MILK COMPOSITION IN ALPACA (LAMA PACOS): COMPARATIVE STUDY IN TWO REGIONS OF CHILE

COMPOSICIÓN DE LA LECHE DE ALPACA (LAMA PACOS): ESTUDIO COMPARATIVO EN DOS REGIONES DE CHILE

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Colostrum. Lactation. Camelids.

SUMMARY

The objective of this study was to determine the influence of different environmental conditions (pasture quality and altitude) on colostrum and milk composition during the first five month of lactation in alpacas. Major milk components were determined and compared in lactating alpacas maintained in two different regions of Chile. Milk samples were taken 48 hours after parturition (colostrum) and subsequently every 30 days up to 5 months of lactation in two groups of alpacas. One of the groups was maintained in the Andean high plateau (4400 meters above sea level; n=24), and the other in the Patagonian region (12 meters above sea level; n=18). Both groups fed ad libitum on natural pastures. Percentage of dry matter, protein, fat, lactose and ash content in milk were measured and differences between groups and between months for each milk component were analyzed. Colostrum from both groups was similar in composition, except for fat, which was higher in animals kept in the Andean High Plateau, and lactose, which was higher in animals kept in the Patagonia. Throughout lactation, milk composition showed little differences between both groups, although the fat content was highly variable. Considering all stages of lactation, milk obtained from the Andean high plateau had a greater amount of fat, while milk from the Patagonia was higher in lactose. Differences in fat and lactose composition could be explained by meadow composition and availability, and by grazing behavior of the alpacas.

RESUMEN

El objetivo de este estudio fue determinar la influencia de diferentes condiciones medioambientales (calidad de los pastos y altura) sobre la composición del calostro y la leche de alpacas, durante los primeros cinco meses de lactación. Los principales componentes de la leche fueron determinados y comparados entre alpacas en lactación mantenidas en dos diferentes regiones de Chile. Las muestras de leche fueron tomadas a partir de las 48 horas posparto (calostrum) y...
subsecuentemente cada 30 días hasta los 5 meses de lactación, en dos grupos de alpacas. Un grupo fue mantenido en el altiplano Andino (4400 metros sobre el nivel del mar; n=24) y el otro en la Patagonia (12 metros sobre el nivel del mar; n=18). Ambos grupos se alimentaron ad libitum sobre praderas naturales. Se midió el porcentaje de materia seca, proteína, grasa, lactosa y ceniza. Los valores obtenidos para cada componente de la leche se compararon entre grupos y entre meses de lactación. La composición del calostro fue similar entre grupos, excepto para materia grasa que fue mayor en el altiplano y lactosa que fue mayor en los animales mantenidos en la Patagonia. A lo largo de la lactación, la composición de la leche mostró pequeñas diferencias entre grupos, aunque el contenido de grasa fue altamente variable. Considerando toda la lactación, la leche obtenida en el altiplano Andino presentó mayor concentración de grasa, mientras que la de la Patagonia presentó más lactosa, tal como ocurrió con el calostro. Las diferencias en las concentraciones de grasa y lactosa podrían ser explicadas por la composición y disponibilidad de la pradera en cada región y por la conducta de pastoreo de las alpacas.

INTRODUCTION

The alpaca is one of the two species of domestic South American camelids, adapted to live at high altitudes, over 3800 meters above sea level (m.a.s.l.). Alpacas have recently grown in importance, not only in the Andean countries of Perú, Bolivia, Argentina and Chile, but also in northern regions of the world as pets as well as for production of wool and meat. Owing to the special characteristics of these products, they have been introduced in different regions of Chile in order to improve animal production. As a result, they are exposed to environmental conditions quite different from those of their natural habitat, the Andean high plateau (AHP).

In South American camelids, the long lactation periods of the newborn of up to eight months, make them highly dependant on maternal milk production and composition during this period (FIA, 2000). At present, information about milk production and composition in alpacas is scarce and partial (Romano et al., 1995). In llamas, however, there are more complete reports and it is generally assumed that, in terms of major components, milk and colostrum composition are similar in domestic (llama and alpaca) and wild (vicugna and guanaco) South American camelids (Fowler, 1989; Ameghino and De Martini, 1991; Morin et al., 1995).

