Meat Science 139 (2018) 149–156

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Fatty acid composition of polar and neutral meat lipids of goats browsing in native pasture of Brazilian Semiarid

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ARTICLE INFO

Keywords:
Goat meat
neutral lipids
polar lipids
fatty acids
Caatinga pasture
semiarid

ABSTRACT

Thirty six male goats grazing Caatinga native pasture were randomly assigned to 4 concentrate supplementation levels (0, 5, 10 and 15 g/kg of body weight) and slaughtered after 120 days. Longissimus muscle meat lipids were extracted and fractionated into neutral (NL) and polar (PL) lipids. Supplementation of grazing goats increased linearly ($P < 0.05$) intramuscular fat (1 to 1.5% of meat) and NL (0.3 to 1% of meat) but decreased linearly ($P = 0.044$) the PL (0.66 to 0.50% of meat). On NL, supplementation increased linearly ($P = 0.047$) the proportion of *c*9-18:1 (31 to 40% of FA) with supplementation. On PL, supplementation reduced linearly ($P < 0.03$) the dimethyl acetals, 18:3n-3 and most of long chain polyunsaturated FA (PUFA) proportions but increased linearly ($P < 0.001$) the *c*9-18:1. Considering the total meat FA, supplementation led to an increase of the saturated and monounsaturated FA contents and a decrease of the long chain n-6 and n-3 PUFA contents.

1. Introduction

Goat meat has been established as lean meat with favorable nutritional quality and it serves as a major source of meat especially in developing countries (Webb, 2014). In Brazil, caprine meat production in the northeast semiarid region is traditionally based on the use of Caatinga rangelands and thus limited by the large seasonal variations in the amount and quality of natural feed resources. The Caatinga biome is characterized by a large diversity of herbs, shrubs and trees that are very exuberant during the 4 months rainfall season. In the long dry season period, the availability of digestible organic matter is strongly reduced and browsing activity of shrubs and tree vegetation comprise the majority of goats feeding (Andrade, Costa, Santos, & Silva, 2010). Strategies for optimization of these traditional goat meat extensive production systems have been pursued and one obvious approach is the supplementation of grazing goats during the dry season with a concentrate feed (Andrade et al., 2010; Silva, Guim, Santos, Maciel, & Soares, 2015). This supplementation practice improves of growth rates and carcass quality (Dantas et al., 2008) but increases the exogenous inputs in the production system. Moreover, the effects of such concentrate supplementation practices on goat meat quality, particularly on meat fatty acid (FA) composition, are much less studied. Ruminant meat produced in intensive finishing systems usually presents a FA profile that has been consider less beneficial to human health than meat from grazing ruminants (Daley, Abbott, Doyle, Nader, & Larson, 2010). In fact, meat from grazing ruminant tends to be leaner, with proportional more polyunsaturated FA (PUFA), including n-3 PUFA, and conjugated linoleic acids (CLA), and less saturated FA (SFA) and *trans* FA than meat from intensive finished ruminants (Daley et al., 2010). The type of PUFA deposited in meat tissues depends largely on the type of feed, usually with cereals favoring the deposition of n-6 PUFA and forages favoring the deposition of n-3 PUFA. Despite that, the proportions of PUFA in meat are mostly explained by differences of its intramuscular fat (IMF) and of the consequent changes on the relative abundance of phospholipids and triacylglycerols (Bessa, Alves, & Santos-Silva, 2015). As PUFA are preferentially esterified in phospho-

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https://doi.org/10.1016/j.meatsci.2018.01.021
Received 4 November 2017; Received in revised form 11 January 2018; Accepted 24 January 2018
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lipids, leaner meat will naturally have higher PUFA proportions but not necessarily higher PUFA content. Moreover, the abundance of long chain PUFA in meat might be associated with the content of plasmalogen phospholipids (Bessa et al., 2015). These plasmalogens in meat can be evaluated through quantification of dimethyl acetals (DMA), which are formed from cleavage of the vinyl ether chain located at sn-1 position of their glycerol backbone.

A minimum amount of IMF must be achieved in order to improve the sensorial evaluation of meat and allow for large oleic acid (*c*9-18:1) and CLA deposition (Bessa et al., 2015). The supplementation of goats grazing in Caatinga with a cereal based concentrate feed is expected to increase the IMF content of their meat but also to reduce its content in n-3 PUFA. Thus, we hypothesize that moderate concentrate supplementation of goats grazing in Caatinga range lands will be able to improve the oleic acid and CLA deposition while maintain the forage derived n-3 PUFA. To test this hypothesis, we conducted an experiment where goats grazing on Caatinga were supplemented with a concentrate feed at 0, 0.5, 1 and 1.5% of their live weight and the FA composition of muscle lipid fractions were evaluated.

2. Material and methods

2.1. Animals and diets

The experiment was held during the dry season, from June to September of 2014, in an Experimental Station from "Universidade Federal da Paraíba" located at São João do Cariri, Paraíba, Brazil (7°29′34″ S; 36°41′53″ W) which is within Caatinga biome region. Thirty six castrated local male goats ageing 134 ± 15 days (mean ± SD) and weighting 16 ± 3 kg of live weight at the beginning of the experiment were used. The animals were weaned and sequentially castrated by Burdizzo-Emasculatome method with 100 days and 15 days before the experiment were dewormed with Ivomec® (Merial, Campinas, Brasil) and vaccinated against clostridiosis with Sintoxan® (Merial, Campinas, Brasil).

