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Nutrient composition and technological quality of meat from alpacas reared in Peru

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ABSTRACT

The aim of this study was to increase the knowledge on alpaca meat quality characteristics. Twenty Huacaya breed alpacas, reared under a traditional unspecialized production system at the Andean region of Peru, were slaughtered at ages between 18 and 24 months. Analyses were carried out on *Longissimus thoracis* and *lumborum* muscle (*LTL*M), unless otherwise specified. These included composition parameters: moisture, fat, protein, ash, minerals, amino acids, fatty acid profile (of both *LTL*M and perirenal fat), retinol and tocopherol concentrations and myoglobin and collagen contents. Other meat quality parameters were evaluated: pH, colour, water holding capacity and Warner–Bratzler shear-force. Alpaca *LTL*M was characterized by a low intramuscular fat content and mineral and amino acid compositions, polyunsaturated to saturated fatty acids ratio and conjugated linoleic acid content comparable to those found for beef and sheep meat. However, specifically, alpaca meat showed a relatively high $n-6$ to $n-3$ (3.7) ratio and low vitamin E concentration. Values of alpaca meat technological quality parameters were in the ranges reported for more conventional red meats, the exception being a lower b^* value.

1. Introduction

Alpaca (*Lama pacos*) is one of the domesticated South American camelids who's natural habitat is localized in the Altiplano, the high Andean zone extending through Bolivia, Peru, Argentina and Chile. Alpacas are reared for their fibre and meat using unspecialized production systems (Aréstegui, 2005), in which alpacas are bred to thrive on the tough vegetation of that zone at altitudes over 4000 m above sea level (Neely, Taylor, Prosser, & Hamlyn, 2001).

Alpacas represent an important meat resource for rural Andean families (Fairfield, 2006). In Peru, the number of alpacas annually slaughtered is around half a million producing more than 11,000,000 kg of meat (Hack, 2001) – the alpaca-carcass dressing percentage expected is at least 50%, with carcass weight averaging around 23 kg.

The main acceptability problems of alpaca meat appear to be related to prejudices on the supply and demand sides, involving hygiene and safety issues (poor meat hygiene and the presence of *Sarcocystis aucheniae*), eating quality and socio-cultural aspects (Fairfield, 2006). According to Hack (2001), not only is alpaca meat consumed locally in Andean rural sectors, but the meat of healthy and young alpacas is demanded by consumers from upper-income sectors. The preferred animals are those up to two years of age, which is partially explained as, at this early age, meat is tender and a much lower number of alpacas are affected by *Sarcocystis*. However, most alpacas in Peru are slaughtered at 7–8 years of age, due to the small producers' reluctance to sacrifice young animals (Fairfield, 2006).

In recent publications the quality of alpaca meat for human consumption was evaluated. Steele, Cox, Hope, Robinson, and Hawkins, (2006) studied the effect of age (between 3 and 5 years) and castration on proximate composition of male alpaca meat and found a positive effect of both factors on fat content. In addition, Cristofanelli, Antonini, Torres, Polidori, and Renieri (2004, 2005) studied and compared several carcass and meat quality characteristics of alpacas and llamas (*Lama glama*) slaughtered at 25 months of age. These authors stated that llamas were more favourable than alpacas for meat production. Thus, carcasses of llamas showed both higher carcass weights and higher proportion of muscle than those of alpacas, although the dressing percentage was more favourable for alpaca. These studies also revealed that alpaca and llama meat showed remarkably low intramuscular fat and cholesterol contents. Moreover, mineral contents and shear-force values of alpaca and llama meats were studied recently (Polidori, Antonini, Torres, Beghelli, & Renieri, 2007a).

Cristofanelli et al. (2004), based on the quality characteristics of alpaca carcass and meat, and considering both the socio-economic conditions of local populations in the Andean regions and the high added-value obtained in richer countries for the alpaca natural fibre, suggested that alpaca should be bred as a fibre animal rather than a meat animal. On the other hand, in spite of the good reasons

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for promotion of fibre sector, Fairfield (2006) stated that alpaca meat production should also be promoted, since small producers need to be able to benefit from their animals in a variety of complementary ways.

Apart from the above-mentioned studies, no further information could be found on the physico-chemical quality of alpaca meat, as stated by Saadoun and Cabrera (2008). Therefore, the aim of this study was to contribute to the knowledge of the composition and technological quality characteristics of alpaca meat.

2. Materials and methods

2.1. Sample collection

The study involved 20 Huacaya breed alpacas 18–24 months old, reared under extensive conditions on pasture characteristic of the Peruvian Andean highlands – these animals can be classified as young males and females produced on pasture, exclusively forage fed, according to the United Nations Economic Commission for Europe (UNECE) standard for Alpaca and Llama meat (2006). After two weeks of forage and grain feeding in feedlot in Lima, animals were conventionally slaughtered in conformity with Peruvian regulation. The carcasses were obtained by eliminating the head (cut at the occipital–atlantoidal articulation), feet (cut at tarsal–metatarsal and carpal–metacarpal articulations), skin, and viscera (except for the kidney and perirenal fat); macroscopical sarcocysts were not found in muscles by visual inspection. Carcasses were stored for 24 h in a cold room (4 °C) and then split into two sides. *Longissimus thoracis* and *lumborum* muscle (*LTL*M) was dissected and collected from the left-hand side of each carcass. The muscle portion between the 6th and the 10th thoracic vertebrae was homogenized. A part was lyophilised, and then, vacuum-packed and frozen (−40 °C) until further chemical analysis (2 months). The other part was used immediately after muscle dissection for expressible juice determination. The portion from the 10th to the last thoracic vertebrae was used immediately for pH and colour studies and, after maturation at 4 °C for 3 days, for cooking loss and texture. In addition, fat around the kidney from each left-hand carcass was sampled and frozen at −40 °C for 2 months until fatty acid (FA) analysis.

