PHYSIOLOGICAL CHARACTERISTICS OF ALPACAS (*LAMA PACOS*) IN SEMIARID CENTRAL VALLEY OF CHILE

CARACTERÍSTICAS FISIOLÓGICAS DE LA ALPACA (*LAMA PACOS*) EN EL VALLE SEMIÁRIDO CENTRAL DE CHILE

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ABSTRACT

The objective of this work was to study some physiological variables of alpacas, which have been maintained for a long time in a semiarid valley environment extremely different from the Andean high plateau. A herd of 31 adult alpacas, 21 females and 10 males, with ages ranging between 2 and 6 years were sampled for six weeks during the fall and winter. Animals were allocated in 2 herds, under similar management in the central region of the country, among 600 - 900 m.a.s.l. The variables studied were: heart rate, respiratory rate, rectal and skin temperature, ruminal movements, red packed cell volume, blood glucose level, plasmatic cortisol, and thin blood film smear. The differential count in white blood cells was also measured. Result, showed an excellent adaptation ability of the alpaca to very different environmental conditions, specifically related to altitude and temperature, without important physiological modifications. Possibly a redistribution of peripheral blood circulation could be its main thermoregulatory mechanism.

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RESUMEN

El objetivo de este estudio fue estudiar algunas variables fisiológicas de alpacas, que han sido mantenidas por un prolongado período de tiempo en el valle semi-árido de la zona central de Chile, ambiente en extremo diferente al hábitat altiplánico. Se utilizó un rebaño de 31 alpacas adultas, 21 hembras y 10 machos, con edades comprendidas entre los 2 y 6 años los que fueron muestreados durante seis semanas durante el otoño e invierno. Los animales fueron mantenidos en dos rebaños con similar manejo, en la región central del país a una altura de 600 - 900 metros de altura sobre el nivel del mar. Las variables estudiadas fueron: frecuencia cardíaca, frecuencia respiratoria, temperatura rectal y cutánea, movimientos ruminales, volumen globular aglomerado, glicemia, cortisol plasmático, y frotis sanguíneo. También se realizó una cuenta diferencial de la serie blanca. Los resultados mostraron una excelente adaptación de la alpaca a las diferentes condiciones del nuevo ambiente, específicamente aquellas relacionadas con altitud y temperatura, sin mostrar modificaciones fisiológicas importantes. Posiblemente el principal mecanismo termorregulador estaría relacionado con una redistribución de la circulación periférica.

INTRODUCTION

In Chile, most of the south American camelids and in particular alpacas, are formed in the Andean high plateau in the northern region of the country at altitudes above 4000 m. Low temperature (- 5.6 to 7.1°C), and low quality forages are the main environment to which these animals have adapted, through their physiological characteristics (Raggi, 1992; Raggi *et al.*, 1994).

When alpacas are moved to very different environments, they enter an acute adaptation process with significant physiological changes. Some of them do not return to the original values (Crossley *et al.*, 1994).

The aim of this work was to analyze physiological characteristics of alpacas kept for a long time in a arid valley environment quite different from the Andean high plateau.

MATERIALS AND METHODS

A group of 31 adult alpacas, 21 females and 10 males, aged between 2 and 6 years, clinically healthy, which spent more than a year at the sea level and apparently adapted to this environment, were sampled for six weeks during fall and winter season.

Animals were distributed in 2 herds in the central region of the country, among 600-900 m.a.s.l., under similar management, range feeding and alfalfa hay supplementation and water ad libitum. One herd was located near the Andean mountains (herd 1) and the other in the interior valley in a semiarid, warm area (herd 2). Daily temperature in the central zone ranged 3.5°C - 22.0°C and 6.5°C - 23.0°C on herd 1 and 2 location respectively.

The variables studied were: heart rate by auscultation method; respiratory rate by direct observation of costal movements; rectal temperature by digital electronic thermometry; skin temperature by electrical telethermometry; ruminal movements by abdominal palpation. All these recordings were done once a week, morning and afternoon alternately (9-11 AM and 15-17 PM).

In addition, some hematologic constants were measured: red packed cell volume; blood glucose level by Frinder's method; plasmatic cortisol by radioimmunoassay; thin blood films smear for white blood cells differential count. Blood samples were obtained by jugular venipuncture collected in vacuum tubes with EDTA, twice during the period of study, one in the morning hours and the other in the afternoon.

