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Assessment of Jute–Acrylic Blends for Development of Knitted Fabrics

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ABSTRACT

The present study investigates the development and performance of plain knitted fabrics produced from jute–acrylic blended yarns in different proportions. Jute, being a low-cost and eco-friendly fibre, was blended with acrylic to improve its suitability for knitted applications and to explore an economical alternative to conventional woollen fabrics. Fabrics were evaluated for constructional parameters, mechanical properties, comfort-related characteristics, and dimensional stability using standard test methods. The results showed that increasing acrylic content improved bursting strength, crease recovery, and fabric flexibility, while higher jute content enhanced abrasion resistance, moisture regain, thickness, and fabric weight. Blended fabrics exhibited balanced performance when compared to pure jute and pure acrylic fabrics. Subjective evaluation by experts indicated that blends containing 20:80 and 30:70 jute–acrylic ratios were rated satisfactory in terms of texture, lustre, aesthetic appeal, and woollen feel. These blends also offered a significant reduction in fibre cost without major loss in fabric acceptability. Overall, the study demonstrates that jute–acrylic blends, particularly at 20–30% jute content, have strong potential for producing cost-effective, functional, and sustainable knitted fabrics for woollen and apparel applications.

KEYWORDS

Jute–acrylic blend, Wool alternatives, Jute, Acrylic, Knitted fabrics

INTRODUCTION

Jute is a natural fiber that comes from plants and is often called the golden fiber. It has this name because of its shiny and golden look. Jute is one of the strongest natural fibers and is also very cheap (Mahabubuzzaman et al., 2007). It is completely biodegradable and safe for the environment. However jute also has some limitations. It has low crease resistance, poor drape, loses strength when wet and may show uneven color and turn yellow when exposed to sunlight. The leading producers of Jute are Bangladesh and India. Traditionally jute fiber has been used to make packaging materials such as hessian sacks, ropes and twines. It has also been used in home textiles like carpets and carpet backing cloth (Gordon, 2005).
Acrylic fibers are man-made fibers that contain at least 85 percent acrylonitrile. They are soft and warm like wool, while remaining lightweight and strong. This makes them comfortable to wear and suitable for regular everyday use (Dai, 2006). The importance of acrylic fibres is clear from their rapid growth and wide popularity around the world (Bajaj, 1997). Most knitting yarns made from acrylic are bulky and are used to produce pullovers,

sweaters, socks, and similar garments. Acrylic fibres are also widely used in blankets and carpets. Acrylic has bright colors, dries quickly, can be machine washed, and does not shrink or wrinkle easily. However, main disadvantages include poor breathability, easy pilling, low moisture absorption, sensitivity to heat and environmental concerns.

Wool has traditionally been used for knitted fabrics, but its high cost has encouraged the search for more economical alternatives. In this regard, a jute–acrylic blend can be considered a suitable substitute for knitted applications. Acrylic fibres possess wool-like properties such as warmth, softness, good bulk, and pile characteristics, which make them appropriate for knitwear. Jute, although a strong and natural fibre, has certain limitations that restrict its use in functional textile products. These limitations can be reduced through fibre blending, which helps improve overall performance and product quality. Jute–acrylic blended products may therefore find acceptance in both domestic and export markets. In addition, such blends are cost-effective compared to pure wool or acrylic products. Hence, this study highlights the potential role of jute–acrylic blends in the woollen industry by utilizing jute as a low-cost, natural, and eco-friendly fibre.

REVIEW OF LITERATURE

Vaidya (1985) studied the global advancements in modifying acrylic fiber. It was found that acrylic fibers popularity is due to their wool-like texture, bulkiness, chemical stability, and resistance to weather, mold, and bacteria. Bi-component acrylic fibers are now widely used in making knitwear, carpets, and imitation furs.

Sett and Sur (1992) reported that jute is increasingly being considered for applications where cotton, wool, and synthetic fibers are traditionally used. They explored the development of innovative jute blended yarns spun using DREF spinning systems, particularly jute/cotton (70:30) and jute/viscose (60:40) blends. The study highlighted that blending jute with other fibers improves yarn quality, uniformity, and strength while retaining the natural characteristics of jute. The chief advantages of these yarns included high production rates, lower costs, improved fabric appearance, higher bulk, and greater breaking extension.

