CHARACTERISATION OF PULP AND PAPER OBTAINED FROM THREE DIFFERENT AGES OF *Acacia mangium* IN SIMILAR HABITAT

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PERPUSTAKAAN
UNIVERSITI MALAYSIA SABAH

SCHOOL OF INTERNATIONAL TROPICAL FORESTRY
UNIVERSITI MALAYSIA SABAH 2006
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PERPUSTAKAAN
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UNIVERSITI MALAYSIA SABAH
2006
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JUDUL : CIRI-CIRI PULPA DAN KERTAS DARIPADA TIGA UMUR *Acacia mangium* DIDAPATI PADA HABITAT YANG SAMA

IIAZAH : SARJANA SAINS

SESI PENGAJIAN : 2004-2006

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DECLARATION

The materials in this thesis are original except for quotations, excerpts, summaries and references, which have been duly acknowledged.

FASIL SAID MANZOOR
PS04-010-003(A)
JULY 2006
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ABSTRACT

Woods samples of *Acacia mangium* tree of three age groups, viz. five, seven and nine years were tested for their alpha cellulose contents, pulp yield and papers quality. The woods were collected from Sabah Forest Industry (SFI) area in Ganui, Sipitang, Sabah. The woods were chipped, grinded into small sizes and turned into powder. The wood chips were treated at 170°C, 7-8 MPa for 2.5 hours. The Brendel et al method was used for the extraction of alpha cellulose. The pulp yields of the sample were studied. Later, papers were made using this pulp and the tested for strength qualities. All tests were conducted in accordance to the ISO standards. The results showed that the alpha cellulose contents of the tree increases slightly. The increments were however found not significant. Almost all the age trees gave nearly the same pulp yield with a same cooking condition. The ANOVA analysis was conducted to determine the relation between the age of the tree and alpha cellulose content, pulp yield and paper strength properties. There were no significant changes seen in the paper strength properties with respect to age. It was found that the 5 year old trees showed better characteristics with respect to the older age trees and it's economically suitable for the paper production. These works recommend for the plantation managers (pulp wood) to cut the *Acacia mangium* trees in the age of 5 rather waiting for 7 - 9 years.
ABSTRAK

CIRI-CIRI PULPA DAN KERTAS DARIPADA TIGA UMUR Acacia mangium
DIDAPATI PADA HABITAT YANG SAMA


UMS
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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>C₆H₁₀O₅</td>
<td>Cellulose</td>
</tr>
<tr>
<td>CD</td>
<td>Cross direction</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>FTIR</td>
<td>Fourier Transform Infrared Spectra</td>
</tr>
<tr>
<td>GSM</td>
<td>Grams per square meter</td>
</tr>
<tr>
<td>H₂SO₃</td>
<td>Sulphurous acid</td>
</tr>
<tr>
<td>HSO₃</td>
<td>Bisulphite ions</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>KCl</td>
<td>Potassium chloride</td>
</tr>
<tr>
<td>LSD</td>
<td>Least significant difference</td>
</tr>
<tr>
<td>MAI</td>
<td>Mean Annual Increment</td>
</tr>
<tr>
<td>MC</td>
<td>Moisture content</td>
</tr>
<tr>
<td>Max</td>
<td>Maximum</td>
</tr>
<tr>
<td>Min</td>
<td>Minimum</td>
</tr>
<tr>
<td>MPPMA</td>
<td>Malaysia Pulp and Paper Manufacturers Association</td>
</tr>
<tr>
<td>MTC</td>
<td>Malaysian Timber Council</td>
</tr>
<tr>
<td>Na₂S</td>
<td>Sodium Sulfide</td>
</tr>
<tr>
<td>NaOH</td>
<td>Sodium Hydroxide</td>
</tr>
<tr>
<td>RM</td>
<td>Ringgit Malaysia</td>
</tr>
<tr>
<td>SCAN</td>
<td>Scandinavian pulp, paper and board testing committee</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Sdn. Bhd.</td>
<td>Sendirian Berhad (Company Limited)</td>
</tr>
<tr>
<td>SFI</td>
<td>Sabah Forest Industry</td>
</tr>
<tr>
<td>SR</td>
<td>Schopper-Riegler</td>
</tr>
<tr>
<td>TAPPI</td>
<td>Technical Association of the Pulp and Paper Industry</td>
</tr>
<tr>
<td>Symbol</td>
<td>Definition</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>%</td>
<td>Percentage</td>
</tr>
<tr>
<td>β</td>
<td>Beta</td>
</tr>
<tr>
<td>mL</td>
<td>milliliter</td>
</tr>
<tr>
<td>rpm</td>
<td>revolution per minute</td>
</tr>
<tr>
<td>m/min</td>
<td>meter per minute</td>
</tr>
<tr>
<td>gsm</td>
<td>Gram square meter</td>
</tr>
<tr>
<td>N/m²</td>
<td>Newton per meter square</td>
</tr>
<tr>
<td>um</td>
<td>Micro meter</td>
</tr>
<tr>
<td>sq.ft.</td>
<td>square feet</td>
</tr>
<tr>
<td>lb</td>
<td>pound</td>
</tr>
<tr>
<td>kN/m.</td>
<td>Kilo Newton per meter</td>
</tr>
<tr>
<td>V</td>
<td>volume</td>
</tr>
<tr>
<td>mm</td>
<td>millimeter</td>
</tr>
<tr>
<td>mm³</td>
<td>millimeter cube</td>
</tr>
<tr>
<td>m</td>
<td>meter</td>
</tr>
<tr>
<td>mg</td>
<td>milligram</td>
</tr>
<tr>
<td>m²</td>
<td>meter square</td>
</tr>
<tr>
<td>cm</td>
<td>centimeter</td>
</tr>
<tr>
<td>°C</td>
<td>Degree Celsius</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram</td>
</tr>
<tr>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>N</td>
<td>Newton</td>
</tr>
<tr>
<td>mPa</td>
<td>milipascal</td>
</tr>
<tr>
<td>kPa</td>
<td>kilopascal</td>
</tr>
</tbody>
</table>
mN  milinewton