On the other hand, evidence in ruminants has demonstrated that milk composition is strongly influenced by feeding conditions (Ferrando and Boza, 1990; Sanz Sampelayo et al., 1998; Mackle et al., 1999). It suggests that when animals are breeding in environments quite different from that considered natural for them, a difference in milk composition may be found.

In alpacas, it has been established that maternal nutrition affects neonatal growth and body weight during suckling. Thus, restriction of maternal food intake decreases the daily gain in body weight after the seventh week of neonatal life (Raggi et al., 1995). In addition, keeping non food-restricted maternal alpacas in different environments with proper natural pastures in each condition, also modifies the growth rate in their newborns (Raggi et al., 1997), suggesting an effect of
The aim of the present study was to determine the influence of different environmental conditions (pasture quality and altitude) on colostrum and milk composition during the first five months of lactation in alpacas.

MATERIALS AND METHODS

Forty-two pregnant alpacas (Huacaya breed; four to six years old), under normal breeding conditions and with previous normal gestation and parturition, were used. Animals were maintained in two different regions of Chile. One group (n=24) was located in a farm in the AHP (Tarapacá region; 18°11' S; 69°15' W; 4400 m.a.s.l.), exposed to the usual habitat for this species in Chile. A second group of pregnant females (n=18) was maintained in a farm at the Chilean Patagonia (Magallanes region; 52°51' S; 70°53' W; 12 m.a.s.l.), the extreme southern region of the country. This region has been traditionally dedicated to sheep breeding, and alpacas have been recently introduced as a new farming alternative. Both regions present similar environmental temperature and pluvial conditions (Ruz and Covacevich, 1988; Raggi et al., 1997). However, the extreme difference in altitude (4388 m) determines differences in meadow composition between regions. In the AHP, the nutritional resources have a predominance of the following species: Oxichloe andina, Festuca nardifolia and Distichia muscoides. The nutritive value for this vegetable formation is 7.4 MJ of metabolizable energy (ME) for kg of dry matter (DM) and 9.2 percent of crude protein (CP) (Castellano et al., 1998). In Patagonia, there is a predominance of Festuca gracillima, Chliotricum diffusum, Berberis buxifolia and Poa pratensis which nutritive value is 7.1 MJ of ME/kg DM and 8.9 percent of CP (Ruz and Covacevich, 1988).

After parturition, both groups of dams were allowed to stay with their newborns during the day and only were separated at night prior to the day of sampling. Milk samples were obtained early in the morning by hand milking. Before sample collection the teats were thoroughly washed and dried. In addition, to avoid contamination, two milk squirts were discarded and samples were filtered through sterile gauze. Colostrum sampling was performed 48 h after parturition and milk samples were obtained monthly from first until fifth month of lactation. In order to obtain the 60 ml of milk necessary to perform the analysis, and to avoid any significant interruption of milk feeding to the newborns, 20 ml milk samples from three females at a similar stage of lactation were collected and pooled. Then, eight pooled samples for AHP and six pooled samples for Patagonia were analyzed at each time. Due to long distance between experimental places and our laboratory, samples collected were preserved by addition of potassium dichromate (A.O.A.C., 1999a) and stored at 4°C until analyzed.

Fat was determined by the Gerber method (Pearson, 1973), protein was estimated by the Kjeldahl method (A.O.A.C., 1999b) and the resulting...
values were corrected by factor 6.38. Lactose was determined by the UV lactose/galactose method (Boehringer Mannheim®, Mannheim, Germany); DM content was obtained by the A.O.A.C. official method (1999c), and ash by incineration of the sample in an electric muffle furnace at 500°C.

Statistical comparisons between groups for colostrum components were established by unpaired Student-t test. In addition, comparisons between months and groups for milk were done by two-way ANOVA. Significant differences were considered when \( p \leq 0.05 \).

