Pulp and Uncoated Papermaking Characterization of *Schumannianthus dichotomus* (Roxb.) Gagnep. (Thin)

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Abstract

This research is based on paper-based materials are highly as packaging materials. The aim of this research is to produce uncoated paper. Pulping was carried out using Kraft process. Pulp obtained from thin core was treated with 12 % sodium hydroxide and 4 % sodium sulfide at 165 °C for cooking time 2 hours and holding time 1 hour using various ratios (thin core : white liquor). Pulp of thin core was characterized by FT IR spectroscopy and Microscopic examination. FT IR analysis results assigned that hemicellulose, lignin and other impurities were removed through the process of extraction of cellulose. Microscopic examination of pulp from thin core using chip sample : liquor ratio (1 : 6) occurred mainly by cellulose than other ratios. The chemical properties of pulp such as (ash content, kappa number, lignin and residual alkali) were decided by Technical Association of the Pulp and Paper Industry (TAPPI) standard methods. According these results, pulp obtained from thin core using thin core : liquor (1 : 6) was consistent with the standard limiting value to produce uncoated paper. The mechanical properties of prepared uncoated paper sheet such as basic weight, folding, thickness, tensile strength, tearing index, fiber length, moisture of paper and water absorption were decided by TAPPI standard methods. To experimental results, prepared uncoated paper from thin core using 1 : 6 was chosen to produce water proof paper which is applied as dry food packaging bags instead of plastic utensils.

Keywords : thin core, chemical properties, mechanical properties, TAPPI standard methods

Introduction

Paper is a thin sheet material arranged by mechanically and chemically processing cellulose fibers. It is derived from pulp. Pulping is the process of production of pulp using wood material is a lignocellulose fibrous materials [1]. The production of pulp and paper is cellulose, which is the main constituent of nearly every form of plant life. There are three major types of raw material resources available for the pulp and paper industry. They are bamboos, tropical hardwoods and agricultural residues. The word " paper'' is applied to describe a felted sheet of fibers formed by introducing a water suspension of the fibers onto a fine screen. The water drains through the screen, leaving a wet sheet of paper which is removed and dried. Additives of one or several kinds are usually introduced after the sheet is formed to contribute desired properties to the paper [2]. Annual plants could be an important source of lignocellulose raw material for the pulp and paper industry as these are easily delignified and require milder pulping conditions compared with wood based raw materials. Different agricultural residues were assessed with the aim of finding alternative raw materials for the paper industry [3]. Wood pulp fibers are gaining increasing interest with several industry sectors. From being used conventionally as the major component in paper, fibers are presently being put to use as reinforcement in bio-degradable composites and as a source of sugar for bio-energy production. Wood pulp fibers can be manufactured by e.g., thermos-

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mechanical, chemi-thermo-mechanical and chemical pulping. Chemical pulping removes the lignin and preserves the cellulose [4]. Natural fibers may be used as important raw materials, especially in developing countries with large agricultural production [5]. Several other lignocellulosic natural fibers such as curaua, henequen, olive husk, rice husk, pineapple, bagasse, banana, wheat straw, oil palm, abaca, aloe vera, and pine needle have also been employed to prepare polymer composites [6]. Non wood fibers are a minor part of raw material supply to paper and paperboard manufacture. Many non-wood fibers such as bamboo, jute, straw, rice and bagasse are currently used in small commercial pulping operations [7]. Paper is used as printing, painting, graphics, packaging, decorating, writing and cleaning. It may also be expended as filter paper, wallpaper, toilet tissue and construction processes [8]. *Schumannianthus dichotomus* (Roxb.) Gagnep.(vernacular name- Murta) plants are found in Myanmar, Thailand, Combodia, Vietnum, Malaysia and Philippines. Murta fibers are exclusively used for making various handicraft products and out of these products the mat is very popular in India and Bangladesh [9]. Figure 1 shows the plant and strip of thin.

Botanical Aspects of Marantaceae (Thin)

Family	:	Marantaceae
Botanical name	:	*Schumannianthus dichotomus* (Roxb.) Gagnep.
English name	:	Bemban
Myanmar name	:	Thin
Part used	:	Core

Figure 1. Plant and strip of Thin

Material and Methods

Material

Raw Material Collection and Preparation

In this research, thin cores were collected from Zee Kone village, Pathein Township in Ayeyarwaddy Region. Thin cores were washed and cleaned with water to remove extraneous matter. Thin cores were dried in an open air for one week. Dried thin cores were cut into 3-4 cm with a knife. Sample preparation of raw thin cores was shown in figure 2.

