# FIBRE MORPHOLOGY, PHYSICAL AND CHEMICAL PROPERTIES OF *GLIRICIDIA SEPIUM*

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## ABSTRACT

In this study, Gliricidia sepium of three age groups were produced and tested for their fibre morphology, physical and chemical properties. The methods used were accordingly to the TAPPI (1993) and Wise et. al (1946). Most of the properties studied increases with age except for fibre wall thickness that was approximately the same. The fibre was found to be unsuitable for papermaking due to its high fibre morphology and lignin values except for wood composite production.

## INTRODUCTION

The fibre, physical and chemical properties of lignocellulosic materials are very important especially in processing for pulp and wood composites products. Fibre length and ash content can influence the mechanical and physical of the product such as toughness, workability and durability. The amount and types of extractives can be used to determine the wood's permeability to liquids and influences other wood properties such as density, hardness and mechanical strength. This study was conducted to determine the fibre morphology, density and the chemical properties of *Gliricidia sepium* with reference to tree age.

## MATERIALS AND METHODS

Plantation grown *Gliricidia sepium* located at the cocoa experimental plot of Lembaga Koko Malaysia situated in Jengka 18 were used in this study. Ten trees from each year of 1996, 2000 and 2001 were selected randomly and felled at 30mm above the ground. A disc of 2.5cm(1") thick at diameter breast height was cut from the logs to be used for physical and chemical properties tests. The discs samples were then processes into wood cubes to determine its density, processed into matchstick sizes for fibre properties determination.

From the fibre measurements, the runkle ratio, coefficient of suppleness and felting power (Runkle 1952) were calculated as follows;

| | | |
|---|---|---|
| Runkle ratio | = | $2\,w/l$ |
| Coefficient of suppleness | = | $(l \times 100)/D$ |
| Felting power | = | $L/D$ |

where,

$w$= fibre wall thickness (um), $l$ = lumen diameter (um), $D$ = fibre width and $L$ = fibre length (mm)

Proximate chemical analysis was conducted on air-dry milled samples according to the following standard methods:

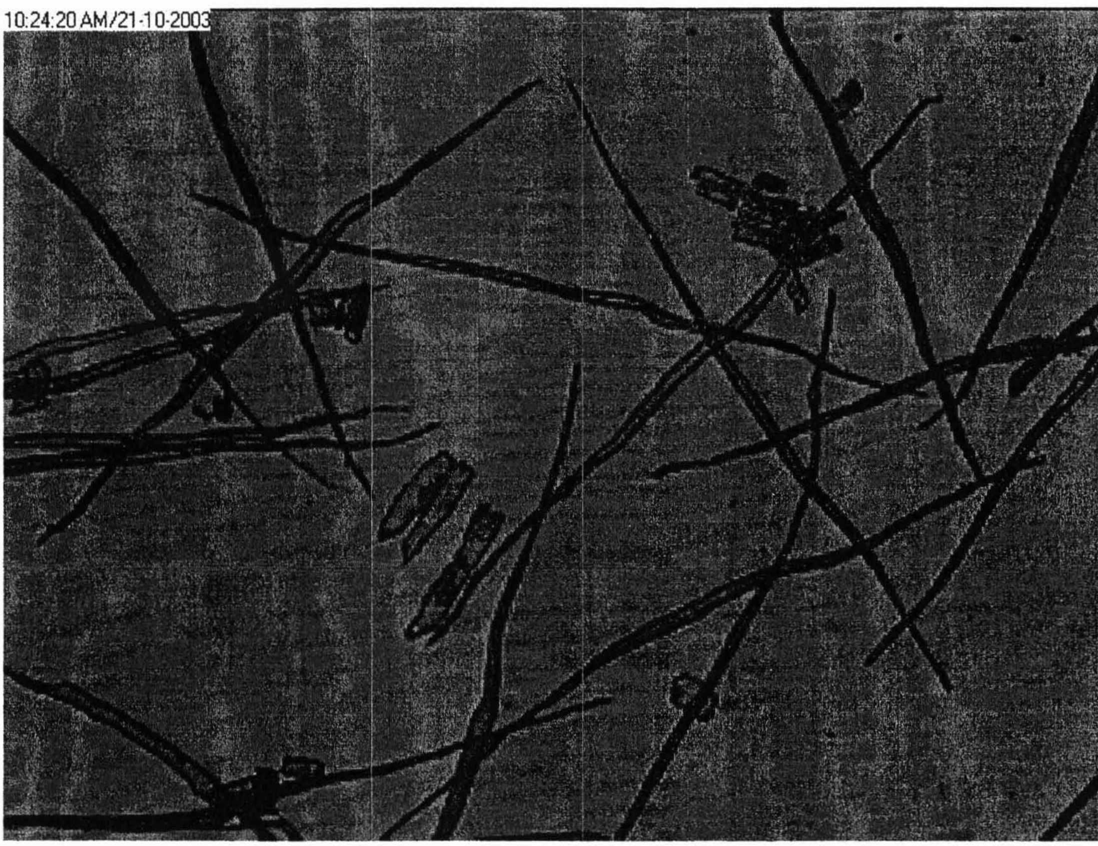
| | |
|---|---|
| Specific gravity | : TAPPI T18 (Anonymous 1993) |
| Fibre morphology | : TAPPI T259 (Anonymous 1993) |
| Ash content | : TAPPI T 211(Anonymous 1993) |
| Hot water solubles | : TAPPI T207 (Anonymous 1993) |
| Alcohol benzenes soluble | : TAPPI T 204 (Anonymous 1993) |
| Lignin content | : TAPPI T 222 (Anonymous 1993) |
| Holocellulose content | : Wise et al. (1946) |

