

Assessment of Fiber and Duct Densities in Colored Huacaya Alpacas from Peru

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ABSTRACT

This study was carried out at the La Raya - FMVZ - UNA - Puno Experimental Center, located 4238 meters above sea level with the objective of determining fiber and hair duct densities on the skin of colored Huacaya alpacas according to their sex and age and to estimate the correlation between fiber density and density of hair ducts. Eighty-six alpacas were used that had been prepared by shaving an area of 1 mm² of their skin at the level of the middle rib on their right side for amplified images using FIBER-DEN equipment. The results of fiber density of the skin of colored Huacaya alpacas showed no differences between the sexes, but between age classes there were differences between the means in the skin of tuis (mean 22.15 ± 4.27 fibers/mm²) and adult alpacas (24.06 ± 4.47 fibers/mm²) respectively. The density of ducts on the skin of colored Huacaya alpacas had a mean of 8.32 ducts/mm², and they did not show differences due to the effect of sex or animal age class. The degree of association between fiber density and duct density in colored Huacaya alpacas was high and positive ($r = 0.61$), with a coefficient of determination of 37.21%. Conclusion: both the fiber density and/or the density of hair ducts should be considered for the selection of reproducers and therefore the quality and production of fiber.

Keywords

alpacas, hair ducts, density, FIBER-DEN

Introduction

In Peru, the population of alpacas is 3,685,516, made up of 12% Suri, 79% Huacaya, and 9% Huarizo alpacas. The largest population of alpacas is concentrated above 3,500 meters above sea level, distributed in the Puna (77.3%), Suni (12.4%) and Janca (7.6%) regions of the country; and just 3% of the population is below the referenced altitude level (INEI, 2012).

Raising domestic South American camelids (alpacas and llamas) is the main means of subsistence for more than one million small producers in the Central Andes of South America (Quispe et al., 2009). The producers commercialize the alpaca fiber and their income is based on the weight of the fleece and the diameter of the fiber (Quispe et al., 2013). The fiber is produced by follicles, hair ducts that are evaluated superficially and that are embedded in the skin (Galbraith, 2019). Various studies have been carried out on the structure of the skin of alpacas, but the information is only preliminary. To reach competitive levels in the commercialization of fiber, the quality must be improved through genetic studies of breeding and production. But this must have a solid basis of knowledge of the structure of alpaca skin (Ormachea, 2013; Quispe et al., 2009).

Alpaca skin has been studied in a preliminary manner at the structural level. However, there are few studies that show relationships between hair ducts and fiber. Furthermore, before any initiative or genetic improvement programs aimed at increasing the quality and quantity of fiber production in alpacas it is essential to have broad knowledge about the hair ducts. This problem first suggests that an elucidation of the relationship between hair ducts and fiber density is necessary, as well as quantifying fiber density, hair duct density, as well as an estimation of the genetic parameters for

fiber density, hair duct density, average fiber diameter, wave curvature, comfort factors, and wick length in Huacaya alpacas (Quispe & Quispe, 2019).

Fiber density and the density of hair ducts, despite its importance in genetic improvement, constitutes one of the little-known and poorly valued traits, probably due to the difficulty involved in measuring it. For this reason, we have chosen to use a novel FIBER-DEN and FIBER-EC procedure and equipment in order to evaluate the density, fiber bundles per conduit, and the number of fibers/number of conduit ratio in alpacas using a non-invasive method. The study allows the generation of results for a baseline in the classification of elite animals for these characteristics to use as future reproducers. Established as the starting point for the realization of genetic improvement, this is a new technology for the evaluation and certification of the quality of alpaca fiber. The objectives were a) to determine the fiber density and density of hair ducts in the skin of colored Huacaya alpacas according to age and class and b) to estimate the correlation between the fiber density and density of hair ducts in the skin of colored Huacaya alpacas.

Materials and Methods

Locality of study

Research was carried out at the La Raya Experimental Center belonging to the Faculty of Veterinary Medicine and Zootechnics of the National University of the Altiplano, located at an altitude of 4238 m in the district of Santa Rosa, Melgar Province, Puno Region.

Study sample

Sample size was determined using the stratified random sampling method, considering that 34% of the animals had good density from previous studies with a confidence level of 95% and a precision error of 10%. The sample was 86 animals as shown in table 1.

