



UNIVERSITI PUTRA MALAYSIA

**PRODUCTION AND PROPERTIES OF 'BULUH SEMANTAN'
(*Gigantochloa scortechinii* Gamble) HARDBOARD COMPARED TO
COMMERCIALY PRODUCED PINE HARDBOARD**

SABIHA SALIM

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By

SABIHA SALIM

**Thesis Submitted to the School of Graduates Studies,
Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree
of Master of Science**

September 2007



Specially dedicated to:

My mother

NORIMAH BT MD DALI

&

My father

SALIM B HARUN

Love is the only rationale act...

Abstract of thesis presented to the Senate of the Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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(*Gigantochloa scortechinii* Gamble) HARDBOARD COMPARED TO
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September 2007

Chairman : Associate Professor Zaidon Ashaari, PhD

Faculty : Forestry

Bamboo, a fast-growing plant with great versatility is being manufactured into various products of wood composites. In Malaysia, Buluh Semantan (*G. scortechinii* Gamble) is the most commercially utilised bamboo species and currently, fast being studied on its anatomical, physical and mechanical properties for contribution towards expanding the bamboo industry. Another potential product utilising bamboo fibre is hardboard, due to its long fibres produced good fibre bonding and strong hardboard. A study was conducted to determine the potential of utilizing bamboo (*Gigantochloa scortechinii*) for hardboard production. The objective of this study were to prepare and evaluate the bamboo fibre after undergone pre-treatment processes prior to refiner mechanical pulping (RMP), to determine the optimum pre-treatment process



for fibre production, and to evaluate the mechanical and physical properties of hardboard from bamboo compared to those of commercial hardboard from pine. Bamboo chips were either treated by soaking in 2% (w/v) sodium hydroxide (NaOH) solution at 60°C for 4, 6 and 8 h or by steaming at 170°C at 5.95 kgcm⁻² pressure for 3 h to soften them. The results showed that chips pre-treated with NaOH yielded higher fibre recovery (77.2%) compared to those of steamed (50.7%). Fibre recovered from NaOH pre-treatment produced more unbroken fibres than those of steam. Fibre after undergone steam pre-treatment produced darker fibres compared to those of NaOH treated. Thus, from these measurements of fibre recovery and morphology, fibre from NaOH pre-treated produced better fibre quality than those of steam-treated. It was also found that soaking in 2% NaOH for 6 h was the most optimum treatment condition for the bamboo fibre. Thirty 3-mm hardboards (density, 1000 kgm⁻³) prepared from the pre-treated fibres of bamboo, with and without resin and additives were then fabricated. Phenol formaldehyde (PF) resin at two concentration levels, i.e., 1% and 2% (based on oven dry weight of board), wax emulsion at 1% and 2% (based on oven dry weight of board), and alum (Al₂(SO₄)₃) at 0.25% (based on oven dry weight of board) were added selectively to enhance the properties of the boards. Boards were hot pressed at 180°C for 20 min and tempered in a forced circulation oven at 160°C for 6 h. Physical and mechanical properties of the boards were evaluated in accordance with Japanese Industrial Standard for Fibreboard (JIS A 5305-2003). Properties of commercial hardboard made from

pine of the same thickness were also tested for comparison purposes. The results showed that all bamboo hardboards produced from NaOH pre-treated fibres showed higher Modulus of Rupture (MOR) and Modulus of Elasticity (MOE) values compared to the commercial hardboard. NaOH pre-treated board with 2% PF resin+1% wax and 2% PF resin+2% wax had the highest bending strength values (MOR values) but poor in dimensional stability compared to the commercial hardboard. Bamboo hardboards without resin and additives produced from steam-treated fibres showed lower MOR and IB values compared to those produced from NaOH pre-treated fibres. The bamboo hardboards without resin and additives showed lower MOR and Internal Bond (IB) values compared to those with resin and additives. Increasing PF resin and wax levels of concentration from 1% to 2% had increased the strength and stiffness properties of bamboo hardboards; namely the MOR, MOE and IB and was significant at $p < 0.01$. The Internal Bond (IB) value showed the highest for hardboard with 2% PF resin+2% wax though was lower than the commercial hardboard (1.64 and 1.92, respectively). Bamboo hardboard was superior in terms of bending strength when compared to the commercially produced hardboard. Meanwhile for dimensional stability, bamboo hardboards showed poorer resistant to water absorption (WA) than the commercial and the value did not meet the JIS Standard specified.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PEMBUATAN DAN PENILAIAN SIFAT PANEL GENTIAN
BERKETUMPATAN TINGGI DIPERBUAT DARIPADA BULUH
SEMANTAN (*Gigantochloa scortechinii* Gamble) DIBANDINGKAN
DENGAN PANEL KOMERSIAL DARIPADA PINE**

