Research Article

Journal of Textile Engineering and Fashion Technology

Perception of Prickliness in Fabrics made with Dehaired and Non-Dehaired Llama Fiber and its Relationship with Fiber-Based Variables detected by Consumers

Frank EN[1,2*], Hick MHV[1,2], Seghetti Frondizi DG[3] and RH Mamani-Cato[4]

[1]*IRNASUS - CONICET - Univ. Católica de Córdoba*

[2]*Univ Nacional de La Rioja, Sede Chamical*

[3]*Private entrepreneur textile*

[4]*INIA, Anexo Experimental Quimsachata, Puno, Perú.*

[*]Corresponding author
Eduardo Frank, Designation Professor, Catholic University of Cordoba, and UNLAR, Armada Argentina 3555, Córdoba, Argentina

Submitted: 18 Mar 2020; **Accepted**: 06 Apr 2020; **Published**: 14 Apr 2020

Abstract
The prickling is a problem in natural animal fiber, but there is no an allergic but a mechanical problem. In this manner, dehairing is a pre-textile process that permit extract objectionable (coarse) fiber and then improve the fabric quality. The objective of this study is to determine the variables of the fiber diameter and fiber frequency may be indicative of the effect of the dehairing on prickliness of Llama fiber fabrics that can be detected by consumers of knitting fabric garments. The variables that panellists consumers can detect when comparing dehaired and non-dehaired fibres are: overall fibre diameter (in fabric and surface), fibre diameter coefficient of variation (significate in yarn); fibres coarser than 30 µm (in yarn and surface); coarse fibre by weight (in yarn and in surface); coarse fibre mean diameter (in yarn and in surface). These differences are explained mainly by the lattice medulated fibre diameter (in yarn and in fabric surface); non-medulated fibre diameter (only in surface); and lattice medulated fibre frequency (only on fabric surface). It can conclude that: the variables that indicate differences in the frequency of coarse fibres (objectionable) are the ones that best indicate the prickle (itching) effect, both inside the yarn and in the protruding fibre tips on fabric surfaces.

Keywords: Itching in Fabric, Mechanical Effect, Dehairing, Objectionable Fibre

Introduction

The prickling or itching effect caused by the protruding fiber of a fabric is the main depreciation effect of animal fibers [1]. In the dehaired fiber, this problem is eliminated, but the process is critical because the successive passes shortening the fibre length and an optimal frequency of passes by the dehairing machine is required [2].

To establish the appropriate pass, the variables that determine the prickling effect must be evaluated in the laboratory and the appropriate number of passes must be established from it [3].

In a work with dehaired and non-dehaired fibre, the effect of this on the quality of the yarn obtained considering different types of fleece was evaluated. The yarn made with dehaired fibre was more uniform and with a higher linear density than that of the fibre without dehairing [4]. It is to be hoped that this difference can be reflected in the fabric made with those yarns.

The objective of this study is to determine the variables of the fiber diameter and fiber frequency may be indicative of the effect of the dehairing on prickliness of Llama fiber fabrics that can be detected by consumers of knitting fabric garments.

Material and Methods

Eighteen pairs (18) of knitted fabric (10 cm x 10 cm) of similar densities and titles were used, made with dehaired fiber and non-dehaired fiber, respectively of the pair. The process of dehairing, carding, spinning, and knitting was performed according to a textile standard laboratory process [5]. Fibre samples coming from the 3 different type of fleece described in Argentina Llama [6].

Eighteen trained non-expert panelists, of different ages, were used to compare each pair (dehair vs non-dehair), providing the following answer: which sample prickle (itches) the most? or does it really not itch any more than the other (tie)? Each sample was intensely humidified in a humidifying cabinet (>85% RH through micro drops) and then deep-frozen on a freezing microtome equipped with a Peltier cell device (-45º C). From the deeply frozen fabric surfaces fibres were cut at a distance approximately 30 µm apart with a razor blade mounted on a pre-surgical razor device, until the shaving showed some cut fibre loops that indicated that a non protruding fibre had been sectioned. The fibre ends protruding from the surface of the fabric show a net cross section and the sections of the fibre loops exhibit a bezel cut. When were observed, under the magnifying glass, some fibres with both ends with a bevel cut or with parts sectioned along the fibre, the shaving was interrupted. Then each section set of the razor blade (seen as ice particles) was stored on a Petri box without top and dried in a forced air-drying oven, and then stabilized at 65% R.H. and 20ºC in conditioned room.

