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**THE COMPARISON OF THE QUALITY OF THE PAPER
BETWEEN GINGER, BANANA, AND SUGARCANE
WASTE**

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F15A0116

**A thesis submitted in fulfillment of the requirements for the
degree of Bachelor of Applied Science (Agrotechnology) with
Honours**

FACULTY OF AGRO BASED INDUSTRY

UNIVERSITI MALAYSIA KELANTAN

2019

DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

Student Name: Nor Sahira Binti Edi

Date :

I certainly certify that the report of this final year entitled Effect of Ginger, Banana, Sugar cane Agro waste in the Quality of Paper by Nor Sahira Binti Edi , matric number F15A0116 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Agriculture Technology) with Honours, Faculty of Agro-Based Industry, University Malaysia Kelantan.

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The Comparison of The Quality of The Paper Between Ginger, Banana, and Sugarcane

ABSTRACT

This final year project will be focusing on making paper from the waste of banana, sugar cane and ginger. Transforming the unwanted waste into a beneficial paper is one of the best methods in utilising the plant 100%. There are three treatments to be studied which are banana, ginger, and sugarcane while the parameters to be evaluated are the strength, dryness, and flammability of papers. However, this study only applies the traditional method in papermaking, where the pulp will be created by using the kitchen blender (Elvidge,2018). The quality of papers is highly affected by the presence of cellulose fibres, which is the main component in order to allow the paper to hold together. Thus, this study will determine the difference of the strength of papers from the different plant (banana, sugar cane and ginger).

Keywords : paper,strength of paper, paper plant, agricultural waste, pulp

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FYP FIAT

Perbezaan Kualiti Kertas Antara Halia, Pisang, dan Tebu

ABSTRAK

Projek tahun akhir ini akan memberi tumpuan kepada pembuatan kertas daripada sisa pisang, tebu dan halia. Mengubah sisa yang tidak diinginkan menjadi kertas yang bermanfaat adalah salah satu cara terbaik untuk memanfaatkan tumbuhan 100%. Terdapat tiga rawatan yang perlu dikaji iaitu pisang, halia, dan tebu manakala parameter yang dinilai adalah kekuatan, kekeringan, dan kebolehbakaran kertas. Kajian ini hanya menggunakan kaedah tradisional dalam proses, dimana pulpa akan dibuat dengan menggunakan pengisar dapur (Elvidge, 2018). Kualiti kertas sangat ditentukan oleh kehadiran serat-serat selulosa, yang merupakan komponen utamanya untuk membolehkan kertas itu bertahan. Oleh itu, kajian ini akan menentukan perbezaan kekuatan kertas dari tumbuhan yang berbeza (pisang, tebu dan halia).

Kata kunci: kertas, kekuatan kertas, kilang kertas, sisa pertanian, pulpa

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CHAPTER 1

INTRODUCTION

1.1 Research Background

The main source of environment and haze problem is the open burning of forests, farms, and agricultural wastes which was is meant to clean up agricultural areas and nourish the soil after harvesting. Some farmers take the easy way by burning open crops. Forest fires often occur because of the irresponsible attitude of the people. The consequences of their actions have given negative impacts in to the future generation.

Agriculture waste especially from sugar cane , banana and ginger may give bad impact to the human health and environment . Sugar cane , banana, and ginger leave a lot of waste as people could not utilise these plants in a proper way. A simple method in destroying this waste without considering the effects may result a bad condition. Burning is the most preferred method, as it is low in cost and easy. However , the open burning of these agro waste may contribute in emitting carbon dioxide, methane and other harmful gaseous .

Nowadays , woods are being used widely to create a pulp. There are some trees that purposely cultivated in order to be the source of paper production. Around 40% of the paper are made by wood as it contain fibers .There are 9-16% of pulp which created from pulp logs , while the rest are made from the waste agricultural waste that was traditionally burnt.

People tend to throw the stem of banana ,bagasse, and the of ginger (the rotten ginger) . This will contribute to environmental pollution. In order to reduce and avoid the pollution to be occurred, an alternative way to utilise the waste of these plant must be done. Turning the waste into a paper is a good and eco-friendly idea to reduce the agro waste, as these plants are rich in fiber which is the main component in making a paper. Therefore, this research will be focusing on the paper making from the rotten ginger, bagasse, and the stem of banana.

