Effect of olive cake on daily gain, carcass characteristics and chemical composition of lamb meat

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ABSTRACT: This experiment investigated the effect of olive cake in the feed of weaned Pramenka lambs on their daily gain, carcass traits and on the chemical composition of different groups of muscles. For that purpose, 45 male lambs were divided into three groups with 15 lambs each and fed separately for 50 days. The first group (control) was fed a commercial concentrate, while the second and third (test) groups were fed a concentrate with the addition of 15% and 30% olive cake, respectively. The results showed that the high level of olive cake inclusion (30%) decreased ($P < 0.01$) daily gain, final weight, empty carcass weight and ($P < 0.05$) dressing percentage of lambs. The olive cake resulted in a significantly higher ($P < 0.01$) proportion of stomach and intestines in the carcass compared to the control. The content of fat, proteins and dry matter in all the analyzed groups of muscles was lowest in the carcasses of lambs fed olive cake. The results of this research suggest that the addition of 15% of olive cake to the concentrate had no significant negative effect on daily gain, carcass weight and dressing percentage of lambs.

Keywords: olive cake; Pramenka lambs; fattening; carcass traits; meat chemical composition

All along the Croatian coastal belt and on the islands man and olives have co-existed for thousands of years, and olives and the oil they yield have both been among the staple foods and valuable items of trade. However, intensive growing and processing of olives produces large quantities of olive cake, which is not used for any practical purposes in Croatia but it is simply discarded in the surrounding areas of oil-making facilities, on meadows or into the sea. This results in the environment pollution and in the loss of remarkably high amounts of nutritious matter. Depending on the yield, Croatian annual production ranges from 9 000 to 35 200 t of olives which, following the extraction of oil, results in up to 15 000 t of olive cake (FAO, 2004). In addition to fishing, olive and wine growing, the population along the coast and on the islands has traditionally engaged in sheep breeding, predominantly local breeds acclimatized to summer heat, to karst and rock and the poor vegetation on such ground. In these conditions sheep are often underfed, indeed hungry, often left to their own devices. Consequently, it is very important – both for economic and ecological reasons – that such a high percentage of by-products of the local plant production and processing be included in animal feed.

A very high percentage of raw fibre (27–41%), tannin and phenol has unfavourable effects on its nutritive value and cellulolytic activity of microorganisms in the rumen (Theriez and Boule, 1970; Lanzani et al., 1993). However, it has to be pointed out that sheep possess the ability for a high level of utilization of fodder with low nutri-

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tive value (Lanzani et al., 1993). In Croatia, no research has been carried out to date on the use of olive cake in the feed of sheep, as opposed to some other types of domestic animals: chickens (Rupić et al., 1992), pigs (Rupić et al., 1997) and rabbits (Rupić et al., 1999). Apart from being used for fattening, olive cake can also be used in the production of sheep, goat and cow milk (Hadjipanayiotou, 1999; Chiofalo et al., 2004). Research has proved (Hadjipanayiotou, 1994a) that ensilage can be safely used for prolonged storage of olive cake on its own, in combination with other by-products (molasses, poultry litter), or with conventional fodder (barley or maize grain).

The aim of this research was to establish the nutritive effect of different quantities of dietary olive cake on daily gain, carcass characteristics and on the chemical composition of different groups of muscles in lambs.

MATERIAL AND METHODS

Forty-five male Pramenka lambs, born within a 5-day period, were obtained from the same farm situated in Central Croatia as soon as they reached weaning weight. Lambs were reared on their mother's milk until weaning at 45 days of age. From the 15th day of age a starter commercial concentrate (22% CP) was offered to them together with grass hay (about 150 g per head/day). At the experimental site the animals were divided according to live weight into three groups of 15, and housed in three collective boxes for the duration of the experiment. At the beginning of the experiment, the lambs were vaccinated against enterotoxaemia and treated against internal and external parasites.

