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BLENDING OF COMBER NOIL AND RAW WOOL AND ITS EFFECT ON BLANKET PROPERTIES

N. Shanmugam*, D.B. Shakyawar, Seiko Jose, Ajay Kumar and Vinod Kadam
Division of Textile Manufacture and Textile Chemistry
ICAR-Central Sheep and Wool Research Institute, Avikanagar- 304 501, Rajasthan
**E-mail address: dr.shanmugam@gmail.com*

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ABSTRACT

An exploratory research was carried out to examine the effects of blending comber noil with raw wool on the properties of woollen blanket. Four types of blankets were prepared by keeping comber noil levels at 10, 20, 30 and 40% with Bharat Merino and Chokla raw wool in the blends. Yarn realization and yarn breaking load decreased ($P<0.05$) with increasing in noil in blends. Thickness of blanket and bending length of warp and weft increased significantly ($P<0.05$) with the addition of noil. Increase in noil in the blend ratio did not affect the abrasion loss. Dynamic friction coefficient got reduced ($P<0.05$) with the addition of noil in the blend ratio. Thermal resistance progressively increased with increase in noil in blend ratio and the maximum smoothness was observed on maximum noil percentage. The sensation of coldness and warmth (qmax) was improved with addition of noil. It was concluded that 30% comber noil can be added with fine and medium wool to get good thermal and smoothness properties of woollen blanket.

Key words: Blanket, Blend, Comber noil, Friction, Thermal, Wool

India has 6.04 lakh spindle capacity for making worsted yarns that are suitable for the preparation of apparels and suiting, shirting, underwear, knitwear and shawls (GOI, 2015). Worsted yarn making involves sequence of processes namely, scouring, oiling, willowing, carding, gilling, combing, roving and spinning. Combing is one of the essential processes in the manufacture of worsted yarn. The main objective of combing is to remove short fibres called noil which are undesirable in the making of worsted yarn. Combing produces finer, stronger and uniform yarn and for producing such a quality yarn short fibres (<20 mm) have to be removed. Short fibres (noil) reduce the strength of the yarn, increase the bulk and gives hairy appearance to the yarn. Wool combing capacity of India stands at 30 million kg. Quantity of noil extracted depends on the type of wool combed and quality of yarn produced and it varies from 4 to 15% (Atkinson et al., 2010). Assuming an average comber noil extraction of 10%, the total quantity of noil produced in the country is 3 million kg. Methods are developed to monitor and quantify the amount of waste produced at comber so that it can be reduced. Majority of the textile operations create waste during cleaning of fibres and combing is one of the processes that also generate waste in the form of noil. The first step in the management of waste is to prevent the waste generation and if that is not feasible, one has to re-use it to add value to the waste. Noil that are very short in nature that cannot be spun into yarn in a commercial spinning system are used in the filling of cushion and in the preparation of agricultural compost. Composite films were prepared from keratin extracted from waste wool fibres in chitosan matrix (Fan and Yu, 2010). Value addition to wool comber noil is being attempted in different methods and in this study an attempt is made to give value addition to wool comber noil through blending.

MATERIALS AND METHODS

For the present study, Bharat Merino (BM) wool, Chokla (CH) wool and Comber noil (CN) were obtained from Southern Regional Research Centre, Mannavanur (Tamil Nadu), Arid Region Campus, Bikaner (Rajasthan) and Mahaveer Woollen Mills, Mandi (Himachal Pradesh). The study was conducted at ICAR-Central Sheep and Wool Research Institute, Avikanagar during January to November, 2018. Raw wool was tested for wool fibre diameter and medullated fibres (%) using the standard test method IS 744: 2000. Staple length was tested as per IS 6653: 1972.

Before blending, BM and CH wool was de-dusted and scoured. Four types of blends were prepared by blending BM, CH and CN in ratios as i) BM/CH/CN: 50/40/10, ii) BM/CH/CN: 50/30/20, iii) BM/CH/CN: 50/20/30 and iv) BM/CH/CN: 50/10/40. BM wool composition was kept at constant level of 50% while CH wool was replaced with comber noil to improve the smoothness of the final product based on earlier study (Shanmugam et al., 2019). Blended wool and noil were willowed and spread on the floor with the application of emulsion of 4% *Mahuva* with water. After 24 h, the wool was carded in Torigoe 3 cylinder 3 doffer woollen card. The roving obtained from condenser card was fed to ring spinning frame having a fixed ratch of 12 inch. A draft of 1.5 and TPI (Twists per inch) of 3.8 was given at ring frame and produced a yarn of 3.0 Nm yarn count. The yarn obtained was tested for breaking load using single thread strength tester (AMETEK, LS1) at a gauge length of 25 cm and at a traverse speed of 250 mm.

