PROCEEDINGS
THE 2ND INTERNATIONAL SYMPOSIUM OF INDONESIAN WOOD RESEARCH SOCIETY
Developing Wood Science and Technology to Support the Implementation of Climate Change Program
12 – 13 November 2010
Inna Grand Bali Beach Hotel, Sanur, Bali
INDONESIA

Organized by

Indonesian Wood Research Society (IWoRS)

In collaboration with
Ministry of National Education of Indonesia
Ministry of Forestry of Indonesia
Perum Perhutani
PT. Wirakarya Sakti
Department of Forest Products – Bogor Agricultural University
Research Center for Settlement, Ministry of Public Works of Indonesia

Published by
Indonesian Wood Research Society (IWoRS)
2011
PROCEEDINGS
THE 2ND INTERNATIONAL SYMPOSIUM OF
INDONESIAN WOOD RESEARCH SOCIETY

Developing Wood Science and Technology to Support
the Implementation of Climate Change Program

12 – 13 November 2010
Inna Grand Bali Beach Hotel, Sanur, Bali
INDONESIA

Editors
Nyoman J. Wistara
Muh. Yusram Massijaya
Deded S. Nawawi
Arinana
Istie Sekartining Rahayu
Suhasman
Wayan Darmawan

Organized by
Indonesian Wood Research Society (IWoRS)

In collaboration with
Ministry of National Education of Indonesia
Ministry of Forestry of Indonesia
Perum Perhutani
PT. Wirakarya Sakti
Department of Forest Products – Bogor Agricultural University
Research Center for Settlement, Ministry of Public Works of
Indonesia

Published by
Indonesian Wood Research Society (IWoRS)
2011
CONTENTS

PREFACE iii

BIOCOMPOSITES

Mechanical and Thermal Properties of Poly(lactic acid)-Bamboo Fiber Composites
_Nanang Masruchin, Sasa Sofyan Munawar and Subyakto_

Tannin Formaldehyde as Extender for Urea Formaldehyde in Making Laminated Bamboo
_I.M. Sulastiningsih, Surdiding Ruhendi and Adi Santosso_

Physical and Mechanical Properties of OSB Made from Bamboo
_Sahriyanti Saad, Yusram Massijaya and Yusuf Sudo Hadi_

Physical and Mechanical Properties of Binderless Particleboard Made from Candlenut Wood Using Various Pretreatments
_Suhasman, M.Y Massijaya and S Saad_

Production Technology of Cellulose Nanofibers from Acacia mangium Pulp
_Firda Aulya Syamani, Lilik Astari and Subyakto_

Urea Formaldehyde Adhesive with Tannin Formaldehyde Extender for Medium Density Fiberboard
_Saptadi Darmawan, Surdiding Ruhendi and Adi Santosso_

Performance of Laminated Veneer Lumber from Three Species of Small Diameter Logs
_SS Kusumah, M.Y Massijaya, B Tambunan and Y Amin_

Studies of Coconut Carbon Fibers for Fuel Cell Device Material
_Suprapedi, Sandi Sufiandi, Danang Sudarwoko Adi, Dwi Hadi Restuningsih, Ismail Budiman and Wida Banar K_

Hydration Characteristics of Wood-Cement Mixture
_Dede Hermawan_

Mechanical and Physical Properties of the Laminated Board of Bamboo
_Elyazar Manuhiwa and Mery Loiwatu_

WOOD PROPERTIES AND QUALITY IMPROVEMENT

Development of Helical Edge Milling Cutters for Planing Wood
_Wayan Darmawan, Dodi Nandika, Christian Gottlöber and Michael Oertel_

Wear Characteristics of Cutting Tools Caused by Extractive and Abrasive Material in Woods and Wood-based Materials
_Wayan Darmawan, Istie S Rahayu and Irsan Aliprajra_
Effect of Growth Rate on the Wood Density and Anatomical Characteristics of Rubber Trees (Hevea brasiliensis) in Two Different Clones and Two Different Planting Densities
Hamid R. Naji, Mohd. Hamami Sahri, Tadashi Nobuchi and Edi Suhaimi Bakar

