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Technical note

The effect of altitude on alpaca (*Lama pacos*) fiber production

W. Braga [a,*], V. Leyva [a], R. Cochran [b]

[a] *Instituto Veterinario de Investigaciones Tropicales y de Altura (IVITA), Facultad de Medicina Veterinaria, Universidad Nacional Mayor de San Marcos, Av. Circunvalación s/n C 28 San Borja, Lima, Perú*
[b] *Department of Animal Sciences, Kansas State University, 253 Weber Hall Manhattan, KS 66506, USA*

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Abstract

In the Peruvian highlands, alpaca rearing areas are located between 4100 and 4700 m above sea level, with the finest fiber production believed to be associated with higher altitudes. The purpose of this experiment was to study the effect of differences in altitude on alpaca production, body weight (BW), clean fiber weight (FW) and fiber diameter (FD). Two areas with similar carrying capacities were identified at 4200 and 4600 m and stocked with 40 2-year-old (tuis), white, huacaya breed male alpacas in total. The experiment was conducted during two phases (phase 1: dry season; phase 2: wet season), with 4 × 28-day periods in each phase, plus a pre-experimental adaptation period of 28 days at 4200 m. Fiber samples were taken from a 10 cm^2 area on the left flank region every 28 days. For phase 1, 20 alpacas were transported to 4600 m, while the remaining 20 were kept at 4200 m. In phase 2, 10 alpacas from each group were switched to the alternate elevations, while the remaining animals were kept at their respective altitudes. In general, BW, FW and FD increased continuously during the course of the trial. The standard error for BW least squares means was 0.9343 kg, with a significant difference ($p < 0.0001$) between periods. The initial FW (1.3 ± 0.3 g × 10 cm^2) and FD (22.9 ± 2.6 μm) did not differ significantly between treatments, with the standard error for FW and FD being 0.1842 g × 10 cm^2 and 1.0663 μm, respectively with significant difference ($p < 0.0001$) between periods, but not between treatments. In general, altitude treatments did not exert a significant effect on any of the variables measured. In contrast, time (period) effects were clearly evident for all the traits measured. Changes in response over time largely appeared to reflect the normal maturation processes of tuis and the availability of higher quality pastures during the wet season. Conclusion, altitude within the normal elevation range for alpaca production does not appear to significantly affect fiber production.

Keywords: Alpaca; Tuis; Altitude; Fiber production

1. Introduction

Peru has 27 million ha of natural pasture, 51% of which is located in the southern highlands where alpaca production is an important industry – particularly higher than 4300 m above sea level. Currently, there is debate regarding the effect of the higher altitudes per se on alpaca fiber production. There are reports that the alpaca fiber diameter is finer when harvested from herds maintained at elevations over 4500 m above sea level, compared to coarser diameters when herds are maintained at lower altitudes (approximately 4300 m above sea level). In these cases differences in fiber diameter were attributed to an altitude effect per se by livestock producers, but it has been suggested to be potentially attributable to a nutritional effect by others (Cortez, 1984, 1985).

* Corresponding author at: 1800 Denison Ave (Coles Hall 309), Manhattan, KS 66506, USA. Tel.: +1 785 532 4620; fax: +1 785 532 4851.
E-mail address: wbraga@vet.ksu.edu (W. Braga).

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Although evaluated under more extreme altitudes, other species have been shown to exhibit differences in production traits in response to a variation in altitude. So for example, Corriedale sheep maintained at 4400 m above sea level have been observed to record ADG's of 216 and 207 g for purebred and crossbred sheep, respectively. When these animals were moved to sea level, the ADG's increased to 354 and 252 g, respectively. Corriedale ewes are also normally uniparous in the highlands, while at sea level a twinning rate of approximately 40% was recorded (Calle et al., 1978). Similarly, both cow milk production and calf growth rate have been shown to be reduced in the highlands, compared to the production at sea level (Koubek et al., 1973; Duranti et al., 1978).

The annual rainfall in the Andean grassland ecosystem varies between 10 and 100 cm, most of which falls between December and March – defining a short wet season. Seasonal growth and forage quality is determined by this rainfall pattern in which, high-quality pastures are abundant during the wet season and scarcer during the rest of the year, or dry season (Van Saun, 2003). Under these extreme conditions, the alpaca fiber production is strongly influenced by nutrition. Fiber length for example, was found to be 25% longer during the wet season in the Andean highlands (Bustinza et al., 1985). This likely reflects the fact that the percentage crude plant protein decreased from 11% in the wet season, to 3.5% during the dry season (Bustinza et al., 1985). Age, breed, physiological stage and sex are also traits that could have a potential effect on alpaca fiber production. In female alpacas, which represent approximately 70% of the alpaca population (Condorena, 1980), fleece weight has been observed to be greater for females before pregnancy and lactation (Calderon and Pumayala, 1981). The aim of this work was thus to determine whether differences in altitude affects alpaca fiber production, independent of other factors such as age, sex or nutrition.

2. Materials and methods

2.1. Area description

Two flat grazing areas in the Cusco highlands of Peru were selected to conduct the trial. One was located 4600 m and the other 4200 m above sea level (Fig. 1). The predominant pasture species present, in order of abundance, was *Calamagrostis curvula, Festuca dolichophylla, Distichia muscoides, Plantago rigida* at the higher altitudes, and *F. dolichophylla, Alchemilla pinnata, Eleocharis albibracteata, Muhlembergia fastigiata* at the lower altitudes. The mean annual rainfall in this area is approximately 1134 mm, and the carrying capacity of the pastures in the two experimental areas did not differ markedly.

2.2. Animals and experimental procedure

Forty, 2-year-old male white huacaya tuis (young alpaca) from a single flock reared under extensive pasture and management conditions in the highlands of Peru were randomly chosen from animals with a body weight range of 46–52 kg. A schematic presentation of the experimental design is set out in Fig. 1. A pre-experimental adaptation phase of 28 days was implemented during which the entire group of 40 tuis were maintained at 4200 m under similar pasture and management conditions (sampling period = 0). Measurements of clean fiber weight (FW), fiber diameter (FD), and body weight (BW) were recorded to establish baseline values for a subsequent comparison. The experimental phase

PRE EXPERIMENTAL PHASE		EXPERIMENTAL PHASE I				EXPERIMENTAL PHASE II			
Initial altitude	**n**	**Previous altitude**	**n**			**n**	**Final altitude**		
4200 m	40	4600 m	20			10	4600 m		
						10	4200 m		
		4200 m	20			10	4600 m		
						10	4200 m		
Sampling periods:	0	1	2	3	4	5	6	7	8
Days	28	28	28	28	28	28	28	28	28
Rainfall (mm):	8.12	85.6	63.3	144.5	141	141.5	218.9	246.3	121.2

Fig. 1. Schematic presentation of the experimental design with alpacas and rainfall (mm) during the trial.