Table 1: Distribution of animals for the study of the variables

Sex/class	Males			Females		
	Tuis	Adults	Total	Tuis	Adults	Total
N° Animals	14	12	26	22	38	60
Total						86

Methodology

The animals under investigation were duly identified by ear ringing. FIBER-DEN equipment, a non-invasive method, was used to capture images of the skin surface of the alpaca to which proprietary software was added (Quispe & Quispe, 2018). To prepare the animal's skin, the fiber was cut over the middle rib. The area was then soaped for shaving with razor and or guillete razor in an area of approximately 1 mm² and dyed. Images were then captured with the FIBER-DEN equipment.

Statistical analysis

Data were analyzed under a factorial arrangement of 2 (sex) x 2 (class) in a completely randomized design. Pearson's correlation was used for the degree of association between fiber density and hair ducts.

Results and Discussion

Fiber density

Table 2 show that fiber density is variable in the skin of colored Huacaya alpacas but there is no difference between the sexes ($p \geq 0.05$), although there are differences between classes ($p \leq 0.05$). This similarity of results due to the sex effect does not influence the fiber density variability. Meanwhile, the average values found in the present study were 22.15 ± 4.27 and 24.06 ± 4.47 fibers/mm² of the skin of alpacas tuis and adults, respectively ($p \leq 0.05$). The values found in this study are similar to the report by Quispe et al. (2013) who found 23.60 ± 0.36 fibers/mm² for alpacas, and 12.73 ± 1.41 fibers/mm² for llamas. Fiber density is a characteristic that interests the producer, because the higher the density, the higher the fleece weight (Calle 1982).

Table 2. Fiber density (fibers/mm²) in the skin of colored Huacaya alpacas, according to sex and class in the Experimental Center La Raya UNA - Puno.

Sex/class	Tuis			Adults		
	n	Mean $\pm$	D.S.	n	Mean $\pm$	D.S.
Males	14	$22.27^a \pm$	4.15	12	$23.82^a \pm$	4.86
Females	22	$22.03^a \pm$	4.40	38	$24.32^a \pm$	4.09
Mean	36	$22.15^b \pm$	4.27	50	$24.06^a \pm$	4.47

Duct density

Table 3 show that the variable density of ducts per mm² in the skin of colored Huacaya alpacas does not show a difference between male tuis (8.94) and female tuis (7.86), nor between adult males (8.2) and female adults (8.27) ($p \geq 0.05$). This result indicates that the variation is not influenced by sex and class. The mean values found in this study were 8.40 ± 1.78 and 8.22 ± 1.60 ducts/mm² on the skin of alpacas tuis and adults. The values of the present study are lower than reported by Quispe et al. (2013). The values in that study were 10.50 ± 0.16 ducts/mm² in alpacas and in llamas 6.77 ± 2.26 ducts/mm², determined by the non-invasive FIBER-DEN method. However, the values found in the present study are lower than those reported by Prado (1985), who found the average follicular density in male alpacas to be 35.54 ± 5.35 follicles per mm² of skin, a result that was higher than that of the females where an average of 32.36 ± 7.14 follicles per mm² of skin was found. This difference could be due to the technique used in the study, since that author used a histological cutting technique, while in the present study it was through FIBER-DEN.

Table 3. Density of ducts (ducts/mm²) in the skin of colored Huacaya alpacas according to sex and class in the Experimental Center La Raya UNA – Puno

Sex/class	Tuis			Adults		
	N	Mean $\pm$	D.S.	n	Mean $\pm$	D.S.
Male	14	8.94 ^a $\pm$	2.18	12	8.20 ^a $\pm$	1.92
Female	22	7.86 ^a $\pm$	1.37	38	8.27 ^a $\pm$	1.28
Mean	26	8.40 ^a $\pm$	1.78	40	8.22 ^a $\pm$	1.60

Regarding the variables studied, the follicular concentration varies in the different areas of the skin Calle (1982); the rib region is 15 fibers/mm². The highest density is in the neck with 20 fibers/mm², and the lowest densities found in the armpits and extremities with 10 fibers/mm². The follicular groups in the alpaca are made up of a primary follicle and a variable number of secondary follicles (S). The primary follicles (P) are accompanied by the sweat glands and the corresponding muscle, while the secondary follicles lack this structure, although both follicles have sebaceous glands in lesser quantity.

