ISSN(Online) : 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2014

Comparative Study of Cotton, Tencel and Cotton/Tencel Blended Ring-spun Yarns

Deepti Sharma

Department of Textile Technology, MLV Textile & Engineering College, Bhilwara (Raj.) India

ABSTRACT: The yarn characteristics of pure cotton, 67:33 cotton–tencel, 33:67 cotton–tencel blends, and pure tencel were studied. Blending was carried out at the draw frame stage. To evaluate the influence of fibre parameters on yarn properties, all machinery parameters were kept constant. The results indicate that the incorporation of tencel significantly enhances single yarn strength, particularly at higher tencel proportions. The presence of tencel also improves the elongation properties of the yarn. The packing fraction of pure tencel and tencel-blended yarns is higher than that of pure cotton yarn. Furthermore, the swelling diameter of pure cotton yarn is lower compared to pure tencel and cotton–tencel blended yarns. Yarn hairiness (H) decreases with increasing tencel content in the blend. It was also observed that the yarn-to-metal coefficient of friction decreases as the proportion of tencel fibre in the blend increases.

KEYWORDS: Ring-spun yarn, Tencel, Yarn diameter, Yarn strength

I. INTRODUCTION

Tencel fibre is increasingly being used in spinning mills, as it can substitute cotton for certain properties. It is considered an eco-friendly fibre because its production involves a solvent-spinning process in which the solvent is largely recycled. Compared to cotton, tencel offers superior drape, moisture management, and lustre.

Blending different fibres to combine the advantages of the parent fibres is a common practice in yarn manufacturing. Numerous studies have examined fibre blending and analysed yarn characteristics experimentally[1-7]. Barella and Manich[8], as well as Canoglu et al.[9], investigated the hairiness of blended yarns. Duckett et al[10]. studied the contribution of inter-fibre friction to breaking energy. Majumdar et al.[11] analysed the properties of ring- and rotor-spun yarns made from cotton and regenerated bamboo fibres. Similarly, Sengupta and Debnath[12] reported studies on jute-based ternary blended yarns, while Choudhuri et al.[13] examined the tensile properties of eri/acrylic blend yarns. Tyagi et al.[14] detailed the comfort behaviour of woven cotton ring and MJS yarn fabrics.

Nowadays, viscose, modal, and tencel fibres are commonly blended with cotton to produce fabrics with enhanced characteristics such as comfort, drapeability, and lustre. Musa Kilic[15] reported the properties of 50:50 cotton–tencel blends produced on different spinning systems. Kilic and Sular[16] further studied the frictional properties of cotton and tencel yarns across various spinning systems.

In the present study, the effect of tencel fibre composition in cotton–tencel blended yarns on yarn strength, elongation, diameter, packing fraction, hairiness, and frictional properties has been investigated.

II. MATERIALS AND METHODS

In this study, four different yarn samples of 30^s (Ne) count were developed using cotton and tencel fibres (Table 1), such as pure cotton yarn, pure tencel yarn, cotton/tencel blend (67:33), and cotton/tencel (33:67) blend. Shankar 6 cotton and standard tencel from Lenzing, Austria were used in this study.

DOI: 10.15680/IJIRSET.2014.0311111

ISSN(Online) : 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2014

Table 1—Properties of cotton and tencel fibres

Parameter	Value
Cotton	
2.5 % span length, mm	27.4
Bundle strength, g/tex	23.8
Fineness, micrograms/inch	4.0
Elongation, %	4.9
Moisture regain, %	7.26
Coefficient of friction (fibre-to-fibre)	
Static	0.27
Dynamic	0.18
Tencel	
Mean length, mm	39.1
Tenacity, g/tex	36.28
Mean denier, titre/tex	1.3
Elongation, %	9.7
Moisture regain, %	10.09
Coefficient of friction (fibre-to-fibre)	
Static	0.21
Dynamic	0.13

In the blow room, the number of beating points and the lap hank (0.0014) were kept constant. During carding, a lower speed was maintained for tencel fibres, while the sliver hank was kept the same (0.13) for both cotton and tencel. The fibres were processed using a Trützschler blow room line and a Trützschler card. Cotton was processed further up to the combing stage, using an LMW LK 250 comber.

Combed cotton slivers and carded tencel slivers were passed through the first draw frame to achieve uniformity and to obtain the required sliver hank for blending at the second draw frame. For the 67:33 tencel/cotton blend yarn, five tencel slivers of 0.141 hank and three cotton slivers of 0.175 hank were combined at the second draw frame. For the reverse (33:67) blend, five cotton slivers of 0.141 hank and three tencel slivers of 0.175 hank were used. In both cases, the blended slivers were delivered with a hank of 0.136 and a draft of 7.2.