Goats had daily access to native Caatinga vegetation from 06:00 until 16:00 and during the rest of the day were housed in individual boxes where the four dietary treatments were randomly applied in order to obtain 9 animals allocated per treatment. The treatments were the supplementation of animals with 0, 5, 10 and 15 g/kg of live weight of a concentrate feed meal containing 671 g/kg DM of ground corn, 224 g/kg DM of wheat bran, 95 g/kg of soybean meal and 10 g/kg DM of a mineral-vitamin premix. The concentrate feed contained 895 g of DM per kg, and 160 g/kg DM of crude protein, 38 g/kg of ashes, 26 g/kg of ether extract and 216 g/kg of neutral detergent fiber. The FA composition of concentrate ingredients and of the main Caatinga plants browsed by goats is presented in Table 1. Weekly the animals were weighted and the amount of concentrate fed adjusted for the live weight. The animals were 120 days under the feeding experiment and then slaughtered.

2.2. Slaughter and sampling procedures

The animals were fasted for 16 h, weighted and slaughtered using a captive bolt stunner followed by exsanguination. Carcasses were refrigerated for 24 h at 4 °C and thereafter cut in halves along the spine and each half carcass separated in 6 joints. The *Longissimus lumborum* muscle was removed from loin joints of the left halves of the carcasses and, after the removal of the epimysium, was minced with a food processor (3 × 5 s), vacuum-packed, freeze-dried, and stored at − 20 °C until lipid analysis.

2.3. Lipid analysis

Feed FA were analyzed after direct transesterification of feed samples with HCl as acid catalyst in methanol (Sukhija & Palmquist, 1988). Intramuscular lipids were extracted using a mixture of dichloromethane and methanol (2:1) adapted from (Folch, Lees, & Stanley, 1957). Neutral (NL) and polar (PL) lipid fractions were obtained by solid-phase extraction using silica gel cartridges (3 mL/500 mg, Discovery SPE DSC-Si Silica tubes, Supelco, Bellefonte, PA, USA) and dichloromethane and methanol as elution solvents, respectively. For the separation of NL fraction the total lipids were eluted with 30 mL of dichloromethane and the PL were obtained by sequential elution with 30 mL of methanol. In both fractions, FA methyl esters were obtained by transesterification of lipids with sodium methoxide (0.5 M) in methanol during 30 min at 50 °C, followed by hydrochloric acid in methanol (1.25 M) during 10 min at 80 °C. Fatty acid methyl esters were analyzed using a Shimadzu QP2010-plus gas chromatograph (Shimadzu, Kyoto, Japan) equipped with a flame-ionization detector and a SP-2560 fused silica capillary column (100 m, 0.2 mm i.d., 0.20 μm film thickness; Supelco, Bellefonte, PA, USA). Complete chromatographic conditions are described in Alves, Raundrup, Cabo, Bessa, and Almeida (2015).

Nonadecanoic acid (19:0) was used as internal standard for FA methyl esters quantification. Identification of FA methyl esters was achieved by comparison of the FA methyl esters retention times with those of commercial standard mixtures (FAME mix 37 components from Supelco Inc., Bellefont, PA, USA) and with published chromatograms (Alves & Bessa, 2009, 2014). Additional confirmation of FA methyl esters and DMA was achieved by electron impact mass spectrometry using a Shimadzu GC-MS QP2010 Plus (Shimadzu, Kyoto, Japan) according to Alves, Santos-Silva, Cabrita, Fonseca, and Bessa (2013).

Results for each FA in both fractions were expressed as mg/g of the sum of total FA in each fraction, assuming direct proportionality

Table 1
Fatty acid (FA) composition (mg/g DM) of concentrate feed and of the main Caatinga plants browsed by goats.

	Concentrate ingredients			Caatinga plants[a]			
	Corn	Soybean meal	Wheat bran	Catingueira	Malva	Marmeleiro	Pereiro
Total FA	38.2	26.9	34.7	9.2	14.6	16.5	6.2
14:0	0.01	0.01	0.02	0.16	0.30	0.19	0.08
16:0	4.91	4.62	5.83	2.16	4.37	3.72	1.74
18:0	0.67	1.00	0.46	0.58	0.69	1.65	0.36
*c*9-18:1	10.8	4.48	6.04	0.92	0.83	1.06	0.96
*c*11-18:1	0.29	0.36	0.32	0.07	0.10	0.03	0.01
18:2n-6	20.5	14.5	20.3	0.78	2.72	2.81	0.36
18:3n-3	0.56	1.60	1.51	4.20	4.46	5.35	2.45
20:0	0.16	0.08	0.06	0.06	0.16	0.98	0.12
22:0	0.06	0.11	0.08	0.04	0.59	0.49	0.03
23:0	0.03	0.06	0.01	0.02	0.07	0.02	0.04
24:0	0.10	0.05	0.10	0.15	0.26	0.16	0.05

[a] Catingueira: *Caesalpinia pyramidalis* Tul.; Malva: *Sida galheirensis;* Marmeleiro: *Croton sonderianus* Mull. Arg.; Pereiro: *Aspidosperma pyrifolium* Mart.

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