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Characterization of the organic wool of Lojeña sheep breed as a contribution to its conservation

Díaz, E[1].; Gonzaléz-Ariza, A.[1]; Navas-González, F.J.[1,2@]; Aguilera, M.[3]; López, B.[4]; Iglesias, C.[1]; León, J.M.[5]; Delgado, J.V.[1]; Camacho, M.E.[2] and Arando, A.[1,6]

[1] Department of Genetics. University of Córdoba, Córdoba, Spain.
[2] Andalusian Institute of Agricultural and Fisheries Research and Training (IFAPA), Alameda del Obispo, Córdoba. Spain.
[3] Association of Breeders of the Lojeña Sheep Breed of the West of Granada (ACROL), Loja, Granada, Spain.
[4] 2° grade Cooperatve EA Group S.Coop. Villanueva de la Serena, Badajoz, Spain.
[5] Agropecuary Provincial Centre, Diputación of Córdoba, Córdoba, Spain.
[6] Animal Breeding Consulting S.L, Córdoba, Spain.

Aditional keywords

Local breeds.
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SUMMARY

Lojeña is considered an endangered Spanish local breed. To contribute to its conservation and valuation the aim of this work was the wool characterization of this breed. For this, 28 samples of wool, 16 of white and 12 of black color, randomly selected from the piles generated after shearing, were used. The wool parameters analyzed were: fiber diameter, standard deviation, and coefficient of variation of fiber diameter, comfort coefficient, percentage of fibers less than 15 µm, length staple, mean fiber curvature, and its standard deviation. For the analysis of the data, a Bayesian ANOVA was performed. The results showed a fiber diameter of 30.62 µm, which classifies it as thick wool. For the different colorations of the wool, only significant differences were observed for the coefficient of variation of the diameter of the fiber and length staple, showing a greater coefficient of variation the black wool (28.48 ± 5.56 % vs. 23.90 ± 4.22 %, respectively), while the white wools showed a greater length staple (51.88 vs. 39.58 mm, respectively). In conclusion, the characteristics of the wool of the Lojeña breed make it suitable for the manufacture of upholstery, carpets, and the craft industry, but not for the manufacture of clothing. The fact that there is a high percentage of black wool specimens, provides an interesting source for a growing niche market that uses unstained pigmented wool as a differential and organic feature.

Caracterización de la lana ecológica de la raza ovina Lojeña como contribución a su conservación

Palabras clave

Raza local.
Conservación genética.
Diámetro de fibra.
OFDA.

RESUMEN

La raza ovina Lojeña está considerada como una raza autóctona española en peligro de extinción. Para contribuir a su conservación y valorización, el objetivo del presente trabajo fue la caracterización de la lana de esta raza. Para ello, se utilizaron 28 muestras de lana, 16 de color blanco y 12 de color negro, seleccionados aleatoriamente de los montones generados tras la esquila. Los parámetros de lana analizados fueron: diámetro de fibra, desviación estándar y coeficiente de variación del diámetro de fibra, coeficiente de confort, porcentaje de fibras menores a 15 µm, longitud de mecha, curvatura media de la fibra y su desviación estándar. Para el análisis de los datos se realizó un ANOVA Bayesiano. Los resultados mostraron un diámetro de fibra de 30.62 µm, lo que la clasifica como lana gruesa. Para las diferentes coloraciones de la lana, únicamente se observaron diferencias significativas para las variables coeficiente de variación del diámetro de la fibra y longitud de la mecha, siendo mayor el coeficiente de variación en el caso de la lana de color negro (28.48 ± 5.56 % vs. 23.90 ± 4.22 %, respectivamente), mientras que las lanas de color blanco mostraron mayor longitud de mecha (51.88 vs. 39.58 mm, respectivamente). En conclusión, las características de la lana de la Lojeña la hacen apta para la fabricación de tapicerías, alfombras y para la industria artesanal, no así para la confección de prendas de vestir. El hecho de que haya un elevado porcentaje de ejemplares de lana negra, proporciona una fuente interesante para un creciente nicho de mercado que utiliza lana pigmentada sin teñir como característica diferencial y ecológica.