The blended slivers from the second draw frame were processed again through a third draw frame to improve uniformity and blending quality, while maintaining the same sliver hank. A Reiter SB 20 draw frame was used for all drawing operations.

For pure cotton yarn, combed cotton sliver was drawn to a hank of 0.136 and then ring spun. Similarly, pure tencel yarn was produced from draw frame sliver of 0.136 hank and subsequently ring spun. The roving was prepared using an LMW LF 1400A, with a roving hank of 1.2 and a spindle speed of 930 rpm. In the ring frame, a twist multiplier (TM) of 3.8 and a spindle speed of 15,000 rpm were maintained. An LR 6/s ring frame was employed for spinning.

Yarn count was determined in accordance with ASTM D1907:2001 standards. Twenty samples were randomly selected for count measurement, and the mean value was calculated. Yarn evenness was assessed as per ASTM D1425:1996 using an Uster Tester 4-SX R2.0 at a testing speed of 400 m/min. Ten samples were tested, and the average value is reported. All testing parameters were evaluated according to standard Uster testing procedures.

ISSN(Online) : 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2014

Tensile properties were measured using an Uster TensoRapid 3 (V7.0) at a testing speed of 5000 mm/min. A total of 200 specimens were tested, and the mean breaking strength, initially recorded in grams, was converted to g/tex. Yarn hairiness was determined following the Uster standard testing method.

Swelling behaviour was also measured. The coefficient of friction was determined in accordance with ASTM D3108:2007 using a Lawson-Hemphill TENSION-W instrument. The wrap angle and input tension were maintained at 180° and 20 g, respectively.

Yarn diameter was measured using a polarised projection microscope, and the average of forty readings is reported. The experimental results are presented in Table 2.

Table 2—Yarn characteristics

Characteristics	Cotton	Cotton/ Tencel (67/33)	Cotton/ Tencel (33/67)	Tencel
Actual count	29.2	29.3	29.4	29.5
Count CV, %	1.2	0.69	0.70	0.72
Single yarn tenacity g/tex	19.12	19.32	19.74	20.74
CV %	7.24	7.22	7.34	7.64
CSP	3086	3617	4068	4648
CV %	3.54	3.67	3.15	3.17
Elongation, %	6.18	6.21	6.83	10.06
U %	10.0	9.67	9.41	9.58
Yarn diameter, mm	0.177	0.161	0.163	0.165
Yarn diameter, mm (Swelling)	0.225	0.224	0.221	0.222
Yarn diameter increase, %	27.12	39.13	35.58	34.55
Packing fraction	0.543	0.713	0.633	0.614
Hairiness (H)	5.7	5.43	5.32	5.22
Coefficient of friction (Fibre- to-metal)	0.15	0.07	0.06	0.06

III. RESULTS AND DISCUSSION

The absolute yarn count of all four samples shows no significant variation, which may be attributed to the consistent machinery parameters and processing conditions maintained during spinning. However, the coefficient of variation (CV%) of count for pure cotton yarn is higher than that of cotton/tencel blends and pure tencel yarn. This indicates that blending tencel with cotton reduces count variation. Similarly, the U% of pure cotton yarn is higher compared to cotton/tencel blended and pure tencel yarns.

Unlike filament yarns, spun yarns fail either due to fibre rupture or fibre slippage. Fibre rupture depends primarily on the intrinsic strength of the constituent fibres and the number of fibres in the yarn cross-section sharing the applied load. In contrast, fibre slippage is influenced by inter-fibre friction, lateral pressure generated by twist, and the differential positioning of component fibres within the blend[17]. Additionally, fibre orientation, distribution, and migration within the yarn structure significantly affect tensile behaviour.

The results show that the inclusion of tencel fibre considerably enhances the strength of blended yarns[18]. However, the

DOI: 10.15680/IJIRSET.2014.0311111

ISSN(Online) : 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2014

67:33 cotton/tencel blend does not exhibit a statistically significant improvement in strength compared to pure cotton yarn, as confirmed by the paired comparison test. This may be due to the predominance of cotton in this blend proportion.

In terms of count strength product (CSP), strength increases progressively from pure cotton to pure tencel yarn. This further confirms that single yarn strength is largely governed by the weakest regions within the yarn structure, while in lea strength testing, the applied load is distributed among multiple yarns. Analysis of strength variation indicates no significant difference in both single yarn strength and CSP values among comparable samples. Notably, pure tencel yarn exhibits very high strength in both single yarn and lea strength measurements.

The elongation behaviour of the yarns follows a trend similar to that observed for single yarn strength. Pure cotton yarn exhibits higher elongation than its parent fibre, which may be attributed to fibre slippage and the partial opening of the fibre helix during tensile deformation. Likewise, pure tencel yarn shows greater elongation than the corresponding fibre elongation.

