CHARACTERISTIC OF PINEAPPLE LEAF FIBRE USING DIFFERENT METHODS AT MINIMUM LEVEL WITH THE ASSIST OF MECHANICAL BREAKER

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ABSTRACT: Pineapple cultivation has resulted in wastage of pineapple leaf fibre (PALF) where it can be used as renewable natural resources. PALF is able to be used in various textile and non-textile products. However, to gain fibre as raw material requires suitable processing methods. Several methods were used in this experiment to identify suitable process using minimal resources. There were four methods used to produce open PALF which are unchanged extracted PALF, unchanged extracted PALF and going through PALF breaker, extracted PALF going water retting for 4 days and extracted PALF treated with 1% NaOH and going through PALF breaker. All PALFs were opened using Shirley Trash Analyser, and analysed by looking at its trash and microscopy. The results found that the assist of water retting and NaOH treatment and going through PALF breaker give better results for textile and non-textile application.

KEYWORDS: *Fibre; PALF; Pineapple Leaf*

1.0 INTRODUCTION

The Malaysian agro-based industry has a variety of potential agricultural products as raw material which can be processed into agricultural products. Most of the crops which are grown for domestic purpose such as bananas, pineaples, coconuts, sugar palm and palm oil produce high agricultural waste. All those wastes contain fibre content that can be processed into textile or non-textile application such as strand or yarn which can be used as cordage or rope, handicraft items, and bio-based composite. Pineapples (Ananas Comosus) produce wastes from leaves, and in practice, the wastes are burned after the fruits are harvested. This open-burning activity imposes a negative impact on the environment, such as air pollution from smoke and haze [1]. However, extracting pineapple leaf fibres (PALFs) needs several processing procedures such as fibre retting or fibre decortication process using several machines, and lastly, the spinning machine to produce twisted yarn for textile application.

Generally, the important fibre characteristics and properties for yarn production are fibre content, length, fineness, strength, extension, rigidity and cohesion [2-3]. For example, wastes from pineapple leaves contain 2.5-3.5% of fibre, while the rest is covered with hydrophobic waxy layer [4]. There are many kinds of methods used for extracting PALF, but some of the methods used for other plants are not suitable for PALF; such as PALF cannot be extracted by submerged retting method as the leaf has a thick waxy layer, therefore it is difficult for the retting microbes to get into the leaf, but if it is lightly scraped, then the retting action is greatly improved [5]. As mentioned, to produce a good quality yarn, the fibre must be fine, and fineness can be defined in micronaire (μg/inch), which measures units of mass (micrograms or μg) per unit of length (inches) to assess linear density [6]. Therefore, to spin the fibre into fine quality yarn, the quantity of the fibre present in the diameter of a yarn with given cross-section must be sufficient so that the yarn has the appropriate mechanical and physical properties. Therefore, it is important to separate the fibre bundle from lignin and other structures to reveal the fineness of PALF. Other than that, the fibre must also has durability to withstand during the process until it becomes the required yarn.

Nowadays, pineapple fibres specifically has no separate spinning system of its own but many studies show that it is capable using spinning technique for pineapple leaf fibre based on cotton spinning method [7-8]. Assuming that the system used for cotton fibre is compatible with PALF fibre, it is possible to conduct a test using a test equipment specifically used for cotton fibre. Therefore, a testing machine of "Shirley Trash Analyser" which is usually used specifically for cotton fibres was used to conduct a test for PALFs. The reason to use the equipment is to determine the content and the condition of the PALFs when it going to the processing machines.

Other than that, previous studies show that most of the methods for processing PALFs use high percentage of chemical content such as 6% and above, while it takes times when retting it with water as most take 14 days and more. The results of all those studies show that using 6-7% NaOH can give the best result for retting, but the main problem is the cost of the chemicals and environmental effects. A percentage of 1% of NaOH can reduce the problem and capable to produce spin able fibre [9]. This research focuses on processing pineapple leave fibres (PALFs) for small scale production adaptable to rural conditions suitable for farmers. A method of minimum usage of chemical and other methods to break and soften PALF fibres into fine fibres is introduced with the assist of PALF breaker machine.