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fjnavas@uco.es

INTRODUCTION

Lojeña is an endangered autochthonous sheep breed, which is located in the region of Loja (Granada, Spain), formed by six municipalities that make up the central area of the West of Granada. It is bred in extensive systems in a rocky mountain environment (MAPA, 2021) where the availability of pastures, despite presenting high biodiversity, is limited (Mena *et al*. 2014, p. 52), which has led to a great rusticity to the breed.

This breed is included in the Official Catalog of Breeds of Spain since 2007 (Pablo *et al*. 2013, p. 194), the same year in which the Association of Breeders of the Lojeña Sheep Breed of the West of Granada (ACROL) was created. This association managed the herd book and the breeding program of the breed (Ruiz et al. 2016, p. 72), which currently has an approximate census of 10,800 animals (MAPA, 2021).

It is a breed specialized in the production of meat, which offers differentiated quality products due to the environmental conditions in which it is produced, being the majority of farms certified as organic (Pablo *et al*. 2013, p. 194; Mena *et al*. 2014, p. 52). This system contributes to the sustainability of the territory, exercising an environmental and social action, where the traditional management of the herds causes a lower impact in the area and generates a greater workforce that avoids rural depopulation (Ruiz *et al*. 2016, p.72).

One of the by-products generated during the production process, is wool, and due to its difficulty in handling it and valuing it, currently, Lojeña breed does not have established its own market, as can be in the case of wool of other sheep breeds, such as Merina or some camelids, such as llamas or vicuñas (Quispe *et al*. 2015, p. 191; Género *et al*. 2016, p. 249;). Within the Lojeña breed, we can find a wide coloration of wool, ranging from white to black as uniform coat and all possible combinations and locations ranging from the presence of black, white, or brownish spots or even red in their different shades (MAPA, 2021).

In recent years, as a result of the introduction of vegetable and synthetic fibers in the textile market, wool derived from sheep has been displaced (Bilbao *et al*. 2018, p. 109). Specifically, the total production of wool in Spain in 2019 was around 22,000 tons, being Extremadura, Castilla y León, Andalucía, and Castilla la Mancha the autonomous communities that produced the most. In any case, Spain is considered a net exporter of wool, registering in the same year export of approximately 82% of production (MAPA, 2019). The main types of sheep wool existing in Spain could be divided into white and black wool, which based on the diameter of fiber can be classified as fine (16 to 19 microns), medium (20 and 27 microns), and thick (more than 28 microns) (Cardeñas *et al*. 2020, p. 561).

The use of sheep wool is directly related to the average diameter of the fiber (Gómez 2009, p.73), being the most common destination in the textile and artisanal industry (Género *et al*. 2016, p. 13). In this context and to enhance the market value of sheep wool and in particular of those breeds with lower quality of wool, in recent years, several studies have focused their efforts on finding new alternatives for use, using it as a thermal and acoustic insulator, as a substrate in forced crops, as an absorbent and in technical textiles within the field of civil engineering, building, decoration, and agriculture, among others (Bilbao *et al*. 2018, p. 109).

Therefore, this study aimed to determine the characteristics of the wool of the Lojeña sheep breed to define possible market strategies, based on sustainability (ecological production), and respect for the environment (colorful wool).

MATERIAL AND METHODS

Animal Sample

A total of 28 samples of wool were analyzed, 16 of white color and 12 of black color, corresponding to 12 farms belonging to the Association of Breeders of the Lojeña Sheep Breed of the West of Granada. The samples were taken randomly from the piles that are made after shearing, not taking into account the anatomical area to which the wool sample corresponded.

Determination of wool fiber characteristics

The equipment used for measuring wool samples was the OFDA 2000, with the fiberglass clean option, with a fat coefficient of 0.0 – (Optical Fibre Diameter Analysis, McLaughlin, 2000). The average number of fibers analyzed per sample was from 1000 to 1700. Of the 53 parameters analyzed by the OFDA team, the following were taken into account: fiber diameter (µm), fiber diameter standard deviation (µm), fiber diameter variation coefficient (%), comfort coefficient (%), percentage of fibers less than 15 µm (%), staple length (mm), average fiber curvature (°/mm) and standard deviation of the average fiber curvature (°/mm).

Statistical analysis

For the analysis of the data, the Xlstat software (XLSTAT 2009) was used, having performed a Bayesian ANOVA.