Oleh

SABIHA SALIM

September 2007

Pengerusi : Professor Madya Zaidon Ashaari, PhD

Fakulti : Perhutanan

Buluh merupakan tanaman spesis cepat tumbuh dan serbaguna yang digunakan untuk pembuatan pelbagai produk kayu gubah. Di Malaysia, Buluh Semantan (*G. scortechinii* Gamble) adalah spesies komersial yang popular digunakan dan pelbagai kajian dijalankan tentang sifat-sifat anatomi, fizikal dan mekanikal dalam membantu menaikkan industri buluh. Antara produk yang berpotensi untuk diperbuat daripada buluh ialah papan gentian berketumpatan tinggi, memandangkan gentian buluh adalah panjang dan berupaya menghasilkan produk tersebut yang kuat terutamanya dari segi kekuatan ikatan gentian. Penyelidikan ini dijalankan untuk mengkaji potensi penggunaan buluh tropika (*Gigantochloa scortechinii*) untuk penghasilan kayu

gention berketumpatan tinggi. Objektif kajian ini adalah menganalisa kesan pra-rawatan sodium hidroksida (NaOH) dan pengewapan ke atas sifat gention sebelum dipulpa menggunakan kaedah Pempulpaan mekanikal (RMP). Seterusnya, untuk menentukan pra-rawatan gention yang optima, justeru itu mencirikan sifat-sifat mekanikal dan fizikal yang terhasil daripada gention yang terawat. Cip-cip kayu terlebih dahulu dirawat dengan merendam di dalam larutan sodium hidroksida berkepekatan 2% (berat/isipadu) pada suhu tetap 60°C selama 4, 6 dan 8 jam atau mengewap/ menstim pada suhu 170°C dan tekanan 5.95 kgcm⁻² selama 3 jam untuk melembutkan cip-cip tersebut. Kedua-dua pra-rawatan ke atas cip-cip menggunakan stim dan NaOH mempengaruhi sifat morfologi gention dan warna pulpa yang terhasil. Gention terhasil dari rawatan dengan NaOH memberikan hasil gention yang banyak, dengan 77.2% berbanding stim; hanya 50.7%. Gention yang telah dirawat dengan NaOH menghasilkan lebih banyak gention yang tidak patah daripada gention yang dirawat dengan stim. Gention yang dirawat dengan stim menghasilkan gention yang berwarna gelap manakala gention dirawat dengan NaOH menghasilkan gention yang berwarna cerah. Daripada pengiraan pulangan gention yang terhasil dan pengukuran morfologi gention, gention terawat dengan NaOH menghasilkan gention yang lebih berkualiti berbanding gention terawat dengan stim. Selain itu, didapati bahawa rawatan optimum untuk melembutkan cip buluh sebelum proses pempulpaan adalah dengan merendam cip buluh dalam 2% NaOH pada suhu 60°C dengan masa rendaman

selama 6 jam. Tiga puluh keping papan gentian berketumpatan tinggi (1000 kgm^{-3}) dihasilkan dengan ketebalan 3-mm diperbuat daripada batang buluh. Panel tersebut dihasilkan menggunakan perekat dan juga tanpa perekat dan aditif lain, kemudian perbandingan dibuat dengan panel komersil daripada pain dengan mengambilkira ketebalan panel yang sama. Perekat fenol formaldehid (PF) dengan dua kepekatan; 1% dan 2% (berdasarkan berat kering oven panel), pengemulsi lilin pada 1% dan 2% kepekatan (berdasarkan berat kering oven panel), dan 0.25% alum ($\text{Al}_2(\text{SO}_4)_3$) (berdasarkan berat kering oven panel) ditambahkan mengikut kepekatan tertentu kepada panel daripada buluh *G. scortechinii* manakala panel daripada bahan lignoselulosa yang lain hanya ditambahkan dengan perekat PF berkepekatan 2% dan pengemulsi lilin 1% serta alum. Panel diberikan tekanan panas pada suhu 180°C selama 20 minit dan kemudian dipanaskan dalam oven pada suhu 160°C selama 6 jam. Semua sifat mekanikal dan fizikal panel yang dihasilkan diuji mengikut ketetapan piawaian papan gentian 'Japanese Industrial Standard for Fibreboard' (JIS A5305-2003). Sifat panel komersil daripada kayu pain dengan ketebalan yang sama juga diuji untuk perbandingan. Keputusan kajian menunjukkan semua panel gentian berketumpatan tinggi diperbuat daripada buluh menggunakan pra-rawatan dengan NaOH menunjukkan nilai rintangan terhadap kepecahan (MOR) dan kekenyalan (MOE) yang lebih tinggi berbanding panel komersil. Panel terawat dengan NaOH menggunakan 2% resin PF+1% pengemulsi lilin, dan 2% resin PF+2% pengemulsi lilin memberikan nilai ketahanan terhadap

