Preliminary information on a genetic improvement program on alpacas in Italy

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Summary

Ninety-one alpaca of the huacaya type (42 males and 49 females) from 17 Italian farms, were monitored at first shearing for three fleece traits: fleece weight, fibre diameter and coefficient of variation of fibre diameter. The means and the minimum and maximum values were: 1.69 kg (0.73-3.80 kg) for fleece weight, 22.8 µm (17.3-31.6 µm) for fibre diameter, 26.3% (17.5-44.6 %) for coefficient of variation of fibre diameter. Effect of sex was never observed on any of the three fleece traits. Significant correlation (r = 0.42; P<0,01) was detected between fleece weight and fibre diameter. A selection index was given to each animal by summing the estimated breeding values (EBVs) related to the three fleece traits. Each EBV concurred to the selection index in different proportions: 0.10, 0.50, and 0.40 for fleece weight, fibre diameter and coefficient of variation of fibre diameter, respectively. The animals with a positive selection index, showing reliability greater than 0.60 (23 males and 25 females), will be used in a breeding program, with the aim of improving the quality of fibre within the Italian alpaca population. It is concluded that there is good opportunities to improve alpaca fibre quality through selection and breeding focussed to reduce the fibre diameter and the coefficient of variation of fibre diameter.

***Key words**: Alpaca, Huacaya, Fleece traits, Selection index.*

Introduction

Alpaca breeding in Italy is quite recent; the first Alpaca import is dated at the end of the 1990s. At present, the number of Alpaca in Italy is of 700-800 animals, distributed among approximately 60 alpaca breeders, located in different Italian regions. Most of the Alpaca breeders (50) are members of an association, ITALPACA, established in 2001 as an answer to the growing need for a professional structure specifically dedicated to this new sector. One of the aim of this association was to create and run a national register of alpacas, containing pedigree information on alpaca born and living in Italy. These information are the first step for any genetic improvement programme.

Alpaca are among the best domestic animals for fibre production, being characterized by homogeneously fine, long and soft fleeces, very much in demand by the European textile industry. Of the two types of alpaca, the "huacaya" is the more common among the Italian breeders and is characterized by compact, soft and highly crimped fibres, with blunt-tipped locks which closely resemble those of Merinos sheep. By contrast, the "suri" has straight, less-crimped fibres and locks with a "cork-screw" shape, very similar to those of Angora goat but not as bright.

Fibre diameter is measured in microns (µm) and is the single most important commercial raw fibre

characteristic. Alpaca fibre is currently classed for fineness, as denoted by the Australian

Alpaca Cooperative (*www.pir.sa.gov.au/factsheets*) into:

1. superfine, less than 20 µm;
2. fine, 20-24.9 µm;
3. medium, 25-29.9 µm;
4. strong, more than 30 µm.

In this context, it is worth bearing in mind that the fibre diameter of 35 µm is the limit value proposed by Wildmann (1954), for distinguishing woolly fibres (undercoat) from coarse ones (outer-coat) in llama fleece. Since the textile industry utilises practically only fibres with diameter smaller than 35 µm, the main goal of the ITALPACA is to develop a genetic improvement program addressed to the production of homogeneously fine fibres from huacaya.

The aim of the present investigation is to supply breeders with information for evaluating alpaca fleece traits. The starting point is understanding the type and the amount of variation found among fleeces and subsequently selecting those animals which could improve quality and quantity of the fibre within the ITALPACA population.

Materials and methods

Throughout two years of investigation (2006-2007), 91 alpaca of huacaya type (42 males and 49 females, belonging to 17 alpaca breeders), devoid of any congenital defects and exhibiting an homogenous coloured fleece (either pigmented or white), were monitored for fleece weight, fibre diameter and coefficient of variation of fibre diameter. The fibre samples were collected from the right mid side of each animal, *i.e*. approximately over the 10th rib, about halfway down the body (Frank, Parisi de Fabro and Mendez, 1989). This body area has been found to be more representative of fleece characteristics than other fleece regions (Martinez, Iniguez and Rodriguez, 1997). The fibres were washed in petroleum ether (pure solution), dried in a stove at 60 °C for 30 min. and the measurements of the diameter were performed on a sample of 150 fibres for each specimen with the aid of a calibrated ocular micrometer mounted on an optical microscope. Sampling was carried out at first shearing, when the animal age ranged from 8 to 14 months old.

Analyses of variance (ANOVA) were performed on the fleece weight, the fibre diameter and the coefficient of variation of fibre diameter. A model I ANOVA was utilised, with sex considered as fixed factor and age as covariate. The relationship among the three fleece traits were calculated by means of the Pearson correlation coefficient. The statistical analyses were performed using the SPSS 12.0 statistical software package (2003).

An estimated breeding value (EBV) was calculated for each trait related to a given animal by means of a software named MTDFREML (Multiple Trait Derivative-Free Restricted Maximum Likelihood) and elaborated by researchers of the "Agricultural Research Service – United States Department of Agriculture". Because of the few animals investigated here (91), we did not feel confident in estimating the hereditability of the three fleece traits on which the EBV are based. Hence, we utilized information from Australian data produced by Ponzoni (2006) as reported in table 1.

