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Effects of Supplementation with Microminerals on Production Indicators and Blood, Feces, and Urine Traces of Grazing Alpaca (*Lama lama*)

Luis Alonso Chicaiza, Cristian N. Arcos Alvarez*, Paola J. Lascano Armas*; Julio Enrique Usca**; Francisco Hernán Chancusig*; Jorge A. Armas Cajas*; Hernán P. Bastidas Pacheco*; Maira N. Martínez Freire*; Silvana Méndez García***; Manuel E. Soria Parra***; Gonzalo E. López Crespo***; Raúl V. Guevara Viera, PhD.*

*** Academic Unit of Agricultural Sciences and Natural Resources, Veterinary Medicine Degree, Technical University of Cotopaxi, Ecuador**

**** Faculty of Animal Sciences, Higher Polytechnic School of Chimborazo, Riobamba, Ecuador**

***** Faculty of Agricultural Sciences, University of Cuenca, Yanuncay Campus, Cuenca, Azuay, Ecuador**

rguevaraviera@yahoo.es

ABSTRACT

To analyze the effect of additional microminerals in the diet supplement on weight and diameter of alpaca fiber, the application of three doses of selenium and zinc (0.0; 1.0; and 1.5 cc) on the diet, on CRD factorial arrangement (3 x 2) + (3 x 2), was assessed. The results showed statistically significant differencences for treatments: selenium doses, ages, zinc doses, and for zinc interaction by ages (Se1E2 with 74.33 kg at 90 days, for height at the withers, Zn1E2, averaging 91.33 cm). Fiber length for treatments Se1E1 and Se1E2 averaged 3 cm. For fiber diameter, treatments 1 (Se0E1) and Se1E1, group 1, and treatments Zn0E2 and Zn1E1, group 2, showed the best fiber quality ($P < 0.05$), averaging 28 microns. Live weight and fiber quality from mature animals based on supplementation with Se and Zn had beneficial effects, which improved phenotypical features of production, like live weight, though residues were found in 3-5 year old animals.

Key words: *south American camelids, fleece characterisitics, mineral nutrition, grazing, organic fluids*

INTRODUCTION

Alpaca and lama raising in Ecuadoran Paramo is made in the traditional or extensive way. Therefore, productivity is low due to several problems like, land owning, inappropriate basic nutrition, mineral deficiencies and unbalances, diseases, poor training and technical support, and inadequate marketing mechanisms (Reyes, 2009 and Vilca, 2011).

The highland soil lacks many minerals, such as, calcium, copper, phosphorus, and sodium; and locally, in magnesium, cobalt, selenium and zinc (Quispe et al., 2009). Selenium deficiency is a serious problem in Mexico and other areas of Latin America. The Ecuadoran volcanic infertile soils have large quantities of changeable sulphur. Consequently, the plants capture sulphur before selenium, and the animals that graze in the area also suffer selenium deficiency (Segovia, 2011; de Razo and Mc Dowell, 2013).

Cotopaxi is developing several alpaca projects for fiber production. However, does not have the competitive quality standards required by the industry, in comparison to Peru and Bolivia (Vilca, 2011).

The production and quality of alpaca fiber is being affected by the environment, genetics and the physiological state, especially undernourishment, because the animals are exposed to very low temperatures in the highlands. Alpacas have a thick fibrous fur, which has been observed to lose commercial value on some locations in the continent (Vilca, 2011; Pari, 2012; and Poissonnet, 2012).

Also, due to mineral-deficient nutrition, it is important to supplement with mineral salt and other microelements in the daily diet, according to a concentration study of those oligoelements in the grass, soil and blood.

The goal of the study was to evaluate the supplementation alternatives based on microelements (selenium and zinc), in relation to the phenotypical features of alpaca fiber production and growth (Huacaya breed) in the highland of Cotopaxi, Ecuador.

MATERIALS AND METHODS

This research was made in three alpaca (lama lama) farms in Cotopaxi, located on 2°11´ north latitude and 78° 14´ west longitude, and altitude of 2 790 meters above sea level, according to INEC.

Management and nutrition of animals grazing on native grass (graminaceae Holcus, Bromus, Dactylo, Poa and Lolium; and legumes, Trifolium and Vivia, to a lesser extent) is the traditional system for mothers and herds over 4 months old, using little balanced supplementation in adults, and some grain stalks (oat, barley, maize). Supplementation with zinc and selenium, as additional minerals in the diet was offered to measure their effects on height at the withers, weight, alpaca fiber diameter, and residual effects on blood, stools and urine.

The animals included were taken at random, and were weighed once a month, using a 100 kg balance. To measure height at the withers, the highest point over the soil was measured through the zoometric stick. Fiber length was measured using a ruler (cm). Fiber diameter was determined after cutting from the mid rib area, at the beginning and end of the research. Blood samples were drawn by femoral vein puncture (5-7 ml), using a vacutainer. The urine samples were collected with a Foley catheter attached to a urine collector. Atomic Absorbtion Spectrophotometry was used to measure the contents of selenium and zinc in blood, urine and stools, with a Pye Unicam.

