3 met the requirements of Type I board, Standard Board, as specified in the British Standards, 5669 : 1979. Yemane could successfully be blended with flakes of other denser woods, for example, keruing (average density 0.80 g/ml) and rubberwood (average density 0.64 g/ml), to produce standard medium density UF-boards, either as homogeneous single layer UF-boards or three layer UF-boards.

Table 3 . Strength and dimensional stability properties of UF-boards of yemane and other species

(Press temperature : $160^{0}C$; Pressing time : 8 *min*; Resin content : 8%)

Sample	Species	Density (kg/m^3)	Bending Strength (MPa)	Internal Bond (MPa)	Screw Withdrawal (N)	Water Absorption (%)	Thickness Swelling (%)
N	Yemane & keruing	653	19.2	0.40	663	11.4	5.4
P	Yemane & industrial wood flakes	667	21.1	0.43	549	8.0	3.1
Q	Yemane & rubberwood	641	22.2	0.36	560	22.3	6;3
R	Yemane & oil palm	672	21.9	0.51	698	13.6	6.0
S	Yemane & batai & mangium	657	28.7	0.71	777	12.3	6.6

Table 4 . Strength and dimensional stability properties of three layer UF-boards comprising flakes of yemane for the surface layers and flakes of different species for the core layer

(Press temperature : 160^{o}C; Pressing time : 8 *min*; Resin content : 8%)

Sample	Core layer	Density (kg/m^3)	Bending Strength (MPa)	Internal Bond (MPa)	Screw Withdrawal (N)	Water Absorption (%)	Thickness Swelling (%)
T	Keruing	649	18.3	0.50	685	16.8	8.2
U	Industrial wood wastes	667	22.5	0.55	662	7.1	3.5
V	Rubberwood	638	20.6	0.41	659	39.8	6.7
W	Oil palm	648	23.6	0.52	741	29.0	9.2

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