Vasantha and Jacob (1993) carried out a study on blending jute with polypropylene and acrylic fibers. They observed that a blend of jute and acrylic in a 20:80 ratio closely resembled pure wool in terms of texture, thickness, and overall appearance, while remaining affordable. The yarn produced from this blend exhibited greater strength than wool yarn. Their findings also highlighted that using acrylic with jute offers an economical alternative for producing durable and visually appealing yarns.

Aditya et al. (1996) reported that blending jute with viscose rayon in proportions of 80:20 and 50:50 and spinning them using conventional jute and cotton systems resulted in yarns with lower tenacity. This reduction in strength was attributed to the significant differences in the load-elongation behavior of jute and viscose rayon fibers. However, when jute-blended yarns were produced using the newer ring spinning technology, their performance improved significantly, making them comparable to cotton yarns of similar counts. The study indicates that modern spinning techniques can enhance the quality of jute–viscose blends, overcoming limitations seen in traditional systems.

Sinha and Basu (2001) investigated the physical properties of jute–acrylic blended bulked yarns. They prepared yarns using three thermal treatments: dry hot air, steam, and boiling water. Their goal was to compare the methods and study the effects of blend composition, ply twist, and treatment time on yarn properties. They found that all three methods produced similar specific volumes. Boiling water treatment was the easiest, most convenient, and economical. The optimum treatment time was 30 minutes. Bulking reduced the flexural rigidity of yarns and increased their extensibility. Tenacity decreased, especially in blends with higher jute content. Increasing the acrylic proportion improved yarn extensibility and influenced specific volume, flexural rigidity, and tensile behavior. Optimal properties were observed in 60:40 and 50:50 jute–acrylic blends. Higher ply twist reduced the bulk of the yarn. The study showed that bulking improved yarn volume and handle. The results suggested that jute–acrylic bulked yarns were suitable for applications where bulk, thermal insulation, and extensibility were more important than maximum strength.

Arya et al. (2014) investigated the effect of yarn and dimensional properties of cotton/polyester (C/P) blends on the tightness factor of knitted fabrics. The study focused on how varying blend ratios influenced the characteristics of weft-knitted fabrics. Cotton/polyester yarns were prepared in ratios of 0:100, 20:80, 40:60, 50:50, 60:40, 80:20, and 100:0 using the OE spinning system. These yarns were analyzed for key parameters including yarn diameter, tenacity, and elongation. Subsequently, the yarns were used to produce knitted fabrics, which were examined for dimensional properties such as loop length, stitch density, loop shape factor, tightness factor, and area shrinkage. The results demonstrated that blending cotton with polyester in different proportions enhanced specific yarn properties for both fibers. In particular, the dimensional analysis showed that increasing the polyester content led to a significant decrease in loop length and area shrinkage, while stitch density and tightness factor increased notably. The study highlights that careful selection of cotton/polyester blend ratios can optimize both yarn performance and fabric dimensional stability, offering valuable insights for fabric manufacturing and textile engineering applications.

Shahid et al. (2016) investigated the physical properties of jute blended yarn using existing jute processing machines. Bangla White B jute fibers were blended with polyester, acrylic, or wool fibers at an 80:20 ratio. Blending was done at the feed stage of the breaker carding machine. The blended slivers were carded, drawn three times, and spun using a slip draft flyer spinning machine. Tensile properties, including tenacity, elongation, and quality ratio, were measured. Jute-polyester yarn showed the highest tenacity (15.81 gm/tex), quality ratio (120%), and lowest unevenness (22.94%). Jute-acrylic and jute-wool yarns were slightly lower in performance. All blended yarns outperformed 100% jute yarn in strength and surface uniformity.