Raw olive cake was collected from a local olive pressing factory during summer 2003. The microbiological examination of fresh olive cake revealed no presence of bacteria of the genus *Clostridium*, while contamination with saprophytic spores was found to be within the values given in the Croatian Bylaws on the quality of cattle feed (Narodne novine, 1998). Once the microbiological and chemical analyses were completed, fresh olive cake was dried at a temperature of 50°C in a dry kiln for pumpkin seed. Dried cake was sifted to clean it of olive tree leaves and other detritus. The cake was then fed into a hammer mill and crushed to particles not exceeding 3 mm in size.

From the 45th to the 52nd day of age the animals were gradually adapted to experimental diets. Lambs in the first group were fed a commercial feed for fattening (control diet). The second and the third group were fed an experimental diet with the addition of 15% and 30% of olive cake, respectively (Table 1). Olive cake was added to replace similar amounts of maize. Soybean and sunflower meals were increased in order to ensure that all diets contained the same amount of protein. All the three diets were ground and supplied *ad libitum*. Fresh feed was given once daily at the same time (08:00 h) and animals had a free access to water.

Body weight of lambs was determined by individual weighing at the beginning and at the end of the experiment, while weight gain was calculated. The lambs were slaughtered, after electrical stunning, at 102 days of age following a 12 hour-fasting period (water was allowed). Slaughtering was performed by the conventional method for lambs, which includes blood letting by the parallel cutting of major neck blood vessels (*v. jugularis externa* and *a. carotis communis*), removal of skin, together with lower parts of legs (distal to carpal and tarsal joints), evisceration (gastrointestinal tract with its content, liver, lungs, heart and spleen). The head was not separated and remained a part of the carcass. Hot carcass weight was determined and the organs were weighed individually (stomach and intestines, liver, lungs and heart), as was the skin together with the lower parts of legs. Hot carcass weight and live weight were used for the determination of dressing percentage. The following muscles were taken from the left side of each carcass: shoulder: *m. deltoideus, m. subscapularis* and *m. triceps brachii*; leg: *m. biceps femoris, m. semitendineus* and *m. gastrocnemius*; back: *m. longissimus dorsi, m. spinalis et semispinalis, m. trapezius* and *m. romboideus*. Connective membranes and particles of bone and cartilage were removed from the muscles. Meat samples were minced, homogenized, marked, packed into plastic bags and frozen until analyses. Chemical analyses of samples that were carried out in accordance with official methods (AOAC, 1995) determined the following parameters: supply and laboratory waters, dry matter, ash, protein, fat and N-free extract.

All the data were analyzed by ANOVA, testing the diet effect. Tukey-Kramer test was used to separate means when a significant treatment ($P < 0.05$) effect was observed. The statistical analysis was performed using the GLM procedure (SAS, 1999).

Table 1. Ingredients and chemical composition of experimental diets (%)

Group	Control	15%	30%
Ingredients			
Maize	60.50	45.50	30.50
Olive cake	–	15.00	30.00
Barley	5.00	5.00	3.00
Wheat feed flour	5.00	5.00	5.00
Soybean meal	21.00	22.00	22.00
Sunflower meal	5.00	4.00	6.00
Calcium carbonate	1.50	1.50	1.50
Magnesium calcium phosphate	1.00	1.00	1.00
Salt	0.50	0.50	0.50
Vitamin-mineral premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
Chemical composition			
Dry matter	88.72	88.92	88.97
Crude protein	17.00	17.01	16.96
Crude fibre	4.61	10.47	16.46
Crude fat	3.79	4.31	4.83
Ash	5.86	5.40	4.52
NFE	57.46	51.73	46.20
Ca	0.87	0.95	0.79
P	0.66	0.75	0.71
MJ/kg DM	16.29	16.22	16.17

RESULTS AND DISCUSSION

Based on the results of the analysis of dried olive cake chemical composition (AOAC, 1995) used in the experiment, the following average values were calculated: dry matter 96.04%; crude protein 6.51% crude fat 9.17%; crude fibre 41.86%; ash 2.75%; N-free extract 35.75%; calcium 0.17%, and phosphorus 0.04%. The given values differ from those reported by Chiofalo et al. (2004). Differences in the chemical composition can be due to the oil extraction process, degree of extraction, year and geographical origin of olives. One of the main limiting factors for the use of olive cake in the feed of domestic animals is its variable chemical composition (Molina Alcaide et al., 2003).

