J. Farm Sci., 30(2): (273-276) 2017

Effect of blend ratio on physical properties of pure UAS sheep breed wool/ recycled-polyethylene terephthalate blended yarns

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(Received: December, 2016 ; Accepted: June, 2017)

Abstract: UAS sheep breed is a product of crossing Southdown, Bannur and Deccani breeds developed at University of Agricultural Sciences, Dharwad was selected for the study. The UAS sheep breed wool has very low tensile strength and elongation. To enhance the optimum utilization of UAS sheep breed fleece, wool fibres were subjected several processes *viz.,* opening, scouring and pre-carding. The fleece was blended with r-PET fibres in varied proportions *viz.,* 70/30, 60/40 and 50/50 through sandwich blending technique. The blended fibres were subjected to woolen carding system and spun on hand charaka and friction machine. Pure and blended yarns were assessed for physical properties such as yarn count (Nm), turns per inch (tpi), single yarn strength (kgf) and elongation (per cent). The results revealed that, the developed friction spun blended yarns have improved fineness, twist and elongation than the hand spun yarns, whereas greater strength was noticed in the hand spun yarns compared to friction spun yarns. The wool/ r-PET blended yarns of varied yarn count with better yarn evenness and physical properties are suitable for production of coarse grade woolen fabric and kamblis.

Key words: Elongation, Hand spinning, Medleri charaka, Tensile strength

Introduction

Blending is a way of value addition in the utilization of coarse varieties of wool available in the country. There is a need to develop diversified products and innovative blending processes that will creates possible to usage of coarser varieties of wool for production of blankets, shawls, furnishing and to enrich the properties such as strength, appearance, comfort etc. (Sharma and Goel, 2003). Commercial point of view, blends are formed to reduce the total costs of production, improve the performance properties and create market demand (Johnson and Russell, 2008). University of Agricultural Sciences (UAS) sheep breed, a product of crossing Southdown, Bannur and Deccani breeds. This breed has combination of 50 per cent Deccani, 25 per cent Bannur and 25 per cent Southdown. In the local area, the UAS sheep breed is mainly reared for the purpose of meat, from each sheep 300 - 400 g of fleece is generated by every clipping per year. Due to shorter, coarser and lower strength of UAS sheep breed fleece, the local weavers are not ready to use thin fleece for the production of kamblis because of its poor fibre traits. The UAS sheep breed fleece can be improved through blending with other stronger natural and manmade fibers.

The consumption of natural fibres in the world is 35 per cent and 65 per cent of man-made fibres. Among the synthetics, nearly 75 per cent of man-made fibres are formed by polyethylene terephthalate (PET) and PET based fibres. However, sixty per cent of PET consumption is used for fibre production, while 30 per cent of this consumption is used for bottle production. Polyethylene terephthalate bottle consumption in 2007 was 15 million tons in the world and this value was 8 per cent of total plastics demand. Moreover, 4.5 million tons of recollected PET bottles were recycled into PET flakes. In the recent years, PET flakes are produced for secondary textile products like carpet bottoms, sleeping bags, pillows and insulation materials. PET fibres are not used solely but blending with other recycled fibres. r-PET fibres are basically derived from recycling PET bottle wastes and by using recycled PET fibres in apparel industry can extend their life cycle and make them primary raw material for textile industry. These fibres can be accepted as eco-friendly because of their advantages and contributes to the reduction of energy and raw material cost (Telli and Ozdil, 2013). Hence the present study was designed to improve the physical properties of coarse grade UAS sheep breed wool by blending with low cost r-PET fibres in varied proportion for the production of pure and blended yarns.

Material and methods

The present study was carried out at Department of Textile and Apparel Designing, College of Rural Home Science, University of Agricultural Sciences during the year 2014-2016. UAS (University of Agricultural Sciences) sheep breed wool fibres were collected from the Department of Animal Sciences, UAS, Dharwad. The recycled polyethylene terephthalate (r-PET) were procured from Wool Research Association (WRA), Thane, Mumbai. The properties of selected fibres *viz.,* fibre length (mm), fibre diameter (micron), fibre tenacity (gm/denier) and fibre elongation (per cent) are shown in the Table 1.

UAS sheep breed wool fleece was shorn with electrically operated wool shearing machine. The fleece was fed to fibre opener for opening and dusting of the fibres. Scouring was carried out in two-bowl scouring machine with 3 per cent sodium carbonate and 2 per cent non ionic detergent keeping 1:40 MLR at 50^0C carried out at Wool Development and Research Centre, Ranebennur, Haveri district, Karnataka. The wool fibres were fed into the carding machine, where the initial straightening and the separation of short staple fibres take place.