The animal protocol for the present study was approved by the Bioethical Committee of the Faculty of Veterinary Sciences, University of Chile.

**RESULTS**

Colostrum composition from samples collected at 48 h post partum, both in the AHP and in Patagonia are shown in [table I](#). It can be seen that while there are no significant differences in DM, protein or ash contents between colostrum from both regions, fat and lactose contents were significantly higher in the samples from AHP and Patagonia, respectively (\( p<0.05 \)).

Alpaca milk composition in samples obtained in the AHP or Patagonia during five months of lactation are shown in [table II](#). In both groups of animals, small but significant variations during the lactation period were observed. Milk from alpacas maintained in the AHP was characterized by reaching the minimal concentrations of DM and fat at the fourth month of lactation. The highest value for fat was found at the second month. Lactose, on the other hand, was its highest concentration at the first month and protein at the third month. Milk obtained from animals maintained in Patagonia contained the highest concentration of protein and fat at the fifth month of lactation. Lactose reached its highest concentration at the first month of lactation, whereas fat reached its lowest value at this time.

Monthly comparisons show significant differences between the milk components from both regions at the second month of lactation; the concentrations of DM, protein and fat in AHP samples were highest. In contrast, lactose concentration was significantly

**Table I.** Colostrum composition (percent WW±SD) obtained 48 hours post partum in alpacas from Andean high plateau (AHP) and Patagonia. (Composición del calostro obtenido 48 horas después del parto en alpacas del altiplano Andino y Patagonia).

<table>
<thead>
<tr>
<th>Region</th>
<th>Dry matter</th>
<th>Protein</th>
<th>Fat</th>
<th>Lactose</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHP</td>
<td>20.66 ± 1.3</td>
<td>9.84 ± 0.6</td>
<td>4.80 ± 1.2*</td>
<td>4.41 ± 0.1</td>
<td>1.63 ± 0.0</td>
</tr>
<tr>
<td>Patagonia</td>
<td>19.06 ± 0.5</td>
<td>9.24 ± 0.5</td>
<td>2.71 ± 0.6</td>
<td>5.33 ± 0.1*</td>
<td>1.78 ± 0.1</td>
</tr>
</tbody>
</table>

Asterisk indicate significant difference in the same column (\( p<0.5 \)).

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higher in the samples from Patagonia at almost all months, except the first month in which there was no significant difference (table II).

The average composition of alpaca milk, taking into consideration the entire sampling period, indicated higher fat concentration in samples from animals kept on the AHP and a significantly higher lactose concentration in samples from Patagonia (table II).

**DISCUSSION**

In the present study, no significant differences could be appreciated in almost all the alpaca colostrum components between animals maintained in the AHP or the Patagonia region. However, animals from AHP presented higher values for fat and values slightly higher in DM and protein, while lactose colostrum concentration was significantly lower in this group.

Studies on alpaca colostrum composition are scarce. Romano *et al.* (1995) published results obtained in alpacas kept in the central valley of Chile (750 meters above sea level), one of the habitats in which alpacas were reloca-
ted for productive purposes. Results reported by these authors show important differences in colostrum composition in comparison with both groups considered in our study. Noteworthy is the low fat content, as also reported for humans (Macias and Schweigert, 2001), the low ash content, and the high protein content presented by colostrum from alpacas living in the central zone of Chile. Many of the differences are probably explained by the richer food availability in the central valley and other environmental conditions. However, another explanation for such differences may be that in the report by Romano *et al.* (1995), colostrum samples were obtained 24 h...
after parturition, whereas in our study samples were taken at 48 h. Although information from other ruminant (Blattler et al., 2001) or monogastric (Adkins et al., 1997) species indicate an opposite tendency in colostrum composition changes during the first 3 days of lactation, the effect of sampling time in the present study can not be discarded. Moreover, in sows, although the major changes in colostrum composition are observed between 6 to 12 h after lactation begins, a significant increase in fat content occur between 24 and 48 h (Klobasa et al., 1987), as probably occurs also in alpacas.

