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Research Article

Quality Characterstics of Cotton, Polyester, Bamboo and Tencel Yarns

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ABSTRACT

Quality characterstics of pure 100 per cent yarns and blended yarns differs to a greater extent. Thus random mixing of different fibres is the most common practice of yarn formation as a result textile fibre is blended to incorporate desirable properties. The most important factor that determines the yarn properties is type of yarn used and ratio of fibres used in the blend. Thus an attempt was made to study the quality characterstics of cotton and polyester yarns with that of regenerated yarns Bamboo and Tencel. Yarn count, yarn twist, yarn crimp, yarn evenness, yarn hairiness, yarn strength and elongation and count strength product using standard methods were assessed. Data analysis was carried by two way ANOVA method two and three factorial analysis using Windostat software. The results indicated that Cotton and Polyester yarns possessed good amount of yarn twist, count strength product, while Polyester yarn possessed good amount of strength and elongation when compared to Cotton due to the plastic nature of Polyester. Bamboo yarns possessed lesser strength when compared to Tencel yarns.

Keywords: *Bamboo, Tencel, Cotton, Polyester and Yarn*

INTRODUCTION

A yarn is a long continuous length of aligned fibres used in production of textiles using sewing, crocheting, knitting, and weaving techniques. Yarns can be by made using number of natural or synthetic fibres. Yarn production depends upon the nature of fibre and its constituents. Thus there are two types of yarns mainly: Spun and filament. Cotton and polyester are most commonly spun fibre. While cotton is grown throughout the world, harvested, ginned and spun to form yarns on the contrary synthetic fibres like polyester are generally extruded in continuous strands using melt spinning techniques.

With the growing demands for more comfortable, healthier and environmental friendly products, efforts in research and development activities in the textile industry have focused on the utilisation of renewable and biodegradable resources as well as environment friendly manufacturing processes in textiles. With respect to the above aspect new kind of regenerated fibres an alternative to cotton have gained importance in apparel and home textiles manufacturing.

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The most commonly known novel regenerated fibre Lyocell (also called as Tencel) produced from wood pulp and Bamboo fibre obtained by bamboo leaves of Bamboo plant by wet spinning technique are the recent ecofriendly fibre/yarns being used (Sekerden, 2011).

The most important factor that determines the yarn properties are the type and ratio of the fibres used in the blend, machine used for yarn manufacturing process and count of yarns used. Thus an attempt has been made to study the quality characterstics of cotton and polyester yarns with that of bamboo and tencel yarns (Erdumulu et al., 2008).

MATERIALS AND METHODS

In this study cotton and polyester yarns were procured from KHDC, Gadag while bamboo and tencel yarns of 20s and 30s counts were procured from Pallava textile mills, Coimbatore. Procured yarns were subjected for testing physical (Yarn crimp, evenness, hairiness, count and twist) and durable (single yarn strength and elongation, lea yarn strength and elongation and count strength and elongation) properties of the yarns and were recorded as per standard testing methods after conditioning the specimens at standard testing relative humidity and temperature for 24 hours.

Physical parameters of Cotton, polyester, bamboo and tencel yarns

Yarn count of polyester yarns were calculated manually using indirect system of yarn count through a formula

$$\text{Count (Nm)} = \frac{\text{Length in meters}}{\text{Weight in grams}}$$

On the other hand, cotton, bamboo and tencel yarns count were assessed using Beesley's balance. Using the template full cotton was marked and yarns from the fabrics were separately raveled in warp and weft direction, weighted on the pointer of the instrument further the yarns were removed and counted and readings were recorded (Booth,1996).

Yarn of 10 inch length were mounted on twist tester for testing yarn twist expressed in terms of twist per inch (tpi) or twist per meter (tpm).

Yarn crimp is used for measuring the percentage of crimp in the yarn which is removed from fabrics. A strip of fabric of 2.5 cm wide and 25 cm long in the warp and weft directions are cut separately. Each strip is trimmed so that at each end all the longitudinal threads terminate at the same crossing thread. The lengthwise thread is removed gently from the strip of the fabric by means of a needle, leaving about an inch at each end in the fabric strip and is fixed in the pivoted grip of the crimp tester, upto the reference mark in the grip. The movable grip is moved away from the pivoted grip till pivoted arm becomes horizontal. The reading of the movable grip is taken and the yarn crimp is recorded.

