Evaluation of Banana Fibre and Kymene Mixture for Suitable Paper

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Abstract

Pollution rate across the world is increasing due to the usage of non-biodegradable materials. Greener form of materials is being researched to find a suitable solution to the problem. A reliable solution is to use banana fibres as papermaking materials. Banana fibres from the stem has a number of unique characteristics. The purpose of this study to determine the appropriateness of utilizing banana stem fibre for paper production. Banana fibre were chemically pulped using 0.1 mole NaOH and cooked about 1.5 hours. The characteristics of the banana fibre, lower lignin content and higher alpha cellulose could demonstrate its potential for the produce of a decent quality handcrafted paper while giving a chance to be utilized as fortifying fibre by mixing the banana fibre with additives ingredient like soy protein (kymene). Therefore, for enhancing the properties of the banana fibre, kymene as the additives ingredients were added into the pulp in the percentage of 20% and 50%. This was purposely to strengthen the paper and the performance of the paper was investigated by parameters such as moisture content, absorbency rate and tensile strength analysis. Difference on weight of papers with different percentage of kymene depicts clearly different of absorbency rate between 0%, 20% and 50% kymene, but nearly same for 20% and 50% kymene. Moisture content of papers revealed the value have not so much different. Indication from this study are that banana stem fibre can be use as the crude material alternative for the production of paper by enhancing the properties with adding additives such as kymene.

Keywords: banana waste; fibre; paper; pulp and paper

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1. Introduction

In this day and age, the use of non-recyclable products is getting out of hand. These types of products are being used by the society mostly due to their convenience and high production rate. The result of this has caused the rate of pollution to rampant and it is severely affecting our mother earth. The non-biodegradable properties of these products have caused a lot of landfills to pop up, since the waste of the products is too much to handle.

Nowadays, production for alternative materials had been developed to replace the current option. One good example was shown by replacing the usage of plastic bags with paper bags or even by bringing their own bags for packaging. Even though it is a good alteration, the usage of those materials still has an impact to the environment as trees are cut down to produce these products. Because of this, engineers and researchers all around the globe have been researching to overcome this problem by searching for a much greener approach to the problem. The most reliable solution that the engineers discovered is by using the banana fibres extracted from the banana stem to produce a much greener form of paper. Natural fibres are much more dependable in certain aspects such as low density, high stiffness, low cost, biodegradability and environmental friendly (Ramesha et al., 2017). Since there is substantial scale accessibility of banana stem waste resultant squanders in the nation and a lack of a better and greener crude materials for pulp generation, it is an insightful origination to execute cleaner creation procedures for banana paper making. According to Hussain & Tarar (2014), the availability of the large scale of banana stem waste in the country and shortage of raw materials for producing pulp and paper, it makes perfect sense to use these wasted banana stem for paper making. A good application for this new material is to integrate it for paper bag production.

In addition, Bakri et al., (2017) stated that the banana fibres from the stem has a number of unique characteristic. First of all, the banana fibre is bio-degradable and has positive effect on the environment and can be categorized as eco-friendly fibre. Secondly, the fibre is light weight but is highly strong, a very welcome characteristic. Furthermore, the fibre is very durable since it can be spun through almost all the methods of spinning, such examples include ring spinning, open end spinning and many more. And finally, these fibres has better fineness and spin ability compared to the bamboo fibre and the ramie fibre. These fibres are obtained after the banana fruit has been harvested and fall in the group of bast fibres.

Based on the study from Shivashankar et al., (2016), the banana pseudo stem is observed to be fit for being utilized as a crude material as it develops quickly and yields high biomass. There are many solutions like recycling of paper and paper products to overcome this shortage, among which is the usage of fibres from fast growing and high biomass yields of non-woody plants. This is considered to be one of the best alternative source of raw materials (Brindha et al., 2012). From this perspective, the examination demonstrates that banana stem which is right now squandered in the wake of gathering organic products is a great cellulosic source and contains low substance of lignin (11.34% lignin). Moreover, the synthetic creation of banana stem appears that banana stems which are abundant, is a decent crude material for the pulp and paper making industry. The research indicates that the wasted banana stem contains a sufficient amount of cellulosic properties and has very low content of lignin. This further proves why it makes sense to use this rather than let it go to waste. Banana stem is a cheap and easily obtainable raw material as a source of making paper pulp for the production of various types of paper. The process of making pulp is economically violable. The lignin can be separated from the cellulose with the help of chemical treatment (Lakhan & Bandyopadhyay, 2013).

