EXPERIMENTAL INVESTIGATION ON PRODUCING PAPER USING NON-WOOD FIBRE

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Abstract : As the consumption of paper is increased, the perspective to deal with organic waste is used from agriculture waste. Plant is cultivated for economic importance but the waste creates a problem increasing environmental pollution, hence these wastes are used to make different eco-friendly products, so as to minimize it and use it efficiently. Agriculture waste disposal is a major problem in industries because of cellulose content and high lignin in waste, thus results in pollution and affects the environment, which are very difficult to degrade. Agricultural residues of non-wood fibre like jute, sorghum stalks, hemp, etc., are possible raw materials used for paper production. Some materials found to be promising are banana stem waste, pineapple leaves, corn husk, bagasse which are very good sources of cellulose. Experiments using different raw materials and different concentration in paper production have been conducted to assess the advantage in terms of physical and chemical properties of paper. The results have been proved with some modification in chemical and physical treatment on different parts of fibres can be utilized to make Kraft paper as the raw materials has low lignin content along with long cellulose fibres of higher strength, which results in reduced demand for chemicals and energy for processing. The Kraft process of pulp and paper making is economically viable and also energy saving as sun rays are used for drying purpose. The main purpose is to highlight the potential of agriculture waste used as non-wood materials for paper production. In this project study of the various stages of pulp and paper making using non-wood fibres are done.

IndexTerms **- Non-wood fiber, cellulose, lignin, Pulp, Kraft Paper.**

I. INTRODUCTION

Increasing demand for paper products worldwide and conventional raw materials for pulping non-wood plants and agriculture residues attracted renewed interest. Studies shows the production process of paper from non-wood fibre is significantly less expensive comparing from wood fibre. Paper consists of a web of pulp fibres derived from wood or other plants from which lignin and other non-cellulose components are separated by cooking them with chemical at high temperature. Production of paper is done by pressing moist fibers and drying them into the flexible sheets [1].

The industries of Indian handmade paper have been placed the category of village industry had seen significant growth in last one decade. As given on estimates, there are more than 500 handmade paper units scattered over India producing 50,000 tonnes of handmade papers and boards. The handmade paper industry in the past for the production of handmade paper industry has reached to a turnover of Rs 250,000 million, which provides employment to about 15,000 people and most of them are situated in the rural areas [2]. Paper is fundamental substance, which are used universally across the globe used as printing, publishing and in packaging industries. People have placed an emphasis on forest preservation and use of forestry and agricultural residues [6]. Selecting appropriate methods, devices and equipment's needed to produce, each product are selected. Papers are made using non-wood material such as bagasse, pineapple, rice husk, maize husk, banana fibers. The application of cellulose fibers has many advantages as it is environmentally good, recyclable, and low in cost. The objective of this study is to investigate cellulose, lignin content of the pulp from the raw materials and prepare paper. Therefore the need to convert this waste to wealth by extracting the fibers from different raw materials, which finds application in the plastic, textile and paper industries as increase in population will be a huge disposal problem in future.

II. THEORY

In 1980s, there were 150 large companies that resulted in a paper that covers 45% of total production. In 2000, production increased by two-fold, from 170 million tones / year to 320million tons / year. In 1979, Robert has created a machine for the production of paper and it has been patented in the same year. After few years, Scientist Bryan Donkin invented a machine for the production of paper pulp in 1809, which is more advanced because it speed up the process of obtaining pulp from raw materials. The papermaking industry in 2002 was recorded as the number of 331 x tones. Although the quantity of paper products is still high, but it still cannot accommodate requests from clients. It is estimated that more than 9000 machine that is used for papermaking and it involved 200 states around the world, and there are 15 large companies that resulted in total world production of paper. In this study, the research emphasis is concerned with thickness, tear, and strength. Based on the available details, the production process through various stages are done. In addition, there are several processes in the production of pulp for paper such as mechanical pulping and chemical pulping. At present, there are more effective processes for production of pulp in the process combination of chemical mechanical process. This process combines chemical and mechanical pulp in order to produce the highest quality pulp. At the onset of fiber will be separated by mechanical means and then it will be dissolved using chemical. In addition, the use of non-wood fiber can reduce the rampant felling of trees and thus reduce environmental pollution. In a short time, the increased use of natural fibers will cause a positive impact on farmers and smallholders in the global context. In addition, it will cause an increase the area of the green earth, and reduce the cost of raw material.

