UNIVERSITI PUTRA MALAYSIA

EFFECTS OF AGE AND HEIGHT ON SELECTED PROPERTIES OF THREE MALAYSIAN BAMBOO SPECIES

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By

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Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Master of Science.

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December 1991

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Faculty : Forestry

Although bamboo is widely found in Peninsular Malaysia, little research has been conducted on its importance for industrial use. A study was initiated to evaluate the effect of age and height of three common bamboo species namely Bambusa blumeana Schult. 'Buluh duri', Bambusa vulgaris Schrad. 'Buluh minyak' and Gigantochloa scortechinii Gamble 'Buluh semantan' on their anatomical, physical, mechanical and machining properties and durability against borers.

All the anatomical properties except radial/tangential ratio of the vascular bundles size, showed no significant relationship with age and height. The fibres of both the

Bambusa species were shorter than those of G. scortechinii (ranges of 1.74 - 3.76 mm and 3.50 - 4.24 mm, respectively). The average cell wall thickness of the three bamboo species was in the range of 5 - 7 μm.

The initial moisture content and oven-dry densities of the bamboos differed significantly with species and maturity but not with height. The moisture content of the samples ranged from 54 - 300 percent in B. vulgaris, 60 - 164 percent in B. blumeana and 67 - 133 percent in G. scortechinii. The densities of the bamboos, however, were in the range of 200 - 630 kg/m^3, 360 - 690 kg/m^3 and 380 - 620 kg/m^3 in B. vulgaris, B. blumeana and G. scortechinii, respectively. The radial and tangential shrinkages decreased with increase in age and culm height. In general, the strength properties of the bamboos increased with age and culm height.

Bamboo should be harvested and processed at two years of age with usage limited to the basal and middle portion to ensure good quality products. G. scortechinii, which generally possessed a higher content of starch and total sugars, was observed to be less susceptible to borer attack than both the Bambusa species. This indicates that the durability of bamboo may also be affected by its inherent physical and chemical properties besides its carbohydrate content.

Abstrak tesis ini dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk mendapatkan ijazah Master Sains.

KESAN UMUR DAN KETINGGIAN BATANG TERHADAP BEBERAPA SIFAT TERPILIH PADA TIGA JENIS BULUH MALAYSIA

Oleh

ABD. LATIF MOHMOD

Disember 1991

Pengerusi : Prof. Madya Mohd. Zin Jusoh

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Buluh boleh dijumpai dengan mudahnya di kebanyakan kawasan di Semenanjung Malaysia. Namun demikian, kerja penyelidikan yang dijalankan kurang memberikan tumpuan terhadap kepentingannya sebagai bahan asas perindustrian. Memandangkan kepada banyaknya buluh yang hidup meliar di negara ini, satu kajian asas dijalankan bagi menilai kesan umur dan ketinggian batang di dalam tiga jenis buluh utama iaitu Bambusa blumeana Schult. (Buluh duri), B. vulgaris Schrad (Buluh minyak) dan G. scortechinii Gamble (Buluh semantan) terhadap sifat-sifat anatomi, fizikal, mekanikal, pemerosesan, kandungan pemakanan dan kerintangannya terhadap kumbang bubuk.

Umur dan ketinggian batang didapati tidak memberi kesan yang bererti terhadap sifat anatomi (kecuali nisbah jejari/tangen). Gentian bagi kedua-dua spesis Bambusa juga didapati lebih pendek (julat antara 1.74 - 3.76 mm) berbanding G. scortechinii (3.50 - 4.24 mm). Ketebalan dinding sel ketiga-tiga buluh pula adalah di dalam julat purata diantara 5 - 7 μm.

Kandungan lembapan dan ketumpatan buluh amat dipengaruhi oleh peningkatan umur tetapi berbeza mengikut ketinggian batang. Kandungan lembapan buluh-buluh adalah berjulat antara 54 - 300 peratus, 60 - 164 peratus dan 67 - 133 peratus setiap satunya di dalam B. vulgaris, B. blumeana dan G. scortechinii. Ketumpatan buluh pula adalah di dalam lingkungan 200 - 630 kg/m^3 (B. vulgaris), 360 - 690 kg/m^3 (B. blumeana) dan 380 - 620 kg/m^3 (G. scortechinii). Nilai pengecutan bagaimanapun didapati menurun mengikut kenaikan umur dan ketinggian batang. Ini berbeza pada sifat mekanikal yang secara amnya dipengaruhi oleh kenaikan umur dan ketinggian batang buluh. Penuaian buluh bagi tujuan pembuatan adalah dicadangkan supaya dilakukan selepas ianya berumur dua tahun dan dengan had penggunaan dari bahagian pangkal ke tengah batang bagi menjamin kadar pulangan, mutu dan hayat barangan yang lebih baik.