RESULTS AND DISCUSSION

Table I shows the average values for the Lojeña breed and each of the different colorations of the wool (black and white).

The results show a fiber diameter of 30.62 µm for the breed, which classifies it as thick wool. For this variable, as for the standard deviation of the fiber diameter, the comfort coefficient, the percentage of fibers less than 15 µm, the mean curvature of the fiber, and the standard deviation of the mean curvature of the fiber, no significant differences were observed between the different colorations of wool.

However, for the coefficient of variation of the diameter of the fiber, significant differences were observed between black and white wool, being greater in the case of black wool (28.48 ± 5.56 % and 23.90 ± 4.22 % respectively).

In the case of staple length, significant differences were observed between both colorations, showing

Table I. Results corresponding to the studied variables of the wool of the Lojeña sheep breed (Resultados correspondientes a las variables estudiadas de la lana de la raza ovina Lojeña).

		N	Mean	Standard deviation	95% of the confidence interval for the mean		Sig.
					Lower bound	Upper bound	
Mean fiber diameter (µm)	White	16	30.81	3.86	28.75	32.87	0.156
	Black	12	30.37	2.04	29.08	31.66	
	Total	28	30.62	3.166	29.39	31.85	
Standard deviation of mean fiber diameter (µm)	White	16	7.43	1.99	6.37	8.50	0.114
	Black	12	8.64	1.69	7.57	9.72	
	Total	28	7.95	1.94	7.20	8.70	
Coefficient of variation of the diameter of the fiber (%)	White	16	23.90	4.22	21.65	26.15	0.029
	Black	12	28.48	5.56	24.95	32.01	
	Total	28	25.86	5.27	23.82	27.91	
Confort coefficient (%)	White	16	55.88	19.73	45.36	66.39	0.741
	Black	12	59.05	11.27	51.89	66.21	
	Total	28	57.24	16.45	50.86	63.62	
Percentage of fibres less than 15 µm (%)	White	16	0.36	0.36	0.17	0.55	0.191
	Black	12	0.63	0.65	0.22	1.05	
	Total	28	0.48	0.51	0.28	0.68	
Length staple (mm)	White	16	51.88	12.63	45.14	58.61	0.013
	Black	12	39.58	6.56	35.42	43.75	
	Total	28	46.61	12.02	41.95	51.27	
Mean fibre curvature (°/mm)	White	16	70.71	9.65	64.67	74.50	0.128
	Black	12	72.83	10.38	67.74	80.92	
	Total	28	71.77	10.02	67.81	75.43	
Standard deviation of mean fibre curvature (°/mm)	White	16	56.77	6.46	53.77	61.07	0.254
	Black	12	58.2	7.39	52.86	61.78	
	Total	28	57.48	6.93	54.75	60.1	

greater length white wool compared to black wool (51. 88 and 39.58 mm, respectively).

DISCUSSION

The wool of the Lojeña breed is classified as thick wool, not finding significant differences between the different colorations of wool, as well as previous studies carried out in the Merino breed, where they did not observe differences in the fiber diameter between the different colorations of the wool (Plowman *et al*. 2019, p. 659).

The diameter of the fiber is a highly variable characteristic that is influenced by multiple factors such as breed, age, nutritional status, health status (Flores *et al*. 2012, p. 1434), the anatomical area from which wool fibers come (Sitotaw *et al*. 2020, p. 1198) or sex, among others. Specifically, sheep have a smaller diameter than rams (Montesinos *et al*. 2018, p. 324), increasing the thickness of the fiber with the age of the animal and with a greater frequency of shearing (Cardenas *et al*. 2020, p. 561). On the other hand, the diameter of fiber can suffer reductions when there are nutritional deficits, stressful situations, diseases, etc. Likewise, pregnancy and lactation can harm this parameter (Sacchero and Mueller 2007, p. 49). Fiber diameter is a parameter that is directly related to fiber strength (Sitotaw *et al*. 2020, p. 1198), fleece weight, yield, and staple length.

In any case, this characteristic is the most decisive at the commercial level, since it has a direct impact on the price and use of wool (Montesinos *et al*. 2018, p. 324), with fine wool being used in the textile industry, while thick wool as is the case of the Lojeña breed, it is mostly used in the handmade industry (Cardenas *et al*. 2020, p. 561).