Table 1: Chemical composition of raw materials

Particulars	Banana Fibre	Pineapple leaves	Bagasse	Corn husk
Ash, %	2~3	1.2~5	1.5~5 0	3~14
Lignin, %	11~14	11~19	19~24	6~22
Cellulose,%	82~85	54~65	32~48	41~45
*Moisture Content, %	40~90	81.6	9~20	10

The Kraft process (also known as Kraft pulping) is a process for conversion of wood into wood pulp consisting of almost pure cellulose fibres. It entails treatment of wood chips with a mixture of sodium hydroxide and sodium Sulphide, known as white liquor, which breaks the bonds that link lignin to the cellulose. The Kraft process is the best chemical pulping method till used for preparation of papers.

III. Materials and Methods

A. Material: Sugarcane bagasse, Corn husk, Banana Stem, Pineapple Leaf Fibers.

The reason for taking these materials are its high availability, low density, toughness, resistant to weathering and unique composition. The main components in raw materials are cellulose. The composition of raw materials is also shown above.

B. Fibre Extraction and Paper Making Procedure:

Step 1: Fibre Extraction: Raw material are required to chop in size of about 1.5-2 inches. Chemical pulp extraction is achieved by heating in alkaline medium of sodium hydroxide.

Step 2: Peroxide Treatment: Peroxide treatment is done for decolourisation by oxidizing organic matter. Peroxide treatment is done by using Hydrogen peroxide. Washing with water is done afterwards to remove the oxidized lignin and un-reacted peroxide.

Step 3: Dilution (Slurry Making): The treated pulp followed by water wash is then diluted to form slurry to aid the pour it on screen. The concentration of slurry is adjusted so as to utilize minimum quantity of water and maintain the level of paper.

Step 4: Mixing of Additives: At this point, various additives are added to meet the market demand and to improve the quality of finished product. At this stage, starch is added as a binding agent. Added starch helps to attach fibres to each other.

Step 5: Screening: This step requires a wire woven screen of 70-80 mesh. Screen is constructed of the same size for the desired size made up of wooden and aluminium. Along with screen, deckle is required to hold the slurry till the liquid passes the screen. While screening, screen is placed in horizontal position and deckle is placed on it. The diluted slurry is poured on screen and water is allowed passing through screen.

Step 6: Drying: After the removal of residual water mechanical pressing is done, the wet sheet of paper is allowed to partially dry on the screen to be enough stiff to be removed from screen. The removed paper sheet is then kept under sun rays for drying. The equilibrium moisture content is found to be 9%.

Figure 1: Experimental Procedure for Kraft Paper Making

C. Method and Experimental Procedure

Pulp and Paper Making: The pulp and paper making process is carried out in following way, Fig.1 Paper Making Processing Steps shows the Paper making process. Raw Material Collection: Banana stem waste, which is thrown away by farmers after harvesting of fruits, is obtained as raw material. Chopping: The stems are chopped into small pieces of 3-4 inch in size. Digestion: The material is soaked in 2-5% NaOH for appropriate period. The alkali loosens the ligno-cellulosic bonds, thereby softening the material. Washing: The softened material is washed with water to remove the black liquor of sodium lignite and unused alkali. Paper Making Processing Steps: Beating: The washed material is then subjected to beating. Beating is required for a getting good quality pulp, depending upon the quality of paper to be produced. Storage: After beating, the desired pulp is produced which is then stored in storage tanks. Paper making: Paper is then making from the pulp of desired quality. Drying: The papers are then allowed to dry.

