The Indian Journal of Small Ruminants 2013, 19(12): 193-197

Indian Journal of Small Ruminants

ASSESSMENT OF MAGRA AND BIKANERI CHOKLA WOOL FOR CARPET MANUFACTURING

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Manuscript received on 18.10.2012, accepted on 31.12.2012

ABSTRACT

The wool of Magra and Bikaneri Chokla sheep of the northwest Rajasthan have similar qualities and known as ideal carpet wool. However, Bikaneri chokla wool is more preferred by carpet manufacturers compared to Magra wool due to its lustre. The Magra and Bikaneri Chokla wool and their blends with nylon in proportion of 90:10 were spun on woollen spinning system to produce yarns of 3.5 to 4 Nm linear densities. The yarns were converted into hand knotted carpet of 100 knots/inch^2. The resiliency was 22% higher in pure Magra carpet than Bikaneri Chokla. The pile abrasion loss was more in Magra carpet but it was within acceptable limits. The pile contraction under dynamic loading was higher in Magra carpet. The study suggested that blending of nylon with wool significantly influenced the resiliency, pile contraction and relaxed recovery under dynamic loading.

Key words: Bikaneri Chokla wool, Carpet resiliency, Magra wool, Medullation

Magra is one of the important carpet wool sheep breeds of western Rajasthan. The native tract of Magra sheep is northern part of Bikaner district locally called “Utteradha” located in Lunkaransar-tehsil of Bikaner district of Rajasthan. Carpet manufacturers believe that wool obtained from Utteradha region is lustrous and suitable for making quality carpet. Therefore, carpet manufacturers classified this wool as different from Magra wool i.e., Bikaneri Chokla. The wool of Magra and Bikaneri Chokla sheep of the northwest Rajasthan have similar qualities and known as ideal carpet wool. However, Bikaneri chokla wool is more preferred by carpet manufacturers compared to Magra wool due to its lustre. However, as per breed classification scientifically, wool obtained from both sheep is known as Magra wool (Acharya, 1982). In order to establish facts about differences in wool, an attempt was made to analyze the fibre surface properties, yarn quality as well as quality of hand knotted carpet made from Magra and Bikaneri Chokla wool. The effect of nylon blending (10%) on quality of yarn and carpets were also studied.

MATERIALS AND METHODS

Magra wool was procured from Central Sheep and Wool Research Institute, Arid Region Campus, Bikaner and Bikaneri Chokla from Wool Mandi, Bikaner. The wool was scoured in 3-bowl scouring machine. The 3-denier Nylon-6 was used with these wools for blending purposes. The pure wool and their blends with nylon in proportion of 90:10 were processed on 3-swift condenser card for roving formation. The prepared roving was spun on woolen ring frame to produce the yarns of 3.5 to 4 Nm linear densities and 5-5.5 twists per inch (TPI). The yarns were scoured and dyed with metal complex dyes to desired shade in Hank dying machine. The dyed yarns were used to prepare hand knotted carpet of 10×10 quality i.e. 100 knots/inch^2 with 12 mm pile height. In the finishing process, the carpets were chemically washed and clipping of pile was done using machine scissors.

Fibre diameter and proportion of medullated fibre in the wool were determined using ASTM (American

Society for Testing and Materials) methods D 2130 and D 2968, respectively. The yarn fineness was evaluated following the new metric system of yarn fineness measurement. An Instron tensile tester was used to evaluate the breaking strength and elongation at break of yarn as per ASTM D 2256 method. The gauge length and rate of extension of specimen yarn was kept 100 mm and 300 mm/min, respectively. The yarn bulk was measured on fabricated instrument, following the standards procedures for WIRA yarn bulkometer. Scale morphology was studied to distinguish the difference between these two wool using Scanning Electron Microscope (SEM).

