UNIVERSITI PUTRA MALAYSIA

A SODA-ANTHRAQUINONE PULPING OF ACACIA MANGIUM

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A SODA-ANTHRAQUINONE PULPING
OF *ACACIA MANGIUM*

By

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Read! In the name of thy Lord and Cherisher,
Who created-
Created man, out of a (mere) clot of congealed blood,
Read! And thy Lord is Most Bountiful-
He Who taught (the use of) the Pen-
Taught man that which he knew not.
(Quran XCVI: 1-5).

ABSTRACT

The objective of this project was to determine the effect of four differents levels (0.125%, 0.25%, 0.5% and 1.0%) of anthraquinone(AQ) additive to soda pulping of nine-year old Acacia mangium Willd. grown in Pahang, Malaysia. Soda-AQ pulping gave high screened yields ranging from 47.4% to 51.5% for the 0.125% AQ and 1.0% AQ addition respectively. Bleachability, as indicated by the decreasing Kappa number (26.3 to 23.2), was improved with increasing addition of AQ. Except for folding endurance, the strength properties of the soda-AQ pulps were also improved and higher than both soda and kraft Acacia mangium pulps.

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Most Merciful

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LIST OF SYMBOLS

A.	Acacia
ANOVA	Analysis of variance
AQ	anthraquinone
CSF	Canadian Standard of Freeness
C	Celcius
cm	centimeter
FRIM	Forest Research Institute of Malaysia
g	gram
ha	hectare
hr	hour
LSD	Least singnificant difference
$M	Malaysian ringgit
m	meter
m^3	meter cubic
ml	milliliter
mm	millimeter
M	million
NSSC	Neutral Sulfite Semi Chemical
N	normality/Newton
no.	number
o.d./OD	oven dry
rpm	revolution per minute
SAS	Statistical Analysis System
TAPPI	Technical Association of Pulp and Paper Industry
UPM	Universiti Pertanian Malaysia
yr	year

CHAPTER 1

INTRODUCTION

Paper and paper products cannot be separated from today's life. Paper and paper products have been used intensively in recording, storage and dissemination of information; wrapping and packaging material; structural application; and religious ceremonies. Malaysia has probably been exposed to the use of paper by both Chinese and Arab traders. Undoubtedly early Arab traders and missionaries had copies of the Quran printed on paper as they spread the faith. The Arabs also brought the art of paper making to Europe from China in the twelfth century (McGinnis and Shafizadeh, 1980).

In recent years, the use of paper and paper products in Malaysia has increased from 148,500 tons in 1980 to 407,900 tons in 1985 (Chen, 1988). This increase is credited largely to the growth in population and rise in standard of living and literacy. Ninety percent of the paper and paper products are imported since existing mills can supply only ten percent of the consumption (Thang, 1989). The imported paper and paper products has caused a lot of loss in Malaysian foreign exchange. To overcome this problem, the UNDP/FAO Asia Pasific Forest Industries Development

Group has recommended four pulp mills to be established in Malaysia (Thang, 1989). Feasibility studies have shown that Malaysia is capable of sustaining more than one pulp mill because of the availabity of wood, financial support, market, and technical support (Chen, 1988).

One of the important factors in establishing a pulp mill is the availability of fibrous material either from wood and/or non-wood sources. Malaysia has natural forests, plantation forests and rubber plantations. There are around 17.69 million hectares of natural forest, 70,000 hectares of forest plantation, and 1.95 million hectares of rubber plantation. In addition 250,00 tons of rice straw, 350,000 tons of baggase, and 1.9 million tons of other resources are available annually. These resources would assure enough fibers for a pulp and paper mill. Furthermore, there are about 108 thousand tons of recyclable papers (Thang, 1989) to augment the fiber supply.

The plantation forests have the greatest potential for utilization by the pulp and paper indusrtries. One of forest plantation species that has been recommended as a good source of fiber for pulp and paper is <u>Acacia mangium</u> (Alloysius, 1989; Logan and Balodis, 1982; Udarbe, 1987).

1.1 JUSTIFICATION

By the year 1995, the Compensatory Plantation Forest Project will have established 200,000 hectares of Acacia mangium plantation. During the 1988 to 1992 period, the total wood residuals from second thinnings are expected to reach 273,520 cubic meters per annum, and during 1998 to 2002 period, it will be increased to 1,052,480 cubic meter per annum . By 1995, the volume of wood residuals produced from the first thinnings will amount to 1.52 M cubic meters (Yong, 1984). Since the young A. mangium trees have poor quality wood- low in strength and small diameter- and are not suitable either for saw or veneer logs, therefore the potential utilization of these thinning residuals is for the production of pulp and paper.

There is only one exiting pulp mill (SFI) at present in Malaysia, an integrated pulp and paper mill, located in Sepitang, Sabah. SFI manufactures kraft pulp from hardwoods. The kraft process, however, creates severe water and air pollution problems because of the presence of sulphur-compounds (Renard et. al., 1981). Due to the environmental concerns, the kraft process (the dominating pulping process) has to be modified or substituted by a less polluting process. The substituted process must give good pulp yield and quality, yet compatible with the existing kraft process equipment and operations. One of the pulping processes that may be a good alternative to the kraft process is the soda-anthraquinone process (Holton, 1977).

