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Studies on Physico-Chemical Properties of BJRI Tossa Pat -8 (ROBI-1) Jute Variety

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ABSTRACT

Human being is very much dependant on plant fibres for various purposes. Natural fibres provide many solutions against general needs of mankind. All fibres cannot be defined as textile fibres. Textile fibres have softness, flexiblity, drapability, durability properties. Jute is a golden fibre of Bangladesh and it is used for various purposes. For the assessment of fibre quality of three types of jute fibre e.g. newly released BJRI Tossa Pat-8 (Robi-1), bleached fibre and variety O-9897 were considered for the analysis of physical properties (Reed jute fibre length, Brightness index, Whiteness index, Bundle strength and Fineness index) and chemical analysis (Cellulose, Hemicellulose, Lignin, Ash content, Fat/Oil content, Oil content in jute seed, Pectin content and saponification value) under the present study. Some field level morphological information was taken as quality contributing characteristics. The study was conducted at the Fibre Chemistry Department, Chemistry Division and Textile Physics Division of Bangladesh Jute Research Institute, Dhaka, Bangladesh during 2019-2020. The assessment of physico-chemical properties of the variety BJRI Tossa Pat-8 (Robi-1) was blue seeded with lower percentage of oil content than naturally brown seeded but saponification value was higher, Brightness (22.04%), fineness (36.26%) and bundle strength (06.20 lb/mg) index were very much comparable to bleached jute samples using 6% hydrogen peroxide. Cellulose content was 65.68% as well as lignin and hemicelluloses content were 13.95% and 17.94% respectively which were more prominent than O-9897 varieties of jute fibres.

KEYWORDS: *Variety, Cellulose, Lignin, Ash, Brightness, Whiteness and Bundle Strength*

INTRODUCTION

Jute contributes as an important cash crop in Bangladesh. Out of country's total supply of raw jute in 1987-1988, 64.8 percent was used for mill consumption, 7.6 percent for house hold use and 27.8 percent for closing carryover (FAO, 1988) [1] whereas in 1999-2000, 75.74 percent was used for mill consumption, 9.43 percent for house hold use and 14.82 percent for closing carryover (FAO, 2001) [2]. The crop occupies a key position in the economy of Bangladesh by ensuring a considerable amount of foreign exchange, taxes, levies, sales and custom duties. Bangladesh occupied a major share of the world's total raw jute production until early seventies. But since 1972-1973 the country has been losing its monopoly in the world jute trade. The share of Bangladesh in the world jute production has fallen from 47.7 percent in 1972-1973 to 26.9 percent in 1986-1987 and 24.1 percent in 1999-2000 (FAO, 1988) [1] and (FAO, 2001) [2]. Now a day the area under jute cultivation is being reduced due to some constraints. Jute is reduced by 15 percent from the year 1986 to 1996 (BBS, 1999) [3]. In recent years, there is an increasing trend of production per unit area (BBS, 1997) [4]. Jute fibre is produced mainly from white jute (C. capsularis), and tossa jute (C. olitorius). In Bangladesh, jute sector accounts as a whole for 10% labour and 7% of GDP. Jute and jute- based products are put to a wide range of uses. Food and Agricultural Organization (FAO) has declared 2009 as the International Year for Natural Fibre which reflects the importance of this group of commodities to many countries. Considering all these facts, improvement of fibre yield and quality of jute is the prime need of Bangladesh. In this aspect, research regarding development of new high yielding variety of jute is very important.

In jute production system, water management includes application of irrigation and draining out the excess water is needed from the jute fields. Irrigation is the artificial application of water to the crop field for its proper growth [5]. Nitrogen is one of the key nutrients needed for crop production; however, it is the most mobile and volatile and the most exhausted nutrients due to its ability to exist in different forms and its easy leach ability [6-8]. In the absence of site-specific recommendations, N management poses a serious challenge in the highlands [9]. Nitrogen management

in agroecosystems has been extensively studied due to its importance in improving crop yield and quality [10-19]. One of the ways of addressing nitrogen limitation is use of inorganic fertilizers [20]. However, there exists inadequate use of fertilizers to replenish the mined nutrients [21]. Jute growers are habituated to follow the technology or practice which has been developed through experiences and tradition and they are reluctant to change their practices [22]. Farmers will pay due attention of the research findings about which they have some experiences and seem to be more economical.