a) Cooking of fibres **b) Cooked fibres**

c) Peroxide Treatment **d) Extracted Fibres**

e) Sample for pH testing **f) Dried Paper**

Figure 2: Experimental laboratory Batch Setup at room temperature

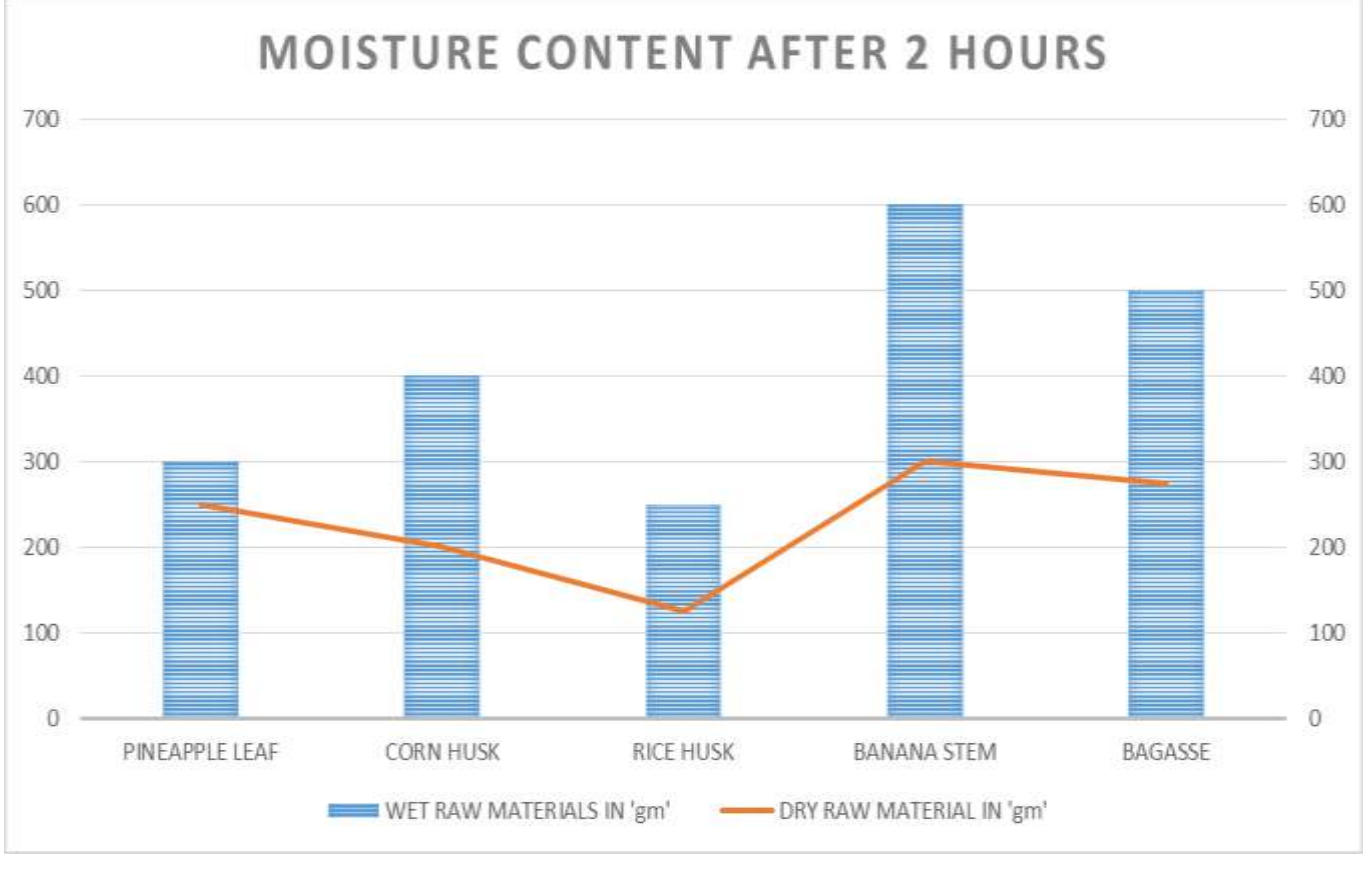
IV. Results and Discussion

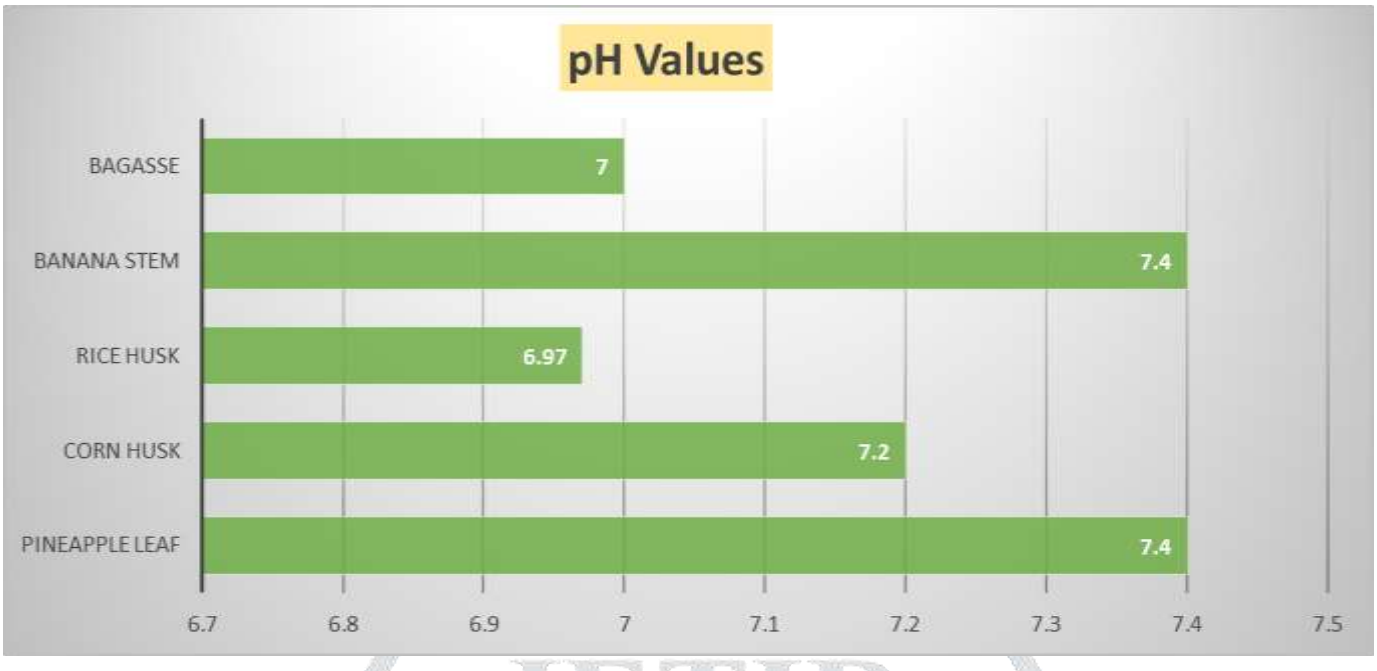
The pulp is successfully extracted from fibres by Krafting process, which is suitable to produce Kraft paper. The fibres were extracted from batch of 60 gm of dried non-wood fibres. First run performed with NaOH Solution, after cooking for 50 min, the yield obtained was 43.8 gm. Second run carried with same NaOH Solution, after cooking for 50 min, the yield obtained was 39.5 gm. The yield of Krafting method is higher than chemical or mechanical retting as well as microbial retting method. NaOH solution can be effectively used for these process. If we compare the results obtained from different raw materials, we found that for a batch of 60 gm of dried non-wood fibre with NaOH solutions gives 73% yield and 2nd trial gives 65.83% yield, which take 50 min for cooking of fibre for making pulp.

The percentage yield of fibres can increase from 65% to 73% as raw material changes. If the concentration of NaOH increases from 15% to 18% it affects the cooking time for a batch. As cooked pulp have good strength properties, which makes a suitable fibre for preparation of paper. The sheet of paper was prepared from extracted pulp, which finds applications in various industries like food packaging, paper sac for agricultural products, e-commerce industry, packer's and mover's.

Table 2: Result of pulping process

MATERIAL	NaOH ml	Wt gm	Cooking Time min	Before Drying (gm)	Drying Time min	After Drying (gm)	pH	Blending Time min	H_2O_2 ml	H_2O ml	Paper pic	Lignin Content	% Yield
