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QUALITY PARAMETERS ANALYSIS OF RING SPUN YARNS MADE FROM DIFFERENT BLENDS OF BAMBOO AND COTTON FIBRES

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ABSTRACT

Besides its decorative handicraft antiques and other conventional uses, the importance of bamboo crop has been increased due to its use in textiles as a vegetable fibre. The absorbent nature of bamboo fibre has lead to its various applications in textiles. The focus of present research is to optimize the quality of bamboo/cotton blends. Therefore, present study investigates the influence of bamboo/cotton fibre blends in rotating blend ratios on the quality of ring spun yarns. The other yarn tensile properties affecting variables like break draft and twist multiplier are also included in this research study. The best results were recorded at twist multiplier 3.9 and break draft 1.27. The moisture regain capacity of bamboo fibre was remarkably higher than that of cotton. However, the tensile strength decreases with increase in bamboo share in blended yarn.

Keywords: *Bamboo fibres, blend ratios, ring spun yarn, yarn strength, knitted fabric shrinkage.*

INTRODUCTION

Textiles demand varies from year to year with the changing fashion; the consumer's preference influences the demand for different types of fibres. The increase in the world demand for textile fibres is expected to continue not only due to increase in the world population but also due to the standards of living. Therefore, the focus of fibre research has shifted towards the exploration of the new fibres and their combinations with the older ones.

In Asia, bamboo has been used in the traditional hand-made production of paper for centuries. Now, through a modern manufacturing process, bamboo pulp is capable of producing bamboo fibre for use in yarn and fabric. Bamboo fibre is a kind of regenerated cellulosic fibre which is produced from raw material of bamboo pulp. Starchy pulp is produced through a process of alkaline hydrolysis and multi-phase bleaching; further chemical processes produce bamboo fibre.

Bamboo can be spun purely or blended with other materials such as cotton, hemp, silk, lyocell and modal. Cotton has been one of the most human friendly plant with its soft, luxury and hygienic touch to the skin. The purpose of blending is to produce yarn with such qualities that cannot be obtained by using one type of fibre alone. Blending is also practiced for reasons of economic production, shortage of natural fibre, better performance in spinning, to improve the yarn strength, yarn evenness, imperfection level etc. Previously in their research work Pan and Postle (1995) investigated that fibre blend ratio was found to influenced not only the yarn strength but also the yarn strength distribution. The properties of blended yarn cannot be explained merely in terms of the proportion of the different constituent fibres in the blends. The combination of bamboo and cotton proved as a supreme blend components for modern and luxurious life style. However, the tensile strength of the yarn produced by the bamboo fibres is lower than viscose rayon as reported by Shanmugasundaram, & Gowda, (2010), The present study was conducted to try different blend combinations of bamboo and organic cotton for the optimum quality of the fabric with excellent absorbency.

MATERIAL AND METHODS

The present study was initiated in the Department of Fibre and Textile Technology, University of Agriculture, Faisalabad and was mainly conducted at Azgard-9 Textile Mills Limited Muzzaffargarh, Multan division. The bamboo fibre was imported from China and medium staple cotton of Punjab, Pakistan was collected from running stock of the mills having the following fibre characteristics.

Table 1: Characteristics of Cotton and Bamboo Fibres

Cotton Fibre Characteristics		Bamboo Fibre Characteristics	
Fibre Length	28.41 mm	Staple Length	38 mm
Uniformity Index	86.16 %	Colour/Luster	Semi dull
Fibre Fineness	4.27 µg/inch	Fibre Denier	1.45
Fibre Bundle Strength	27.88 g/tex	Tenacity	2.37 cN/dtex
Maturity Ratio	0.90	Elongation	23.32%
Moisture Regain	8.5	Moisture Regain	13.01%

Spinning Process:

Bamboo and cotton fibres were processed separately in Blow room and then card slivers of individual components were obtained. The raw material blended in rotating ratios given here under at draw frame. The resultant composite roving samples were spun into yarn samples of count Ne 30^s at the same spindles of the ring frame by varying break draft and twist levels as given in Table 2:

In total sixty three (63) yarn samples were spun using the above mentioned variables. Then these sixty three samples were tested for their physical characteristics.

Table 2: Variables of Research

Bamboo/Cotton		Break Draft		Twist Factor	
B_1	100:0	D_1	1.23	T_1	3.5
B_2	90:10	D_2	1.25	T_2	3.7
B_3	70:30	D_3	1.27	T_3	3.9
B_4	50:50				
B_5	30:70				
B_6	10:90				
B_7	0:100				

Yarn Characteristics

Yarn samples prepared at each set of above changes were tested for the following important quality characteristics.