In recent articles, it states that obtaining pulp from banana leaf residue build up might introduce intriguing properties as far as paper reinforcement, and a fascinating fibrillation degree. Virtually, the obtained pulp from banana leaves introduced lower cellulose content (alpha and beta), higher hemicellulose (gamma cellulose) content and lignin content (25.25%) than bleached pulps. In a comparative way, the obtained pulp from banana leaves presented lower cellulose content (alpha and beta) and higher hemicellulose (gamma cellulose) content than those of bleached pulps (Tarrés et al., 2017). Their analogy is regarding the strength determination of individual fibre and a bundle of fibre, tensile strength of bundle fibre is better than individual fibre strength (Nongman et al., 2016). Other than that, a comparison can be conducted with banana peel, which the green banana peel grain presents cellulose substance of 7.5%, which makes it a great solid basic material with hub firmness, a desirable element for a fortifying fibre. The green banana peel bran presents cellulose content of 7.5%, which makes it an extremely strong structural material with axial stiffness, a desirable feature for a reinforcing fibre (Tibolla et al., 2017). Despite all of that, the main materials that is being chosen is still banana stem due to their high amount of fibres, lack of implementation and their abundancy. To further improve the banana fibre mold, papermaking additives will be added into the mixture.

The reason to add additives into the mixture is to enhance the characteristics and the bonding of the fibres, thus producing a high quality and durable handmade paper. The list of additives that was chosen to be used ranges from Konjac Glucomannan, a non-ionic water-soluble polysaccharide polymer which increases the dry-strength of paper (Wang et al., 2015), Nano fibrillated cellulose (CNF), whereby it increases air resistance and reduces water absorption (Boufi et al., 2016), and last but not least is kymene, which helps to increase the wet strength capabilities of paper. After much research, the desired additives that is to be used is kymene as it has the requirements needed for this experiment which is to increase the wet-strength capabilities of paper. Not only that, kymene is also chosen because it is a soy protein-based adhesive, which has many unique properties. The unique properties of soy protein adhesives are it is low cost and has ease of handling, which means it can be made and used easily. Comparing to other additives, it is much more practical and inexpensive (Li et al., 2004). Furthermore, the effectiveness of the kymene can be improved easily with the addition of alkali (Sun, 2005).

To deduce, producing an alternative paper from banana fibre with kymene mixture will be the main objective of the research. It is because the characteristic of fibre from the banana has met the requirements to proceed with the experiment on testing the strength and quality of banana fibre as paper packaging. The main objective that is set to achieve is to determine which percentage of the additives will result in the most suitable composition for the paper. This paper represents the research and application of banana stem fibre as alternative material to production of paper.

The impact of key parameters, such as moisture content analysis, absorbency analysis, tensile strength analysis and wet strength analysis for the banana wrapping packaging will be investigated. It is expected that the result of this outcome will be a relative discovery and advantage to the environment by improving reusability and recyclability of generated waste.

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2.1 Material preparation: Paper