Determination of Cellulase (A.C.C.) Retention and Penetration at Three Moisture Content and Heights Levels at Poplar Tree (Populus nigra var. horizontalis) Using a Modified Ruping Process
Hamid R. Naji and Davoud Parsapajouh

Anatomical Characteristics and Possible Utilization of Six Lesser Used Rattans from Indonesia
Ratih Damayanti and Jasni

Termite Resistance of Medium Density Fiberboard (MDF) Made from Agricultural Fiber
Yuliati Indrayani, Gustan Pari and Adi Santoso

Effect of Log Diameter and Physical Properties on Core Veneer Recovery
Benoni Kewilaa

Identification of Beetles Attacking Wood during Storage
Ira Taskirawati, Astuti Arif and Patimah

The Mound Building Architecture of Subterranean Termite Macrotermes Gilvus Hagen (Blattodea: Termitidae) in Yanlappa Natural Reserve West Java, Indonesia
Niken Subekti

Pilot Scale of Close System Compression Hot Press Machine
Wahyu Dwianto, Suprapedi, Teguh Darmawan, Jayadi, Ananto Nugroho, Yusup Amin and Ika Wahyuni

Heat Transfer Analysis in a Production Scale of Close System Compression
Sandi Sufiandi, Wahyu Dwianto, Teguh Darmawan and Danang Sudarwoko Adi

Trial Test on the Preservation and Steaming of Mahoni Wood Using the Designed Machine of FPRDC
Efrida Basri, Jasni and Ratih Damayanti

Durability of Low-Molecular Weight Phenol Formaldehyde Treated Oil Palm Wood against Termite Coptotermes Curvignathus and White-Rot Fungi Pycnoporous Sanguineus
Edi Suhaimi Bakar, Jun Hao and Zaidon Ashaari

An Assessment on the Effects of Different Diameter and Rake Angle of Forstner Bit toward the Quality of Cut on Treated Oil Palm Wood
Chong Yi Way, Edi Suhaimi Bakar and Zaidon Ashaari
Quality Improvement of Oil Palm Wood with Modified Compreg Method: The Effect of Microwave Heating Power and Re-Drying Moisture Content on the Physical and Mechanical Properties
Faizatul Farhana Zulkifli, Edi S Bakar, Zaidon Ashaari and Mohd. Hamami Sahri

Effect of Initial Moisture Content and Hot Pressing Condition on the Steamed Densified Low Density Oil Palm Wood
Nur Farizan Faisal, Nur Syuhada Omar and Edi Suhaimi Bakar

Above Ground Degradation of Woods in Some Cities in Java
Trisna Priadi, Dodi Nandika, Kurnia Sofyan, Achmad and Arif Budiwirto

Transferring Effectivity of Entomopathogen Nematodes as Biological Control of Subterranean Termite Coptotermes curvignathus
Arinana and Noor Farikhah Haneda

Permeability Evaluation of Teak Wood from a Plantation
Mayuree Doungpet

Ammonia Fumigation of Less Durable Woods
Istie S. Rahayu, Arinana and Imam Wahyudi

Drying Schedule Formulation of a Sortiment from Terminalia catappa
Yustinus Suranto

WOOD DESIGN AND ENGINEERING

The Ability of Steel Bar Shear Connector on the Timber Bolt Joint
Indah Sulistyawati

Physical and Mechanical Properties of 17 Years Old Mangium
Dwi J Priyono, Surjono Surjokusumo, Yusuf S Hadi and Naresworo Nugroho

The Effect of Density and Wave Velocity Differences on the Stiffness of Small Clear and Full Sized Specimen of Mangium Wood
Dwi J. Priyono, Surjono Surjokusumo, Yusuf S Hadi and Naresworo Nugroho

Pull-Out Performance of Screw Depending on Diameter and Form of Thread
Satoru Murakami, Akihisa Kitamori, Jung Kiho, Makoto Nakatani and Kohei Komatsu

Development of Friction Joint System Using Compressed Wooden Fasteners
Akihisa Kitamori, Kiho Jung and Kohei Komatsu
Physical and Mechanical Properties of Binderless Particleboard Made from Candlenut Wood Using Various Pretreatments