Yarn hairiness (number of hairs/km) and the length of the hair (mm) of cotton, polyester, bamboo and tencel yarns in the current study were recorded using the instrument Zweigle hairiness tester. The speed of the tested sample was 25 meter/minute and length of the specimen required for each reading requires 10 meter and the test was carried out at DKTE, Ichalkaranji.

Yarn evenness is the measure of the evenness and unevenness of the yarn diameter throughout its length. Evenness of cotton, polyester, bamboo and tencel yarns were tested on USTER Tester 4 SE at textile cooperative mill, Gadag. Size of the specimen required to take each observation was 1 kilometer further five observations were recorded.

Durable parameters of Cotton, polyester, bamboo and tencel yarns

Single yarn strength is a measure of its resistance to the gradually increasing force. It is usually expressed in terms of tenacity. Tenacity is defined as the mass stress at break and is ratio of breaking strength in gram force to linear density in Tex units. Hence its unit is kg/tex.

Elongation is the increase in length of the specimen from its initial length expressed in units of length. The distance that material will extend under a given force is proportional to its original length. Hence elongation is quoted as strain or percentage extension. The breaking strength of the yarn determined is usually taken as an index of yarn quality and is expressed either in grams or pounds. The specimens were tested as ASTM D2256 using MAG Unistretch 250 instrument.

The lea strength is the tensile strength of a skein of 80 revolutions on the warp reel, comprising 120 yards of yarns. The lea strength is probably the most useful indicator of single yarn strength. Since it depends upon variability as well as single thread strength (Saville, 2004). It is the accepted trade measure of the strength of many yarns. Lea strength of cotton, polyester, bamboo and tencel yarns was tested on lea strength tester.

Statistical analysis was carried out by two way ANOVA two and three factorial designs using WINDOSTAT software developed by INDOSTAT services.

RESULTS AND DISCUSSIONS

Table 1 indicated that, cotton yarns obtained highest yarn twist (16.84) when compared to polyester (9.26), tencel (9.24 and 4.84) and bamboo(3.84 and 3.26) yarns which may be due to the fibre content, the crysatllinity of cotton fibre which enhances the yarn to twist more, further adding strength. Similar results with respect to twist of cotton yarns were obtained in a study on Effect of blend ratio on quality characterstics of bamboo/cotton blended ring spun yarn by Prakash et al. (2011).

Likewise the count strength product was also seen higher in cotton (2954) and polyester (8335.0) yarn may be because of the yarn count and yarn twist contributes to strength of the yarn which ultimately enhances the count strength product.

The results obtained in the Table 2a and 2b indicates that, Cotton × Cotton fabric obtained highest yarn crimp in both warp (26.48%) and weft direction (26.82%) when compared to Polyester × Bamboo 20s in warp direction (27.16%) and Polyester × Polyester in weft direction (26.20%) in polyester union fabrics. This may be attributed to the reason that in general because of filamentous origin polyester yarns have more plasticity than elasticity and also possess higher tenacity. On the other hand, cellulosic yarns have elastic property which contributes to better crimp percentage, thus making a fabric more flexible.

Statistical results explain the interaction behaviour among the fabrics, in warp and weft direction and in between fabrics and warp and weft direction. Hence significant results were obtained in interaction between the fabrics (0.07*), in warp and weft direction (0.04*) and also in between the fabrics and warp and weft directions (0.10*) in case of cotton union fabrics, while in polyester union fabrics interaction between the fabrics (0.08*), in warp and weft direction (0.05*) and also in between the fabrics and warp and weft directions (0.12*) at 5 % level of significance (Table 2a and 2b).

Table 3 indicated that among all the yarns tencel 30s (8.4), bamboo 30s (8.2), and cotton (8.0) yarns had the highest unevenness percentage, while thick places were higher in cotton (8) and bamboo 30s yarns which may be due to an uneven blend of two or more fibres will alter the relative permittivity (dielectric constant) in parts of the yarn and hence appear as unevenness.

