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Evaluation of mechanical properties of oak tasar silk waste/viscose blended knitted fabrics

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Abstract
The present study was carried out to investigate the effects of blending oak tasar silk waste with viscose fibre to develop blended yarns for the construction of high quality knitted fabrics. The oak tasar silk waste and viscose blended yarn were prepared on worsted spinning system with three different blend ratios *viz*. 60:40, 50:50 and 40:60, spun into two different yarn counts (15 Nm and 20 Nm) for each blend ratio. Best four yarns out of total six were selected for further development of Single jersey knitted fabrics using circular knitting machine. The prepared knitted fabrics were evaluated for mechanical properties: breaking load and elongation, bursting strength, fabric growth, fabric stretch, abrasion resistance, snag resistance and thermal insulation. Results revealed that the addition of viscose fibre content improved the bursting strength, elongation percentage, abrasion resistance and snag resistance.

Keywords: blending, knitted fabrics, mechanical properties, oak tasar waste, viscose

Introduction
Blending of different fibers is extensively practiced for uplifting the performance and the aesthetic properties of resultant fabric. Blending of natural fibers with man-made ones can provide the benefits of combining the good properties of both fiber components, such as comfort, softness, strength etc. These advantages also allow an increased variety of products to be made and deliver a stronger marketing advantage (Svetnickienė V and Ciukas R, 2009) [1]. Reckoning of the performance of blended yarns has also been studied by numerous authors (Pan N, Postle R, 1995; Pan N, Chen K, Monego CJ, Backer S, 2000 and Kemp A, Owen JD, 1995) [2, 3, 4] Natural fibers and their blends with man-made fibers improve the performance characteristics. Natural fibres like silk, provide aesthetic comfort, synthetic fibres are easy to care and possess good strength properties, So blending with such a combination of fibres produces a fabric which is economical and also aesthetically appealing. The trend of blended fabrics have been increased even in India. Blending combines the attributes of each of the fibre and produces a proved state of blended fabric. While blending, the good qualities of the fibres are emphasized and poor ones are minimized, if mixing of fibres is done carefully. Hence, blending needs knowledge of both, fibre science and as well as art. It enables the technicians to produce a preffered fabric for desired enduse.

Blending of silk and viscose is advantageous over blending of silk and cotton. Viscose is more functional and uniform as compared to cotton, as it is a manmade fibre. It secures over synthetics, due to its biodegradable nature and thus causes fewer burden to ecosystem. Viscose exhibits a silk like aesthetics, drape and feel; and retains rich brilliant colour. Also viscose fibre is manufactured from cellulosic base which contributes many properties to it, that are similar to cotton and other natural cellulosic fibres.

Generally the yarn produced by blending is converted into fabric by the process of weaving. Very few attempts have been made to knit the blended yarns especially silk and viscose, therefore, in the present study efforts have been made to build a fabric with the help of knitting technology. Knitted fabrics have various advantages over woven ones. Knitted fabrics are produced by set of connected loops from a series of yarns. In this method one set of yarn is used and it does not require sizing. Yarn preparation is not necessary before fabric manufacturing and production capacity is more as compared to weaving. Also production cost is less than weaving cost and above 52% fabrics are produced by knitting technology in textile sector. Therefore, the present study was carried out to figure out the effects of blending oak tasar silk waste with viscose fibre to develop blended yarns for the construction of high quality knitted fabrics.

Material and Methods

Oak tasar silk waste and viscose blended yarns in three different proportions, *viz*. 60% OTW: 40% V, 50% OTW: 50% V and 40% OTW : 60% V were developed, using two different yarn counts (15 Nm and 20 Nm) for each blend ; maintaining yarn twist constant at the rate of 10 twists per inch for both the yarn counts. Hence six blended yarns were obtained from three blend ratios. Each blend ratio produced two type of yarns having different counts. Oak tasar silk waste was opened properly by hand and then was fed into carding machine. Further to this, the fibres were blended using gillbox. At this step, fibres were blended into different proportions. After this, drawing procedure was carried out. The developed yarn cones weighed 50 g each. Prepared yarns were tested for yarn eveness, yarn strength and moisture regain.

On the basis of the yarn properties evaluated in table 1, best four yarns were selected and further used to develop knitted fabrics using circular knitting machine. Single jersey knitted fabrics were developed by using suitable blended yarns *viz*. 60% OTW:40%V (20 Nm), 50%OTW:50%V (15 Nm) and both the counts of 40%OTW:60%V on knitting maching of gauge 10 using creel with 36 cones. Blended knitted fabrics were subject to mechanical properties listed in Table-3 along with test method. Developed knitted fabrics were assigned codes for ease of discussion and understanding as mentioned in Table 2.

