

# Application Of Resins And Gums From Natural Sources For Making Handmade Paper From Jute Residues

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## ABSTRACT

Jute mainly grows in eastern India. It has been used as packaging material for different commodities and also to some extent for carpet backing, hessian, decorative fabrics etc. Due to stiff competition from synthetic fibre, it is necessary to find some new uses of jute fibre and its by-product. It has been established that jute fibre in the form of caddies, root cuttings, feshwa, gunny and thread waste etc. having high percentage of cellulose and long fibre are quite suitable as non-wood plant fibre for manufacture of different grades of paper and paper board, both in large scale as well as in handmade paper mills. The technique of handmade paper making is gaining importance day to day as it is inexpensive, consumes less energy and is free from pollution unlike large paper industries. Application of various natural resins and gums viz starch, cationic starch, yellow dextrin, gum arabic, guar gum etc. has been found effective in increasing the strength and other properties of jute pulp giving quality paper/paper board.

## INTRODUCTION

In India, the supply of conventional paper making raw materials like wood and bamboo etc. are short in supply due to environmental protection and our protest against deforestation. This situation compels us to go for non-conventional raw materials e.g. agricultural residues and other non-wood plant fibres. Jute fibre in the form of caddies, feshwa, root cuttings (called jute residue) etc. are found as non-wood raw materials for making paper. Although cellulosic fibre is the basic component of pulp and paper industries, large quantities of other non-cellulosic materials are used by the industry to provide specific properties to meet end use requirement and to facilitate efficient production. Among these additives are starch, modified starch, dextrin, vegetable gums etc. Filling and coating pigments, colouring materials, internal and surface sizing agents are also considered as additives.

Sizing of paper is the process by which paper becomes resistant to penetration of liquids. Internal sizing refers to the process of introducing chemical additives to make paper hydrophobic. Internal sizing or beater sizing agents are added to the pulp followed by addition of rosin soap and alum

whereas surface sizing agents are applied to paper or paper board for improving its porosity, resistance to writing ink and printing properties. In handmade paper industries, the traditional cellulosic raw materials are various textile wastes viz. hosiery cuttings, tailors cuttings etc. Due to the high price of these materials as compared to jute residues and huge availability of jute in eastern India, emphasis is given to use jute residues in economic way in our existing handmade paper industries either wholly or partially with other raw materials including waste paper/recycled paper. Despite advantages of large scale paper technology, handmade paper industry has ample scope of employment generation particularly in rural areas with less capital investment. It has solution to the problem of energy and pollution unlike large paper mills.

In this paper, an attempt has been made to study the effect of addition of different natural resins and gums e.g. maize starch, cationic starch, yellow dextrin, gum arabic, guar gum, binary mixture of gums etc. to jute pulp and also to examine their applicability as beater sizing on the pulp.

## MATERIALS AND METHODS

### Materials

*Jute fibre:* Grey jute fibre (TD-5) was used for making of handmade paper.

*Natural resins and gums:* Different natural resins and gums, in paste form,

were applied to jute pulp as under:

*Starch:* Starch consists of about 25% amylose and 75% amylopectin. The starches of commerce are corn, tapioca, maize, potato, wheat, sorghum, rice, sago etc. To prepare a paste, an aqueous suspension of starch was cooked at 60° to 70°C just enough time to get gelatinization.

*Dextrin:* Dextrin is the dehydration product of starch. Dextrin is of two types viz. white dextrin and yellow dextrin (canary). Yellow dextrin was converted to viscous dextrin solution with additives followed by heating at 85°C.

*Cationic starch:* It is a starch derivative which has affinity towards negatively charged substrate such as cellulose. Chemically, it is tertiary amino alkyl starch. Same method was followed as stated in case of starch to prepare paste of the material. The presence of tertiary amino group on starch lowers the gelatinization temperature. The cooked paste remains fluid and clear at ambient temperature even at low pH values.

*Gum arabic:* It is obtained from the trees belonging to the various species of the genus acacia. It exists in nature as a neutral / acidic salt of a complex polysaccharide containing calcium, magnesium and potassium cations. It is water soluble.

*Guar gum:* It is derived from the seed of guar plant, cyamopsis tetragonolobus family leguminosa. Guar gum solution

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was prepared from its powder in water by heating at elevated temperature for 15 minutes to attain the desired viscosity.

*Rosin soap:* It was prepared by cooking rosin (abietic acid) with sodium hydroxide in hot water. The amount of alkali used depends upon the acid number of rosin and the degree of saponification desired. It is used as additive together with alum during pulping.

*Alum:* Alum refers to paper maker's alum which is aluminium sulfate  $[Al_2(SO_4)_3, 14-18 H_2O]$  used to precipitate rosin size during paper making.

### Methods

Pulping of jute residue was conducted by hot soda process. A portion of the unbleached pulp was bleached by using hydrogen peroxide by conventional bleaching process. Both unbleached and bleached pulps were used with or without addition of starch, cationic starch, yellow dextrin, gum arabic, guar gum for comparison. Rosin soap and alum were used during the beating process as usual. All these natural resins and gums were added to the pulp slurry in the beater as beater sizing. Standard handmade paper sheets were formed. Strength as well as optical properties of paper were evaluated as per standard methods.