The presence of anthraquinone (AQ) in soda pulping system may be utilized in a number of ways to achieve a variety of improvements in mill operation. If alkalinity is left constant, it is claimed the AQ can increase the through put of digesters, decrease effective alkaline level, increase pulp yields, lower the steam requirements in pulping and/or carry the pulping of bleachable grade materials to lower lignin contents as a means of lowering the discharge of organic materials from bleach plants.

An important consideration of modern pulp mill design and operation is to treat mill effluents so that their impact on the environment is minimal and essentially non-polluting. The implementation of pollution abatement program within the pulp mill is generally capital-intensive and entail significant operating costs. Furthermore, environmental measures are often expensive to implement in existing mill, sometimes, impossible due to space restrictions. In the kraft pulping, the main air and water pollutants are maladorous organic sulphur compounds formed during cook. Sometimes as far as five miles away from the mill, the smell of four types of reduced sulphur gases may already be detectable (Zerrudo, 1990). The smell is due to hydrogen sulfide, methyl mercaptan, dimethyl sulfide and dimethyl disulfide (Smook, 1982). One method to overcome this problem is by adding a chemical recovery system. The chemical recovery system has two functions- to recovery chemical for further use and to eliminate air, water and land pollution (United Nations Environment Programme, 1983). Some mills can eliminate pollutants and get recovery as high as 99% of the sodium.

In developing tropical countries, hardwoods are being used increasingly for pulping in an effort to conserve the limited softwood resources. These pulp mills are usually small and utilize local hardwoods. Also, these mills are located in the populated areas and pollution control is negligible since a recovery system is not economical for small mills (less than 200tons/day) (Zerrudo, 1990). Therefore the soda-AQ pulping is very suitable since it contains no sulfur and the odorous air emission is largely avoided and the spent liquor has a lower toxicity level than kraft black liquor (MacLeod and Cry, 1983).

AQ presents no problems. It has been produced and handled on a large scale without difficulty for many decades. The additive is used in small amounts, and the majority of it and its decomposition products would be burned with the black liquor. Also the existing kraft pulp mill does not need any major modification for soda-AQ pulping. The additives themselves are not particularly hazardous and their application do not require special techniques nor equipment (Holton, 1977).

The soda-antraquinone pulping of temperate hardwoods and softwoods has been widely studied (Ghosh et. al., 1978; Holton, 1977; Lomendahl and Samuelson, 1976; MacLeod et. al., 1981, McLeod and Cyr, 1983). Malaysian tropical hardwoods, however have not been subjected to this process (Mohd Nor, 1990).

1.2 Objectives:

The objectives of this study are:

i. To determine the variations in pulp yield and quality of A. mangium using four different levels of anthraquinone additives.

ii. To compare the strength properties of soda-anthraquinone pulps with soda, and kraft pulps of A.mangium.

CHAPTER 2

LITERATURE REVIEW

2.1 FOREST PLANTATION

Malaysian forest, during last two decades, has been logged extensively. Rapid logging and land clearing for agricultural development has severely reduced the forest resources, so much so, that there is now a projected shortage of timber for domestic consumption in Peninsular Malaysia by the year 2000 (Table 2.1). The National Forestry Council during its fifth meeting in 1981, recognised the need to develop and expand the forest resource of the country. As a result of this meeting, a programme to grow fast-growing forest plantations that could supplement the supply of timber from the natural forests, termed "Compensatory Forest Plantation", has been implemented (Johari 1987).

Fast growing species which can be grown to yield general utility timber, are expected to have yields of 4 tons/annum to the acre or 60 tons on a rotation of 15 years (Freezaillah, 1980). The Compensatory Forest Plantation Programme(CFPP) envisaged the establishment of about 188,000 ha of forest plantations in Peninsular Malaysis within 15 years, starting from

Table 2.1: Timber supply and demand (M m^3)
in Peninsular Malaysia

Period	Projected average annual consumption	Projected timber flows	Timber surplus/ deficit
1986-1990	2.65	4.28	+1.63
1991-1995	3.45	3.74	+0.29
1996-2000	4.40	3.74	-0.66
2001-2005	5.40	3.74	-1.66
2006-2010	6.60	3.74	-2.86

Source: Freezaillah (1980)

1981 and ending in 1995. In Sabah, 150,000 ha of plantation forest will be established by the year 2000 (Wan Razali et. al., 1989).

The CFPP is expected to cost about M$517 million (Johari, 1987). The investment may be considered to be high but the alternative to this would be a timber shortage that would adversely affect socio-economic development. Imports of timber toward the end of this century is not considered feasible in view of the dwindling timber supplies in the region and the competition with other established markets. It is considered that the Compensatory Plantation Project is a programme that the country cannot afford not to invest in (Freezaillah, 1980). For this purpose, fast-growing species such as Acacia mangium, Gmelina arborea, and Paraserianthes falcataria (Albizia falcataria) are planted. The main species being planted is Acacia mangium (Johari, 1987; Udarbe, 1987).