Concerning the experimental design, the research factors were the micromineral doses (D), selenium (Se), and zinc (Zn), and alpaca ages (E) (Table 1).

A completely randomized design was used (CRD), with factorial arrangement (3 x 2) + (3 x 2). Three doses of selenium and three doses of zinc were analyzed for the two animal age groups, with three observations per treatment, for a single animal unit. To separate the means from each factor and treatment, the Tukey´s test (5%) was made in instances where statistic significance was observed.

RESULTS AND DISCUSSION

For the inhabitants of the Andes, over 2 500 meters above sea level, alpacas are an alternative for productive animal raising in areas with difficult access and management. However, reduced fertility rates, high mortality percents (especially in the herds), poor growth, and dry skin with scales are obstacles to overcome. Accordingly, fiber quality is low and income is poor. This issue has been demonstrated in works on alpaca fiber production and quality, in Ecuador and Peru (Apomayta *et al*., 1998; Gonzalez *et al*., 2004; del Rio, 2006; Frank *et al*., 2006; Mena *et al*., 2010) (Table 2).

Significant differences were observed ($P < 0.05$), where SelE2 showed the best response, averaging 74.33 kg; group 2, averaged 65.67 kg, where zinc had an increased weight effect on the animals. Treatment 4 was the best, probably due to the application of selenium. It coincides with reports by Ruiz *et al*. (2009), on the physiological role of selenium in the animal, determined by its role as a co-factor of different enzymes, like glutathione peroxidase (Table 3).

Treatments 3 (SelEl), and 4 (SelE2) had the best results ($P < 0.05$), averaging 3 cm. Some influence was observed on fiber length, due to the feed type supplied, and it coincided with reports from Gutierrez (2009), noting that apart from protein nutrition and quality, factors with a genetic origin like size and color of alpaca fiber growth and quality, were influenced by mineral supplementation of selenium and other microelements (Ancassi, 2012). This author also claimed that proper fiber growth during a year, was 12 - 14 cm.

In Peru, Hervas (2011) performed several serological diagnostics that resulted in important shortages of zinc and copper. They also explained that market-ready fleece growth must be 10-12 cm long every year, on average, and also highlighted that this indicator is dependent on animal management, which is affected by the type of nutrition, for which the supply of microelements has a significant influence (Table 4).

At the end of the research, significant effects were observed in the Se0El treatment, with the best response ($P < 0.05$), averaging 28 µm; along with the SelEl treatment, both within the selenium group, and were compared to treatments Zn0E2 and ZnlEl. The SelE2 and Se2E2 treatments had the highest values, averaging 31 µm. Alpaca fiber is made of proteins bound as chelates with minerals (Chaves, 2008; Guerrero *et al*., 2009; Hervas, 2011; de Razo and McDowell, 2013).

Del Razo and McDowell (2013) noted that the absorbsion and homeostasis processes of selenium and zinc at the cellular and organic levels have provided greater understanding to scientists. Their role as carriers located at the plasmatic and cellular membranes was unveiled, and they have developed specific paths to regulate nutrient availability and its interaction with the fiber tissue (Table 5).

The concentration of zinc in the blood is observed in the cells and plasma; most zinc is found in the red cells. Moreover, no studies have been made on the efficiency levels of zinc and selenium in camels. However, the Company of Chemical Clinics, recommends 0.20 and 0.42 ug ml^{-1} for selenium; whereas the reference value for zinc is 0.3 and 0.6 ug ml^{-1}.

The effect of treatments for the zinc and selenium levels in the blood of alpacas supplemented with microelements from treatment 6 (Se2E2) has the best average (0.53 ug ml^{-1}), in relation to treatment 1 (Se0El), averaging 0.33 ug ml^{-1}. At 90 days, treatment 6 (Se2E2) had an average of 0.51 ug ml^{-1}, in comparison to treatment 1 (Se0E1). The best treatment was the 1.5 cc, which coincided with reports by Unger and Chiape (2008); Cecana *et al*. (2008); Ruiz *et al*. (2009); and Quispe *et al*. (2009). When assessing the effect of the zinc dose, the result of the Zn2E2 treatment was 0.49 ug ml^{-1}, in relation to treatment 7, with 0.30 ug ml^{-1}, respectively. According to Ancassi (2012) and Del Razo and McDowell (2013), the absorption process of Zn goes from the intestinal lumen into the enterocyte, and transport goes from the cell and to the blood and other tissues, like fiber and fur.

The effects found in the paper on fiber improvement and its possible relation with genetic breeding and protein and mineral nutrition, favor fiber composition. They are similar to reports by Lupton *et al*. (2006) and Montes *et al*. (2008), when studying these features in Australian alpacas, well adapted to dry ecosystems, and animals from the Peruvian Andes, in the Huancavelica region, indicating regional or local effects in the fiber´s textile quality.

Similarly, this study coincides with research done by McGregor *et al*. (2004) and Mc Gregor (2006), in Australia, who evaluated the possible relation of several management, nutrition, race, and environmental factors to their morphological features, and found links to various indicators, like season, mineral supply, animal age, and to some extent, fur color (Table 6).