Lastly, the individual EBVs were weighted, *i.e* multiplied by a proper factor, and summed to produce an overall index value, named selection index (SI), for each animal.

Results and discussion

Table 2 illustrates the results obtained by the weighing of the fleece and the measurements of the fibres of the 91 huacaya investigated in this study.

These results are similar to those reported in literature for huacaya by other authors (*cfr*.: McGregor and Butler,2004; Lupton *et al*.,2006; and references therein). Generally, the mean fibre diameter varies from 20 to 30 µm (with a minimum and a maximum value ranging from 15 up to 50 µm) and a similar range of variation is observed for the percentage values of the C.V. On alpaca fleece, however, there is a strong environmental effect. Fibre diameter and its C.V. appear to be influenced by: farm management, year, age, breed, live weight, colour of fibre, disease, reproduction, and position over the body (McGregor, 1999; Aylan-Parker and McGregor, 2002; McGregor and Butler,2004). Effect of sex was never observed. Because of the small number of the animals and their distribution throughout 17 different alpaca breeders, it was no possible to carry out any statistical analysis to evaluate the effect of the environmental factors given above. On the contrary, it was possible to estimate the effect of sex. In agreement with data reported by McGregor and Butler (2004), no evidence of a significant difference between male and female resulted from the ANOVA carried out for the three fleece traits (P=0.08, 0.81, 0.44, for fleece weight, fibre diameter and coefficient of variation of fibre diameter, respectively) . Nevertheless, since all the fibre samples were collected from the same body region of pre-selected animals (healthy, in non-reproductive stage, nearly homogeneous in age) and farm management was largely standardized within the ITALPACA

Table 1. Hereditability of the fleece traits.

	Clean fleece weight	Fibre diameter	C.V.[1]
Hereditability	0.60	0.60	0.70

[1]Coefficient of variation of the fibre diameter.

Tab. 2. Means, standard deviation and maximum and minimum values of the fleece traits

	Fleece weight (kg)				Fibre diameter (µm)				C.V. (%)[1]			
Sex (*n*)	$\bar{x}$	S.d.	Min.	Max.	$\bar{x}$	S.d.	Min.	Max.	$\bar{x}$	S.d.	Min.	Max.
Male (*42*)	1.62	0.60	0.73	3.80	22.7	2.8	17.3	29.4	25.7	3.4	17.5	33.5
Female (*49*)	1.75	0.50	0.96	2.80	22.9	3.6	17.7	31.6	26.8	4.3	18.3	44.6
Total (*91*)	1.69	0.55	0.73	3.80	22.8	3.0	17.3	31.6	26.3	3.9	17.5	44.6

[1]Coefficient of variation of the fibre diameter.

breeders, according to the suggestions given by Berna (2006), we can assume that most of the variability of the fleece traits is due to genetic differences among the animals. If this assumption is true, there is good potential for the improvement of the quality of alpaca fibre through selection and breeding.

An estimated breeding value (EBV) for each trait was calculated for each animal, as a measure of an animal's ability to transmit its genes on to the next generation. These EBVs were properly weighted (Table 3) and then pooled together to obtain an overall selection index for each animal. The weight given to the quantitative trait "fleece weight" was limited to 0.10. This choice was based on the output of a correlation analysis among the three fleece traits as shown in table 4.

In fact, the significant positive correlation between fleece weight and fibre diameter lead us to minimize the influence of the fleece weight on the selection index, to avoid a possible increase of the fibre diameter. Moreover, for textile purpose, the potential benefit is greatest from reducing the fibre diameter and its coefficient of variation.

By considering animals showing a positive selection index with reliability greater than 0.60 (mean, 0.77; s.d., 0.05), it was possible to detect a breeding nucleus consisting of 23 (54.8 %) males and 25 (51.0%) females, distributed among 12 alpaca breeders. These animals will be used in a breeding program, based on exchange of ram within the ITALPACA flocks, in order to improve the quality of the fibre for textile industry.

The validity of this genetic improvement program will be evaluated in the next future, as son as a new progeny is obtained from these rams and dams. This offspring is expected to exhibit a sensible average decrease in both the fibre diameter and its coefficient of variation.

Acknowledgments

We are very grateful to the members of ITALPACA association for providing the animals, and to Dr. A. Rosati for providing us with the software used for calculating the EBVs. Thanks are also due to Mr. Lebboroni G. (Department of Environmental Sciences, University of Camerino) for his competence and patience in preparing and measuring the fibre samples.

Table 3. Weight assigned to the EBVs of the three fleece traits.

	Fleece weight	Fibre diameter	C.V. [1]
Weight	0.10	0.50	0.40

[1]Coefficient of variation of the fibre diameter

Table 4. Pearson correlation coefficient (r).

	Fleece weight	Fibre diameter	C.V. [1]
Fleece weight	1		
Fibre diameter	0.42[2]	1	
C.V.	0.05	0.06	1

[1]Coefficient of variation.
[2]Correlation is significant at the 0.01 level (2-tailed).

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