Table 1: Properties of blended yarns

Yarn composition	Yarn count (Nm)	TPI	Breaking Force (g)	Moisture Regain (%)	Neps (+200)	Yarn evenness (U%)
60OTW%: 40%viscose	15	10	703.1	6.36	3155	21.84
	20	10	975.9	9.99	1915	23.4
50OTW%: 50%viscose	15	10	794.1	8.36	2458	21.66
	20	10	699.9	7.98	2652	22.42
40%OTW: 60%viscose	15	10	960.4	8.89	1877	19.43
	20	10	665.2	7.50	1447	19.54

Table 2: Developed fabrics with codes

Fabric code	Fibre Content	Yarn count (Nm)	Yarn Density (WPIxCPI)
S1	60OTW%: 40%viscose	20	20x16
S2	50OTW%: 50%viscose	15	20x15
S3	40%OTW: 60%viscose	15	20x15
S4	40%OTW: 60%viscose	20	20x16

CPI- Courses per inch, WPI- Wales per inch

Table 3: Fabric testing methods and equipments

Fabric testing equipments	Name of the equipment	Test method
Test		
Courses and wales per unit length	Textile inspector	BS 5441:1988
Bursting strength	Diaphragm bursting	IS 1966-78 Re 2006
Elastic properties -Fabric stretch -Fabric growth -Fabric recovery	Stretch recovery tester	ASTM D 6614:07
Flat abrasion resistance	Martindale abrasion tester	IS: 12673: 1989
Fabric pilling	Digital pilling tester	IS: 10971-1984
Snagging resistance	ICI Mace snag tester	ASTM D 3939:09
Tensile strength and elongation	Tensile strength tester	BIS: 4303-1968
Thermal Insulation	Thermal Insulation Tester	KES-F 7 THERMO LABO II

Results and Discussion

Mechanical properties of developed blended fabrics have been presented in table 4

Table 4: Mechanical properties of blended fabric

Mechanical parameters	S 1 60OTW:40viscose (20 Nm)	S 2 50OTW:50viscose (15 Nm)	S 3 40OTW:60viscose (15 Nm)	S 4 40OTW:60viscose (20 Nm)	CV	CD
Breaking load (N)						
Waleswise	177.57 ± 2.994	122.28 ± 0.567	175.85 ± 2.884	131.71 ± 4.228	0.191	29.095*
Coursewise	136.51 ± 3.227	102.13 ± 2.052	158.55 ± 2.904	101.37 ± 2.352	0.224	15.493
Elongation (%)						
Waleswise	44.53 ± 0.357	45.38 ± 0.348	49.24 ± 0.518	45.73 ± 0.431	0.045	5.059
Coursewise	103.58 ± 2.253	103.44 ± 2.155	94.89 ± 2.052	111.89 ± 2.957	0.067	10.948
Bursting strength	4.11±0.0565	4.88±0.048	4.90±0.005	5.61±0.082	0.126	0.18*
Elastic properties						
-Fabric stretch (%)						
Waleswise	47.2 ± 1.207	46.16 ± 0.440	44.93 ± 0.515	45.3 ± 0.993	0.022	2.78
Coursewise	128 ± 0.134	116.8 ± 1.275	112.8 ± 1.701	101.3 ± 1.264	0.096	4.04*
-Fabric growth (%)						

Waleswise	10.13 ± 0.257	8.66 ± 0.185	10.0 ± 0.161	7.06 ± 0	0.160	0.58*
Coursewise	34.90 ± 0.672	24.67 ± 0.282	19.60 ± 0.224	22.130 ± 0.38	0.265	1.39*
Flat abrasion resistance	2500 ± 14.977	2000 ± 39.552	2200 ± 35.388	2500 ± 28.583	0.107	101.11*
Snagging resistance						
Waleswise	3.0 ± 0.289	3.5 ± 0.289	3.5 ± 0.289	3.0 ± 0.289	0.089	0.94*
Coursewise	3.0 ± 0.289	3.5 ± 0.289	3.5 ± 0.289	3.0 ± 0.289	0.074	0.94*
Thermal insulation						
Heat keeping ratio (%)	20.91 ± 0.009	15.20 ± 0.237	16.93 ± 0.343	14.78 ± 0.323	0.165	0.86*
Tog value	1.54 ± 0.032	1.42 ± 0.027	1.46 ± 0.015	1.42 ± 0.005	0.039	0.07*

Breaking force (N)
Table 4elicits that, the breaking force of fabric S1 was highest (177.57) in wales wise direction whereas, in course wise direction it was highest for fabric S3. Lowest breaking force was observed for fabric S2 (122.28) in wales wise direction and fabric S4 in course wise direction. The results of the breaking force of fabric were in accordance with the results of breaking force of blended yarns. Further the difference between all the fabric samples was significant in wales wise direction except for fabrics S1 and S3; and S2 and S4, whereas in course wise direction, the difference between all the fabric samples was non-significant, except for fabrics S2 and S4.