### RESULTS AND DISCUSSIONS

The experimental results tabulated in following tables indicated that the increase in tensile index, burst index and folding strength of jute paper was noticed by beater addition of small amount of different natural resins and gums viz. maize starch, cationic starch, yellow dextrin, guar gum etc. to jute pulp. Tensile and burst index of jute paper also increased by increasing the percentage addition of guar gum to the jute pulp slurry in the beater whereas folding strength of jute paper was found to be very high i.e. more than 1000. Addition of binary mixture of gum arabic and starch (1:1 w/w) to jute pulp indicated best improvement of strength properties of jute paper. There was no significant change of the optical properties of bleached jute paper by natural resin and gum addition in individual cases.

**Table 1: Effect of addition of maize starch to jute pulp.**

| Sample                    | Strength properties of paper |                                    |                  | Optical properties of paper |                          |                                |                              |
|---------------------------|------------------------------|------------------------------------|------------------|-----------------------------|--------------------------|--------------------------------|------------------------------|
|                           | Tensile Index (Nm/g)         | Burst Index (KPam <sup>2</sup> /g) | Folding Strength | K/S value                   | Whiteness Index (HUNTER) | Yellowness Index (ASTM D 1925) | Brightness Index (TAPPI 452) |
| Unbleached paper          | 18.00                        | 2.45                               | 56               | 0.34                        | 60.94                    | 36.18                          | 31.46                        |
| Unbleached paper + starch | 19.50                        | 2.78                               | 32               | 0.33                        | 60.92                    | 35.93                          | 31.51                        |
| Bleached paper            | 21.30                        | 3.06                               | 20               | 0.31                        | 74.44                    | 19.89                          | 50.87                        |
| Bleached paper +starch    | 23.10                        | 3.31                               | 46               | 0.32                        | 76.02                    | 22.73                          | 52.50                        |

**Table 2 : Effect of addition of yellow dextrin and cationic starch to jute pulp.**

| Sample                           | Strength properties of paper |                                    |                  | Optical properties of paper |                           |                                |                              |
|----------------------------------|------------------------------|------------------------------------|------------------|-----------------------------|---------------------------|--------------------------------|------------------------------|
|                                  | Tensile Index (Nm/g)         | Burst Index (KPam <sup>2</sup> /g) | Folding Strength | K/S value                   | White ness Index (HUNTER) | Yellowness Index (ASTM D 1925) | Brightness Index (TAPPI 452) |
| Bleached paper                   | 21.30                        | 2.74                               | 88               | 0.32                        | 75.65                     | 7.45                           | 57.11                        |
| Bleached paper + cationic starch | 24.00                        | 3.23                               | 167              | 0.31                        | 71.69                     | 21.74                          | 59.45                        |
| Bleached paper + yellow dextrin  | 22.20                        | 2.89                               | 138              | 0.33                        | 71.82                     | 13.95                          | 62.29                        |

**Table 3: Effect of addition of guar gum to jute pulp**

| Sample                          | Strength properties of paper |                                    |                  | Optical properties of paper |                           |                                |                              |
|---------------------------------|------------------------------|------------------------------------|------------------|-----------------------------|---------------------------|--------------------------------|------------------------------|
|                                 | Tensile Index (Nm/g)         | Burst Index (KPam <sup>2</sup> /g) | Folding Strength | K/S value                   | White ness Index (HUNTER) | Yellowness Index (ASTM D 1925) | Brightness Index (TAPPI 452) |
| Bleached paper                  | 22.70                        | 5.76                               | > 1000           | 0.19                        | 82.40                     | 20.62                          | 62.10                        |
| Bleached paper + 0.5% guar gum  | 25.80                        | 7.16                               | >1000            | 0.16                        | 84.09                     | 18.89                          | 65.27                        |
| Bleached paper + 0.75% guar gum | 27.60                        | 7.40                               | >1000            | 0.17                        | 83.56                     | 19.67                          | 64.21                        |
| Bleached paper +1.0% guar gum   | 28.50                        | 7.54                               | >1000            | 0.18                        | 83.50                     | 20.91                          | 63.70                        |

**Table 4: Effect of addition of gum arabic to jute pulp**

| Sample  | Strength properties of paper |                                    |                  | Optical properties of paper |                           |                                |                              |
|---|------------------------------|------------------------------------|------------------|-----------------------------|---------------------------|--------------------------------|------------------------------|
|   | Tensile Index (Nm/g)         | Burst Index (KPam <sup>2</sup> /g) | Folding Strength | K/S value                   | White ness Index (HUNTER) | Yellowness Index (ASTM D 1925) | Brightness Index (TAPPI 452) |
| Bleached paper  | 20.74                        | 1.33                               | 7                | 0.35                        | 76.84                     | 28.37                          | 52.07                        |
| Bleached paper + gum arabic                                 | 26.05                        | 1.39                               | 18               | 0.38                        | 76.07                     | 28.69                          | 50.96                        |
| Bleached paper +binary mixture of gum arabic & maize starch | 38.22                        | 3.66                               | 112              | 0.25                        | 81.45                     | 18.34                          | 61.48                        |

## CONCLUSION

The handmade paper industry is gaining wide acceptance in our country. Originally, cotton rag, hosiery cuttings etc were the prime raw materials of handmade paper industry in India. Due to non availability and high price of cotton rag, attempts may be made to utilize jute and allied fibres to manufacture different grades of handmade paper and paper broad either alone or in admixture with some rag pulp. Incorporation of various natural resins and gums in small amount increases the strength and other physical properties of paper from jute. These materials have been adopted by the pulp and paper industry to a great extent. The increase in tensile strength, bursting strength and folding

endurance of paper by addition of resins and gums will give better properties of corrugated media and liner board for use in making corrugated packaging boxes.

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