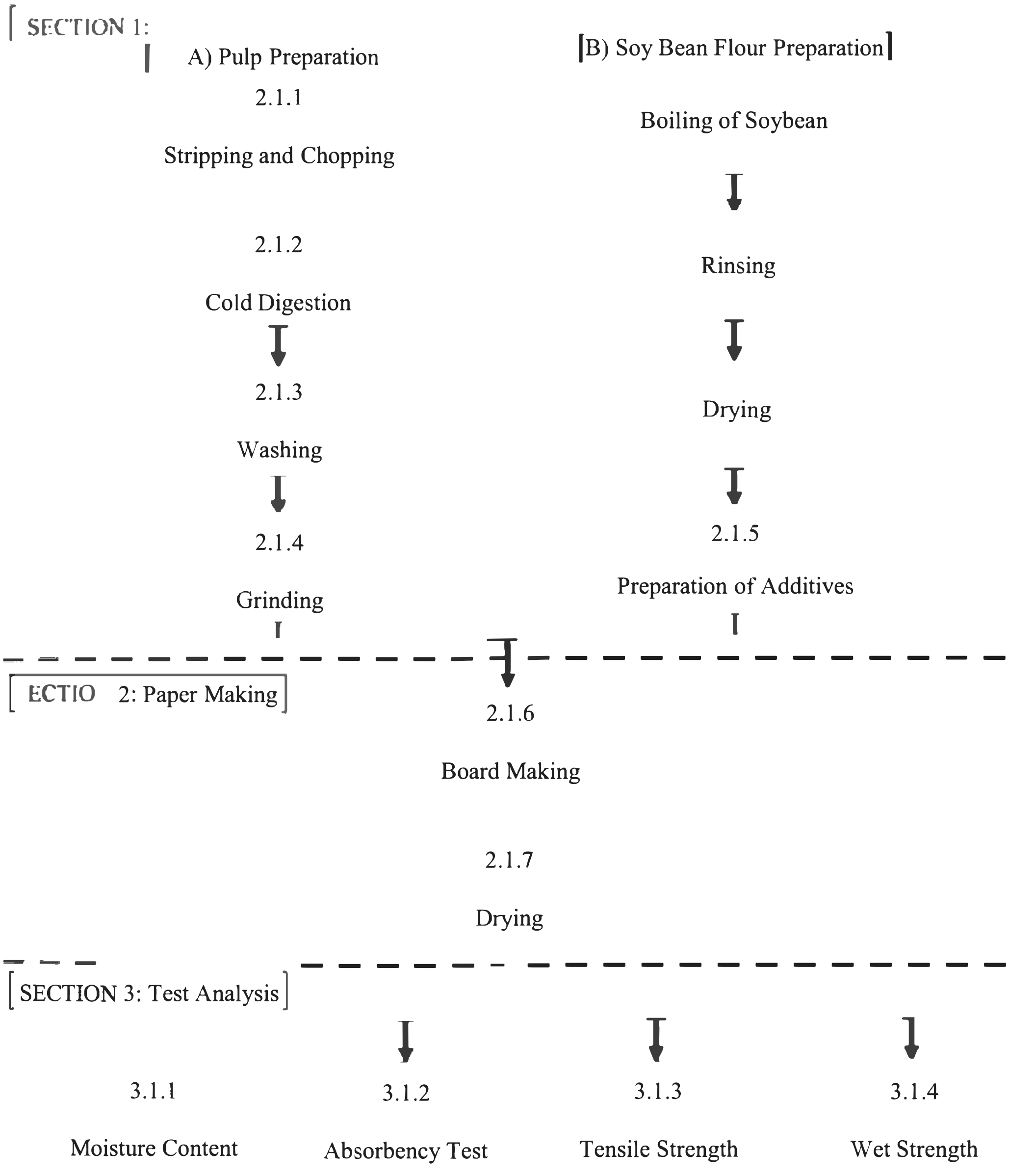


Fig.1 Flowchart of the process for paper making

roperties

	Percentage of Kymene (%)	Weight of fibre (g)
1	0	80
2	20	80
3	50	80

Based on Fig.1, the process of the experiment was divided into three sections. At the first section, the side A tes the method of preparing the raw material while on the side B is the method of preparing the soy flour and additives, Kymene. The second section shows the flow of the paper making which require the mixture of banana pulp from step A and additive from step B. The last section shows the testing analysis which consists of four methods of testing the banana fibre paper. The end result of the methods was the production of three samples which paper 1, paper 2 and paper 3 with different percentages of kymene in each sample, as shown in Table 1.

