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Study of Mechanical Properties of Woolenised Jute Yarns

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ABSTRACT:In the early stage,Jute fibre was known as the golden fibre of Bangladesh. It is consisting of varieties of qualities such as eco-friendly, biodegradable, and multipurpose of end uses. The problem arises whenever the jute is processed in a different count then the mechanical properties fluctuate based on the alkali, bleach, and dyed treatment of jute yarn. In this paper, the comparison study of woolenized jute yarn is focused to observe the mechanical properties of chemically processed different count jute yarn. The tensile strength shows that woolenized jute yarn 4.96, 5.34, 6.92 MPa (8,10,12 lbs/spindle) which is higher than bleached jute and dyed jute yarn. The elongation at break % of woolenized jute yarn at different count (12,10,8 lbs/spindle) exhibits 9.56, 6.9, 5.88 that is also higher than bleached yarn and dyed yarn except some special cases. The tenacity results show that in different count of woolenized yarn (12,10,8 lbs/spindle) gives 13.36, 10.3, 8.16 gm/tex which is better than bleached and dyed jute yarn. The CSP and quality ratio follows the same trends as like as tenacity and other physical tests result. Finally, from different count of processed yarn and 100% jute yarn study shows that the woolenized jute yarn can be used for the further application and decorative purposes.

KEYWORDS: JuteYarn, Woolenized jute yarn, Dyed jute yarn, Tensile strength, Extension at break, Elongation of yarn.

I. INTRODUCTION

Jute is the most versatile natural fiber gifted to men by nature and is popularly known as golden fiber. It is the strongest of all natural fibers and is considered as fiber of the future[1].Jute contains relatively hard cellulose and has high tensile strength and low elongation at break[2]. Jute is one of the cheapest, eco-friendly natural cellulosic bast fibers which is light in weight, renewable, sound absorbent, and textile fiber of good spinnable character [3]. Nowadays jute-textile is earning 12% of total foreign currency for Bangladesh but it is facing tough competition with cheap synthetic fibers in the different fields of use [4]. Hence for the survival of this environment-friendly fiber, it is necessary to diversify the use of jute by making new products from raw jute and modified jute. Jute fiber possesses some advantageous physical and chemical properties like high tensile strength, specific stiffness, low thermal conductivity, antistatic properties, and good dyeability but has drawbacks like relative coarseness, brittleness, hardness in feel, rugged appearance, inextensibility, poor washing ability, and fiber shedding as well as the presence of lignin [5]. For these reasons, it becomes very difficult to produce fine yarns from jute fiber. Several attempts have been made to improve the physical properties of jute fiber like flexibility, crimp ability, softness, etc. The improvement of these properties is considered as the main demand to improve its spin ability or to produce fine yarn of jute [6, 7]. Biodegradable and low-priced jute products are increasing day by day [8]. Woolenization of jute is the process of treating the jute fiber or yarn with strong alkali to improve severely the appearance, handle and blend of jute fibres or yarns [9]. The effect of woolenization on jute yarn has shown a remarkable change in physical and chemical properties and the structure of jute that turned into nearly as wool. As a result, the yarn becomes soft to touch and develops a high degree of crimp or waviness. Shahid et al.[10] reported that the physical properties of the yarn are very important for post-spinning operations. Datta et al.[11] also reported that the sulphonation of jute fiber is more beneficial than other existing procedures in modifying the properties of jute fiber.

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However, the main limitation of jute is its stiffness, and also the yarn is coarse compared to wool[12]. Wool is widely used in the world as textile product. In our growing world, wool fiber is very much needed[13]. The price of wool yarn is much higher than jute yarn. So, if some wool can be replaced by woolenized jute yarns, it would be a better-diversified use of jute. But the systematic study of the different physical properties of jute fibers, 100% jute yarns &woolenized jute yarns is yet to be known. B.L. Ghosh and A.K.Dutta [20] found that there is a possibility for improving the mechanical properties of jute composites by alkali treatment of fiber[20]. Andrzej etal.[20] found that there is a possibility of improving drapability of jute composites by alkali treatment of fibers. Chowdhury and Azad [21] Tried to find the chemical effect of physic-mechanical properties of jute and jute-synthetic blended (80/20) yarns and they reported more quality ratio in woolenized yarn other than grey, bleached,dyed&softenedyarn. However, the different count of jute yarn processed in a variouschemically treated not compared before to observe the physical test . In this study this is the new approach to compare the physical parameters .

