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Effects of genotype and slaughter weight on the meat quality of Criollo Cordobes and Anglonubian kids produced under extensive feeding conditions

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ABSTRACT

Physicochemical and organoleptic characteristics of meat (*longissimus* muscle) from Criollo Cordobes (CC) and Anglonubian (AN) suckling kids were analysed to determine the effects of genotype and slaughter weight. Forty suckling entire male kids, 20 CC and 20 AN were assigned to two age/slaughter weight groups (I: 60 + 2 days old and ⩽11 kg, and II: 90 + 2 days old and >11 kg). Colour, shear force and cholesterol levels of meat were affected by breed. Tenderness decreased and cholesterol increased with age/slaughter weight. Fatty acid profiles were affected primarily by genotype. The sensory attributes were perceived as medium-high intensity, and meat from CC and AN goat kids was valued as tender. However, initial tenderness and connective tissue varied with genotype. The main effect due to the increase in age/slaughter weight was a decrease in tenderness (initial and overall), as observed for instrumental shear force.

1. Introduction

Meat quality is important for consumers when it comes to making purchasing decisions. Meat from goats has gained acceptance mainly because of its low-fat content, especially in developed countries. Also, cholesterol content (62–65 vs 73–78 mg/85 g meat) and saturated fatty acid levels (0.79–1.01 vs 6.8–8.7 g/85 g meat) of cooked goat meat are lower when compared to other red meats (USDA, 1989). The content and the amount of fatty acid saturation can affect the human health and the degree of fat firmness, which influences the value and acceptability of meat products (Perry, Nicholls, & Thompson, 1998). On the other hand, the colour, tenderness and sensory properties are important in affecting meat acceptability. Several reports have been published on the characteristics of goat meat and factors that influence its composition and acceptability (Park & Washington, 1993; Cifuni, Napolitano, Pacelli, Riviezzi, & Girolami, 2000; Velasco et al., 2001).

The Argentinean goat population is approximately 4.4 million (SAGPyA, 2005) distributed throughout the country but located primarily (55% of the total livestock) in the north and central zones. The central provinces, such as Cordoba (approximately 174,000 goats), are important goat meat producing areas. Criollo Cordobes (CC) goats represent a local genotype obtained by adaptation of the Creole goats (Maubecin, 1976) to the environmental conditions of Cordoba, it is the most common goat breed in this region (70%), and its main commercial product is the kid. Currently milk production increased after the introduction of dairy breeds, mainly Anglonubian (AN), whose male kids are destined for meat production (Maubecin, 1976). Therefore the main sources of goat meat in Argentina are CC and AN goat kids. Traditionally, kids have been slaughtered at 3–7 months old and 12–15 kg carcass weight. Recently, the market demands younger animals (30–65 days old and 6–11 kg liveweight; Arias & Alonso, 2002), because the meat from these young suckling kids is considered a delicacy. However, Sormunen-Cristina and Kangasmäki (2000) suggested that the best goat meat is produced by 3–6 month old kids, whose meat is nearly fatless and light in colour. However, meat characteristics of these two breeds, as well as the effects of reducing their age/weight at slaughter, have not been studied to date.

Therefore, the objective of this study was to determine the effects of genotype and slaughter weight on the physicochemical and organoleptic characteristics of meat from CC and AN kids.

2. Materials and methods

2.1. Animal management

The study was conducted at the Faculty of Agronomy and Veterinary (University National of Rio Cuarto, Cordoba, Argentina) (latitude 29–35°S, and longitude 61–65°O).

On the basis of weight and age, a total of 40 entire male goat kids (20 CC and 20 AN) were selected at weaning (60–90 days of age and 9–13 kg of live weight) from two commercial goat farms

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in Cordoba (Argentina). Adults were fed on pastures without concentrate supplements (extensive system). Kids were reared according to the traditional system of the region: kept with their does and suckling until slaughter. Kids were assigned to one of two groups: I (60 + 2 days old and $\geqslant$11 kg) and II (90 + 3 days old and >11 kg). When kids reached the predetermined age/slaughter weight, they were separated from their dams and transported to the abattoir (5 km away). Immediately after arrival at the abattoir, kids were kept in covered yards and then fasted for 12 h with free access to water. Kids were weighed immediately prior to slaughter (live weight at slaughter; LWS), stunned using a captive bolt pistol and dressed according to method of Colomer-Rocher, Fehr, Delfa, and Sierra (1988). Warm carcasses were weighed (hot carcass weight; HCW), hung by the Achilles' tendon, held at room temperature (12 ± 2 °C) for 6 h, to avoid cold shortening, and then chilled at 2 °C (±2 °C) until 24 h *post-mortem*. The gastro-intestinal content was weighed, and empty body weight (EBW) was calculated by deducting the weight of digesta from the fasted live weight at slaughter. Hot dressed yield (HDY) was calculated as (HCW/EBW) × 100. After chilling, the carcasses were split down the dorsal midline, and *longissimus thoracis et lumborum* (LTL) muscle was removed from the left side of carcasses, and separately vacuum packaged, aged for 72 h and frozen and stored at −20 °C for up to 1 week, prior physicochemical and sensory evaluations. The day before the analysis, the samples were thawed overnight at 4–5 °C.