Blankets were prepared from each yarn using handloom. Blankets were milled, scoured, raised and stentered using industrial type machines. Constructional parameters namely, ends per inch (EPI), picks per inch (PPI), thickness and grams per square metre (GSM) were measured using in-house test procedures. Bending length of warp and weft of blankets were measured using method of determination of stiffness of fabrics cantilever test IS: 6490-1971. Blanket abrasion loss was evaluated using WIRA carpet abrasion tester as per test method IWS TM 28314. In this method, weight loss after subjecting the blanket to abrasion for 1000 cycles was measured. Subjective evaluation of surface smoothness of blanket was carried out using Thurston pair comparison method as described by Shanmugam et al. (2019). A sample size of 2.5 cm x 15 cm was prepared and tested at a gauge length of 7.5 cm with at loading rate of 300 mm/min for breaking force and elongation as per ASTM D5035-11. Blanket fabrics were tested for coefficient of static and dynamic friction using Instron universal testing machine. Specimen size of 7 x 20 cm was cut from blanket fabric and sled covered with Teflon weighing 197 g was moved over the specimen for a distance of 50 mm at a speed of 50 mm/min for recording of dynamic and static friction coefficient. Thermal properties of the blanket namely, thermal resistance or thermal insulation (temperature difference between two phases of fabric divided by the heat flux) and q_{max} (warm-cool feeling) of the blanket samples were measured using Thermo labo II. Specimen fabric was kept over a measuring plate and a heated plate (32ºC) is brought in contact to the fabric, the peak amount of heat transferred within 0.2 second of the contact was measured and expressed as q_{max}. BM:CH (50:50) blankets was commercially produced and used for comparison of smoothness using method as described by Shanmugam et al. (2019). One way ANOVA was carried out to know the effect the blending of comber noil on the blanket properties viz. thickness, bending length of warp and weft, abrasion loss, breaking load and extension of warp and weft way, dynamic and static friction.

RESULTS AND DISCUSSION

Physical properties of wool and comber noil are given at Table 1. Bharat Merino (BM) wool having a fibre diameter of 21.6 µm was classified under fine wool grade while Chokla (CH) wool having fibre diameter of 30.1 µm was classified under medium wool grade fibre as per IWTO (International Wool Textile Organization) classification. Medullation percentage was zero and 10.7 for BM and CH wool, respectively. Wool comber noil was the waste extracted from BM wool in worsted processing during the manufacture of shawls. The noil fibre diameter was found to be less than that of BM wool fibre diameter. It was reported in a study on the relationship of fineness in wool top, noil, card sliver and grease wool. Pohle et al. (1953) reported that wool top diameter fineness was normally coarser than grease wool and due to removal of short and fine noil. Patil and Agarwal (2017) used wool noil of 17.5 µm in the manufacture of composites. Staple length was highest for BM wool and lowest for CH wool. It is well known that staple length depend on the number of shearing done per year. Chokla wool was obtained from Bikaner where two shearings are practised per year and hence, it has lower staple length. Combing machine was set to remove fibres of length less than 20 mm and hence the noil was found to be less than that length.

Table 1. Wool fibre and noil properties

Property	Bharat Merino	Chokla	Noil
Fibre diameter (µm)	21.6±0.3	30.1±0.6	17.5±0.2
Medullation (%)	0.0±0.0	10.7±1.8	0.0±0.0
Staple length (cm)	8.2±0.4	5.3±0.2	~1.2

Effect of noil blend ratio on yarn realization percentage (YR %), ends down and yarn breaking load in Newtons (B load) are depicted in Fig.1. Spinning was carried out on 24 spindles and ends down was noted for a doff duration. Amount of yarn obtained from input wool at carding is expressed as yarn realization %. It can be seen that YR % as decreasing with increasing in blend of noil %. This could be due to short length of fibres in the noil and short fibres falling down as waste while carding and increasing the waste % in carding, leading to low yarn realization. Yarn breaking load was coming down with increase in blend of noil %. It was observed during carding, while increasing the blend of noil %, frequent choking of carding was experienced and due to this poor carding action, roving was found to have thick and thin places. Because of non-uniform roving, poor drafting happened and led to more ends down during spinning of high noil content blended yarn.