1.2 Problem statement

There are many waste from banana, sugar cane and ginger because people are not aware of the environmental health. Besides, they have lack of knowledge in utilizing agricultural waste which suppose to help them from having the harmful surrounding . According to Tahir (2012), sugarcane contain more fiber than banana and ginger with 48% , 39% and 5% respectively .Therefore, there will be a difference in strength of the paper. Moreover,this method is considered to be very beneficial and profitable. Because of this ,the research study will be focused on papermaking , as it is one of the most simple way to reduce pollution and safely demolish agricultural waste .

1.3 Objectives

To study the quality of the paper from different sources (plant wastes).

1.4 Hypothesis

H0 : Sugarcane will produce a better quality paper compared to banana and ginger

H1 : Sugarcane could not produce a better quality paper compared to banana and ginger.

1.5 Scope Of Study

This study , there will be three different plant to make a paper which are banana, sugar cane and ginger. The experiment was conducted in laboratory . The different type of papers were observed and discussed.

1.6 Significance Of Study

This study is important to utilize the plant properly in order to avoid waste pollution. It is also significant as the strength of paper can be determined. This research will be focusing on evaluating and comparing the quality of papers from different plant wastes by using three parameters which are strength, dryness and flammibility

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Paper

Throughout the history of paper, it was related to the ancient Egypt 3 millennium BC. The word 'paper' was derived from the word papyrus which is actually a plant that can be found easily around the Nile river in Egypt. Papyrus is a monocotyledon plant which has maximum height from 2.5 m to 3.0 m, and maximum plant spread from 0.9 m to 1.2 m. This plant has a very fast rate growth and fibrous root (underground). Papyrus, or the scientific name is *Cyperus papyrus*, was often used in paper-like production by the ancient Greeks, Romans and Egyptians. Papyrus paper are known as early as 3100 BC, due to the discovery of papyrus scrolls from tombs dated to that era. The papyrus paper manufacturing required the inside of triangular stalk to be cut or peeled into strips and laid it in two layers, vertical and horizontal. The layers must be pressed and dried. In this method, stones and shells were used to produce a smooth texture for writing purposes. Papyrus paper production didn't use any glue because papyrus contains natural gums that hold the papyrus paper together.

In China (AD 105) , bamboo sticks were often used to record important documents and transcriptions. This material considered as heavy and hard to be carried with. However, some Chinese, especially from Royal family preferred the usage of silk as their writing material, as it is very light and symbolize the wealth. Silk was known as the softer and lighter writing material. Therefore it was hard to be used by common people as it was very expensive. Thus, an idea of innovation came to replace the usage of bamboo and silk as their documents. Ts'aiLun, a chinese eunuch had invented a method to make a paper from cotton rags which was more convenient than silk and bamboo to record documents. The idea of paper making included materials from rags, fishnets, waste of hemp and macerated trees' bark. This invention was considered a success as it had a very good quality and less expensive. The paper then was slowly spreading to the nearby countries. However, chinese were unwilling to tell others the method of paper manufacturing. Thus, the other east asian countries , could not make the paper themselves.

2.2 Importance of Paper

In this era of modernism , papers are still being used for multichannel communication. It acts as a significant learning tool for human development. From preliminary school to the highest education , people tend to use paper as their medium to understand and learn any information . Based on a test conducted on 6th graders , researchers found out that the students who study from the printed books had a better result on quizzes that related compared to those who read e-books (Jeong,2012). Besides, the display of the e-books might cause eye fatigue . On the other hand , the research of Fisher, Lapp , and Wood, 2011, cited in Schugar , and Penny, (2011) , found that an information

digitally performed worse in recalling it. Therefore it is proven that paper or paper based book is essential for students where they are were effectively absorb the information written.