The pile height of carpet backing structure to its extremity was measured using pile height gauge. The carpet pile depression under maximum standard pressure of 844 gf/cm^2 termed compressibility of carpet was measured on WIRA thickness gauge as per ASTM D 6859 method. The results are expressed as percent of pile compressed from minimum to maximum exerted pressure. Carpet resilience was assessed by measuring the pile thickness on pile compression and pile recovery after compression during a complete loading and unloading cycle with different pressure of 17.6, 52.7, 211, 422, 633 and 844gf/cm^2 on WIRA thickness gauge. A typical pressure-volume curve was plotted and area under the curves was measured. The ratio of area under recovery curve to compression curve is expressed as carpet resiliency. The abrasion resistance of carpet was determined by rubbing the carpet on the WIRA abrasion tester with a double rotary motion using a standard coarse abradant fabric at constant pressure of 8 lb/in^2. Carpet pile contraction under dynamic loading was measured on WIRA Dynamic loading machine for 1000 impacts of dynamic loading and recovery of distorted carpet pile after 48 h relaxation time was also assessed.

The carpet samples were subjectively assessed for lustre, softness, compressibility and handle properties. The evaluation was carried out through 10 observers in score scale of 1-10 for dull to bright lustre, stiff to soft, uncompressible to compressible and poor to excellent general handle of carpet. Correlation of score was awarded to carpet samples by different observers and average score was worked out.

RESULT AND DISCUSSION

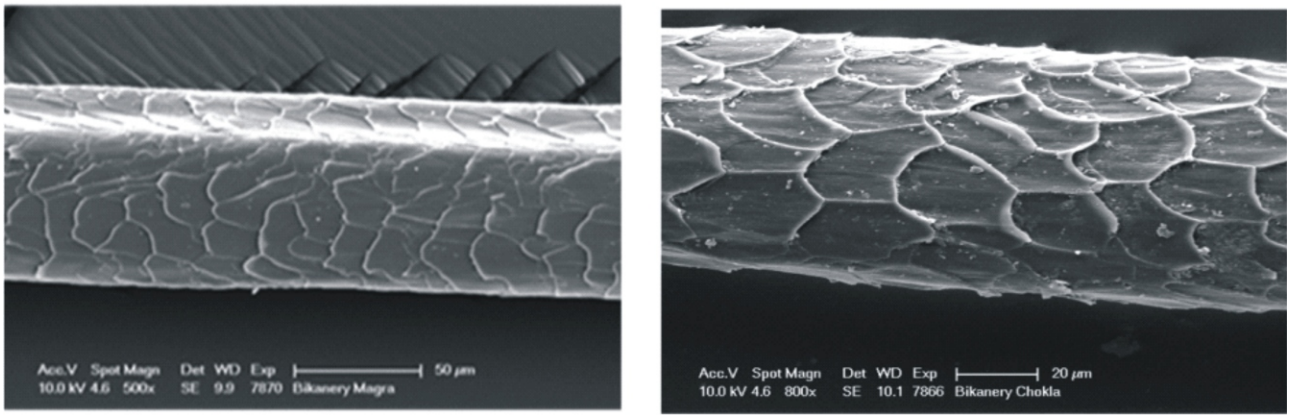
The average fibre diameter and medullation were higher in Bikaneri Chokla wool as compared to Magra (Table 1). The hairy fibres were twice that of hetro fibres and total medullated fibres were 55% for Bikaneri Chokla wool whereas, hetro type medullated fibres were more in Magra wool than hairy type fibre with total medullation of 43%. Medullated fibre proportions were at desired level in Magra wool.

Table 1. Fibre characteristics of different wools

Fibre characteristics	Magra wool spring clip	Magra wool autumn clip	Bikaneri Chokla wool autumn clip
Fibre diameter (µ)	34.35±0.69	33.27±0.61	34.90±0.69*
	(36.60)	(33.58)	(34.40)
Hetero fibre (%)	19.00	22.77	17.00
Hairy fibre (%)	26.67	20.18	38.00
Total medullation (%)	45.67	42.95	55.00
Staple length (cm)	5.6	5.4	6.2
Fibre scale properties			
Scale per 100 (µm)	5.39	5.39	4.61
Scale frequency/10000 µm^2	19.08	19.08	22.45