2.0 METHODOLOGY

2.1 Materials

The pineapple leaves were randomly collected from Johor pineapple plantation, and extracted using the machine "Pineapple Leaf Fibre Machine 1" developed by "Universiti Tun Hussein Onn Malaysia" (UTHM). The extracted PALF was dried and stiff in the form of fibre bundle as shown in Figure 1. The chemical treatment used where PALFs are immersed using a commercial-grade sodium hydroxide (NaOH).

Figure 1: Extracted PALF

2.2 Preparation of PALF

The extracted PALFs were divided into several parts to determine the best method, consisting of unchanged extracted PALF (UCEPALF), unchanged extracted PALF going through PALF breaker (UCEPALFB), and water retting for 4 days (WREPALFB) and treated with 1% wt. of sodium hydroxide (NaOH) solution (TNaOH1PALFB). PALF other than UCEPALF would go through PALF breaker as shown in Figure 2. In this process, the PALF breaker was driven using a diesel engine suitable for fieldwork. It had top and bottom fluted rollers that rotated in opposite directions suitable to crushed PALF intended to soften and break the fibres. The related PALF was rolled out between the rollers for several times to get the best result.

Figure 2: PALF breaker machine

Figure 3 shows the flowchart of the experiment which covers the method used to produce the best process suitable for rural conditions and affordable for farmers.

2.3 Microscopy Test

All the prepared samples were observed under Meiji Techno optic microscope equipped with a video camera and software of VIS PLUS version 2.0 to capture digital images and sample measurements. The fibre samples were observed under the microscope to see if the primary fibre can be separated into finer fibril.

