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DETERMINATION OF FIBRE BLEND RATIO IN JUTE-COTTON BLENDED ROVING AND YARN

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Abstract: Jute and cotton fibres are most important natural fibres. Cotton is being blended with jute fibre to impart comforts, technical properties, flexibility for producing diversified products and cost reduction. As cotton and jute both are natural cellulosic fibres, determination of individual percentage ratios in their blending by chemical analysis is difficult. Presence of individual fibres have been identified by FTIR analysis as jute possesses aromatic ring group and cotton does not. Fibre fineness analysis is also helpful to ensure the existence of jute fibre in jute-cotton blended materials. Here, blending ratio of jute and cotton fibre has been determined by dyeing and weighing process. Physical identification of component fibres by absorbing a selective dye with respect to jute has been helpful to differentiate and separate the jute-cotton fibres. In this respect, basic dye is substantive to jute fibre and pure cotton fibre has very poor substantivity to that dye. Using this technique, Jute and cotton fibres have been identified and manually separated from their blended roving and yarn. Their percentage ratios have been determined by weighing the separated fibres. This experimental results reveals that the Jute/Cotton weight percentage of jute cotton blended yarn was found as 16.58/83.42 respectively whereas the initial feed ratio of these fibres in blow room was 30/70. This research will help the spinners of jute-cotton blended yarns to control their desired product requirements and quality.

Keywords: *natural fibre; jute; cotton; blending; blend ratio; basic dye; FTIR.*

1. INTRODUCTION

A fibre is a fine hair-like structure that is either natural or synthetic. Natural fibres may come from plants or animals. Cotton comes from the seedpods of cotton plants and jute comes from stems. Jute is bast fibre, where cotton is seed fibre. Being bast fibres, jute instincts lignin and hemicellulose in its chemical composition, whereas cotton does not instinct lignin and hemicellulose in its chemical composition. Hence, cotton is more or less, 88-96.5% α–cellulosic material [1]. Jute has 58-63% cellulose, 20-22% hemicellulose, 12-14% lignin [2][3]. Jute fibre has good mechanical properties, environmental friendly, nonabrasive, renewable, availability, biodegradable, high moisture absorption, and cheapest [4-6]. Jute fibre is conventionally not used for wearable textile products because of having coarseness, stiffness, drape, low extensibility, branching nature, wash ability and abrasion [7]. At present, jute is the third foreign currency earner agricultural product and it is next to the garment sector. Now it is facing stiff competition from synthetic counter parts to the world textile market. To overcome the competition, diversified usages of jute have become essential [8]. Blending of jute with other fibres may considered as alternative and possible diversified usages of jute yarns and fabrics [9]. Because of its great abundance and shortage of cotton, jute is blended with cotton and jute cotton blended yarns are manufactured mainly to take advantages of the lower price of jute fibre [10]. Jute blended with cotton or any other synthetic and natural fibre and the blended yarns are used for production of blended fabrics[11]. For this reason jute-cotton blended yarn is required to overcome the drawback of jute fibre [12]. Jute-cotton blended have been carried out to improve processes performance, to impart some functional properties to the yarn as well as fabric, to improve aesthetic appeal of the fabric, to impart fancy effect, to reduce cost of the products. Jute and cotton fibres are most important natural fibres, which are widely being used throughout the world [13].

It is important to know the blend ratio existence of blended yarn. Some researchers are developed a method to determine the blend proportion in a jute-cotton blend by greater absorption of potassium permanganate solution by jute than cotton and differentiated by spectrophotometer [2]. Measurement of Blend Proportion in Jute-Cotton Yarn with the Assistance of a High Volume Tester [14]. Blending ratio of cotton/jute textiles by half dissolving-light absorption [15].

Identification of fibre percentage from jute-cotton blended yarn is very difficult. As both are cellulosic fibre, chemical analysis is difficult but affinity of basic dye on cotton fibres is not sufficient because of having no absolute anionic group, basic dye cannot

make effective bond with it [16]. Basic dye is cationic in nature and jute is anionic because of having lignin and hemicellulose in its structure, which is capable to make an ionic bond with basic dye.

$Dye\text{-}NH_2 + H^+ \longrightarrow Dye\text{-}NH_3^+$ &
$Jute\ Fibre^- + Dye\text{-}NH_3^+ \longrightarrow Jute\ Fibre^-.....^{ionic\ bond}.....^+ NH_3\text{–}Dye$ [17].