** Fibre diameter is different significantly at 5% level, figures in bracket indicate CV %*

Scale morphology is an important feature to distinguish the difference between wool samples. Scale structure also influences lustre of wool. The scanning electron microscope (SEM) images of both wool samples are depicted in Plate 1. The number of scales per unit length of 100 µm were 5.39 and 4.61 for Magra and Bikaneri Chokla wool, respectively (Table 1). This revealed closer scale pattern in Magra wool. The scale frequency (number of scale per 10000 µm^2) was higher in Bikaneri Chokla (22.45) compared to Magra wool (19.08). However, Bikaneri Chokla wool showed more uniform and peculiar diamond shape of scale structure with larger scale size, which may be attributed to higher lustre in Bikaneri Chokla as compared to Magra wool.



Magra wool Bikaneri Chokla wool

Plate 1. Scanning electron microscopic images of Magra and Bikaneri Chokla wool

The yarn properties of pure wool and 10% nylon blended carpet yarns are given in Table 2. The tenacity and elongation at break was highest for nylon-blended Bikaneri Chokla yarn and it could be attributed to higher staple length and more twist. Among the pure yarns, tenacity and elongation at break were better in pure Magra than Bikaneri Chokla yarn mainly because of lesser number of medullated fibres. Gupta et al. (1998) observed negative correlation of fibre diameter and medullation with yarn tenacity and elongation at break. Yarn tenacity was lower for Magra wool nylon blended yarn. In an earlier study also it was also observed that beyond the optimum level of nylon blending, yarn tenacity decreased (Shakyawar et al., 2011). The higher tenacity of Bikaneri Chokla-nylon blended yarn was attributed to coarse yarn count and high twist level.

Table 2. Yarn properties of different pure and blended yarns

Proportion of wool in yarn		Sample Code	Yarn count (Nm)	Yarn twist (TPI)	Strength (g/tex)	% Elongation at break	% Yarn realized	Bulk (cm^3/gm)
Magra spring clip (100%)		MGS	4.09	4.97	5.48	47.61	68.0	9.65
	CV%		(12.43)	(9.56)	(12.05)	(14.04)		
Magra autumn clip (100%)		MGA	4.30	4.90	5.17	42.46	74.0	9.38
	CV%		(6.51)	(10.06)	(8.66)	(14.5)		
Bikaneri Chokla autumn clip (100%)		BCA	4.13	5.10	4.39	35.99	70.0	10.28
	CV%		(9.95)	(6.62)	(8.93)	(15.64)		
Magra spring clip (90%) + Nylon (10%)		MGSN	4.11	5.70	4.87	57.20	84.0	10.97
	CV%		(13.46)	(6.21)	(8.89)	(10.88)		
Magra autumn clip (90%) + Nylon (10%)		MGAN	4.19	5.50	4.41	55.22	91.1	10.00
	CV%		(6.9)	(8.52)	(11.27)	(8.83)		
Bikaneri Chokla autumn clip (90%)		BCAN	3.94	5.80	9.8	81.32	79.6	12.50
+ Nylon (10%)	CV%		(3.7)	(7.99)	(7.36)	(7.99)		

The bulkiness was higher for Bikaneri Chokla wool yarn compared to Magra and can be attributed to higher proportion of medullated fibres in Bikaneri Chokla wool. The blending of nylon with wool improved the spinnability and enhanced yarn realization to the extent of 14% and 24% for Bikaneri Chokla and Magra wool yarns, respectively. The yarn bulkiness was also improved by 22% and 7% respectively.

The results of carpet performance characteristics of hand knotted are given in Table 3. The carpet resiliency of pure Magra wool was 15-22% higher than Bikaneri Chokla. This is attributed to the optimum proportion of medullated fibres (42.67%) with 22.77% of hetro-type fibres in the wool. On the other hand, compressibility was higher in carpet made from Bikaneri Chokla wool due to higher bulkiness of yarn due to higher proportion of hairy fibres (38%). The higher pile compression resulted in more inter-fibre friction and more loss of compressional energy within pile. It may also due to more fibre entanglement which resisted recovery of pile after compression. It was also found that the compressibility and resilience properties of the carpet depend on the proportion of medullated fibres in the carpet pile.

