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MANUFACTURE OF MELAMINE UREA FORMALDEHYDE PARTICLEBOARD FROM HUJAN PANAS (*Croton argyratus*)

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ABSTRACT

Croton argyratus locally known as hujan panas was used in the manufacture of melamine urea-formaldehyde and cement-bonded particleboard. It has an average specific gravity 700 kgm^{-3} and the high holocellulose content indicates its potential as a raw material for board manufacture. Single-layer particleboard with a resin content of 6 to 10% (with 1% wax addition) was able to meet all the minimum requirements of the BS 5669 British Standards for particleboard. Three-layer boards were also able to surpass the requirements.

INTRODUCTION

Croton argyratus is locally known as hujan panas comes under the family of *Euphorbiaceae*. It is easily recognized by its distinct golden bronze color below the leaves surface. Its bark has a sweet smell and is used locally as a medicine to cure purging, decoction for diarrhea and use after childbirth. Its timber is said to be used as timber for houses and fuel. As it is a fast-growing plant, it could be a ready source of raw materials for the manufacture of melamine urea formaldehyde (MUF). This paper examines the properties of MUF-boards from *Croton argyatus*.

MATERIALS AND METHODS

Sample collection and preparation

Six trees with a diameter breast height (DBH) between 10 cm to 16 cm were felled from UiTM Forest reserve in Jengka, Pahang Darul Makmur. The trees were then cut into six feet length including the big branches. A one-inch disc at DBH height level was cut from each tree for the determination of specific gravity and proximate chemical analysis. Remaining wood samples were then subsequently processed for board manufacture.

Specific gravity determination

For specific gravity (SG) determination, sample strips 2 cm in width were taken starting from the pith to the bark section. The strips were then divided into three equal portions and signated as near pith (NP), middle section (MS) and near bark (NB). All samples were marked and soaked until saturation. SG was then determined using TAPPI standard method T-258 (Anon 1978).

Proximate chemical analysis

Sample not used for SG determination were converted into matchstick sizes and then ground into wood meal using a wiley mill. Wood meals that are retained on sieve size of 60BS are collected for chemical analysis. The following standard procedures were used;

a. Hot and Cold water solubility - TAPPI 1979
b. 1 % NaOH Solubility - TAPPI 1979
c. Alcohol benzene solubility - TAPPI 1979
d. Holocellulose Content - Wise et al.(1946)
e. Lignin Content - TAPPI 1979
f. Ash content - TAPPI 1979

Particle preparation for MUF-board manufacture

Chips produce by the Pallman drum chipper were flaked by a Pallman knife ring flaker with knives set at 0.6 mm. After flaking the particles produced were air dried for 1 week and then screened into 0.5, 1.0 and 2.0 mm particle sizes. Since the particle size of 0.5 mm was not enough, oversized particles are reflaked and screened again. The screened particles are then dried in the oven set at 60 C until it reaches a moisture content of less than 5%. Sieve analysis and bulk densities of the particles were determined.

Particleboard manufacture

Measured quantities of flakes and fines for the production of 12 mm thick single and three-layered melamine urea formaldehyde (MUF) boards at varying resin and wax content were sprayed in a glue mixing tank with a resin mix containing MUF, hardener and water. The target board density was set at 721 kgm^{-3}. The sprayed flakes with a controlled m.c of 12% were then laid in a wooden mould and pre-pressed at 8 $kgcm^{-2}$. The consolidated mat was finally pressed in a Taihei hot press at 160 °C for 6 minutes.

Board evaluation

All the boards were cut into test pieces and conditioned in constant temperature and humidity room (20°C and 65% relative humidity). Strength and dimensional stability tests were carried out according to the BS 5669: Part 1 1989 " Specification for Wood Chipboard and Methods of Test for Particleboard" (Anon 1989).

RESULTS AND DISCUSSION

Specific Gravity and Chemical Composition

Table 1 gives the specific gravity and approximate chemical composition of *Croton argyratus*. It has a SG of 700 kgm^{-3} and gives low bulk density. The high holocellulose content indicates its potential as a supplier of lignocellulosic material for board manufacture.

Table 1. Specific Gravity and Approximate Chemical Composition of Croton

Specific Gravity (kg m^{-3})	700
Hot Water Solubles (%)	5.80
Alcohol Benzenes Solubles (%)	0.55
Ash Content (%)	0.42
1 % NaOH Solubles (%)	15.40
Lignin Content (%)	23.60
Holocellulose Content (%)	76.80
Alpha-cellulose Content (%)	53.90

Values are averages of three determinations

Particle analysis

Table 2 gives the percentage by weight of the particles of various sizes for the manufacture of MUF-board and CBP. The average bulk density of the particles for board manufacture was 89.1 gl-1 at 5% moisture content.

