The International Journal Of Engineering And Science (IJES)
|| Volume || 5 || Issue || 4 || Pages || PP -24- 27|| 2016 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Different Approaches to Modify the Properties of Jute Fiber: A Review

[1]Eshita Datta, [2]Salvia Rahman, [3]Mohammad Mobarak Hossain
[1]*Department of Textile Engineering, Bangladesh University of Business and Technology (BUBT)*
[2]*Department of Textile Engineering, Bangladesh University of Business and Technology (BUBT)*
[3]*Department of Textile Engineering, Bangladesh University of Business and Technology (BUBT)*

----------ABSTRACT----------
This paper reviews several studies on physico- mechanical properties of jute fibre. Here a number of effective approaches are studied that has been using in order to enhance the physico- mechanical properties of jute fibre which are essential for it's spinning as well as weaving techniques. However, it has been seen that sulphonation of jute fibre is more beneficial than other existing procedures to modify the properties of jute fibre.

Keywords : *Jute fibre, physical properties, sulphonation, enzyme, aminosilicone.*

Date of Submission: 06 April 2016 Date of Accepted: 20 April 2016

I. INTRODUCTION

Jute is a long, shiny, 100% bio-degradable bast fibres, that can be spun into coarse, strong threads and mainly used as low cost packaging materials.

Jute is the second most common natural fibre cultivated in the world [1].

Jute is one of the most affordable natural fibers and second only to cotton in amount produced and variety of uses of vegetable fibers. Jute is the most important cash crop in South Asian countries, which is characterizes by it's lusture, high tensile strength, low extensibility, considerable resistance to fire and heat [2] and so on.

India, Bangladesh, China, Nepal and Thailand are the major producers of jute accounting for over 95% of the world productivity [3].

Jute fiber is not only using for packaging materials but also used for home furnishings cloths, geo-textiles as well as composite materials.

Jute fibre blends with cotton and other natural and synthetic fibres have been highlighted as one of the main outlets for jute towards an entirely new sector of the textile furnishing and apparel industries [4].

Jute consists of cellulose cemented by uncellulose materials, such as lignin, pectin, hemicelluloses etc [5].

The chemical composition of jute fibre is given below:

Cellulose	58-63%
Hemicellulose	21-24%
Lignin	12-14%
Wax	0.4-0.8%
Pectin	0.2-0.5%
Protin	0.8-2.5%
Mineral matter	0.6-1.2%

Cotton and jute hold the prior places in the total production of cellulosic fibres throughout the world. In spite of, the verities applications of jute fibre is greatly interrupted due to the inherent shortcomings of jute fibre.

Jute fibre has some inherent drawbacks such as, stiffness, harshness, meshy structure with variable fibre length and branching as well due to the presence of lignin [1]. For these reasons, it becomes very difficult to produce finer yarns and delicate woven and knit fabric productions by this golden fibre.

As jute is a hard and coarse [6] fibre, a number of researches have been carried out in order to improve the mechanical properties of jute fibre by partial removal of non-cellulosic matters.

In recent years, several attempts have been made to develop the physical properties of jute fibre that like flexibility, crimp ability, softness which is considered as the main demand to improve its' spin ability or to produce fine yarn [7, 8].

The aim of this paper is to study the several procedures, which has been using to enhance the properties of jute fibre those are considered as obstacle for finer as well as soft jute yarn production.

II. METHODS

2.1 Modification of jute fibre by sulphonation method

Jute fibre can be modified by the sulphonation method to enhance it's physico-mechanical properties. Mohammad Ali *et al.* [9] studied the modification of jute fibre by sulphonation method.

In this study jute fibres were treated with sulphite liquor, which was prepared by dissolving the measured amount of sodium sulphite or bisulphate with or without sodium carbonate or hydroxide at 165ºC for a definite period of time.

They reported the effect of sulphite processes on the properties of jute fibre which is given below-

TABLE I: Effect of sulphite processes on the general properties of jute fibre [9]

process	Feeling by hand	Appearance	Apparent strength	Filament texture
Neutral sulphite $Na_2SO_3 + Na_2CO_3$	Smooth and light	Brightly whitish gray	Good	Flexible, thin and well separated
Neutral Sulphite EDTA/AQ	Smooth	More bright, lustrous and whitish	Good	Flexible, thin and well separated
Untreated	Rough and coarse	Dull brownish gray	Good	Hard, thick and not well separated.

Nurul Islam *et al.* [10] also noted that, the physico-mechanical properties of jute fibre, modified by the sulphonation method. They measure the moisture regain, cell wall thickness, lusture and bundle strength of modified fibre. It was obtained that, the lusture of sulphonated jute fibre increases with sulphonation, which is more stable than the bleached jute fibre.

