

HYDROPHOBIC PROPERTY OF HANDMADE JUTE PAPER TREATED BY SIZING MATERIAL 'ROSIN'

H. M. Zakir Hossain¹, Md. Kamal Uddin¹, Khaled Saifullah², M. M. Rashid³
and M. M. Mollah³

¹Pilot Plant and Processing Division

Bangladesh Jute Research Institute (BJRI), Manik Mia Avenue, Dhaka

²Mechanical Processing Division (BJRI), Dhaka

³Textile Physics Division (BJRI), Dhaka

E-mail: engrzakir_bjri@yahoo.com, sflhkhaled@yahoo.com

Abstract: To produce hydrophobic handmade paper internal material rosin along with external additive (MCC suspension), internal additive (wax emulsion) and reinforcement were used. Optimum result was obtained when rosin along with alum was used as internal additive during pulp preparation and MCC in the form of suspension was applied as external additive. The hydrophobicity was increased by 92.46% due to rosin-alum treatment and application of MCC suspension as external additive. It was also observed that application of wax along with rosin hampered/hindered the hydrophobicity.

Keyword : Handmade, Jute, Paper, Hydrophobic, Sizing material

1 Introduction

The use of Polypropylene (PP) and Polyethylene (PE) as packaging materials has thrown threat to the environment and economy of Bangladesh [1]. 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 inroads of synthetics, the use of jute as packaging purpose has been decreased [2]. On the other hand, demand of nonwood plant fibres as raw material has been being increased day by day [3-4]. 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 [5]. Swollen starch pulp when used with wood pulp, increase the tensile strength folding endurance of hand sheet as starch pulp had reinforcing effect on inter fibre bonding between wood pulps in the hand sheets. Adding poly-amidamine epicholohydrin resin (PAE), a wet strength resin, together with swollen starch pulp had a synergistic effect on the increase in folding endurance [6]. 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 [7-8].

It has been reported that application of glutaraldehyde and poly(vinylalcohol) not only improved wet strength of paper but also significantly increased dry strength, tensile energy, absorption and folding endurance of treated paper [9].

The effect of sizing material 'rosin' along with internal sizing material (wax emulsion) and

external sizing material (MCC suspension) and reinforcement of fibre 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 [10]) and raw jute fibres were reinforced to increase the hydrophobic property of paper in this present work.

2 Materials and Methods

Bangladesh white B (BWB) jute and collected from Mechanical Processing Division of Bangladesh Jute Research Institute and Mennonite Central Committee provided chemicals and laboratory facilities. Ten experiments were performed. Such as:

Experiment- 01 : To make control paper without using any sizing/ reinforcement.

Experiment- 02 : To make paper using rosin and alum as internal sizing.

Experiment- 03 : To make paper using rosin and alum as internal sizing and incorporating jute fibre reinforcement.

Experiment- 04 : To make paper using rosin, alum and wax emulsion as internal sizing.

Experiment- 05 : To make paper using rosin, alum and wax emulsion as internal sizing and incorporating jute fibre reinforcement.

Experiment- 06 : To make paper using rosin and alum as internal sizing and MCC as external sizing.

Experiment- 07 : To make paper using rosin and alum as internal sizing incorporating jute fibre reinforcement as well as using MCC as external sizing.

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 °C	Relative Humidity (%)			
1	27.0	47	7.5	-	No additive used
2	28.4-28.7	39-50	6.5	5.5	
3	28.4-28.7	39-50	7.5	5.5	
4	30.5-31.0	30-33	7	5.5	
5	31.1-31.5	27-33	7.5	6.5	
6	28.4-28.7	39-50	6.5	5.5	
7	28.4-28.7	39-50	7.5	5.5	

2.1 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 cm -2.54 cm ($\frac{1}{2}$ -1 inch)

2.2 Preparation of pulp:

2.2.1 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 litre through the whole boiling process. As soon as a water reached the boiling temperature fibers 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 then properly washed by

water until the effluent 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.

2.2.2 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 $2\frac{1}{4}$ - $2\frac{1}{2}$ hours. The pulp was keep standing for 17.25 hours. Then pulp was washed to Maintain pH 7 .