The pile abrasion losses were more for Magra wool carpet, however it was within acceptable limit proposed by IWS standard (70 mg fibre loss per 1000 cycle of abrasion). Comparatively lower abrasion losses in carpet pile of Bikaneri Chokla wool may be attributed to higher bulkiness of yarn. Carpet pile contraction under dynamic loading was better for carpet of Bikaneri Chokla wool and its blend as compared to carpet made from Magra wool and its blends. The recovery of contracted carpet pile after 48 h was similar for both the carpets after the dynamic impact loading of 1000 cycles. Nylon blending negatively influenced the carpet compressional properties viz., enhanced the pile contraction and gave poor recovery after dynamic loading for carpet. This was attributed to reduction in proportion of medullated fibres in the carpet pile with nylon blended carpets.

Table 3. Performance characteristics of hand knotted carpet from different wool and their blends

Sample Code	Pile height (mm)	Compressibility (%)	Resiliency (%)	Abrasion loss (mg)	Pile contraction (%) under dynamic loading	Pile recovery after 48 h (%)
MGS	11.25	66.76	33.82	70	9.59	90.98
MGA	10.80	68.02	39.06	69	9.92	95.66
BCA	10.90	77.24	31.91	66.6	5.34	96.36
MGSN	10.95	72.98	37.91	65.6	12.92	91.78
MGAN	11.65	63.56	33.77	62.6	13.22	91.78
BCAN	11.10	66.01	32.93	70.2	9.84	93.94

Although blending of nylon improved the spinnability and produced better quality yarn, it resulted in better abrasion resistance for Magra wool carpet due to more number of pure fibres and deteriorated resiliency, pile contraction and relaxed recovery after dynamic loading. Carpet made of Bikaneri Chokla-nylon blended yarn improved resiliency mainly due to the reduction in proportion of medullated fibres. However, carpet pile contraction and relaxed recovery after dynamic loading remained similar to Magra-nylon blended yarn carpet.

The carpet samples were subjectively assessed for lustre, softness, compressibility and general handle properties. The average scores in scale of 1-10 were awarded to carpets from different wool and their nylon blend are given in Table 4.

Table 4. Average score (10 point scale) on subjective assessment of carpets

Sample code	Lustre	Softness	Compressibility	Handle
MGS	6.90	7.05	5.90	6.55
MGA	6.05	6.85	6.60	6.70
BCA	5.05	5.35	4.55	5.85
MGSN	7.10	7.20	7.45	8.05
MGAN	6.35	7.20	7.20	6.65
BCAN	4.40	4.85	4.90	5.30

The correlation coefficients among observers for carpet lustre, softness, compressibility and handle are given in Table 5. The average rank correlation coefficient between different observers showed positive trend, however moderate agreement was seen in the opinion of different observers. Significantly higher (0.83) correlation coefficient was observed for carpet compressibility. Pure Magra wool carpet was found more lustrous, softer and better handle properties as compared to Bikaneri Chokla. It also resembles with the objective evaluated results of carpet performance properties. Nylon blending up to 10% with Magra wool observed to improve subjectively assessed properties.

Table 5. Correlation coefficients among observers for subjectively evaluated properties

	Observers										Average
	1	2	3	4	5	6	7	8	9	10	
Lustre	0.75	0.52	0.52	0.93	0.85	0.83	0.57	0.77	0.77	0.85	**0.73**
Softness	0.46	0.89	0.90	0.54	0.65	0.87	0.86	0.71	0.83	0.39	**0.71**
Compressibility	0.70	0.89	0.70	0.84	0.90	0.92	0.87	0.78	0.81	0.92	**0.83**
Handle	0.70	0.72	0.49	0.50	0.67	0.78	0.71	0.71	0.50	0.81	**0.66**

It was concluded that pure Magra wool and its blended carpets have better performance both in objective and subjective evaluations compared to Bikaneri Chokla wool and its blended carpets. This is attributed to higher proportion of medullation in Bikaneri Chokla wool. The blending of nylon with wool though improves subjectively assessed properties and abrasion resistance, it adversely affects resiliency, pile contraction and relaxed recovery after dynamic loading.

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