Elongation (%)
It can be envisaged that, the elongation percent of fabric S3 was found to be highest (49.24) in wales wise direction whereas, in course wise direction, fabric S4 exhibited highest (111.89) elongation percentage. Second highest elongation was observed by fabric S4 (45.73) in wales wise direction and fabric S1 in course wise direction. Lowest elongation percent was depicted by fabric S1 in wales wise direction and fabric S2 in course wise direction. However, there was no significant difference between all the fabric samples in both the directions.

Bursting strength
Bursting strength is a method of measuring strength in which the material is stressed in all the directions at the same time and is therefore more suitable for materials such as knitted fabrics, lace or non-woven. The bursting strength of fabric S4 was highest with mean value of 5.61±0.082, followed by fabric S3 (4.90±0.005). Whereas, lowest strength was found in fabric sample S1. Results clearly reveal that, as the proportion of viscose fibres in the yarn increases, the bursting strength also increase. Also there was a significant difference among all the fabric samples except for S2 and S3.

Elastic properties
The term elasticity describes the ability of a fabric to elongate (or stretch) when tension is applied, and to recover its original shape when the tension is released.

Fabric stretch: Highest fabric stretch per centage was found in fabric S1 in both wales wise and coarse wise direction with mean values of 47.2 ± 1.207 and 128 ± 0.134 respectively. Second highest fabric stretch was found in fabric S2 with mean values of 46.16 ± 0.440 in wales wise and 116.8 ± 1.275 in coarse wise direction, whereas, lowest stretch was reported in fabric S3 (44.93 ± 0.515) in wales wise and S4 (101.3 ± 1.264) in coarse wise direction. Statistical analysis revealed that, there was no significant difference between all the fabric samples in wales wise direction, whereas, there was a significant difference between fabric samples in coarse wise direction except for fabrics S2 and S3.

Fabric growth: Maximum fabric growth was found in fabric S1 in both the directions with mean values as 10.13 ± 0.257 (wales wise) and 34.90 ± 0.672 (coarse wise). This was followed by fabric S1, second highest fabric growth was reported in fabric S3 in wales wise (10.0 ± 0.161) and fabric S2 in coarse wise (24.67 ± 0.282) direction. Minimum fabric growth was found in fabrics S4 and S3 in wales wise (7.06 ± 0) and coarse wise (19.60 ± 0.224) direction respectively. Statistical data also revealed that, there was a significant difference among all the fabric samples in both the directions except for fabrics S1 and S3 in wales wise direction.

Flat abrasion resistance
Abrasion is an aspect of wear. It is the rubbing away of the component fibres and yarns of the fabric. The ability of a material to resist the action of abrasive forces is one of the major criteria to take into account for assessing the durability.
Highest abrasion resistance was found same for both the fabrics S1 and S4 (2500 cycles), whereas, lowest resistance was noticed in fabric sample S2 with mean value of 2000 cycles. Statistically there was no significant difference between fabrics S1 and S4 but there was a significant difference among all the other fabric samples.

Snag resistance
Snagging is a defect caused by the pulling or plucking of yarns from a fabric surface. The degree of fabric snagging is assessed by comparing the tested specimens with visual standards. These visual standards could be either fabrics or photographs of fabrics. In this test standard photographs of fabrics were used to evaluate the snag resistance of fabrics.
Photographic rating standards show the following extent of snagging:

Rating 5 no snagging
Rating 4 slight snagging
Rating 3 moderate snagging
Rating 2 severe snagging
Rating 1 very severe snagging

Results depicts that, a moderate snagging was found in fabrics S 1 and S4 with rating 3, whereas, there was a moderate to slight snagging in fabrics S2 and S3 with rating 3.5 in both wales wise and coarse wise ways. Further, it was analyzed that there was no significant difference among all the fabric samples in both the directions.

Thermal insulation
The effectiveness of a fabric as a thermal insulator depends upon its ability to hold as large an amount of still air as possible and then to retain this during use. Fabric S1 exhibited maximum heat keeping ratio (20.91 ± 0.009), followed, by fabric S3 (16.93 ± 0.343), whereas minimum thermal insulation was noticed in fabric S4 with mean value of 14.78 ± 0.323. Statistically the results were significant at 0.5 level

of significance, except for, fabrics S2 and S4.

TOG value: TOG is a unit of measure of thermal insulation used in the textile trade and is the international standard measurement of a blanket's thermal effectiveness. Results for Tog value shows that highest tog value was found in fabric S1 (1.54 ± 0.032), followed, by fabric S3 (1.46 ± 0.015) and lowest value was observed in fabrics S2 and S4 with same mean value i.e. 1.42. Further, there was no significant difference observed between fabrics S2, S3 and S4.

Conclusion

Thus, it can be concluded that, blending of viscose fibre with oak tasar waste improves improved the bursting strength, elongation percentage, abrasion resistance and snag resistance of the resultant fabric. Therefore, blending of tasar silk waste with viscose offers an excellent scope, considering the overall characterictics of yarns and fabrics.

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