II. MATERIALS AND METHODS

In this study, white tossa jute were selected to produce 8,1,10/1, and 12/1 Ib/spindle yarn. Fiber processing and spinning were performed in the BJRI laboratory Bangladesh. Jute fibres were opened manually, and after sandwich hand blending, the feed lattice was used to open and blend the fibers to be spun, followed by jute softener, breaker card, finisher card. The four types (100% jute yarn, woolenized jute yarn, bleached jute yarn and dyed jute yarn) of sample were prepared according to the desired shape for the physical tests.

100% jute yarn: 100% jute yarns, prepared in the flyer spinning machine of the experimental spinning mill of BJRI, were collected in the bobbin form. Then they were used for the next process.

Preparation of woolenzed jute yarns: Our ultimate end product of the investigation is woolenized jute yarns. For this purpose, at first, the 100% jute yarns, prepared of the bobbin form in the flyer spinning machine, were turned into hank form by the hank machine in the experimental spinning mill of BJRI. Then the 100% jute yarns of hank form were used for the preparation of woolenized jute yarns.Then the woolenized jute yarns were prepared in the wet processing laboratory of BJRI.The jute yarns of hank form collected from hank machine of experimental spinning mill in BJRI, were treated with caustic soda in the caustic bath of wet processing department of BJRI for a batch of 50 kgs jute yarns. The caustic soda was mixed about 15%-20% according to water. The water in the bath was 3500 liter. The process was done in the room temperature for about 20 minutes. As a result, the jute yarns became soft to touch & developed some feeling as wool. In the caustic treatment process, the main part of woolenization was completed. The 100% jute yarn was treated under bleaching medium to bleach the jute yarn as a collection of bleached sample. The jute sample yarn were dyed under dyeing lab to bring out the sample size according to the mechanical test parameter.All yarn samples were kept under standard laboratory conditions (20 ± 2 °C and 65 ± 2% RH) for 24hrs before testing as per ISO 139. The sample were tested to measure the Tensile strength (Fig.1),Elongation, Tenacity, Quality ratio, CSP according to ASTM method.

Figure 1. Tensile tester

III. RESULTS AND DISCUSSION

Mechanical properties are physical properties that a material exhibits upon the application of forces. After treating the yarn to various applications of forces, different material properties such as tensile strength, extension at the break, elongation of yarn, tenacity of yarn, count & strength product and quality ratio have been

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measured. These defining characteristics are discussed below:

3.1 Tensile Strength: The strength or force on which the yarn is broken, is called the tensile strength or breaking strength of the yarn.It is an important mechanical property that indicates the strength and load-bearing capacity of the yarn. Figure illustrates the variation of tensile strength concerning different counts and different processes applied to obtain the dyed jute yarn. We can discuss the effect of these processes from two different perspectives. First, we can observe the effect of varying counts for constant processes. We observed that the tensile strength is highest(7.88lbs) for 12 counts of 100% jute yarn. The 12 count of jute is always stronger than the other counts of jute after each process ended. With the increase in the jute count, an increase in the coarseness of yarn is indicated. That is why the strength of the yarn increases with the higher count. Secondly, when we kept the count fixed and observed the effect of the processes, we observed a similar trend appearing for all counts of jute. The tensile strength of different types of yarn gradually decreased due to different chemical treatments except for bleached yarn, but the difference is negligible.

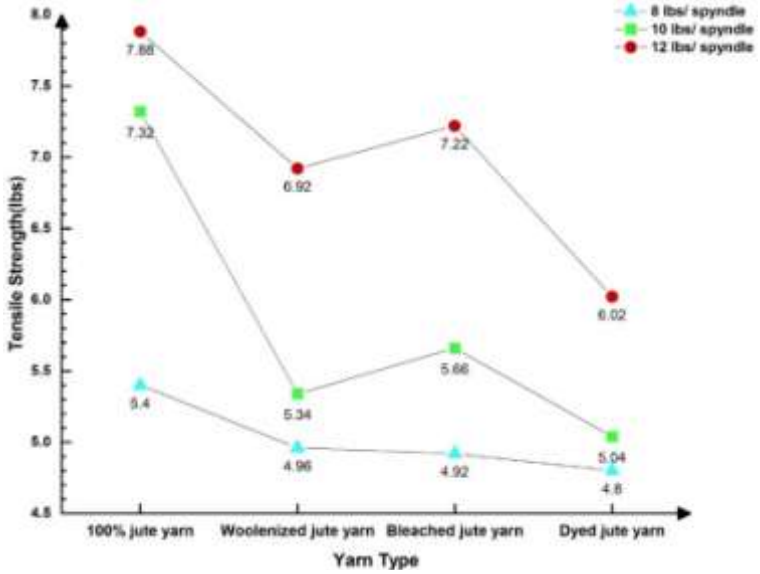

Figure 2: Effect of different processes on tensile strength of the yarn at different counts