Using dye absorption method, it can be easily separate jute and cotton fibres blend ratio at different stages of spinning. Presence of individual fibres of jute-cotton blended yarn have identified by FTIR and fibre fineness analysis system.

2. MATERIALS AND METHODS

A. Materials

- ***Jute fibre***

Jute variety- 0-9897 (*Corchorus olitorius*) collected from Manikgonj station of Bangladesh Jute Research Institute (BJRI). This fibre was alkali treated in Pilot Plant and Processing Division (BJRI). The properties of treated jute are furnished bellow.

TABLE I: PROPERTIES OF ALKALI TREATED JUTE FIBRE

Variety of Jute	Fibre Type	Fibre Properties		
		Strength (gm/tex)	Breaking Twist (TPI)	Fineness (tex)
0-9897	Alkali Treated Jute	33.08	31	1.85

- ***Cotton fibre***

CIS cotton fibre collected from a local Textile Spinning mill. This cotton fibre tested in testing laboratory of Bangladesh University of Textiles. The physical properties of CIS cotton fibre furnished below.

TABLE II: PROPERTIES OF CIS COTTON FIBRE

Micronaire Value (µg/inch)	Maturity Ratio	Uniformity Ratio	Strength (gm/tex)	Elongation (%)
4.58	0.91	84.4	34.8	6.5

- ***Blended materials***

The above alkali treated jute fibre and CIS cotton fibre was supplied to Jute and Textile Product Development Center (JTPDC), BJRI, Manik Mia Avenue, Dhaka-1207. The JTPDC wing made the blending of these two fibres and in blow room the feed ratio was 30/70 jute/cotton. Then, after processing in subsequent machines the Roving and Yarn were collected.

B. Methods

- ***Fourier Transform Infrared (FTIR) Spectroscopy***

The infrared spectra of the treated jute, cotton fibres from jute-cotton blended yarn recorded on Fourier transform infrared spectroscopy (FT/IR–4600LE, JASCO) with attenuated total reflectance (ATR) mode with a diamond crystal. Scanning conducted in the frequency range 4000–500 cm^{-1} with a 16 repetitions scan average for each sample and a resolution of $4cm^{-1}$.

- ***Fibre Fineness Analysis System***

Jute and cotton fibres visually viewed by fibre fineness analysis system (YGOO2C, Panasonic WV-CP310/CH) with 40 times magnification.

- ***Dyeing of Jute Materials with basic dye***

Twisted materials were prepared as untwisted form.

- ***Recipe***

Material weight: 0.5 gm
Basic Dye: 3% (on the weight of blended materials)
Acetic acid: 1 gm/L
P^H: 4.5-5.5
Material:Liquor ratio - 1:30
Temperature: 80^oC
Time: 40 minute

- ***Dyeing curve***

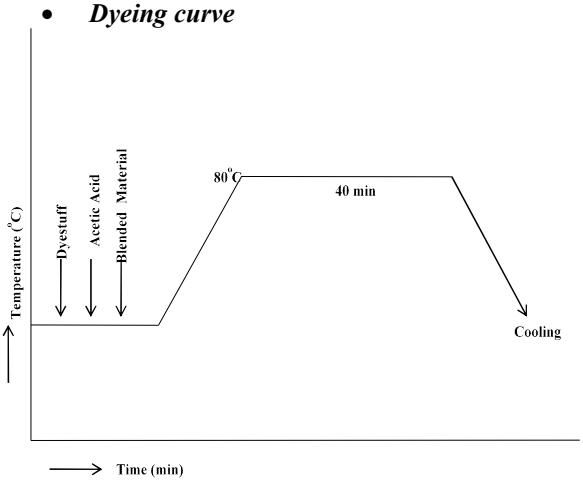

Fig. 1: Dyeing curve of Jute, Cotton and blended materials

- ***Procedure***

Fig. 1 depicted the total dyeing process through curve. The solid basic dye 3% (on the weight of blended materials) first pasted with 1 gm/L acetic acid and then added 30 times water. Jute-cotton blended materials was soaked in the dye bath with maintaining P^H 4.5-5.5 and continued dyeing for 40 minutes with the gradually increase of temperature up to 80^0C. After dyeing, the material is pulled out and washed with cold water. Finally, the material squeezed and dried which are shown in Fig. 2.