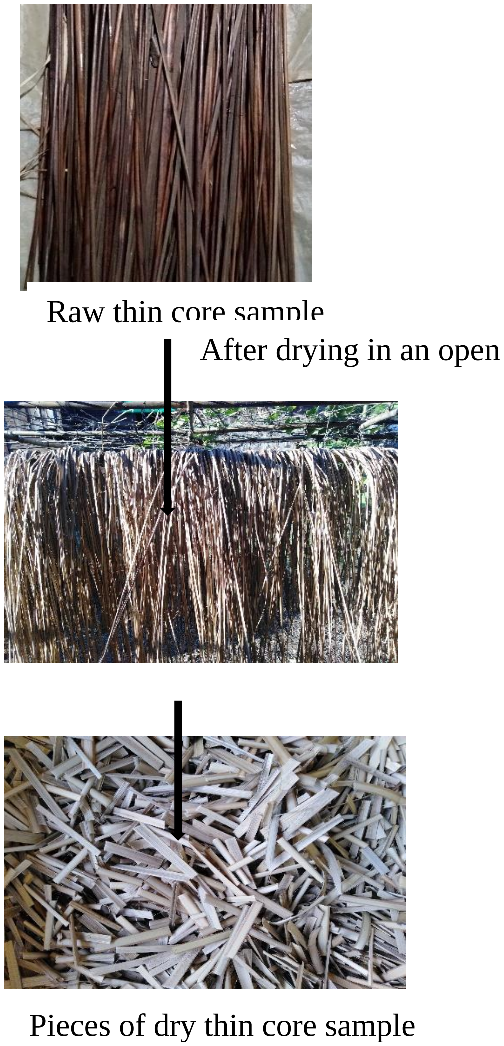


Figure 2. Sample preparation of raw thin core sample

Methods

In the paper production process, the process can be divided into three parts, namely pulping, material preparation and producing paper. The pulping processes of thin core have mechanical pulping process, Thermo- mechanical pulping process and chemical pulping process (Soda process, Kraft process, Sulfite process, etc). In this research, Kraft pulping process was chosen because it is safer and more efficient based on yield.

Pulping Process of Thin Core

Cooking process of Thin Core

This pulping process involved dried thin core and white liquor (12 % NaOH and 4 % Na_2S) were cooked using various ratios of thin core to white liquor (1:4,1:6 and 1:8) at 165 °C for cooking time 2h and holding time 1h by digester.

Washing process of Pulp

After cooking, the pulp was filtered in a large test sieve. The black liquor was allowed to flow through the test sieve. After filtration, pulp was thoroughly washed with water for about 50 minutes to remove black liquor and excess alkali. Screening was performed to separate the pulp into accepts and rejects. At this stage, uncooked fibers were removed as rejects. The wet pulp was weighed to calculate the yield percentage. The chemical properties of pulp such as ash content, kappa number, lignin and residual alkali were determined by T 413 ts-66, T 236 os-76, T 222 om-88 and

T 624 os-68. This pulp was characterized by Fourier Transform Infrared Spectroscopy (FT IR) technique and microscopic examination.

Blending process

The washed pulp was subjected to blend in presence of water in an electric blender. The revolving rotor refined the pulp into uniform length for pulp consistency. Figure 3 shows pulping process using digester.

Cooking with digester | After cooking with digester | Washed pulp

Figure 3. Pulping process using digester

Sheet Forming Process

Pulp solution was placed into the cylinder mold then distilled water was added to the solution. Then roller was used to smooth out of pulp. After that, the water was removed in the mold by tap. The wet pulp sheet was taken from the cylinder and press with hand roller to remove the traces of water. After pressing, the wet paper sheet was obtained. This paper was dried at 110 °C and 0.05 MPa by sheet former machine. Finally, the smooth product of uncoated paper was obtained. Figure 4 describes production of uncoated paper process. Then, the uncoated paper sheet was tested for mechanical properties according to the TAPPI standard methods. The mechanical properties such as basic weight, thickness, tearing index, fiber length, folding, tensile strength, moisture of paper and water absorption were determined by T 410 os-79, T 411 os-76, T 414 ts-65,T 232 su-68, T 511 su-69, T 494 os-70 T 412 su-69 and T 441 os-77.