3.2 Extension at Break: The extension of jute yarn that occurs at the tensile or breaking load of the yarn is called extension at break of the yarn. It is a measure of ductility for the yarn. The higher the value of it suggests that the fiber will still resist fracture until it reaches the limit of extension while keeping its shape intact. For the same yarn count, the extension at the break of the yarn gradually increases. The reason is that when the jute yarns are treated with different chemicals it becomes flappy & soft. As a result, the thickness of the yarn increases as the weight remains fixed. So, the extension at the break of the yarn gradually increases for different chemical treatments. For the same type of yarn, when the yarn count increases, the extension at the break of the yarn increases. When the yarn count increases, the tensile strength of the yarn increases. Logically, the extension at the break of the yarn increases. 3 illustrates this phenomenon in a graphical manner.

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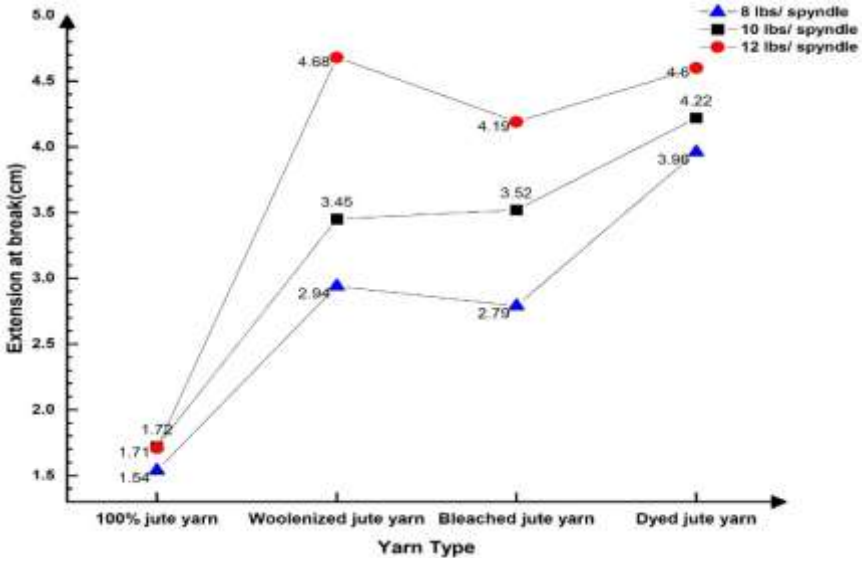

Figure 3:Effect of different processes on the extension at break of the yarn at different counts

3.3 Study of Elongation: Figure illustrates the progressive change in the elongation of yarn with the change in yarn type and count. Elongation of Yarn: The ratio between the extension of yarn and the fixed length of yarn which is expressed in percentage is called the elongation of yarn. It is expressed using the following formula:

$$\text{Elongation of yarn} = \frac{\text{Extension of yarn}}{\text{Original length of yarn}} \times 100\%$$

We observed that the extension at the break of the yarn gradually increases with different chemical treatments along the way. Elongation of yarn is co-related with extension at break of yarn. We also observed that the extension at break of any type of yarn increased with the increasing of yarn count.

