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Study on Reducing Shrinkage Characteristics through Woolenized Jute Knitted Fabric

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Abstract:
The purpose of this study was to investigate the impact of various treatments to solve the problem of considerable shrinking in jute knitted textiles. Without any treatment, jute knit materials naturally shrinks a lot. In this study, firstly 8/1 lb/spindle white tossa jute yarn was selected and a scouring process was applied. Subsequently, the jute yarns were woolenized through 23% sodium hydroxide treatment. After completing the knitting process, the woolenized jute knitted fabrics exhibited a weight of 300-350 GSM (Grams per square meter). The data were analyzed based on stitch length, compaction, and stentering. The single jersey woolenized jute knitted fabric showed a shrinkage of 4 to 4.5 after the experiment, however, 1x1 woolenized jute knitted Lycra Rib (double jersey) fabrisc showed a more shrinkage range from 4.7 to 5. These findings demonstrate that the proposed treatment method can help reduce the shrinkage of jute knitted fabrics, making it a promising approach for achieving enhanced performance in jute knitted products. The study was conducted at the pilot plant and processing division of the Bangladesh Jute Research Institute.

Keywords: *Jute wool, shrinkage effect, Jute knitted fabrics, woolenisation effect .*

1. INTRODUCTION

Scientists and academicians are attempting to utilize natural fiber in new technology because they are sustainable and hazardous-free and have no detrimental effects on health. The most significant natural fiber in the environment is wool, and mammalian hair comprises complex proteins [1]. The fiber obtained from the stems of plants of the tiliaceae family genus Corchorus is commonly known as "jute." [2]. Wool fiber is found mainly in sheep and camels. There are many uses for wool from natural sources. Jute has a relatively high cellulose percentage and is characterized by high tensile strength and low elongation [3]. The handycraft and cottage sectors may be influenced by several varieties of yarn. According to blending and mixing, a jute with mixed yarn exhibits good mechanical properties [4]. To get different variable properties, different types of fibre used for blending like jute-polyster, jute-wool, jute -acrylic etc.[4]. The woolenization process employs a powerful alkali to significantly improve the appearance, smell, and blend of jute fiber or yarn [5]. Woolenized jute yarn exhibited a significant strength and tenacity and also showed a better elongation property than bleached and dyed jute yarn [6]. Currently, natural, biodegradable, renewable resources, and environmentally friendly chemical processes are crucial for today's textile sectors [8]. Researchers are trying to find a new way to improve derivative items by mixing jute yarn with another type of yarn. Blended jute yarn exhibits excellent mechanical properties compared to raw jute yarn. The price of wool yarn is higher than that of the yarn. If the achieved woolenized jute yarn property is applicable in some specific areas such as sweaters, mufflers, and hand bags, then it will be economically viable. Rowel et al. [2] reported that small alkali for woolenisation play less role to change the jute fibre, but increase the extensibility. During alkali treatment, the shrinkage is reduced by the tension applied to the jute yarn. Jute fibers in their raw state are severely constrained by their low cellulose content, roughness, stiffness, low elongation, poor gripping performance, and other drawbacks [11]. Wool fabrics have special qualities including elasticity, flexibility, heat retention, flame resistance, hydrophilicity, and heat insulation [9-10]. To produce blended jute-wool, a suitable amount of jute yarn was inserted at the nip of the drawing and drawing-pressing roller, after a feed of wool fiber top was fed into the drafting zone of a jute spinning machine. Therefore, wool fibers are wrapped around the jute core as a casing [13]. However, this is expensive. Woollen fabrics cleaned in traditional washing machines have a ratcheting effect that is progressively tighter as a result of friction caused by movement between the strands [12]. Jute is treated with a strong alkali during the woolenizing process to improve its appearance, grip, and blending ability. Significant physical changes occur in the structure, including lateral expansion and lengthening noticeably [14]. Woolenized fabrics are used to produce sweaters and mufflers, especially during the winter season.The objective of this study was not only to reduce the shrinkage effect but also to improve stability after washing. If we prevent shrinkage of the knitted jute, then it will be a good achievable for us.

