Research Article

Environmental Friendly Approach in Paper Making using Natural Organic Waste

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Abstract

Present research work focused on mango seed hard cover having potential cellulose source which can be used in Pulp and Paper industries. Environmental concerns have increased the need for non-wood pulp as a low-cost raw material for papermaking. This has also led to the developing of alternative pulping technologies that are environmentally benign. Cellulose pulp from Mango waste is chemically prepared in the laboratory and is used in the paper making and was compared against the standard paper prepared form wood pulp. The performance measured in terms of tensile strength, Porosity, absorbency as compared with the standard paper.

Keywords: Mango seed, cellulose, pulp, paper etc

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Introduction

Pulp and paper production is one of the high demand sectors in the world of industrial production. The total global consumption from paper-making was projected to increase from 316 million tons in 1999 and 351 million tons in 2005 to about 425 million tons by 2010. [1]

Non-wood fiber is one of the major sources for the pulp and paper industry in developing countries due to their abundance and cost-effectiveness. These non-wood materials have considerable potential to be used as alternative choices in many paper grades, including writing and printing papers. The present's research manuscript provides attentions of researcher that agricultural fibers may be used for fabrication of papers. Fibrous materials that are discussed include bagasse, seeds, cereal straw, cotton stalks, kenaf, canola, and rice straw.

Non-wood plant fibers that are currently used in the paper industry are broadly divided into three groups based on their availability. These are agricultural residues, natural growing plants and non-wood crops grown primarily for their fibers.

Agricultural-based paper is a guaranteed way to reduce the stress of paper production on old growth and endangered forests. What's more, some agricultural residue pulps take less time to cook than wood pulps. That means agricultural-based paper uses less energy, less water and fewer chemicals.

There is a growing interest in the use of non-wood such as annual plants and agricultural residues as a raw material for pulp and paper. Non-wood raw materials account for less than 10% of the total pulp and paper production worldwide.[2] This is made up of 44% straw, 18% bagasse, 14% reeds, 13% bamboo and 11% others.

Nonwood are in some applications alternatives to paper made from wood pulp, like filter paper or tea bags. Non-wood fibers are used for all kinds of paper. Writing and printing grades produced from bleached non-wood fiber are quite common. Some non-wood fibers are also used for packaging.

After consumption or industrial processing of the fruits, considerable amounts of mango seeds are discarded as waste and disposable of mango seed waste is again a problem. It leads to environmental imbalance. Hence attempt is made to develop a paper from mango seed waste that is mango seed hard cover and studied its properties.

Experimental

Source

Mango fruits were purchased from the local market of Ratnagiri and Thane district, Maharashtra - India, during March to April- 2013 and 2014. The Alphanso variety of mango was selected for the present research work.

Pulp production

For pulp production from mango seed hard cover the chemical process called organosolv was used. [3] In the cooking operation, a revolving (at 2 rpm) laboratory rotating digester with a capacity of 15 liter was used. It is resistant to a maximum pressure of 25 kg cm^{-2} and has a digital temperature control mechanism. Loadings and discharges were made by hands and 300 g dry mango seed hard cover chips was used in cooking. 40 % Ethanol–water liquor was used as cooking liquor, according to the general principles of Kleinert (1975). [4] Also catalyst (H_2SO_4) was added to the liquor to increase delignification. The rising period to maximum temperature is considered constant as 90 minutes and the ratio of liquor to chip was kept as a constant level of 8/1. In this study, the pulp was treated at 95ºC for 60 min by 8% alkaline environment. After these operations, the precipitated pulp which is cleaned from organosolv lignin was washed with water. The pH value of the black liquor, taken from the digester at the end of cooking, was measured. After these operations, the pulp was filtered through Strainer filter (0.4 mm mesh) to isolate the uncooked material. The pulp was then squeezed to 20-25% ratio of solid particle and placed into polyethylene bags and used for further process of paper making.

Paper making [5]

The pulp is then transferred in to a big container. At this point, a filler material is added in this pulp such as chalks, clays. These additives will influence the opacity and other qualities of the final product. Sizing is also added at this point. Sizing affects the way the paper will react with various inks. A sizing such as starch makes the paper resistant to water. This pulp is taken out using a big flat sieve with a thin cloth on it. The sieve is shaken so as to spread the pulp evenly on the cloth. Extra water also drains out in this process. The cloth is removed carefully without disturbing its contents. This process is repeated several times till all the pulp is removed from the container and is spread on cloth sheet. These sheets are placed on one above the other thus building up a stack of interleaved sheets. Pressure is then applied from either side to squeeze out excess water from the sheets. This improves the physical properties of the paper and facilitates drying. The sheets are removed after the water is sufficiently removed and the shape of the paper is retained, hung like clothes and dried under the sun and after in shade.
R1 is prepared by 100% replacement of Cellulose by Mango fiber pulp
R2 is the 50:50 blends of Cellulose and Mango fiber pulp

Tensile strength

The tensile force required to produce a rupture in a strip of paper or paperboard, measured in MD and CD, expressed in kN/m. Tensile Strength is measured by standard TAPPI T 494 method.[6]

Porosity

Porosity of paper is measure by Air resistance of paper (Gurley method) T 460.[7] The porosity is an indication of the openness of paper, as measured by resistance to the passage of air through the sheet. Two types of instruments are generally used to measure porosity - Gurley and Sheffield. The Gurley Instrument measures the seconds required for given volume of air to pass through a single sheet of and are generally used for porous papers. A high reading indicates a less porous (or denser) paper. Sheffield porosity measures the flow rate of air through a single sheet and is generally used for non-porous or dense sheet. A high Sheffield reading indicates a more open paper. A typical Gurley porosity test for 50 lb. Smooth offset would be 10-20 seconds. Sheffield readings of 60 lb. Coated paper would be 10-20 units of air flow.

