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STUDIES ON THE PHYSICO-MECHANICAL PROPERTIES OF SODIUM HYPO CHLORATE TREATED JUTE FIBER

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ABSTRACT

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The experiment was conducted in the Laboratory of Fibre Chemistry, Physics and Testing Department of Bangladesh Jute Research Institute (BJRI), Head Quarter, Dhaka during 2006 and 2007. For the improvement of physico-mechanical properties of jute fibre, some chemical treatments were taken using sodium hypo chlorate. The physico-mechanical properties of chemically modified jute fibre such as bundle strength, fineness/ diameter, brightness, whiteness, tex etc. were studied. By increasing brightness, whiteness and decreasing bundle strength, diameter/ fineness, tex of modified jute sample became more soft than original sample. Yarn quality of modified jute fibre was more similar with cotton sample than that of control jute sample.

Key words: Jute fibre, physico-mechanical properties, bundle strength, breaking twist, whiteness, brightness

INTRODUCTION

Jute is a textile fibre next to cotton. Fore diversified textile uses, it has the ability to be blended with other natural/ synthetic fibres. As the demand of natural comfort about jute fibre like cotton fibre will be fulfilled by chemical modification of jute fibre. By treating jute fibre with caustic soda (Woollenization) fibre became crimp, soft, pliable and appearance is improved as wool like appearance which is suitable to be spun with wool (Rahman and Kamaluddin, 1995), liquid ammonia has a similar effect on jute (Sukur et al., 1979) as well as the characteristics of improving flame resistance when treated with flame proofing agents (Hossain et al., 1980).

Jute is very coarse in nature. For this defect jute fibre alone can not be used in the preparation of good quality blankets and carpets (Booth, 1976). Due to this it has been tried to bleach/ chemically modify the jute fiber to get good dyeing property. Considering overall properties of bleached jute fiber it was found that hypo chlorite peroxide combination set is better than that of hypo chlorite combination set (Salam et al., 1977). In untreated jute fibre dye can be used only on the thick jute fabric but not in the fine jute fabrics. So the modification of jute fibre to get the nearest cotton properties with very cheap and easy way is our main interest.

Jute fabric/ yarn was modified by chemical treatments using ethylene glycol (EG), diethylene glycol (DEG), Polyethylene glycol (PEG) of two varieties and poly alcohol in the presence off $Al_2(SO_4)_3$ as the catalyst employing a pad-dry-cure technique. Modification of jute by optimum dose of PVA prior degradation with $NaIO_4$ produces the most improved and balanced effects including notable improvements in tenacity and elongation at break and hence in resilience, feel, and texture and substantial are lowering in hairiness, bending length and fiber shedding character. Difference in the surface modification of the jute fibers could be brought effects by use of different glycolic/ polyol modifying agents which was revealed by scanning electron micrographs. After treating with sodium hydroxide the thermal characteristics such as crystallinity index, reactivity and surface morphology of untreated and chemically fibers have been studied using differential scanning calorimetry (DSC), X-ray diffraction (WAXRD), Fourier transformed infrared spectroscopy (FTIR), and scanning electronic microscopy (SEM), respectively by Leonard and Ansell (2002).

Changes in textile related properties of jute fiber consequent to its treatment with plain water, steam, dilute aqueous NaOH solution and different oxidizing agents such as H_2O_2, $K_2S_2O_8$ and $NaIO_4$ was studied under specified conditions and found promising textile related properties in respect of energy efficiency and fiber droppage during carding, trouble-free spinning (zero to low end breakage rate), yarn structure (packing fraction and structural irregularities) and yarn properties like tenacity, initial modulus, flexural rigidity, quality ration and work of rupture (Ghosh et al., 2004).The present work was undertaken to study the physico-mechanical change of chemically modified jute fibre for diversified textile uses like cotton.

MATERIALS AND METHODS

The jute fibre of BW-1 was collected from the experimental plot of BJRI and the experiment was conducted in the Laboratory of Fibre Chemistry, Physics and Testing Department of Bangladesh Jute Research Institute, Head Quarter, Dhaka during 2006 and 2007. The middle portion of the collected BW-1 was cut off with a length of 5 cm and roughly cleaned manually. Neither combing nor the scouring was done. The cleaned jute was chemically modified by mechanical agitation in Sodium hypo chlorate (Na $(OCl)_3$) for 15 minutes at different concentration.