2.3 Role of Fibre

Paper manufacturing can be done with lots of methods . However , in order to make the paper hold together, fibers must be included. Wood is one of the most used material in paper making as many fibers can be extracted from it. Single fiber strength is very important to paper and paperboard strength (Van Den Akker et al.,1958) . Fibers are made up from cellulose, hemicelluloses and lignin. Specifically, cellulose is the main component in strengthening a paper. It is known for having a long linear polymer and toughness for intermolecular and intramolecular bond of hydrogen, which resulting the microfibrils formation (Rolf Wathen, 2006) . In addition , it is a composed of glucose with B-1,4 glycosidic bonds. Based on Hinterstoisser et al. (2001) study, when the cellulose mechanically loaded , deformation process will occur on the carbon-oxygen-carbon bonds in addition to hydrogen bonds (Rolf Wathen, 2006). Microfibrils are the other larger component from single cellulose chain, where it contains 30-40 parallel cellulose chains. The size of fibers are small. However, there is a strength between each fibers. The indicator of fiber strength can be illustrated by tensile testing of papers with nominally zero-span length, and in paper industry with zero-span strength (Seth and Chan,1999).

2.4 Introduction To Sugar Cane

Sugar cane is a cultivated plant that provides sucrose . It is from the Poaceae family. There are 1,310 hectares of sugarcane in Malaysia in 2010 with 28,410 metric tons produced and further increased to 1,890 hectares in 2014 with an estimated production of 55,284 metric tons. In sugarcane factories, sugarcane is washed, and then cut and chopped by rotating knife. The chopped sugar cane is then mixed repeatedly with water and rolled between the rollers; The accumulated sugar cane (known in Brazil as garlika) contains 10-15% sucrose, while the remaining solids are known as bagasse, burned as fuel.

2.5 Introduction To Ginger

Ginger (*Zingiberofficinale*) is the most easily found herbaceous plant. Most traditional Malay cuisine uses ginger as a spice for cooking dishes and also to remove the smell of some meat like goat meat and fishy fish species. Ginger is a plant of the Zingiberaceae family. It is a kind of plant that is always used as a spice seasoning in cooking. The plant is believed to have originated in China and then spread its use to India, Southeast Asia, West Africa and the Caribbean. This plant offers a lot of benefits to the consumers, however, they tend to leave the fibre waste without realising its benefits.

2.6 Introduction To Banana

Bananas (botanical name: *Musa spp.*) are the edible fruits, botanical berries, produced by several types of large herbaceous plants in the genus of Moses. In some

countries, bananas used for cooking can be called plantains, in contrast to dessert bananas. The fruit varies in size, color and firmness, but it is usually long and curved, with rich content rich in starch covered with green, yellow, red, purple, or brown skin when cooked. Fruits that grow in groups are dependent on the top of the plant. Almost all edible parthenocarpic (seeded) modern bananas come from two wild species - *Musa acuminata* and Forest Bananas. Banana is one of the most commercialised fruits as it is always being demanded by people. Therefore, there are lots of people cultivate the banana. However, the stem of the banana tend to be wasted away.

CHAPTER 3

METHODOLOGY

3.1 Research Design

In this study , three types of waste from plants which are banana , sugar cane and ginger will be used in paper making . The waste will be collected from the fruit and vegetables sellers. For the moulder, a recycled wood frame will be used with a small steel net in it. A kitchen blender is also required in order to crush the fiber content within the plant waste. Other than that, a basin and a towel must also be prepared (Babcock, 2018). In this research, there will be 3 groups (treatments) and the research will be going through one way ANOVA.

3.2 Materials and equipment

The papermaking materials and equipments that were used in this experiment are

- Moulder
- Cloth
- Scissors/knife
- Vat
- Kitchen blender
- Stove
- Pot
- Plant waste (from banana, sugarcane, ginger)
- Cheesecloth bag

3.3 Papermaking from agricultural waste (banana, sugarcane, ginger)

The research work was conducted at laboratory in University Malaysia Kelantan. The tested plant waste in this experiment are banana, sugarcane and ginger.

