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Original

Castration influence on the chemical composition of alpaca (*Vicugna pacos*) meat

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ABSTRACT

Objective. Determine the influence of bilateral castration in young alpacas over the centesimal chemical composition and content in their meet. **Materials and methods**. A total of 20 male Huacaya breed animals aged about 1.5 years old, were studied in two groups: experimental and control with 10 animals each. The experimental one was subjected to bilateral castration and the control one remained "intact". The animals' feeding was based on natural pastures from the surrounding area under an extensive rearing system. After six months, the animals were slaughtered and muscle tissue samples were taken from five anatomical regions: neck, arm, ribs, back, and leg. Moisture was determined by oven drying to constant weight, total fat by Soxhlet method, crude protein by Kjeldahl method, ashes by muffle calcination, and cholesterol by the colorimetric method after fat extraction with chloroform/ methanol (2:1). **Results**. Fat content was higher in castrated animals (2.28%) than in the intact ones (1.82%) ($p \leq 0.01$) and varies among different anatomical regions ($p \leq 0.05$); humidity is higher in intact animals (76.14%) than in castrated ones (75.45%) ($p \leq 0.01$), but it was similar among different anatomical regions ($p > 0.05$); there is no statistical difference in protein, ash, and cholesterol content ($p > 0.05$) with a general average of 20.39%, 1.13%, and 55.56 mg/100 g, respectively. **Conclusion** Castration effect was evidenced on the centesimal composition of alpaca meat from young males by its fat content increase and humidity decrease.

Keywords*:* Alpacas; castration; meat composition; cholesterol (*Source: CAB*).

RESUMEN

Objetivo. Determinar la influencia de la castración de alpacas jóvenes sobre la composición centesimal y contenido de colesterol de su carne. **Materiales y métodos.** Con 20 animales machos, de 1.5 años de edad, de raza Huacaya se formaron grupos de 10 animales: experimental y control. Los del experimental, fueron sometidos a castración bilateral y los del control permanecieron "enteros". La

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alimentación de los animales fue en base a pastos naturales de la zona, bajo un sistema de crianza extensiva. Luego de seis meses, los animales fueron beneficiados y se tomaron muestras de tejido muscular de cinco regiones anatómicas: cuello, brazo, costillar, lomo y pierna. La humedad se determinó por desecación en estufa hasta peso constante, la grasa total por el método de Soxhlet, la proteína bruta por el método Kjeldahl, las cenizas por calcinación en mufla y el colesterol por el método colorimétrico, previa extracción de grasas con cloroformo/metanol (2:1). **Resultados**. El contenido de grasa es superior en los castrados (2.28%) que en los enteros (1.82%) ($p \leq 0.01$) y varía entre las distintas regiones anatómicas ($p \leq 0.05$); la humedad es mayor en enteros (76.14%) que en castrados (75.45%) ($p \leq 0.01$), pero similar entre las distintas las regiones anatómicas ($p > 0.05$); no hay diferencia estadística en el contenido de proteínas, cenizas y colesterol ($p > 0.05$), siendo el promedio general de 20.39%, 1.13% y 55.56 mg/100 g, respectivamente. **Conclusiones**. Se evidenció efecto de la castración sobre la composición centesimal de la carne de alpaca de machos jóvenes al incrementar el contenido graso y disminuir la humedad.

Palabras clave*:* Alpacas; castración; composición de la carne; colesterol (*Fuente: CAB*).

INTRODUCTION

Alpacas are domestic South American camelids from South America. Their rearing is carried out by Andean families since they are animals adapted to altitude. They play an important role in the population since they are the source of a high biological value protein, fur, and quality fiber. In addition, meat consumption is increasing in developed countries due to its low fat and cholesterol content compared to beef and sheep meats, becoming a great value product for local and international markets (1). In this regard, Popova et al (2), point out that alpaca and llama meats are alternative red meats since they produce lean carcasses. In this way, the alpaca contributes to the food security of high-altitude regions due to its ability to live in hostile climatic conditions, besides its having a digestive system adapted to consume fibrous and thorny plants (3). In recent years, interest in alpacas and research on them, as a valuable source of meat, have surpassed the borders of South American countries (2).