2.3 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.

a) 1.5% Rosin (The most commonly used water repellent compound in stock sizing) soap in

form of solution was applied and stirred for 5 minutes by blender. Then (after 30 minutes) 3% Alum solution was mixed and stirred for another 5 minutes.

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

- On the wt. fibre material.

2.3.1 Preparation of Rosin size soap: 500g of powdered rosin was taken. 50g NaOH (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 minutes.

2.3.2 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 hot water.

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

2.4 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 blender. No emulsifier was used.

2.5 Washing of pulp/stuff: The stuff after unloading 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 stuff gets neutral condition.

2.6 Determination of p^H : p^H , the indirect measure of the chemical state of the stuff. Sowing the degree of acidity or alkalinity was measured by p^H paper.

2.7 Lifting: 1 liter of polyamide solution (0.05% i.e. 7.5gm polyamide in 15 liter water) was taken 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 or lap form by lifting net and kept on a bed table one after another using pieces of cloth as separators.

2.8 Reinforcement of fiber: Jute fiber filament 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.

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

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

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

2.12 External sizing:

a) 0.5% MCC suspension (10g MCC in 2000cc water) was prepared. Paper samples were soaked in the suspension of MCC for 1 minute. Then samples were dried in sunlight.

2.13 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 humidity (Temp= $23 \pm 1^\circ\text{C}$, RH= $50 \pm 2\%$) for paper as per TAPPI standard test methods¹¹⁻¹² after conditioning for 3 days according to (T402 gm-93). For each experiment, samples were cut from different sheet (one from each sheet)

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

2.13.2 GSM: 10 Samples (10cm×10cm) for each experiment were taken. The weight of the samples were taken 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 to TAPPI T410 om-98 and results were as g/m^2 Which indicates the unit area of paper on a sector scale when a sample of 10cm×10 cm size is suspended from a hook fixed to the pointer arm).

2.13.3 Cobb Water Absorptivity: Three samples (12.5cm×12.5cm) for each experiment were cut. Water absorptivity was tested according to TAPPI T 441om-98. Each sample

was weighed first to the nearest 0.01g. A dry rubber mat 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 and ample was fastened firmly enough in place with crossbar to prevent any leakage between the ring and the sample. 100ml of water ($23 \pm 1^{\circ}\text{c}$) was poured into the ring as rapidly as possible thus giving a head of $1.0 \pm 0.1\text{cm}$. The water was poured quickly from the ring after 110 seconds. 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 side up on a sheet of blotting paper resting on a flat

rigid surface .Exactly at the end of the pre-determined test period (2 minutes), a second sheet of blotting paper was placed on top of the sample and the surface water was removed by moving a hand 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:

$$\text{Weight of water absorbed (Gm/m}^2\text{)} = \{ \text{Final wt. (g)} - \text{Conditioned wt (g)} \} \times 100$$

$$\text{Water Absorption Index} = W_1/\text{GSM}$$

Where, W= Weight of water absorbed in GM/M² , GSM= Weight paper in GM/M²

3 Results and Discussions

Table 2 Test results of hand made papers from Jute fibers

Expt. No.	Thickness(mm)				GSM(Gm/m ²)				Cobb water Absorptivity 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	09.31			181.4	06.03			047.67	91.57
3	0.35	14.29			202.9	16.97			067.67	87.86
4	0.28	10.47	0.31	13.16	163.5	09.71	182.31	8.85	302.67	45.69
5	0.27	11.39			163.6	06.27			271.67	51.26
6	0.32	07.37			187.7	04.81			242.00	92.46
7	0.38	22.38			201.3	15.00			047.33	91.51

CV_w = Co- efficient of Variation within experiment

CV_b = Co-efficient of Variation between experiments

Tearing Index = Tearing Force (mN)/GSM (Gm/M²)

WRI =Water Resistance Inversed

- Experiment -01 Control
- Experiment - 02 Rosin+ Alum
- Experiment - 03 Rosin + Alum+ Fiber Reinforcement
- Experiment - 04 Rosin+ Alum +Wax as internal additive
- Experiment - 05 Rosin+ Alum+Wax as internal additive+Fiber Reinforcement
- Experiment- 06 Rosin+ Alum+ MCC as external additive
- Experiment -07 Rosin + Alum+ Fiber Reinforcement+ MCC as external additive