3.3.1 Waste preparation

The plant wastes were cleaned to remove any component that has possibility to contaminate the pulp. The waste of banana, sugar cane and ginger must be prepared and cut into smaller pieces by using a scissor and knife. Then ,the wastes were boiled in a pot with $\frac{3}{4}$ of water for 1 hour starting with sugarcane waste first and followed by the rest

(Appendix A : Figure A3). The fibers were rinsed so that it can easily be separated . Then, the fibers were strained in the cheesecloth bag and must be rinsed until the water is clear

3.3.2 Pulp making

The fibers were blended with water by using kitchen blender until it become pulp. This method was done by blending the banana waste first and followed ginger and sugarcane.

3.3.3 Papermaking

The plant pulp was be added to the water and stirred .The next step was to hog the vat and throwing the wave (Appendix A : Figure A2). The vat must be filled $\frac{1}{2}$ full of water. Mould and deckle were be placed on top of the screened mould tightly hold together. Then applied the motion of side to side , and forth to back motion. This motion leads to scooping up the water and fibre . After that, the water allowed to drain. Next step was to press the paper as it dries.

3.4 Data collection

The papers from 3 different plants are tested by the parameters of strength , dryness, and soot. The papers are weighed and tested according to the three different parameters (Elvidge,2018) . Statistical analysis was done by using the data obtained to undergo one-way analysis of variance (ANOVA).

3.4.1 Strength determination

The paper strength can be determined by placing a small load on the wet paper and record the weight of each paper can hold before teared (Elvidge,2018). The load used is 70.1g.

3.4.2 Dryness determination

The dryness of the paper can be illustrated by soaking the papers into water and record the time for each paper to dry in microwave. The surrounding heat of the microwave offered to the all papers is constant .

3.4.3 Flammibility

This experiment required a recorded time for each paper to burn completely. The time taken analysed and discussed.



CHAPTER 4

RESULTS AND DISCUSSION

This research is to analyse the effect of waste of banana and ginger towards the quality of paper. This research is significant as Malaysia can utilize the agro waste and transform them into a very beneficial product as well as saving the environment. This matter is concerning as Malaysia produces over 1.2 million tones of agricultural waste per year (Tahir,2012). Therefore, by making papers out of the agro waste will limit the bad impact on the environment. This research will be focusing on paper production from banana and ginger waste. According to the result obtained through one-way analysis of variance (ANOVA), it is showed that the significant level of p value is more than 0.05 ($P>0.05$). It proves that the three treatments have a common in paper production.

4.1 Weight of Treatments

Weight plays an important role in the quality of the paper. The usage of the paper depends on the weight. For example, for the heavy printing, such as a postcard, its paper must be heavier than the common paper with 4g and 5g respectively. This is because the heavier paper has the better durability and quality. Based on the experiment conducted, the size of the paper used is 8.6m x 5.4 m. Meanwhile, the average thickness of agricultural waste paper is 0.1cm.

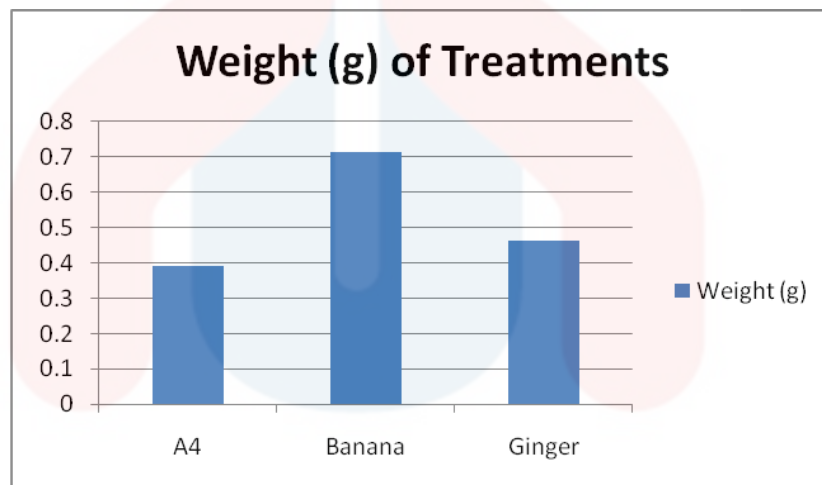


Figure 4.1.1: The average of weight for each papers.