°SR  Schopper-Riegle degree
CHAPTER 1

INTRODUCTION

In today’s world, paper plays a vital role in our daily life. Paper allows the expression of ideas and thoughts, and it also facilitates communication. The usage of paper is expected to increase with the increasing world population. In 1950, the world population was recorded as 2.5 billions and is expected to reach 9.9 billions by the 2050. According to the statistics (Rymsza, 1999), the world production of pulp and paper in the year of 1961 is recorded as 61,862 million metric ton and this value has increased to 102,840 million ton metric in 1970. In 1980 and 1990, there was an increase of 128,310 million ton metric to 165,873 million ton metric respectively. In 1997, the world pulp and paper production was recorded as 178,550 million ton metric (Rymsza, 1999)

In the context of Malaysia, the paper and paper board industry played an important role in its steady economic growth and development (Kevin, 1994). The country has a total capacity of slightly over 1 million tonnes of paper per annum, with self-sufficiency in the supply of paper and paper board growing at a slow rate. It is predicted that the demand for the paper in the region will grow with an annual average of 6 - 10 % (MTC, 2004). According to the records, Malaysia has 61% area covered with forest and 16% of the total area is under plantation (MTC, 2003) even though it could satisfy the local demands. According to MPPMA, Malaysia imported 1,189,120 metric tonnes of all types of paper and paper products worth RM2.7 billion in 2000 as compared to 1,353,515 metric tonnes valued at RM2.4 billion in 1999. In 2000 the country recorded a 50% self-sufficiency rate in contrast to 43% in 1999, and is striving to achieve the objective of being self-sufficient by the year 2005.
The pulp industry is facing the ever-increasing demands of quality paper and paperboard that is causing search for new and hitherto unexploited sources of cellulosic fibers (Jahan et al., 2005). The awareness of forest conservation has increased in recent years which had led to the decrease in supply of the wood from the natural forest to the industries and this also made the raw materials expensive. To meet the demand of wood, Malaysia is setting up more plantations specially the Acacia mangium plantations. Acacias have good biomass production potential and the wood is generally considered to be a good fuel with a high calorific value. Considerable work has been undertaken in recent years to explore this potential in overseas countries, to address pressing issues of fuel shortages, land degradation and pulp production.

This study aim on investigating the suitability of using young A. mangium trees for the pulp and paper industry in Malaysia. The outcomes of the study will be rely and pass on to the plantation managers (especially for the chips). If the study can prove that the early age trees can produce good paper with respect to the 9 year age trees it can help to cut down the rotation period of trees and also can help to supply the raw materials to the paper industry continuously without any problem.

1.1. Distribution and Location of Paper Factory in Malaysia

Malaysia has about 19 paper manufacturing mills (Table 1.1) in operation of which 15 paper mills are the members of Malaysian Paper Manufacturers Association. There are no mills in Negeri Sembilan, Terengganu and Kelantan. The imported pulp or regular paper or mixed together with pulp from tropical hardwood are used by many of the companies. Sabah Forest Industry (SFI) is the only integrated pulp and paper
mill in the country which use wood fibers from various tropical wood species (Kevin, 1994).