kepecahan yang tertinggi (nilai MOR) tetapi lemah terhadap rintangan terhadap air dan kelembapan (nilai WA) berbanding panel komersil. Panel yang diperbuat menggunakan gentian buluh yang terawat dengan stim, tanpa resin dan bahan tambah lain menghasilkan panel dengan ketahanan terhadap kepecahan (MOR) dan kekuatan ikatan dalaman (IB) yang lebih rendah berbanding panel yang diperbuat menggunakan gentian terawat dengan NaOH. Panel yang diperbuat tanpa resin dan bahan tambah menunjukkan kekuatan (MOR) dan ikatan dalaman (IB) yang lebih rendah berbanding panel yang diperbuat menggunakan resin dan bahan tambah. Dengan pertambahan kepekatan resin PF dan pengemulsi lilin daripada 1% ke 2%, kekuatan dan kekerasan panel tersebut turut bertambah; iaitu nilai MOR, MOE dan IB adalah bererti pada $p < 0.01$. Nilai kekuatan ikatan dalaman (IB) tertinggi terhasil daripada panel buluh yang diperbuat menggunakan 2% resin PF +2% pengemulsi lilin. Panel gentian berketumpatan tinggi yang diperbuat daripada buluh memberikan kekuatan yang superior. Manakala untuk kestabilan dimensi atau kadar resapan (WA), panel gentian berketumpatan tinggi daripada buluh adalah tidak tahan terhadap lembapan berbanding panel komersil dan nilai kadar resapan (WA) tidak mencapai piawaian yang ditetapkan oleh JIS A 5305-2003.

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...May Allah bless us always...



I certify that an Examination Committee met on 7th September 2007 to conduct the final examination of Sabiha bt. Salim on her Master of Science thesis entitled “Production and Properties Evaluation of Buluh Semantan (*Gigantochloa scortechinii* Gamble) Hardboard compared to Commercially Produced Pine Hardboard” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Member of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

SABIHA SALIM

Date: 7th November 2007

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	x
APPROVAL	xi
DECLARATION	xiii
LIST OF TABLES	xviii
LIST OF FIGURES	xx
LIST OF ABBREVIATIONS	xxiv

CHAPTER

1	INTRODUCTION	
1.1	Background of the Study	1
1.2	Statement of Problem	5
1.3	Objectives	6
2	LITERATURE REVIEW	
2.1	Bamboo, a Natural Forest Resource in Malaysia	7
2.2	Uses of Bamboo	8
2.3	Area of bamboo Distribution in Malaysia	10
2.4	Properties of Bamboo	13
	2.4.1 Physical and Mechanical Properties	13
	2.4.2 Chemical Properties	15
	2.4.3 Anatomical properties	18
2.5	<i>Gigantochloa scortechinii</i>	22
2.6	Hardboard	23
	2.6.1 Hardboard Application and Uses	24
	2.6.2 Hardboard Fabrication	25
	2.6.3 Research on Hardboard	28
	2.6.4 The Differences of Wet-processed Hardboard Compared to Paper	29
2.7	Manufacturing Process	31
	2.7.1 Fibre Pre-treatment	31
	2.7.2 Refiner Mechanical Pulping (RMP)	36
	2.7.2.1 Effect of Mechanical treatment on Hardboard Properties	37