After that the mixed chemical with jute was heated for 15 minutes at 40^0C, 50^0C and 60^0C for each concentration of the chemical. During the chemical modification it is very important that, if the time of temperature is increased the chemically modified jute becomes bristle. The jute is naturally quite brown color, which is not desired for color sensitive materials. Jute can be used for dark color representative. That's why $(Na(OCl)_3)$ is used for its bleaching quality. The next step was soaking. The chemically modified jute was then soaked for 24 hours in two ways. One is by using acetic acid (CH_3COOH) and other is by Glycerin. After that the soaked jute was washed by distilled water. To observe the washing treatment in case of soaking by acetic acid (CH_3COOH) the litmus paper was used. If the litmus paper became red the washing treatment was not proper because the soaking was done by acetic acid. In case of glycerin the chemically modified jute became oily, which could be removed by washing 5/6 times. At last the chemically modified jute is dried at room temperature. To solve the slight change of the room temperature the whole process was done in a closed airtight room.

Bundle Strength

The bundle character is helpful for measuring the strength of the fibre (Meredith, 1945). Bundle Strength is expressed in Pressley Index (PI lb/mg or PI kg/mg) which was determined by Pressley Fibre Bundle Strength Tester using zero gauge length. The flat bundle of fibre approximately 6.35 mm ($1/4$ inch) in width was held by a pair of clamps. All protruding ends were shared off with a sharp razor. Tension was applied to separate the clamps and there by rapture the fibre. After breaking, the bundle was taken off from the clamps and weighted by a precision balance Pressley Index was calculated from the ratio of breaking load (lbs) and bundle weight (mg) of the test specimen.

$$\text{Pressley Index}(PI) = \frac{\text{Breaking Load}(lb/kg)}{\text{Bundle Weight}(mg)}$$

Linear density/ Count

The linear density is the weight of 1 km length of materials in gram which is called tex (Lyons, 1963). The linear density was determined by cut middle method (Ali, 1993) following the below formula.

$$Tex = \frac{590.5}{\text{Cotton Count}}$$

Breaking Twist angle

If the fibre is twisted far enough, it will eventually rupture. The number of turns to rupture is inversely proportional to the fibre diameter. The twist angle through which the outer layer is shared and is given by

$$\tan\alpha = L / r_b \pi d$$

Where,

α= Breaking twist angle$^{(0)}$
L= Test length of fibre in cm
r_b= No. of twists to rupture the fibre
d= Diameter of fibre

Fineness

Wira fibre fineness meter (Anderson, 1954) was used to determine the fineness (diameter) of fibre in micron. In this apparatus air was sucked through a cylindrical bundle of fibre 7.62 cm long and 8.38 cm diameter. The resistance to air flow was indicated in a flow meter which was calibrated in terms of fibre diameter in micron. On switching the machine the position of the float was read which indicated the diameter of the fibre in micron.

Whiteness and Brightness

Brightness and whiteness of the fibre was determined by Photo Volt Meter using green and blue filters. The brightness and whiteness of the top specimen under test and were then read of as a percentage of white contents and glitters of the standard.

RESULTS AND DISCUSSION

The different physical properties of the chemically modified jute were tested in the laboratory of Physics, Chemistry and Testing department of BJRI. The tested properties were brightness (%), whiteness (%), fineness (micron) or diameter by microscopic method, bundle strength (lb/mg), breaking twist per inch and count in tex furnished in Table 1and Table 2.

Table-1: The Bundle Strength of the chemically modified jute

Jute Sample no.	Temperature	Concentration of $Na(OCl)_3$ (ppm)	Bundle Strength (lb/mg)				Mean	SD	CV%
			Top portion of fibre	Middle portion of fibre	Bottom portion of fibre	Whole fibre			
4A	40^0C	0.25	10.34	9.52	9.11	9.25	9.555	0.55	5.76
4B		0.50	08.13	7.26	8.67	8.47	8.112	0.54	6.67
4C		0.75	10.53	9.23	8.81	9.16	9.352	0.64	6.83
4D		1.00	09.44	9.86	9.25	9.42	9.156	0.22	2.43
5A	$50\ ^0C$	0.25	07.65	7.78	6.62	7.84	7.473	0.57	7.68
5B		0.50	08.27	9.33	9.20	8.83	9.076	0.56	6.12
5C		0.75	09.03	9.16	8.60	10.63	9.355	0.60	9.44
5D		1.00	08.66	8.81	8.60	9.18	8.926	0.39	4.33
6A	$60\ ^0C$	0.25	07.63	7.74	9.53	7.65	8.138	0.93	11.42
6B		0.50	08.88	9.02	7.88	8.05	8.170	0.81	9.96
6C		0.75	09.17	8.82	8.99	8.64	8.905	0.23	2.55
6D		1.00	06.91	6.59	7.11	7.45	7.015	0.36	5.14
Control		-	11.47	12.05	8.96	8.84	10.33	1.67	16.16