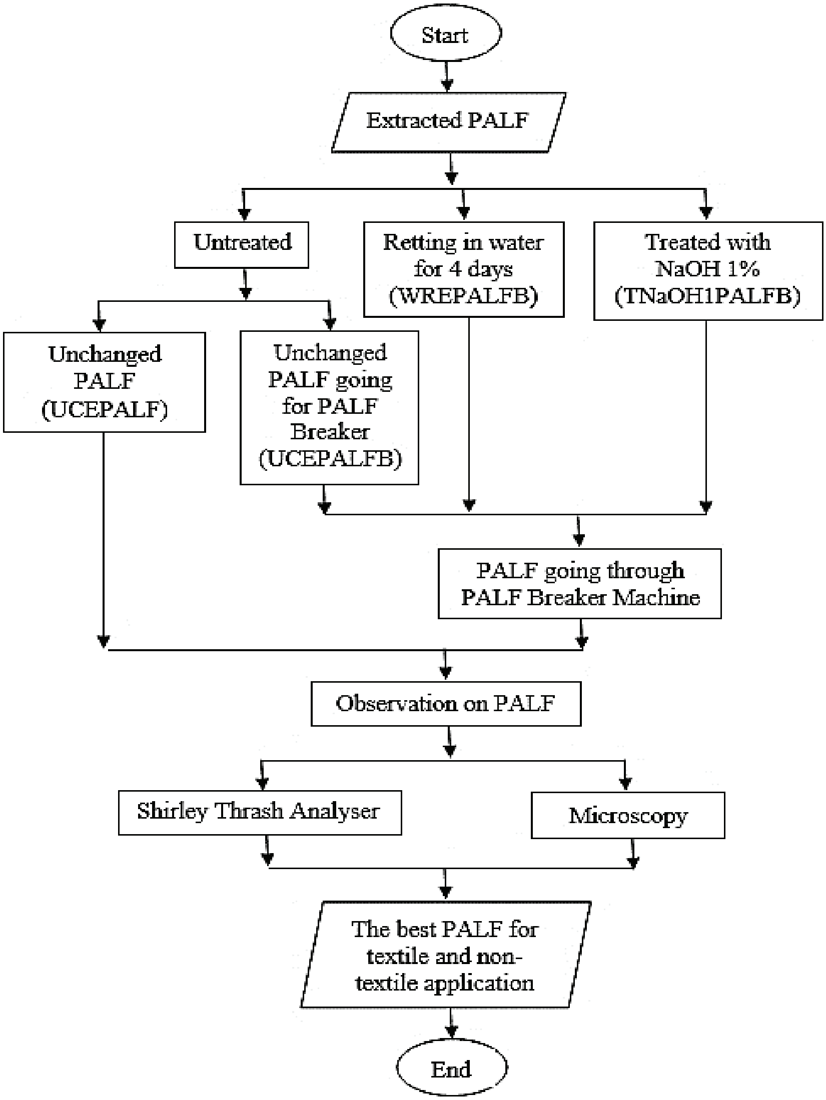


Figure 3: Flowchart of the method used to identify the best process for PALF

2.4 Shirley Trash Analyser

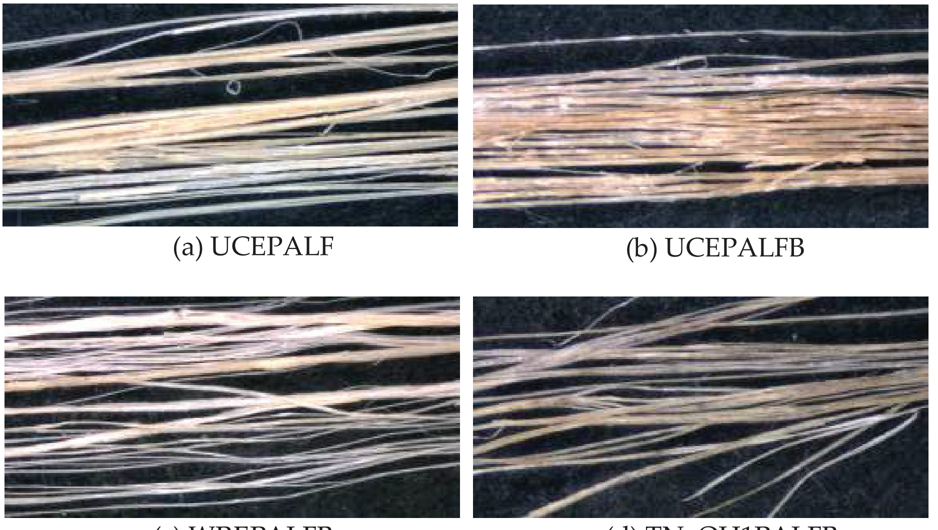
This test was conducted using Shirley Trash Analyser to determine the condition of the fibres after being processed through a machine. The reason is to open the compact PALF after being extracted, dried, processed in different methods, and passed through the fibre breaker. The compact fibres also kept within them a lot of impurities, and there was still some dry waxy layer attached to the PALF. Through opening process, the PALF was being mechanically opened into loose fibres in the form of smaller tuft. The PALF was observed on its opening of loose fibres, the durability to withstand the mechanical forces, the percentage output and the percentage of waste. This was determined through several parts of the trash analyser as shown in Figure 4. The front trash container is for trash and heavy particles, while the trash delivery box is for clean fibres and light trash where they are collected separately, and the fine dust or the micron trash is sucked through a filter tray. The content and the condition of the trash and the dust gave the pattern of the PALF after being processed using different method.