Whole Yarn: Following a zigzag path from each fabric sample, the yarn was extracted and then untwisted to allow the fibers to be dissected on a velvet board. Snips were cut with a fibre microtome (WIRA fibrotome) from each group of fibres (objectionable and desirable fibres), previously weighed in a precision balance (near 0.1 mg). The snips were mounted on slides in a glycerol-water drop, and then observed and measured under a micro-projector to 500X.

Surface Fabric: The fibre sections, were placed on a stuffed velvet board and grouped as objectionable and desirable fibres, and then weighed on precision balance (near 0.1 mg) and afterwards mounted on slides with glycerol-water to study and measure them under a 500x micro-projector. If some looped fibre was detected, it was discarded from the measurement. This process are widely described in Frank *et al* [3].

The number of fibres measured per sample (in yarn and fabric surface) was determined by *an* providing a 95% confidence limit (CL), thus allowing for a range not wider that 5% units of the mean fibre diameter of each sample [7]. This procedure was originally used by Martinez et al. and by Frank *et al* [5, 8].

Variable Descriptions

Those fibre-based variables that are routinely measured or otherwise arise, from the dissection on the velvet board (macroscopic variables):
OWFD (μm): overall weighted fibre diameter
FDCV (%): fibre diameter coefficient of variation
F>30 (%): frequency of fibres coarser than 30 μm
FFW (%): fine desirable fibre weight/total fibre weight*100
CrFW (%): coarse objectionable fibre weight/total fibre weight*100
FFMD (%): fine desirable fibre mean diameter.
CFMD (μm): coarse objectionable fibre mean diameter.
Bulk: volume of fabric (g/cm^3)

Those fibre-based variables determined under microprojector? to identify the fiber type based on its medulla type:
CoFD (μm): continuous medulated fibre diameter
CoFF (%): continuous medulated fibre frequency
FFD (μm): fragmented medulated fibre diameter
FFF (%): fragmented fibre frequency
IFD (μm): interrupted medulated fibre diameter
IFF (%): interrupted medulated fibre frequency
LFD (μm): lattice medulated fibre diameter
LFF (%): lattice medulated fibre frequency
NMFD (μm): non-medulated fiber diameter
NMFF (%): non-medulated fibre frequency

Statistical Evaluation

The wearer panelist or consumer (n=18) established a rank for each pair of samples (dehaired vs. non-dehaired): score 1 (one) for the less prickly, score 0 (zero) for ties and 2 (two) for the more pricklier. The Rank Sum for each sample was calculated by adding the ranks of the overall combinations for all consumers (informal judges) and 2 replications. This rank was used as a prickle scale with increasing prickliness corresponding to an increase in the value of the Prickliness Rank Sum. The Wilcoxon test for paired samples (non-parametric equivalent of the paired samples t-test) was used to compare each sample pair: sample 1 (dehaired) vs. sample 2 (non dehaired) [9]. A list of significant (p<0.05) variables between pairs for each of the 18 panelist was obtained. A Spearman correlation was calculated between the Prickle score and the fiber-based variables. An also Spearman correlation was calculated between whole yarn variables and the same variables of the fibre end evoked from surface fabric [7, 10].

Agreement among consumers (18) was determined with coefficients of Concordance [10].

Results and Discussion

Perceptions of prickliness varied among fabrics in addition to the effect of the dehaired, due to the differences between types of fleece and the discrepancy between judges. Moderate to high agreement among consumers was observed with coefficients of Concordance from 0.35 to 0.60, higher than other works with alpaca/wool blends, but similar to similar works with other Llama fibres [5, 11].

Table 1: Spearman correlations between pared difference (D vs ND) in Wilcoxon rank´s and fibre-based variables from whole yarn (Y), Fabric Surface (S) and between Y-S fibre based variable. Wilcoxon paired test non-significant between D and ND