2.2 Acacia mangium Willd.

There are more than 1,000 described species of Acacia throughout the world (Moran et. al., 1989). One of these, A. mangium Willd., has emerged in the last decade as a major forest plantation species for tropical moist environment (National Academy of

Sciences, 1983).

A. mangium is endemic to northern Queensland, the Western Province of Papua New Guinea, and the Indonesian provinces of Irian Jaya and Maluku (Figure 2.1). Over this geographical range, A. mangium grows primarily in coastal tropical lowlands on margins of closed forest, and in open forest and woodland. The species appears to be a strong colonizer of areas disturbed either by fire or man (Moran et. al., 1989).

A. mangium was first introduced to Malaysia, in Sabah from Australia in 1966 as fire-break trees. It has adapted well and has outperformed most of the plantation species tested, particularly, when grown on poorer sites. On more fertile soils it has been recorded to have reached a growth rate of 44 m^3/ha/yr. Growth at an initial spacing of 3 m by 3 m, the stand closes canopy in 2 to 3 years with the height at about 8 m. At seven years trees may reach a height of over 20 m with breast-height diameters of over 28 cm. The stand will require at least two thinnings to produce a final crop of 300 to 400 trees per hectare (Udarbe, 1987). Presently the wood is better known for its suitability for the manufacture of pulp and paper (Ubarde, 1987).

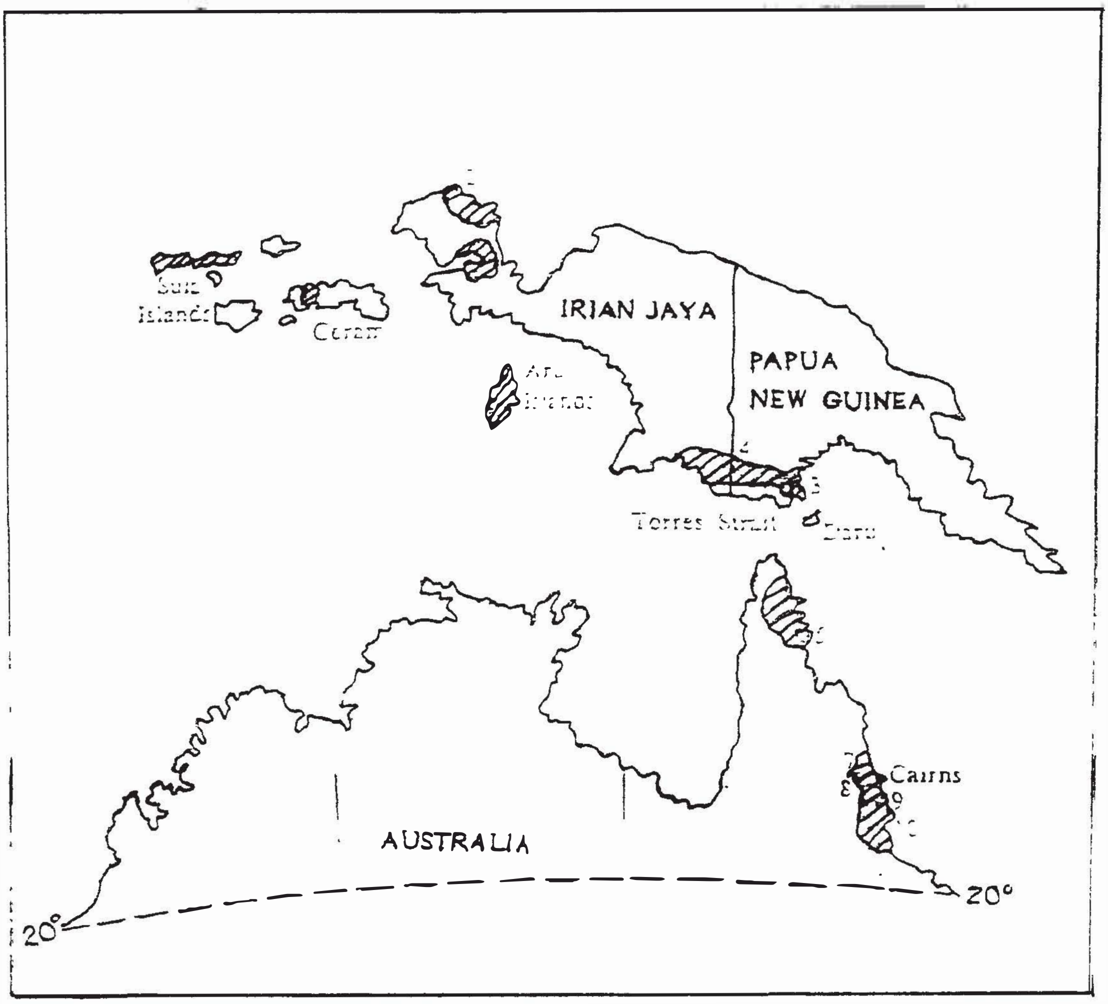

Figure 2.1: Distribution of native *Acacia mangium*
Source: Moran *et al* (1989)