Dip et al. (2018) investigated the physico-mechanical properties of jute–polyester blended yarn. They used B-grade Tossa jute and 1.4 denier polyester fibers, blending them in an 80:20 ratio at the second draw frame of a jute spinning system. Polyester slivers were prepared through carding, drawing, and doubling, while jute fibers were emulsified, carded, and drawn. The blended sliver was spun into yarn using an apron draft spinning machine. Physical tests were conducted to determine yarn count, twist per inch (TPI), single yarn strength, quality ratio, moisture regain, moisture content, hairiness, and constituent fiber percentages. The mean yarn count was 7.5 lbs/spindle, TPI was 6.4, and single yarn strength was 5.2 lbs. The quality ratio averaged 69.78%, moisture regain was 9.64%, and moisture content was 8.8%. The final yarn contained 83% jute and 17% polyester. Some faults such as thick and thin places and uneven distribution of polyester fibers were observed, attributed to differences in fiber length and drafting zone gauge. The study concluded that jute–polyester blending improved yarn properties compared to single fibers and demonstrated a practical approach to combining natural and synthetic fibers for enhanced performance.

Iqbal et al. (2019) investigated the development and evaluation of jute–acrylic blended fabrics for winter clothing. They examined the limitations of 100% jute, such as brittleness and harsh hand feel, and explored blending it with acrylic, a soft, warm, wool-like synthetic fiber, to improve wearability. The fabrics were subjected to chemical treatments including woollenisation, scouring, bio-polishing, and dyeing to enhance their surface, mechanical, and aesthetic properties. Knitted fabrics with different jute–acrylic ratios were tested for crease recovery, drape coefficient, bursting strength, and thermal conductivity. The results showed that the 40/60 blend improved crease resistance by 27.31% and drape by 21.02%, while the 50/50 blend increased crease resistance by 32.33% and bursting strength by 10.04% compared to untreated fabrics. Wear trials further demonstrated that the blended fabrics provided better comfort, hand feel, and overall user satisfaction than 100% jute garments. The study concluded that chemically treated jute–acrylic blends offered superior mechanical, thermal, and aesthetic properties, combining the biodegradability and strength of jute with the softness, warmth, and easy-care benefits of acrylic.

Molla et al. (2022) investigated the production and performance of jute–cotton–viscose blended yarn as an alternative to 100% cotton yarn to promote diversified and sustainable use of jute. A 30/40/30 jute–cotton–viscose blend was spun on a rotor frame and compared with 100% cotton yarn in terms of count, lea strength, and count strength product (CSP). Both yarns showed nearly similar counts (6.0 for the blended yarn and 5.89 for cotton yarn); however, the cotton yarn exhibited higher lea strength (318.6 lb) and CSP (1876) than the blended yarn (208 lb and 1246). Despite lower strength, the blended yarn showed consistent quality parameters, indicating stable yarn formation. The study is significant for introducing viscose into jute–cotton blending, improving spinnability and offering an alternative to pure cotton.

MATERIALS AND METHODS

Blended yarns made from Jute white variety grade 2 and acrylic fibers were obtained from the National Institute of Research on Jute and Allied Fibres, Calcutta. The jute and acrylic fibers used are shown in Figure 1 and 2 respectively. Five jute-acrylic blended yarns were selected with ratios of 10:90, 20:80, 30:70, 40:60, and 50:50, along with pure jute and pure acrylic yarns for comparison. All yarns were knitted into plain fabrics using a 9-inch diameter round knitting machine without a dial at the TITS Jute Extension Centre, Ludhiana, Punjab. The fabrics were tested at TITS, Bhiwani, Haryana, for various physical properties. Fabric count was measured, weight per unit area was determined according to ASTM D 3776-90, and thickness was tested following ASTM D 1777-64. Bursting strength was assessed using ASTM D 3786-87, while abrasion and tear resistance were evaluated as per ASTM D 1175-64. Flexural rigidity was measured according to ASTM D 1388-64, and crease recovery was tested following ASTM D 1295-67. Moisture regain and shrinkage were also recorded as per ASTM D 2654-67. In addition to these objective tests, a subjective evaluation was conducted by thirty experts to assess consumer acceptability of the fabrics. The experts rated the samples on texture, lustre, aesthetic appeal, and woollen feel using a three-point scale, with scores of 3, 2, and 1 assigned for good, medium, and poor, respectively. The mean score for each fabric was calculated to determine overall preference. This combined approach of objective testing and expert evaluation provided a clear understanding of both the physical performance and consumer appeal of the jute-acrylic blended fabrics.