Dehaired (D) vs Non-Dehaired (ND) (p>0.05)+						
Variables	**Y**		**S**		**Y – S+**	
Bulk	-0.29	*	-	-	-	
OWFD	0.45	***	0.22	ns	0.58	***
FDCV	0.01	ns	-0.24	ns	0.61	***
F>30	0.52	***	0.10	ns	0.51	***
FFW	-0.47	***	-0.21	ns	0.49	***
CrFW	0.47	***	0.21	ns	0.49	***
FFMD	0.35	**	0.12	ns	0.59	***
CFMD	0.07	ns	-0.19	ns	0.42	***
NMFF	-0.04	ns	0.66	***	0.66	***
FFF	-0.54	***	0.06	ns	0.27	ns
IFD	0.06	ns	-0.18	ns	0.27	ns
CoFF	0.32	*	0.77	***	0.77	***
LFF	-0.04	ns	-0.06	ns	-0.28	*
NMFD	0.28	*	0.16	ns	0.31	*
FFD	0.22	ns	0.19	ns	0.69	***
IFD	0.25	ns	0.16	ns	0.60	***
CoFD	0.44	***	0.24	ns	0.52	***
LFD	0.23	ns	-0.12	ns	0.59	***

+Paired Comparison of perception between dehaired and non-dehaired fabric by Wilcox on paired test
*Spearman correlations between whole yarn and fabric surface within fibre-based variables
Ns: non-significant (p>0.05); *: significant (p<0.05): **: significant (p<0.01); ***: significant (p<0.001)

Within the group of samples where Prickle was not significant for between panelist's comparisons, only the yarn variables correlated significantly with Prickle, while fabric surface does not show a significant relationship.

In contrast, in those fabrics significantly separated by group by the wearer panelists, a significant Spearman correlation coefficient is obtained between almost all fibre-based variables and Prickle, confirming once again a finding already detected in other works but with paired t Student test [3]. Some differences between paired means comparisons and the Spearman correlation have to do with the different nature of the data used.

The variables CoFD, LFF and FFD show as well a highly significant correlation with the yarn and end fibre variables, highlighting them as good indicators of the difference between dehaired and non-dehaired yarns and fabric surfaces. The fibre ends variable is not used here as when it is based on the existing strong correlation between wool fibre diameter and fibre length, but in the case of the fibre used for this work this correlation is r=0.56 (p <0.05), which does not seem high enough to be used as a predictor of end fibre diameter [1]. Dehairing randomly breaks the fibre in different places; therefore, this relationship cannot be used as it is as Naylor *et al* [1].

Table 2: Spearman correlations between pared difference (D vs ND) in Wilcoxon rank´s and fibre-based variables from whole yarn (Y), Fabric Surface (S) and between Y-S fibre based variable. Wilcoxon paired test significant between D and ND

Dehaired (D) vs Non-Dehaired (ND) (p<0.05)+						
Variables	**Y**		**S**		**Y – S+**	
Bulk	-0.70	***	-	-	-	
OWFD	0.27	ns	0.50	**	0.54	**
FDCV	0.20	ns	-0.04	ns	0.12	ns
F>30	0.44	*	0.53	**	0.14	ns
FFW	-0.62	***	-0.60	***	0.43	*
CrFW	0.62	***	0.60	***	0.43	*
FFMD	0.21	ns	0.38	ns	0.71	***
CFMD	0.26	ns	0.00	ns	0.14	ns
NMFF	-0.11	ns	0.52	**	0.52	**
FFF	0.30	ns	0.06	ns	0.15	ns
IFD	-0.48	*	-0.18	ns	0.11	ns
CoFF	0.12	ns	-0.11	ns	0.52	**
LFF	0.81	***	0.61	***	0.27	ns
NMFD	0.07	ns	0.39	ns	0.58	***
FFD	0.50	**	0.41	*	0.31	ns
IFD	0.42	*	0.42	*	0.27	ns
CoFD	0.65	***	0.71	***	0.66	***
LFD	0.11	ns	-0.17	ns	0.12	ns

+ Paired comparison of prickle perception between dehaired and non-dehaired fabric by Wilcoxon paired test
+ Spearman correlations between yarn and fabric surface within fibre-based variables
Ns: non-significant (>0.05); *: significant (p<0.05); **: significant (p<0.01; ***: significant (p<0.0001)

Differences between Dehaired and Non-Dehaired Fibres

The fibre-based variables compared by pairs shown in Tables 1 and 2 try to explain by Spearman correlation the Prickling determinant differences detected by the panelists when comparing dehaired samples (D) with non-dehaired (ND) ones [5, 12]. The fibre-based variables within the yarn that explain the differences between D and ND coincide approximately with alpaca fibre dehairing results and dromedary hair dehairing results [13, 14]. The first three correlation variables: OWFD (µm), FDCV (%), EF (µm) and F>30 (%) express the same criteria, since CrFW reflects the coarse fibre content on the basis of weight/weight, and F>30 together with FDCV and EF basically reflect as well the coarse fibre content when it exceeds them by 24% [15].