Yarn irregularity *viz.,* neps were found to be higher in polyester and tencel (20s) yarns as in staple yarns evenness can be achieved with certain natural limits thus to produce regular yarn same number of fibres should be present in each cross-section throughout the yarn. Whereas, polyester possessed lesser number of thick places when compared to cotton may be because polyester being synthetic in nature and in filamentous form is extracted under controlled conditions thereby reducing the presence of thick places. On the contrary cotton being extracted naturally from pods possesses number of variations within the fibre strand creating difficulties during spinning process thus increasing the number of thick places and neps. The results are on par with the study conducted by Majumdar et al. (2011) who concluded that, 100 per cent cotton and bamboo yarns have comparable yarn unevenness percentage. However, while in case of 30s bamboo yarn, the unevenness percentage was higher than that of 20s bamboo yarn.

Statistical results showed that the interaction among the yarns (0.47), warp and weft directions (0.33) were found to be non-significant. Whereas the interaction between the yarns and the directions (0.81*) was found to be significant at 5 per cent level of significance.

According to the results presented in Table 4 it is seen that bamboo 20s yarn possed highest hairiness (770) and length of hairs (922) ranging from 3mm to 15 mm compared to other yarns which may be attributed to the yarn manufacturing, yarn production techniques. Higher yarn hairiness leads to faulty and poor quality of yarns that affects the thermal insulation and other apparel characterstics. Majumdar et al. (2011) reported that yarn hairiness of bamboo was found to be higher than cotton as bamboo fibres are longer in length when compared to cotton fibres. Statistical results depicted non significant difference among all the yarns, at different lengths of hairiness and the length of hairs (0.26) and combination of different yarns and lengths of hairiness and length of hairs (0.65) at (5 %) level of significance.

Data depicted in Table 5 explains that, polyester yarns obtained highest single yarn strength (1152.9) and elongation (9.8) which is because of well aligned polymer orientation of polyester fibres and high crysatllinity which takes more time to break the yarn at greater force applied thus increasing the tenacity of the yarn. Contrarily, cotton yarns have more of waviness and elastic nature but less crystalline region than polyester yarns hence they tend to break at lower force applied. The results are in line with explanation of Majumdar et al. (2011) and stated that, breaking elongation of cotton is much lower than that of bamboo yarns. Sekerden (2011) reported that, 100 per cent cotton and bamboo yarns have high tenacity and elongation at break.

Interaction among the yarns (2.30*), yarn strength and elongation (1.33*) and between yarns and yarn strength and elongation (3.25*) were found to be significant at (5 %) level of significance.

Table 6 explained that polyester yarn exhibited highest lea yarn strength (403.9) than cotton yarns (152.6) which is due to the friction of the pulleys on which the hanks were mounted and also the yarn friction. Yarn friction may alter by the fibre constituent of the yarn and also the force at which the yarn initiates to break which depends on the type of instrument used. As the braking elongation of cotton fibres/yarn are expected to reach the rupture point earlier resulting in collapsing the entire yarn structure which makes the yarns unstable to take the load applied thus cotton yarns possessed lesser, elongation when compared to bamboo yarns. Results are on par with a study on properties of ring-spun yarns made from cotton and regenerated bamboo fibres by Majumdar et al. (2011).

Table 6 explains that, interaction among the yarns (0.72*), Lea yarn strength and elongation (0.41*) and interaction between yarns and Lea yarn strength and elongation (1.02*) were found to be significant at 5 per cent level of significance.

Table 1: Physical properties of cotton, bamboo, tencel and polyester yarns

Sl. No.	Yarns	Yarn count	Yarn twist (TPI)	Count strength product (CSP)
1.	Cotton	2/20s	16.84	2954
2.	Polyester	80d	9.26	8335.0
3.	Bamboo	20s	3.26	1540.6
		30s	3.84	1373.1
4.	Tencel	20s	4.84	2947.8
		30s	9.24	2610.9

Table 2a: Yarn crimp of yarns obtained from cotton union fabrics

Sl. No.	Fabrics	Yarn crimp (%)	
		Warp	Weft
1.	Cotton × Cotton	26.48	26.82
2.	Cotton × Bamboo20s	25.80	25.94
3.	Cotton × Bamboo30s	25.94	25.80
4.	Cotton × Tencel20s	25.82	26.18
5.	Cotton ×Tencel30s	25.82	26.02

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Union fabrics)	0.02	0.07*
B- (Warp and weft)	0.01	0.04*
A × B- (Union fabrics) × (warp and weft)	0.03	0.10*