From the bar chart above, the weight of the paper from banana is the highest compared to ginger paper and A4 with 0.714 g, 0.463 g and 0.391 g respectively. It was weighed by using analytical balance (Appendix A : Figure A1). This means that banana paper has the highest durability compared to the ginger paper and A4 paper.

4.2 Strength of Paper

A load of 70.1g was used to test the strength of the papers. Kellogg and Thykeson (1975), found the strength in hardwood pulp sheets could be affected by fibre strength and cell wall thickness. According to Madison (1988), a load or stress is applied in the stress-strain plot. It causes elongation of the paper increasing linearly. The stressed point started to curve until it meets its limit where the paper will rupture. The breaking time is significant as a convenient measure to compare the strength of papers from banana, ginger and A4. Based on the result obtained, It is concluded that ginger paper has the higher quality of strength with difference with 29% from banana paper(0.17 minutes) to be tore apart. Meanwhile A4 paper has the lowest strength with the reading of 0.02 minutes. Banana plant is worth pulping due to its relatively low lignin (Md.Zaved,2014). However, the result shows that ginger has the advantage of having lower lignin.

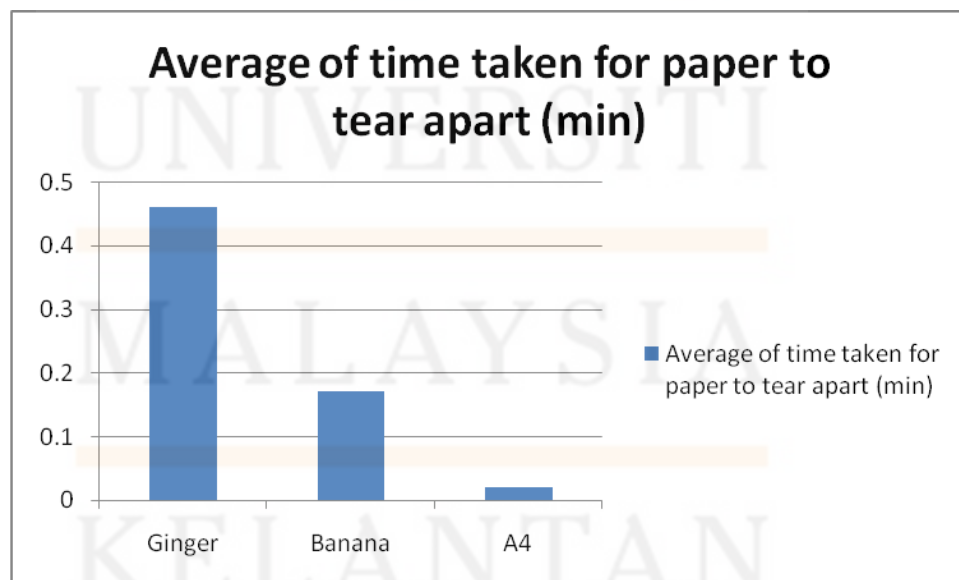


Figure 4.2.1 : The average of time taken for paper to tear apart.

4.3 Dryness of Paper

The oven-drying method was used to determine the dryness of the papers. The result was recorded by soaking the papers into water for 5 seconds and heat it in an oven with 200°C . The significant of this parameter is to determine the quality of the paper as the moisture effect the quality through the mechanical surface. Alvaro Tejado and Theo G.M van de Ven (2010), stated that the wet paper is weak and there will be no break of fibers when ruptured . Moreover, there is a present of liquid bridges between the fibers which has attractive capillary force on the cellulose which attach the paper together. Besides, it is also significant as it will effect the printability quality towards the paper