Data statistical variance analysis was done following the formula:

$$Y_{ijk} = U + G_i + H_j + (G*H)_{ij} + E_{ijk}$$

Where:

Y_{ijk} = Observed variable
U = Population mean
G_i = i Group effect (i = 1,2,3)
H_j = j Hour effect (j = 1,2)
$(G+H)_{ij}$ = Group, hour interaction effect
E_{ijk} = Experimental error

In those cases where variance analysis show statistically significant differences between groups, Scheffé test was used.

RESULTS

Heart rate mean value was 65.0 ± 8.8

beats/min with no significant differences by sex and location **(table I)**. Similarly respiratory rate values (mean value 23.5 ± 6.1/min.), in relation to time of day and location did not change, but sexual differences appeared ($p<0.05$) **(table I)**, with male values higher.

Location seemed to generate differences ($p<0.05$) in rectal temperature, animals of herd 2, had higher values than those of herd 1. This characteristic is related to the time of day, specifically the morning hours, but was sexually independent. Also, in the warmest zone (herd 2) it was possible to detect significant differences between morning and afternoon values, independent of sex of the animals. The mean value for this variable was 38.31 ± 0.4°C **(table I)**.

Skin temperature presented a different pattern in comparison with rectal temperature. Differences between morning and afternoon values were observed only in males of herd 1 ($p<0.05$) **(table I)**. Females located in the valley (herd 2), showed differences between morning and afternoon values ($p<0.05$) **(table I)**. The mean value for this variable was 36.09 ± 1.0.

Ruminal movements show statistical differences ($p<0.05$), between morning and afternoon values, increased only in females of herd 2. The mean value for this variable was 4.5 ± 1.2 in three minutes **(table I)**.

Hematologic constants did not exhibit significant differences by location, sex or hour of the day, and the mean values are in **table II** and **table III**.

Table I. *Heart rate, respiratory rate, rectal temperature, skin temperature and ruminal movements of alpacas in the central region of Chile.* (Frecuencia cardíaca, frecuencia respiratoria, temperatura rectal, temperatura cutánea y movimientos ruminales de alpacas en la zona central de Chile).

Group	Day time	Heart rate Beats/min	Respiratory rate Resp./min	Rectal temperature (°C)	Skin temperature (°C)	Ruminal movements Mov./3min
Females Herd 1	A.M.	60.7± 7.6	19.1±4.8	38.02±0.5*[a]	35.71±1.1	4.3±0.9
	P.M.	64.2± 5.5	23.1±5.6	38.53±0.2	36.42±0.7	4.6±0.8
Females Herd 2	A.M.	66.9± 8.8	21.7±6.1	38.42±0.3[b]	35.22±0.9*	3.6±1.1*
	P.M.	67.1± 7.1	25.5±5.3	38.58±0.2	36.58±0.6*	5.2±1.2*
Males Herd 1	A.M.	62.1±10.2	24.3±5.1	37.96±0.2*[a]	35.52±0.8*	4.6±1.2
	P.M.	69.6±11.3	27.4±7.2	38.36±0.4*[a]	37.11±0.7*	4.9±1.4
Mean Value		65.0± 8.8	23.5±6.1	38.31±0.4	36.09±1.0	4.5±1.2

[a,b] indicate statistical differences between groups, at the same hour of the day ($p<0.05$).
*Indicate statistical differences in the same group between morning and afternoon values ($p<0.05$).
(means ± standard deviation).

Table II. *Red packed cell volume, blood glucose and cortisol for alpacas in the central region of Chile.* (Volumen globular aglomerado, glicemia y cortisol de alpacas en la zona central de Chile).

Red packed cell volume (p.100)	Blood glucose (mg/dl)	Cortisol (nmol/l)
33.19 ± 2.2	107.28 ± 14.76	17.14 ± 9.81

Mean ± standard deviation

DISCUSSION

During the experimental period all animals were healthy and had similar behavior for feeding and water consumption, and showed a well defined social structure.