2. MATERIAL AND METHODS

2.1. Material

In this study, 8/1 lb/spindle white tossa jute yarn was selected for this research. Subsequently, scouring operations were performed. Then, caustic soda solutions at different concentrations for woolenization were used and then dyed. A flat-bed knitting machine (7 gauze) was used to produce the knit fabric. After woolenized jute knitted fabrics were taken with a GSM of approximately 300-350 in different constructions of fabric for measuring shrinkage effect.

2.2. Methodology

Woolenized fabrics was knitted with woolenized yarn, which showed shrinkage effects.

Scouring of jute yarn

↓

Woolenization of Jute yarn

↓

Jute Knitted fabrics by woolenized yarn

↓

Shrinkage reducing by stentering and compaction

Figure 1: The flow diagram illustrates the step-by-step method process.

2.2.1. Scouring:

At first jute yarn treated to scouring process. So for this following recipe are given below:
Sodium hydroxide: 10-25g/L
Sodium silicate 1-6 g/L
Yarn to liquor ratio: 1:30.
Maintaining those under 80-100^0 centigrade temperature about 1-1.5 hrs.

2.2.2. Woolenization of Jute yarn

At first, jute yarn was treated with 23% NaOH. A significant modification occurred in the physical condition, where lateral swelling occurred together with a significant shrinkage in length; the fiber became softer and exhibited a significant amount of crimp or waviness. The crimp gives the fiber a wool-like appearance.

The impact is negligible at alkali concentrations up to approximately 12%, but at concentrations of 18% and above, the extensibility increases quickly and may approach 8 or 9%. However, when the alkali concentration increased, the tensile strength of the fiber decreased. Banbaji [7] studied the tensile qualities of jute fibers prior to and following alkali treatment and found that the tenacity decreased with increasing concentration: an initial value of 3.6 g/den decreased to 2.5 g/den at 9% alkali and to 1.5 g/den at 24% alkali, at 2°C and 1-h immersion. The RMS values of the width (D) and number of crimps per unit length of the stretched fiber (n) are the two measurements used to define the crimp. For weights of approximately 1800 mg, the crimp vanished, and the extension of the fibers at break was 18% greater than the starting length of the crimped fiber. The fibers undergo significant weight loss (15% or more) and appear to be split up after mercerizing. Under this condition, the fiber loses its diameter. The mercerizing process has several physical impacts if the jute material is maintained under stress as opposed to being lax.

The durability of the crimp was weak, and when the fiber was straightened under strain, there was little propensity for it to return to the crimped condition. When tension is released, the woolenizing procedure does not provide fiber elasticity.

2.2.3. Knitted fabrication from jute woolenised yarn

After woolenizing the jute yarn, it was dyed in a reactive dye. After dyeing, the dyed yarns were placed in a cone package. In this case, a manual flat knitting machine or an automated flat knitting machine may be used. Seven gauze flat knitting machines were used in this study. Circular knitting was difficult, because this yarn was somewhat fluffy, it breaks more during knitting. After that, the woolenised yarn was taken into the knitting lab. Jute knitted fabrics can be dyed after or before knitting. Knitted fabrics develop shrinkage effects after knitting. Jute flat rib knitted fabrics exhibited more shrinkage than cotton fabrics. Therefore, it is necessary to maintain the shrinkage effect of jute-knitted fabrics.

3. RESULTS AND DISCUSSION

3.1. Relaxation shrinkage:

Relaxation Shrinkage occurs when the fibers and threads are under strain. The fabric was later relaxed when wet and under reduced stress. Later, when the fabric was moist and under reduced strain, relaxation occurred.