The castration of male animals is a widely practiced task in various species as a means to control male behavioral problems (they become less aggressive, more docile, and easy to handle), avoid unwanted mounts and pregnancies, remove undesirable odors, and improve meat texture (4). Orchiectomy prevents reproduction due to testicle suppression where germ cells are responsible for producing sex hormones such as testosterone; thus affecting general and sexual behavior (5).

Castration effects on certain meat characteristics are known in different cattle breeds. For example, the castration effect on meat quality of hypertrophied Piedmontese cattle was studied, finding that in the castrated ones, their meat had lower water content and higher protein and fat contents than in the intact males' meat (6). In another study on Hanwoo steers, weaning and castration ages were found to have only small effects on growth and carcass characteristics (7). Another study on the edible portion of the shoulder (muscle and fat) of lambs determined that castrated animals had a greater amount of total fat and cholesterol, the latter reducing with age (8).

In alpacas, little information exists about castration effect on chemical meat composition. For this reason, the study's objective was to determine the effect of castration on young male alpacas over centesimal chemical composition (moisture, proteins, lipids, and ashes) and cholesterol content in five anatomical muscle regions which correspond to commercial cuts from the region.

In alpacas, the puberty age has not yet been well defined. Although there are male alpacas that show sexual interest in females at one year old, only 8% showed complete preputial adhesions release. However, at two years old, 70% are capable of copulating and after three years, all males show complete adhesion release (9). This, coupled with the animal availability were the reasons for choosing one-year-old animals for the study.

MATERIAL AND METHODS

Location. The study was carried out at "La Raya" Experimental Center at Universidad Nacional del Altiplano-Puno, Santa Rosa, Melgar, Puno, located at an altitude of 4136 to 5740 m.a.s.l., between geographic coordinates 14°13'33" S and 70°57'12" W. The climate is varied with temperatures of 14.16°C and -14.88°C and rainfall of 525.7 mm. The area corresponds to the Humid Puna agroecological zone, containing grasslands with a heterogeneous distribution and predominant species were: *Festuca dolichophyla, Muhlembergia fastigiata, Stipa ichu, Bromus unioloides, Calamagrostis sp, Alchemilla pinnata, Hordeum muticum, Trifolium amabili*, among others.

Experimental units. Twenty male Huacaya breed alpacas aged one and a half years old were selected; from these, 10 were castrated (experimental group) and 10 remained uncastrated ("intact") (control group). The handling and feeding of animals during the experimental period (April-September) were based on natural pastures under an extensive rearing system.

Bilateral castration. Castrations were done by surgical procedure with local anesthesia to minimize animal stress. After removing the testicles, a healing agent was applied to the wound and a long-acting antibiotic was administered via intramuscular. The castrated animals were observed for three days with no secondary complications; thus, they recovered completely and joined the respective herd.

Benefit, skinning, and evisceration. Six months after castration, the 20 animals were processed by slaughterers using the traditional technique for slaughtering alpacas practiced in the region and taking into consideration the Animal Slaughtering Sanitary Regulations from Peruvian Agrarian Health Service Supply which involve neck cutting, main blood vessels, trachea, esophagus, and spinal cord at the atlanto-occipital joint. The head and legs were separated and afterwards the skinning, evisceration, and entire carcass separation were processed.

Sampling. Approximately 30 g samples per anatomical region were taken after 30 min carcass airing which were placed in polyethylene bags in a refrigerated box. The sampled muscles and the cuts were: brachiocephalic (neck), *Longíssimus dorsi* (rib), *transversus spinosus* (loin), triceps brachii (arm), and semitendinosus (leg).

Chemical analysis. The centesimal determination of the samples was performed in the Bromatology Laboratory of the Veterinary Medicine and Zootechnics Faculty from Altiplano National University through standardized procedures. Moisture content was determined by drying in a forced hot air oven until constant weight. Total fat was determined by Soxhlet method until constant weight. Total protein was quantified by Kjeldahl method and ash content by muffle calcination at 550°C. (10). Cholesterol was determined by colorimetry using lipids extracted with a chloroform/methanol mixture (2:1) (11). Analyses were performed in triplicate.

