ANATOMICAL CHANGES IN ARTIFICIALLY INCLINED STEM OF NATURALLY GROWN POMETIA PINNATA AND DYERA COSTULATA AT AYER HITAM FOREST RESERVE

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By

MOHAMAD ZUBAIR AZIM BIN MOHD RAZIK

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DEDICATION

In the name of Allah, this thesis is dedicated to the most fondness

My beloved parent,

Mohamad Razik bin Arshad (Father), Khoriyah binti Abdullah Hashim (Mother)

My beloved sisters,

Nor Alisa Adznim and Nur Afisha Adznim.

My colleagues,

Mohamad Syawalludin bin Saidi, Muhammad Akmal Bin Ab Latif, Noor Zulaika Binti Mohd Yusof, and Nur Atikah Binti Abu Bakar and all my friends that help me directly and indirectly through out this study.

Thank you so much for all your kindness and courage.

ABSTRACT

Tension wood is abnormal wood compared to normal wood. This research aimed to study the formation of the tension wood between the low density and medium density hardwoods in tropical rainforest species. This study was conducted at the Ayer Hitam Forest Reserved Forest, Puchong, Malaysia. The selected species for low density species is Jelutong (*Dyera Costulata*) and medium density is Kasai (*Pometia Pinnata*). The trees selected is artificially inclined for 30 ,60 and 120 days.The cambial marking was applied to the all selected tress using high DC pulse. The density, time taken, and the inclined angle is the major factor affecting the tension wood. The results showing there is varies of G-layers formed on the both species in the different time period. The conclusion is the Jelutong is easily formed compared to Kasai based on the anatomical characteristics.

ABSTRAK

Kayu tekanan adalah kayu yang tidak normal jika dibandingkan dengan kayu normal. Kajian ini bertujuan untuk mengkaji pembentukan kayu tekanan di antara kayu keras sederhana ketumpatan rendah dan sederhana diantara spesies hutan tropika. Kajian ini dilakukan di Hutan Simpan Ayer Hitam, Puchong, Malaysia. Spesies yg terpilih ialah ketumpatan rendah, Jelutong (*Dyera Costulata*) dan ketumpatan sederhana, Kasai (*Pometia Pinnata*).
Pokok-pokok yang dipilih secara artifisial cenderung untuk 30, 60 dan 120 hari. Tanda cambial digunakan untuk semua pokok yang dipilih menggunakan denyut DC tinggi. Ketumpatan, masa diambil dan sudut condong adalah faktor utama yang mempengaruhi kayu ketegangan. Keputusan yang menunjukkan terdapatnya pelbagai G-lapisan yang terbentuk pada kedua-dua spesies dalam tempoh masa yang berbeza. Kesimpulannya adalah Jelutong mudah dibentuk berbanding Kasai berdasarkan ciri-ciri anatomi.

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APPROVAL SHEET

I certify that this research project entitled "**Anatomical changes in artificially inclined stem of naturally grown *Pometia pinnata* and *Dyera costulata* at Ayer Hitam Forest Reserve**" by Mohamad Zubair Azim bin Mohd Razik, has been examined and approved as a partial fulfilment of the requirement for the degree of Bachelor of Wood Science and Technology in Faculty of Forestry, Universiti Putra Malaysia.

Approved by,

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percentage
°	Degree
D.B.H	Diameter Breast Height
DCHV	Direct Current High Voltage
HSAH	Hutan Simpan Ayer Hitam

CHAPTER I

INTRODUCTION

1.1 General Background

Presence of tension wood causes the wood to warp and twist when it dries, decreases its usefulness and value respectively (Bowling and Vaugn, 2008). It is because in the tension wood fiber there is presence of thick, inner G-layers and it is unlignified, also loosely attached to the other cell walls layer resulting in decreasing numbers of vessels and lignin content in the wood (Sultana and Rajashi, 2012). The G-layers may nearly composed of pure cellulose but also may contain of pollysacharides that including pectin and hemicellulose (Blowling and Vaugn, 2008). So, the G-layers really give a problem when it composed in the wood.

There is so many differences of physical, chemical and anatomical characteristic of tension wood compared normal wood. The vessels of the tension are decreases in the diameter and less numbers compared to the normal wood (Ruelle, 2012). In the hardwood species, there is variation for vessel frequency and fibre proportion in the tension wood structure. The vessels structure in tension wood tissue seems to be unchanged but most study report a decrease in the diameter and frequency of vessels in tension wood tissue compared with normal wood (Ruelle et al., 2012). The physical differences are the tension wood are woolly compared to then tension wood (Barnett et al., 2014). The tensile growth stress increases with the number of gelatinous fibers, increasing cellulose content, and decreasing microfibrillar angle in the tension woods (Yoshida et al., 2000). The formation of tension wood is because the eccentricity of the stem resulted by increasing radial growth of upper side (Sultana et al., 2012).

