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Analysis of the Chemical Compositions and Fiber Morphology of Pineapple (*Ananas comosus*) Leaves in Malaysia

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Abstract: Malaysia relies on agriculture as one of its economy sector. Unavoidably, abundance quantity of agro wastes is produced at every harvesting season. With proper planning and management, the agro waste material can benefit to many production industries. The studied crop is pineapple (*Ananas comosus)* leaves. This agro waste material has a high potential to become an alternative fiber in paper making industry. The objective of this study is to analyse the chemical compositions of pineapple leaves and to investigate the fiber morphology properties of pineapple leaves fiber. The chemical compositions of fiber were analyzed by TAPPI Test method, Chlorination method and Kurschner-Hoffner method. Chemical compositions analysed are Cellulose (Kurschner-Hoffner), Holocellulose (Chlorination method), Hemicellulose (Chlorination method), Ash content (T211-om-93), Lignin content (T222-om-98) and Sodium Hydroxide solubility (T203-om-88). Results indicate pineapple leaves have a high Holocellulose content (85.7%), followed by Cellulose (66.2%) and Hemicellulose (19.5%) content. Lignin content is the lowest (4.2%) compared to other chemical compositions in this study. Pineapple leaves morphology was observed by Scanning Electron Microscopic (SEM) which showed a condensed composition of fiber structure. The chemical compositions and morphology study of pineapple leaves indicate that it is suitable to be used as an alternative pulp in paper making industry, promoting the green technology.

Key words: Fiber, pineapple (*Ananas comosus*), chemical composition, green technology, pulp and paper making

INTRODUCTION

Wood contributes to about 90% of conventional raw material for pulp and paper production in this world (Madakadze *et al*., 1999). However, depleting forest tree had made an impact for the environment and human. Malaysia has abundance of agro waste material that have not been fully utilised to a maximum production. Thus, the finding of a new alternative fiber in non wood material will be favourable in paper production. Pineapple (*Ananas comosus*) is the common tropical plant which consists of coalesced berries. This pineapple is a leading member from family of Bromeliaceae and it came from genus *Ananas*. Fiber bundle from pineapple leaf can be separated from the cortex where it reveals the pineapple leaf fiber in multi-cellular and lignocelluloses pattern (Md Rejab, 2004).

All parts in pineapple from fruits to leaves could be consumed to give a health benefit for human life. Pineapple had been used as textile fiber, anti-inflammatory and also anti-helminthic agent (Tran, 2005). According to FAO online database, Malaysian had consumed 255,000 tonnes per year and in third position in the world of consuming pineapple production. Pineapple is mainly produced for canned fruits and also coarse textiles in some Southeast Asian countries. Leaves from pineapple had been used as coarse textiles because of the fiber composition and structure inside the leaves (Banik *et al.*, 2010).

All fibrous in non wood materials especially pineapple leaf consists of cellulose, holocellulose, hemicelluloses and lignin along with some extraneous materials called extractives such as gum and resin. Previous research indicates pineapple leaf fiber from different cultivar contained higher cellulose content than wood fiber. Pineapple leaf fiber also consist of lignin an adhesive component that binds the cellulose and hemicelluloses together.

Therefore, the purpose of this study was to analysis the chemical compositions and to investigate the fiber

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morphology properties of pineapple leaf fiber and to determine the suitability of the leaves as alternative fiber in paper making industry.

MATERIALS AND METHODS

Raw material: The sample of pineapple (*Ananas comosus*) leaf is collected from Ayer Hitam, Johor. This raw material was used as an alternative to wood content fibers in paper production of this study. Sample was thoroughly washed with water to remove all debris and suspended particles, followed by air-dried for 72 h (3 days). The sample was further dried in an oven at 110°C for 24 h to make sure no trapped water particles. Next, the sample was cut into smaller pieces prior to grinding and size selection using a sieve at approximately 0.4 mm. The sample was bagged for further analyses.

Preparation of samples: The prepared sample undergoes T 264 om-97 TAPPI Test Method before analyses for chemical composition in pineapple leaf.

Chemical composition analysis: Chemical compositions in these samples such as cellulose, lignin, hemicelluloses, holocelluloses, 1% sodium hydroxide soluble, hot water soluble and ash content were determined accordance with respective TAPPI standards method; T 211 om-07 (ash content), T 207 om-88 (hot water soluble), T 212 om-88 (1% sodium hydroxide solubility) and T 222 om-88 (lignin content). For cellulose and holocellulose, the methods were different where cellulose content will be analysed by following Kurcnher-Hoffner method and chlorination method for determination of holocellulose in sample.

Surface observation: The samples were observed under Scanning Electron Microscope, SEM to study its fiber morphological properties.