The pre-carded UAS sheep breed wool fibres were blended with r-PET fibres in varied proportions *viz.*, 70/30, 60/40 and 50/50

Table 1. Fibre properties

Test parameters	Wool	r-PET
Fibre diameter (micron)	30.54	12.61
Fibre length (mm)	45.00	60.00
Fibre tenacity (gm/denier)	3.88	3.73
Fibre elongation (%)	30.00	13.23

by adopting sandwich blending technique. The pure and blended fibres were processed in woolen carding system. The pure and blended slivers were spun on hand charaka at Medleri, Ranebennur taluk, Haveri district, Karnataka and friction machine at Wool Research Association (WRA), Thane, Mumbai. Physical properties such as yarn count (Nm), yarn twist (tpi), single yarn strength (kgf) and elongation (per cent) were assessed for the developed pure and blended yarns based on the standard test methods. The data was analyzed using one-way ANOVA technique to draw valid conclusions.

Results and discussion

Yarn count (Nm)

Yarn count is a numerical expression which defines its fineness. Table 2 shows that hand spun pure UAS sheep breed wool and blended yarns possessed lower yarn count than the friction spun pure UAS sheep breed wool and blended yarns indicated that the hand spun yarns were coarser and bulkier than the friction spun yarns due to constant speed of the friction spinning machine. Yarn count of the hand spun and friction spun UAS sheep breed wool blended yarns found to be highly significant than the control. Irrespective of spinning methods, hand spun and friction spun pure UAS sheep breed wool samples obtained least yarn count (2.26 and 7.47) than the rest of the yarns due to crimped configuration of the wool which prevents the wool fibres aligning themselves too closely when being spun into yarn. Further, 50/50 blended yarns depicted higher yarn count in both hand (6.48) and friction (10.94) spinning systems respectively. Irrespective of spinning methods, the yarns become finer as r-PET percentage increases in the blend ratio which may be owing to fibre content *i.e.,* r-PET has uniform fibre diameter and lower length variation which contributes finer yarn count. The same results are in line with the Samanta (2014) reported that, the polyester fibres has uniform cross section throughout its length and minimum length variation contributed finer yarn count.

Yarn twist (tpi)

Twist is the measurement of spiral turns given to a yarn in order to hold the constituent fibres or threads together. The effects of the twist are twofold: as the twist increases the lateral force holding the fibres together is increased so that more of the fibres can contribute to the overall strength of the yarn (Saville, 2004).

In general (Table 3), higher turns per inch was observed in the friction spun yarns when compared to hand spun pure UAS sheep breed wool and blended yarns due to uniform sliver feeding, constant pressure and uniform speed of the friction spinning machine during spinning operation. The results are on par with the study conducted by Goel (2015) on "Muga silk and rambouillet wool: A unique combination for yarn" stated that the blended yarns spun on machine spinning showed uniform yarn twist level and finer count than the handspun blended yarns due to constant speed of the machine. The significant difference in the yarn twist of hand and friction spun blended yarns was observed and less CV per cent (3.43) was registered in the friction spun yarns than hand spun yarns (18.06). Among the blended yarns, hand spun wool/ r-PET (70/30) blended yarn possessed greater turns per inch (4.86) than the other blends. The trend of decreased turns per inch with increased r-PET content in the blends was noticed in all the blended yarns. Whereas, friction spun wool/ r-PET (50/50)

Table 2. Effect of blend ratio on yarn count (Nm) of the pure UAS sheep breed wool and blended yarns

Fibres	Blend ratio	Yarn count (Nm)	
		Hand spun	Friction spun
UAS sheep breed wool	100 per cent	2.26	7.47
UAS sheep breed wool /r-PET	70/30	3.34**	9.66**
	60/40	3.76**	10.08**
	50/50	6.48**	10.94**
S.Em± 0.45284	0.15291		
C.V. % 25.55	3.59		

**Significant at 1 per cent level

Table 3. Effect of blend ratio on yarn twist (tpi) of the pure UAS sheep breed wool and blended yarns

Fibres	Blend ratio	Yarn twist (tpi)	
		Hand spun	Friction spun
UAS sheep breed wool	100 per cent	4.18	8.16
UAS sheep breed wool /r-PET	70/30	4.86**	11.94**
	60/40	4.42**	12.44**
	50/50	4.08*	13.04**
S.Em± 0.35419	0.17493		
C.V. % 18.06	3.43		

*Significant at 5 per cent level

**Significant at 1 per cent level

Table 4. Effect of blend ratio on single yarn strength (kgf) of the pure UAS sheep breed wool and blended yarns

Fibres	Blend ratio	Single yarn strength (Kgf)	
		Hand spun	Friction spun
UAS sheep breed wool	100 per cent	0.26	0.25
UAS sheep breed wool/ r-PET	70/30	0.62**	0.33**
	60/40	0.55**	0.39**
	50/50	0.61**	0.30**
S.Em± 0.03476	0.01766		
C.V. % 15.19	12.50		

**Significant at 1 per cent level

blended yarn showed maximum turns per inch (13.04) than the 60/40 (12.44) and 70/30 (11.94) due to finer yarn count (10.94, Table 2) leads to greater twist level. However, the ideal amount of twist varies with the yarn count and thickness in which finer the yarn count, higher the yarn turns per inch.

