Genetic parameters for growth of fibre diameter in alpacas

L. Varona[1], I. Cervantes[2], M.A. Pérez-Cabal[2], R. Morante[3], A. Burgos[3] and J.P. Gutiérrez[2]
[1]Unidad de Genética Cuantitativa y Mejora Animal. Universidad de Zaragoza, Spain
[2]Departamento de Producción Animal, Universidad Complutense de Madrid, Avda. Puerta de Hierro s/n, E-28040 Madrid, Spain; gutgar@vet.ucm.es
[3]Pacomarca S.A., P.O. BOX 94, Av. Parra 324, Arequipa, Peru

Abstract

Alpaca is the most important fibre producer of South American camelid species, and an important income for the Andean communities. Nowadays, the fibre diameter is considered the main selection criterion in alpaca populations all over the world. However, fibre diameter increases with the age of the animals, and it would be preferable to select those animals that maintain a thin fibre throughout their life. The aim of this study is to describe the genetic relationship between fibre diameter at birth and its evolution over a lifetime. The analysis of the evolution of fibre diameter was studied as a longitudinal trait using the Bayesian procedure for the analysis of production functions. The results suggested that there is substantial genetic variation in fibre diameter at birth and also on the linear growth of fibre diameter. This confirms the need for a genetic programme to modify the evolution of the fibre diameter over time. However, selection to increase the growth of the fibre without a substantial reduction in the fibre diameter at birth seems implausible.

Keywords: alpaca, evolution, fibre diameter

Introduction

Alpaca is the most important fibre producer of South American camelid species, and an important income for the Andean communities. There are two alpaca breeds with different fleece characteristics: Huacaya (HU), which represents 85% of the alpaca population in Peru (Quispe *et al*., 2009) and Suri (SU).

Genetic programmes for fibre characteristics have been implemented by PACOMARCA S.A. by using a textile value index as selection criterion. In addition, estimates of heritabilities for fibre traits suggest moderate genetic determinism (Cervantes *et al*., 2010).

Fibre diameter is nowadays considered the main selection criterion in alpaca populations all over the world (Gutiérrez *et al*., 2009). However, fibre diameter increases with the age of the animals, and it would be preferable to select those animals that maintain a thin fibre throughout their life.

The analysis of the evolution of fibre diameter can be studied as a longitudinal trait using the Bayesian procedure for the analysis of production functions described by Varona *et al*. (1997). Thus, the aim of this study is to describe the genetic relationship between fibre diameter at birth and its evolution over a lifetime.

Material and methods

The data set consists of a pedigree of 3,621 individuals of the Huacaya breed, and 6,808 records of fibre diameter corresponding to 2,784 individuals. The average fibre diameter was 23.01

μm and standard deviation was 4.17 μm. The relationship between age and fibre diameter is presented in Figure 1.

Statistical model

The statistical model assumed that the jth measure of the fibre diameter for the ith individual (y_{ij}) is determined by the effect of the month-year of recording (f_i with 36 levels), the fibre diameter at birth (a_i) and the slope of linear growth for fibre diameter (g_i) time the age at the jth measure (x_{ij}) plus a residual (r_{ij}):

$$y_{ijk} = f_i + a_j + g_j x_{jk} + r_{ijk} \tag{1}$$

The residuals (r) are assumed to be Gaussian and identically distributed:

$$\mathrm{r} \sim N(0, \mathrm{I}\sigma_{\mathrm{r}}^2) \tag{2}$$

where σ_{r}^2 is the residual variance.

Fibre diameter at birth and the slope of the increase in fibre diameter are assumed to be determined by systematic (sex -2 levels- and colour -3 levels-), genetic and environmental effects.

$$\begin{bmatrix} \mathrm{a} \\ \mathrm{g} \end{bmatrix} = \begin{bmatrix} \mathrm{X} & 0 \\ 0 & \mathrm{X} \end{bmatrix} \begin{bmatrix} \mathrm{b}_a \\ \mathrm{b}_g \end{bmatrix} + \begin{bmatrix} \mathrm{Z} & 0 \\ 0 & \mathrm{Z} \end{bmatrix} \begin{bmatrix} \mathrm{u}_a \\ \mathrm{u}_g \end{bmatrix} + \begin{bmatrix} \mathrm{e}_a \\ \mathrm{e}_g \end{bmatrix} \tag{3}$$

The additive genetic effects and the environmental effects were assumed to be distributed with the following multivariate Gaussian distributions:

$$\begin{bmatrix} \mathrm{u}_a \\ \mathrm{u}_g \end{bmatrix} = N(0, \mathrm{A} \otimes \mathrm{G}) \tag{4}$$

$$\begin{bmatrix} \mathrm{e}_a \\ \mathrm{e}_g \end{bmatrix} = N(0, \mathrm{A} \otimes \mathrm{G}) \tag{5}$$

Where G and R are the matrices of additive genetic and environmental (co)variances components. Prior distributions for b_a, b_g, G, R and σ_{r}^2 were assumed to be flat between bounded limits.