Mold | Roller | Heater | Uncoated paper sheet

Figure 4. Production of uncoated paper process

Results and Discussio

Chemical Properties of Pulp

Table 1. Chemical Properties of LPT 12, LPT 6 and LPT 8

No.	Chemical Properties	LPT 12	LPT 6	LPT 8
1.	Ash content (%)	5	4	4
2.	Kappa number	37.0	28	23.4
3.	Lignin content (%)	5.74	4.34	3.63
4.	Residual alkali (g / L)	2.71	2.91	3.2
5.	Pulp yield (%)	44	43	40

LPT 12 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 4
LPT 6 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 6
LPT 8 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 8

The results of chemical properties of pulp were described in Table 1. Kappa number approximately indicates the effectiveness of the amount of lignin left after delignification of pulp. The high Kappa number of thin core pulp indicated that they can undergo further delignification. Although in the present case Kappa number was not important as it was target to supply raw material for handmade paper. The Kappa number of thin core to white liquor ratio (1:4) was higher than the two remain ratios (1:6 and 1:8). The Kappa numbers of thin core to white liquor ratio (1:6 and 1:8) were 28 and 23.4. To produce uncoated paper, thin core to white liquor ratio (1:6) was more suitable ratio than thin core to white liquor ratio (1:8). Thin core to white liquor ratio (1:4) was not suitable to produce uncoated paper because its Kappa number was not consistent to manufacture packaging bags. The lignin content of thin core to white liquor ratio (1:6) was lower than thin core to white liquor ratio (1:4) but it was not very different with the remaining ratio (1:8). The amount of residual alkali in the black liquor was used again to the chemical reaction. The yield percentages of three ratios were 44, 43 and 40. They were only slightly different.

FT IR Analysis

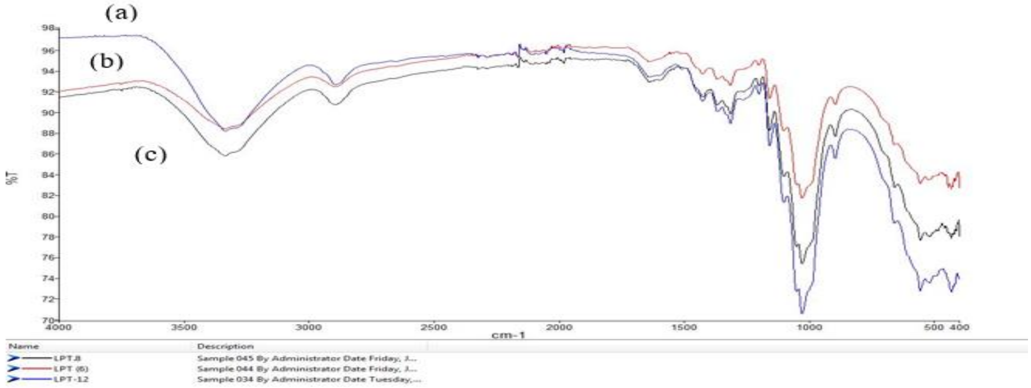
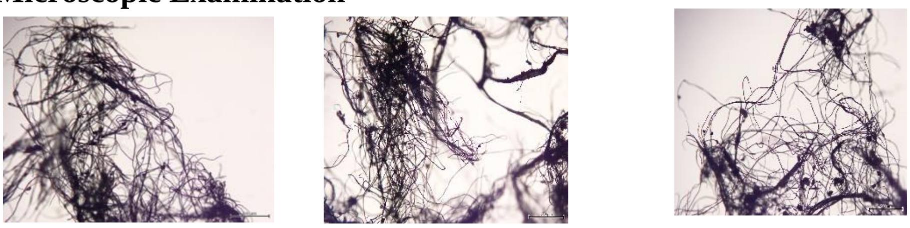


Figure 5. FT IR spectra of (a) LPT -12 (b) LPT - 6 and (c) LPT – 8

LPT 12 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 4
LPT 6 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 6
LPT 8 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 8

The FT IR results of (a) LPT 12 (b) LPT 6 and (c) LPT 8 were shown in figure 5. According to this spectra, the signal at 3338 cm^{-1} shows OH stretching vibration of the water and alcohol group. The signal at 2898 cm^{-1} appears asymmetric and symmetric =C-H stretching vibration of cellulose, hemicellulose and lignin. The signal at 1642 cm^{-1} shows –C=C stretching due to aromatic characteristic of lignin. The signal at 1430 cm^{-1} C-H bending in lignin, cellulose and hemicellulose. The signal at 1320 cm^{-1} assigns –OH in-plane deformation in cellulose. The signal at 1028 cm^{-1} asymmetric stretching of C-O-C in the cellulose and hemicellulose. The FT IR results had indicated that hemicellulose, lignin and other impurities were removed through the process of extraction of cellulose.

