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LABORATORY ANALYSIS OF EFFECT OF BENDING RATIO ON PHYSICAL PROPERTIES OF YARNS

Dr. Nishi Dubey

Ph D. Punjab Agricultural University, Ludhiana (Punjab)

ABSTRACT

The present study was undertaken with a view to produce oak tasar and wool blended fabric. Technical programme of the work was planned keeping the broad objectives of the investigation in mind. Experiments were thus, planned to study the profile of two fibers, optimizing the fiber blends to produce yarns; developmentfabrics from the yarns spun with the optimized blend proportion; testing of properties of fabrics; investigating end uses of the developed fabrics and the cost analysis.

Keywords: *textile, yarn, blending, fibers, chemicals, wool.*

INTRODUCTION

The need of the man for shelter and protection led to the innovation of clothes from leaves to fiber extrusion, yarn construction and fabric manufacturing techniques. Starting with the vegetable fibers, later animal fibers were exploited and ultimately came the synthetics. Over the years, the developed fabrics were manipulated to form garments, put to different types of industrial uses and were evaluated for their various characteristics. Certain desirable properties are essential in order to judge the suitability of a fabric for different end uses such as clothing, industrial etc. Also there is a need for enhancing the quality or decreasing cost of textiles in the context of global scenario. This cost competitiveness has given unstinted access to Indian textiles in the highly competitive international market and made it imperative to adopt cost effective technologies such as blending. The technology of blending of waste and left over fibers which results in improving the qualities of the constituent fibers and the cost effectiveness of the resultant yarn/ fabric, has a great potential for adoption and development. There is also a need to develop diversified products and innovative blending processes that will make use of wool and silk waste in the production of good quality fabric and apparel.

Wool is a unique animal protein fiber and enjoys a special position among textile fibers because of its unmatched properties of warmth, excellent drape, high absorbency, outstanding stretchability, excellent resilience, water repellence, flame retardence, crispness and superior compressional recovery. It has an attractive appearance, pleasing to touch, can be dyed easily and permanently and can change its look, texture, handle and performance offering numerous application across apparels, interior and other industrial uses. It would never wear out, not absorb odour and would afford protection from cold.

Tasar (Tussah) is a copperish colored, coarse silk used for dress materials furnishings and interiors. Itis less lustrous than mulberry silk, but has its own feel and appeal. Tasar silk is generated by the silkworm, *Antheraea mylitta* that thrives on the food plants *Asan* and *Arjun*. In India, tasar silk is mainly produced in the states of Jharkhand, Chattisgarh, Orissa, Maharastra, West Bengal and Andhra Pradesh (Kariyappa *et al* 2008).

Oak tasar (temperate tasar) is mainly used for furnishing, dress materials and sarees. Bomkai, Paithani, Ikkat and Katki are some popular fabrics produced using tasar silk. Bafta is a popular blend of tasar and cotton. Shawls and mufflers are also produced using a blend of oak tasar and other natural fibers which is ideal for making jackets for men and women or traditional costumes like '*salwar- kurta*' as well (Anonymous 2008).

Although wool- silk blended fabrics are not new to the world but due to lack of awareness mills are not using blends. Therefore researches for developing appropriate method for utilization of wool, blended with other protein fiber like silk need to be intensified. Silk competes with wool because of its high elasticity, colour brilliance, resistance to pilling, strength, and colour fastness properties. In the present study emphasis has been laid on to determining fine wool and oak tasar blend proportion best in all respects from performance to aesthetic appeal and economy.

OBJECTIVES

1. To explore the possibility of developing yarns by blending oak tasar with wool in varying proportions.
2. To study the selected physical properties of the developed yarns.

EXPERIMENTAL SETUP

The present study was undertaken with a view to produce oak tasar and wool blended fabrics. Technical programme of the work was planned keeping the broad objective of the investigation in mind. Experiments were thus, planned to study the profile of the two fibers; optimizing the fiber blends to produce yarns; development fabrics from the yarns spun with the optimized blend proportion; testing of properties of fabrics; investigating end uses of the developed fabrics and the cost analysis.