Table-2: Other Physico- mechanical properties of the chemically modified jute fiber

Jute Sample no.	Temperature	Concentration of $Na(OCl)_3$ (ppm)	Count (tex)	Mean Whiteness (%)	Mean Brightness (%)	Fineness/ Diameter (μ)	Breaking twist
4A	40^0C	0.25	1.78	32.43	53.56	25.25	40
4B		0.50	1.86	36.46	50.32	21.03	38
4C		0.75	2.12	43.42	61.11	29.99	35
4D		1.00	1.82	38.56	49.31	21.13	31
5A	$50\ ^0C$	0.25	1.65	37.97	53.56	26.29	36
5B		0.50	1.78	43.83	57.2	29.54	33
5C		0.75	1.72	46.78	61.11	16.90	30
5D		1.00	1.80	41.95	56.58	30.19	29
6A	$60\ ^0C$	0.25	2.32	40.49	57.7	18.10	26
6B		0.50	2.02	44.76	60.25	12.95	21
6C		0.75	1.80	47.14	62.24	16.37	19
6D		1.00	1.96	44.01	61.86	19.61	12
Control -		-	3.12	32.54	49.92	30.69	42

Table3. Yarn properties of chemically modified jute fibre compare to standard values of cotton

Sample	Commercial or conventional regain (%)	Absorption regain (%) at 65% r.h. and $20\ ^0C$	Desorption regain- absorption regain (%) at 65% r.h. and $20\ ^0C$
Control	17.10	14.50	1.85
Jute	13.75	12.00	1.50
Cotton	8.50	7.80	0.90

Chemical modification was done in control temperature and that was up to 60 ^{0}C. In Table 1 it was found that the bundle strength of different chemically modified samples with different concentrations of $Na(OCl)_3$ at 40 ^{0}C, 50 ^{0}C and 60 ^{0}C were more or less similar but less value than control sample. Bottom and whole portion were near about the control sample, but top and middle portions contained high value. There fore chemically modified jute samples became soft due to lower value of bundle strength.

After chemical treatment, tex and fineness of chemically modified jute fibre showed lower value than control sample **(**Table 2**)**, but whiteness and brightness parameters were increased than original sample. It is a great achievement of any treated sample with lower diameter/ fineness, higher brightness, whiteness value than original one that would be

welcome in the field of textile (Werfast, 1966). Lower value of fineness indicates more fine fibre and the finer the fibre, the finer the count that can be strengthened and reasonable end- breakage can be maintained (Morton and Hearle, 1975).

Relative Humidity and ambient temperature is an important factor for testing of the different physico-mechanical properties of jute fiber in the laboratories. So it is very essential to control the room temperature and the relative humidity for measuring the different parameters of jute. Jute absorbs lot of humidity from the air and changes its properties. Due to slight change of the humidity and temperature jute shows quite different quality. That is why it is very important for jute research to keep the relative humidity and standard atmospheric temperature. The conventional regain of moisture, Absorption regain and the difference between desorption regain and absorption regain of the comically modified jute yarn, all were decreased to 13.75%, 12.00% and 1.50% respectively due to chemical treatment on the jute fibre as the controlled fibre had 17.10%, 14.50% and 1.85% respectively where the standard values of cotton 8.50%, 7.80% and 0.90% were plotted in the Table 3.

CONCLUSION

Most of the spinning mills in Bangladesh are cotton based. For diversified textile uses of jute, cotton based spinning technique may be used for making fine yarn using chemically modified jute fibre. After chemical modification by $Na(OCl)_3$, jute fibre showed the physico-mechanical properties very near about the cotton fibre. Therefore modified jute fibre will be suitable to use in cotton spinning system which is opening up a great scope for the commercial use of our golden fibre.

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