ANATOMICAL STRUCTURE AND PHYSICAL PROPERTIES OF NEWLY INTRODUCED *HEVEA* SPECIES

By

NORUL IZANI BINTI MD ALLWI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

Dedicated to my beloved father, Md Allwi Hassan; my loving mum, Norunnaha Md Nor; my brothers, Khairil Anuar and Khairul Amru; my fiancé, Fadzli Asyarihi Ramlee and all my loving family……..

Norul Izani

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Professor Mohd Hamami Bin Sahri, PhD

Faculty : Forestry

Understanding wood properties and behavior is important to evaluate the performance of producing high quality end products. A study was conducted to determine the anatomical and physical properties of new *Hevea species* viz *Hevea pauciflora, Hevea guianensis, Hevea spruceana, Hevea benthamiana* compared to the executing *Hevea brasiliensis* clone RRIM 912. This study was conducted in order to determine its suitability and potential usage of these woods. Five trees of 15 years old from each species were selected and felled from Rubber Research Institute of Malaysia (RRIM) Plantation at Bandar Penawar, Johor. Each tree was divided into three different portions along the height namely, bottom, middle and upper parts, and two radial samples namely outer and inner parts were chosen for comparative study on the anatomical structure and physical properties. Physical testing were conducted

using ISO 3129-1975 (E) – Wood Sampling Methods and General Requirements for Physical and Mechanical Tests (Anon, 1975a).

Clone *RRIM 912* exhibited the longest fibre compared to other species with 1214 µm, followed by *Hevea benthamiana* (1200 µm), *Hevea pauciflora* (1189 µm), *Hevea spruceana* (1158 µm) and *Hevea guianensis* (1145 µm). Longer fibre was observed in outer wood compared to inner wood. The fibre length of these rubberwood species was increasing from bottom to the upper part of the tree. *Hevea guianensis* has the largest fibre diameter (24.9 µm) and lumen diameter (12.5 µm). Along the radial zones, there is no significant difference in lumen diameter either in the inner wood or in the outer wood. The cell wall thickness of *Hevea pauciflora* recorded the lowest with 6.08 µm, compared to the highest with 6.51 µm (*Hevea spruceana*). Most of these *Hevea species* showed decreasing pattern from outer region to inner region. Vessel diameter was found to be higher in *RRIM 912* clones with 153.3 µm. The results indicated that the mean vessel diameter is larger at outer region compared to inner region. The mean vessel frequency was higher in *Hevea guianensis* with 2.61 per sq. mm. The increase in the amount of vessel will decrease the specific gravity and thus the strength of the wood. Wood from *RRIM 912* clones showed the highest proportion of rays with 33.3%, compared to the lowest with 29.8% (*Hevea spruceana).*

Hevea spruceana had the highest initial moisture content compared to other species. Basically, bottom part possessed the highest moisture content followed by middle and

upper part, respectively. The highest specific gravity was obtained from *RRIM* 912 clones with 0.60, while the lowest was 0.57 (*Hevea guianensis).* Generally, species with a high specific gravity have corresponding high strength value. The strength properties of timber increase with decreasing moisture content. *Hevea guianensis* exhibited the highest percentage of shrinkages for all directions (tangential, radial and longitudinal). Overall, from the results it showed that the tangential shrinkage recorded the greatest value followed by radial shrinkage and longitudinal shrinkage.

Overall, the properties of clone *RRIM 912* was found to be comparatively better because of higher strength due to longer fibre length, thicker cell walls and higher specific gravity than other *Hevea species.* Therefore, this species can be inferred as a potential general utility timber.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