Table 2. Particle classification of *Croton* particles

Sieve size (mm)	Percentage by weight (%)
< 0.25	0.9
0.25	4.4
0.50	14.9
1.00	14.1
1.40	19.1
2.00	14.9
2.80	4.8
3.35	26.9
Particle thickness t (mm)	0.37
Particle length L (mm)	16.33
Slenderness ratio (L/t)	44.14

Values are averages of 2 determinations

Properties of MUF Board

Properties of single layer MUF boar

The physical and strength properties of single layer MUF particleboard are shown in Table 3. MUF- boards with resin contents of 6 to 10% met all the strength properties requirements of the BS 5669. Increasing resin content improved significantly all the strength properties and also the dimensional stability of the boards. With a 1% wax addition the thickness swelling of the boards were significantly reduced and are able to surpassed the minimum requirements of 12 % as stipulated in the BS standards. Table 4 gives the ANOVA and the effect of varying resin and wax contents on the properties of the MUF-boards.

Table 3. Properties of MUF-Particleboard manufacture from Croton

RESIN (%)	WAX (%)	MOR (MPa)	IB (MPa)	SW (N)	WA (%)	TS (%)
10	Control	26.02	1.34	1028	43.3	6.43
	1	22.14	0.70	872	15.4	4.81
8	Control	22.36	1.09	842	51.2	9.64
	1	18.90	0.62	693	17.2	5.95
6	Control	18.13	1.04	824	58.5	17.0
	1	18.36	0.43	620	23.3	11.0
BS 5669		>13.8	>0.34	>360	-	<12.0

Values are average of 6 determinations
Note: MOR - Modulus of Rupture, IB - Internal bond, SW- Screw withdrawal, WA-Water absorption and TS-Thickness swelling

Table 4. Analysis of variance (ANOVA), the effect of varying resin and wax content on the board properties

SOV	DF	MOR	IB	SW	WA	TS
RESIN(R)	2	103.04**	0.21**	2.3E5**	403.9**	226.15**
WAX(W)	1	50.60**	3.46**	3.5E5**	9421.9**	128.97**
R X W	2	15.28**	0.11**	3.7E3ns	45.1**	14.69**
RESIN (%)						

10		24.10a	0.97a	950a	29.37c	5.62c
8		20.63b	0.84b	768b	34.18b	7.79b
6		18.25c	0.74b	722b	40.92a	13.98a
WAX (%)						

1		19.80b	0.58b	728b	18.6b	7.24b
Control		22.17a	1.14a	898a	51.0a	11.02a

Note; ns and **, mean squares are not significant at the 5% and highly significant at 1% probability level. Means having the same letter down the column are not significantly different at the 5% probability level.

The analyses showed that the effects of changes in resin and wax contents on the dimensional stability and strength properties were highly significant at the 1% probability level. A similar trend was reported by Stegmann and Durst (1964) and attributed this phenomenon to the resistance wax offers during gluing.

Properties of three-layer MUF board

Table 5 gives the dimensional and strength properties of the three-layer MUF boards manufactured from *Croton*. The MOR, IB and SW values of the particleboard manufactured surpassed the minimum requirements stipulated in the BS 5669. Only control board having a resin content of 8-6-8 % failed in the TS. Addition of 1% wax content improved the dimensional properties of the board.

Increments in resin contents within the surface and core layers increased the strength properties and decreased the thickness swelling significantly. Moslemi (1974) and Siti Norralakmam & Razali (1992) also observed similar board properties - resin content relationship. Wax addition was used to enhance the dimensional stability of the board. In this study the addition of 1% wax content shows a significant improvement in the thickness swelling (Table 6). However the strength properties were also significantly reduced.

Table 5. Properties of three-layer MUF-boards

RESIN (%)	WAX (%)	MOR (MPa)	IB (MPa)	SW (N)	WA (%)	TS (%)
12-10-12*	Control	25.09	0.81	1054	41.90	7.22
	1	22.44	0.66	768	26.67	6.21
10-8-10	Control	24.72	0.72	985	49.70	8.67
	1	23.85	0.59	719	15.80	4.30
8-6-8	Control	22.58	0.60	754	59.90	12.15
	1	19.40	0.44	435	17.80	5.92
BS 5669		>13.8	> 0.34	>360	-	<12.00

Table 6: Analysis of variance and the effects of varying resin and wax content on the board properties

SOV	DF	MOR	IB	SW	WA	TS
RESIN (R)	2	37.75*	0.11*	454315*	120.12*	23.81*
WAX (W)	1	45.00*	0.16*	1012392*	8329 60*	134.87*
R X W	2	4.39ns	0.00ns	2962ns	569.92*	21.06*

Resin (%)	MOR	IB	SW	WA	TS
12-10-12	23.76a	0.73a	911a	34.28b	6.72b
10- 8-10	24.28a	0.65b	852a	32.75b	6.48b
8- 6 -8	20.99b	0.52c	594b	38.83a	9.03a

WAX (%)	MOR	IB	SW	WA	TS
Contro					
1	24.13a	0.71a	931a	50.50a	9.35a
1	21.89b	0.56b	641b	20.08b	5.47b

Note: ns= mean squares are not significant at the 5%

* = significant at $P<0.01$ probability level

Means having the same letter down the column are not significantly different at $p<0.05$

CONCLUSIONS

Croton argyratus was found to be a suitable species for the manufacture of MUF particleboards. The MUF-boards at a density of 721kgm^{-3} with a minimum resin content of 6% and 1% wax content met all the requirements of the British Standard for single-layer particleboard. Three-layer particleboard with 1 % wax addition and at all the resin content also met the requirements.

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