Heart rate variations were similar to those described by other authors (Vallenas 1952). On average, they did not differ from those animals in high altitudes (Calle 1982; Ulloa, 1986). Values in this study were higher than those obtained in Chile by other authors, in the Andean high plateau or at sea level (Raggi *et al.*, 1994; Crossley *et al.*, 1994). When these values are compared with those during the period of alpaca adaptation, after being moved from the andean high plateau to the central region of the country (Crossley *et al.*, 1994), they were higher than those on the first days after arrival to the new environment and similar to those 10 days later. The increase in heart rate frequency was possibly due to higher temperature, characteristic of the central zone, and not necessarily related, to the higher oxygen concentration, since this should produce bradycardia (Monge and Wittemburg, 1976) or a lower systolic discharge, caused by a right ventricle diminution size (Martínez *et al.*, 1988).

The respiratory values in this study did not differ with those for the same specie in the andean high plateau (Raggi *et al.*, 1994), at the sea level (Crossley *et al.*, 1994), or even during the acute phase of adaptation to a different environment (Crossley *et al.*, 1994). The absence of differences in this variable, under such different environmental temperatures, may indicate, that in alpacas, panting is not the main active physiologic mechanism in the regulation of body temperature. Redistribution of blood through peripheral circulation could be the mechanism used, as it happens in other species in the warm and arid zones (Linzell, 1974).

Strongly related with previously mentioned phenomena are rectal and skin temperatures. In alpacas, rectal tem-

Table III. *Leukocyte differential counts (p.100) for alpacas in the central region of Chile.* (Cuenta diferencial leucocitaria (p.100) de alpacas en la zona central de Chile).

Neutrophils	Lymphocytes	Eosinophiles	Monocytes	Basophile	Juvenile
51.14±11.48	41.62±13.16	5.62±8.42	0.53±1.27	0.03±0.12	1.08±3.30

Mean ± Standard deviation

peratures change through the day (Vallenas, 1952). A similar situation was observed in relation with morning and afternoon temperatures that undoubtedly were caused by different environmental temperatures, being stronger in herd 1. Average values for rectal temperatures were similar to those described by Sillau *et al.*, (1976), Calle, (1982); Blight and Sumar (1988); Raggi *et al.*, (1994); Crossley *et al.*, (1994); both in the andean high plateau and sea level. The great differences of these environments and the absence of differences in rectal temperature could indicate a well-developed adaptive homeostatic mechanism in alpaca.

Length of fleece seems to be the cause of significant differences found in the two groups in skin temperature, through out the day, being shortest in those animals which have these differences. Evidence on this topic has been reported by other authors (Crossley, 1989). The mean value obtained in this work was higher than described for the andean high plateau (Raggi *et al.*, 1994; Crossley *et al.*, 1994), and similar to those by Crossley *et al.* (1994), in the central zone, during the acute stage of adaptation.

Ruminal movements observed, were similar to those mentioned by Raggi *et al.* (1994), in the andean high plateau, in spite of the lower fibre content of the forage in the central zone, being a characteristic feed that influences rumen motility (Vallenas, 1960). The mean value was lower than obtained by Vallenas (1965), for alpacas in the Peruvian highlands.

Plasma cortisol concentration did not vary significantly in relation to location or hour of the day sampling, and the average value was lower than indicated by Crossley *et al.* (1994), in measurements done in the andean high plateau, at the sea level, and even during the first hours of acute adaptation to transportation to a different region. These results differ from those indicated by Raggi *et al.* (1994) where it was demonstrated that there are differences between morning and afternoon values.

Plasma glucose levels were similar to those indicated by Crossley *et al.* (1994) in studies done in the same region, but they were higher than those usually found in the andean high plateau (Raggi *et al.*, 1994; Crossley *et al.*, 1994), possibly due to the better quality of feedstuffs.

Red packed cell volume values were similar to those mentioned in the literature but lower than results obtained in the andean high plateau (Raggi *et al.*, 1994; Crossley *et al.*, 1994; Palomino *et al.*, 1964; Hawkey, 1975). No significant differences by sex were noted for this variable in contrast to those indicated by Montes *et al.* (1983).

White blood cells differential count showed figures similar to those in the literature, with a higher ratio of neutrophils over lymphocytes, independent of the region in study (Crossley *et al.*, 1994).

CONCLUSION

Alpacas show an excellent capability of adaptation to quite different environmental conditions, specifically related to altitude and temperature, without significant physiological modifications, caused possibly by a redistribution of peripheral blood circulation their main thermoregulatory mechanism, rather than panting.

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