Jute provides textile fibres as well as raw material for some value added non textile products. Jute is used for manufacturing of different types of traditional packaging fabrics, hessian, sacking, carpet backing, mats, bags, tarpaulins, ropes and twines. Recently jute fibres are used in a wide range of diversified products: decorative fabrics, cheek-saris, salwar kamizes, soft luggage's, footwear, greeting cards, molded door panels and other innumerable useful consumer products. Supported by several technological developments today jute can be used to replace expensive fibres and scare forest materials. The quality of jute fibre is very much important for the development of jute products (diversified jute products). Jute is a lignocellulosic bast fibre. It consists of cellulose cemented by non-cellulosic materials i.e., pectin, lignin, hemicellulose etc. The usual composition of chemical constituents in jute fibre is alpha cellulose (58-63%), hemicellulose (21-24%), lignin (12-14%), wax (0.4-0.8%), pectin (0.2-0.5%), ash (0.6-1.2) and traces of other coloring materials [23]. Hemicellulose and lignin make interlinkages among small ultimate cell of jute fibre. The fibre become soft and flexible through partial removing of lignin and hemicellulose [24]. The percentages of different chemicals in jute fibre are responsible and influence the quality of fibre significantly. Brightness and whiteness index of jute fibre is very important property for jute grading and end uses. Various costly chemical treatment is carried out for upgradation of jute fibre. Jute fibres are composed primarily of the plant materials i.e. cellulose and lignin. It is thus a lignocellulosic fibre that is partially a textile fibre. Jute fibres are lignocellulosic [25] and thus the secondary wall development of the sclerenchymatic fibre cells involves deposition of lignin over the cellulose matrix [26-27]. Microbial degradation is prohibited by presence of lignin in fibre cell wall [28]. In these dicotyledonous plants, the commercial fibres are sclerenchyma cells with copious secondary wall thickening [29-30]. The lignin content of the fibre cell wall varies from species to species. While it is around 15% in jute, it is less than 5% in flax and ramie [31-32]. Attentions always given to the development of improved variety of jute. Different bleaching treatments have been carried out for increasing whiteness and brightness of jute fibre [33-35]. If a new jute variety is invented where there is no need of any bleaching treatment of diversified uses, that type of variety should be very valuable. Present work indicates to find out an improved jute variety which will be mostly comparable with the bleached jute fibre.

MATERIALS AND METHODS

The study was conducted at the Chemistry Division and Textile Physics Division of Bangladesh Jute Research Institute, Dhaka, Bangladesh during 2019-2020. The matured jute fibre of the variety BJRI Tossa Pat-8 (Robi-1) was collected from the Agricultural Wing of Bangladesh Jute Research Institute (BJRI). For proper investigation of comparative study, jute fibre of variety O-9897 was also taken as control jute sample.

