EFFECTS OF KID FEEDING WITH A DE-STONED OLIVE POMACE ON THE QUALITY OF RAW AND COOKED MEAT

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Background

Olive oil by-products have been widely employed for animal feeding in many species (Sansoucy, 1985; Molina Alcaide and Nefzaoui, 1996). In Southern Italy, the semi-arid ecosystems hamper the availability of pastures and forages during the year, therefore, the possibility of using agricultural by-products may be quite interesting, both under a zootechnical and economic point of view, on the condition that the products used are of good quality and safe for animal feeding and welfare. The olive oil industry plays an important role in Southern Italy; furthermore, the exploitation of olive oil by-products is even more feasible in a region like Apulia, where olive oil is produced for about 12% of the total world output and small ruminant breeding is particularly practised. Previous reports carried out on lambs have shown that feeding olive cakes positively affects growth performances and meat quality (Lanza *et al.,* 2000; Zumbo *et al.*, 2001; Foti *et al.*, 2003). In this trial we investigated the use of a new type of by-product, i.e. a virgin olive pulp produced by the removal of stones from the olives (Amirante *et al.*, 2002), which has already provided satisfactory results in lamb feeding, as we have described elsewhere (Ragni *et al.*, 2003; Vicenti *et al.*, 2003).

Objectives

The aim of the study was to evaluate the effect of using a de-stoned olive pomace as a feed for kids' diet on meat colour and on the chemical composition, fatty acid profile and tenderness of raw and cooked meat.

Materials and methods

The experiment was carried out at the University farm located in Bari (Apulia, Southern Italy, 41 °N) on sixteen male Garganica kids, weaned at about 50 days of age, divided into 2 groups of 8 subjects each, homogeneous for age and body weight. Kids were fed *ad libitum* for 6 weeks on either a concentrate pelleted diet (control group) or on a diet containing 20% olive pomace (olive pomace group). Diets were planned in order to contain approximately the same amount of protein (16.5%), fat (5.0%) and crude fiber (10.5%). Kids were slaughtered following 12 hours fasting. After 24 hours of refrigeration at 4 °C, the Longissimus lumborum (Ll) muscle was dissected from the right half carcass and split into two pieces, one of which was used raw while the other was cooked in an electric ventilated oven at 180 °C until the internal temperature of 75 °C was reached in the core of the meat sample, recorded by a thermocouple (ASPA, 1996). Meat samples were weighed before and immediately after cooking to determine cooking loss percentages. Colour (L = Lightness; a = redness; b = yellowness) was evaluated only on raw samples using the Hunter Lab system (colourmeter Miniscan XE; D65/10° illuminant). Tenderness was assessed by the Warner Bratzler Shear device system on raw (cylindrical, half an inch of diameter) and cooked (rectangular, 1x1 cm section) meat cores using a universal test machine (Instron 5544). Peak force was expressed as kg/cm^2 and represents the cutting force required to shear perpendicularly to the direction of the fibres. Raw and cooked meat samples were analysed for chemical and fatty acid composition (ASPA, 1996). Lipids were extracted using a chloroform/methanol 2:1 v/v solution (Folch *et al.*, 1957). Fatty acids were methylated using a BF_3/methanol solution (12% v/v) and analysed by gas chromatography (Chromopack CP 9000) using a 60 m silicated glass column with a 0.25 mm internal diameter and 0.2 μm film thickness. The atherogenicity (AI) and thrombogenicity (TI) indexes (Ulbricht and Southgate, 1991) and the PCL/PCE (plasma cholesterol lowering/plasma cholesterol elevating) ratio (Reiser and Shorland, 1990) were also calculated.

Data were processed by analysis of variance using the GLM procedure of SAS (1999/2000). The model adopted took into consideration as main effects the diet and the cooking method and their interaction. Means were compared by Student's t test.

Results and discussion

Meat colour was not affected by the integration of the olive pomace in the diet (Figure 1). Previous studies have documented that olive cakes are rich in unsaturated fatty acids (Sansoucy, 1985), which in meat may increase its susceptibility to lipid oxidation, with consequences on colour, texture, flavour as well as its nutritional value (Ponnampalam *et al.*, 2002). For this reason, olive cake feeding has been accompanied with the administration of antioxidants such as vitamin E to stabilize meat lipid deterioration (Lanza *et al.*, 2000; Zumbo *et al.*, 2001).