Figure 4: Shirley trash analyser

3.0 RESULTS AND DISCUSSION

3.1 PALF after Going through PALF Breaker

Figure 5 shows the images under a microscope between UCEPALF with the other PALF after using different methods, and passed through the PALF breaker. Previous studies indicate that PALF consists of bundles of microfibers where it can be broken down into finer fibres [10-11]. The image of UCEPALF shows that the PALF was still in coarser condition, while the others showed that coarser fibre broke into finer fibres, although it indicated that some still had coarse fibre. In addition, the PALF which passed through the PALF breaker showed that the fibre was smoother than UCEPALF. With the additional process, either water retting or treated with NaOH, it has been indicated that the separation of fibre was better even though in minimal process. The best result under the microscope are from TNaOH1PALFB since the bonding material of bundles of microfibers is soluble in NaOH solution [12], the breaking of the microfibers get better with the help of the PALF breaker. Meanwhile, WREPALFB also got good result due to the water retting which is done for a period of time reducing non-fibrous content in a PALF [13], while PALF breaker breaks the microfibers into fine fibres. Here we can identify the role of PALF breaker in producing fine fibres using common method at a minimum level.



(a) UCEPALF (b) UCEPALFB

(c) WREPALFB (d) TNaOH1PALFB

Figure 5: Comparison of PALF after extracted, water retting, chemical treatment and PALF breaker

3.2 The Condition of PALF after Going through Shirley Thrash Analyser

Figure 6 shows the results of PALF being opened using Shirley Trash Analyser, and the results found that the open fibres were in good condition and well opened. The concept of carding process used in Shirley Trash Analyser is capable to open the PALF into loose fibres. With these conditions, the open PALF was ready to be processed for textile application and non-textile application.

Figure 6: PALF after being opened using Shirley Thrash Analyser

Even though UCEPALF and UCEPALFB were well opened, but through observation, clearly it produced more coarse fibres and contaminated by remnants of dried thick epidermis layer compared to the others. This is mentioned by Zimniewska et al. [14] that decorticated fibers are thick, strong, non-divisible, and heavily contaminated by remnants of other plant tissues (wood, epidermis), and not suitable for textile application. Decorticated fibers means PALFs does not go through degumming process either water retting or alkali treatment which can release the microfibers and only relying on mechanical action.

However, Figure 7 shows a significant result, whereby there was a difference when the PALF was not treated, and passed through PALF breaker with treated NaOH or water retting. The result shows that the front trash container was mostly composed of pieces of dried upper layer of leaves (impurities), coarse and fine fibres and dust as labelled in Figure 7. The comparison of trash between different methods showed that the condition of the trash had different physical properties where fibres treated with NaOH were finer compared to others. As been stated before, the usage of NaOH has proven its effectiveness but the most convincing is the difference of the quantities of the NaOH being reduces to 1% and it has successfully reach the objective. It is also found that fibres from UCEPALF were coarser compared to the others, while UCEPALFB and WREPALFB were almost the same. This has shown that the usage of PALF breaker machine can break the primary fibres, and facilitate the fibril separation using Shirley Trash Analyser.

Table 1 shows the result of percentage output and the weight for different types of trash. The value for percentage output showed that the UCEPALF and UCEPALFB were in one group where it showed higher output compared to WREPALFB and TNaOH1EPALFB with lower output. The result gave an indication whereby the trash analyser setting tended to remove finer fibres as a waste. This can be proven on how fine fibres from WREPALFB and TNaOH1EPALFB were removed by analyser as it can be seen visually in Figure 7 while Table 1 indicated the weight of front trash has the highest value but low in percentage output.