Oak tasar silk and merino wool fibers were evaluated for various physical and mechanical properties viz. fiber fineness, length, crimp, tenacity, stress-strain behaviour and diameter of oak tasar and wool fiber, using standard test methods. Both the fibers were tested for percent moisture regain and their longitudinal structures were also observed under microscope. Scanning electron microscopy was performed for both the fibers. Blending and spinning was done using the Ring Spinning System at the Pilot Plant of Northern India Textile Research Institute (NITRA), Ghaziabad. Yarns from pure oak asar waste fibers could not be prepared because there was a lot of fiber breakage during processing due to the brittle nature of tasar silk fibers. Z twist was inserted in all the yarns. Blended and pure woolyarns were tested for single yarn strength and elongation, lea strength, count strength product, twist per inch (TPI), yarn hairiness, yarn unevenness, yarn crimp, whiteness index and moisture regain.

OBSERVATION AND INTERPRETATION

Blending

Oak tasar fiber waste and merino wool fibers were blended together in the proportions of 65:35, 50:50 and 35:65, respectively. Blending is done on the carding stage. Since oak tasar is unsuitable in reeling, blending of it with fine merino wool was an attempt to utilize the tasar fiber in a way to make proper use of its properties and compensate the shortcomings such as harsh texture and stiffness. Yarns of 100 percent wool fibers were also prepared for base reference. Oak tasar fiber could not be processed alone on carding machine. The pure and blended yarn fibers were processed on a Ring Spinning System because the short staple length of oak tasar waste fiber was not adequate for its processing on worsted system. No difficulty was encountered, while processing these blends, except some problem in the case of pure merino wool at the carding stage due to the static charges that made the lap formation difficult. As excessive breakage took place on carding frame owing to its brittle nature it could not be formed into a web,

Spinning

After processing of the fibers, the carded slivers prepared from the fibers of merino wool and their blends were spun. Blended yarns of two different counts (10 Ne and 16 Ne) were prepared on a Ring Spinning System. In this, merino wool fiber acted as a carrier of oak tasar fibers these fibers on the ring spinning system. This shows that the wool fibers improved spinnability of oak tasar fibers. Gahlot (2007) also reported inability to prepare yarns from pure tasar waste fibers because there was lot of breakage during processing due to the brittle nature of tasar silk fibers.

EVALUATION OF PROPERTIES OF BLENDED YARNS

Physical Properties of YarnYarn twist

A perusal of tables 4 and 5 also elicites the details of TPI of the yarns prepared from pure wool, and wool/oak tasar blends. (Fig 1)The mean twist value of 10 Ne yarn was 11.42 tpi in the case of 100 percent wool which increased significantly with an increase in the ratio of oak tasar in the blend. The TPI was found to be maximum (14.53) for 35:65 wool/oak tasar blend. A similar pattern was observed in the case of 16 Ne yarns where the maximum and minimum mean values were 15.98 and 12.68 tpi wool/oak tasar and pure wool yarn respectively (Table 5). The reasons for this can be the fineness and length of oak tasar fiber. Vidyasagar (1992) had emphasised that yarn with long fibers do not require much twist as yarn with short fiber.

Moisture regain

It can be elicited from the Table 4 and Figure 2 that the moisture regain value of 10 Ne yarn was highest in the case pure wool i.e. 13.762 percent, and the lowest regain was observed in 35:65 W/OT blended yarn. It was found to increase significantly (CD = 0.052) with an increase in the amount of wool in the blend. The reasons for this are the fact that the wool fiber has highest moisture regain. A similar trend was found in 16 Ne yarn also. For the 100:0, 65:35, 50:50, 35:65 W/OT yarns the percent moisture regain was 13.618, 13.188, 12.898 and 11.376, respectively. Gohl and Vilensky (2003) reported that the absorbent nature of wool is due to the polarity of its peptide groups and salt linkages and the amorphous nature of its polymer system. The peptide groups and salt linkages attract water molecules which readily enter the amorphous polymer system of wool fiber, while silk has crystalline polymer system it is less absorbent than wool.Statistical analysis indicated that blended yarns had a significant difference at the level of 0.05 percent in the moisture absorbency of pure wool and blended yarns in both the counts because of the inherent absorbency of wool.