Walaupun G. scortechinii didapati mengandungi kanji dan jumlah gula yang lebih tinggi, kerintangannya terhadap serangan

kumbang bubuk ternyata lebih baik berbanding dengan kedua-dua buluh lain yang dikaji. Ini membawa pengertian bahawa kerentanan buluh juga melibatkan sifat-sifat fizikal dan kandungan kimia tertentu yang dimiliki oleh jenis-jenis buluh itu sendiri.

CHAPTER I

INTRODUCTION

Bamboo belongs to a unique group of plants of the giant arborescent grass family (Gramineae) in which the woody culms emerge from underground rhizomes. It is a shrub that has a tree-like habit with culms that are usually erect but sometimes climbing (Holtum, 1959; Liese, 1985). It is also characterised by its woody, mostly hollow culms with internodes and branches at the nodes of culms.

Bamboo generally grows in forest areas from sea level to about 400 m above sea level in all continents except Europe. Out of an estimated 600 - 700 species in the world, more than half can be found in Asia (Liese, 1985). Bamboos, like other lignocellulosic materials have long been exploited by mankind for various purposes in many developing countries in Asia, Africa and South America (Tewari and Bindhi Singh, 1979). It is considered as one of the oldest building materials used in the rural areas and villages, and is popular mainly due to its availability, low cost, strength, and the fact that it is a high yielding renewable resource.

In Malaysia, bamboo is found in abundance although widely scattered in about five percent of the total forest reserve area (Abd. Latif, 1987). It has, however, received

comparatively little attention as far as research is concerned. Forest management in Malaysia, for instance, has not given due emphasis to bamboo as an industrial resource to be exploited systematically. Traditionally, bamboo has been considered as a weed in forestry practice in which attempts were made to prevent or control its growth (Medway, 1973; Ng, 1980; Salleh and Wong, 1987).

The bamboo industry in Malaysia goes back to 1950's when bamboo was commonly exploited for craft and agricultural needs. Among the products are baskets for transporting vegetables, poultry and hogs. The industry which produces these products is mainly cottage as well as part time in nature. The work force comprises mostly housewives and children to supplement the family income (Abd. Latif et al., 1989). Due to the current demand for disposable items such as chopsticks, the bamboo machine-intensive industry has been booming over the last five years. This has encouraged the import of Taiwanese- and Japanese-made machines for processing Malaysian bamboos. As a result, bamboo which was once considered a weed has been extensively exploited to meet the demand from consumer countries particularly Japan, the Republic of Taiwan and Korea.

One hundred and four machine-intensive bamboo processing factories have been established since 1985 in Peninsular Malaysia. These are mostly located in the west coast of

the peninsular and produce bamboo products like skewers, chopsticks, furniture, specific craft items and joss paper for religious purposes (Abd. Latif et al., 1989). Even though the number of mills has increased, The Malaysian Department of Statistics reported that Peninsular Malaysia exported only about MR 218,685 FOB worth of bamboo products in 1988, that is approximately 0.6 percent of the global market (Malaysian Trade Commission Tokyo, 1988). The primary reason for this miniscule export quantity is that the quality of locally-made bamboo products is considered relatively poor to meet the high standards imposed by the importing countries (Lee, 1989). This industrial set-back is related to indiscriminate harvesting of bamboo without much consideration given to its final or specific intended usage.

The selection of bamboo materials suitable for machine-intensive industry, construction and housing is dictated by its anatomical, physical and mechanical properties. Improper selection of age and species of bamboo will often result in higher wastage and products of low grade for export. Furthermore, bamboo is also prone to fungal and insect attacks due to the available nutrients such as starch and sugars (Plank, 1950; Liese, 1980; Sulthoni, 1987, 1988). Detailed studies on the relationship of species, age and height to the natural durability will further lead to proper selection of more resistant bamboos for industrial application.

No published report exists on the effect of species, age and stem sections on the properties of natural stand Malaysian bamboos for industrial use. Therefore, the general objective of this study is to assess the variation in some natural stand of bamboo species. Three commonly utilized Malaysian bamboos namely Bambusa blumeana Schult (Buluh duri), B. vulgaris Schrad. (Buluh minyak) and Gigantochloa scortechinii Gamble (Buluh semantan) of known age (one- to three-years-old) were selected for the study. The parameters used are the anatomical properties namely, fibre length, vascular bundle distribution and size, and cell wall thickness. The physical properties measured are moisture content, density and shrinkage; while the mechanical properties measured include shear, compression and bending strength. Machining properties, carbohydrate content (starch and total sugars) and the natural durability towards borer are also taken into consideration. The above properties were studied because of their importance in the manufacturing process and in the ultimate product quality and durability.