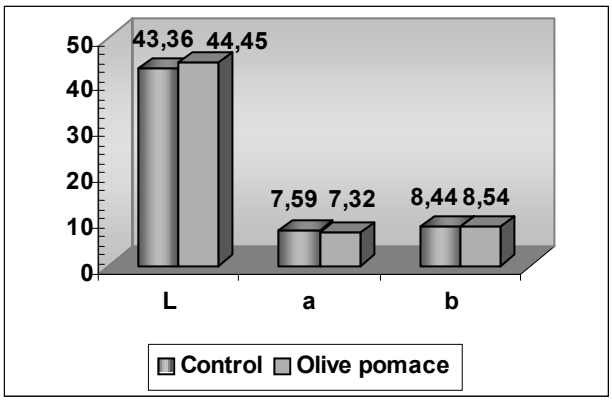

Figure 1. Meat colour of the *Longissimus lumborum* muscle in kids

In this study, similarly to what we (Vicenti *et al.*, 2003) and other Authors (Foti *et al.*, 2003) previously found in lambs, the values of meat colour were not changed by the integration of the olive pomace in the diet.

As for the chemical composition of meat (Table 1), no significant differences between diets were found for raw meat, whereas cooked samples of the olive pomace group displayed a greater moisture content (P<0.05) and significantly (P<0.01) less fat and N-free extract in comparison with cooked control samples. For both the diets administered, cooking determined a decrease of meat moisture in turn of a concentrating effect on fat (P<0.01) and protein (P<0.01) and, although only in the olive pomace group, also on ashes (P<0.01). The olive pomace diet resulted in a significantly (P<0.05) greater cooking loss (16.19%) in comparison with the control group (13.30%). The chemical composition of kid meat obtained in this study was comparable to that reported by Dhanda *et al.* (1999), who studied meat quality characteristics in different goat genotypes.

Table 1. Chemical composition of raw and cooked meat samples and cooking loss (%)

	Control			Olive pomace			Significance of main effects		SED
	Raw		Cooked	Raw		Cooked	Diet	Cooking	
N (samples)	8		8	8		8	32	32	*DF = 28*
Moisture	75.43	**	66.28^{B}	75.05	**	67.18a	ns	**	0.652
Protein	18.97	**	26.12	19.26	**	26.25	ns	**	0.481
Fat	3.29	**	5.20^{A}	3.55	**	4.54^{B}	ns	**	0.327
Ash	1.08	ns	1.12	1.01	**	1.15	ns	**	0.079
N-free extract	1.21	ns	1.27^{A}	1.13	ns	0.87^{B}	*	ns	0.289
									DF = 14
Cooking loss		13.30^{B}			16.19^{A}		*	/	2.227

Differences between diets within raw or cooked meat samples: A, B: P<0,01; a, b: P<0.05. Differences between raw and cooked samples within each diet and significance of main effects: **: P<0.01; *: P<0.05; ns = not significant.

Raw control meat samples showed significantly (P<0.01) more SFA and PUFA in comparison with the olive pomace group, whereas less (P<0.01) MUFA and UFA. In the corresponding cooked samples, the fatty acid class distribution was somewhat reversed. Cooked meat samples of the olive pomace group contained a greater amount of SFA (P<0.01) and a lower proportion of MUFA (P<0.05) as well as UFA (P<0.01) as compared to the control diet.

Within the polyunsaturated fatty acids present in meat, raw samples of the control group, showed a higher (P<0.01) amount of ω6 fatty acids with no difference in the ω3 fatty acid fraction, so that the ω6/ω3 ratio was comparable between the diets for both raw and cooked samples. The PUFA/SFA ratio was markedly better in raw control samples than in the olive pomace ones (P<0.05), while cooking cancelled this difference. However, other studies conducted on goats have reported higher PUFA/SFA values respect to those found by us in this study (Banskalieva *et al.*, 2000), although the differences may be ascribable to the diet, to the slaughtering age and to the goat breed.

