Changes in husbandry practices: from grazing production systems towards intensive systems. Consequences on the nutritional quality of goat kid meat lipid fraction

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Abstract— **The comparison of meat lipid fraction nutritional quality of Bravia goat kid meat (BK), a Portuguese native breed produced under traditional rearing methods, with Saanen goat kid meat (SK), which is produced in intensive dairy farms on the dependence of concentrate feeding, was the study's objective.**

We used the *longissimus lumborum* muscle of 15 goat kids of each breed. The animals used in this study had similar age and carcass weight. For the characterization of lipid fraction we performed the appropriate analytical procedures to quantify total lipids (gravimetry), total cholesterol (HPLC) and fatty acid profile (GC).

Both goat kid meats were considered lean (total fat below 5%), but the BK meat had significant lower contents of total fat than SK (9.8 and 12.0 mg/ g of meat, respectively). The global analysis of the goat kid meat, by means of fatty acid sums (SFA, MUFA, PUFA, n-3PUFA and n-6PUFA) and nutritional ratios (PUFA/SFA and n-6/n-3), shows that BK is a healthier meat than SK. BK meat has significantly lower contents of SFA and MUFA, and higher contents of PUFA and n-3 PUFA. Such differences provided superior score considering nutritional ratios, BK meat had significantly higher PUFA/SFA ratio (0.32/0.84) and lower n6/n-3 ratio (2.37/3.74).

Nevertheless, BK meat has also significantly higher cholesterol and transesterified fatty acids (tFA) contents than SK meat.

Therefore, it is possible to conclude that BK feeding management leads to a healthier fatty acid profile to human nutrition, although Bravia genetics seems to be responsible for higher content of total cholesterol.

Keywords— **Fatty acid profile; cholesterol; goat kid;**

I.INTRODUCTION

The desertification of the interior rural lands and the abandonment of traditional agricultural practices have been associated with the intensification of livestock production systems. Such changes in agriculture and husbandry practices have conducted to a sharp loss in the indigenous goat breed flocks, which are being replaced by exotic goat breeds, as Saanen goat, raised under intensive husbandry practices.

The replacement of traditional production systems, based on sustained grazing by intensive production systems where the feeding management is predominantly based on concentrated feed, determines important changes in the composition of meat lipid fraction with important consequences for human health.

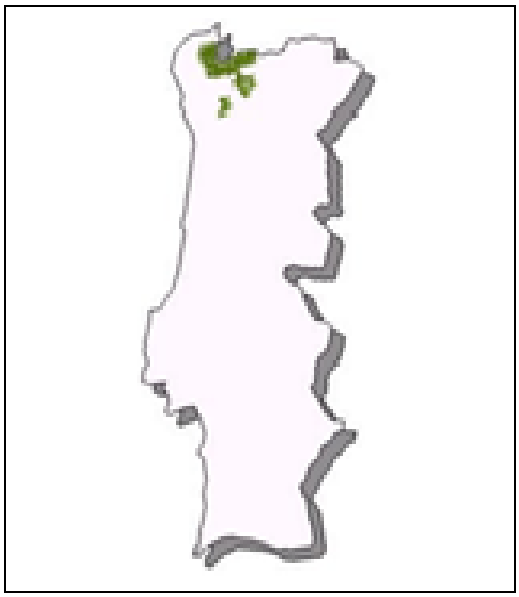

Figure 1- Geographic distribution of Bravia goat breed

In this study we compared the meat lipid fraction of a certified (PGI) goat kid meat (indigenous breed raised on pasture) with the undifferentiated goat kid meat (exotic breed and intensive production system). The Portuguese native breed is Bravia, from the Mountainous region of Minho in the north of Portugal (Figure 1) created under extensive production, while Saanen goat breed was selected to represent the exotic dairy breeds raised intensively in dairy farms.

A. **II.** MATERIAL AND METHODS

Meat samples: The goat kid meat used in this study was obtained from the *longissimus lumborum* muscle of 15 animals of each breed. Animals were slaughtered with similar carcass weights (5.6±0.8 kg and 5.0±0.5 kg, for Bravia and Saanen breeds, respectively; values presented as average ± standard deviation).

Analytical procedures: Total meat lipids were extracted from the lyophilized meat samples (0.25 g) and measured gravimetrically. Lipid extracts were dissolved in 1 ml of dry toluene, then fatty acids methyl esters were prepared by base-catalyzed transesterification with sodium methoxide for 2 hours at 30ºC. Fatty acid methyl esters were analysed using a GC chromatograph equipped with a flame-ionization detector (GC-FID) and a fused-silica capillary column (CP-Sil 88; 100 m × 0.25 mm i.d. × 0.20 mm film thickness; Chrompack, Varian Inc.). The column temperature of 100 ºC was held for 15 min, increased to 150 ºC at a rate of 10 ºC/min and held for 5 min, then increased to 158 ºC at 1 ºC/min and held for 30 min, and finally increased to 200 ºC at a rate of 1 ºC/min and maintained for 65 min. Helium was used as carrier gas. The injector and detector temperatures were held at 250 and 280 ºC, respectively. Identification was accomplished by comparison of sample peak retention times with those of FAME standard mixtures (Sigma, St. Louis, MO, USA).