Apparently, the differences detected by the panelists are explained by the medulla variables: LFD and IFF. With the lattice medulla, the reason is evident, however, no explanation was found for the frequency of interrupted medullas case. It could perhaps be explained by the similarity between interrupted medulla and continuous medulla.

In contrast, in the case of the protruding fabric fibres, the significant variables do not coincide with those of the yarn. However, the differences between the yarn and the protruding fabric fibres were explained by the fibre-base variables, mainly CrFW (≈40%) plus the more protruding fabric fibres than the ones found in the non dehaired yarn samples (ND). This is fundamentally reflected in the variables identified by the lattice medulla types, coinciding with the findings of Naylor [1]. Where coarse protruding fabric fibres are the ones responsible for the differences in prickle sensation. It also coincides with findings in superfine wool/cashmere blends [16]. It must be emphasized that in both dehaired and non-dehaired conditions the difference between yarn and fabric surface is always significantly high, and always higher than on fabric surface [1].

Tables 1 and 2 present the variables that best explain the differences between dehaired and non-dehaired samples (FFW, CrFW and CoFD), while the correlation of the variables between yarn and fibre tip is more important within non-significant samples but with some exceptions (FFF and IFD) This results coincides with that obtained in other works where it is the protruding fibers that present the more itching effect [3].

Figure 1 clearly shows the differences in the perception of prickle in dehaired samples (red points and lines) versus non-dehaired Llama fibre samples (blue solid line), by consumers acting as judges. The horizontal solid line indicate the rank sum of Wilcoxon test rank that is significant (p<0.05), and the vertical line mark the Alpaca fibre diameter that is commercial acceptable for woven fabric [17]. The relationship between prickle and average fiber diameter is clearer in the case of dehaired ones. Even the lowest OWFD is lower in D (red points and lines).

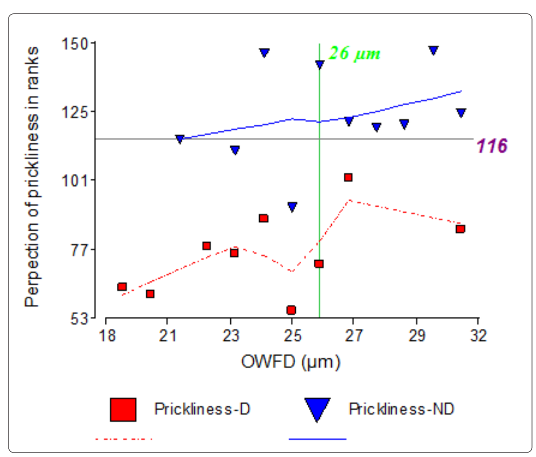

Figure 1: Relationship between prickliness detected by customers on fiber diameter of fiber into yarn in relation to dehaired (D) and non-dehaired (ND) fiber from Llama fleeces

Figure 2 shows even more clearly the differences in the perception of prickle in dehaired samples (red points and lines) versus non-dehaired Llama fibre samples (blue solid line), by judges. The horizontal solid line indicate the rank sum of Wilcoxon test rank that is significant ($p<0.05$). The relationship between prickle and the relative frequency of objectionable fibers (CrFW) highlights more clearly in the case of dehaired fibres (D). Even the highest CrFW is very low in D (red point and lines), which indicates the effect of dehaired on the extraction of coarse fibers [5].

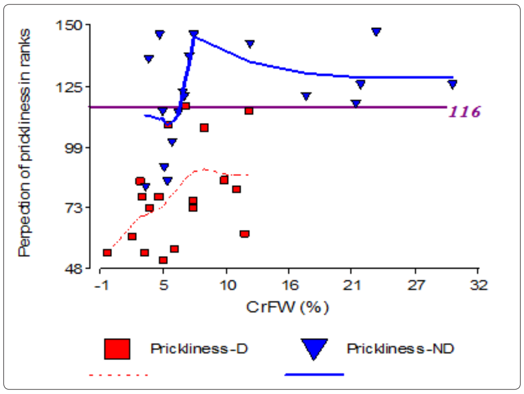

Figure 2: Relationship between prickliness detected by customers on coarsefiber percentage into yarn in relation to dehaired (D) and non-dehaired (ND) fiber from Llama fleeces

Conclusions

This paper was designed to identify fibre-based reliable determinants for yarn/fabrics that can serve as predictor of differences in handle prickle perception between dehaired and non-dehaired Llama fibres.