Yarn Evenness

Unevenness is one of the most important yarn properties that significantly correlate with the fabric appearance and processing performance of the yarn (Li and Yan 1990). The yarn evenness of 10 Ne as well as 16 Ne yarn was maximum in the case of 100 percent wool yarn with respective mean values of 12.132 and 14.36 percent. these values significantly decreased with an increased in the proportion of oak tasar waste in the yarn. The data show that the maximum values of uneveness percent of 22.838 and 25.21 were observed against 35:65 wool/oak tasar blend under both the counts of yarn. (Table 4, 5 and Fig 3).A comparison of the yarn evenness under 10 Ne and 16 Ne count showedthat difference was not significant in 10 Ne yarn except in the case of 35:65 blend while the yarns made in 16 Ne showed significant difference in terms of their evenness percentage. In all blends the unevenness increased by increasing the ratio of oak tasar waste in the blend, that was in staple length. Kadole (2001) endorsed that the main cause of unevenness in the spun yarn is the substantial variation in the number of fibers in the yarn cross section along the length.

Yarn imperfections Neps (+200percent/km and +140percent/km)

The data presented in Table 4 showed that the neps in 10 Ne yarns on (+200percent/km) as well as (+140percent/km) found to highest in the case of 35:65 per cent W/OT blend i.e. 203.2 and 593, respectively. following a similar patteren in the16 Ne yarn, the highest per cent of neps/km were in 35:65 per cent W/OT blended yarn on +200percent/km and +140percent/km i.e. 289.4 and 815.9, respectively.

The percentage of neps in the blended yarns of both the counts reduced significantly with an increasein the proportion of wool in the blend (Table 4 and 5). Statistical analysis showed that there existed a significant difference in the neps among all the blends of both the yarn counts in the case of +200percent/km as well as +140percent/kms. It is evident from the results that imperfections increased by increasing the proportions of oak tasar waste in blend. The irregularity in the strand is depending upon the average number of fibers in the cross section and imperfections can be reduced with a greater number of fine fibers.

Thin places (+50percent/km)

It is evident from the data in Table 4 that the average values of thin places for 100:0, 65:35, 50:50 and 35:65 W/OT yarn of 10 Ne was found to be 11.4, 26.3, 33.6 and 39.8/km, respectively. The 16 Ne yarn also showed a similar pattern. The 35:65 W/OT blend had the maximum thin places (103.3/km) while the minimum were observed in 100:0 W/OT blend (54.1/km). (Fig 4) Statistical analysis of results showed a significant difference in all the blends of 10 Ne as well as 16 Ne yarns.

Thick places (+50percent/km)

The data presented in Table 4 showed that the thick places of 10 Ne yarns were 124.8/m, 228/m, 353.8/m and 550.7/m for pure wool, 65:35, 50:50 and 35:65 blend ratios, respectively.