Yarn Lea Strength:

Yarn strength was expressed in term of "Lea strength" and was determined on pendulum type tester by "Skein method" as suggested by ASTM committee (1997).

Single Yarn Strength:

Tensile properties of the yarn samples viz, single and strength, yarn elongation and rupture per kilometer were calculated with 'Uster Tensorapid-3' which acts on the principle of Constant Rate of Extension (CRE) principle according to ASTM Committee (1997a).

Yarn Moisture Regain

Regain is the weight of water in a material expressed as a percentage of the oven dry weight:

$$Moisture\ Regair\ \% = \frac{W}{D}\ x\ 100$$

Where, D is the dry weight and W is the weight of absorbed water by the material.

Knitting Process

All the 63 yarn samples were subjected to knitting process on Terrot brand knitting machine having 24 inch gauge, 25 feeders, 24 inch cylinder diameter and of dial height 4 inch. Single Jersey fabric samples were prepared and conditioned. Then, the following fabric characteristics were determined.

Fabric Characteristics

Knitted Fabric Shrinkage:

The lengthwise & widthwise shrinkage percentages of knitted fabric samples were measured according to ASTM. Shrinkage was calculated by following formula:

$$Fabric\ Shrinkage\ \% = \frac{A - B}{A}\ x\ 100$$

Where, A is the fabric measurement before washing and B is that of after washing.

Statistical Analysis:

The data thus obtained was statistically analyzed by Analysis of Variance (ANOVA) technique using 3-Factor Factorial experiments under Complete Randomized Design (CRD) as suggested by Faqir (2004). M-stat micro computer statistical program devised by Freed (1992) was also used.

RESULTS AND DISCUSSION

The focus of present study was to examine the influence of change in blend ratios, break draft and twist multiplier on yarn tensile strength and other concerned quality parameters i.e. single end strength, Rupture per kilometer and yarn elongation% and ultimate knitted fabric shrinkage%. Therefore, the results about these quality parameters are discussed in Table 1 to Table 4.

Yarn Characteristics

Yarn Lea Strength

The data of lea strength was subjected to statistical analysis of variable (ANOVA), which indicated that the effect of different twist multiplier (T) break draft (D) and blend ratio (B) were highly significant while all their interactions influenced the yarn lea strength non-significantly.

Comparison of individual treatment mean values for yarn lea strength under the effect of different twist multiplier (T) was presented in Table 3 exposed that the mean values of yarn lea strength for T_3, T_2 and T_1 ranked as 74.07, 73.08 and 72.10 pounds respectively. These values differed significantly from each other. The results showed that with increased in twist factor, the average value of lea strength also increased. These results were almost in line with the findings of Haider (2000) who concluded that with the increased in twist multiplier (TM), the average value of lea strength also increased. Similarly, Biermann and Jansen (2003) expressed that the twist factor was particularly significant and had an effect on the tensile strength of ultimate yarn. These results also supported by the findings of Almashouley (1988) who narrated that strength of cotton yarn vary with twist. Up to a certain point additional twist caused an increase in strength, however, beyond that point added twist caused a decrease in strength. The logic of this increase in strength with the increase of twist is that the fibres get composed giving their accumulative strength increased, however, beyond the optimum twist limit further twist insertion causes fibre damage and therefore a sudden fall in the yarn strength is noted.

Table 3 illustrated the effect of break draft (D) at ring machine on yarn lea strength significantly. The skein strength mean values 73.75, 73.22 and 72.28 pounds for D_3, D_2 and D_1 respectively, which showed that the effect of different level of break draft was significant on yarn lea strength. The present findings were found at par with the study results of Shafique (2002) who reported that effect of different levels of break draft on yarn lea strength was highly significant. The rationale behind this observation is that draft causes fibre attenuation and displacement that might be because of skein strength variation with the change of draft distribution of the fibrous strand.

In case of change in blend ratio (B) Table 3 showed the influence from the comparison of the individual treatment mean values for yarn lea strength. The lea strength values for blend ratio (B) were ranked as 73.65, 73.56, 73.29, 72.98, 72.87, 72.83 and 72.40 pounds for B_7, B_6, B_5, B_4, B_3, B_2 and B_1 respectively. These values differed significantly from each others. These values showed that fibre blend ratio influenced yarn lea strength and also that the cotton yarn was found to be stronger than 100% bamboo yarn. The results agree with the findings of Pan and Postle (1995) who investigated that fibre blend ratio was found to influence not only the yarn strength but also the yarn strength distribution. Moreover bamboo/cotton blended yarns of Ne 30^s Hosiery showed that the actual values for tenacity and elongation as lower than that of cotton Ne 30^s Hosiery. The reality of low tenacity of bamboo fibre than that of cotton might be due to its manufacturing process influence being n-cellulosic chain from pure bamboo cellulose, as in case of rayon from cotton linter or wood pulp.