The simultaneous determination of total cholesterol, and tocopherols was performed as previously described [1]. The contents of total cholesterol and tocopherols were estimated in duplicate for each sample based on the external standard technique from the standard curve of peak area versus compound concentration.

III. RESULTS

The two types of goat kid meats showed significant differences in both total lipid and total cholesterol contents (Table 1). The goat kid meat from Saanen displayed higher total lipids and lower total cholesterol than Bravia.

Table 1 – Total lipids and total cholesterol in Saanen and Bravia *longissimus lumborum* muscle (average ± standard deviation)

	Goat kid breed		P
	Saanen	Bravia	
Total lipids[1]	11.97 ± 2.22	9.76 ± 2.12	<0.05
Total cholesterol[1]	0.48 ± 0.02	0.59 ± 0.05	<0.001

[1] mg/g of meat

The major vitamin E isoform (α-tocopherol) revealed no significant difference between meats (P >0.05), while Bravia goat kid meat possessed a significantly superior γ-tocopherol than Saanen (Table 2).

Table 2 – α-Tocopherol and γ-tocopherol contents of *longissimus lumborum* muscle from Saanen and Bravia goat kids (average ± standard deviation)

	Goat kid breed		P
	Saanen	Bravia	
α-tocopherol[1]	4,23 ± 1,05	3.73 ± 0.79	>0.05
γ-tocopherol[1]	0,04 ± 0,03	0.12 ± 0.07	<0.001

[1] µg/g of meat

The fatty acid profile of Saanen and Bravia goat kid meats is displayed in Table 3. The fatty acid profiles of Saanen consist of 26 fatty acids, while the Bravia fatty acid profile comprises 23 fatty (18:1t and CLA are not included in this numbers).

The fatty acid profile of Saanen and Bravia shows significant differences in the relative amount of each fatty acid (with the exception of palmitoleic acid and γ-linolenic acid). Despite differences found in the fatty acid profile, it is also possible to observe that palmitic and stearic acids are the major saturated fatty acids (SFA), while oleic and araquidonic acids were major mono and polyunsaturated fatty acids (MUFA and PUFA, respectively) in both breeds.

Bravia goat kid meat contains significantly higher amounts of long chain polyunsaturated fatty acid from both n-6 and n-3 families, including significantly higher contents of the n-3 long chain PUFA (LCPUFA), 20:5n-3, 22:5n-3 and 22:6n-3 (EPA, DPA and DHA, respectively).

Table 3 - Fatty acid profile of *longissimus lumborum* muscle from Saanen and Bravia goat kids (g/100 g total fatty acids; average ± standard deviation)

	Goat kid breed		P
	Sannen	Bravia	
10:0	0.34 ± 0.08	0.06 ± 0.02	<0.001
12:0	0.34 ± 0.07	0.16 ± 0.07	<0.001
14:0	3.58 ± 0.43	1.74 ± 0.79	<0.001
14:1c9	0.16 ± 0.03	0.06 ± 0.03	<0.001
15:0	0.21 ± 0.02	0.32 ± 0.06	<0.001
16:0	21.05 ± 1.07	17.62 ± 1.41	<0.001
16:1c7	n.d.	0.34 ± 0.06	--
16:1c9	0.76 ± 0.25	0.91 ± 0.25	n.s.
17:0	0.35 ± 0.06	0.86 ± 0.23	<0.001
17:1c9	0.27 ± 0.06	0.41 ± 0.16	<0.01
18:0	15.39 ± 1.05	17.37 ± 1.14	<0.001
18:1t	1.30 ± 0.65	1.99 ± 0.46	<0.01
18:1c9	43.62 ± 3.19	25.64 ± 4.15	<0.001
18:2n-6	4.43 ± 0.99	12.98 ± 3.36	<0.001
20:0	0.11 ± 0.02	0.28 ± 0.06	<0.001
18:3n-6	0.06 ± 0.02	0.09 ± 0.02	n.s.
20:1c11	0.09 ± 0.02	0.21 ± 0.05	<0.001
18:3n-3	0.42 ± 0.11	1.90 ± 0.84	<0.001
20:2n-6	0.04 ± 0.01	n.d.	--
20:3n-9	0.97 ± 0.24	n.d	--
22:0	0.03 ± 0.01	n.d	--
20:3n-6	0.25 ± 0.07	0.84 ± 0.29	<0.001
20:4n-6	3.57 ± 1.03	7.99 ± 2.97	<0.001
20:5n-3	0.68 ± 0.28	2.96 ± 0.82	<0.001
22:4n-6	0.08 ± 0.03	n.d	--
22:5n-3	0.99 ± 0.29	3.68 ± 0.70	<0.001
22:6n-3	0.39 ± 0.14	1.12 ± 0.22	<0.001

Fatty acids partial sums showed that goat kid meat from Bravia has lower SFA and MUFA and higher PUFA contents than Saanen goat kid meat. Bravia goat kid meat has also significantly higher amounts of *trans* octadecenoates (18:1t), of which trans vaccenic acid was the predominant trans octadecenoate, than Saanen goat kid meat. All the differences observed in fatty acid partial sums were highly significant (P<0.001), with the exception of trans fatty acids (tFA) in which P was below 0.05 and CLA (conjugated linoleic acid), which showed no significant difference in between breeds (Table 4).

