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Effects of goat milk or milk replacer diet on meat quality and fat composition of suckling goat kids

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Abstract

The effects of a diet with goat milk "GM" or milk replacer "MR" on the meat quality and fat composition of suckling Murciano-Granadina kids were studied. MR consisted of powdered skimmed milk, coconut oil and fat, and cereal products and by-products. Raw meat quality (moisture, protein, lipids, ash, collagen, cholesterol, haem pigments, CIELab colour, pH and water retention capacity), fatty acid "FA" composition and eating quality of cooked meat (odour, flavour and texture) were determined. Diet had only a slight effect on raw meat quality but had a pronounced effect on fatty acid composition and eating quality of cooked meat. MR diet increased the water/protein proportion in the muscle. The saturated/unsaturated FA ratio in GM and MR fat was 0.94 and 2.27, respectively. The major FA in GM and MR fat were C16:0 and C18:1, respectively. Short-chain C4–C12 hardly accumulated in the adipose tissue of suckling kid, increasing the relative percentages of C14–C20. This effect was more pronounced in MR fat, due to the fact that MR contained more short-chain fatty acids than GM. MR diet gave cooked meat a more intense characteristic goat meat odour and flavour, more tenderness and more juiciness than the natural suckling diet. This fact could be related to differences in meat and fat composition.

1. Introduction

The meat of suckling goat kids (fed solely with goat milk or milk replacer) is highly valued in Spain. In Spanish specialist dairy goat farms (Murciano-Granadina, Malagueña and Canaria breeds), the kids are usually separated from their mothers, and fed with milk replacer for slaughter at less than 8 kg to provide the meat. These milk replacers are normally based on cow's milk, cereals and vegetable fat. This reduces feed costs and increases the growth of the kids (Potchoiba, Lu, Pinkerton, & Sahlu, 1990). However, some farmers choose to feed the kids with natural goat milk, believing that this increases meat quality. However, there is limited information available on this subject.

The raw meat quality and fat composition of the suckling kids of Alpine, Greek, Verata, Girghetana and Canaria breeds (Marichal, Castro, Capote, Zamorano, & Argüello, 2003; Potchoiba et al., 1990; Rojas et al., 1994; Todaro et al., 2002; Zygoyiannis, Kufidis, Katsaounis, & Phillips, 1992; respectively) has been studied. The meat of kids is very lean, with about 20% protein and just 1% intra-muscular fat. Age and weight at slaughter have little effect on the composition of the meat at such an early age (Marichal et al., 2003; Todaro et al., 2002). Raw meat from suckling kid is paler, retains less water and needs less shear force than raw meat from adult goats (Marichal et al., 2003). Most of the fat in the kid carcass is in perirenal and subcutaneous deposits (Marichal et al., 2003; Todaro et al., 2002). The major fatty acids in the fat are C18:1, C18:0 and C16:0 (Potchoiba et al., 1990; Rojas et al., 1994; Todaro et al., 2002; Zygoyiannis et al., 1992). The fatty acid profile in depot fat of kids usually reflects the fatty acid profile of the diet, although

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they hardly accumulate short chain fatty acids in the adipose tissue. The saturated/unsaturated fatty acid ratio in the fat varies between 1 and 2 (Potchoiba et al., 1990; Rojas et al., 1994; Todaro et al., 2002; Yeom, Van Trierum, Lee, & Beynen, 2003; Zygoyiannis et al., 1992). Although there are no sensory studies about the effects of lactation on goat kid meat, considering the above, it is probable that diet can affect some sensory attributes of the cooked meat. The objective of this study was to determine the effect of diet (milk or milk replacer) on the meat quality and fat composition of suckling kids of the Murciano-Granadina breed.