Microscopic Examination



(a) (b) (c)

Figure 6. Microscopic examination of (a) LPT- 12 (b) LPT- 6 and (c) LPT- 8 at 165 °C for cooking time 2 h and holding time 1 h

LPT 12 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 4
LPT 6 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 6
LPT 8 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S,
chip sample : liquor 1 : 8

Microscopic examination of pulp using various ratios of thin core to white liquor (1:4, 1:6 and 1:8) were described in figure 6. All three ratios were constituted mainly by fibers. The fibers were the vital cells for the properties of pulping and papermaking.

Mechanical Properties of Uncoated Paper

Table 2. Mechanical Properties of LTP 12, LTP 6 and LTP 8

No.	Mechanical Properties	LTP 12,	LTP 6	LTP 8
1.	Basic weight (gsm)	74.3	73.3	75.4
2.	Folding (times)	13	17	6
3.	Thickness (mm)	0.21	0.22	0.24
4.	Tensile strength (kN/m)	1.87	1.73	1.4
5.	Tearing index (mNm^2/g)	6.3	5.7	6
6.	Fiber length (mm)	1.81	1.83	1.85
7.	Moisture of paper (%)	12.5	8.3	7.2
8.	Water absorption (g/m^2)	280	207	403

LPT 12 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 4

LPT 6 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 6

LPT 8 = Laboratory Pulp using raw Thin core with 12 % NaOH, 4 % Na_2S, chip sample : liquor 1 : 8

The mechanical properties of uncoated paper sheet were described in table 2. The folding, tensile strength and water absorption were very important for producing water proof paper. From this table, the amount of folding of thin core to white liquor ratio (1:6) were significantly larger than the two remaining ratios (1:4 and 1:8) while the water absorption of thin core to white liquor ratio (1:6) were significantly smaller than the two remaining ratios (1:4 and 1:8). The amount of tensile strength of thin core to liquor ratio (1:4 and 1:6) was consistent to produce packaging bags while the amount of tensile strength of thin core to white liquor ratio (1:8) was not consistent to produce packaging bags. The fiber length of thin core to liquor ratio (1:6) was not very different to the remaining ratios (1:4 and 1:8). So thin core to white liquor ratio (1:6) was selected to produce uncoated paper.

Conclusion

In this research, pulp and uncoated paper sheets were produced from thin core was treated with 12 % NaOH and 4 % Na_2S at 165 °C for cooking time 2 h and holding time 1 h using various ratios of thin core to white liquor (1:4, 1:6 and 1:8). Kraft pulping process was used in order to produce the good strength and good quality of water proof paper sheet. The lower amounts of kappa number and lignin generally reduce the amount of energy required to produce pulp using either mechanical or chemical processes. Therefore, the ratio of thin core to white liquor (1:6) was selected in order to save the energy consumption to produce uncoated paper sheet. The pulp was characterized by FT IR and microscopic examination. The amounts of hemicellulose, lignin and other impurities were removed through the process of extraction of cellulose from FT IR data. All three ratios of thin core to white liquor (1:4, 1:6 and 1:8) were not constituted by homogeneous parenchyma cells and the fiber. The mainly fibers only were found in the three ratios. This results were shown as evidence in microscopic examination. Prepared uncoated paper was tested for folding, thickness, basic weight, tensile strength, tearing index, fiber length, moisture of paper and water absorption weight by TAPPI standard methods. Among these properties, the amounts of folding, tensile strength and water absorption of the thin core to white liquor ratio (1:6) were consistent values to produce water proof paper. From the chemical and mechanical properties, it was observed that thin core to white liquor ratio (1:6) is the most suitable ratio for production of water proof paper which is used in dry food packaging bags. This ratio is acceptable ratio to save the energy consumption and is also economically viable.

Acknowledgements

The author is especially grateful to the editorial board of the author and would like to express our sincere gratitude to Rector for his kind provision and submission of this paper. Thanks are also extended to the Chair person and Journal Committee (Dagon University) for allowing our paper to introduce this journal. Special thanks to Dr Cho Cho (Pro-Rector, University of Yangon), Dr Saw Hla Myint (Part-time Professor, University of Yangon) and Dr Nwe Nwe Aung (Associate Professor, University of Yangon Distance Education).

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