Single yarn strength (kgf)

In general, friction spun UAS sheep breed wool blended yarns showed lower strength than the hand spun UAS sheep breed wool blended yarns which may be due to coarseness and bulkiness of hand spun yarns than the friction spun yarns contributing to greater tenacity and vica versa (Table 4).

Hand and friction spun pure UAS sheep breed wool yarns exhibited significantly lesser strength (0.26 and 0.25) than the blended yarns due to polymer system of the wool fibre *i.e.,* 70-75 per cent of amorphous region and formation of few hydrogen bonds in wool fibre which contributes to lower strength. Gohl and Vilensky (2005) stated that, the low tensile strength of the wool is due to relatively few hydrogen bonds that are formed and the lack of strength is compensated by alpha/ beta keratin configurations in the wool fibres.

The wool/ r-PET blended yarn of 70/30 (0.62) and 50/50 (0.61) possessed greater strength than the 60/40 (0.55) blends. A mixed trend was observed in friction spun wool/ r-PET blends i.e., greater tenacity was noticed in 60/40 (0.39) followed by 70/30 (0.33) and 50/50 (0.30). The strength of the both hand spun and friction spun blended yarns decreased as r-PET content increased in the blend. The decrease in strength is due to less tenacity of the recycled polyethylene terephthalate fibres (3.73) than the wool fibre (3.88, Table 1). The results are on par with the study on "Properties of the yarns produced from recycled polyethylene terephthalate (r-PET) fibres and their blends" conducted by Telli and Ozdil (2013) reported that r-PET has lower strength, as r-PET ratio increases in the blends the tensile strength in the blended yarns was decreased.

Yarn elongation (per cent)

Elongation is the increase in length of the specimen from its starting length expressed in percentage. The distance that a material will extend under a given force is proportional to its original length; therefore elongation is usually quoted as strain or percentage extension (Saville, 2004).

Yarn elongation of hand and friction spun blended yarns was found to be highly significant than the control samples (Table 5). Further in the hand spun wool/ r-PET blends, the 60/40 blended yarn depicted greater elongation percentage (4.73) than the 70/30 (4.65) and 50/50 (4.59) yarns. However, increased r-PET fibre in the blend ratio increased elongation percentage of the friction spun wool/ r-PET blended yarns *i.e.,* 70/30 (9.55), 60/40 (9.74) and 50/50 (9.92), respectively. Irrespective of blend ratio and spinning methods, yarn elongation was found to be more in friction spun blended yarns than the hand spun blends due to insertion of high spiral turns. Increased twist insertion was found in friction spun yarns due to high speed and constant pressure in drawing and twisting during friction spinning.

Conclusion

Irrespective of spinning methods, the yarns become finer as r-PET percentage increases in the blend ratio. 50/50 blend ratio depicted finer yarn count in both hand and friction spinning systems. Higher turns per inch were observed in the friction spun yarns compared to hand spun pure UAS sheep breed wool and blended yarns. Hand spun wool/ r-PET (70/30) and friction spun wool/ r-PET (50/50) blend possessed highest turns per inch than the other blended yarns. Hand spun blended yarns showed greater strength than the friction spun blended yarns whereas, hand spun wool/ r-PET (70/30) and friction spun wool/ r-PET (60/40) blended yarn possessed greater strength than the other blended yarns. Irrespective of blend ratio and spinning methods, yarn elongation was found to be more in friction spun blended yarns than the hand spun blends.

Table 6. Effect of blend ratio on yarn elongation (%) of the pure UAS sheep breed wool and blended yarns

Fibres	Blend ratio	Yarn elongation (%)	
		Hand spun	Friction spun
UAS sheep breed wool	100 per cent	3.75	8.71
UAS sheep breed wool/ r-PET	70/30	4.65**	9.55**
	60/40	4.73**	9.74**
	50/50	4.59**	9.92**
S.Em± 0.46787	0.19407		
C.V. % 23.64	4.58		

**Significant at 1 per cent level

In general, friction spun UAS sheep breed wool/ r-PET blended yarns yield finer yarn count which are further suitable for production of shawls and made-ups. However, hand spun UAS sheep breed wool/ r-PET provides coarser, bulkier and textured effect which can be suitable as weft for production of traditional kamblis and variegated plain woven fabrics with cotton as warp. The local wool spinners can be effectively spun shorter and weaker UAS sheep breed wool blended with r-PET on hand charaka has wider scope and importance in local woolen industries and sheep rearing in view of marginal profit to the shepherds as well as kamblis weavers of Northern Karnataka.

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