2.7.3	Wet Forming Process	37
2.7.4	Press Cycle	39
2.8	Adhesive Bond in Composites	41
2.8.1	Phenol formaldehyde (PF) resin and wax emulsion	42
2.8.2	Alum ($Al_2(SO_4)_3$)	44
2.9	Bamboo among the Non-Wood Fibre Plant of the World	44
2.9.1	Alternative Fibre for Wood-Based Composites	46
2.9.2	Bamboo-based Composites	48
2.9.3	Current Research on Bamboo-Based Composites in Malaysia	48
2.10	Some Common Species of Fibre Utilized for Wood-Based Composites	49
2.10.1	Pine and other Softwoods	49
2.11	New direction for research and development on Bamboo Hardboard	50
3	MATERIALS AND METHODS	
3.1	Materials	52
3.1.1	Bamboo	52
3.1.2	Chemicals	54
3.2	Experimental Design	55
3.3	Bamboo Hardboard Production	56
3.3.1	Fibre Preparation	58
3.3.2	Mat Forming	66
3.4	Evaluation of Fibre Quality of Pre-treated Bamboo	69
3.4.1	Fibre Recovery after undergone Mechanical Refining	69
3.4.2	Colour Changes of Pre-treated Fibres	70
3.4.3	Measurements of Fibre Morphology	70
3.4.4	Determination of Lignin Content in Fibres	72
3.5	Evaluation of Bamboo Hardboard	73
3.5.1	Spring back of Boards	74
3.5.2	Evaluation of Colour of Boards	77
3.5.3	Determination of Board Density	77
3.5.4	Determination of Board Moisture Content	78
3.5.5	Mechanical Properties	78
3.5.5.1	Static Bending Flatwise Direction	78
3.5.5.2	Internal Bond	80
3.5.5.3	Impact Resistance Test	81
3.5.5.4	Scratch Resistance Test	83

3.5.6	Physical Properties	84
3.5.6.1	Thickness Swelling and Water Absorption Tests	84
3.5.7	Calculation of Adjusted Data	88
3.6	Statistical Analysis	88
4	RESULTS AND DISCUSSION	
4.1	Fibre Quality of Pre-Treated <i>G. scortechinii</i> Fibres	90
4.1.1	Effect of Pre-treatments on Fibre Recovery, Morphology and Lignin Content of <i>G. scortechinii</i>	90
4.1.1.1	Fibre Recovery	90
4.1.1.2	Fibre Morphology	93
4.1.1.3	Fibre Lignin Content	99
4.1.2	Effect of Refining on Fibre Recovery and Morphology of pre-treated <i>G. scortechinii</i>	101
4.1.3	Summary of Results on Fibre Quality of Pre-treated <i>G. scortechinii</i>	112
4.2	Properties of Hardboard Fabricated from Buluh Semantan (<i>G. scortechinii</i>)	113
4.2.1	Properties of Hardboard in Relation to Density	113
4.2.2	Effect of Pre-treatment	117
4.2.2.1	Bending Strength	117
4.2.2.2	Internal Bond	117
4.2.2.3	Impact and Scratch Resistance	118
4.2.2.4	Springback	120
4.2.2.5	Water Absorption/Thickness Swelling	121
4.2.3	Effect of Resin and Wax	121
4.2.3.1	Bending Strength	122
4.2.3.2	Internal Bond	123
4.2.3.3	Springback	124
4.2.3.4	Water Absorption/Thickness Swelling	125
4.3	Comparison of Bamboo Hardboard with Commercial Pine Hardboard	130
4.3.1	Bending Strength	131
4.3.2	Internal Bond	131
4.3.3	Impact and Scratch Resistance	132
4.3.4	Springback	133
4.3.5	Water Absorption/Thickness Swelling	133
4.3.6	Effect of Fibre Morphology on Mechanical and Physical Properties of Hardboards	134
4.4	Summary of Results on The Performance of Hardboards	136

5	CONCLUSION AND RECOMMENDATION	
5.1	Conclusion	138
5.2	Recommendations	140
	REFERENCES	141
	APPENDIX	153
	BIODATA OF THE AUTHOR	



LIST OF TABLES

Table		Page
2.1	Bamboo Resources in some Asian Countries	8
2.2	Area planted with bamboo (in Peninsular Malaysia)	12
2.3	Some chemical composition of timber (softwood and hardwood), non-timber (bamboo and kenaf) and agricultural plant (oil palm EFB)	16
2.4	Length and width of selected agro-fibres compared to hardwood	21
2.5	Leading non-wood fibres of the world	46
3.1	Treatment combination of manufacturing 3-mm-thick hardboard made from <i>Gigantochloa scortechinii</i> fibres and commercial panels as control	56
3.2	Properties and specimen size for physical and mechanical evaluation of hardboard	75
4.1	Quantitative fibre morphology of <i>G. scortechinii</i> after undergone steam and NaOH pre-treatments	94
4.2	Colour changes of fibres and lignin content of pre-treated <i>G. scortechinii</i> when compared to pine (commercial)	100
4.3	Quantitative fibre morphology of pre-treated <i>G. scortechinii</i> fibres after refining for 1 cycle (2.5 mm plate gap) and 2 cycles (2.5 mm followed by 0.5 mm plate gap)	103