The average final weights of lambs are shown in Table 2. At the end of the fattening period the significantly lowest ($P < 0.01$) average body weight was found in the group of lambs fed 30% of dietary olive cake. The control group showed slightly higher, but not at a significance level, final body weight than lambs fed 15% of olive cake. There was not a significant difference in average daily gain between the control group and lambs fed 15% of olive cake in the concentrate (235 g per day versus 218 g per day). The lowest ($P < 0.01$) average daily gain was found in lambs receiving 30% of olive cake, which is in accordance with the results of research carried out by Aboayasha et al. (1982), Belibasakis (1985) and Abo Omar and Gavoret (1995). The above-mentioned authors reported that olive cake could be used in the diet for lambs at an amount from 20 to 25% without negative effects on their body weight and daily gain. However, contrary to our results, Dattilo and Congiu (1995) found that the lambs fed 30% of olive cake in the concentrate achieved higher daily gains in comparison with the lambs receiving a lower percentage or no dietary olive cake. Hadjipanayiotou (1994b) states that olive cake achieves better results in the lamb fattening process if it is consumed in the form of silage with ground maize grain and poultry litter.

Carcass weight, proportion of stomach and intestines, lungs and heart, liver, skin with lower parts

Table 2. Least-squares means for fattening performance and proportion of non-carcass components of Pramenka lambs fed a control diet and diets containing 15% and 30% olive cake

	Diet			S.E.	Significance
	control	15%	30%		
Initial weight (kg)	16.20	16.70	16.50	0.357	NS
Final weight (kg)	27.97[a]	27.60[a]	24.53[b]	0.419	**
Average daily gain (g)	235.00[a]	218.00[a]	160.00[b]	8.398	**
Carcass weight (kg)	12.26[a]	11.69[a]	10.13[b]	0.224	**
Dressing percentage (%)	43.85[a]	42.35	41.29[b]	0.451	*
Stomach and intestines (%)	24.54[a]	27.07[b]	28.43[b]	0.773	**
Lungs and heart (%)	2.64	2.65	2.68	0.077	NS
Liver (%)	2.18[a]	2.03	1.82[b]	0.064	*
Skin and legs (%)	20.75	20.51	20.49	0.592	NS

[a,b]Mean values with different superscripts in the same row are significantly different at $P < 0.05$ or $P < 0.01$; *$P < 0.05$; **$P < 0.01$; NS = not significant

of legs in the warm carcass of slaughtered lambs, and dressing percentage are presented in Table 2. The lowest ($P < 0.01$) carcass weight was found in lambs fed 30% of dietary olive cake. The proportion of 15% olive cake in the diet did not significantly reduce carcass weight compared to the control group of lambs. The dressing percentage was significantly ($P < 0.05$) lower in lambs fed 30% of olive cake compared to the control group, while the diet with 15% olive cake did not significantly reduce the dressing percentage of lambs. Our results of dressing percentage are similar to those reported by Džinleski et al. (1971) for five-months-old male lambs of the Ovčepoljska sheep, and by Mijatović (1962) for Pramenka lambs from Bihać area. Pavić (2002) concluded that the dressing percentage of Pramenka lambs was relatively low, i.e. about 45%, which is similar to our results. Lanza et al. (2003) stated that lambs of the Barbaresca breed of similar age had a yield of over 50%, as did somewhat older lambs of the Rammbouillet breed (Snowder et al., 1994) and of the Awassi breed (Macit et al., 2002).