Changes in the microscopically observed variables of dehaired and non-dehaired fibres are usually measured in the laboratory. They can also be identified visually, as is in the case of medulla type fibres.

The variables that panellists can detect when comparing dehaired and non-dehaired fibres are overall fibre diameter (in fabric and surface), fibre diameter coefficient of variation (significate in yarn); fibres coarser than 30 µm (in yarn and surface); coarse fibre by weight (in yarn and in surface); coarse fibre mean diameter (in yarn and in surface). These differences are explained mainly by the lattice medulated fibre diameter (in yarn and in fabric surface); non-medulated fibre diameter (only in surface); and lattice medulated fibre frequency (only on fabric surface).

The variables that indicate differences in the frequency of coarse fibers (objectionable) are the ones that best indicate the prickle (itching) effect, both inside the yarn and in the protruding fibre tips on fabric surfaces.

Acknowledgements

We are very sincerely grateful to our Agricultural Sciences Students and people of our friendship who collaborated as the consumer judges test with the dehaired and non-dehaired fabrics sample.

Conflict of interest

The authors declare no to have any conflict of interest in relation to this article with any person or any institution of our Country, Argentina.

References

1. Naylor GRS, Veitch CJ, Mayfield RJ, R Kettlewell (1992) Fabric-Evoked Prickle. Tex Res J 62: 487-493.
2. Frank EN, Hick MVH, Castillo MF, DG Seghetti Frondizi (2018) Determination of the optimal number of runs of dehairing in fibers of Patagonian cashmere goats. J Textile Eng Fashion Technol 4: 188-190.
3. Frank EN, Hick MVH, Castillo MF, Prieto A, OG Adot (2014) Fibre-Based Components Determining Handl/Skin Comfort in Fabrics made from Dehaired and Non-Dehaired Llama fibre. Int J of Applied Sci and Tech 4: 51-66.
4. Frank EN, Hick MVH, Castillo MF, DG Seghetti Frondizi (2019) Effect on Textile Behavior of Fleece Types and Dehairing Process on the Linear Density and Regularity of Yarn from Argentine Llama Fibre. Journal of Textile Science & Fashion Technology 2: 1-3.
5. Frank EN, Hick HVH, OG Adot (2011) Descriptive differential attributes of Llama fleece types and its textile consequence 2.- Consequence from dehairing processes. The J of the Tex Inst 102: 41-49.
6. Frank EN, Brodtmann LI, MHV Hick (2019) Multivariate Analysis for Fleece Types Classification in Argentine Llamas. J of Text Scien & Fashion Tech 3: 1-4.
7. Snedecor GW, WG Cochran (1967) Statistical Methods, sixth ed. Iowa State University Press, Ames, IA 1967: 593.
8. Martinez Z, Iñiguez LC, T Rodríguez (1997) Influence of effects on quality traits and relationships between traits of the llama fleece. Small Rumin Res 24: 203-212.
9. Altman DG (1991) Practical statistics for medical research. London: Chapman and Hall 1991: 123.
10. Siegel S, NJ Castellan (1988) Non-parametric Statistics for the Behavioral Sciences. 2nd Ed. McGraw Hill Bool Comp, N York 1988: 212.
11. Mac K Swinburn DJ, Laing RM, BE Niven (1995) Development of Alpaca and Alpaca/Wool blend knitwear fabrics. The 9th Int Wool Text Res Conf 1995: 536-544.
12. Frank EN, Hick MVH, OG Adot (2012) Determination of dehairing tactile attributes with different Llama fleece types. Arch Des Sciences 12: 294-312.
13. Wang L, Singh A, X Wang (2008) Dehairing Australian alpaca fibres with a cashmere dehairing machine. The J of the Text Inst 99: 539-544.
14. Msahli S, Harizi T, Sakli F, T Khorchani (2008) Effect of the dehairing dromedary hair process on yield, fibre diameter, fibre length and fibre tenacity. The J of the Tex Inst 99: 393-398.
15. Lunney HWM (1983) The Distribution of Fibre Diameter in Wool Tops. Text Res J 53: 281-289.
16. Naebe M, BA McGregor (2013) Comfort propierties of superfine wool and wool/cashmere blend yarns and fabrics. The J of the Text Inst 104: 634-640.
17. Mcgregor BA (1997) The quality of fibre grown by Australian alpacas: 1- The commercial quality attributes and value of alpaca fibre. Proc Int Alpaca Industry Conf Sydney 1997: 43-44.