Table 4 Physical properties of pure and blended yarns of 10 Ne

Properties	100:0 W:OT	65:35 W:OT	50:50 W:OT	35:65 W:OT	CD (5%)
Twist per inch (TPI)	11.42	12.482	12.972	14.534	.912
CV	4.043	7.187	5.092	4.336	
SE	0.02	0.401	0.295	0.281	
Moisture regain	13.762	13.676*	12.942*	11.792*	.052
CV	0.094	0.281	0.269	0.447	
SE	5.830	0.017	0.015	0.025	
Unevenness	12.676*	18.298*	19.72*	22.838*	.778
CV	1.542	1.545	4.848	4.192	
SE	0.083	0.126	0.201	0.428	
Yarn neps (+200%/ km)	19.1*	92.4*	109.6*	203.2*	13.233
CV	14.44	9.758	6.661	3.589	
SE	6.35	4.032	3.264	3.261	
Yarn neps (+140%/km)	95.4*	190*	338.8*	593*	22.582
CV	15.597	8.918	7.069	1.233	
SE	6.654	7.577	10.711	3.271	
Thin places (+50%/km)	11.4*	26.3*	33.6*	39.8*	9.077
CV	22.663	28.409	23.655	19.106	

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SE	1.55	3.341	3.554	3.400	
Thick places (+50%/km) CV SE	124.8* 13.107 7.315	228* 9.649 9.838	353.8* 6.967 11.024	550.7* 6.285 15.481	33.818
Hairiness CV SE	12.676 1.797 0.101	12.518 0.509 0.028	12.44 0.627 0.034	12.138* 1.420 0.077	.203
Lab values of yarn					
L value CV SE	70.55* 0.253 0.080	63.57* 0.391 0.111	60.634* 0.385 0.104	56.33* 0.490 0.123	0.319
a value CV SE	1.15* 51.645 0.026	4.224 12.655 0.023	4.794 12.527 0.268	5.022 3.587 0.080	0.681
b value CV SE	13.196* 0.794 0.046	14.308* 1.033 0.066	15.952* 1.043 0.074	16.224* 1.576 0.114	0.238

W = Wool, OT = Oak Tasar CD = Critical Difference, * = Significant Difference at 5 percent level

Table 5 Physical properties of yarns of 16 Ne

Properties	**100:0 W:OT**	**65:35 W:OT**	**50:50 W:OT**	**35:65 W:OT**	**CD (5%)**
Twist per inch (TPI) CV SE	12.682 4.481 0.25	13.172 4.951 0.291	14.334 2.024 0.129	15.984 1.61 0.115	.632
Moisture regain CV SE	13.618* 0.095 5.830	13.188* 0.391 0.023	12.898* 0.149 8.602	11.379* 0.760 0.038	.045
Unevenness CV SE	14.46* 0.711 0.045	20.19* 4.675 0.430	21.28* 2.703 0.267	25.13* 2.292 0.258	.885
Yarn neps (+200%/ km) CV SE	117* 14.929 7.811	163.2* 22.217 16.215	209.4* 6.483 6.071	289.4* 11.983 15.509	36.744
Yarn neps (+140%/km) CV	507* 4.44	618.6* 1.929	777* 2.39	815.9* 3.767	31.094

SE	10.084	5.337	8.308	14.354	
Thin places (+50%/km) CV SE	54.1* 23.988 5.803	77.1 9.568 3.299	77.68* 16.409 5.700	103.3* 20.203 9.351	19.218
Thick places (+50%/km) CV SE	309.2* 6.863 9.49	423.9* 8.687 16.469	446.5 6.882 13.743	637.5* 4.097 11.682	39.262
Hairiness CV SE	11.788* 1.216 0.064	11.282* 0.921 0.046	10.976* 3.147 0.154	10.372* 1.255 0.058	.058
Lab values of yarn					
L value CV SE	71.414* 0.223 0.071	64.216* 0.401 0.115	60.708* 10412 0.383	58.014* 0.577 0.149	0.650
a value CV SE	1.078* 15.833 0.249	4.116* 13.205 0.243	4.978* 12.339 0.274	5.11 13.182 0.301	0.804
b value CV SE	12.61* 0.675 0.038	14.79* 0.766 0.050	16.214* 0.778 0.056	17.266* 1.382 0.106	0.201

W = Wool, OT = Oak Tasar CD = Critical Difference, * = Significant Difference at 5 Percent level