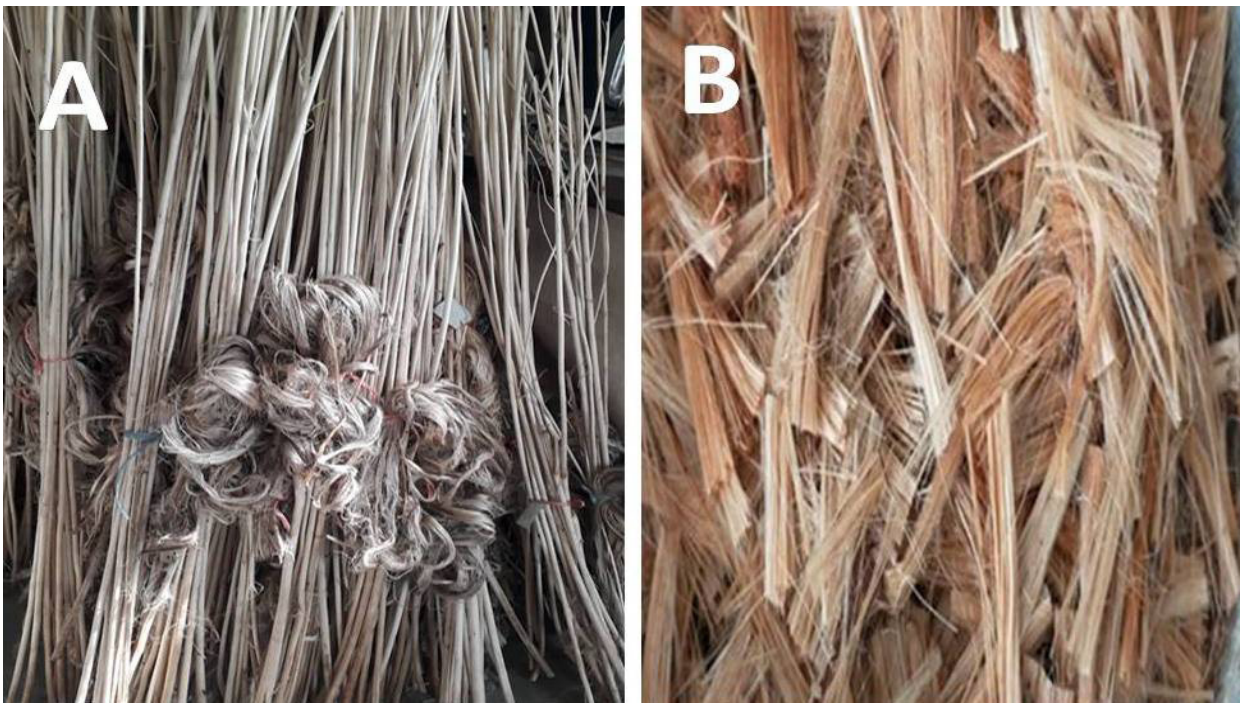

Figure 1. Fibre with stick of BJRI Tossa Pat-8 (Robi-1) variety (A); Pieces of fibre of BJRI Tossa Pat-8 (Robi-1) variety (B)

Physical Parameters

Reed fibre length, brightness/whiteness index, bundle strength, fineness etc. were determined according to standard methods followed by BJRI.

Brightness (%): Brightness of both samples was taken by Leukometer as reflectance value by using Magnesium Oxide block of 100% reflectance value.

Bundle strength test: To measure the strength of the bundle, a bundle of fibers from each sample was scraped so that the fibers were parallel and suitable for testing. The bundle strength of the sample was determined by the Presley fiber bundle strength tester using zero gauge length. The bundle strength was calculated from the following formula,

Pressley Index = Breaking load (lb) / Bundle Weight (mgs)

Fineness test: To measure the fineness of the fibers, the specimens were inserted tightly through a 6-inch-long sample container and the elongated fibers were cut at the edge of the sample container by a cutting machine. It is then weighed as 54.2g and again inserted into the sample holder of 3 inches length. After cutting the elongated fibers from both ends of the container, it was used to measure the fineness of the fiber and then weighed again and the actual fineness was calculated.

The final fiber cell length and diameter of both fiber samples were taken by microscopic method. After fiber conditioning at 65% r. H. (Relative humidity) and 25^{0}C, the cell length and diameter of the fiber strand of the filament were calculated from the measurements of 100 random samples, using a microscope with 500x magnification. The diameter of the submerged fiber was determined by a projection microscope using a fiber rotator [36].

Chemical Parameters

The fibers were defaced by Soxhlet Extractor using petroleum ether (b.p.-60-80^{0}C) before going for chemical analysis. The amount of oil / wax was also determined by the Soxhlet extractor method. The percentage of chemical constituents in each sample was estimated based on the dry weight.