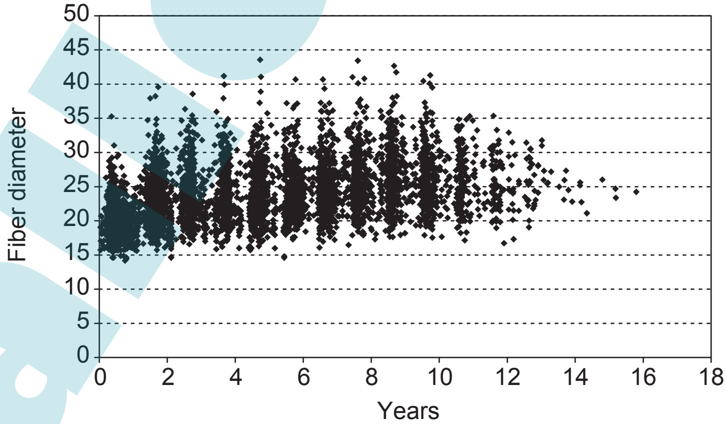

Figure 1. Relationship between age and fibre diameter.

The Bayesian analysis was implemented with a Gibbs sampler algorithm with a single long chain of 1,000,000 iterations after discarding the first 250,000.

Results and discussion

The results of the posterior distributions of the variance components are presented in Table 1.

Moreover, the posterior mean estimate of the residual variance was 5.125 with a posterior standard deviation of 0.115. These results suggest that there is substantial genetic variation in fibre diameter at birth and also in the linear growth of fibre diameter. The last results imply that a genetic programme is plausible for modifying the evolution of the fibre diameter over time. However, the posterior mean estimate of the additive genetic correlation between diameter at birth and linear growth was 0.889 with a posterior standard deviation of 0.105. This result is confirmed by the plot of the posterior mean estimates of the breeding values for both traits (Figure 2).

Table 1. Posterior mean and standard deviation (SD) of genetic parameters of the fibre diameter at birth (a) and its posterior linear growth (c).

	Diameter at birth (a)		Linear growth (c)	
	mean	SD	mean	SD
σ^2_u	1.212	0.161	0.052	0.011
σ^2_e	0.142	0.062	0.134	0.018

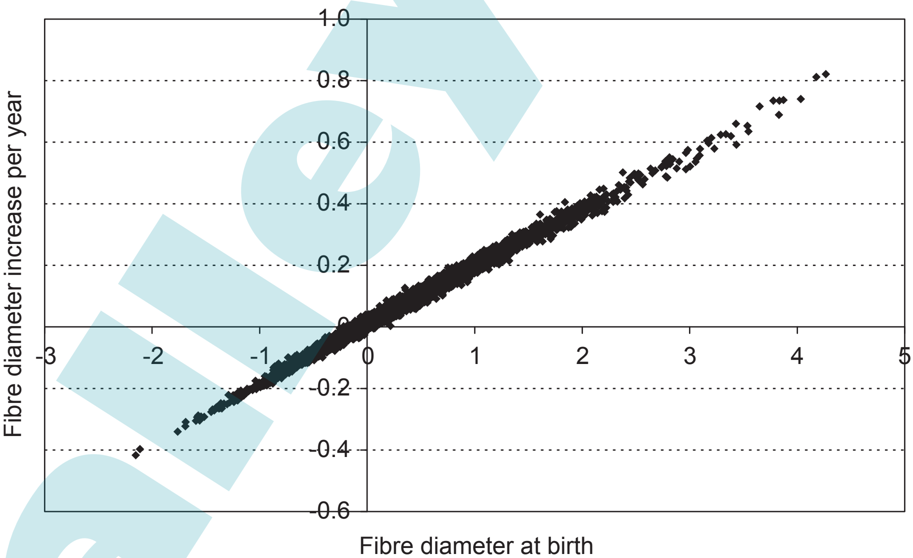

Figure 2. Posterior mean estimate for breeding values for fibre diameter at birth and linear growth.

Therefore, selection to increase the growth of the fibre without a substantial reduction in the fibre diameter at birth seems implausible. Further research is needed.

References

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