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Effect of the gestation and lactation on fiber diameter and its variability in Peruvian alpacas

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ABSTRACT

A study was conducted to know the influence of the pregnancy and lactation states on the fiber performance in alpacas at Pacomarca experimental farm in the Peruvian highlands. Records obtained from the regular performance recording software of the farm were used, gathering 8648 records of 1541 females and 366 males of Huacaya ecotype, and 2410 records of 374 females and 132 males of Suri ecotype, registered from 2001 to 2015 and belonging to animals of three or more years. A mixed linear model for fiber diameter, standard deviation and coefficient of variation fitted the physiological state with five categories (milking, pregnant, milking and pregnant, open females and males) as an effect jointly with others such as year of recording, age from 3 to 9 or more years old and coat color. Huacaya and Suri ecotypes were independently analyzed. All the effects included in the model appeared as highly significant, being the paired differences less significant in Suri because of the lower number of records. Lactation physiological state appeared as an important effect affecting fiber performance, explaining a difference of 1.2 and 1.0 µm of differences in respectively Huacaya and Suri pregnant females, while pregnancy appeared with a much less relevant influence. Other factors greatly influenced the fiber diameter. Thus, age had a very important effect increasing 3.71 µm from 3 to 9 years of age in huacaya and 4.52 µm en Suri. A difference of 3.09 µm in huacaya and 5.93 µm in Suri was found between dark and white coat colored alpacas. These results recommend modifying the genetic evaluation model by fitting the physiological state of females to increase the accuracy of the breeding values used to select animals in the breeding scheme of the farm.

1. Introduction

International market of natural fibers based on natural fiber is highly competitive for the textile industry. Pacomarca experimental farm was created to face this, developing a successful breeding program while addressing profuse research (Gutiérrez et al., 2009, 2011, 2014, Cervantes et al., 2010, Pérez-Cabal et al., 2010, Paredes et al., 2014, Cruz et al., 2015, 2016). The main objective selection in alpacas is the reduction in fiber diameter to produce fine fiber. Genetic improvement should also be encompassed with improvement in other areas such as nutrition, health, reproduction and management as part of an integrated business management strategy (McGregor et al., 2013a, 2013b, 2016). The estimated heritabilities for fiber traits in alpacas have been moderate to high, so the responses to artificial selection have been relevant for these traits (Gutiérrez et al., 2009, 2014; Cruz et al., 2015). Efficient selection has to be based in top-rated animals according to reliable breeding values for the desired traits, and the reliabilities depend on the amount of information provided by both each individual and its parents. In addition the fitted model for evaluation of the animals would have to include all effects that have influence on the traits (Gutiérrez, 2010). The current statistical model used for genetic evaluation in Pacomarca experimental farm includes, among other effects, the sex, although this has not ever seemed to be highly relevant in the fiber diameter and its variability. However, across their life, the females undergo significant changes in weight, body condition, feeding habits and feed requirements according to pregnancy and lactation periods.

The female alpaca starts reproduction at two years of age, reaching three years usually with a younger animal on its care. From this age onwards a female can be clearly identified under periods of gestation and lactation. A female becoming pregnant has usually a gestation of about 342 days of length, not coming back open until the next breeding season. After calving, the baby will suckle about five or six months (Cruz et al., 2015), representing an overlapping of gestation and lactation in which the female mobilizes the nutrient reserves according to their physiological needs, which may affect fiber performance (low

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Table 1
Distribution of fiber records according to the status of the animal in both Huacaya and Suri ecotypes.

	Huacaya ecotype						Suri ecotype					
Years of age	O	M	P	PM	S	Total	O	M	P	PM	S	Total
3	5	4	15	7	28	**59**	2	2	3	1	8	**16**
4	237	134	217	455	341	**1384**	47	35	69	125	96	**372**
5	316	184	152	419	164	**1235**	32	52	49	126	57	**316**
6	228	176	160	399	116	**1079**	35	46	61	136	45	**323**
7	149	144	195	370	82	**940**	32	44	55	129	34	**294**
8	119	118	179	375	53	**844**	31	28	37	125	20	**241**
9 or more	405	604	626	1342	130	**3107**	133	154	166	335	60	**848**
Total	1459	1364	1544	3367	914	**8648**	312	361	440	977	320	**2410**

(O): open; (P): pregnant; (M): milking; (PM): pregnant and milking; (S): sires.

fiber diameter and variability). Then, two very different stages can be defined within pregnancy period. The starting half of the gestation period with increase in the levels of anabolic hormones, and a consequent increase of blood volume, increase in the cardiac output in turn, also an increase in the nutrient reserves, fat and liver glycogen and appetite, and also increasing the food intake. The rest of the pregnancy carries an increase in catabolic hormones, leading to the mobilization of fat reserves and nutrients, decreasing the hepatic glycogen and increasing the metabolism, even in the absence of food intake. Similarly to pregnancy, the energy expenditure is sensitively increased during lactation, resulting in mobilization of energetic reserves to turn them into components of milk. Liesegang et al. (2006) reported mobilizations of the total bone mineral content occur at the end of gestation and beginnings of lactation in goats and sheep.