Chemical parameters were taken on the basis of humidity correction It was extremely necessary to predict the exact result. The percentage of moisture content was determined by the standard method [37]. The pectin content was determined by boiling the sample with oxalic acid and ammonium oxalate solution. Fatty / oily substances were extracted from jute seeds and jute fibers in a soxhlet apparatus with petroleum ether [36]. The content of alpha cellulose and hemicellulose was determined by the TAPPI method. The lignin content was determined by the TAPPI sulfuric acid standard method [39]. The content of the ash was determined by ashes in a muffle furnace in a porcelain crucible according to a standard method [40].

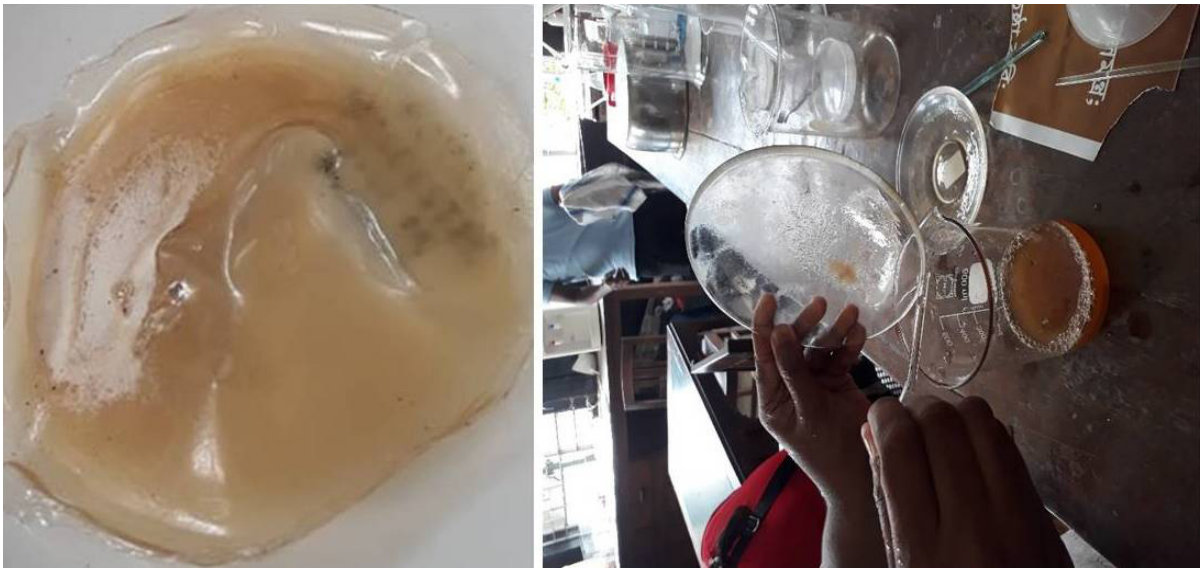

Figure 2. Hemicellulose from Jute variety BJRI Tossa Pat-8 (Robi-1).

Bleaching Treatment was done by the Following Way

(a) Scouring has been carried out by heating jute sample at 80-90^{0}C with 8-10 g/l sodium carbonate solution containing slight amount of wetting agent for half an hour.

(b)Bleaching was done with hydrogen peroxide by using

Hydrogen peroxide = 6% on the weight of jute sample.

Sodium silicate = 3% ”

Sodium carbonate = 3% ”

Wetting agent = 0.1% ”

P^H = 10-11.

Time = one hour,

Temperature = Up to boiling

After bleaching treatment jute sample was washed and air dried.

RESULTS AND DISCUSSIONS

Result of some physico-chemical properties of variety BJRI Tossa Pat-8 (Robi-1) in comparison with O-9897 jute samples were summarized in the table 1, table 2 and table 3.

Table 1. Physical parameter of BJRI Tossa Pat-8 (Robi-1) variety and O-9897 jute samples.