TABLE II: Properties of sulphonated jute fiber

Sample of the fiber	Density ($g\ cm^{-1}$)	Linear density ($mg\ m^{-1}$)	Moisture% at 65% RH	Fiber diameter(μm)	Fiber length(cm)	Swelling (%)	Cell wall thickness(μm)	Flexural rigidity of yarn (dyne/cm)
Untreated	1.46	2.566	10	41	7.0	22	5.0	668
Treated at 110˚c, 1 h	1.46	2.48	10.1	40	7.1	22	5.6	500
Treated at 165˚c, 3 h	1.48	1.85	11.2	37	6.7	35	8.5	297

M. A. Salam *et al.* [11] discussed the effectiveness of sulphonation on jute- cotton blended yarn characteristics, which was a good attempt of making shirting and suiting fabrics from jute yarn.

TABLE III: Mechanical properties of fabrics prepared from sulphonated jute-cotton blended yarn [11]

Sample	Bending length (cm)	Flexural rigidity (mN mm)	Breaking strength (kgf)	Drape coefficient (%)
Sulphonated jute/cotton (60/40) blended 30 tex yarn	1.82	8.25	20.00	38.00
Cotton (100%) 30 tex yarn	1.65	4.50	23.10	35.00

2.2 Treatment of jute fibre with enzyme and aminosilicone

A.B Kundu *et al.* [12] discussed the changes occurred in physical structure and chemical composition of jute fibre at various stages of enzyme treatment. They reported that, treatment with enzyme increases the transverse swelling about 14% and reduces bulk torsional rigidity and makes the fibre more flexible and softer.

A.K. Samanta *et al.* [13] reported that, application of 4% mixed enzyme (Cellose, xylanase, Pectinase) on jute fibre at 55ºC for 2 hour at Ph 4.8 gives much finer, softer and brighter jute fibre, but there are some lowering of bundle tenacity. In this report, it was found that, weight loss and moisture regain are increased whereas, bundle tenacity, flexural rigidity and coefficient of friction are decreased with the increase of enzyme quantity.

They also suggested that, the treatment of jute fibre with 3% H_2O_2 and 0.75% $k_2S_2O_8$ for 2 hours at 30 ºC temperature (pH 11), prior to 1% aminosilicone treatment is more convenient for textile uses.

TABLE IV: Effect of selective pretreatment on subsequent aminosilicon application on physical properties of jute fibre [13].

Physical Properties						
Treatment	Weight gain(+)/loss(-) (%)	Moisture regain (%)	Linear density (tex)	Bundle tenacity (cN/tex)	Flexural rigidity (cN-mm^2)	Coefficient of friction (fibre to fibre parallel)
Control TD-3 grade raw jute reed- untreated	-	12.90	3.58	29.77	61.19	0.32
1% aminosilicone	0.34	12.77	2.95	29.05	52.90	0.20
4% enzyme	-3.41	15.13	2.24	26.50	41.88	0.28
Sequential treatment with 4% enzyme followed by 1% aminosilicone	-2.80(+0.37)	13.87	2.35	27.20	47.	0.14
Sequential treatment with 3%H_2O_2 and 0.75% $k_2S_2O_8$ fot 2 hours at 30 ºC (pH11) followed by1% aminosilicone	-4.10(+0.35)	13.82	2.11	29.20	51.60	0.25

Likewise, Gautam Basu *et al.* [14], also noted that, the yarns spun from low-temperature oxidative bleached (with a combination of H_2O_2 and $k_2S_2O_8$) jute of conventional H_2O_2 bleached jute after further treatment with 1% aminiosilicon offers much softer and supple yarn with much improved surface appearance properties and with a little lower tenacity than that obtained for only 1% amino treatment without pretreatment.

C. Vigneswaran *et al.* [1] studied the effect of using cellulase enzyme and mixture of enzymes(cellulase, xylanase and pectinase) on the physical characteristics of jute fibres. They reported that, the tenacity of jute fibre decreased with the increase of enzyme concentration but there were some improvements in physical characteristics such as, elongation, whiteness index and flexural rigidity as well.

TABLE V: Physical characteristics of raw jute and enzyme-treated jute fibers [1]

Sample	Tenacity(cN/tex)	Elongation to break (%)	Flexural rigidity (mg/mm$^{2)}$
Raw jute	38.67 ± 5.57	1.860 ± 0.12	60.69 ± 1.91
4% cellulase	31.00 ± 4.33	1.958 ± 0.10	39.65 ± 1.87
4% mixed enzyme	29.46 ± 7.06	1.962 ± 0.10	38.25 ± 1.49

2.3 Treating blended jute fibre using different methods of thermal treatment

Jute fibre and its blend with synthetic fibre can be used for making diversified woven and knit wears by bulking which was reported by A. K. Sinha *et al.* [15].

In his study, jute-acrylic blended yarn samples were produced. They were treated separately in dry hot air, steam, and billing water. Then the physical properties were evaluated. It was found that, treatment with boiling water in 30 min is easy and more convenient as well as economical and flexural rigidity of yarns decreases after bulking.