2.2. Physical analysis

Before packaging, meat colour and pH were determined from the LTL muscle at 8 ± 2 °C. The ultimate pH values (pH_{24}, measured at 24 h after slaughter) was measured directly in LTL muscle (at the 12–13th rib site) using a penetrating glass electrode connected to a portable CRISON 506 pH-meter (Crison Instruments, SA, Barcelona, Spain). Three measurements were taken for each carcass. Muscle colour was evaluated at the same site as for pH_{24} and after cutting the muscle surface to allow it to bloom for 1 h at 3 °C in a plastic tray covered with a gas permeable film. Then three colour was measurements were taken, using the CIE-L^*, a^*, b^* system, by a chromometer (ByK Gardner Colour View, model 9000, USA) following the recommendations (standard illuminant D65 and 10° standard angle observer) of AMSA (1991). Chroma or saturation ($(a^{*2} + b^{*2})^{1/2}$) was calculated using a^* and b^* values according to Wyszecki and Stiles (1982). Values were registered from three different locations on the upper side of the steaks. *Longissimus thoracis* (LT) and *longissimus lumborum* (LL) muscles were collected for subsequent physicochemical and sensory analysis, respectively.

Water holding capacity (WHC), expressed as percentage of liquid expelled, was determined following the filter paper press methodology described by Zamorano and Gambaruto (1997). For determination of cooking loss and shear force (WBS) values, samples were weighed and then cooked into a plastic bag in a water bath at 75 °C until an internal temperature of 71 °C was achieved. After cooling, the samples were taken from the bags, dried with filter paper and reweighed. Cooking loss was expressed as the percentage loss related to the initial weight. Then 3–5 muscle cores (1 cm × 1 cm × 3 cm) were cut parallel to the long axis of the muscle fibres, and WBS values were taken on the cores using an Instron apparatus (Instron Ltd., UK) equipped with a Warner–Bratzler shear device, as in AMSA (1995). The texture analyzer was set with a 25 kg load cell and a crosshead speed of 200 mm/min.

2.3. Cholesterol and fatty acid analysis

Total intramuscular fat (IMF) content of LT muscle (from 10 g of meat) was determined according to official methods (AOAC, 1992) by using a Tekator analyzer (Foss Tekator AB Soxtec 2050). IMF for fatty acid and cholesterol determinations was extracted (from 5 g of meat) as described by Folch, Lees, and Stanley (1957). Total cholesterol was measured after saponification with 4% KOH in ethanol absolute, using an enzymatic and colorimetric reactive (BioSystem S.A.). Fatty acid methyl esters were prepared according to the method of Pariza, Park, and Cook (2001) and measured using a chromatograph (Chrompack CP 900) equipped with a flame ionization detector and fitted with a silica capillary column CP-Sil 88 (100 m, 0.25 mm i.d., 0.2 μm film thickness, Chrompack Inc., Middleburg, The Netherlands), using N_2 as carrier gas (2.5 psi). The oven temperature was programmed at 70 °C for 4 min, increased from 70 to 170 °C at a rate of 13 °C/min and then increases from 170 to 200 °C at 1 °C/min. The injection port and detector temperature were maintained at 250 °C. Tricosanoic acid methyl ester (C23:0 ME) at 10 mg/ml was used as an internal standard. Individual fatty acids were identified by comparing their retention times with those of an authenticated standard fatty acid mix Supelco 37 (Sigma Chemical Co. Ltd., Poole, UK). Individual fatty acids were corrected by their relative response factor (using the value of the internal standard) and expressed as a percentage of total fatty acids identified. Fatty acids were grouped as follows: saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA). The following ratios were calculated: PUFA/SFA, $n-6/n-3$ and 18:0 + 18:1/16:0.

2.4. Sensory analysis

Sensory evaluation was carried out on whole LL muscle (~100 g) samples by six trained panellists. Samples were cooked using the same cooking method as for shear force measurements. Every steak was then trimmed of any external connective tissue, cut into approximately 1 × 1 cm sub-samples, transferred into a pre-warmed glass beaker, covered and placed into an oven at 60 °C to equilibrate their temperature prior to being served. Samples were coded and the serving sequence was randomised. The attributes were assessed using a nine-point scale (IRAM, 1985; AMSA, 1995) for flavour intensity (9 = extremely intense; 1 = extremely bland); initial and overall tenderness (9 = extremely tender; 1 = extremely tough); juiciness (9 = extremely juicy; 1 = extremely dry); aroma (9 = extremely desirable; 1 = extremely undesirable); and amount of connective tissue (9 = no perceptible; 1 = abundant perceptible).

2.5. Statistical analysis

The effects of genotype and slaughter weight group on meat quality and fatty acid profiles of intramuscular fat were analysed by ANOVA using the General Linear Model (GLM) procedures of the Statistica statistical package (Statistica, 2001). No significant genotype by slaughter weight interaction was noted for the parameters evaluated in this study. Therefore only main effects have been presented and discussed.

3. Results and discussion

3.1. Carcass quality

Table 1 shows LWS, EBW, HCW and HDY values for CC and AN kids. Similar results have previously been reported for suckling kids in Argentina (Gallinger, Dayenoff, & Garriz, 1994; Rossanigo, Frigerio, & Silva Colomer, 1996; Leguiza, Chagra, & Vera, 2001; De Gea, Petryna, Mellano, Bonvillani, & Turiello, 2005; Domingo, Abad, Lanari, & Bidinost, 2008; Zimerman, Domingo, & Lanari, 2008). However, HDY values reported in this study were higher than those reported by other authors (Johnson, McGowan, Nurse,