RESULTS AND DISCUSSION

Chemical analysis: The chemical compositions of pineapple leaf fiber are listed in Table 1. The ash content of the fiber is 4.5%. This amount of ash content is a function of the absence or presence of others materials (various chemicals, metallic and mineral matters) or singly or in combination (Tappi Method 211 om-98). Pineapple leaf fiber give lower ash content than other non wood fiber especially in plant. In comparison with other non wood materials from previous studies, the amount of ash content in this pineapple leaf fiber is lower than jute leaf with 8.8% (Basak *et al*., 1996) and palm leaves with 9% (Khiari *et al*., 2010). Lower ash content indicates good quality of paper that will be produced from the pulp of pineapple leaf (T 211 om-07; Lopez *et al*., 2004).

The moisture content is very high (81.6%) in pineapple leaf which is higher than other non woods. This high moisture content will affect the mechanical and surface of the paper where it has a less dimensional stability against the grain. However, the high content of holocellulose of pineapple leaf will make the paper more dimensional stable with grain (T 207 om-99; Khampan *et al*., 2010).

From Table 1, it was found that pineapple leaf fiber contain high cellulose (66.2%) content. Hemicelluloses and holocellulose contents are also high in pineapple leaf; 19.5 and 85.7%, respectively. Hemicellulose content from pineapple leaf is within the range found in wood about 14 to 34%. These are important parameters in determining the suitability of raw material for pulp and papermaking. The quality of fiber from non wood material that will be produced depends on the content of cellulose, hemicelluloses and holocellulose in this non wood material. High content of cellulose can yield a strong fiber and the quality of papermaking or pulp will be increased (Khalil *et al*., 2006). This result suggests that pineapple leaf has an acceptable content of fiber when compares to wood (Aziz and Zhu, 2006) and has a great potential to be an alternative fiber in paper making industry.

Lower lignin content is normally found in non wood fiber and function as adhesive to bind the cellulose in fiber. Lower lignin content makes the fiber strength increase and difficult to break. Pineapple leaf fiber give low lignin content with 4.2% compares to lignin in wood (21%). Lower lignin content is easier to discard from the pulp and the paper that will be produced is of more quality than other non wood material (Tran, 2005).

The chemical composition aspects have been considered in the previous literature, such as banana stem, coconut and oil palm and had been reported extensively. Pineapple leaf reported has a lowest lignin (10.5%) rather than banana stem (18.6%), oil palm (20.5%) and coconut (32.8%) which suggest can undergo bleaching more easily and have a high fiber strength (Khalil *et al*., 2006). Besides that, pineapple leaf contain

Table 1: Chemical compositions of pineapple leaf fiber

Constituents	Percentage
Ash content	4.5
Cellulose content	66.2
Holocellulose content	85.7
Hemicellulose content	19.5
1% NaOH solubility content	39.7
Lignin content	4.2
Hot water soluble content	32.5
Moisture content	81.6

high holocellulose content (87.6%) than banana stem (65.2%), oil palm (83.5%) and coconut (56.3%) (Md Rejab, 2004: Khalil *et al*., 2006). Those properties depend on the content of chemical composition in the pineapple leaf fiber which is cellulose, hemicelluloses and lignin content (Madakadze *et al*., 1999).

Pineapple leaf gives a content of 1% sodium hydroxide of 39.7%. The solubility in 1% sodium hydroxide indicates the extent of fiber degradation during pulping process. Pineapple leaf gives a high 1% sodium hydroxide content which indicates a significantly high production of pulp from the screen yield (Onggo and Astuti, 2005). Pineapple leaf fiber also have a high content of hot water solubility with 32.5%. The high content of hot water solubility in pineapple leaf indicates high content of sugars, colouring matters, such as starch and proteins and could consume pulping reagents and lengthen the pulping process (Khiari *et al*., 2010).

Morphological analysis: Scanning Electron Microscopy (SEM) analysis is shown in Fig. 1 and 2. From this analysis, pineapple leaf fibers have many matrix of fiber on the surface.

Pineapple leaf gives high fiber content because of the arrangement of fiber. From Fig. 1, SEM analysis shows