Figure 1- Jute fibers

Figure 2- Acrylic Fibers

RESULTS AND DISCUSSION

The constructional parameters of plain knitted jute–acrylic blended fabrics are summarized in Table 1. All samples were produced under identical knitting conditions, with blend composition as the primary variable. As the jute content increased from 0% (Fabric A) to 100% (Fabric G), a gradual reduction in fabric count was observed. The number of courses decreased from 16 to 8, while the number of wales reduced from 13 to 7, indicating a coarser fabric structure with higher jute incorporation. This reduction can be attributed to the comparatively stiffer and coarser nature of jute fibres, which limits loop formation during knitting. This trend is depicted in Figure 3. Fabric thickness showed a consistent increasing trend with increasing jute content. Thickness increased from 9.4 mm for the 100% acrylic fabric (Fabric A) to 15.0 mm for the 100% jute fabric (Fabric G). Similarly, fabric weight increased steadily from 242 g/m² to 413 g/m² as the jute proportion increased, reflecting the higher linear density and lower compressibility of jute fibres compared to acrylic. Blended fabrics (B–F) exhibited intermediate values of thickness and fabric weight, with thickness ranging from 10.5 to 14.0 mm and fabric weight ranging from 256 to 339 g/m². This indicates that blending jute with acrylic allows for controlled modification of fabric bulk and mass while maintaining a uniform plain knit structure. A significant reduction in fibre cost was also observed with increasing jute content. The fibre cost decreased from Rs. 100/kg for 100% acrylic fabric to Rs. 20/kg for 100% jute fabric. The progressive reduction in cost across blended fabrics demonstrates the economic advantage of incorporating jute fibre into knitted fabric production. Overall, the results indicate that increasing jute content leads to heavier, thicker, and structurally coarser fabrics with reduced production cost, while acrylic contributes to finer fabric construction and lower fabric mass. These findings highlight the potential of jute–acrylic blends for producing cost-effective knitted fabrics with tailored physical properties.

Table 2 summarizes the performance properties of plain knitted fabrics produced from varying jute–acrylic blend compositions. The results clearly demonstrate that fibre composition significantly influences the mechanical, comfort, and dimensional stability characteristics of the fabrics. Bursting strength showed a decreasing trend with increasing jute content. The 100% acrylic fabric (Fabric A) exhibited the highest bursting strength of 17.0 kg/cm², while the 100% jute fabric (Fabric G) showed the lowest value of 3.2 kg/cm². Blended fabrics displayed intermediate bursting strength values, indicating that the inclusion of acrylic fibre contributes substantially to the resistance of the fabric against multidirectional stress. Flexural rigidity increased sharply with increasing jute content, reflecting a rise in fabric stiffness. The flexural rigidity increased from 32.90 mg·cm for Fabric A to 460.79 mg·cm for Fabric G. This substantial increase confirms the rigid and less flexible nature of jute fibres. Fabrics with lower jute proportions maintained better flexibility, whereas higher jute content resulted in stiffer structures. Abrasion resistance improved with increasing jute content. The abrasion cycles increased from 505 (course direction) and 490 (wale direction) for the acrylic fabric to 1300 and 1265 cycles, respectively, for the jute fabric. This trend suggests that jute fibres impart enhanced resistance to surface wear, and blended fabrics exhibited progressive improvement in abrasion performance as jute proportion increased. Crease recovery angles decreased in both course and wale directions with higher jute content. The 100% acrylic fabric showed the highest crease recovery (150° in both directions), whereas the 100% jute fabric exhibited the lowest values (95° in course and 90° in wale direction). This reduction indicates diminished elastic recovery and increased crease retention with higher jute incorporation. Moisture regain increased consistently with increasing jute content, ranging from 1.96% for acrylic fabric to 11.09% for jute fabric. This trend highlights the hydrophilic nature of jute fibres compared to acrylic, contributing to improved moisture absorption and potential comfort characteristics in blended fabrics. Area shrinkage increased with increasing jute content. The 100% acrylic fabric showed negligible shrinkage (0.00%), while the 100% jute fabric exhibited the highest shrinkage of 5%. Blended fabrics demonstrated moderate shrinkage values, suggesting that acrylic fibre improves dimensional stability when blended with jute. Overall, the results indicate a trade-off between mechanical strength and comfort-related properties with varying jute–acrylic ratios. While acrylic-rich fabrics provide higher bursting strength, flexibility, and crease recovery, jute-rich fabrics offer improved abrasion resistance and moisture regain, albeit with increased stiffness and shrinkage. The blended fabrics present a balanced performance profile, making them suitable for diversified textile applications.