2. Materials and methods

2.1. Animals and rearing

Thrity-six Murciano-Granadina male goat kids were randomly assigned to one of two treatments, either goat milk "GM" or milk replacer "MR" ad libitum during autumn–winter. Kids were fed colostrum during the first 2 days of life. The approximate composition of the natural milk was as follows; moisture 84%, lactose 4.7%, protein 4.1% and lipids 6.4%. The commercial milk replacer consisted of 64% powdered skimmed milk, coconut oil and fat, and cereal products and by-products. The proximate composition of the milk replacer was as follows; moisture 10%, carbohydrates 35.4%, protein 23.7%, lipids 24.2% and ash 6.7%. On average, the milk replacer was diluted in water at 100 g/l. An automatic feed machine (AG21, JR) was used. No feeding restrictions (access to dams or to machine) were applied to GM and MR kids. Table 1 shows the profile of the main fatty acids of both the goat milk and the milk replacer used.

Table 1
Major fatty acids of goat milk and milk replacer

Fatty acid (%)[a]	GM[b]	MR[b]
C4:0	0.79	0.28
C6:0	1.70	0.18
C8:0	1.04	4.81
C10:0	4.22	4.52
C12:0	3.91	29.22
C14:0	11.29	7.81
C15:0	0.70	0.09
C16:0	30.10	23.22
C16:1	0.64	6.69
C17:0	0.51	
C18:0	13.74	3.41
C18:1	21.84	15.94
C18:2	9.53	3.62
SFA[c]	0.68	0.75
UFA	0.32	0.25
UFA/SFA	2.12	3.06

[a] Percentage fatty acid methyl ester of total acid methyl ester (GM: 952 mg/g; MR 984 mg/g).
[b] GM, goat milk; MR, milk replacer. $N = 12$.
[c] SFA, saturated fatty acids; UFA, unsaturated fatty acids.

2.2. Slaughtering

The kids were slaughtered at 35 ± 5 days of age (GM: 35.1 ± 5.7; MR: 35.8 ± 5.7) and weighed 7.6 ± 0.4 kg (GM: 7.49 ± 0.42; MR: 7.56 ± 0.26). Transportation from the farm to the slaughterhouse took 30 ± 10 min. Stunning was performed in the waiting area using electrical methods (90 W for 5 s). After stunning, the kids were hoisted by their hind legs, and exanguated. The carcasses, with heads, thoracic entrails and omenta, were cooled for 24 h at 3 °C.

2.3. Physical and chemical analysis

The proximate composition of milk, milk replacer and raw meat in the *Longissimus dorsi-lumborum* muscle were determined. The moisture (expressed as a percentage) was determined as per ISO Norm 1442 (1997) using a drying oven (Heraeus). Total protein (expressed as a percentage) was determined following the Kjeldhal method as specified by ISO Norm 937 (1978) using a 423/326 digestion/distillation unit (Büchi) and a 702 SM Titrator (Metrohm). Intramuscular fat (expressed as a percentage) was determined as per ISO Norm 1443 (1979) using an HT2 1045 Soxtec System extraction unit (Tecator). Ash content (expressed as a percentage) was determined as per ISO Norm 936 (1998) using a muffle furnace (Heraeus).

Total collagen (expressed as a percentage) was determined by spectrophotometry as described by Bonnet and Kopp (1984). Cholesterol (expressed in mg/kg) was determined by HPLC as described by Cayuela, Bañón, Ros, and Garrido, 2003. The HPLC system was made up of the following: an L-6200 pump (Merck–Hitachi); a 360 auto-sampler and a Sedex 45 light-scattering detector (S. E. D. E. R. E.). The other components were a waters resolve guard-pack silica pre-column and a waters resolve 5-m spherical silica column, 3.9 150 mm (Waters). The mobile phase was a 90:10 v/v mix of isooctane and tetrahydrofuran. The concentration of haematic pigments (expressed in mg/g) was determined by means of spectrophotometry as described by Garrido, Pérez, and Sanchez-Ferrer (1994). Colour (expressed in CIELab values) was measured by reflectance using a Minolta Chromameter. Chroma $= (a^2 + b^2)^{1/2}$ and Hue $=$ Arctan (b/a). A micro-pH-meter (Crison) with a Xerolyt (Ingold) electrode was used to measure pH. Water retention capacity (expressed as a percentage) was calculated according to Grau and Hamm (1957).

Fatty acids in the milk, milk replacer and perirenal fat were determined as per Granados (2000). Fat was extracted following the method of Folch, Lees, and Stanley (1957). Fatty acids were separated prior to derivati-