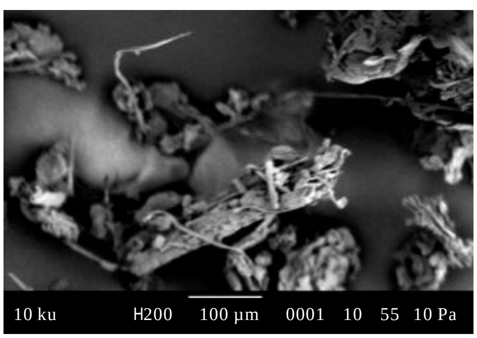

Fig. 1: Surface area of pineapple leaf fiber

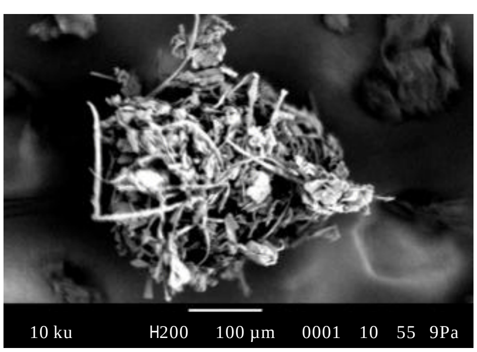

Fig. 2: Packing of pineapple leaf fiber

many bundle of packed fiber on the surface area of pineapple leaf fiber. The surface of pineapple leaf fiber had been filled with many fiber matrix that were condensely packed together. Figure 2 shows the fiber seems to be closely packed and could probably indicate the strength of the paper produced from it. The arrangement and packing of fiber matrix on the surface and fiber of pineapple leaf will affect the strength of the fiber itself (Reddy and Yang, 2005). The fiber surface contains waxes and other of entrusting substances like lignin, pectin and hemicelluloses. These substances form a thick layer to protect the substances of cellulose inside the matrix layer of fiber (Rowell *et al*., 2000). The condensed fiber is important in the structure of the paper produced from the pineapple leaf (Sridach, 2010). Both figures show the surface area of the pineapple leaf and the condensed arrangement of the fiber that is, the agglomeration of fiber structure inside the leaf. This could increase the fibre strength and the quality of the paper produced (Han and Rowell, 1999).

CONCLUSION

Cellulose, lignin, hemicelluloses, holocelluloses, 1% sodium hydroxide solubility, hot water soluble and ash content are the main components that indicate the quality of paper produced. Favourable high amount of cellulose content and low lignin content could give a high quality of pulp and paper making production from pineapple leaf fiber. Furthermore, Scanning Electron Microscopy (SEM) analysis shows the condensed arrangement of fiber which form a strong fiber structure in pineapple leaf. Thus, this abundance Malaysia's agro waste material can become an effective source and has a high potential for alternative fiber in paper making industry. This study is hoped to give confirmation of the suitability of pineapple waste as an alternative pulp for paper making industry.

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REFERENCES

Aziz, A. and J.Y. Zhu, 2006. New technologies in non-wood fiber pulping and paper making. Proceedings of the 3rd International Symposium on Emerging Technology of Pulping and Paper Making, November 8-10, 2006, South China University of Technology Press Guangzhou, China.

Banik, S., D. Nag and S. Debnath, 2010. Utilization of pineapple leaf agro-waste for extraction of fiber and the residual biomass for vermicomposting. Fiber Textile, 36: 172-177.

Basak, M.K., S. Chanda, S.K. Bhaduri, S.B. Mondal and R. Nandi, 1996. Recycling of jute waste for e dibble mushroom production. Ind. Crops Prod., 5: 173-176.

Han, J.S. and J.S. Rowell, 1999. Chemical composition of fibers. Paper Composites Agro-Based Resour., 5: 83-134.

Khalil, A.H.P.S., S.M. Alwani and M.A.K. Omar, 2006. Chemical composition, anatomy, lignin distribution and cell wall structure of Malaysia plant waste fibers. Bioresource, 1: 220-232.

Khampan, T., N. Thavarungkul, J. Tiansuwan and S. Kamthai, 2010. Wet strength improvement of pineapple leaf paper for evaporative cooling pad.. J. Eviron. Earth Sci., 1: 16-19.

Khiari, R., M.F. Mhenni, M.N. Belgacem and E. Mauret, 2010. Chemical composition and pulping of date palm rachis and *Posidonia oceanica*: A comparison with other wood and non-wood fibre sources. Bioresour. Technol., 101: 775-780.

Lopez, F., A. Alfaro, M.M. Garcia, M.J. Diaz, A.M. Calero and J. Ariza, 2004. Pulp and paper from tagaste (*Chamaecytisus proliferus* L.F. Ssp. Palmesis). Chem. Engin. Res. Design, 82: 1029-1036.

Madakadze, I.C., T. Radiotis, J. Li, K. Goel and D.L. Smith, 1999. Kraft pulping characteristics and pulping properties of warm season grasses. Bioresour. Technol., 69: 75-78.

Md Rejab, M.N.A., 2004. Mechinical properties of pineapple leaf fiber reinforced polypropylene laminated composites. M.Sc. Thesis, Universiti Putra Malaysia.

Onggo, H. and J.T. Astuti, 2005. The effect of sodium hydroxide and hydrogen peroxide on the yield and color of pulp from pineapple leaf fiber. J. Trop. Wood Sci. Technol., 3: 37-43.

Reddy, N. and Y. Yang, 2009. Extraction and characterization of natural cellulose fibers from common milkweed stems. Polymer Engin. Sci., 49: 2212-2217.

Rowell, R.M., J.S. Han and J.S. Rowell, 2000. Characterization and Factors Effecting Fiber Properties. In: Natural Polymers and Agrofibers Composites, Frollini, E., A.L. Leao and L.H.C. Mattoso (Eds.). San Carlos, Brazil, ISBN-13:9788586463068, pp: 115-134.

Sridach, W., 2010. Pulping and paper properties of palmyra palm fruit fibers Songklanakarin J. Sci. Technol., 32: 201-205.

Tran, A.V., 2005. Chemical analysis and pulping study of pineapple crown leaves. Ind. Crops Prod., 24: 66-74.