Table 3 shows the expert acceptability of jute–acrylic blended fabrics, with emphasis on maximizing jute content while maintaining acceptable fabric quality. Among the blended samples, fabrics C (20:80) and D (30:70) showed balanced performance across all evaluated parameters. Although fabrics with lower jute content recorded slightly higher scores, the differences between Codes B, C, and D were not very large. Texture, lustre, aesthetic appeal, and woollen feel of fabrics C and D remained close to those of the lower jute blends. This indicates that a higher proportion of jute can be incorporated without causing a major decline in expert acceptance. Fabrics with jute content above 40% showed a noticeable reduction in scores, suggesting a limit to acceptable blending levels. Therefore, blends containing 20–

30% jute appear to be optimal, as they allow increased use of jute while maintaining functional and aesthetic properties comparable to lower jute blends. Fabrics C (20:80) and D (30:70) are shown in Figure 4 and 5 respectively.

Fabric Code	Blend Composition Jute: Acrylic	Knit (Stitch)	Fabric Count		Fabric Thickness (mm)	Fabric Weight (g/m^2)	Fibre Cost (Rs/kg)
			Courses	Wales			
A	0:100	Plain	16	13	9.4	242	100
B	10:90	Plain	15	11	10.5	256	92
C	20:80	Plain	14	11	10.9	266	84
D	30:70	Plain	13	11	11.6	280	76
E	40:60	Plain	12	11	12.2	300	68
F	50:50	Plain	10	9	14.0	339	60
G	100:0	Plain	8	7	15.0	413	20

Table 1- Constructional parameters of fabric

Fabric Code	Blend Composition Jute: Acrylic	Bursting Strength (kg/cm^2)	Flexural Rigidity (mg cm)	Abrasion/ Wear & Tear (cycles)		Crease Recovery (°)		Moisture Regain (%)	Area Shrinkage (%)
				Course	Wales	Course	Wales		
A	0:100	17.0	32.90	505	490	150	150	1.96	0.00
B	10:90	15.5	38.43	699	650	145	140	3.28	0.25
C	20:80	12.8	61.17	800	790	135	130	4.18	0.56
D	30:70	10.5	98.10	855	840	125	125	5.22	0.90
E	40:60	8.6	139.59	969	950	120	115	6.06	1.02
F	50:50	6.0	231.48	1000	975	110	105	9.09	1.44
G	100:0	3.2	460.79	1300	1265	95	90	11.09	5

Table 2- Experimental analysis of fabric properties

Fabric Code	Blend Composition Jute: Acrylic	Texture WMS	Lustre WMS	Aesthetic Appeal WMS	Woollen Feel WMS
A	0:100	3.0	2.8	3.0	3.0
B	10:90	2.8	2.8	3.0	2.8
C	20:80	2.6	2.7	3.0	2.6
D	30:70	2.5	2.6	3.0	2.5
E	40:60	2.0	2.5	2.8	2.0
F	50:50	1.2	1.9	1.9	1.5
G	100:0	1.0	1.6	1.5	1