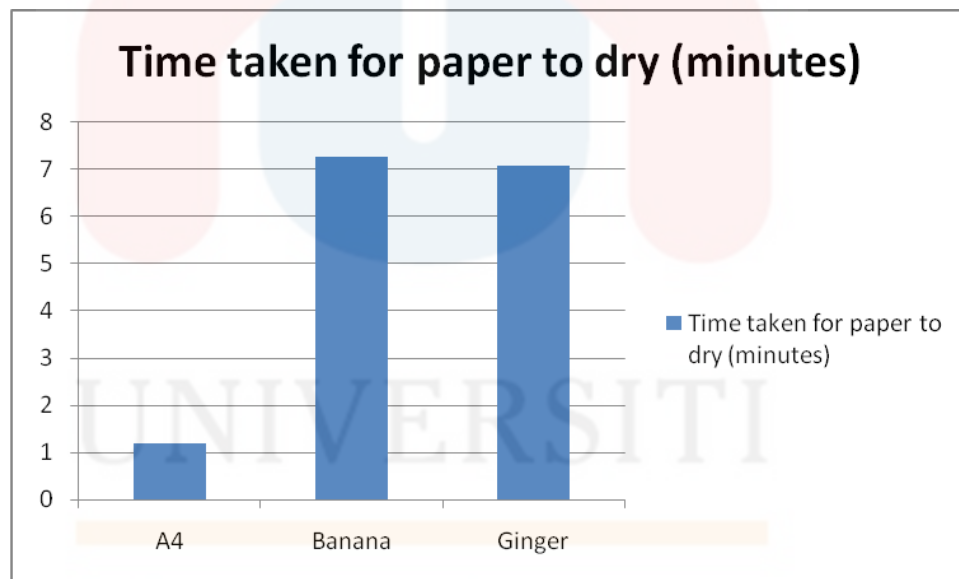


Figure 4.3.1: The average of time taken for paper to dry.

Based on the result obtained, it is concluded that A4 paper has the lowest time taken for its to dry with 1.19 minutes . Meanwhile banana paper has the higher reading compared to ginger paper with 7.27 minutes and 7.08 minutes respectively. This is highly effected by

the capillary of fibers , depending on the fibers' geometry , the crossing and the contact angle.Laplace forces theory is accounted to ensure the fibers in wet paper attached together (Alvaro Tejado and Theo G.M van de Ven , 2010) . In this case the capillary forces of banana paper is more stable due to the attractive force of surface tension that repulsive Laplace and the wetting forces. According to Alvaro Tejado (2010) , the rough fibers will effect the wet strength and duration time for it to completely dry.

4.4 Flammability

The experiment was done in a temperature room . The tip of each papers were lighted with small fire and was allowed to burn completely.

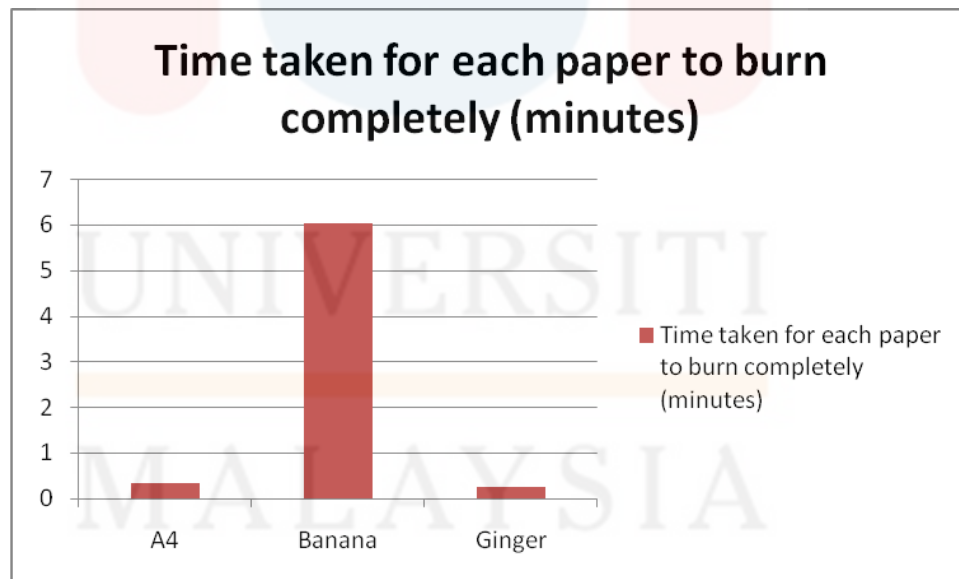


Figure 4.4.1: The average of time taken for each paper to burn completely.