From result table 2 it was observed that the mean thickness and GSM of paper were 0.31 and 182.31mm respectively. The mean thickness of paper varied a lot as the CV% of

paper thickness (within experiments) were 7.37%-22.38% and the CV% (among experiment) was 12.32%. The mean GSM of paper also varied as the CV% were 4.81%-

16.97% (within experiment) and that among experiment was 8.85 %. The variation in thickness and GSM was due to lack of uniformity in lifting.

Rosin played a significant role in imparting hydrophobic character to hand paper from jute as water resistance increased in all experiments.

The application of MCC suspension enhanced the hydrophobic properties of paper in all cases (experiment no. 6 and 7) and optimum result (92.46%) obtained (experiment 6).

The application of wax along with rosin hampered/hindered the hydrophobicity of paper compared to 100% rosin treated paper (experiment no.4 and 5).

The reinforcement of paper by jute fibre did not exhibited any significant result regarding hydrophobicity (experiment no.3,5 and 7).

5 Conclusion

Hydrophobic is an important property of paper that repels water. Various paper grades require a low level of porosity to air in order to feed properly in copiers and sorting machines for example. Other paper grades require a highly continuous film on their surface that will resist penetration by non-aqueous fluids. The use of sizing in paper is known to provide several beneficial attributes to the paper and processing thereof including paper strength, retarding paper penetration into the sheet and the quality and ease of printing on the paper.

The water repellent handmade jute paper has a great potential in market of grocery, vegetables ,butcher etc as substitute of poly bags for packing purpose.

References

- [1] Muhmmad Serazul Haque, "Manufacturing and marketing of cheap jute bag as substitute of polyethylene" keynote paper presented in the seminar titled "To encourage the use of cheap jute bag as substitute of ployethylene forpreventing environment pollution" held on January 26,2002, Dhaka,Bangladesh
- [2] Mohammad Ali "Modification of jute fibre and farics-Bangladesh" Vol.11 No.9&10 p-20
- [3] Atchison, J.E, "Worldwide capacities of non-wood plant fibre pulping increasing faster than wood pulping capacities".TAPPI Nonwood plant fibre Pulping Progress Report, 1990, No.19, pp.1-7
- [4] Chandra, Mudit. "Use of nonwood plant fibres for Pulp and Paper industry : Focus on China",masters dissertation, Virgina Polytechnic Institute and State University, Virgina, USA, 1997 '.
- [5] Isogai, Akira "Properties of Hand sheets Containing Cellulose Regenerated from Cellulose/Aqueous NaOH solution", "Journal of the Society of Fiber Science and Technology, Japan". Vol. 53 No.3, March 1997, (Abstracted in Textile Research Journal, USA. March-1997)
- [6] Suzuki, Takashi; Isogai, Akira; Onabe, F "Properties of Hand sheets Containing Starch Pulp Prepared with Various Wet-End Additives", "Journal of the Society of Fiber Science and Technology, Japan" Vol.53 No.10, March 1997, (Abstracted in Textile Research Journal, USA. October-1997).
- [7] Hossain, H.M.Zakir;Mollah, M.E.;Rahman, SMB; Rashid and MM; Abdullah, "Application of Microcrystalline cellulose to Increase the Hydrophobic Property of Paper Produced from Jute Waste", "Bangladesh Journal of Jute and Fibre Research"Vol.16 No.1-2, 2006,pp.12-17
- [8] Hossain, H.M. Zakir;Mollah, M.E.;Rahman, SMB;Matin, Nilufar and Shahidullah,Md. "Modification of Handmade Paper From Jute by CMC in mixture with MCC suspension for Increasing Hydrophobic Property", "Bangladesh Journal of Jute and Fibre Research" Vol.16 No.1-2,2006,pp.18-23.
- [9] Abdullah; Khan; Salam; "Preparation of Microcrystalline Cellulose from Jute", "Bangladesh Journal of Jute and Fibre Research", No.3, 1978, pp.39-43.