Table 3- Expert's acceptability of fabrics

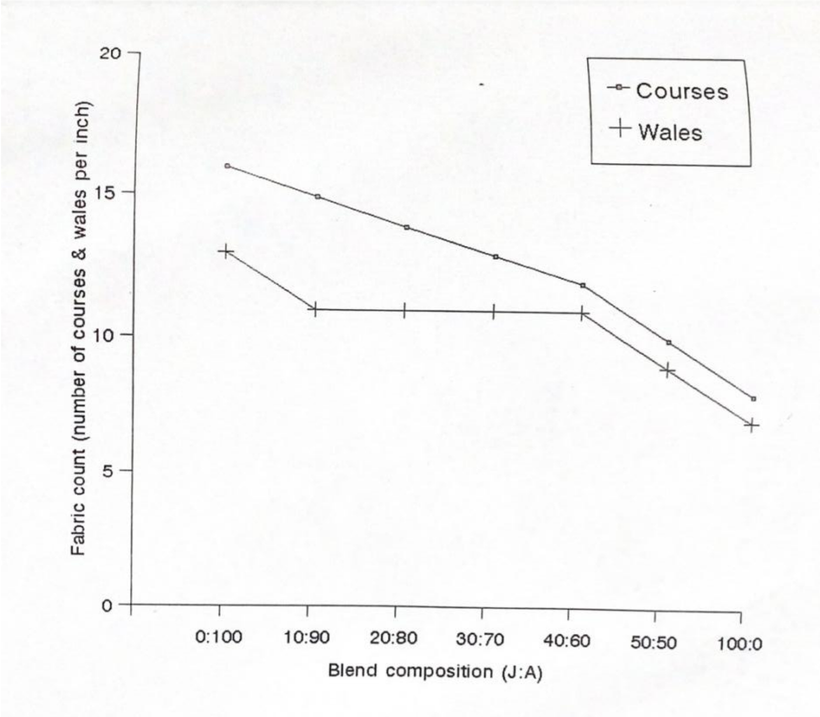

Figure 3- Effect of blend composition on fabric count

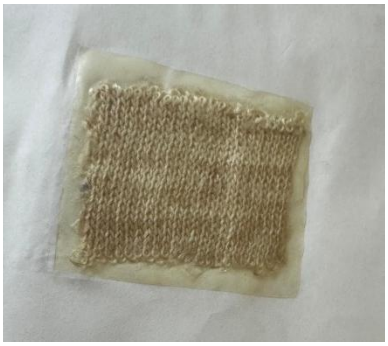

Figure 4- Jute: Acrylic (20:80) fabric

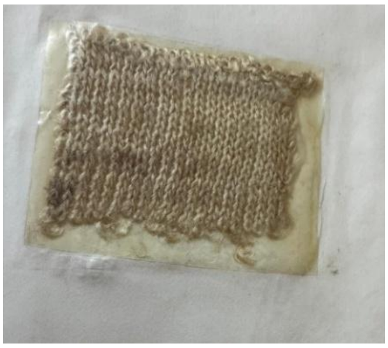

Figure 5- Jute: Acrylic (30:70) fabric

CONCLUSION

This study evaluated the effect of jute–acrylic blend composition on the constructional and performance properties of plain knitted fabrics. Fabric count, bursting strength, abrasion/wear and tear value and crease recovery were found to be maximum for 100 per cent acrylic and decreased with the addition of jute and being least for 100 percent jute. This is due to acrylic being finer, stronger and has more elongation as compared to jute. Fabric thickness, weight, flexural rigidity, moisture regain and shrinkage were found to be maximum for 100 per cent jute and least for 100 percent acrylic. This is due to jute being coarser and stiffer fibre with low extension. It is clear from results that blending of jute with acrylic was found to improve certain properties of jute and that of acrylic. On the basis of laboratory tests, these blends were found to have good strength, wear and tear value, crease recovery, flexural rigidity, moisture regain and having less shrinkage. Blended fabrics exhibited balanced performance with moderate strength, acceptable comfort, and improved dimensional stability. The significant reduction in fibre cost with jute incorporation highlights the economic advantage of these blends. Overall, jute–acrylic blended knitted fabrics demonstrate strong potential for cost-effective, sustainable, and functional textile applications in the woolen and apparel industries. Based on the subjective evaluation, the jute–acrylic blends containing 20:80 and 30:70 proportions showed satisfactory overall performance. These blends were rated well in terms of texture, lustre, aesthetic appeal, and woollen feel by the experts. The results indicate that a higher proportion of jute can be incorporated without significantly affecting fabric acceptability. Hence, the 20:80 and 30:70 blends can be considered suitable and economical options for knitted textile applications.

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