Data processing and statistical analysis. The data was evaluated by using the Kolmogorov-Smirnov test to verify its normality. For variance homogeneity and mean statistical differences, the Factorial model 2 x 5 (condition and anatomical region) was used under a completely randomized design. The data was organized in an Excel sheet and processed through InfoStat statistical package.

RESULTS

Table 1 shows the centesimal chemical composition results and Table 2 cholesterol content from Intact and castrated alpacas according to the anatomical region.

As it can be seen, the moisture content is higher in intact animals (76.14%) than in castrated ones (75.45%) ($p \leq 0.01$); however, there is no difference between anatomical sections ($p > 0.05$). In contrast, the fat content is higher in castrated animals (2.28%) than Intact ones (1.82%) ($p \leq 0.01$) and varies between cuts ($p \leq 0.05$). In protein, ash, and cholesterol contents, no differences were found between intact and castrated ones, nor among anatomical regions ($p > 0.05$).

Table 1. Centesimal chemical composition in muscle tissue from young alpacas Huacaya breed according to condition and anatomical region.

Condition	Anatomical region	n	Centesimal composition (%)			
			Moisture	Protein	Fat	Ash
Intact	Neck	10	76.05	20.39	1.85	1.17
	Arm	10	75.88	20.18	2.18	1.11
	Ribs	10	76.30	19.93	1.89	1.12
	Back	10	76.40	20.34	1.47	1.13
	Leg	10	76.07	20.49	1.68	1.11
	Total	**50**	**76.14** [a]	**20.27** [a]	**1.82** [b]	**1.13** [a]
Castrated	Neck	10	75.67	20.26	2.29	1.22
	Arm	10	75.53	20.47	2.19	1.15
	Ribs	10	75.07	20.52	2.60	1.10
	Back	10	75.85	20.37	1.99	1.10
	Leg	10	75.15	20.90	2.31	1.10
	Total	**50**	**75.45** [b]	**20.50** [a]	**2.28** [a]	**1.13** [a]
TOTAL		**100**	**75.80**	**20.39**	**2.04**	**1.13**

Tabla 2. Cholesterol content (mg/100 g) in young Huacaya alpacas' muscle tissue according to condition and anatomical region.

Condition	Anatomical region	n	Cholesterol (mg/100 g) Mean ± S.D.
Intact	Neck	10	53.61 ± 1.89
	Arm	10	55.00 ± 2.25
	Ribs	10	56.55 ± 1.31
	Back	10	55.76 ± 3.24
	Leg	10	55.37 ± 1.70
	Total	**50**	**55.26 ± 2.22** [a]
Castrated	Neck	10	54.34 ± 2.04
	Arm	10	55.64 ± 2.94
	Ribs	10	56.97 ± 1.81
	Back	10	56.15 ± 3.31
	Leg	10	56.18 ± 1.09
	Total	**50**	**55.86 ± 2.34** [a]
Total		**100**	**55.56 ± 2.28**

DISCUSSION

The higher fat content in castrated ones would be attributed to a drastic decrease in testosterone, a hormone that fulfills several functions in males. In addition to causing permanent sterility and secondary sexual characteristics, it improves fattening ability and meat quality by increasing fat storage as androgens inhibit the ability of certain fat cells to store lipids by blocking a signal transduction pathway. Purchas et al (12) indicate that castration in male cattle improves the color, texture, softness, juiciness, and flavor of meat through its incremental effect on intramuscular fat, a fact that would also occur in alpacas. Schreurs et al (13) indicate that hormonal differences (between castrated and intact) affect muscle composition since, in males, testosterone favors a rapid formation of muscle against the fat deposit, producing meat with a lower fat content in comparison to females or castrated males, which in turn affects physicochemical and sensory characteristics of meat. Similarly, Cruz et al (8) in their study on Santa Inés lambs, indicate that the edible portion of the shoulder in castrated ones had a higher amount of total lipids.