Table 1.1: Paper Factories of Malaysia

<table>
<thead>
<tr>
<th>State</th>
<th>Number of factories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kedah</td>
<td>2</td>
</tr>
<tr>
<td>P.Pinang</td>
<td>3</td>
</tr>
<tr>
<td>Perak</td>
<td>2</td>
</tr>
<tr>
<td>Selangor</td>
<td>3</td>
</tr>
<tr>
<td>Melaka</td>
<td>1</td>
</tr>
<tr>
<td>Johor</td>
<td>2</td>
</tr>
<tr>
<td>Pahang</td>
<td>3</td>
</tr>
<tr>
<td>Sabah</td>
<td>1</td>
</tr>
<tr>
<td>Sarawak</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
</tr>
</tbody>
</table>

The total Production capacity is approximately 1 million tonnes

1.2. Present Status of Pulp and Paper in Malaysia

Total import of paper in Malaysia exceeds 6 million tonnes/year. The Government is very keen interest in sustainable forest management system with replanting and creating forest plantations. Malaysia imports 762,359 tonnes of paper products in 1998 which is worth of RM 1.72 billion. This shows decrement compared to 1997 which total up to 1.05 tonnes worth 1.97 million. This was due to the economic crisis in 1997. During this period Malaysia was not able to export the paper (MTC, 1999).
By 2013 countries in Asia pacific region is estimated to become the largest paper purchaser of the world. This region is estimated to produce 86 million tonnes of paper and paper products that is 30.2% of world production. Factors such as recovery of the economic crisis, increment of population, development in the living standards and development of packaging industry will make the region become the largest buyers (MTC, 1999).

1.3. Pulp and Paper Demand in Developing and Developed Countries

Demand rate for pulp and paper increased from year 1961 to 1991 (Table 1.2), so it is estimated that there will be an increment from year 1991 to 2010. Developing countries has more rate of increment compared with developed country, even though 80 – 90 % of world paper market is controlled by developed country. After 1991 both developing and developed countries showed a decrease in the rate of demand. This is because of economic crisis in 1997 and development in computer technology which decrease the paper usage. The rate of increment for the demand of pulp and paper for developing country is higher compared with developed country because developed country has enough economy and modern technology to do so.

Table 1.2: Rate of Increment of Pulp and Paper

<table>
<thead>
<tr>
<th></th>
<th>Year 1961 (Tonnes)</th>
<th>Rate of Increment (%)</th>
<th>Year 1991 (Tonnes)</th>
<th>Rate of Increment (%)</th>
<th>Year 2010 (Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Countries</td>
<td>70</td>
<td>3.5</td>
<td>194</td>
<td>2.3</td>
<td>310</td>
</tr>
<tr>
<td>Developing Countries</td>
<td>7</td>
<td>6.2</td>
<td>49</td>
<td>2.8</td>
<td>130</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>3.7</td>
<td>243</td>
<td>5.1</td>
<td>440</td>
</tr>
</tbody>
</table>

1.4. Demand of Pulp and Paper in the World

According to Table 1.3, it is forecasted that the world demand for the pulp and paper will increase from year 1991 to 2010. In 1991 the total world demand of paper was 242,939,000 tons. In 1991 the Wood fiber and non wood fibers are respectively 153,939,000 and 14,725,000 tons. In 2010 the paper demand is estimated to reach 443 million ton. For the wood pulp there will be an increment of 257 million ton and for non wood fibers there will an increment of 26 million tons. This shows the rate of pulp and paper demand in the world is always increasing.

Table 1.3: Demand of Pulp and Paper in World (’000 Tons)

<table>
<thead>
<tr>
<th>Countries</th>
<th>1991</th>
<th>2010</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Paper Products</td>
<td>Wood Pulp</td>
<td>Non Fiber Wood</td>
</tr>
<tr>
<td>Africa</td>
<td>2,684</td>
<td>1,967</td>
<td>236</td>
</tr>
<tr>
<td>North/Middle America</td>
<td>92,389</td>
<td>73,266</td>
<td>474</td>
</tr>
<tr>
<td>South America</td>
<td>8,039</td>
<td>4,947</td>
<td>488</td>
</tr>
<tr>
<td>Asia</td>
<td>60,146</td>
<td>22,957</td>
<td>12,880</td>
</tr>
<tr>
<td>Europe</td>
<td>67,258</td>
<td>40,689</td>
<td>379</td>
</tr>
<tr>
<td>Oceanic</td>
<td>2,833</td>
<td>1,901</td>
<td>13</td>
</tr>
<tr>
<td>USSR</td>
<td>9,590</td>
<td>8,212</td>
<td>255</td>
</tr>
<tr>
<td>Total</td>
<td>242,939</td>
<td>153,939</td>
<td>14,725</td>
</tr>
</tbody>
</table>

REFERENCES