(a) (b) (c)

Fig. 2: a) Dyed jute fibre b) Dyed cotton fibre c) Dyed blended materials

3. RESULTS AND DISCUSSION

A. FT-IR Analysis

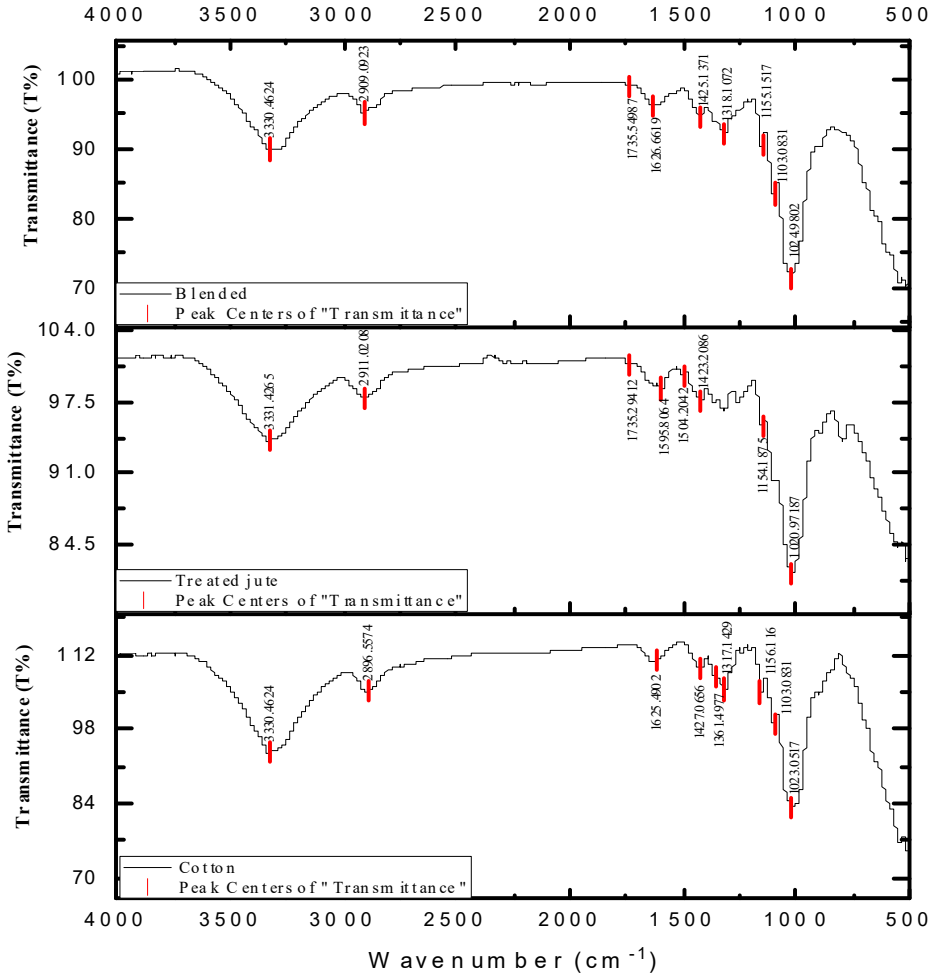

Fig. 3: FTIR spectra of jute-cotton blend, treated jute and raw cotton fibre

TABLE III: ASSIGNMENT OF THE MAIN ABSORPTION BANDS IN FTIR SPECTRA OF JUTE, COTTON, AND JUTE COTTON BLENDED[18][19].

Wavelength (cm^{-1})	Assignment
3600–3100	Intra and inter molecular Hydrogen bonding of OH stretching in cellulose,hemicelluloses
~2900	v (C-H)
1735	stretching acetyl or carboxylic acid
~1635	Adsorbed water
1595	Aromatic ring in lignin (exclusively in jute spectrum)
1502	Aromatic ring in lignin (exclusively in jute spectrum)
1425	Carboxylic acid and COO- vibration
~1365	8(C-H)
~1155	v(C-C) ring breathing, asymmetric
~1105	v(C-O-C) glycosidic
~1025	v(C-OH) 10 alcohol

Fig.3 showed that the alkali treated jute fibre, cotton fibre and jute-cotton blended materials have a similar footprint in many wavelengths. The pick at 2909 cm^{-1} in jute-cotton blended sample and the pick at 2911 cm^{-1} in alkali treated jute sample indicates presence of hemicellulose and cotton does not possess similar pick, as it has not hemicellulose [20]. The pick at 1735cm^{-1} representative of stretching acetyl or carboxylic acid group of hemicellulose present in jute and jute-cotton blended materials [21]. This pick is not present in cotton. This pure negative group is very much essential to make an ionic or salt linkage bond with cationic basic dye. Thus, our experiment shows that component jute fibre has dyed by basic dye.