.1 Stripping and chopping

Banana stem waste *(Musa acuminate colla)* was obtained to serve as the main material in the process. The m was cut into a quarter piece and the outer layer of the stem was peeled into strips. Then, the strips of banana stem were dried in an oven at 110°C for about 6 hours. This is to ensure that the moisture content inside the bundle of banana tem trip has been fully removed. After that, the stripped banana stem was cut into small sizes about 0.25 – 0.50 inche

.1.2 Cold digestion

The small-stripped banana stems were soaked in sodium hydroxide (NaOH) solution with 0.1 mol and heated up at 32°C for 1.5 hours. This process allows the alkali solution to loosen the lingo-cellulosic bonds in the fibre, thereby oftening the material (Baharin et al., 2016).

2.1.3 Wc hing

The softened material was transferred into a filter and rinsed with tap water. The purpose of this procedure was to remove excessive and unwanted brown solution which is a mixture of NaOH and the lingo-cellulosic material.

2.1.4 Grinding

The 50 g of cut fibres was then placed into a high-speed grinder with 200 ml of tap water and was grinded at room temperature until the banana stem mixture shows a pulpy consistency. This is purposely to separate the fibre from its wall . Then, the water contained in the pulp was drained out to achieve the weight of dry pulp of approximately 75 g.

2.1 5 Preparation of additives

Based on the technique that proposed by Li et al., (2004), the soy protein powder (30 g) was blended with 400 mL of refined water at room temperature (27°C) and after that it was mixed for 2 hours by using stirrer at 300 rpm., mixed with NaOH with pH value adjusted to 10 and ready to use as adhesive ingredient.

2.1.6 Board making

The pulp is then blended with approximately 700 ml of water and required kymene solution. Then, the pulp mold is lifted and transferred onto a fabricated wooden mould with size of 24 cm x 18 cm. Depending on the thickness needed, a significant quantity of pulp was poured into the mold and was flatten and pressed using a cloth to remove excessive water. The process was repeated to ensure the surface of the pulp was even and compact.

2.1.7 Drying

The wet boards were then allowed to dry in an oven for 9 hours at 90°C. The intention of this process was to remove almost 90% to 95% of water so that the fibre paper does not become too stiff which can cause the paper to easily break. After that, the paper was peeled off from the board and was taken to perform testing on its properties. *2.2 Testing and analysis*

2.2.1 Moisture content test

Ramdhonee and Jeetah (2017) specified that the paper samples are placed into a plate and were weighed. The plate and the samples were then set in an air-forced drying oven and kept at 150°C until the point that a steady weight was accomplished. The moisture content (MC) was then obtained in percentage by using equation (1):

$$\% MC = (WW-DW)/WW \times 100\% \quad (1)$$

Where: WW =Wet weight of sample and plate, g.

DW =Dry weight of sample and plate, g.

.2.2 Absorbency test

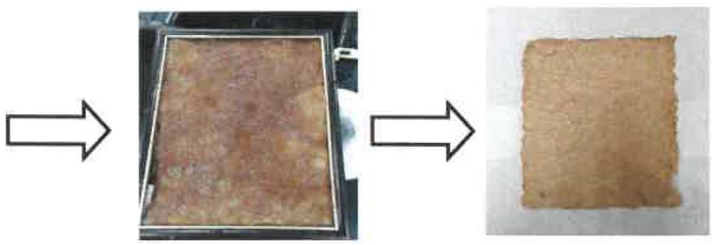
This test determines the fluid absorption rate of paper items utilizing gravimetric standards. A set volume of water is dropped onto the paper surface and the ideal opportunity for the drop to be consumed is measured. The absorbency analysis was synthesized the technique proposed by (Mahale & Goswami-Giri, 2015).

.3 Tensile strength test

This test technique portrays the methodology, utilizing steady rate-of-lengthening gear, for deciding four elastic breaking properties of paper and paperboard: rigidity, stretch, tensile energy retention, and tensile firmness. The samples were tested by using a tensile testing machine, Machine no. I33005303451, Shimadzu Corporation (Muchorski, 2006).

2.4 Wet strength test

This test technique utilizes the same techniques for tensile strength analysis but by changing the properties of test subject. The paper is soaked water until it is damped evenly. Once the paper is damped, it is attached to the ile testing machine to test the strength of the paper when it is wet.



(a) (b) (c)

Fig. 2. (a) Preparation of materials; (b) Preparation of banana paper; (c) Banana fibre paper.