Single End Strength (SES)

The statistical analysis of variance regarding single end strength was given in Table 3, which indicated that the effects of blend ratio (B), break draft (D) and twist multiplier (T) were highly significant while all their interactions influenced the single end strength non-significantly.

Comparison of individual treatment mean values for single end strength under the effect of different twist multiplier (T) was presented in Table-2 elaborated that the mean values of SES for T_3, T_2 and T_1 as 320.97, 316.67 and 312.63 grams respectively. These values differed significantly from each others. The results showed that with increased in twist factor, the value of single end strength also increased. These results were supported by the findings of Iqbal (1992) who observed that by increasing the twist factor, the value of yarn single end strength increased (Twist factor had a large influenced on yarn strength).Similarly, Jamil *et al*. (2001) who expressed that different break draft and twist multiplier produced highly significant effect on single yarn strength. The results found also agree with the findings of Oxtoby (1987) who stated that the strength of yarn depends on the fibre strength, the frictional resistance to slippage and the effect of fibre themselves being twisted about their own individual axes.

Comparison of individual treatment mean values for single end strength under the influence of different break draft (D) as presented in Table-2 exposed the mean values of SES for D_3, D_2 and D_1 ranked as 319.58, 317.28 and 313.40 grams respectively. These values differed significantly from each others, which showed that the effect of different level of break draft was significant on single end strength. The results found agree with the findings of Jamil *et al.* (2001) expressed that different break draft and twist multiplier produced highly significant effect on single end strength.

In case of change in blend ratio (B) Table 3 showed the influence from the comparison of the individual treatment mean values for single end strength. The single end strength values for blend ratio (B) were ranked as 319.15, 318.74, 317.59, 316.25, 315.75, 315.59 and 314.22 grams for B_7, B_6, B_5, B_4, B_3, B_2 and B_1 respectively. These values differed significantly from each others. These results were supported by the findings of Pan and Postle (1995) who investigated that fibre blend ratio was found to influence not only the yarn strength but also the yarn strength distribution. Moreover, bamboo/cotton blended yarns of $Ne30^s$ Hosiery showed that the actual values for tenacity and elongation as lower than that of cotton Ne30^{s} Hosiery. Similarly Krifa *et al.* (2001) who stated that many factors had an impact on yarn strength, which depended on both fibre quality parameters and spinning condition. Also Oxtoby (1987) who stated that the strength of yarn depends on the fibre strength, the frictional resistance to slippage and the effect of fibre themselves is being twisted about their own individual axes.

He further stated that bamboo/cotton blended yarns of Ne 30^{s} Hosiery showed that the actual values for tenacity and elongation as lower than that of cotton Ne 30^{s} Hosiery. These results were also in line with the findings of Booth (1983) who defined breaking length as the length of specimen, which would just break under its own weight when hung vertically. He also stated that the expression of the strength in term of breaking length was useful for comparing single fibre strength with yarn strength.

Table 3: Individual Comparison of Mean Values for Lea-Strength and Single End Strength

Blend ratio (B)			Break draft (D)			Twist multiplier (T)		
	Lea Strength (lbs)	**Single End Strength (g)**		**Lea Strength (lbs)**	**Single End Strength (g)**		**Lea Strength (lbs)**	**Single End Strength (g)**
B_1	72.40 g	314.22 g	D_1	72.28 c	313.40 c	T_1	72.10 c	312.63 c
B_2	72.83 f	315.59 f	D_2	73.22 b	317.28 b	T_2	73.08 b	316.67 b
B_3	72.87 e	315.75 e	D_3	73.75 a	319.58 a	T_3	74.07 a	
B_4	72.98 d	316.25 d						
B_5	73.29 c	317.59 c						
B_6	73.56 b	318.74 b						
B_7	73.65 a	319.15 a						

Mean values having different letters differ significantly at 0.05 level of probability

Yarn moisture regain (%)

The statistical analysis of variance regarding yarn moisture regain indicated that the effect of blend ratio (B) was highly significant while the variables twist multiplier (T), break draft (D) and all their interactions influenced the yarn moisture regain non-significantly.