*- Significant at 5 % level of significance; CD- Critical difference

Table 2b: Yarn crimp of yarns obtained from polyester union fabrics

Sl. No.	Fabrics	Yarn crimp (%)	
		Warp	Weft
1.	Polyester × Polyester	26.42	26.20
2.	Polyester × Bamboo20s	27.16	25.94
3.	Polyester × Bamboo30s	26.06	25.66
4.	Polyester × Tencel20s	26.06	25.96
5.	Polyester ×Tencel30s	26.40	25.96

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Union fabrics)	0.03	0.08*
B- (Warp and weft)	0.01	0.05*
A × B- (Union fabrics) × (Warp and weft)	0.04	0.12*

*- Significant at 5 % level of significance; CD- Critical difference

Table 3: Yarn evenness of cotton, bamboo, tencel and polyester yarns

Sl. No.	Yarns	Yarn Evenness		
		Unevenness %	Thick places/km	Neps /km
1.	Cotton	8.0	8	7
2.	Polyester	7.8	7	8
3.	Bamboo 20	8.0	7	7
4.	Bamboo 30	8.2	8	7
5.	Tencel 20	7.6	7	8
6.	Tencel 30	8.4	7	7

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Yarns)	0.16	0.47 NS
B- (Unevenness %, thick places, neps)	0.11	0.33NS
A × B- (Yarns) × (unevenness %, thick places, neps)	0.29	0.81*

*- Significant at 5 % level of significance; CD- Critical difference; NS-Non significant

Table 4: Yarn hairiness of cotton, bamboo, tencel and polyester yarns

Sl. No.	Yarns	Yarn hairiness (No of hairs/km)						
		3mm	4mm	6mm	8mm	10mm	12 mm	S3
1.	Cotton	200	6	14	3	3	3	246
2.	Polyester	190	8	2	0	0	0	200
3.	Bamboo 20	770	42	84	26	0	0	922
4.	Bamboo 30	255	12	34	0	0	0	303
5.	Tencel 20	274	8	22	1	0	0	307
6.	Tencel 30	304	4	30	0	0	0	340

S3- Length of hair (3-15 mm)

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Yarns)	0.09	0.26 NS
B- (3, 4,6,8,10 mm and length of hairs)	0.09	0.26 NS
A × B- (Yarns) × (3, 4,6,8,10mm and length of hairs)	0.23	0.65 NS

*- Significant at 5 % level of significance; CD- Critical difference; NS- Non significant

Table 5: Single yarn strength and elongation of cotton, bamboo, tencel and polyester yarns

Sl. No.	Yarns	Single yarn strength (kgf)	Elongation (%)
1.	Cotton	556.5	4.5
2.	Polyester	1152.9	9.8
3.	Bamboo 20	166.4	9.1
4.	Bamboo 30	132.6	8.4
5.	Tencel 20	447.4	6.6
6.	Tencel 30	287.7	6.1

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Yarns)	0.81	2.30*
B- (Single yarn strength and elongation)	0.46	1.33*
A × B- (Yarns) × (Single yarn strength and elongation)	1.14	3.25*

*- Significant at 5 % level of significance; CD- Critical difference

Table 6: Lea yarn strength and elongation of cotton, bamboo, tencel and polyester yarns

Sl. No.	Yarns	Lea yarn strength (lbs)	Elongation (%)
1.	Cotton	152.6	6.78
2.	Polyester	403.9	11.75
3.	Bamboo 20	78.2	14.86
4.	Bamboo 30	46.5	14.25
5.	Tencel 20	143.2	10.22
6.	Tencel 30	87.78	9.91

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)
A- (Yarns)	0.25	0.72*
B- (Lea yarn strength and elongation)	0.14	0.41*
A × B- (Yarns) × (lea yarn strength and elongation)	0.36	1.02*

*- Significant at 5 % level of significance; CD- Critical difference

CONCLUSION

Yarn acts as a base material in textiles which depicts the wear and tear, durable characterstics of the yarns based on which fabric production can be decided. But for understanding the yarn characterstics one needs to understand the fibre content and ratio of fibre incorporated in the blend which acts as a deciding factor in planning up the usage of yarns for further production processes. Cotton and polyester yarns possessed good amount of yarn twist, count strength product, while polyester yarn possessed good amount of strength and elongation when compared to cotton due to the plastic nature of polyester and bamboo yarns possed lesser strength when compared to tencel yarns.

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