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STUDY ON HYDROPHOBIC PROPERTY OF HANDMADE JUTE PAPER TREATED BY WAX

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ABSTRACT

Hossain HMZ, Asaduzzaman M, Azad M, Chowdhury N, Uddin MK, Hussain MZ (2010) Study on hydrophobic property of handmade jute paper treated by wax. *J. Innov. Dev. Strategy 4*(1), 1-4.

To produce hydrophobic handmade paper sizing material wax along internal additives (rosin) and reinforcement were used. Optimum result was obtained when rosin along with wax was used as internal additive during pulp preparation and it was enhanced when it was reinforced by jute fibre. The hydrophobicity was increased by 51.26 % due to rosin along with wax treatment and application of reinforcement. The experiment was done at the handmade paper laboratory of Mennonite Central Committee, Dhaka in the year 2002-2003.

Key words: *hydrophobic property, handmade paper, pulp preparation*

INTRODUCTION

The use of Polypropylene (PP) and Polyethylene (PE) as packaging materials has thrown threat to the environment and economy of Bangladesh (Haque *et al.* 2002) Reportedly huge amount of land in Bangladesh are occupied daily by non-degradable polybags which reduces the fertility of land and obstructs the flow of rain water resulting flood in Bangladesh. In this situation, development of a degradable natural packaging material is very important and paper made of cheap jute fibre having high strength and high hydrophobic character can be a solution. Besides this, due to inroad of synthetics, the use of jute as packaging purpose has been decreased (Ali 1985). On the other hand, demand of nonwood plant fibres as raw material has been being increased day by day (Atchison 1990 & Chandra 1997). Hence the use of jute could be diversified by using it as the raw material of paper.

It has been reported that when MCC in the form of regenerated cellulose gel is mixed with bleached kraft pulp to produce hand sheet (Hand towel), the mechanical properties (Young Modulus, Tensile & Tear indices, Folding Endurance) of hand sheet are improved. Swollen starch pulp when used with wood pulp, increase the tensile strength folding endurance of hand sheet as starch pulp had reinforcing effect on inters fibre bonding between wood pulps in the hand sheets. Adding poly-amidiamine epicholohydrin resin (PAE), a wet strength resin, together with swollen starch pulp had a synergistic effect on the increase in folding endurance (Isogai 1997). The effect of MCC, CMC and mixture MCC and CMC on hydrophobic property of paper produced from jute was studied. It has been observed that the treatment with MCC suspension increased the water repellent property of handmade paper. In case of treatment by mixture of MCC suspension and CMC solution in the ratio of 50:50, the hydrophobic character is usually increased with the increase of MCC concentration in the mixture but the hydrophobic character is decreased with the increase of CMC solution concentration in the mixture(Hossain *et al.* 2006 a & b).

The effect of fibre reinforcement along with /without sizing material, internal sizing material (rosin, alum, wax emulsion etc) and external (MCC suspension) is yet to be studied. Hence handmade papers produced from jute were treated with various internal sizing materials (rosin alum, wax emulsion) and external sizing material (MCC solution prepared from jute (Abdullah *et al.*1978) and raw jute fibres were reinforced to increase the hydrophobic property of paper in this present work.

MATERIALS AND METHODS

Bangladesh white B (BWB) jute and collected from Mechanical Processing Division of Bangladesh Jute Research Institute and MCC provided chemicals and laboratory facilities. Four experiments were performed (Table-1). Such as:

Experiment-01 : To make control paper without using any sizing/ reinforcement.
Experiment-02 : To make paper without using any sizing but incorporating jute fibre reinforcement and using wax emulsion as external additive.
Experiment-03 : To make paper using rosin, alum and wax emulsion as internal sizing.
Experiment-04 : To make paper using rosin, alum and wax emulsion as internal sizing and incorporating jute fibre reinforcement.

Table 1. Parameters used for pulp preparation in different experiments

Experiment No.	Atmosphere of Pulp Preparation		p^H After Washing	p^H With Additives	Remarks
	Temperature ^0C	Relative Humidity (%)			
1	27.0	47	7.5	-	No additive used
2	27.7-32.7	37-46	7	-	No additive used
3	30.5-31.0	30-33	7	5.5	
4	31.1-31.5	27-33	7.5	6.5	

Preparation of fiber sample

The fibers were cleaned carefully so that no barks roots were present. These cleaned fibers were cut to the size of 1.27 am -2.54 cu ($1/2$ -1 inch).