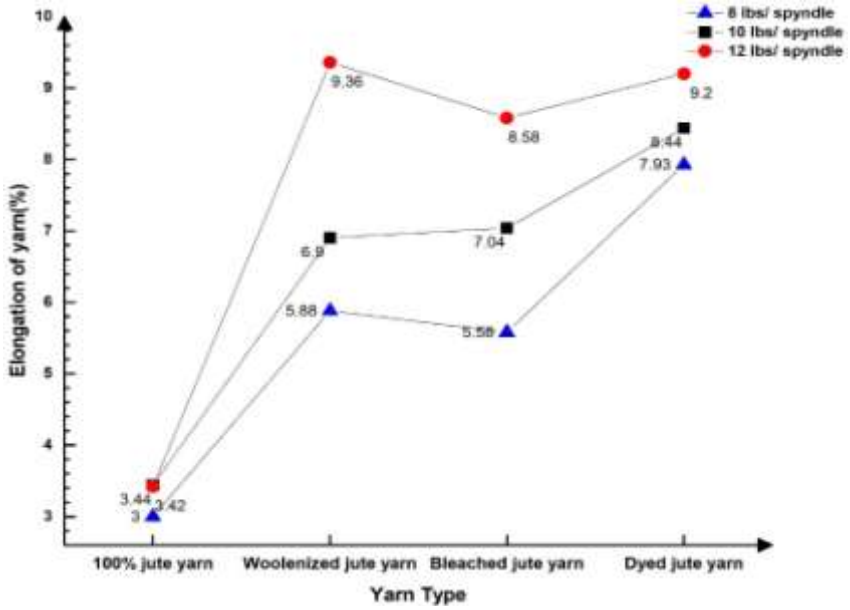

Figure 4:Effect of different processes on the elongation of the yarn at different counts

3.4 Study of Tenacity: From Figure , we see that the tenacity of yarn gradually decreases with different chemical treatments of yarn. When jute yarn is treated with different chemicals at afixed count, the yarn gradually losses its strength. Tenacity is also highly correlated with tensile strength. As the strength decreases due to different chemical treatments, the tenacity of yarn decreased. We also found that the tenacity of yarn gradually increased with the increase of yarn count.We know

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that for jute yarn, as the count increased, the yarn became coarser& the yarn tensile strength increases. As the yarn tensile strength gradually increases with the increase of yarn count, the tenacity of yarn increased.

Tenacity of Yarn:The ratio of load required to break the yarn & the linear density of that yarn is called tenacity of yarn. It is expressed by the following equation:

$$\text{Tenacity of yarn} = \frac{\text{Tensile strength (gm)}}{\text{Yarn count (tex)}}$$

We first converted the tensile strength in gm& the yarn count intex. The following formulas were used

i) 1 lbs=453.6 gm

ii) Yarn count(tex)=Jute count x 34.45

Then we calculated the tenacity of yarn in gm/tex unit.

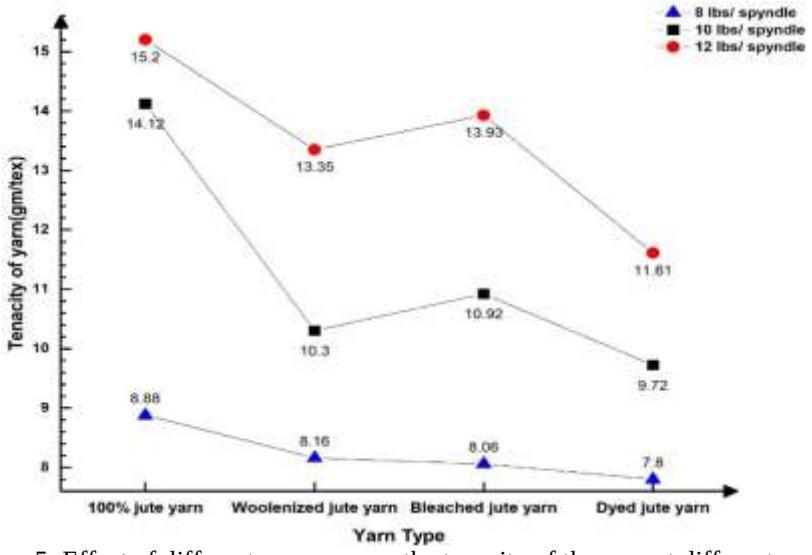

Figure 5: Effect of different processes on the tenacity of the yarn at different counts

3.5 Study of CSP:Figure 6, we observed that the C.S.P. gradually decreases with different chemical treatments of yarns.

Count and Strength Product(C.S.P): The product of yarn count (N_e) & tensile strength (lbs), is called the count & strength product (C.S.P.).

C.S.P.=Yarn count (English count)
× Yarn tensile strength (lbs)

Here, English count, N_e = 17.14/Jute count.

When the jute yarns were treated with different chemicals in each stepfor a fixed count, the yarn gradually lost strength. As the tensile strength decreased, the C.S.P.also declined.

The C.S.P.of yarn gradually decreased with the increasing of jute yarn count. With respect to C.S.P., the count is English count. We know that for English cotton count, as the count increases, the yarn becomes finer and its strength decreased. From the relation of English count & jute count, we find 8 jute count is equal to 2.14 N_e, 10 jute count is equal to 1.71 N_e, 12 jute count is equal to 1.41 N_e. So, with the increasing of jute count, N_e decreased. SoC.S.P. decreased as well.