Suhasman¹, M Y Massijaya², S Saad¹
¹Faculty of Forestry, Hasanuddin University, Makassar
²Biocomposite Laboratory, Forest Product Department, Faculty of Forestry, Bogor Agricultural University, Bogor
Corresponding author: suhasman@yahoo.com

Abstract
Development of binderless particleboard technology by oxidation treatment indicated that the product has a number superior characteristic, especially in term of dimensional stability and modulus of elasticity. The aim of this research was to analyze the influence of particle pretreatment on physical and mechanical properties of particleboard. The material used was particle from candlenut wood (Aleurites moluccana) which passed 10 mesh sieves in size. The particle in dry-air condition were pretreated as following: immersion in boiling water for 15 minutes, 30 minutes, 45 minutes, and 60 minutes, immersion in cold water for 48 hours, immersion in NaOH 1 % solution for an hour, and particle without pretreatment as control. The pretreated particle were air-dried and oxidized with 20 % hydrogen peroxide based on particle dry-weight and 5 % ferrous sulphate based on weight of hydrogen peroxide. Particles which have oxidized then utilized to produce binderless particleboard with board density target of 0.75 g cm⁻³. The results of this research indicated that the best characteristic of particleboard was the board that produced from particle without any pretreatment. This phenomenon indicated that existence of any extractive substance did not have any negative influence to binderless particleboard which was produced by oxidation methods. Compared with JIS A 5908, binderless particleboard which was made from particle without pretreatment fulfilled almost all of parameter in the standard, except in modulus of rupture which has slightly lower value, (79.11 kgf cm⁻²) compared with minimum 80 kgf cm⁻² in standard.

Keywords: binderless particleboard, candlenut wood, oxidation, hydrogen peroxide

Introduction
Particleboard is a product which is developed with purposes to increase efficiency of wooden material utilization and optimize usage of another lignocelluloses material as an effort to meet the increasing demand of community in wood products. The products should have many special quality compared to solid wood because its raw material can be provided from any sources such as whole-log wood and exploitation and industrial wood waste.

Major disadvantage of wood based panel is that adhesive is required in manufacturing process. The most commonly used adhesives such as urea formaldehyde, melamine formaldehyde, and phenol formaldehyde is crude oil-based material. Among these adhesives, 96.6% (Li et al, 2002) is formaldehyde-based adhesive that contain harmful
emission exist in both in production process and usage. Therefore, it is not environmentally friendly products. Considering current environmentally issues, new "green" product has to be developed.

Binderless particleboard could be a solution for conventional wood based panel products. Lignin in wood particles can be activated to stimulate a self bonding mechanism (Yelle et al. 2004). Wedsten et al. (2003) developed oxidation methods to improve self bonding of lignin in spruce (Pinus abies) and beech (Fagus sylvatica) fiber. Pantze et al. (2008) reported that ester-binding is the most responsible to inter fiber self-binding mechanism of wood. Nevertheless, the application of this technique for tropical wood has not been notified and it has been elaborated in the present researches.

Method

Material Preparation. Candelnut wood lumber was conditioned to air dry moisture content and henceforth was made to be a shaving. The shaving then was converted into particles with hammer mill, and particles were screened to pass 10 mesh sieves.

Pre-treatment. Air-dried particle was pre-treated with immersion in cold water (CW), sodium hydroxide solution 1 % for 1 hour (SH), and hot water at 100°C (for 15, 30, 45, and 60 minutes and designated as H15, H30, H45, and H60, respectively). Control board (CO) was also produced for comparison. Each category of treated particle was conditioned as long as 1 month to achieve air-dried moisture content.

Board Production. Air-dried particle was oxidized with hydrogen peroxide in level of 20 % (based on particle dry weight) and ferrous sulfate in level of 5 % (based on hydrogen peroxide weight). Oxidized particle was conditioned for 15 minutes then was matted and hot-pressed. Specific pressing load was 25 kgf cm² at 180 °C for 10 minutes. The size of board was 30 x 30 x 0.7 cm³ with target density of 0.75 g cm⁻³. Boards were then conditioned for 2 weeks in room temperature before physical and mechanical properties were tested. The boards were then tested for their water absorption, thickness swelling, modulus of rupture, modulus of elasticity, and internal bond. Parameters measurements were carried out according to JIS A 5908 2003.