2.2. Chemical composition analysis

Moisture, fat, protein and ash contents were estimated according to methods recommended by the AOAC (AOAC, 1999, chp. 39) – Official methods nos. 950.46, 991.36, 981.10 and 920.153, respectively. For mineral content, aliquots of approximately 0.25 g (±0.01) of lyophilised muscle sample were accurately weighed, and digested with concentrated HNO_3 in tightly closed screw-cap glass tubes and mineral contents were determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES) according as described previously (Osorio et al., 2007a).

Amino acid contents were assessed by reverse-phase high pressure liquid chromatography. Firstly, the hydrolysis of proteins of meat samples (0.1 g) was carried out in screw-capped tubes, using 6 M HCl acid (5 ml) at 110 °C for 24 h. Afterwards, 1-ml aliquots of a standard of free amino acids (Alltech Grom, Rottenburg–Hailfingen, Germany) or the hydrolyzed samples were derivatized with phenylisothiocyanate (PITC) as described by Bidlingmeyer, Cohen, and Tarvin (1984). The chromatographic system was composed of a 2690-model separation module (Waters Corporation, Milford, MA, USA), equipped with a Waters 996 Photodiode Array detector and a C18 Symmetry® (Waters) column (250 mm long × 4.6 mm i.d. and 5 μm pore size). The column temperature was maintained at 50 °C with a SP8792 column heater (Spectra-Physics, San Jose, CA, USA). Samples were injected in a volume of 20 μl. The solvent system consisted of two eluents: (A) 0.14 M pH 6.5 sodium acetate buffer and (B) 60% (v/v) acetonitrile in water. The solvent gradient was as follows: 0 min, 100%A; 20 min, 78%A–22%B; 40 min, 54%A–46%B; 42 min, 100%B; 44 min, 100%A. Elutions were followed at 254 nm, spectra were taken between 205 and 400 nm.

For analysis of retinol, tocopherols and FA of *LTL*M samples, intramuscular fat (IMF) was first extracted from 10 g of lyophilised sample previously re-hydrated with 30 ml of water for 12 h, as described by Bligh and Dyer (1959). Vitamins were then extracted from the IMF after saponification and their contents were determined by reverse-phase high pressure liquid chromatography (Osorio, Zumalacárregui, Cabeza, Figueira, & Mateo, 2008). Haem pigment content was estimated as described by Hornsey (1956) and hydroxyproline (collagen) content was measured colorimetrically according to AOAC (1999, Chp. 39) – Official method 990.26.

Finally, for FA determination, 30–50 mg aliquots of the previously extracted IMF or the homogenized PRF samples were used for the methylation of the FA with 5% methanolic HCl (Carrapiso, Timón, Petrón, Tejeda, & García, 2000). Gas chromatographic analysis of FAME was performed as described previously (Osorio, Zumalacárregui, Figueira, & Mateo, 2007b). The individual fatty acid contents were expressed as g 100 g^{-1} total fatty acids.

2.3. Analysis of meat quality parameters

The pH, meat colour and expressible juice were measured 24 h after slaughter. For pH measurement, a pH meter probe was inserted into the *LTL*M (at the level of the 13th thoracic vertebrae and 2.5 cm below the dorsal surface). Colour was determined on the transversal surface of the *LTL*M, just after the last thoracic vertebra with a Minolta (CR-400) chromameter (Konica–Minolta, Osaka, Japan). Colour measures were taken in the CIE $L^*a^*b^*$ colour space (illuminant: D65; visual angle: 10°; SCI mode; 11-mm aperture for illumination and 8 mm for measurement; chromometer was calibrated with the white calibration tile provided with the equipment), as described by Honikel (1997).

Expressible juice was determined according to a modification of the Grau and Hamm (1957) method. Before homogenization, duplicate 300-mg samples of each *LTL*M sample were weighed, placed over a previously weighed Whatman no. 1 filter paper (Whatman International Ltd., Kent, UK) and pressed between two rigid plastic plates, using a 1.000 kg weight, for 5 min. Afterwards, the muscle samples were removed, filters were reweighed and the increase in weight, which corresponds to the juice loss, was expressed in terms of percentage of the initial meat weight.

For cooking loss and shear-force determinations, the above-mentioned muscle portions, maturated (at 4 °C for 3 days), were cooked in a water bath at 75 °C, to a core temperature of 70 °C; afterwards, cooking loss was obtained (Honikel, 1997). Then, two to three rectangular prisms (1 cm^2 × 3 cm long), parallel to muscle fibre orientation, were obtained from each cooked sample and shear-force was evaluated using a QTS-25 texture analyzer (Brookfield Engineering Laboratories, Inc., Middleboro, Massachusetts, USA) equipped with a Warner-Bratzler device, with a 50 mm min^{-1} cross head speed, using a 25-kg load cell, with the sample prisms being sheared at right angles to the fibre axis (Honikel, 1997).

2.4. Statistical analysis

Statistical analyses were performed using STATISTICA for Windows (StatSoft Inc., 2001). Effects of fat deposit (two groups) on FA contents were studied by one-way analysis of variance.