Next, stated by Clair and Tibhaut (2014) is the strength of the tension wood also weaker compared to normal wood. In a study, Clarke (1937) explain that the tension wood of Fagus spp. was weaker under compression and observed that tension wood failed by buckling while normal wood has a shear type failure. The tension wood is shrink when drying (Norgberg and Meier, 1966). For normal wood go through the dimensional changes during drying. Normal wood shrinks in the radial direction and tangential direction about 4–6 % and 8–10 % respectively, but less in the longitudinal direction. “Shrinkage along the radial and tangential directions is due to a combination of effects at the cell wall level and effect of structure linked to the organization and the shape of the cells. In the longitudinal direction, differences in shrinkage are explained mainly by differences in microfibrils angle in the S2 layer. The larger the microfibrils angle, the more the axial shrinkage and the less the transverse shrinkage of the wall” (Clair and Tibhaut, 2014). It is clear that microfibrils angle affect the rate of shrinkage of the wood.

Density of wood affecting the wood itself. the denser the wood the stronger it is and the wood harder to bend. The low-density species is weaker the high-density species it because density is related to physical properties such as swelling and shrinkage of wood. So, density is the one of the parameter to measure in wood which is generally used to estimate its quality and potential uses of the wood (Clair and Thibaut, 2014).

Thus, this will be a problem to wood utilization because of the differences of tension wood compared to normal wood in terms of physical, chemical and anatomical features (Suzana, 2015). This is supported by Sultana et al. (2012) states that in the drying process, the tension wood is occurring to warping, bending, and cracking of logs, planks, machined part and veneer. the lumber that contain tension wood are warping and twisting will give problems for wood-based industry when presence of the tension wood in the major area of the materials. For example, Nobuchi (2008) did a survey on the para rubber processing factory in southern Thailand which study that only 30% of logs transported from plantation sites to the factory to be utilized in the final product because of the high amount of tension wood causing warping and twisting during the process of drying. It is important to study about the tension wood to minimize the problem which is minimizing the development of the tension wood in the plantation.

However, the lower levels of lignin might be considered advantageous for the pulp industry. There is less cost to remove the lignin or delignification process. If reaction wood were present in wood in only small amounts, these problems might be overcome. Most of study agreed that tension wood is serious defects in terms of utilization of wood products (Barnet et al., 2012).

1.2 Problem Statement

The tension wood forms in the leaning trees in the dicotyledinous study. There are many factors contributing the forms of the tension wood. In the previous study, the diameter of sample taken is quite high which 6 cm – 7.3 cm which is make the trees harder to bend and the progress for tension wood to form in specifics time is quite slow. In another study, Nobuchi (2008) conducted a study which artificial leaning stem on the para rubber but there is problem of the para rubber which is the para rubber have a low recovery ratio. This problem makes the study harder to carry out the results of the tension wood.

If the purpose of the tension wood study is to study the formation of tension wood in tropical rainforest species between the low-density species of medium hardwood selected is Jelutong (*Dyera Costulata*) and for medium density species of medium hardwood is Kasai (*Pometia Pinnata*) which to study the anatomical features between these two species. To makes it more clearly, the study has been investigated following the research question the factor affected is the time taken for fiber deformation in tension wood formation on medium and low density tropical medium hardwood species and the time formation and declination angle of tension wood formation in selected high and low density tropical trees affecting the fiber deformation.

For the knowledge of the reaction wood studies, there is limited research about the tension wood in the academical studies for the tropical rainforest species. There is need more studies to carried out to proving how the tension wood forming physically, chemically, and anatomically. There are limited studies on how the tension wood change its characteristics during the formation for the high-density species and the low-density species. So, there should have more studies on tension wood in order to maximize the utilize of the tension wood and minimize the wood development in order to prevent problem is wood based field and industry respectively.

1.3 Objectives

The objectives of this study to investigate the formation of tension wood in selected tropical trees that is Jelutong (*Dyera Costulata*) and Kasai (*Pometia Pinnata*). To fulfill this objective, the following objectives must be followed:

1. To investigate the time formation and declination angle of tension wood formation in selected high and low density tropical trees.
2. To investigate the changes of fiber characteristics towards leaning condition in selected high and low density tropical trees.

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