Since the fiber diameter is a highly variable parameter within the same wool sample, the standard deviation and the coefficient of variation of the fiber diameter were evaluated, where the black wool showed a coefficient of variation significantly higher than the white one. The high values of both parameters can be a consequence of the Lojeña breed has not been previously selected for this character, which makes the wool not so homogeneous. Similarly, the fact that the samples have not been taken from a particular anato-

mical area may also influence these results (Sitotaw *et al*. 2020, p. 1198).

High standard deviation values of the fiber diameter show a higher variation of this character, while the lower the coefficient of variation of the fiber diameter, the higher the market demand, price, and quality of the wool. Therefore, premiums are offered for wool with a low standard deviation of fiber diameter and a low coefficient of variation values (Holman and Malau-Aduli 2012, p. 1). These high levels of diversity imply a high perspective of genetic response to selection, so the breed can be significantly improved for these characteristics of wool, such as finesse and length.

On the other hand, the comfort coefficient indicates the comfort of the wool and the percentage of fibers with diameters below the threshold of 30 µm. To ensure user comfort and improve the value of the product and marketing, it is advisable to limit wool fibers above this figure to less than 5% (Holman and Malau-Aduli 2012, p. 1). Indeed, diameters greater than 30 µm result in a low flexibility of the ends of the fiber, which causes itching, decreasing customer acceptance (Montesinos *et al*. 2018, p. 324). In the case of the Lojeña breed, wool has a high percentage of fibers that exceed this threshold, which means that this wool is not the most suitable for the manufacture of clothing.

The percentage of fibers with a diameter less than 15 µm, is another indication of wool quality, taking into account that the higher the value of this variable, the greater the fineness of it. The values obtained in the present study were very low, an aspect that was to be expected considering the fiber diameter and the comfort coefficient observed.

In the case of the staple length, as with the diameter of the fiber, it is a determining parameter in the textile industry, being increasingly important as a criterion of quality and value of wool, since defines its performance during its processing (Holman and Malau-Aduli 2012, p 1). According to other studies, this characteristic depends on the rate of growth caused by the secondary follicles from the last two months of gestation to the first year of life and is also influenced by a series of factors such as nutrition, age, gestation, and lactation, among others (Flores *et al*. 2012, p. 1434). Long fibers are those that are greater than 50 mm, which are used for the combing system, while short fibers (less than 50 mm) are used in the carding system (Género *et al*. 2016, p. 249).

Wool with longer staple lengths are more commercially desirable, as they tend to be easier to rotate, form stronger threads, and be more uniform compared to wool with shorter fibers. When wool with short fiber lengths are present at high levels, they often result in lint formation in clothing fabrics and fiber losses in wool carpets (Holman and Malau-Aduli 2012, p.1). In the case of this parameter, significant differences were observed between both colorations studied, showing greater staple length white wool compared to black wool, suggesting a higher performance of white wool during processing. In general, the fineness and length of wool are inversely proportional, since the longer the fiber length the lower the fineness or, in another case, the greater the diameter.

The average curvature of the fiber in the Lojeña sheep was 71.77 °/mm, lower than that reported in previous studies carried out in Merino sheep breed or vicuñas (Pollott *et al*. 2004, p. 2840; Quispe *et al*. 2015, p. 64). However, this parameter was higher than previously described in rabbits of the Angora breed (Rafat *et al*. 2007, p. 3116). According to the results of the standard deviation of the mean curvature of the present study, these were similar to those reported in vicuñas and slightly higher than those reported in rabbits, which again suggests the lack of homogeneity in the Lojeña breed for this character as a result of the lack of selection.

CONCLUSIONS

According to our results, the wool of the Lojeña sheep breed is defined as thick wool. Therefore, it is proposed as a raw material for the elaboration of carpets, blankets, fashion accessories (bags, shoes, etc.), and handmade products. This potentiality is reinforced by its ecological value when produced in systems of this type, as well as by its variability of natural coloration, which allows avoiding in its processing, a large number of chemical products, such as artificial dyes, allowing the valorization of the product, which must be taken into account not only in production but also in the processing and marketing of final products.

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