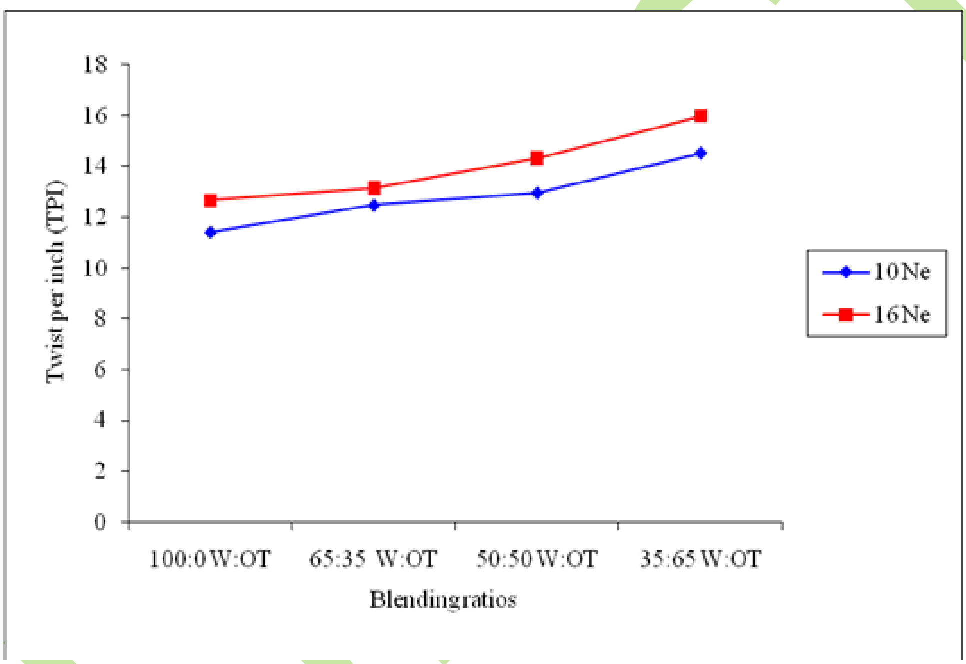

Figure 1: Effect of blending ratios on twist per inch of yarns

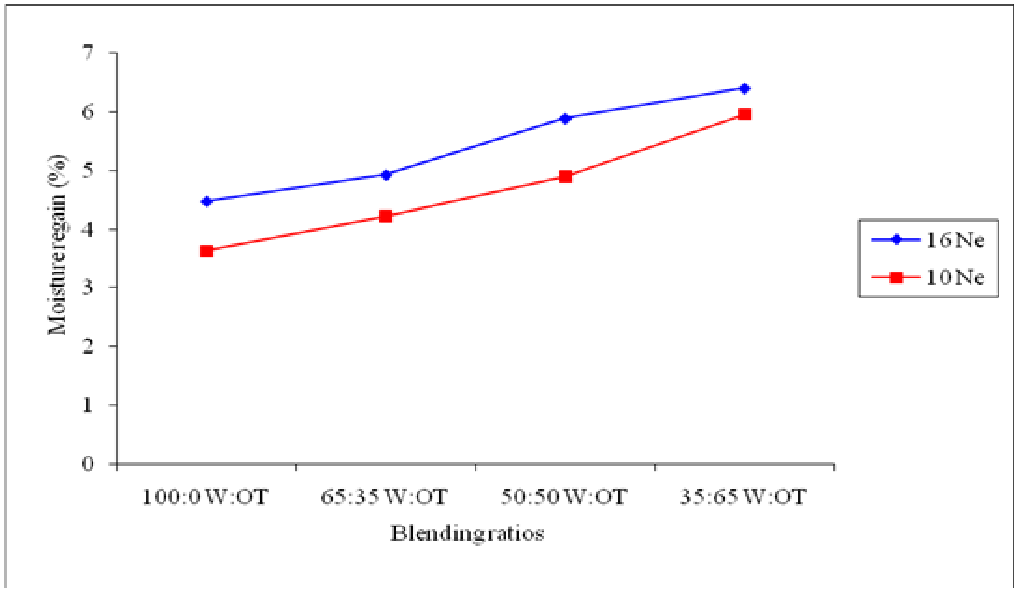

Figure 2 Effect of blending ratios on moisture regain percentage yarns

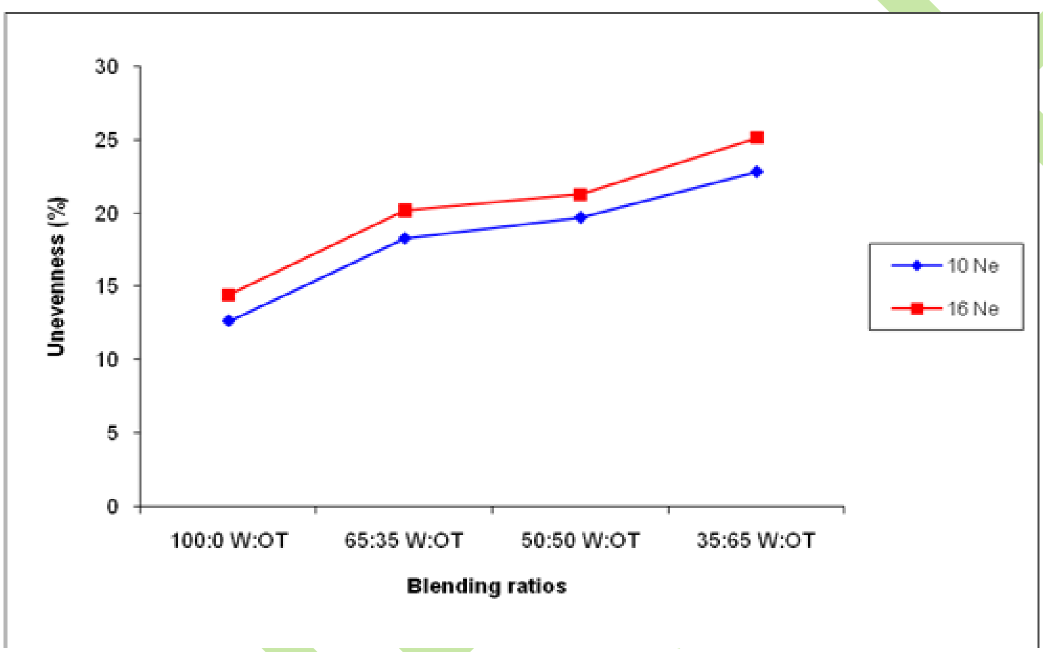

Figure 3 Effect of blending ratios on unevenness of yarns

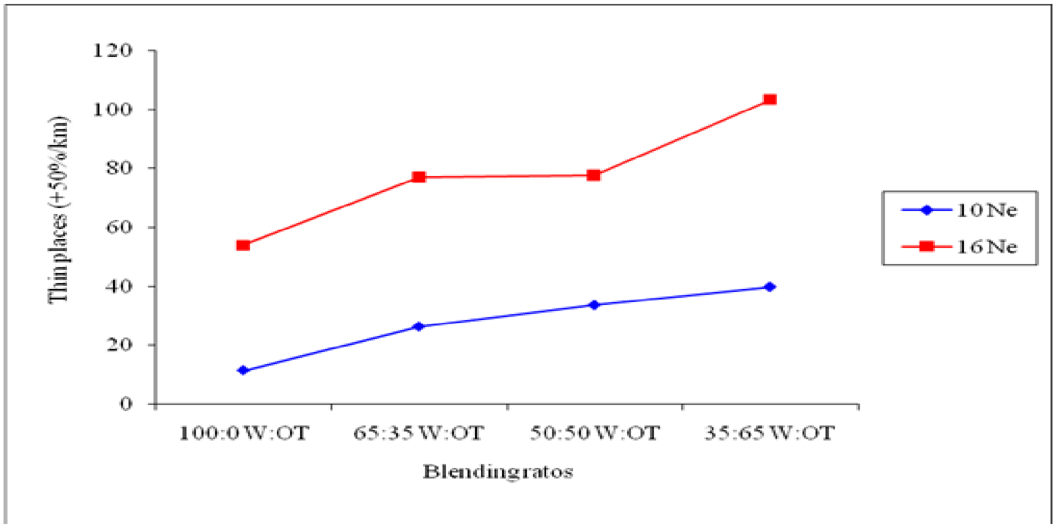

Figure 4 Effect of blending ratios on thin places of yarns

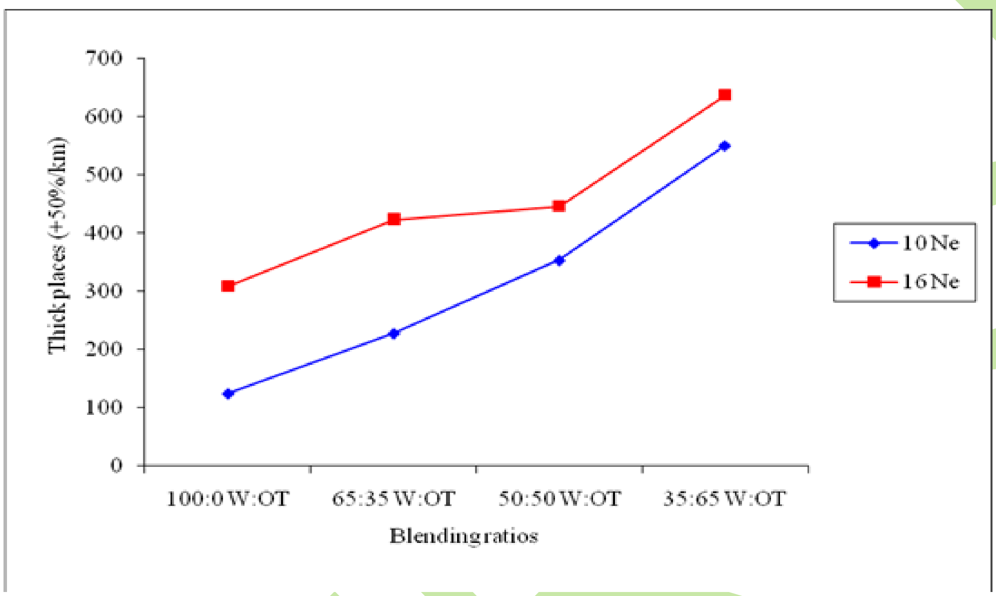

Figure 5 Effect of blending ratios on thick places on yarns

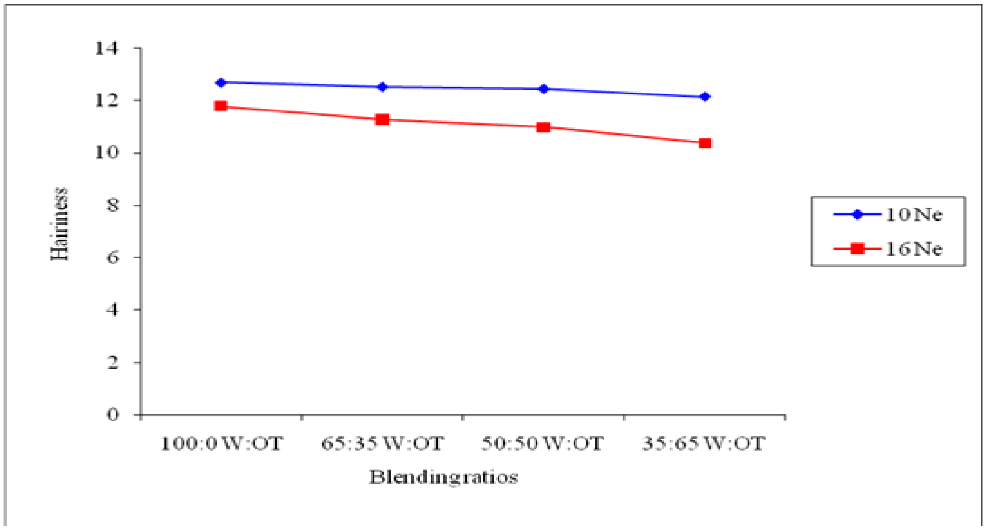

Figure 6 Effect of blending ratios on hairiness of yarns

A similar trend was observed in the yarn of 16 Ne. The lowest thick places/m were in pure wool yarn i.e. 309.2/m. It increased with an increasing proportion of oak tasar waste in the blend. A significant difference was there among all the blends of 10 Ne yarns. The 16 Ne yarn also had significant difference except 50:50 W/OT blended yarn.The results of SEM analysis of fibers (Plate 4) clearly revealed that the oak tasar fiber has irregular and rough fiber, due to this irregularity the resultant yarns has found to be more imperfections when the proportion of oak tasar waste was increased in the blend.