Many factors influence meat quality, but the fat content is the parameter with the greatest effect and an amount below 2% could be responsible for rejection by consumers because the fat present in meat contributes to texture, juiciness, and flavor (14). In this regard, De Lima Júnior et al (15), indicate that castration is an extrinsic factor that influences meat quality. In this sense, it would be advisable to castrate alpacas to increase their fat content and improve their quality and better acceptance.

Compared to other livestock species, alpaca meat contains protein levels similar to those of lambs (20.8%), pigs (20.5%), and calves (20.2%); although the fat content of alpaca meat is lower than the one in lambs (4.40%), pigs (5.41%) and calves (2.87%) (16). Compared with other studies on alpacas, the results are

consistent with most of them. Thus, for example, Cristofanelli et al (17) report a content of 73.64% moisture, 23.33% protein, 0.49% fat, and 2.54% ash after analyzing *Longissimus thoracis* and *Quadratus lumborum* muscle in alpacas. The differences are due to some factors such as age, sex, season, and diet, among others.

Concerning the results with alpaca congeners, Mamani-Linares et al (18) in llama meat determined a moisture content of 73.34%, protein 23.88%, fat 1.56%, and ashes 1.19%, noting that protein content is superior to alpacas, as well as moisture content is lower. This difference could be attributed to species, and age since these authors analyzed the meat of adult animals; and, as it is known, the water content in young animals is higher than in adults. Kadim et al (19), studied the chemical composition of camel meat, finding 71% moisture, 21.4% protein, 4.4 fat, and 1.1 ashes, results slightly similar to those of alpacas in this study. except for fat content. Similarly, Zarrin et al (3) mention that Bactrian camel meat contains 17 to 21% protein, 1.8 to 3.8% fat, and 0.9 to 1.1% minerals, ranges in which the results are found for alpaca meat.

Regarding cholesterol, the results show that it is similar in castrated and non-castrated; and, among different anatomical regions. Although Lee et al (20) mention that castration affects meat chemical composition due to changes in animal hormonal status, it is likely that the similarity is because the animals under study were very young and testosterone action is not yet as evident as in adults, since they are the ones that demand higher levels of cholesterol for hormones synthesis. This result is supported by Rule et al (21) when studying cholesterol in steer meat, which showed that castration did not affect cholesterol content in meat from young cattle.

The mean cholesterol in alpaca meat was 55.56 mg/100 g of muscle tissue, a result slightly higher than that reported by Cristofanelli et al (17), who found 51 mg/100 g in *L. dorsi* muscle. Compared to other species, this value is lower, a characteristic that favors its consumption. These qualities are particularly attractive for local and international markets, representing a substantial income for small and medium local producers (18). Studies conducted in Australia have also reported that alpaca meat has a low fat coating, which makes these carcasses susceptible to cold-induced shortening during processing (22).

In conclusion, a statistical difference was found between chemical composition in alpaca meat from young castrated and non-castrated animals. Moisture is higher in intact animals (76.14%) than in castrated ones (75.45%), and fat content is higher (2.28%) in castrated ones than in intact animals (1.82%). No differences were found in protein content (20.39%), ash (1.13%), and cholesterol (55.56 mg/100 g), nor between anatomical regions.

Conflict of interests

We declare all the authors that during the realization and preparation of this work there was no conflict of interest.

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Contribution Information

Pedro Ubaldo Coila Añasco performed the following roles: conceptualization, methodology, formal analysis, research, writing, and resources.
Domingo Alberto Ruelas Calloapaza performed the following roles: formal analysis, resources, and supervision.
Diana Sánchez Herencia performed the following roles: methodology, formal analysis, research, and resources.
César Augusto Olaguivel Flores performed the following roles: methodology, formal analysis, research and resources.
Kelly Anely Coila Coaquira performed the following roles: formal analysis, research, resources, and writing.

Ethical/Legal Aspects

The study did not incur any ethical or legal problems.

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