Preparation of pulp

Boiling: 300g of cut fibers were taken.18 g sodium hydroxide (6% of the arterial) was dissolved in 10 liter of water by boiling. The amount of water was maintained about 10 tre throughout the whole boiling process. As soon as a water reached the boiling temperature, fibres were immersed in the boiling water of a open tube and boiling was continued for 4 hours to remove some impurities as may be soluble in mild alkalis at moderately high temperature as well as to soften and condition the fiber. The boiled fibers were than properly washed by water until the effaced was practically clear. The length of washing time was so adjusted that the fiber/ stock will be as clean as possible with a minimum of fiber loss.

Beating: The washed jute fibers were taken with 70 kg of fresh water in the open vessel of beater. The fibers were converted into a pulp through cutting and beating in beater for $2\ 1/4 - 2\ 1/2$ hours. The pulp was keep standing for 17.25 hours. Then pulp was washed to maintain pH 7.

Internal Sizing: The washed pulp had under gone different sizing treatment to increase strength and hydrophobic property of the papers to be produced. Pulp was kept in a open bucket containing 20 Litter of water.

(i) 1.5% Rosin (The most commonly used water repellent compound in stock sizing) soap in form of solution was applied and stirred for 5 winters by bleeder than (after 30 minuets) 3% Alum solution was mixed and stirred for another 5 minuets.

(ii) 1.5% Rosin soap was applied and stirred for 5 minutes by blender. Than (after 30 minutes) 0.75% was emulsion was mixed and stirred for another 5 minutes. Than 3% alum in the from of solution was applied and stirred for 5 minutes. The pulp was kept for 20 minutes after applying internal sizing.

Preparation of Rosin size soap: 500g of powdered rosin was taken. 50g 10% of rosin powder) was dissolved in to 1 liter of water by heating .Rosin powder was first converted in to paste by adding some hot caustic soda solution. Rosin soap was prepared by adding the remaining caustic soda solution with Rosin paste and boiled 30 minuets.

Preparation of Rosin Size Solution: 1.5% (on the wt. of fibre material) i.e. 4.5gm rosin soap was taken and solution prepared by diluting Rosin soap with not water.

Preparation of Alum Solution: 3% (On the wt. fiber material) i.e. 9gm alum was taken and alum solution was prepared by adding hot water.

Preparation of wax solution: 0.75% (On the wt. fiber material) i.e. 2.25g liquid paraffin wax was mixed in water by stirring in a bladder. No emulsifier was used.

Washing of pulp/stuff: The stuff after wooding from beater was kept on a net to allow the liquid to be drained out. The stuff was washed properly by water so that the staff gets neutral condition.

Determination of p^H: The '$p^{H'}$ is the indirect measure of the chemical state of the stuff. Sowing the degree of acidity or alkalinity was measured by p^H paper.

1 liter of polyimide solution (0.05% i.e. 7.5gm polyamide is 15 liter water) was taka in lifting vat containing 20 liter of water. Pulp was suspended uniformly in water of lifting Vat. Pulp was lifted from the lifting vat in sheet form by lifting net and kept on a bed table one after another using of cloth as separators.

Reinforcement of fiber: Jute fiber from carded sliver of BTB jute were collected. These filaments were reinforced between two layers of pulp manually. The distance between fibers (both vertically and horizontally) was kept 2.54cm.

Pressing: The pulps in lap form were pressed for 15 minutes by hydraulic press having a capacity of 10 ton to from paper sheet.

Drying of paper: The produced papers were dried in sunlight.

Calendaring: The paper sheets got deformed on drying. It was tried to make paper sheet flat by calendaring.

External sizing: (b) 0.5% wax emulsion (i.e. 5g in 100cc water) was prepared. Paper samples were soaked in wax exclusion for 1 minute. Than samples were dried in sunlight.

Test of the Properties

The physical properties of paper like thickness, GSM, tearing strength, Cobb water absorptivity, folding endurance were measured for each experimental group in the standard temperature and humility for paper as per TAPPI standard test methods. Temperature= 23 ± 1^0C, RH=50 ± 2% after condition for 3days according to (T402 gm-93). For each experiment, samples were cut from different sheet (one from each sheet).

Thickness: 10 samples (10cm × 10cm) for each experiment were taken. Thickness was measured by venire calipers according to TAPPI T441om-97. Five reading were taken from each sample and results were recorded in mm.