Lambs fed olive cake had a significantly higher ($P < 0.01$) proportion of stomach and intestines than lambs in the control group (Table 2). The consumption of fodder rich in crude fibre (including olive cake) leads to the enlargement of rumen and other sections of the digestive tract as it remains in the tract for a longer period. Mijatović (1962) results of the proportion of stomach and intestines (24.71%) in lambs of the Pramenka breed are comparable with our results obtained for the control group of lambs. Lambs fed 30% olive cake had a significantly lower ($P < 0.05$) proportion of liver than lambs in the control group. The proportion of lungs and heart was about the same in all groups involved in the experiment, which is also in accordance with the results of Mijatović (1962), but higher than the values given by Kozarovski et al. (2000) and Macit et al. (2002) in their researches conducted with lambs of different breeds and age. In our research, groups fed olive cake had a lower proportion of skin with lower parts of legs than lambs in the control group, although these differences were not significant.

The basic chemical composition (water, dry matter, fat, proteins, ash and N-free extract) of muscles in leg, back and shoulder in all three groups of lambs is shown in Table 3. Results of the chemical composition of lamb meat in the groups on different diets in the experiment and in different anatomic positions of analyzed muscles are very heterogeneous. Mioč et al. (2001) stated that the chemical composition of kid meat was significantly influenced by the anatomic position of a given muscle. Compared with lambs in the control group, those fed olive cake were found to have a significantly higher ($P < 0.01$) average content of water in all analyzed groups of muscles, i.e. lower levels of dry matter. Muscles of lambs fed a commercial feed for fattening (control group) had higher average contents of fat and proteins than lambs receiving 15% and 30% olive cake, but the differences were

Table 3. Least-squares means for the chemical composition of different muscle groups

Chemical composition (%)	Control	15%	30%	S.E.	Significance
Leg					
Water	77.43[a]	77.69	78.11[b]	0.159	**
Protein	19.74[a]	19.43	19.22[b]	0.131	*
Fat	1.47	1.31	1.30	0.110	NS
N-free extract	0.28[a]	0.52[b]	0.31	0.063	*
Ash	1.08[a]	1.05[b]	1.05[b]	0.005	**
Back					
Water	77.05[a]	77.46[b]	77.93[c]	0.121	**
Protein	19.91	19.69	19.64	0.127	NS
Fat	1.54[a]	1.33	1.06[b]	0.089	**
N-free extract	0.44	0.45	0.32	0.056	NS
Ash	1.07[a]	1.06	1.05[b]	0.006	*
Shoulder					
Water	77.68[a]	78.11[b]	78.39[b]	0.113	**
Protein	19.47	19.18	19.23	0.136	NS
Fat	1.36[a]	1.13	1.04[b]	0.078	*
N-free extract	0.43	0.53[a]	0.29[b]	0.061	*
Ash	1.06	1.05	1.05	0.006	NS

[a,b,c]Mean values with different superscripts in the same row are significantly different at $P < 0.05$ or $P < 0.01$; *$P < 0.05$; **$P < 0.01$; NS = not significant

not always significant. The highest average content of fat and proteins (1.54 and 19.91%, respectively) and, consequently, the lowest average content of water (77.05%) were found in the group of back muscles of lambs in the control group. Data presented in Ta-ble 3 clearly show a small amount of intramuscular fat, ranging from 1.04 to 1.54%. Lambs receiving a 15% addition of olive cake had the highest average content of N-free extract in all analyzed groups of muscles, although the differences were not always significant.

CONCLUSIONS

The results of this study demonstrated a possibility of feeding olive cake in diets for Pramenka lambs. The replacement of 15% of maize with olive cake in the concentrate resulted in daily gain, carcass weight and dressing percentage of lambs that were not significantly different compared to lambs from the control group that received a commercial feed for fattening. This is of advantage to farmers in areas where olive cake is produced and maize production is low.

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