STRUKTUR ANATOMI DAN CIRI FIZIKAL BAGI SPESIES *HEVEA* YANG BARU DIPERKENALKAN

Oleh

NORUL IZANI BINTI MD ALLWI

Jun 2006

Pengerusi : Profesor Mohd Hamami Bin Sahri, PhD

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Pengetahuan tentang ciri-ciri sesuatu kayu merupakan suatu keperluan untuk kita membuat penilaian bagi sesuatu kegunaan seperti untuk penghasilan kayu berkualiti tinggi dan juga untuk menilai potensi kegunaan kayu. Kajian ini telah dijalankan untuk mengkaji anatomi dan ciri-ciri fizikal dalam spesies baru pokok getah seperti *Hevea pauciflora, Hevea guianensis, Hevea spruceana, Hevea benthamiana* untuk dibandingkan dengan *Hevea brasiliensis* klon RRIM 912. Lima spesies pokok getah berumur 15 tahun telah dipilih dan ditebang dari Ladang Institut Penyelidikan Getah Malaysia (RRIM) di Bandar Penawar, Johor. Setiap pokok dibahagikan kepada tiga bahagian mengikut tinggi pokok iaitu bahgaian atas, tengah dan bawah dan dua sampel mengikut jejari iaitu bahagian luar dan dalam. Ujian sifat fizikal telah dijalankan menggunakan piawaian ISO 3129-1975 (E) – Wood Sampling Methods and General Requirements for Physical and Mechanical Tests (Anon, 1975a). Gentian terpanjang untuk spesis *Hevea* terdapat pada klon *RRIM 912* dengan 1214 µm, diikuti dengan *Hevea benthamiana* (1200 µm), *Hevea pauciflora* (1189 µm), *Hevea spruceana* (1158 µm) dan *Hevea guianensis* (1145 µm). Daripada ujikaji, gentian terpanjang terdapat pada bahagian luar kayu berbanding bahagian dalam kayu. Selain itu, panjang

gentian untuk spesis kayu getah ini didapati meningkat dari bahagian bawah pokok ke bahagian tengah dan seterusnya ke bahagian atas pokok. *Hevea guianensis* memberi nilai terbesar untuk garis pusat gentian dan diameter lumen iaitu masing-masing 24.9 µm dan 12.5 µm. Untuk diameter lumen, kedudukan sampel tidak menunjukkan sebarang perbezaan beerti samada untuk bahagian dalam atau luar kayu. *Hevea pauciflora* memberi nilai ketebalan dinding sel yang paling rendah dengan 6.08 µm, berbanding nilai yang paling tinggi iaitu 6.51 µm (*Hevea spruceana*). Sebahagian besar spesis kayu getah ini menunjukkan nilai ketebalan dinding sel yang semakin rendah dari bahagian luar ke bahagian dalam kayu. Klon *RRIM 912* didapati memberi nilai diameter vessel yang paling besar iaitu 153.3 µm. Daripada ujikaji, jelas didapati bahawa min terbesar diameter vessel ialah pada bahagian luar kayu berbanding bahagian dalam kayu. Nilai tertinggi untuk frekuensi vessel ialah direkod pada *Hevea guianensis* dengan 2.61 bagi setiap mm persegi. Penambahan jumlah vessel didapati akan menurunkan nilai graviti spesifik dan seterusnya mengurangkan kekuatan kayu. Kayu dari klon *RRIM 912* menunjukkan nilai peratusan taburan ruji yang terbesar dengan 33.3%, berbanding peratusan terendah iaitu 29.8% (*Hevea spruceana).*

Untuk ujian fizikal, *Hevea spruceana* memberi nilai kandungan lembapan awal yang tinggi berbanding spesis kayu getah yang lain. Secara asas, kandungan lembapan yang plaing tinggi dicatatkan di bahagian bawah pokok, diikuti bahagian tengah dan seterusnya bahagian atas pokok. Min graviti spesifik tertinggi didapati direkod pada klon *RRIM* 912 dengan 0.60, manakala min terendah iaitu 0.57 (*Hevea guianensis).* Secara amnya, spesis dengan nilai graviti spesifik tertinggi mempunyai kaitan dengan

nilai kekuatan kayu yang tinggi. Kekuatan kayu bagi sesuatu balak bertambah dengan pengurangan dalam kandungan lembapan. *Hevea guianensis* menunjukkan nilai peratusan pengecutan yang tertinggi pada semua arah (tangen, radial dan memanjang). Secara keseluruhannya, kajian menunjukkan pengecutan pada arah tangen merekodkan nilai peratusan yang tertinggi diikuti pengecutan radial dan seterusnya pengecutan pada arah memanjang.

Daripada keputusan yang diperoleh, ciri-ciri pada klon *RRIM 912* menunjukkan nilai yang lebih baik berdasarkan sifat kekuatan kayu tersebut yang dipengaruhi oleh panjang gentian, ketebalan dinding sel dan nilai graviti spesifik yang tinggi berbanding spesis kayu getah yang lain. Oleh itu, boleh disimpulkan bahawa klon *RRIM 912* dapat memberi potensi yang tinggi untuk bekalan kayu balak pada masa depan.

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I certify that an Examination Committee met on 5 JUNE 2006 to conduct the final examination of Norul Izani Binti Md Allwi on her Master of Science thesis entitled "Anatomical Structure and Physical Properties of Newly Introduced *Hevea* Species" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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NORUL IZANI MD ALLWI

Date: 3 JULY 2006

TABLE OF CONTENTS