CORN AND BAGASSE	500	60	50	243.3	30	43.8	10.13	5	50	550		15~18	73%
CORN AND BANANA	500	60	50	182.9	30	39.5	10.12	5	50	350		12~15	65.83%
BAGASSE	500	50	50	125	45	31	8.94	5	50	550		19~24	62.00%





V. CONCLUSION

Krafting process by extracting fibres from different raw materials is found to be economical, pollution free and safe process. The experimental investigation of non-wood fibres with cellulose content and lignin showed that these raw materials are very suitable for producing Kraft paper in which the low lignin content indicates that fibres requires very mild pulping conditions. The paper obtained from kraft process has good strength, which is suitable material for packing and carrying. Kraft process to make Kraft paper from different fibres are commercial viable processes. The high biomass output of the fibre plants provides large amounts of pulp, which substitutes the conventional raw materials used in India. It is recommended that these fibres can replace imported long wood fibres pulp sheets, which are still being imported by large paper mills. Strong papers and paperboard are both important for traditional use as well as in new fields of application, such as fibre-based packaging, furniture and light-weight building material. This study investigated the strength properties of papers obtained from the pulp blending of long-fibre and short-fibre in different ratios. Blending of pulps from agricultural wastes such as corn husk and pulps from other non-wood materials such as bagasse contributes to the improvement of the paper strength properties and has the potential of producing paper of differing qualities and can find use in wide variety of applications.

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