Physical parameters	Types of jute sample		
	Jute variety BJRI Tossa Pat-8 (Robi-1)	6% H_2O_2 Bleached	Jute variety O-9897
Reed jute fibre length (meter)	0.3-3.95	--	03-3.5
Brightness index (%)	22.00	44.63	21.50
Whiteness index (%)	18.26	45.79	17.31
Bundle strength (Kg/mg.)	5.00	04.31	04.95
Fineness index(micron)	35.50	--	35.39

Reed jute fibre length of BJRI Tossa Pat-8 (Robi-1) was found to be 3- 3.95 m which was higher values of O-9897variety jute samples. In table 1, brightness index of BJRI Tossa Pat-8 (Robi-1) was observed higher than that of the O-9897jute fibre and more or less same as like as 6% H_2O_2 bleached sample. Bundle strength of jute fibreis another important physical parameter. After bleaching, about 16% bundle strength was deteriorated than unbleached sample. Variety BJRI Tossa Pat-8 (Robi-1) was not affected to loss bundle strength like bleached jute samples, on the other hand having higher brightness index without bleaching. Fineness parameter of jute variety BJRI Tossa Pat-8 (Robi-1)is also nearly to O-9897 jute samples.

Table 2. Major chemical constituents of new variety jute sample BJRI Tossa Pat-8 (Robi-1)in comparison with O-9897 jute samples.

Name of samples	Cellulose content (%)	Hemicellulose content (%)	Lignin content (%)
Jute variety BJRI Tossa Pat-8 (Robi-1)	66.18	18.12	14.67
6% H_2O_2 Bleached jute fibre	64.29	17.47	13.56
Jute variety O-9897	63.24	18.47	14.04

From table 2, it was found that major chemical constituents in new variety BJRI Tossa Pat-8 (Robi-1) indicated a good quality jute fibre owing to higher percentage of cellulose content with lower percentage of lignin and hemicellulose than that of normal jute fibre. Another significant indication is 6% H_2O_2 bleached jute sample showed nearly about same value on the lignin and hemicellulose content (on the basis of bleached sample) like unbleached fibre.

Table 3. Minor chemical constituents of new variety jute sample BJRI Tossa Pat-8 (Robi-1)in comparison with O-9897 jute samples.

Name of samples	Pectin content (%)	Fat/Oil content (%)	Ash content (%)	Saponification values
Jute variety BJRI Tossa Pat-8 (Robi-1)	0.23	0.53	0.65	219.21
Jute variety O-9897	0.21	0.46	0.79	212.73

Minor chemical constituents were shown in table 3, oil content inBJRI Tossa Pat-8 (Robi-1) variety was found higher than that of conventional O-9897 jute variety, but pectin percentage is higher in jute fibre BJRI Tossa Pat-8 (Robi-1) as well as saponification value. Higher percentage of oil content in any textile fibre is helpful for spinning which acts as a softener and lubricating agent. Lower content of ash also supports the quality jute fibre like BJRI Tossa Pat-8 (Robi-1). On the overall survey it may be concluded that the new variety BJRI Tossa Pat-8 (Robi-1) jute fibre would be very helpful/useful as cost effective raw materials for diversified end uses of jute fibre.

CONCLUSION

The present study focuses on the physico-chemical properties of the newly published jute variety BJRI Tossa Pat-8 (Robi-1). From the results it is clear that the physical parameters of BJRI Tossa Pat-8 (Robi-1) fiber have been found to be of better quality in terms of strength, fineness and whiteness. On the other hand chemical properties are also an important factor for jute fiber where alpha cellulose is the most important chemical component which was higher in BJRI Tossa Pat-8 (Robi-1) fiber than other types of jute fiber. From the overall discussion it can be concluded that the variety of BJRI Tossa Pat-8 (Robi-1) is improved (i.e. improved quality) which is beautiful to look at and considering the maximum amount of fibrous material which is the most important jute fiber for diversified use.

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