INVESTIGATION OF ORGANIC COMPOSITION OF POTENTIAL PLANTS AS ALTERNATIVE FIBER IN PAPER MAKING INDUSTRY

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A thesis is submitted in fulfillment of
the requirement for the award of
Master of Civil Engineering

Civil and Environmental Engineering
Faculty of Civil and Environmental Engineering
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DECEMBER 2014

To my beloved parents, family, lecturer and my fellow friends. All of you will be in my heart. Thank you for the care and suport given

ACKNOWLEDGEMENT

and thanks to Allah S.W.T. for allowing me to finalise and completed this research where made possible by the guideline provided by my supervisor, Assoc. Prof. Dr. Zawawi bin Daud and my co-supervisor, Dr. Angzzas Sari binti Mohd Kassim. The appreciation also goes to the all parties involved in completing this project especially to Environmental Laboratory, Univeristy of Tun Hussien Onn Malaysia (UTHM), Microbology Laboratory, UTHM and also side from Forestry Research Insitute Malaysia (FRIM). My sincere appreciation also extends to my family especially to my parents, Mohd Hatta bin Suliman and Hapsah binti Satibi with their understanding and support. Last but not least, thanks to all my UTHM comrades especially to Ashuvila binti Mohd Aripin and housemate that always help me up at my difficult time in completing this research. Thank you.

ABSTRACT

Malaysia was known as a country that rich with a source of agro waste material. Three different crops had been studied which include the pineapple *(Ananas Comosus)* leaf, corn (*Zea mays)* stalk and Napier grass (*Pennisetum purpureum)*. Those crops were characterized as agro waste material in Malaysia and have a high potential to become an alternative fiber. The objective of this work was to analysis the chemical composition which are pineapple leaf, corn stalk and Napier grass; to investigate the properties of hand sheet made from those crops; to determine the influence of different pulping process and process variables on the physical and chemical properties. Every chemical components analyse; Cellulose, Hemicellulose, Ash and Lignin content by TAPPI Test Method. All of three samples were undergo acidic and alkali pulping process. Fiber Analyser was used for fiber analysis and SEM use for observation on sample. From pulping process, the step will continue for papermaking. Lastly, tensile, bursting, folding, and tearing tester machine will test paper production. Result shows that pineapple leaf gives high cellulose content (66.2%) and lower lignin content (4.2%) compared corn stalk and napier grass. Alkaline pulping shows a quality of pulp rather than acidic pulping process due to the pulp strength and colour of fiber. Corn stalk gives a high potential to be an alternative for mechanical properties viewed. High tensile index (90.99 Nm/g), burst index (6.64 kPa*m^2/g) and fold index (3.51 Nm) by corn stalk paper rather than pineapple leaf and napier grass but lower in tear index (2.85 Nm^2/g). This wass due to the long fiber length by pineapple leaf about 13.36 mm from SEM images. This arrangement form and effect a structure of fiber. Based on all tests, corn stalk materials have high potential to be fiber substitution but pineapple leaf and napier grass have their own characteristic to be alternative fiber. This research also promote green technology where one of the solid waste material technology for waste from agricultural residue.

ABSTRAK

Malaysia dikenali sebagai sebuah negara yang kaya dengan sumber bahan buangan pertanian. Tiga tanaman yang berbeza akan dikaji termasuk nanas (*Ananas Comosus*) daun, batang jagung (*Zea Mays*) dan rumput *Napier* (*Pennisetum purpureum*). Tanaman ini telah disifatkan sebagai bahan sisa pertanian di Malaysia dan mempunyai potensi yang tinggi untuk menjadi gentian alternatif. Objektif penyelidikan ini adalah untuk analisis komposisi kimia daun nanas, batang jagung dan rumput *napier*; untuk menyiasat sifat-sifat kimia tanaman; untuk menentukan pengaruh proses pulpa dan proses pembolehubah yang berbeza ke atas sifat fizikal dan kimia. Setiap komponen kimia menganalisis; Selulosa, Hemiselulosa, dan kandungan *Lignin* oleh ujian kaedah *TAPPI.* Semua tiga sampel menjalani proses pulpa berasid dan alkali. *Fiber Analyzer* akan digunakan untuk analisis serat dan SEM digunakan untuk pemerhatian ke atas sampel. Dari proses pulpa, langkah akan terus untuk pembuatan kertas. Akhir sekali, tegangan, pecah, lipatan, dan mengoyak mesin penguji akan menguji pengeluaran kertas. Hasil kajian mendapati daun nanas memberikan kandungan selulosa tinggi (66.2 %) dan lignin (4.2%) rendah daripada batang jagung dan rumput *napier*. Pulpa alkali menunjukkan pulpa berkualiti daripada pulpa proses berasid kerana kekuatan pulpa dan warna gentian. Batang jagung memberikan potensi yang tinggi untuk menjadi alternatif kepada sifat mekanik dilihat. Indeks yang tinggi tegangan (90,99 Nm / g), indeks pecah (6.64 kPa * m2 / g) dan lipat indeks (3.51 Nm) daripada daun nanas dan rumput *napie*r tetapi rendah bagi koyak index (2.85 Nm2 /g) . Ini adalah kerana panjang serat panjang dengan nanas daun kira-kira 13.36 mm daripada imej SEM. Susunan ini akan membentuk dan menentukan struktur serat. Berdasarkan semua ujian, batang jagung mempunyai potensi yang tinggi untuk penggantian serat tetapi daun nanas dan rumput *napier* mempunyai ciri mereka sendiri untuk menjadi serat alternatif. Kajian ini juga mempromosikan teknologi hijau di mana salah satu daripada teknologi bahan sisa.

