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Performance of oak tasar silk waste/viscose blended yarns

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Abstract
Oak tasar silk waste and viscose fibres were blended in three different proportions i.e. 60% oak tasar silk waste: 40 %viscose, 50% oak tasar sik waste: 50% viscose and 40% oak tasar silk waste: 60%viscose for preparing 15 Nm yarn. The yarns developed were tested for physical and mechanical properties. Physical properties such as yarn eveness, yarn hairiness, yarn crimp, moisture regain and whiteness index were analyzed. For mechanical properties yarn breaking force, elongation at break, lea strength and count strength product were studied. It was observed that yarn eveness, moisture regain, breaking force and elongation percent were highest in 40% oak tasar silk waste: 60 % viscose blended yarn. Yarn blended in 60% oak tasar silk waste: 40% viscose ratio exhibited best results for yarn hairiness, whereas, blend ratio 50% oak tasar silk waste: 50% viscose exhibited best results for lea strength and CSP.

Keywords: Blending, count strength product, yarn hairiness, unevenness, oak tasar waste, viscose fibre

Introduction
Nature has bestowed us with various kinds of natural fibres, which cannot be replaced by synthetic fibers due to their intrinsic biodegradable and wear comfort properties. But all the fibres alone are not perfect in some or another way. They all have combination of some good, fair and poor attributes. Blending is a novel method which combines the desired or positive attributes of each of its component, and minimizes the undesired attributes intentionally thus opens the way for value addition of the product. Also blending economize the cost of the material.
Silk, the glorious gift of nature is an wonderful natural fibre which is popular for its aesthetic properties. Tasar is one of the varieties of natural silk. In terms of production and quality it comes next to mulberry silk. Oak tasar silk is not suitable for reeling when spun in pure form. The demand for pure tasar fabric is low, has a rough texture and lacks the sheen associated with silk and is not easy to dye. Therefore, tasar could be blended with other fibres such as cotton or viscose to develop a yarn with some new functional properties.
Blending of silk with viscose has various advantages over blending of silk with cotton and synthetic fibres. Viscose is more functional and uniform than cotton as, it is a manmade fibre. Viscose has a silk like aesthetic with remarkable drape and feel and retains rich brilliant colour. Viscose absorbs more moisture than cotton, is breathable, soft to skin, comfortable to wear, easily dyed in vivid colours and has moderate dry strength and abrasion resistance. All these properties make viscose a blend friendly fibre which is one of rayon's best strength.
Thus, the present study was carried out to blend oak tasar waste with viscose fibre to explore the positive characteristics of each of the fibre and to develop a new yarn with more functional properties.

Material and Methods
Oak tasar waste and viscose fibres were blended in different proportions (60s: 40 v, 50s: 50 v and 40s: 60v) using worsted spinning system for preparing yarns of 15 Nm count. The yarns developed were tested for physical and mechanical properties. Physical properties such as yarn evenness, yarn hairiness, yarn crimp and moisture regain were analyzed. For mechanical properties yarn breaking force, elongation at break, lea strength and count strength product were studied. Prior to the testing, all the samples were conditioned to moisture equilibrium in standard atmosphere at 65±2% relative humidity and 27±2ºC temperature.

The exhaustive list of equipment used for study has been listed below

Yarn testing equipments		
Test	**Name of the equipment**	**Test method**
Lea strength	Universal Tensile Tester	IS- 1671
Moisture regain	Oven drying method and weighing balance	IS: 199-1973
Single yarn strength and elongation	Universal Tensile Tester	IS- 1670
Yarn evenness	USTER TESTER- 3	ASTM D- 1425
Yarn hairiness	Shirley yarn hairiness tester	ASTM 5647-07
Yarn twist	Eureka twist tester	IS 832-1985

Result and Discussions

Table 1 shows the results of various properties of yarns tested

Table 1: Physical properties of blended yarns (15 Nm)

Physical properties	Proportions			CD
	60OTW:40viscose	**50OTW:50viscose**	**40OTW:60viscose**	
Yarn evenness U%	21.84 ± 0.441	21.66 ± 0.518	19.43 ± 0.303	1.49*
Imperfections/Km				
-Thin places (-50%)	509.0 ± 8.609	350.0 ± 5.1	272.0 ± 0.283	20.02*
-Thick places (+50%)	2411 ± 49.436	2136 ± 31.125	1647 ± 28.285	129.84*
-Neps (+200%)	3155 ± 64.035	2458 ± 38.375	1877 ± 24.421	157.12*
Hairiness H	9.64 ± 0.181	10.54 ± 0.247	10.43 ± 0.092	0.64*
Moisture regain (%)	6.36 ± 0.031	8.36 ± 0.074	8.89 ± 0.143	0.33*