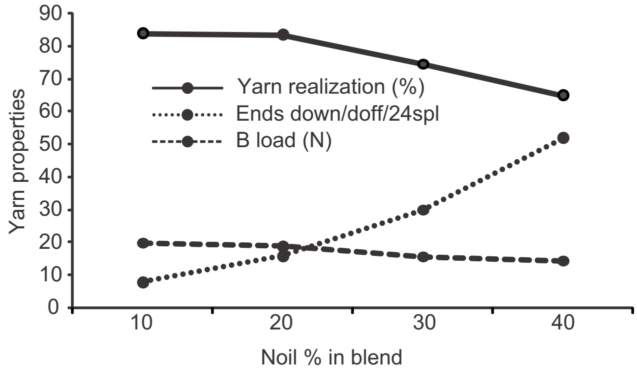

Fig 1. Effect of blend of noil % on yarn properties

Construction particulars of the blanket namely, EPI, PPI and GSM were in the range of 20-22, 15-17 and 550-575, respectively. Addition of noil to the blend was found to increase the thickness of the blanket significantly ($P<0.05$) (Table 2). BM comber noil being finer in nature in terms of fibre diameter and having high crimp frequency compared to CH wool resulted in high bulkiness (thickness of blanket). Bending length is dependent on the thickness and GSM of the fabric and higher the value of these two factors, higher would be the bending length (Saville, 1999). Bending length of warp and weft was found to increase significantly ($P<0.05$) with the addition of noil per cent. This can be attributed to the increase in the thickness of the blanket with the addition of noil per cent. In the present study it was found that increase in noil per cent was not significantly increasing the abrasion loss. In case of tensile properties, warp breaking load and weft breaking load were decreasing with the addition of noil and the decreased levels were 11% (warp BL) 22% (weft BL) when noil per cent changed from 10 to 40. Warp extension was found to increase significantly ($P<0.05$) with the addition of noil and whereas the effect was not significant for weft breaking extension. Between the treatments, there existed a significant difference for dynamic friction coefficient and whereas for static friction coefficient there was no significant difference. Dynamic friction coefficient came down with the increase in noil per cent.

Table 2. Bending, tensile, friction and thermal properties of blankets

Property	Type of blanket (BM:CH:Noil)				P value
	50:40:10	50:30:20	50:20:30	50:10:40	
Thickness (cm)	2.47	2.49	2.71	2.97	0.000
Warp BL (cm)	3.26	3.06	3.16	3.25	0.002
Weft BL (cm)	2.76	2.41	2.42	2.57	0.000
Abrasion loss (mg)	25.0	23.4	24.6	26.6	0.469
B Load warp (N)	329	294	307	290	0.009
B Load weft (N)	225	147	152	174	0.000
Warp ext (%)	28.8	24.5	24.8	30.7	0.000
Weft ext (%)	20.1	21.6	22.7	23.2	0.105
DYFri warp	0.97584	0.95802	0.97383	0.94813	0.004
StatFri warp	0.99462	0.98023	0.99861	0.9622	0.019
DYFri weft	0.98037	0.98381	0.93833	0.96146	0.000
StatFri weft	0.99801	1.01008	0.97813	0.98855	0.017
Thermal resistance (m^2K/W)	0.0898	0.0944	0.0960	0.1006	-
q_{max} (W/cm^2)	0.060	0.062	0.065	0.063	-
Smoothness score	1	2	3	4	-

Thermal resistance progressively increased with increase in noil per cent in blend ratio and highest thermal resistance was observed for the blanket fabrics having 40% noil in the blend ratio. Thermal insulation of textile fabrics is primarily due to the still air contained within the fabrics and yams. Fabric thickness is the most important factor governing the thermal insulation of textiles. Thermal insulation of wool comes from its high crimp value. Manmade fibres with high crimp provide better thermal insulation (Ukponmwan, 1993). In this case, noil having high crimps contributing to the increased fabric thickness within holding of more still air and led to high thermal resistance.

The q_{max} indicates the bulk thermal conductivity which contributes to the cool or warm feel of a person while his finger or skin touches the fabric sample. The sensation of coldness and warmth (q_{max}) was found to increase marginally with the increase in noil per cent. It was reported that finer fabrics having smoother surface will have a better thermal contact and will lead to higher q_{max} (Vivekanadan et al., 2011). Fabric smoothness was found to improve with the addition of noil and least smoothness was observed for BM:CH 50:50 blanket. The maximum smoothness was observed when noil per cent added to maximum and similarly q_{max} also found to be improving with addition of noil indicating that blanket with higher noil per cent would offer a cold feeling to touch. The higher the q_{max}, the cooler the person can feel (Huang et al., 2017). A higher value of q_{max} denotes that there is a more rapid movement of heat from the skin to the fabric surface which will provide a cooler feeling. This study conclusively showed that smoothness of blanket improved with the addition of noil per cent and similarly thermal resistance also enhanced by 12% from 0.0898 to 0.1006 m^2K/W. Major finding of this study is that one can add up to 30% comber noil in blends with fine and medium wool to get good thermal and smoothness properties and at the same time without affecting the process performance and tensile and bending characteristics. By using comber noil at the rate of 30% in the blend of Bharat Merino and Chokla wool, one can reduce the raw material cost by 15.8% with enhanced blanket smoothness.

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