Table 4 – Partial sums of fatty acids and nutritional fatty acid ratios of longissimus lumborum muscle from Saanen and Bravia goat kids (g/100 g total fatty acids; average ± standard deviation)

	Goat kid breed		P
	Sannen	Bravia	
∑ SFA	41,14±1,62	38,03±2,74	<0.001
∑ MUFA	44,90±3,32	26,96±4,37	<0.001
∑ PUFA	12,39±2,78	31,25±6,92	<0.001
∑ n-6	8,96±2,00	21,68±6,55	<0.001
∑ n-3	2,46±0,76	9,56±2,23	<0.001
CLA	0,51±0,18	0,49±0,22	n.s.
∑ tFA	1,30±0,65	1,97±0,46	<0.05
PUFA/SFA	0,30±0,07	0,84±0,24	<0.001
n-6/n-3	3,74±0,57	2,37±0,89	<0.001

IV. DISCUSSION

In this study we are comparing two different realities. In one side we have a native breed (Bravia) goat kids raised with their dams which are exclusively on mountain pasture and bushes, in agreement with traditional husbandry practices. On the other hand we have goat kids from a selected dairy breed (Saanen), raised with milk replacers and finished with concentrate feeds. Therefore, we are comparing two different genetics and two different husbandry practices. This comparison represents the traditional and the intensive husbandry practices.

In the traditional rearing method, suckling goat kids are solely fed with their dam's milk. On the other hand, the Saanen kids, as other dairy goat breeds, are usually separated from their mothers at birth, and fed with milk replacer and finished on concentrate feeding. Such changes in the feeding management should be responsible for differences in their nutritional quality.

Differences found among breeds in the total lipid content should be associated with differences in the intensity of muscular exercise between breeds. The low total lipid contents found in Bravia is not surprising considering the fact that they display a much intensive muscular activity, following their dams, in the mountainous region of Serra do Gerês and Serra do Alvão, immediately after birth, while

Saanen goat kids were fed with milk replacer in a restricted area, without the need of substantial exercise. Differences observed in the cholesterol content could be dependent of genetic factors or could have resulted from adaptation of skeletal muscle to intensive muscular activity [2]. Such adaptation could have conduct to different muscle fibre composition or increased number of mitochondria in each muscular fibre, which contributes to increased cholesterol content in meat.

The fatty acid profile of Saanen and Bravia goat kids meat showed some differences in the fatty acid number, with Saanen goat kid meat displaying some fatty acids that are absent in Bravia (20:2n-6, 20:3n-9, 22:0, 22:4n-6).

The predominant fatty acids were oleic acid (as major MUFA), palmitic and stearic acids (as major SFAs) and linoleic acid (as major PUFA). These 4 fatty acids were responsible 73.6 and 84.5% of total fatty acid contents for Bravia and Saanen kids, respectively. which is in accordance with the results previously reported in lambs produced in different production systems [4].

Differences found between goat breeds were expectable considering their different feeding management and husbandry facilities. Similar results were obtained by Bañón et al [5], when comparing the effect of feeding with goat's milk or milk replacer.

Partial sums of fatty acids and nutritional fatty acid ratios (Table 4), shows that Bravia goat kid meat is of superior nutritional quality, with significantly lower content of SFA and MUFA, higher content of n-3 and n-6 PUFAs and higher contents of n-3 LCPUFA, as EPA and DHA, which are of prime nutritional relevance [5].

Concerning the fatty acid profile, it is important to say that at the age these goat kids were slaughtered, they are early ruminants, being for a long period pre-ruminant in which the fatty acid composition of muscular and adipose tissues reflects the milk consumed [3]. Milk replacers are usually made with powdered skimmed milk, coconut oil or other vegetal oil sources, cereal products and by-products. Such composition will promote a massive predominance in palmitic, stearic and oleic acids (which were responsible for 80.1% of total fatty acids, but cannot provide the n-3 LCPUFA with health promoting properties that are possible to find in goat's milk obtained from goats raised on pasture, as Bravia.

V. CONCLUSION

The preservation of native breeds is an important biodiversity issue, because they are well adapted to local conditions. Not less important is the preservation of traditional rearing methods and silvo-pastoral grazing, which provides good animal welfare and reduces fire risk, thanks to the reduction of shrub land areas.

In terms of meat quality, the superior quality of Bravia is consequence of Bravia goat´s milk superior quality. Differences found in the fatty acid profile between breeds could vanish if the nutritional quality of milk replacer would be improved to match milk from grazing goats.

In this comparison, it was shown that Bravia goat kids raised under traditional rearing methods offer meat with superior nutritional quality and significantly higher amounts of n-3LCPUFA, than those obtained from intensive dairy goat farms. However, genetic or intense muscular activity have promoted increased cholesterol content in Bravia goat kid meat.

VI. REFERENCES

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