## RESULTS AND DISCUSSIONS

### Fibre Morphology

The fibre dimensions of *Gliricidia sepium* are shown in Plate 1, while the fibre measurements are presented in Figure 1. The fibres are short averaging about 0.9 mm for all the age groups. Thus, *Gliricidia sepium* is categorised under the hardwood species, which has a fiber length of less than 2mm. It is assumed that the fibre has matured after the first year. The fibre diameter was highest for wood at the age of 3 to 7 years with a diameter of about 15.85um, while the 2 yr-old has the lowest (14.64um). It seems that as the tree ages the lumen diameter increases in size and 7 yr-old has the highest (8.5um). However the fibre wall thickness remains the same throughout the age group.

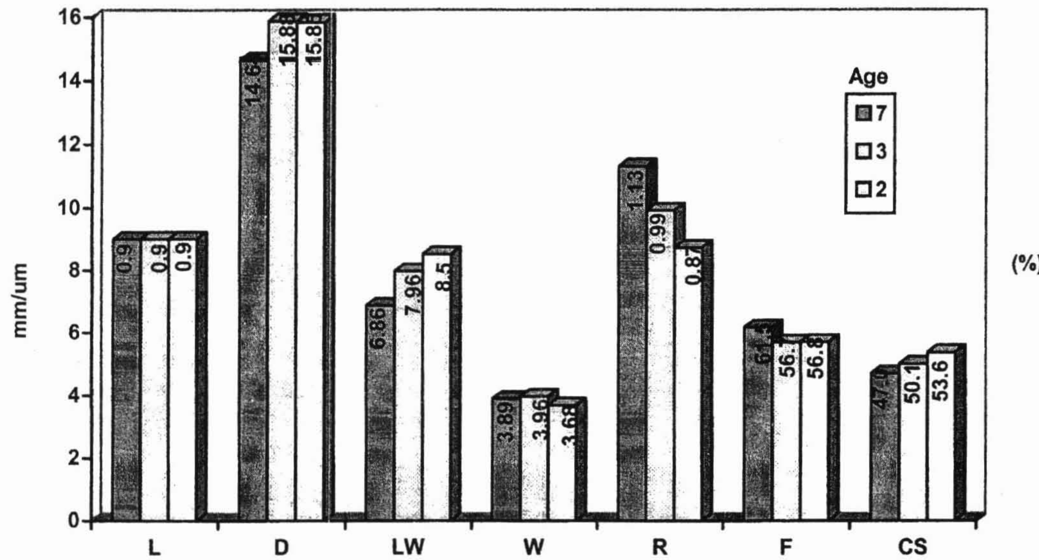
**Plate 1: Fibres of *Gliricidia sepium* (Magnification 100x)**




Runkel ratio is a ratio of double *w* divided by *l* and it gives the indication of the fibre suitability in the manufacture of pulp and paper. The higher the ratio meaning the fibres are thick wall and not easily beaten during the refining stage. Even the 7-yr-old fibre has a ratio of 1.13 indicating their unsuitability as the recommended ratio is below 1.0.

*G. sepium* fibres has a flexibility ratio of 56 to 61%, similar to those of Malaysian hardwoods (Peh et al. 1986), thus, indicating paper produced from this species is of low tearing strength. The coefficients of suppleness are a general term used as a guide for assessing the degree of fibre bonding of paper (Anon. 1955). High coefficient of suppleness will produce paper with high tensile and bursting strength due to good inter-fibre bonding. However, the coefficient of suppleness of *G. sepium* is between 47 to 53% indicating their unsuitability for papermaking.