*Significant at 5 per cent level of significance, CD = Critical Difference
OTW- Oak Tasar silk Waste

Physical properties

Yarn eveness

U% this is a measure of variation of imperfections in the yarn. The lower the value the better the yarn, because less imperfections exist in the yarn. Table 1 clearly shows that, 40 OTW: 60 viscose blended yarn exhibited best results (19.43 ± 0.303) for U%. Further, it was observed that, as the proportion of viscose in the yarn increased, even yarn was obtained. This may be due to irregular denier of silk fibres which led to yarn unevenness, whereas, viscose fibre showed regular denier, hence even yarn. The statistical analysis also revealed that there was significant difference among the yarn samples, except for 60 OTW: 40 viscose and 50 silk: 50 viscose.

Thin places (-50%)/Km

The less thin places in the yarn, the better is it. Data pertaining to thin places (table 1) revealed that, the 60 OTW: 40 viscose blended yarn exhibited maximum number of thin places, with the mean value of 509.0 ± 8.609/Km of yarn. Thin places reduced to 350.0 ± 5.1/Km that was significantly different ($p \leq 0.05$) from that of 60 OTW: 40 viscose blended yarn, when the proportion of viscose fibre increased to 50 per cent. A further increase in the proportion of viscose fibre upto 60 per cent reduced the mean value to 272.0 ± 0.283/Km, giving minimum number of thin places among all the yarns of 15 Nm yarn count. This result was also significantly different from 60 OTW: 40 viscose and 50 OTW: 50 viscose blended yarn.

Thick places

Thick places are determined, where the yarn diameter exceeds 50% of the average yarn diameter and the length is 8-12 mm. The results furnished in table 1 shows that thick places (+50%) were the highest in case of 60 OTW: 40 viscose blended yarn with a mean value of 2411 ± 49.436/ Km. Thick places (+50%) decreased with the increase in the viscose component in the blended yarn and was found to be lowest in case of 40 OTW: 60 viscose blended yarn (1647 ± 28.285). Statistical analysis revealed that there was a significant difference among all the blended yarns of 15 Nm yarn count.

Neps (+200%)

A nep is a very short thick place in the yarn, a small fault having a length of 2mm, diameter 3 times or more at a standard setting of 200%. It is evident from Table 1 that, the highest number of neps (+200%) were found in 60 OTW: 40 viscose blended yarn (3155 ± 64.035) which subsequently reduced with the increase in viscose proportion and lowest number of neps were reported in 40 OTW: 60 viscose blended yarn (1877 ± 24.421). The results were in accordance with the results of U%, thin and thick places. Statistical analysis revealed that, there was a significant difference between all the blended yarns.

It is evident from the results that the evenness of the yarns increased with an increase in the proportion of viscose fibres. The irregularities in the strands are dependent upon the average number of fibres in the cross section. With a greater number of viscose fibres which were more uniform in diameter reduced the irregularities. On the other hand oak tasar silk waste had more irregularities and variation in diameter. Also blends with higher viscose proportion exhibited good strength. Therefore, in terms of eveness 40 OTW: 60 viscose blended yarn was considered to be the optimum blend followed by 50 OTW:50 viscose blended yarn.

Yarn hairiness

The hairiness value informs about the count of fibres protruding from the yarn base. It is evident from table 1 that, maximum hairiness was found in 50 OTW: 50 viscose blended yarn with mean value 10.54 ± 0.247, whereas hairiness decreased slightly in case of 40 OTW: 60 viscose blended yarn (10.43 ± 0.092). Lowest hairiness was exhibited by 60 OTW: 40 viscose blended yarn with mean value of 9.64 ± 0.181. The statistical analysis also revealed that there was significant difference between 60 OTW: 40 viscose and 50

OTW: 50 viscose blended yarns whereas there was no significant difference between 50 OTW: 50 viscose and 40 OTW: 60 viscose blended yarns. The larger the number of fibres in the cross–section of the yarn, and with constant twist, the larger is the number of protruding fibres. A coarse yarn therefore has a higher hairiness than a fine yarn. Here, viscose is coarser therefore by increasing viscose content hairiness increased.