The values found in this research were lower than that of (Antonini et al., 2006), who report the total follicular density, at 10 months of age in Huacaya alpacas, Suri alpaca and Chaku llamas of 22.30 fibers/mm², 19.90 fibers/mm², and 17.98 fibers/mm² respectively. However, no significant differences were found in the proportion between secondary and primary follicles between males and females of the three types of animals. At 10 months, values of 8.08, 6.89 and 4.66 fibers/mm² are reached for Huacaya, Suri, and Ch'acu respectively. Therefore, (Antonini et al., 2004) concludes that the South American camelids, at an early age, reach full maturity of the follicular apparatus of the skin, with the S/P ratio of 4.89 observed in the Peruvian Chaku llama population. These differences could be due to the type of equipment used to measure study variables, such as the histological study and the FIBER-DEN.

Pearson correlations between fiber density and density of hair ducts

Table 4 and figure 1 show the degree of association and coefficient of determination between fiber density and duct density in the skin of colored Huacaya alpacas where the correlation between the two variables is positive and high. This result leads us to apply in the selection of reproducers fiber density and/or the other variable is automatically associated.

Table 4. Degree of association between fiber density and density of ducts in the skin of colored Huacaya alpacas in the Experimental Center La Raya UNA – Puno

VARIABLES	n	r	r ²
FD/DD	86	0.61	37.21 %

FD=Fiber density; DD=Density of Ducts

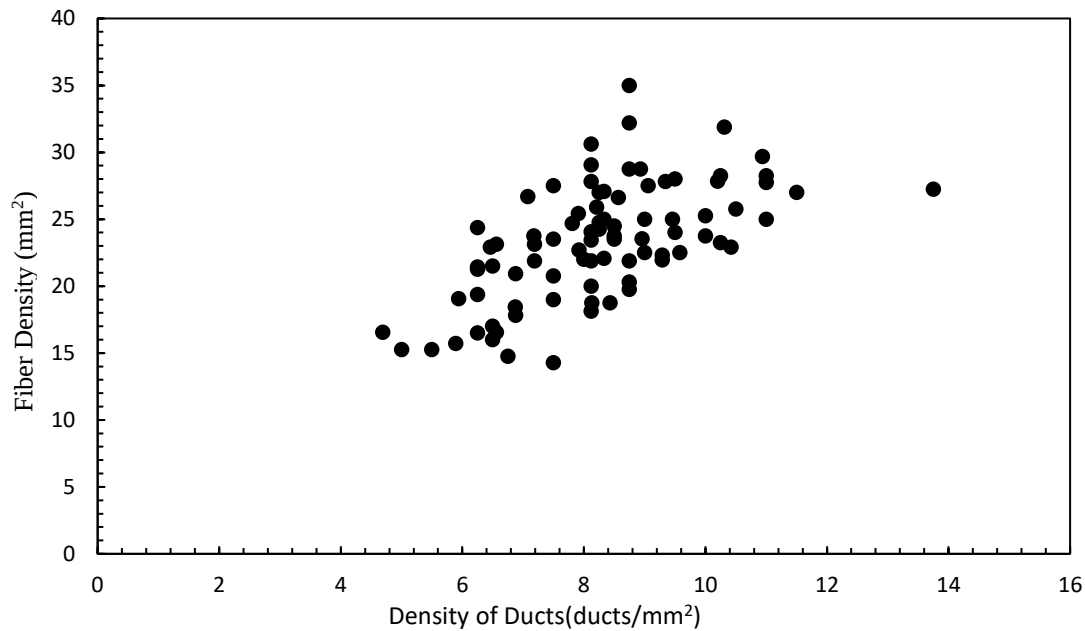


Figure 1: Degree of association between fiber density and density of ducts in the skin of colored Huacaya alpacas.

The values found in the present study are different from that of Bustinza (2001) who reports a negative correlation ($r = -0.8$), meaning the higher the follicular density of the fiber the smaller he diameter. This high and negative association favors the selection of replacement breeders. Meanwhile, Paucar & Sedano (2014) found a correlation between follicular index and dirty fleece weight for one-year-old and two-year-old male and female alpacas at 0.172, -0.030, -0.348 and -0.057. For this reason, this author indicates that there is no correlation between follicular index and dirty fleece weight in 1-year-old, 2-year-old alpacas.

Conclusions

The fiber density and the density of ducts in the skin of colored Huacaya alpacas did not show a difference between the sexes. Only the fiber density was observed differences between tuis and adults.

The degree of association between fiber density and duct density in colored Huacaya alpacas was high and positive. Therefore, duct density must be considered for the selection of breeders for fiber production.

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