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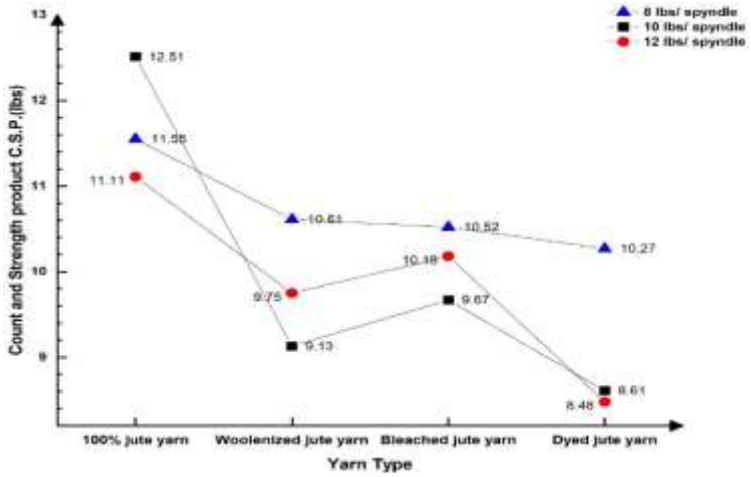

Figure 6:Effect of different processes on the Count Strength Product(C.S.P.) of the yarn at different counts

3.6 Study of Quality Ratio: In Figure 7, we observed that the Q.R. of different types of yarns gradually decreased with different chemical treatments of different types of yarns. Quality Ratio (Q.R.):The ratio between the tensile strength & the linear density of the yarn which is expressed in percentage, is called the quality ratio (Q.R.) of yarn. It is expressed by the formula below:

$$\text{Q.R.}(\%) = \frac{\text{Tensile strength (lbs)}}{\text{Jute count (lbs/spyndle)}} \times 100\%$$

When the yarns were treated with different chemicals, the tensile strength of different yarns gradually reduced. As the tensile strength reduced, the Q.R. of different yarns gradually reduced. The Q.R. of a fixed type of yarn wasnearer to each other for increasing yarn counts.We know that generally the tensile strength of jute yarn increases with the increasing of yarn count. Q.R. is the ratio between strength & count. This is the reason why the graphs appeared closer to each other as both strength and count increased proportionally.

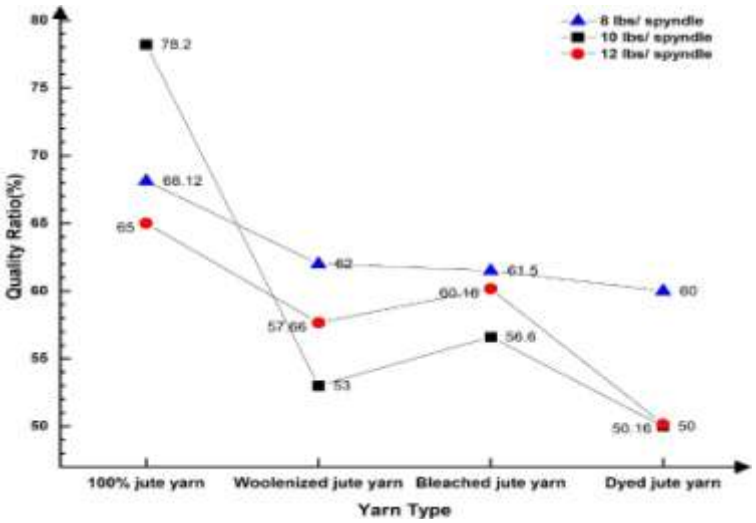

Figure 7:Effect of different processes on the Quality Ratio(Q.R.) of the yarn at different counts

IV. CONCLUSION

In this study, the result reveals that woolenized jute yarn shows second highest tensile strength because the 100% jute yarn is the top due to not processed as like other different count processed yarn. The tensile strength shows that woolenized jute yarn 4.96, 5.34, 6.92 MPa (8,10,12 lbs/spindle) which is higher than bleached jute and dyed jute yarn. The elongation at break % of woolenized jute yarn at different count (12,10,8 lbs/spindle) exhibits 9.56, 6.9, 5.88 that is also higher than bleached yarn and dyed yarn except some special cases. The tenacity results show that in different count of woolenized yarn (12,10,8 lbs/spindle) gives 13.36, 10.3, 8.16 gm/texwhich is better than bleached and dyed jute yarn. The CSP

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