TABLE VI: Effect of treatment time (boiling water method) on properties of jute fiber [15]

Time (min)	Specific volume cm^3/g	Diameter CV%	Tenacity (cN/tex)	Extension%
0	2.39	18.6	-	-
15	10.85	28.7	7.1	36.5
30	14.72	23.6	7.4	39.7
60	15.38	23.4	7.4	38.5

2.4 Liquid ammonia treatment

Jute fibre can be prepared by liquid ammonia mercerization to improve its mechanical properties. A.C. Mukherjee *et al.* [16] studied the various properties of jute fibre by treating with liquid ammonia. It was found that, by treating with liquid ammonia the lumen size become smaller due to the expansion of secondary cell- wall of the jute fibre. Liquid ammonia treatment showed better result than caustic soda. Because caustic soda causes strength loss of fiber, but liquid ammonia treatment increases the extensibility and swelling% of fiber.

III. CONCLUSION

Now-a-days people get concerned regarding non-biodegradable and synthetic manmade fibres. Re-establishment of natural fibre is necessary for the environment. As jute is the golden fibre as well as second common natural fibre of the world after cotton and it is the cash crop of Bangladesh, so to achieve more profits from jute fibre and jute blended products, appropriate commercially feasible techniques must be developed to overcome the problems associated with the processing of jute and jute blended products. Among the procedures discussed above, it is observed that, sulphonation of jute fibres assure satisfactory physical properties that would be helpful for textile processing.

REFERENCES

[1] C. Vigneswaran and J. Jayapriya, Effect on physical characteristics of jute fibres with cellulose and specific mixed enzyme systems, *The Journal of The Textile Institute, Vol. 101,No. 6,* june 2010,506-513.

[2] Dr. S.K. Chakrabarti, Eco-Friendly Processing of Jute & Allied Fibers, Indian Jute Industries' *Research association (IJIRA).*

[3] Kozlowski R, Manys S, The Textile Institute, Textile Industry: *Winning Strategies for the New Millennium, World Conference,* (1999): 10–13.

[4] Mukherjee, A.C., A.K. Mukhopadhyah, A.S. Dutta and U. Mukhopadhyay, Liquid ammonia mercerization of jute part-II,Study of the effect of liquid ammonia on jute yarn and fabric. *Textile Res. J., 51:* 574-578, 1981.

[5] Zakaria Ahmed, Md. Shamsul Haque, Firoz Akhter and Mahmuda Begum, Study of the Chemical Composition of Different Pipeline Verities of Jute Fibres, *Pakistan Journal of Biological Sciences 6(16):* 1463-1467,2003.

[6] Mohammed Ali, M Nurul Islam, A Jabber Mian and A M Sarwaruddin Chowdhury, Adapting The Principle of Neutral Sulphite Cooking for Modification of Textile Quality of Jute Fiber, *Indian Journal of fiber and Textile Research, vol.25,* pp 298-302,December 2000.

[7] Banerjee, S.K., A. Day, S.C. Bag, P. Sengupta and D.N.L. Sarkar, Textile chemical finishing of jute yarn and fabric,*Colourage,* 32: 23-28, 1985..

[8] Daul, G., Studies on the partial carboxymethylation of cotton, *Textile Res. J., 22:* 787-792, 1952.

[9] Ali, M., M.N. Islam, A. Jabber-Miah and A.M. Sarwaruddin-Chowdhury, Studies on the modification of Jute fibre by sulfonation for diverse textile use, Part-1: *Fibre science and textile technology. J. Textile Inst., 92:* 34-43,2001

[10] M.N. Islam, Ali, M. Kamal Uddin, K. Ahmed and A.M. Sarwaruddin-Chowdhury, Studies on the Physico-mechanical properties of the modified Jute Fibre by Sulphonation Method, *Pakistan Journal of Biological Sciences 9 (8):* 1424-1429, 2006.

[11] M.A. Salam, F.I Farouqui and Md. I. H. Mondal, A Study on Sulphonated Jute- Cotton Blended Yarn and Fabrics and their Characteristics, *Bangladesh J. Sci. Ind. Res. 42(3),* 281-286, 2007.

[12] A.B.Kundu, B.S.Ghosh and S.K.Chakrabarti, Enhanced Bleaching and Softening of Jute Pretreated with Polysaccharide Degrading Enzymes, *Vol. 63(8),* pp.451-454, 1993.

[13] A.K.Samanta, G.Basu and P.Ghosh, Enzyme and Silicone Treatments on Jute Fiber. Part I: Effect on Textile- Related Properties, *Vol.99,* pp. 295-306, 2008.

[14] Gautam Basu, Ashis Kumar Samanta and Preamoy Ghosh, Enzyme and Silicone Treatments on Jute Fiber. Part II: Effect on Process Performance during Yarn Making and Yarn Properties, *Vol.99,* pp. 307-316, 2008.

[15] A K Sinha and G Basu, Studies on Physical Properties of Jute-Acrylic Blended Bulked Yarns, Indian Journal of fiber & Textile Research, Vol.26, pp. 268-272, September 2001.

[16] A.C Mukherjee, A.K.Mukhopadhyay, B.K. Sarkar,A.S.Dutt and U. Mukhopadhyay, Liquid ammonia Mercerization of Jute Fiber, Part I. Changes in Mechanical Properties and Fiber Structure, *Textile Research Journal,* pp 40-44, January 1981.