The bar chart above illustrates the time taken for each different type of papers to burn completely. The result shows that, banana paper has the highest reading with 6.02 minutes compared to A4 paper and ginger paper with 0.34 minutes and 0.25 minutes respectively. It is concluded that banana has the strongest fibers compared to ginger. It is clearly can be seen and compared by the Figure 4.3.2 and Figure 4.3.1 .Book of Paper and Paperboard Characteristics, Nomenclature and Significance of Test (2018) statement has supported that this experiment is to determine the treatment with the most effectiveness of the flame proofing . It is significant to evaluate and decide the most proper application to use the paper.



Figure 4.4.2 : The ginger pulp.



Figure 4.4.3 : The banana pulp.



Figure 4.4.4 : The ashes of banana paper.



Figure 4.4.5 : The ashes of ginger paper.

4.5 Outcome

Based on the results , it is concluded that banana has the most durability as a paper compared to ginger, sugarcane and A4 paper. This is because banana pulp contain more fibers with 39%, while ginger has only 5% of fibers. Meanwhile A4 's fiber contain could not be identified as it is consisted by many other components such as flax, bamboo ,wheat straw, hemp and linen rags (Adam,2018) . Fibers has a very important roles to strengthen a paper, acting as a bonding to hold papers from separated. The longer the fiber, the stronger the bonding will be.



Figure 4.5.1 : The banana paper.



Figure 4.5.2 : The ginger paper.

Sugarcane waste (bagasse) were also being observed in this research study , however , experiment could not be conducted upon it as the a proper form of paper could not be prepared. Different from the other treatment's pulp, bagasse's pulp is more likely to have a spiky structure and rough. The fibre of the bagasse could not attach and bond together. This research is 100% using organic material and waste without using any chemicals to enhance the strength of paper. Therefore, due to the lack of chemicals in pulping , the bagasse fibers could not form a proper paper.



Figure 4.5.3: The bagasse paper.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The purpose of this research is to study the better quality paper from plant waste . The plant waste treatments that being used are from banana, sugarcane and ginger. While A4 paper acts as a controller ,a baseline . It is important for comparing the results of the main treatments that are being examined. Based on the result obtained , it is concluded that 100% organic paper from banana has the most quality and durability compared to other treatments. The main factor that effecting the result is the fiber contain . The strength of a paper can be illustrated by the bonding held by the cellulose to make sure the paper is attached , and avoiding the paper from tearing apart. Overall , based on the experiment conducted, it is concluded that banana paper has the highest quality compared to ginger and sugar cane . Therefore, the H0 is rejected while H1 is accepted.

In this research , paper made of bagasse could not be formed properly . This is might be due to the rough pulp as the bagasse could not be blended into smooth pulp like ginger and banana. The pulp could not be attached together, forming a good paper, due to its rough and sharp structure. The problem can be solved if there is a certain chemicals added to the bagasse pulp , such as sodium sulfide, caustic soda and sulfurous acid. These chemicals will dissolve the lignin , extracting the cellulose from the plant. By adding these chemicals to the bagasse pulp, it will increase the ability of paper strengthening.

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APPENDICES

Appendix A : Figures



Figure A1 : Weighing a paper.

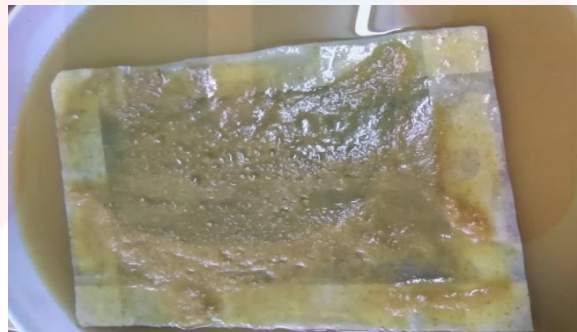


Figure A2 : Papermaking by mould.



Figure A3 : Boiling plant waste.



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