The highly variable properties of bamboo present problems in processing and utilization. Thus, future processing improvement should be focussed on harvesting bamboo of desired quality, species and suitable age for end-uses. The inter-relationship of the properties studied may indicate whether silviculture treatment, tree improvement, and harvesting practices are required to produce bamboo stands with improved

properties suitable for manufacturing purposes. The study was conducted at the Forest Research Institute of Malaysia (FRIM), Kepong, Selangor, Malaysia where the naturally occuring bamboo samples of known age were obtained.

CHAPTER II

LITERATURE REVIEW

Information on the basic properties of Malaysian bamboos particularly in relation to their industrial applications is very limited. Since many bamboo species remain unutilized, research effort is needed to determine the properties of such species and to develop appropriate technology to utilize them. Due to lack of research information on local bamboos, a major portion of this literature review is based on the work done by researchers in other countries.

Types of Bamboo for Industrial Use

Out of the 45 bamboo species identified by Holtum (1958) in Peninsular Malaysia, only about 13 species are widely used. These include Bambusa blumeana Schult, B. heterostachya Munro, B. vulgaris Schrad., Dendrocalamus asper (Schult.) Backer, D. pendulus Ridl., Gigantochloa latifolia Ridl., G. levis (Blanco) Merr., G. liqulata Gamble, G. scortechinii Gamble, G. wrayi Gamble, Schizostachyum brachyladum Kurz, and S. grande Ridl. (Holtum, 1958; Gilliland et al., 1972; Ng, 1980; Abd. Latif, 1987).

This section describes the three species selected for this study.

Genus: Bambusa Schreber

Bamboos that are grouped in this genus are easily identified from the culm sheath auricles and their stiff sheath-blade covered with darkish brown hairs. This genus can also be recognised by the presence of thorns or spikes at the lateral branches. Some common examples are:

Bambusa blumeana Schult. (Buluh duri)

The shoot of this species has dark brown hairs which gets darker towards the apex. The culms are tall, about 10 cm in diameter and grow in clumps and easily recognised by thorny characteristics from the copious spreading low thorny branches. This species is classified as large diameter bamboo.

The culm sheath may extend up to 30 cm and its back is covered with loose dark brown hair. The internodes are green and glabrous when young with lateral branches borne almost at the basal portion. The lower branches spread horizontally and bear stout, curved spines in groups of three, with the middle spines being longest.

The ligules are stiff and about 5 mm to 12 mm tall in the middle while the outer part consists of a stiff bristle about 12 mm long.

This bamboo is widely distributed in Java and Eastern Peninsular Malaysia and traditionally used for furniture and musical instrument (Ng, 1980).

B. vulgaris Schrad. (Buluh minyak, aao, aro, beting, pan).

The clump is usually big and umbrella-shaped. It is a common sight in the village and on river banks.

The culms are about 10 - 20 m tall, slightly irregular, and about 5 - 10 cm in diameter at the base. The culm is classified as big diameter bamboo and not closely tufted. The culm internode is green in colour. Culm sheath is densely covered with appressed almost black loose hairs. The sheath blade is yellowish when young.

The nodes are prominent, with 20 - 45 cm internode length, possess appressed dark hairs and scales of wax when young but become smooth and shiny with age. The ligules are normally 3 mm tall or more, with slightly crisped edges and short hairs.

The origin of this bamboo is still unknown, but it is often cultivated in the tropics, including Malaysia. It can be

found growing abundantly on the river banks and are valued for its good quality edible shoots (Hildebrand, 1954) besides being used for toothpicks, blinds, chopsticks and ornamental purposes (Abd. Latif, 1987; Abd. Latif et al., 1989).

Genus: Gigantochloa Kurz.

The species belonging to this genus grow in Burma, Indochina, the Malay archipelago and the Philippines. Gigantochloa can be identified in the field by its straight culm, almost low but firm auricles with narrow sheath-blade. The ligule is often tall and thin, with the blade either erect or deflexed. The most common species is:

G. scortechinii Gamble (Buluh semantan).

The culms are about 10 - 20 m tall, straight and usually covered with fine, white waxy powder when young, green when old and with internodes of about 40 cm long. The culm-sheath is light orange at the top when young and covered with appressed, coarse nearly black hairs. The sheath blade is much narrower than the top of the culm-sheath, and deflexed at right angles.

The branches at each node are few but with dense foliage; the auricles are small and usually accompanied with few