With regards to the dietetic properties of meat (Table 3), the atherogenicity index did not differ among diets as far as raw meat samples are concerned, while cooking resulted in a significant increase of the AI in the olive pomace group with respect to the controls, both in the raw (0.62 vs 0.54; P<0.01) as well as cooked ones (0.62 vs 0.52; P<0.01). Within raw samples, the thrombogenicity index was significantly higher in the control group with respect to the olive pomace diet (1.32 vs 1.09, P<0.01), while in cooked samples the trend was completely reversed, with olive pomace samples displaying a thrombogenicity index value of 1.20 against 1.11 obtained for the control group (P<0.05). Moreover, a significant (P<0.01) reduction of the TI value was recorded in control samples after cooking, on the contrary of the olive pomace diet, where cooking markedly increased meat thrombogenicity index (P<0.01).

The control diet improved the PCL/PCE ratio in comparison with the olive pomace feeding treatment, at a level of P<0.05 for raw meat while at P<0.01 for cooked samples. In both feeding treatments the PCL/PCE ratio did not change following cooking.

Table 2. Fatty acid classes in raw and cooked meat samples (%)

	Control			Olive pomace			Significance of main effects		SED
	Raw		Cooked	Raw		Cooked	Diet	Cooking	
Samples (n.)	8		8	8		8	32	32	DF = 28
SFA	44.02A	**	38.97B	39.75B	**	41.45A	*	**	1.157
MUFA	47.67B	**	54.82a	53.82A	ns	53.00b	**	**	1.442
PUFA	8.22A	**	5.50	6.30B	*	5.35	**	**	0.852
UFA	55.90B	**	60.32A	60.12A	*	58.35B	*	**	1.292
ω6	7.15A	**	4.83	5.30B	ns	4.60	**	**	0.726
ω3	1.07	**	0.67	1.00	ns	0.75	ns	**	0.245
ω6/ω3	7.09	ns	7.15	5.98	ns	6.14	ns	ns	1.712
PUFA/SFA	0.19a	**	0.14	0.16b	*	0.13	*	**	0.023

Differences between diets within raw or cooked meat samples: A, B: P<0,01; a, b: P<0.05. Differences between raw and cooked samples within each diet and significance of main effects: **: P<0.01; *: P<0.05.
ns = not significant.

Table 3. Atherogenicity (AI) and thrombogenicity (TI) indexes and PCL/PCE ratio in raw and cooked meat

	Control			Olive pomace			Significance of main effects		SED
	Raw		Cooked	Raw		Cooked	Diet	Cooking	
Samples (n.)	8		8	8		8	32	32	DF = 28
AI	0.55	ns	0.52B	0.54	**	0.62A	**	ns	0.033
TI	1.32A	**	1.11b	1.09B	**	1.20a	**	*	0.067
PCL/PCE	1.34a	ns	1.31A	1.24b	ns	1.19B	**	ns	0.081

Differences between diets within raw or cooked meat samples: A, B: P<0,01; a, b: P<0.05. Differences between raw and cooked samples within each diet and significance of main effects: **: P<0.01.
ns = not significant.

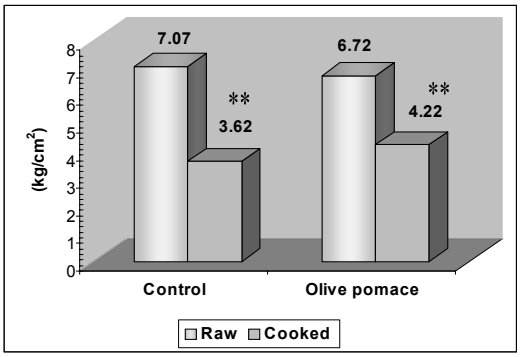

Figure 2. Peak force (kg/cm^2) in raw and cooked *Longissimus lumborum* meat samples
Differences between raw and cooked samples within each diet: ** p<0.01.

Meat tenderness did not seem to be influenced by the diet (Figure 2), neither for raw samples nor for cooked ones. However, cooking improved meat tenderisation, as showed by the significant (P<0.01) decrease of the peak force required to shear meat, both in the control group (7.07 vs 3.62) than in olive pomace meat samples (6.72 vs 4.22).

Conclusions

Based on the findings of this study, we may conclude that the integration of a de-stoned virgin olive pomace at 20% level in the diet of growing goat kids did not influence meat chemical composition, colour and texture. It did, however, provide controversial results in terms of meat dietetic properties, especially following cooking.

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