Major milk constituents, during the measured lactation period of five months, were higher in AHP samples, except lactose, which was significantly higher in Patagonia milk samples. These characteristics could explain the higher growth rate observed in newborns bred in the AHP (Raggi et al., 1997). Thus, initial differences in body weight at birth, clearly higher in Patagonian offspring in comparison with AHP offspring, are nullified during the lactation. Comparing our results with those previously reported for animals kept in the central zone of Chile (Romano et al., 1995), only minor differences can be observed. Milk from alpacas raised in central Chile is characterized by a lower protein and ash content, and a higher fat content than milk from alpacas in the extreme (AHP and Patagonian) regions of Chile.

Despite the above mentioned differences, milk fat content, both in AHP and Patagonia regions, falls within the range of 2.0 to 5.7 percent mentioned in the literature for alpacas (Jimenez, 1970), llamas (Johnson, 1994; Ruiz de Castilla, 1994; Morin et al., 1995) and camels (Elamin and Wilcox, 1992). However, alpaca milk content of DM and protein are much higher than those reported for llamas and camels (Elamin and Wilcox, 1992; Morin et al., 1995). The lactose levels described in the present work for alpacas are in agreement with those reported in camels (Elamin and Wilcox, 1992), but are inferior to those reported in llamas (Morin et al., 1995). Considering the content of macronutrients in milk from several ruminant species like cows (Mackle et al., 1999), goats (Sanz Sampelayo et al., 1998), ewes (Mills, 1989), llamas (Morin et al., 1995) and camels (Elamin and Wilcox, 1992), the alpaca milk seems to be one with better nutritive value, surpassed only by milk from the Iberian red deer (Landete-Castillejos et al., 2000).

The effects of feed components (Jurjanz et al., 1998; Kalscheur et al., 1999; Sanz Sampelayo et al., 1999), their physical form (Sanz Sampelayo et al., 1998) and availability (Peris et al., 1993; Mehaia et al., 1995; Lacy-Hulbert et al., 1999), on milk yield and composition has been extensively studied in ruminants. From these studies, two general conclusions emerge that may contribute to an explanation of the results obtained in the present work. First, total energy intake obtained from pastures is directly related to the fat content in milk. However, when energy is supplemented by concentrate diets, this results in a decrease in milk fat content. Second, consumption of diets rich in protein produce milk rich in protein. Thus, the higher content of protein and
fat in milk obtained from alpacas raised in the AHP may be because pastures from this region have more ME and protein than those from Patagonia (Ruz and Covacevich, 1988; Castellaro et al., 1998).

Finally, it is important to point out that milk lactose concentration was significantly higher in alpacas maintained in the Patagonian region. This difference can not be explained by a difference in pasture characteristics. However, this could be explained by the daily exercise incurred by the animals to obtain the total amount of feed. The availability of DM per hectare (ha) in both regions under study is notably different, 2857 kg DM/ha/year for the AHP (Castellaro et al., 1998) and 3907 kg DM/ha/year for Patagonia (Latorre, E., unpublished results). This difference obliges animals living in the AHP to walk longer distances and to dedicate more time each day to activities related with grazing. Previous results obtained by our group show that, in the AHP, alpacas spend 6.3 h per day and walk 3.2 km for grazing activities, whereas, in a zone with similar amount of DM/ha to that of Patagonia, alpacas spend only 5.1 h and walk 1.1 km during daily grazing (Raggi et al., 1994).

Experiments in rats have shown a decrease in milk lactose content produced by exercise (Teadway and Lederman, 1986; Matsuno et al., 1999). This effect of exercise on milk lactose content has been explained by an increase of daily energy requirements produced by additional muscle work, which results in a competition by blood glucose with mammary gland (Matsuno et al., 1999). These observations are consistent with our observations in alpacas; however, other experiments are necessary to clarify these effects in this species.

In conclusion, milk from alpacas present a high concentration of the major components with slight variations during the first five months of lactation. Differences in milk components between animals kept in AHP or Patagonia, were observed only for fat and lactose concentrations, which could be explained by the clear differences in meadow composition and availability between both regions, and its effect on grazing behavior of the alpacas.

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