Generally, element residues depend on animal age, with zinc doses (Zn0) being the highest, at age (E2) 3-5 years. However, selenium had the least residue values in the general results, the highest one observed was dose (Se0), at age ((E2). For fiber length, the highest values were for treatments 3 and 4, in the first group, averaging 3 cm. Fiber has to grow over 7 cm every year to meet the requirements of the textile industry.

CONCLUSIONS

A positive effect was observed for live weight and fiber quality on mature animals, supplemented with the Se and Zn microelements, then enhanced with phenotypical features, like live weight. However, residues were observed in urine of animals aged 3-5 years.

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Table 1. Supplementation with microminerals

Dose (ml)	Treatments		Ages
	Selenium	Zinc	
0.0	Se0	Zn0	E1: 1-3 years
1.0	Se1	Zn1	
1.5	Se2	Zn2	
0.0	Se0	Zn0	E1: 3-5 years
1.0	Se1	Zn1	
1.5	Se2	Zn2	

Table 2. Effects of treatment on Alpaca weight

Treatments	0 days		30 days		60 days		90 days	
	Averages	Ranges	Averages	Ranges	Averages	Ranges	Averages	Ranges
Se0E1	51.33	b c	51.67	B	52.00	B	52.67	b
Se0E2	64.67	a b c	65.00	ab	65.33	Ab	66.00	ab
Se1E1	57.33	a b c	59.33	ab	61.67	ab	64.00	ab
Se1E2	71.67	a	72.67	a	73.00	a	74.33	a
Se2E1	58.33	a b c	57.67	ab	57.67	ab	59.33	ab
Se2E2	59.67	a b c	60.67	ab	62.00	ab	63.33	ab
Zn0E1	48	c	48.00	b	48.67	b	58.00	b

Zn0E2	67.33	a b	67.33	ab	68.00	ab	68.67	ab
Zn1E1	54.33	a b c	56.00	ab	57.00	ab	58.67	ab
Zn1E2	54	a b c	55.00	ab	56.67	ab	57.00	ab
Zn2E1	57	a b c	58.33	ab	59.00	ab	60.33	ab
Zn2E2	58	a b c	60.67	ab	63.33	ab	65.67	ab

a, b, c different letters represent significant differences (P < 0.05)

Table 3. Effects of treatments on fiber length

Treatments	30 days		60 days		90 days	
	Averages	Ranges	Averages	Ranges	Averages	Ranges
Se0E1	1.00	abc	2.17	ab	2.33	a
Se0E2	0.67	Nalidixic Ac.	1.67	a	2.17	a
Se1E1	1.17	ab	2.50	a	3.00	a
Se1E2	1.00	abc	2.17	ab	3.00	a
Se2E1	1.00	abc	2.33	a	2.83	a
Se2E2	0.93	bc	2.00	ab	2.33	a
Zn0E1	0.67	bc	1.17	bc	2.33	a
Zn0E2	0.50	c	1.00	c	2.00	b
Zn1E1	1.00	abc	2.33	ab	2.83	a
Zn1E2	1.00	abc	2.50	a	2.33	a
Zn2E1	1.17	ab	2.67	a	2.67	a
Zn2E2	1.33	a	2.50	a	2.83	a

Table 4. Effects of treatments on fiber diameter (microns)

Treatments	Averages
Se0E1	28.00 [a]
Se0E2	29.22[ab]
Se1E1	28.00[a]
Se1E2	31.00 c

Se2E1	29.22 bc
Se2E2	31.00 c
Zn0E1	31.00 c
Zn0E2	28.00 c
Zn1E1	28.00 c
Zn1E2	29.00 c
Zn2E1	28.11 c
Zn2E2	29.00 c

a, b, c different superscripts in the column indicate significant differences ($P < 0.05$)

Table 5. Effects of treatments on Se and Zn blood levels in Alpacas

Treatments	0 days		90 days	
	Averages	Ranges	Averages	Ranges
Se0E1	0.33	ab	0.35	ab
Se0E2	0.34	ab	0.41	ab
Se1E1	0.41	ab	0.42	ab
Se1E2	0.43	bc	0.48	ab
Se2E1	0.45	bc	0.48	a
Se2E2	0.53	ab	0.51	a
Zn0E1	0.25	c	0.30	ab
Zn0E2	0.22	c	0.31	ab
Zn1E1	0.33	bc	0.42	ab
Zn1E2	0.50	ab	0.33	ab
Zn2E1	0.43	ab	0.41	b
Zn2E2	0.60	A	0.49	a

Table 6 . Effects of treatments on Se and Zn levels in urine residues

Treatments	Averages	Ranges
Se0E1	1.01	a
Se0E2	0.88	ab
Se1E1	0.59	c
Se1E2	0.58	c
Se2E1	0.97	a
Se2E2	0.75	bc

Zn0E1	1.02	a
Zn0E2	1.05	a
Zn1E1	0.71	bc
Zn1E2	0.63	c
Zn2E1	0.98	a
Zn2E2	1.01	a

a, b, c, different spuperscripts in the column indicate significant differences ($P < 0.05$)