4.4	Fibre morphology of <i>G. scortechinii</i> pre-treated using NaOH, steam, and untreated compared to pine	111
4.5	The Mechanical and Physical Properties of pre-treated <i>G.scortechinii</i> Hardboard	116
4.6	Impact resistance and scratch resistance of Bamboo Hardboards from NaOH and steam pre-treated compared to Commercial Hardboards	118
4.7	Level of significant difference for the Mechanical and Physical Properties of Hardboard from Bamboo compared to the Commercial	122
4.8	Summary of ANOVA of Mechanical and Physical Properties Value for Bamboo ¹ Compared to Commercial Hardboard	130



LIST OF FIGURES

Figure		Page
2.1	Distribution of Bamboo in Peninsular Malaysia	11
2.2	Cross section of <i>Yushania alpina</i> bamboo culm wall middle layer;	19
2.3	An old Japanese paper mill showing all the processes of papermaking by hand in operation	30
2.4	Typical SIS hardboard press cycle	40
3.1	Bamboo plantation at Hutan Simpan Chebar Besar, Nami, Kedah	52
3.2	Schematic diagram of harvesting bamboo culm	53
3.3	Bamboo culms ready for soaking in fresh water	54
3.4	The Experimental Design	55
3.5	The Process Flow of Fabricating Wet-process Hardboard	57
3.6	Preparation of Bamboo Fibre for Hardboard Manufacture	59
3.7	Hand splitter used to split bamboo, and bamboo splits	60
3.8	Wood planner used to remove the epidermis of bamboo splits	60
3.9	Mini Wood Chipper used to chip bamboo	61

3.10	Digesters used to steam bamboo chips	62
3.11	(a) Refiner Mechanical Pulping (Andritz Sprout Bauer model); (b) the refining plate and (c) chip feeder	65
3.12	Beater used to beat the pulp continuously	67
3.13	Wet former (Niagara Type) used to form mat by wet process	67
3.14	Hot press machine used to press boards to targeted thickness	68
3.15	Microscope with Leitz DMRB Image Analyzer attached to a computer used to quantify fibre morphology	71
3.16	Board Properties Evaluation	74
3.17	Cutting design of board for testing	76
3.18	Static bending test	80
3.19	Impact tester used to test impact resistance	82
3.20	Scratch tester (Martens) used to test scratch resistance	83
3.21	Rigorous cyclic test	85
3.22	Thickness swelling measurement of test sample	86
4.1	Fibre recovery of <i>G. scortechinii</i> bamboo after pre-treatments and refining	91

4.2	(a) Damaged, (b) broken and (c) unbroken fibres, long and tapered end produced from steam pre-treatment observed using optical micrograph with 20x magnification	92
4.3	Swollen fibre wall after undergone NaOH pre-treatment at; (a) 4 h (note the unclean surface) and (b) 8 h (clean surface)	95
4.4	Fibrillation occurred to the fibre after undergone NaOH pre-treatment by chemical and mechanical reaction at (a) 4 h, (b, c and d) 6 h, and (e) 8 h	97
4.5	Schematic diagram of (a) original fibre, (b) partially collapsed, and (c) flattened fibre	105
4.6	The effect of refiner plate gap size actions on fibres	107
4.7	Effect of plate gap of refiner on (A) fibre length, mm (10^{-1}), (B) fibre diameter, μm and (C) felting power of steam pre-treated and NaOH pre-treated fibre	109
4.8	Effect of density on strength properties of bamboo Hardboard	114
4.9	Impact resistance test; (a) small dent resulted in commercial test sample (b) big dent of bamboo steam pre-treated and (c) undistinguishable dent on NaOH pre-treated bamboo hardboard	119
4.10	Effect of Pre-treatment of Bamboo Fibre on the Springback of Hardboards	120
4.11	Effect of Resin and Wax Levels of Concentration on Springback of Hardboards	124
4.12	Water absorption and thickness swelling of hardboard after undergone cyclic water-soak test	126

4.13	The correlation of water absorption and thickness swelling of bamboo hardboard	129
4.14	Effect of fibre length and diameter on the strength and physical properties of hardboard	135