Data Analysis. In the preset experiments, 4 replications were used. Therefore, for overall number of board were 28 sheets. The obtained values were averaged for each parameter of board, and then compared to JIS A 5908 2003.

Results and Discussion

Water absorption characteristics of board are shown in Figure 1. It can be seen that immersion of boards in hot as well as cold water with sodium hydroxide treatment have a higher water absorption capacity than that of control. Immersion pretreatment has been known to remove extractive from wood cells. Extractive removal could increase wood permeability, thus improved adhesive penetration. Nonetheless, board with high water absorption property is undesirable. Based on absorption capacity, board without immersion treatment was considered as the best board. This board was also found to have the lowest thickness swelling. These facts indicate that pretreatment procedure did not improve dimensional stability of board, even tends to reduce it. It can be seen from Figure
2 that the highest thickness swelling was found at board H45. However, duration of immersion was not significantly influencing board properties.

![Water Absorption Graph](image)

**Fig. 1. Water absorption of particleboard**

The finding in the present experiments was not in accordance to those commonly found for particleboard or fiberboard with adhesives. Immersion treatment usually increased dimensional stability of board with adhesives. It seems that this phenomenon was caused by differences in bonding mechanism. In particleboard with adhesive, immersion treatment would increase wood permeability and improve adhesive penetration, thus increased the bond strength. In binderless particleboard with oxidation treatment, lignin act as adhesive, therefore it did not require improvement of wood permeability before adhesion.

![Thickness Swelling Graph](image)

**Fig. 2. Thickness swelling of particleboard**

MOR of boards immersed in cold water for 48 hours and in hot water for 30 minutes was 7% (6-7 kgf cm²) higher than that of the control. MOR values of other treatments were equal to that of control. NaOH pretreatment resulted in a lower MOR value. MOR of board
with immersion in cold water was not significantly different to that immersed in hot water. Thus, it can be said that immersion treatment did not affect MOR of particle boards.

![Graph showing MOR (Kgf cm⁻²) for different treatments.](image)

Fig. 3. Modulus of rupture of particleboard

Figure 4 indicates that the highest MOE of boards was obtained from untreated particles. Thus, immersion pretreatment in various media did not affect MOE of board. Immersion in 1 % NaOH and in hot water for 15 minutes, 45 minutes, and 60 minutes resulted in lower MOE compared to that of control. Degradation in some part of hemicelluloses and increasing of material plasticity by immersion in hot or cold water is assumed to bring about the reduction in MOE.

![Graph showing MOE (Kgf cm⁻²) for different treatments.](image)

Fig. 4. Modulus of elasticity of particleboard

Figure 5 indicates that the lowest internal bond was found in board made from particles immersed in sodium hydroxide. MOR and MOE indicate the same tendency.

Pretreatment with hot and cold water in the present experiment was intended to remove extractives that could negatively affect board properties. However, since hot and cold water treatment did not affect board properties, it can be assumed that extractive of no influence to board characteristics.
NaOH treated particles produced boards with lower physical and mechanical properties to that of control. It could be that the wood extractives and low molecular weight carbohydrate were dissolved by NaOH, and thus brought about inferior board properties.

**Conclusion**

Oxidation of untreated particles resulted in a better mechanical and physical properties to those pretreated with hot, cold and NaOH immersion. Furthermore, the existence of extractives in oxidized particles did not negatively affect board properties. Only binderless particleboard made from untreated particles resulted in board characteristics that satisfying the requirement of JIS A 5908, except for it MOR.

**Acknowledgement**

The author extends deep gratitude to Hasanuddin University for financial support to this research through competitive grant scheme (Hibah Bersaing). The acknowledgement is also offered to the DP2M Directorate General Higher Education the Ministry of National Education.

**References**