Comparison of individual treatment mean values for yarn moisture regain under the effect of different twist multiplier (T) was presented in Table 4, it revealed that the mean values of yarn moisture regain for T_1, T_2 and T_3 as 10.20, 10.16 and 10.16 respectively. These values differed non-significantly from each others. Comparison of individual treatment mean values for yarn moisture regain under the effect of different break draft (D) showed that the mean values of yarn moisture regain for D_1, D_2 and D_3 ranked as 10.19, 10.19 and 10.18 respectively. These values differed non-significantly from each others, while the individual treatment mean values comparison for yarn moisture regain by the change in blend ratios of bamboo and cotton (B), as given in the above Table- revealed the regain ranking as 12.98, 12.41, 11.30, 10.18, 9.08, 7.98 and 7.41 for B_1, B_2, B_3, B4, B_5, B_6 and B_7 respectively with the best value of yarn moisture regain for B1 showing the capacity of regaining the moisture of bamboo fibre remarkably higher than that of cotton as it was obvious from the result of B_7. Similarly, Booth (1983) who stated that the moisture regain of cotton yarn as 7.50 percent where as the raw cotton moisture regain value as 8.5 percent. This statement attests the fact that the yarn form of the fibrous mass gains somewhat less moisture that is certainly due to its compactness usually caused by that amount of twist. Finally, it has been confirmed that bamboo fibre is more absorbent and softer than cotton; thus, it is more suitable to share the blends with cotton and other cellulosic fibres to produce skin friendly fabrics.

Fabric Shrinkage

The statistical data interpretation regarding fabric shrinkage (Length-wise and width-wise) revealed that the effect of twist multiplier (T) and blend ratio (B) was significant while the variable break draft (D) and all their interactions influenced the fabric shrinkage non-significantly.

Comparison of individual treatment mean values for the fabric shrinkage under the effect of different twist multiplier (T) was presented in Table-, it exposed that the mean values of fabric shrinkage (length-wise) for T_1, T_2 and T_3 as 6.45, 6.64 and 6.75 percent, whereas, width-wise shrinkage was ranked as 6.05, 6.17 and 6.29 respectively. These values differed significantly from each others.

Table 4- illustrated the comparison of individual mean values of fabric shrinkage influenced by the variable break draft (D), it revealed that the

mean values of fabric shrinkage (length-wise) for D_1, D_2 and D_3 ranked as 6.60, 6.60 and 6.64 percent whereas for width-wise shrinkage the ranking was 6.15, 6.17 and 6.20 respectively. These values differed non-significantly from each others.

Table 4, also illustrated the comparison of the individual treatment mean values for fabric shrinkage by the change in blend ratios of bamboo and cotton (B) showing the fabric shrinkage (length-wise) for B_1, B_2, B_3, B_4, B_5, B_6 and B_7 ranking as 3.72, 4.44, 5.62, 6, 74, 7.47, 8.60 and 9.71 percent, whereas width-wise shrinkage was ranked as 3.20, 4.20, 5.31, 6.35, 7.37, 8.12 and 8.65 percent respectively. These values differed significantly from each others. The present results were found at par with the findings of Wegner (1981) observed that yarn count and blending ratio were the factors that affected the appearance of the blended yarn and the fabric produced from it. Similarly, Devi *et al*, (2007) they stated fabrics made from pure bamboo fibre yarns had less shrinkage problem as compared to cotton fabric.

Table 4: Individual Comparison of Mean Values for Yarn Moisture regain and Fabric Shrinkage

Blend ratio (B)				Break draft (D)				Twist multiplier (T)			
	Yarn Moisture Regain (%)	Fabric Shrinkage % (Length wise)	Fabric Shrinkage % (Width wise)		Yarn Moisture Regain (%)	Fabric Shrinkage % (Length wise)	Fabric Shrinkage % (Width wise)		Yarn Moisture Regain (%)	Fabric Shrinkage % (Length wise)	Fabric Shrinkage (Width wise)
B_1	12.98 a	3.72 q	3.20 g	D_1	10.19	6.60	6.15	T_1	10.20	6.45 c	6.05 c
B_2	12.41 b	4.44 f	3.21 f	D_2	10.19	6.60	6.17	T_2	10.16	6.64 b	6.17 b
B_3	11.30 c	5.62 e	5.31 e	D_3	10.18	6.64	6.20	T_3	10.16	6.75 a	6.29 c
B_4	10.18 d	6.74 d	6.35 d								
B_5	9.08 e	7.47 c	7.37 c								
B_6	7.98 f	8.60 b	8.12 b								
B_7	7.41 g	9.71 a	8.65 a								

Mean values having different letters differ significantly at 0.05 level of probability.

CONCLUSION

- Bamboo fibre possesses high potential to be used in textiles, where the high degree of absorbency is required, like stockings and undergarment.
- Bamboo: Cotton blend showed appreciable regain value with the increase of bamboo fibre content.
- Appreciable minimum shrinkage is reported with high percentage of bamboo fibres in the blend.

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