The addition of tencel fibre slightly increases the elongation of blended yarns, possibly due to differences in the frictional characteristics of the constituent fibres. Thus, yarn elongation in cotton/tencel blends can be attributed to a combined effect of fibre slippage, helix opening under tensile load, and intrinsic fibre elongation. Enhanced elongation is advantageous during weaving preparatory processes and on weaving machines, as it helps reduce end breakage rates in pure tencel and cotton/tencel blended yarns.

The diameter of pure tencel and cotton/tencel blended yarns was found to be lower than that of pure cotton yarn. Packing fraction, calculated based on yarn diameter, was lowest for cotton yarn, while pure tencel and blended yarns exhibited similar packing fraction values. This indicates that tencel fibres pack more efficiently within the yarn structure, even in blends. Such behaviour may be attributed to the higher fibre length and lower modulus of tencel.

Yarn diameter was also measured after wet swelling. The percentage increase in diameter upon wetting was comparatively lower for pure cotton yarn. This variation may be due to differences in the moisture absorption characteristics of cotton and tencel fibres.

Hairiness in spun yarn is primarily influenced by fibre length, twist level, fibre bending rigidity, and the spinning system employed. In the present study, the spinning system and twist level were kept constant. It was observed that 100% tencel yarn exhibits lower hairiness compared to blended yarns, while pure cotton yarn shows the highest hairiness. The incorporation of tencel fibre reduces the hairiness (H) value, which may be attributed to the absence of short fibres and the lower modulus of tencel fibres.

The frictional behaviour of blended yarns shows a significant reduction in the coefficient of friction with the addition of tencel, compared to pure cotton yarn. Variations in both static and dynamic frictional properties of the parent fibres influence the overall frictional characteristics of the blend. Even a small proportion of tencel in the blend causes a noticeable decrease in the friction coefficient, possibly due to a sheath–core effect, where tencel fibres predominantly occupy the yarn surface. The differences in hairiness among all samples were found to be statistically significant. Therefore, it can be concluded that the presence of tencel fibre reduces the coefficient of friction of the resultant yarn.

Overall, the study demonstrates that increasing the proportion of tencel fibre significantly enhances the strength of blended yarns. Yarn elongation shows only a marginal increase with higher tencel content. Pure cotton yarn has a larger diameter than pure tencel and cotton/tencel blended yarns. However, upon wet swelling, the percentage increase in diameter is comparatively lower for cotton yarn due to its lower water absorption under the test conditions. Blending tencel with cotton reduces yarn hairiness, and even at lower proportions, tencel significantly influences the frictional characteristics of the yarn. The favourable frictional behaviour of tencel indicates strong potential for improving the comfort properties of fabrics made from cotton/tencel blends.

DOI: 10.15680/IJIRSET.2014.0311111

ISSN(Online) : 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2014

REFERENCES

1. Ratnam T V, Shankaranarayana K S, Underwood C & Govinarajulu K, *Text Res J*, 38 (1968)360.
2. Zurec W, Sobieraj I & Trzesowska T, *Text Res J*, 49 (1979)438.
3. Ishtiaque S M, Das A & Prashant Vishnoi, *Indian J Fibre Text Res*, 36 (2011)152.
4. Sett S K, Mukhejee A & Sur D, *Text Res J*, 70 (2000) 723.
5. Debnath C R & Bandyopadhyay S B, *Text Res J*, 45 (1975)404.
6. Debnath C R, *J Text Inst*, 65 (1974)393.
7. Sandeep D N, Shivaprakash A V & Maharaddi V H, *Man-Made Text India* 39 (2011)89.
8. Barella A & Manich A, *Text Res J*, 54 (1984)840.
9. Canoglu S & Tanir S, *Text Res J*, 79 (2009)235.
10. Duckett K E, Goswami B C & Ramey H H, *Text Res J*, 49 (1979)262.
11. Abhijit Majumdar, Samrat Mukhopadhyay, Ravindra Yadav & Achintya Kumar Mondal, *Indian J Fibre Text Res*, 36 (2011)18.
12. Surajit Sengupta & Sanjay Debnath, *Indian J Fibre Text Res*, 42 (2012)217.
13. Prabir Kumar Choudhuri, Prabal Kumar Majumdar & BijonSarkar, *Indian J Fibre Text Res*, 38 2013)66.
14. Tyagi G K, Bhattacharya S & Kherdekar G, *Indian J Fibre Text Res*, 36 (2011)47.
15. Musa Kilic, *Text Res J*, 81 (2011)56.
16. Gonca Balci Kilic & VildanSular, *Text Res J*, 82 (2012) 755.
17. Balasubramaniam N, *Text Res J*, 40 (1970)129.
18. Rajesh D Anandjiwala, Bhuvanesh C, Goswami, Charles K Bragg & Jefferson D Bargeron *Text Res J*, 69 (1999)129.