B. Microscopic view analysis

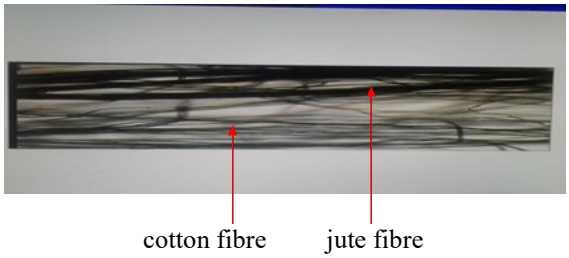

Fig. 4: Microscopic view of jute-cotton blended yarn

Fig.4 showed that the microscopic view of jute-cotton blended yarn indicates dark-coarser lines for jute fibres and finer lines for cotton fibres. This idea was helpful for further manually separation process of jute-cotton fibres.

C. Dyeing analysis

Basic dye is substantive to jute fibre and pure cotton fibre has very poor substantivity to that dye. Jute fibres absorbed basic dye and became far darker than cotton fibre, as cotton absorbed very trace amount of basic dyes. The fibres were visually differentiated by their colours, fineness, and brittleness according to Fig. 5(b), 5(c), 5(d). After that, jute and cotton fibres were easily separated manually. The separated cotton and jute fibres were weighed by electronic balance. Fibre percentage was determined by using equation 1 and the result is shown in table IV. Here, percentage ratio of jute to cotton fibre in blended roving was found as 22.45 to 77.55 and in blended ring yarn as 16.58 to 83.42 with respect to blow room feed ratio as 30 to 70.

$$Fibre\ (\%) = \frac{Constituent\ fibre\ weight}{Blended\ fibre\ weight} \times 100 \qquad (1)$$

TABLE IV: FIBRE WEIGHT PERCENTAGE OBSERVED IN THE JUTE-COTTON BLENDED MATERIAL
*Fibre percentage determined by using equation 1.

Jute-Cotton Blended Materials	Jute Fibre Percentage*	Cotton Fibre Percentage*
Roving	22.45	77.55
Ring Yarn	16.58	83.42

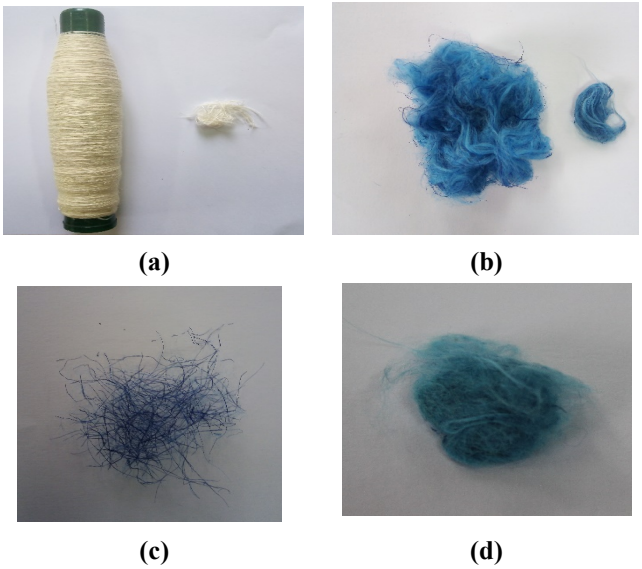

Fig. 5: (a) Blended material (b) Dyed blended materials (c) Separated jute fibre from blended materials (d) Separated cotton fibre from blended materials

4. CONCLUSION

Jute-cotton blended yarn bears importance to reduce cost and impart other synergistic properties. However, its users sometimes complain about the existence of jute in jute-cotton blended yarn. Therefore, it was necessary to determine the percentage ratio of jute in jute-cotton blended yarn. This work confirms the presence of jute fibre by showing carboxylic acid group of hemicellulose in FTIR spectrum. During dyeing of Jute-cotton blended yarn, the jute

component has dyed by basic dye. Thus, these two components have been separated manually and their percentage was calculated. The result confirms that, in blended yarn ratio jute/cotton 16.58/83.42 is lower than blow room feed ratio Jute/Cotton 30/70. Probably, the loss of jute fibres happened in various intermediate stages of spinning. The designed process is simple and easy, but laborious. Visual and manual separation is quite difficult. Therefore, further research can be proceeded by chemically separation processes.

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