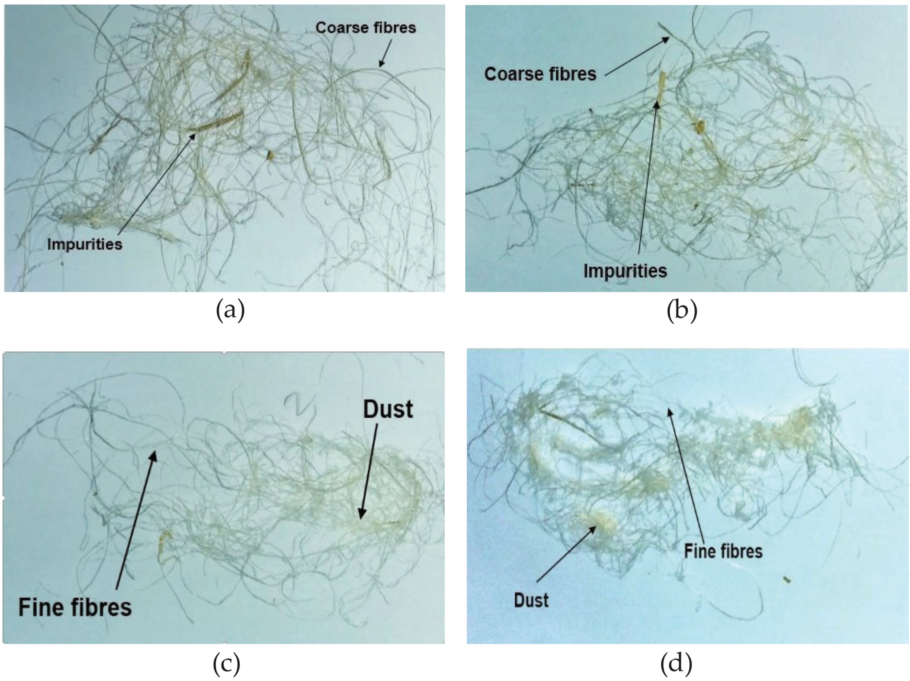


Figure 7: Front trash from (a) UCEPALF, (b) UCEPALFB, (c) WREPALFB and (d) TNaOH1EPALFB

Further, it was found that the value for TNaOH1EPALFB had the lowest percentage output with the highest micron trash. This may occur as a result of the removal of impurities on the PALF outer surfaces as stated in some previous studies. Most studies used Scanning Electron Microscope (SEM) to shows a clean and smooth surface of PALF through chemical treatment [15-16]. In some cases it is important for the removal of impurities and the surface modification of the outer PALF surface which can help to improve the interfacial bonding between PALF with matrix in natural based composites [17]. Therefore, the presence of high micron trash has strengthen the evidence of previous studies where the ability of alkali treatment to clean PALF surface. In addition, the use of PALF breaker may contributes to micron trash removal as more fine fibres are produces it will reduce fibre surface area.

Table 1: Result of percentage output and weight of different type of thrash

Sample	Input weight (g)	Percentage Output (%)	Front Trash (g)	Trash Delivery Box (g)	Micron Trash (g)
UCEPALF	10	74.2	2.30	0.10	0.18
UCEPALFB	10	79.8	1.80	0.04	0.18
WREPALFB	10	66.9	3.12	0.05	0.14
TNaOH1EPALFB	10	56.9	4.05	0.03	0.23

However, it was different with WREPALFB, although it had low percentage output, the micron trash was the lowest among the PALF due to no effect of water retting towards PALF impurities. The trash delivery box does not convey any meaning since the weight for each sample is too small and the trash content almost the same as the trash in front trash. In actual condition, machine setting was needed to ensure that the output must always be in acceptable percentage.

3.3 The Length of PALF

The extracted PALF had its original length of 47 cm, but it was not suitable for spinning process. Previous studies show that the cutting length for synthetic fibres is 40-60 mm [18], while there is cutting length of 50mm for natural fibres [19] where it is cut manually or using cutter and shredder machine. The cutting process can be done depending on the application, as non-textile application was not critical rather than for textile application. However, the condition of the waxy PALF surface showed that it was not suitable to be cut using previous cutting length where the cohesiveness between PALF was less convincing. The cutting process for the PALF was recommended after being processed through PALF breaker.

4.0 CONCLUSION

The method of PALF extraction to individual fibres for textile and non-textile application has found that using minimal process can be done. The result of the methods studied found that extracted PALF without going through retting or chemical treatment and mechanical processing will produce coarse fibres. The use of water retting in a short time or treated with NaOH at minimum can help produce fine fibres. However, the use of this method should be supported by the usage of PALF breaker in order to get better results.

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