GSM: 10 Samples (10cm × 10cm) for each experiment were taken. The weight of the samples were measured by electronic balance and these were multiplied by 100 to get the weight of the sample in Grams per Square Meter (GSM). (Beside this method GSM could be measured according s to TAPPI T410 om-98 and results were as g/m^2 Which indicates the was unit area of paper on a scale when a sample of 10cm × 10 cm size is suspended from a hook fixed to the pointer arm).

***Cobb Water Absorptivity*:** Three samples (12.5cm × 12.5cm) for each experiment were cut. Water absorptivity was tested acceding to TAPPI T 441om-98. Each sample was weighed first to the nearest 0.01g. A dry rubber mot was placed on the metal plates and a weighed sample was placed on it. The metal ring (after wiping perfectly dry) was placed upon the sample was fastened firmly enough in place with crossbar to prevent any leakage between the ring and the sample. 100ml of water (23 ± 1^0c) was poured into the ring as rapidly as possible thus giving a head of 1.0 ± 0.1cm. The water was poured quickly from the ring after 110seconds. The crossbar was taken out of the way by loosening the wing nuts promptly while holding the ring in position by pressing it down with one hand. The ring was removed carefully but quickly and the sample was placed with its wetted of the pre-determined test period (2 minutes), a second sheet of blotting paper was roller once back and once forward over the pad without exerting any additional pressure on the roller. The sample was folder with the wetted area in side and was re-weighted immediately. The weight of water absorbed in g/sq meter was obtained from the following formula:

$$\text{Weight of water absorbed } \left(\frac{Gm}{m^2}\right) = \left\{Finalwt\ .(g) - Conditione\ \ dwt\ .(g)\right\} \times 100$$

Water Absorption Index = W_1/GSM

Where, W = Weight of water absorbed in GM/ M^2

GSM = Weight paper in GM/M^2

RESULTS AND DISCUSSION

Table-2 : Thickness, GSM and Absorptivity of Paper

Expt. No.	Thickness(mm)				GSM(Gm/m^2)				(Obb water) Absorptive Test	
	Mean	CVw (%)	Mean	CVb (%)	Mean	CVb (%)	Mean	CVb (%)	Water absorbed Gm/m^2	WRI (%)
1	0.28	11.16			175.8	09.84			557.33	-
2	0.30	18.97	0.28	4.45	201.5	11.16	176.10	10.16	492.00	11.72
3	0.28	10.47			163.5	09.71			302.67	45.69
4	0.27	11.39			163.6	06.27			271.67	51.26

CV_w = Co-efficient of Variation within experiment

CV_b = Co-efficient of Variation between experiments

WRI =Water Resistance Inversed

Experiment – 01 : Control
Experiment – 02 : Fiber Reinforced + Wax as external additive
Experiment – 03 : Rosin + Alum + Wax as internal additive
Experiment – 04 : Rosin + Alum + Wax as internal additive + Fiber Reinforcement

From Table-2 it was observed that the mean thickness and GSM of paper were 0.28 and 176.10 mm respectively. The mean thickness of paper varied a lot as the CV% of paper thickness (within experiments) were 10.47% -18.97% and the CV% (among experiment) was 4.45 %. The mean GSM of paper also varied as the CV% were 6.27%-11.16% (within experiment) and that among experiment was 10.16%. The variation in thickness and GSM was due to lack of uniformity in lifting. It was found that the paper strengths were increased in all cases when the fibers were treated by wax emulsion. The application of rosin played a significant role in imparting water resistance to the paper (Experiment-7 & 8). It was enhanced when it was reinforced by jute fibre (Experiment no.2 & 4).

The hydrophobicity was increased by 45.69 % due to rosin along with wax treatment. (Experiment no.-3). The hydrophobicity was increased by 51.26 % due to rosin along with wax treatment and application of reinforcement (Experiment no.-4).

The findings of this study are a good agreement with the results described by Isogai 1997; Hossain *et al.* 2006 a & b; Abdullah *et al.*1978; Atchison 1990 & Chandra 1997.

CONCLUSION

Optimum result was obtained when rosin along with wax was used as internal additive during pulp preparation. When jute fiber was reinforced, then it was enhanced. The hydrophobicity was increased by 51.26 % due to rosin along with wax treatment and application of reinforcement. The output of this study would be useful for quality and effective handmade paper pulp preparation.

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