Shrinkage calculation:

Shrinkage is important in knitting industry specially in cotton industry. In jute knitted fabrics there is also found shrinkage. Shrinkage calculated by mechanical force under relaxation method. The specimen were taken into sample measurement of 60cm X 60cm in 100^0 centigrade for 30 minutes. The noticeable changes by lengthwise and widthwise was calculated. In shrinkage of jute knitted fabrics, the lengthwise fabric will be increased and widthwise will be decreased. Physical shrinkage can be calculated by the following equation:

$$\text{Shrinkage \%} = \frac{\text{The sample length of jute knitted fabric after wash} - \text{the sample length of jute knitted fabric before wash}}{\text{sample length of jute knitted fabric before wash}} \text{X100}$$

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Table-1 Shrinkage parameters of single jersey woolenized jute and 1x1 woolenized jute knitted lycra rib before compaction and stentering.

Fabric Name	Loop Length (mm)	Fabric Wt. (GSM)	Shrinkage %
Single Jersey woolenized jute knitted fabrics) (Plain)	15	350	4.6
	12	360	4.5
	10	380	4.1
1x1 woolenized jute knitted Lycra Rib	20	420	5.1
	15	430	4.9
	12	440	4.6

This study emphasizes how the knitting structure affects shrinkage characteristics. From table -1, that stitch length plays important role for controlling GSM and shrinkage, the more stitch length, the less shrinkage and also less GSM of the fabric.

3.2. Compacting and Stentering

To improve dimensional stability, compaction is required, and then stentering is needed. After compaction and stentering, the following properties are improved: It needs a temperature of range 80–100^0 centigrade. At this time, dimensional stability improved, and reducing shrinkage by mechanical force improved to a significant extent. From table 2, we see that after compaction and stentering, its shrinkage effect was improved compared to table 1. We have also observed that the shrinkage effect for single jersey is 4 to 4.5, whereas for 1x1 woolenized jute knitted lycra rib, it is 4.7 to 5.

Table-2 shrinkage parameters of woolenised single jersey jute and 1x1 woolenized jute knitted lycra rib after compaction and stentering.

Sample Fabric Name	**Loop Length** mm	**Fabric Weight GSM**	**Shrinkage** %
Single Jersey woolenised jute fabrics) (Plain)	15	365	4.5%
	12	370	4%
	10	380	4%
1x1 woolenised jute knitted Lycra Rib	20	415	5.0
	15	440	4.8%
	12	445	4.7%

3.3. Shrinkage effect after wash:

We observed that more shrinkage occurred after washing. This experiment was performed using a normal water wash. We considered single jersey woolenized jute knitted fabrics and double jersey woolenized jute knitted fabrics for the calculation of the shrinkage effect. Fig:2 shows the shrinkage difference between after wash and before wash of s/j woolenized jute knitted fabrics and 1x1 woolenized jute knitted lycra rib.

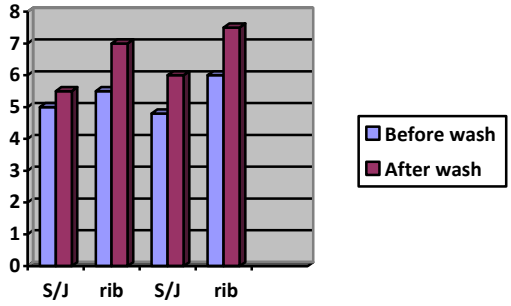

Fig: 2 Comparison of shrinkage effect between single jersey and rib knitted woolenized jute fabrics after wash.

4. CONCLUSION

Woolenized jute knitted products may be used to create handcrafted textiles in the jute knitted industry. To manufacture bags, sweaters, or a wide range of aesthetic products, woolenized jute knitted fabrics play a vital role. Although woolenized fabrics exhibit attractive features for creating diverse jute knitted products, shrinkage is a significant concern. Shrinkage effects are primarily observed during the compacting, stentering, and relaxation stages. In conclusion, this work offers prospective answers to shrinkage issues in jute woolenized materials, opening up new avenues for the textile sector. By putting the suggested principles into practice, producers may create jute-based goods that are high-quality, reliable, and profitable while also meeting the varied demands of customers and advancing eco-friendly business practices. To further enhance the functionality and adaptability of woolenized jute knitted textiles in a variety of applications, more research must be conducted and collaboration with specialists is important.

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