Moisture regain

Table 1 reveals that, the moisture regain increased with the increase of viscose proportion in the blended yarns. This may be due to the reason that the very amorphous polymer system of viscose (60-65 per cent), as well as its polar polymers, make viscose the most absorbent fibre in common use. Whereas, silk has a very crystalline polymer system (65-70 per cent). The greater crystallinity of silk's polymer system allows fewer water molecules to enter than does the more amorphous polymer system of viscose fibre (Gohl and Vilenskey, 2005) [3]. Yarn blended using 60 OTW: 40 viscose exhibited highest moisture regain value of 8.89 per cent, whereas, moisture regain reduced to 6.36 per cent by reducing the content of viscose fibres in blended yarns. Statistical analysis also revealed that there was a significant difference between all the blended yarns.

Mechanical properties

Table 2: Mechanical properties of blended yarns (15 Nm)

Mechanical properties	Proportions			CD
	60OTW:40viscose	50OTW:50viscose	40OTW:60viscose	
Breaking force (g)	703.1 ± 6.477	794.1 ± 13.224	960.4 ± 21.491	52.08*
Elongation at break %	7.82 ± 0.083	7.45 ± 0.042	8.11 ± 0.101	0.87*
Lea strength	206.2 ± 4.560	243.9 ± 1.650	234.7 ± 3.053	11.37*
CSP	2089.8 ±39.478	2107.0 ± 42.764	2023.2 ± 5.264	116.90

*Significant at 5 per cent level of significance, CD = Critical Difference

Breaking force (Single yarn strength)

The force required to break the yarn is said to be the breaking strength of yarn. Table 2 shows the breaking force in terms of mean values. Yarn blended using 40 OTW: 60 viscose exhibites the highest strength followed by 50 OTW: 50 viscose blended yarn. The results clearly show that as the proportion of viscose in the yarn increases, the strength also increases. This may be due to the reason that viscose fibre has greater denier as compared to oak tasar waste silk. The statistical difference among all the yarns was found to be significant.

Elongation at break %

Elongation is the percentage of length up to which the yarn can be extended before the occurrence of yarn breakage. It can be observed from table 2 that, maximum elongation of 8.11% was observed for 40 OTW: 60 viscose blended yarn. Blended yarns in the proportion of 60: 40 and 50: 50 OTW: viscose exhibited similar type of values for elongation i.e. 7.82 and 7.45 per cent respectively. (Gohl and Vilenskey, 2005) [3]. Silk is considered to be more plastic than elastic because its very crystalline polymer system does not permit the amount of polymer movement which could occur in a more amorphous system, like that of viscose. The statistical difference among all the yarns was found to be significant.

Lea strength

This is breaking load required to rupture one lea. It is generally expressed in pound.

Table 2 shows that, the lea breaking strength is highest (243.9 lbf) for 50:50 oak tasar waste: viscose blended yarn, followed by 234.7 lbf for 40 OTW: 60 viscose blended yarn. Minimum value of lea strength was depicted by yarn having highest proportion of oak tasar silk waste i.e. 206.2 lbf. The statistical difference among all the yarns was found to be significant.

Count Strength Product (CSP)

It is a number which is derived by multiplication of count & lea strength (in lbs). Table 2 clearly shows that, 50 OTW: 50 viscose blended yarn exhibits maximum mean value (2107.0 ± 42.764) for CSP which is in accordance with the results of lea strength. Whereas, 40 OTW: 60 viscose blended yarn exhibited lowest CSP value of 2023.2. The statistical difference among all the yarns was found to be non-significant.

Conclusion

It is evident from the results that the evenness of the yarns increased with an increase in the proportion of viscose fibres. The irregularities in the strands are dependent upon the average number of fibres in the cross section. With a greater number of viscose fibres which were more uniform in diameter reduced the irregularities. On the other hand oak tasar silk waste had more irregularities and variation in diameter. Also blends with higher viscose proportion exhibited good strength. Therefore, in terms of eveness, 40 OTW: 60 viscose blended yarn, was considered to be the optimum blend followed by 50 OTW: 50 viscose blended yarn. Further 50OTW: 50 viscose blended yarn exhibited best results for hairiness, lea strength and CSP. The results of the study also revealed that, yarn strength and elongation values decrease with the increase in tasar silk fibre component in the blend and 40 OTW: 60viscose blended yarn showed more strength and elongation.

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