Yarn hairiness

Since hairiness is the property associated exclusively with the fibers having rough and irregular surface. The minimum number of hairs in 10 Ne yarn with a mean value of 12.13 were found in the case of 35:65 W/OT blend. The number of hair increased with an increase in the ratio of wool in the blend and was maximum in 100 percent wool mean value of 12.676/m. The yarn made in 16 Ne yarn also followed the same pattern the difference being that the number of hair/meter were higher in comparison to that in 10 Ne yarn. The minimum and the maximum mean value of 35:65 wool/oak tasar and pure wool yarns were 10.372 and 11.788, respectively. (Table 5 and Fig 6) It is clear from the data that as the proportion of wool increased in the blend, the number of hairs/meter also increased considerably. The higher number of hairs/meter of 10 Ne yarn were more than that in the 16 Ne was because the higher diameter. The difference among different blends of 10 Ne yarn was not found to be significant except in the case of 35:65 W/OT blend. However, a significant difference existed among all blends of 16 Ne yarns. SE of 10 Ne and 16 Ne yarns varied from 0.028 to 0.101 and 0.046 to 0.154, respectively. According to Tyagi (2004) the yarn unevenness with higher silk content is due to high twists that add higher crimp to the yarn, which gives a wavy effect owing to the mechanical hindrance resulting in a higher Uster value.

CIE Lab values of yarns

The mean of L value of 10 Ne yarn was 70.55 in the case of 100 percent wool (Table 4). It was found to decrease significantly (CD = 0.319) with the increase in the proportion of oak tasar in the blend and was lowest in 35:65 W/OT blend having with a mean value 56.33. It showed that the pure wool yarn is brighter than the blended yarns. However, minimum a value was observed in 100 percent wool yarn (1.15), which significantly increased with increasing proportion of oak tasar waste in the blend. It showed that 100 percent wool yarn was more towards green and less red as compared to the blended yarns. Data pertaining to b value of 100 percent wool elicited less yellow colour content as comparedto blended yarns. In the case of 16 Ne yarn (Table 5), a similar trend was observed where the higher L value (mean value 71.411) of 100 percent wool was found to decrease significantly (CD = 0.650) with an increase in the amount of oak tasar waste in the blends. The value was found to be lowest in 35:65 W/OT blend (mean value 58.014). The a and the b values were the lowest in the case of 100 percent wool which increased significantly with an increase in the amount of oak tasar waste in the blend. Kariyappa *et al* (2006) also reported that luster and brightness index properties improved by blending the wool with eri silk.

CONCLUSION

Fiber obtained from oak tasar waste fiber had rough surface and more variation along the fiber length and can be thus, utilized for blending with the fine quality merino wool. Blends of wool and oak tasar fiber in 65:35, 50:50 and 35:65 can be spun into yarns of varying counts on the Ring Spinning System in the counts of 10 and 16 Ne.

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