Absorbency

This test determines the liquid sorption rate of bibulous paper, paperboard, and paper products using gravimetric principles. A set volume of water is dropped onto the paper surface and the time for the drop to be absorbed is measured.[8]

Result and Discussion

In organosolv (ethanol-water) cooking method, the delignification of the mango seed hard cover was made in a closed autoclave according to the cooking conditions. In this study, cooking was made with and without catalyst. In cooking without catalyst, the necessary acidic environment for delignification was obtained by the hydrolysis of acetyl groups of lignocellulosic materials at high temperature. As a result, the lignin structure was broken and passed to the solvent phase without decreasing the pH level of the cooking liquor. The purpose of this application is to reach high pulp efficiency and limited degradation carbohydrate part. (Figure 1)

The Organosolv pulping processes are alternatives to conventional pulping processes, and have environmental advantages. Organosolv pulping features an organic solvent in the pulping liquor which limits the emission of volatile sulfur compounds into the atmosphere and gives efficient chlorine-free bleaching. These processes should be capable of pulping all lignocellulose species with equal efficiency. Another major advantage of the Organosolv process is the formation of useful by-products such as furfural, lignin and hemicelluloses.

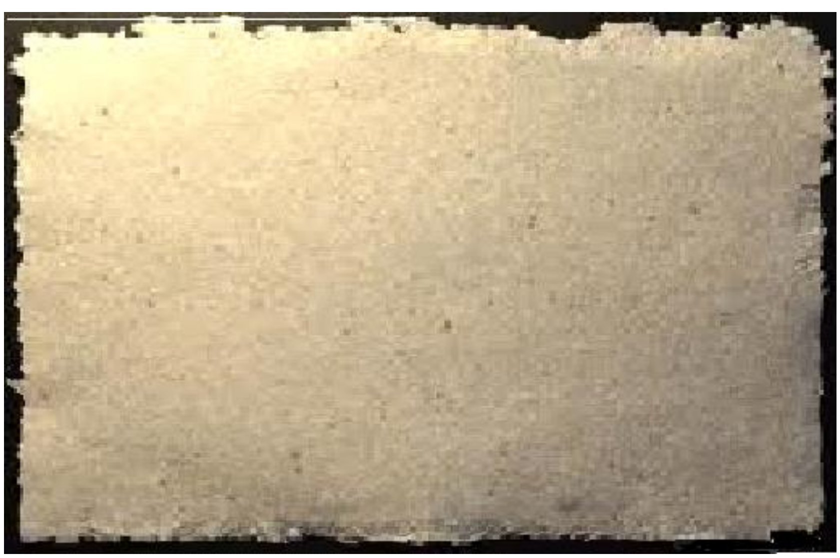

Figure 1 Paper from mango seed outer hard cover pulp

Table shows the values of tensile strength, Porosity and Absorbency of Manufactured paper and was compared with the commercially available standard paper.

Table 1 Tensile Strength, Porosity and Absorbency of manufactured and commercial paper

Papers (70 ± 2 GSM)	Standard TAPPI T 494		Porosity (Air Resistance)	Absorbency in seconds
	MD(kN/m)	CD(kN/m)	Grand Mean (Seconds)	Mean of 10 values
Standard	3.6	2.6	10.3	1.17
R1	4.8	3.4	11.3	1.24
R2	4.1	3.2	10.6	0.93

Tensile strength data shows that the values of R1 and R2 as 4.8 kN/m and 4.1 kN/m as against standard 3.6 kN/m in machine direction and 3.4 kN/m and 3.2 kN/m as against standard 2.3 kN/m in cross direction respectively. It can be observed that the strength of paper prepared from 100 % Mango waste is 1.3 times more than standard cellulose paper and the blend component (50% Cellulose and 50 % Mango pulp) is also 1.14 times more than cellulose paper.

This is because the interlacing of bonds is much stronger in case of mango fiber than that of cellulose fiber.

Porosity data shows that as the air resistance is higher in case of mango fiber 11.3sec than the blend component10.6sec and followed by standard10.3sec. This can be concluded that air permeability is more for standards the results are more or less comparable.

The Absorbency of All the three paper products show more or less similar results and are comparable ones. The paper is shown in figure no 1.

Conclusion

The increasing demands for paper and environmental concerns have enhanced the need for non-wood pulp as a low-cost raw material for papermaking. This has also led to the developing of alternative pulping technologies that are environmentally benign. Agricultural waste potential competitive alternative resource for pulp manufacture due to the fact that they are more available and readily regenerated. Therefore there is a need to identify more non-wood materials as mango seed hard cover with high potential for pulp and paper production. From the above research work concludes that the paper prepared from mango waste pulp may be completely or partly replaced by cellulose papers which show the enhanced or similar physical properties.

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