Metabolic adaptation has been found important for fiber production during pregnancy in sheep when raised in intensive system (Duehlmeier et al., 2011). Likewise the nutrition influences the milk production and the formation of fetal exoskeleton during the gestation, increasing metabolic mobilization of some components, especially the calcium (Liesegang et al., 2007). Also animals under gestation and lactation are more susceptible to diseases, especially parasites that were detrimental in milk production and production of fiber (González-Garduño et al., 2014). Nutritional effects on alpacas and merino sheep have also been reported on fiber yields (McGregor, 2002) and goats (McGregor et al., 2013a, 2013b).

Routine annual estimation of genetic parameters and breeding values prediction are currently being carried out independently for the two defined ecotypes in Pacomarca. The model used to perform such analyses includes the month-year of sampling, the coat color with three levels (white, light fawn and dark) and the age (linear and quadratic covariate) as effects (Cervantes et al., 2010; Cruz et al., 2015, 2016; Gutiérrez et al., 2009, 2011). However, physiological status of the female concerning gestation and lactation can importantly influence on the fiber features, and could be interesting to take part of the model. Quantifying gestation and lactation influence seems to be needed. Thus, this research aimed to study the effect of gestation and lactation on fiber diameter, standard deviations and coefficient of variation of the fiber diameter to evaluate their inclusion in the models used for the prediction of breeding values. As a secondary objective, influence of color, year and age on fiber diameter and its variability was also addressed.

2. Material and methods

The data were collected between 2001 and 2015, in the Pacomarca experimental farm, and correspond to 1907 (1541 females and 366 males) Huacaya ecotype individuals and 506 (374 females and 132 males) Suri ecotype animals, three or more years old. Alpaca females are suitable for reproduction at two years of age, but they only can become lactating or sufficiently advanced pregnant from three years old. Therefore, animals younger than three years were ignored in these analyses because they are much finer and has no chance of having pregnancies and milking stages. The mean age was 6.9 years for both Huacaya and Suri ecotypes. Animals with records of fiber performance were classified according to the state of the animal. For the Huacaya ecotype the number of records owned by open females not milking an offspring (O) was 1459, there were 1364 records for open females milking an offspring (M), 1544 records for pregnant females no milking an offspring (P), 3367 pregnant females simultaneously milking an offspring (PM), and 914 males (S). The respective records for the Suri ecotype were 312, 361, 440, 977 and 320. This classification was considered as the target group for this research in order to assess the influence of the physiological state on fiber performance. As a by-product of the analyses, significance was also studied concerning other highly relevant effects analyzed simultaneously, such as year, color and age effects. Description of the data structure according to the main grouping and the age in years is shown in Table 1. Concerning performance traits, the fiber samples were shorn from the middle side of the body. These samples were washed and after minicored and 4000 snippets of 2 mm using an Optical Fiber Diameter Analyzer 100 in the laboratory of Inca Tops S.A. (IWTO-47-95, 1995). The analyzed traits were the Fiber Diameter (FD), the Standard Deviation (SD), both FD and SD measured in μm and Coefficient of Variation (CV) expressed in percentage (%).

The three traits were analyzed under a linear model fitting the physiological state group as an effect, but also the age in years from three to nine or more, the coat color defined in white, cream and dark groups, and the year of recording from 2001 to 2015 were fitted to take into account the same effects fitted in the genetic evaluation routine process (Cervantes et al., 2010; Gutiérrez et al., 2014). This enabled establishing conclusions about the need of including milking and pregnancy states in that routine genetic evaluation process. Depending on the number of records, some first order interactions between effects were estimable and also fitted. These interactions were: physiological state by age, physiological state by coat color and age by coat color in Huacaya. Lactation and gestation influence did not appear as significant in the Suri ecotype when the interactions were fitted, probably due to a low number of records for such a complex model. Because of that, they were not fitted in the Suri ecotype. Conclusions have to be taken with caution in this ecotype. Finally, also the individual was fitted in the model as a random effect given that there were repeated measures for several animals. Analyses were carried out using the PROC MIXED of SAS software (1999). Differences between the main five groups were estimated also using the same procedure, establishing significant differences between groups based on the least significant difference (LSD) methodology.

3. Results

Table 2 shows the significance of the different effects fitted in the