**Figure 1: Fibre Morphology of *GliricidiaSepium***

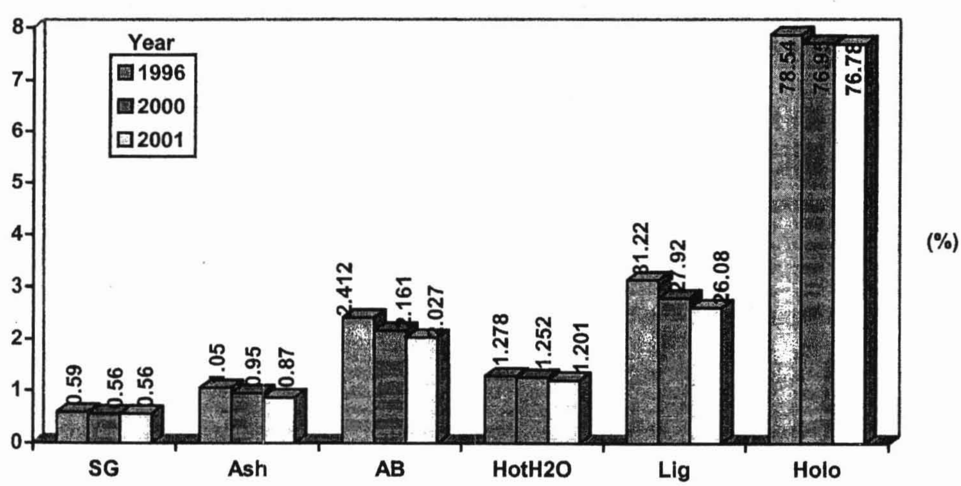



Notes: L-length, D-fibre diameter,LW-lumen width, W-cell wall thickness, R- runkel ratio, *F- flexibility ratio, CS-coefficient of suppleness*

**Specific Gravity and Chemical Properties**

Figure 2 shows the specific gravity and chemical properties of *gliricidia sepium* according to age. The highest specific gravity was recorded for the 7-yr-old wood (0.59) as compared to the 3- and 2-yr-old wood. The 7-yr-old wood has matured with hardened cell-wall and has accumulated more extractives in its tissue giving rise to the higher specific gravity compared to other age group. The wood was reported to have specific gravity of 0.5 to 0.8 (Anon. 1998a; Dorthe 2002). In its place of origin, Mexico and central America, the wood of *gliricidia* was known as ironwood due to its hardness and durable wood which were resistant to weathering and fungal attack (Anon. 1998b).

**Figure 2. Specific Gravity and Chemical Properties of *Gliricidia Sepium***




Notes: SG- specific gravity, AB- alcohol benzene solubles, Lig- lignin, Holo- holocellulose content

The importance of chemical properties is unlimited. It is closely related to carbohydrate industry, pulp and papermaking and it also can be used to explain the phenomenon of low resistance towards insects, flow in wood and also tree growth. The ash content varies from 0.87 for 2-yr-old to 1.05% in 7-yr-old wood falls within the ranges of those of Malaysian hardwoods (0.1 to 2.5%) (Khoo & Peh 1982). The higher ash content in older wood is due to the accumulation of siliceous material during its growth.

The alcohol benzenes and hot water soluble are also higher in older wood, while in younger tree, lesser amount of ash, hot water and alcohol benzenes soluble are found. The higher concentrations of these substances may influence the durability of the wood towards insect and fungi attack (Plank 1951). The lignin content also revealed that 7-yr-old tree had the highest (31.22%) while the lowest in the 2-yr-old *gliricidia*. The lignin content influences the woody structural rigidity by holding and stiffening the fibres together. A high lignin content will consumes high chemical if the wood is to be used in chemical pulping. It also affects the beating quality of pulp resulting in lower strength of paper produced. Holocellulose content ranges from 76 to 78% and is more abundant in older tree as compared to younger ones.

## CONCLUSIONS

In fibre morphology, the fibres were short (approximately 0.9mm) while the fibre wall thickness remains the same for all age groups. The fibre and lumen diameter were the highest with older tree. The fibre Runkel ratio, flexibility ratio and coefficient of suppleness values were the highest with older tree exceeding the requirements for papermaking. The Specific Gravity and chemical properties increase with age.

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