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LIST OF SYMBOL AND ABBREVIATION

Nm/g	Newton meter per gram
mNm^2/g	Mili newton meter square per gram
$kPa.m^2/g$	Kilo Pascal meter su=quare per gram
cm	centimetre
mm	milimetre
µm	Micrometre
ga/kga	Gram per kilogram
v/v	Volume over volume
^0C	Celcius
ml	Militre
g	Gram
w/w	Weight over weight
%	Percentage
H_0	Hyphotesis
L	Litre
NaOH	Sodium hydroxide
HNO_3	Nitric acid
H_2SO_4	Sulphuric acid
$NaClO_2$	Sodium chlorite
C2H402	Acetic acid
$C2H_5OH$	Ethanol
C3H5OH	Acetone
SEM	Scanning Electron Microscopy
ANOVA	One Way Varians Analysis
H_2SO_3	Sulphurous acid
HSO_3-	Bisulphite ion
SO_2	Sulphur dioxide

Mg	Magnesium
NH_3	Ammonia
Na	Sodium
N	Nitrogen
MARDI	Malaysia Agriculture Research And Development Insitute
FAMA	*Lembaga Pemasaran Pertanian Persekutuan*

FRIM	Forestry Research Insiture Malaysia
RCRA	Resource Conservation and Recovery Act
UNEP	United Nations Environment Programme
Ca	Calcium

CHAPTER 1

INTRODUCTION

1.1 Background of the Study.

Malaysia is one of the countries that has a larger tropical forest in the world. The use of tropical tree as a source of pulp creates a significant problem to Mother Nature. Every day, the news about on depleting forest tree activities and a problem that were produced by depleting tree activity can be seen (Mmom *et al.,* 2013). The paper industry is one of the main industries that requires a forest tree for their beneficial and pulp production. Without them, the industry cannot do well in their production process and it will affect the whole economy especially the country where the main industry uses wood industry.

Wood had become a large conventional raw material for pulp and paper production in the world with more than 90% of the world production is being produced in the develop countries (Mmom *et al.,* 2013). From this increasing used of wood, develop country had found the use of recycled paper to become one of the solution to reduce depleting of forest trees; hence contribute to the sustainable development of Mother Nature. However, recycled paper cannot be used directly to become another option of paper production. It is because the strength of recycled

fiber is subject to degradation after consecutive cycles (Aziz and Zhu, 2006). Most paper mill industry adds a certain amount of imported virgin pulp to restore the strength of recycled paper to make paper production more quality.

The aim of this study was to investigate the potential of alternative crop as fiber substitution to the conventional imported virgin pulp. Three different crops had been studied which are characterized as being the agrowaste in Malaysia (Ansah *et al.,* 2010; Aziz and Zhu, 2007; Khalil *et al.,* 2006). This investigation include corn stalk, pineapple leaf, and napier grass. All of these crops were investigated with regards to their chemical composition related to paper production. Among the chemical composition in those crops, fibre was the main component that were took as a research study. All non-wood material contain fiber component but the percentage of the fiber will act as the main factor in paper making (Khalil *et al.,* 2006).

Pineapple is a tropical plant that can be found in Malaysia due to suitable climate. Besides the fact that the fruit is rich in nutrition like protein, the leaves from this fruit consists of cellulose that is essential in paper making (Banik *et al.,* 2010). From early on, corn had been used as human consumption and is fed to livestock, primarily in the form of silage. Textile, chemical and pharmaceutical industries uses corn starch as the main of their production and the properties of corn starch makes it capable to be another uses product especially wheat (Thmae *et al.,* 2009). Meanwhile, corn stalks contain hemicelluloses which have potential as alternative fiber in paper making. Corn stalk offer a highly content of hemicelluloses that can be partially extracted prior to pulping without reduce the quality of paper (Aziz and Zhu, 2007).

Another crop that had been studied was napier grass which in scientific term is called *Pennisetum purpureum*. This plant grows to 2 – 4.5 meters tall and only grow in tropical or sub-tropical regions (Aganga *et al.,* 2005).This study were undergoing three stages where the first part will investigate the chemical composition of each crops. The investigation of this crop chemical includes cellulose, hemicelluloses and lignin contents. Then, the crops were determine the properties of hand sheet made with several ratios of crop pulp; recycled paper. The last stage will evaluate the variables during processing period such as temperature, time and active alkali percentage.

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