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Effects of safflower cake supplementation on growth performances, carcass traits and meat quality of Comisana lambs

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Abstract

Two groups of Comisana lambs ("Safflower cake" and "Control") were fed *ad libitum* with pelleted total mixed rations. After a 7-days adaptation period, the diet of the "Safflower cake" group were supplemented with 20% of safflower cake. All the lambs were slaughtered at 96 days of age. Dietary safflower cake did not affect feed intake and growth traits of lambs. The use of safflower significantly modify (P<0.05) the fatty acids profile of meat: in particular safflower cake decreased the level of saturated fatty acids (46.74 vs 48.50% respectively for "Safflower cake" and "Control" group) and increased the level of unsaturated fatty acids (53.26 vs 51.40% respectively for "Safflower cake" and "Control" group) in lamb meat. Furthermore, the safflower cake supplementation affected atherogenic index, thrombogenic index and cholesterol level. All these values were significantly lower in meat of lambs fed "Safflower cake" diet (atherogenic index 0.93 *vs* 1.02%, P<0.01; thrombogenic index 1.56 *vs* 1.69%; P<0.05; cholesterol 68.62 *vs* 77.30 mg/100 g; P<0,05). Results indicate that safflower cake may be successfully used in lamb rations to obtain meat with improved quality in order to protect the consumer health.

Key words: safflower cake, lambs, meat, fatty acids

1. Introduction

Safflower (*Carthamus tintorius* L.) belongs to the family Compositae or Asteracea. It is a branching, thistle-like herbaceous annual or winter annual plant, with numerous spines on leaves and bracts, mainly grown in dry hot climates. Safflower has been cultivated since antiquity for its flowers, used for flavouring and colouring foods and for making dyes, and for its seed oil (Dajue & Mundel, 1996). Nowadays, safflower is an underutilized minor oilseed crop with great potential in many areas of the world because of its agronomic performance and seed oil quality (Knowles, 1989). Conventional safflower oil has a high linoleic acid content (70%), which is a unique trait amongst oilseed crops (Velasco et al., 2005). High oleic acid oils are highly appreciated for food and non-food applications because they combine a hypocholesterolemic effect (Mensink & Katan 1989) with a much greater oxidative stability than oils with higher polyunsaturation levels (Yodice 1990). Safflower has high adaptability to the low moisture condition of Mediterranean areas (Corleto et al., 1980; Koutroubas et al., 2009). This may be a good chance also considering that food is the main global consumer of water, with irrigation taking 70% or more of all the water used, apart from huge volumes of rainwater (Kirby, 2004). Moreover, safflower is moderately tolerant to salt stress and is cultivated in dry areas where salinity can be a serious threat (Kafka, 1999; Lovelli et al., 2007; Ghorashy et al, 1972; Devi et al., 1980; Siddiqi et al., 2011; Yuldasheva et al., 2011; Yeilaghi et al., 2012). After the oil is expressed, safflower seed cake can often be used as livestock feed and the remaining plant, if not too spiny, can be used as forage or silage (Pinto et al., 1989; Vonghia et al., 1991; Weinberg et al., 2002; Cazzato et al., 2011; Pinto et al., 2011; Pinto et al., 1990; Pinto et al., 1992; Vicenti et al., 1993; Vicenti et al., 1995).

In recent years, the economic trend of consumers is mostly oriented to prefer healthy and wholesome products. This trend does not exclude products of animal origin: increased interest in enhancing the nutritional quality of meat foods has stimulated research on manipulation of their fatty acid profiles through nutritional strategies of livestock (Muci et al., 1992; Kott et al., 2003; Boles et al., 2005; Pinto et al., 2011). In order to protect the consumer health, the goal is to produce meat which meets the dietary recommendations for a reduced intake of fat and cholesterol in the human diet and an optimal ratio of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids (Nicolosi et al., 1997; Baghurst, 2004; Givens, 2005; Brenna, 2011).

The aim of the present work was to study the effects of safflower cake in lambs diet on their growth performances, carcass traits and meat quality.

2. Materials and Methods

The study was carried out on fourteen male lambs belonging to Comisana breed reared at the experimental station of the Department of Animal Production (University of Bari "Aldo Moro"). The animals were divided in two equal groups ("Control" and "Safflower cake") balanced for body weight and age. Lambs were weaned at 40 days of age and then they were fed *ad libitum* with pelleted total mixed rations that meet or exceed nutrient animal requirements for a 7-days adaptation period. After this period, the diet of the "Safflower cake "group were supplemented with 20% of safflower cake. All the lambs were slaughtered at 96 days of age.

For the investigation the following traits were measured: initial body weight, final body weight and feed intake. Moreover average daily gain and feed conversion ratio were calculated (Tab.1). At the end of the feeding period, all lambs were weighed after 24 h feed deprivation and slaughtered by exsanguination using conventional procedures.

The hot carcasses were chilled at 4°C for 24 h. The cold carcasses were sawed into two symmetrical sides along backbone. The leg and rack-loin were cut and weighed separately. Each cut was were dissected into the main tissue components (lean, fat and bone), the weight of each tissue was recorded and the respective percentages were calculated (Tab.2). The M. *longissimus lumborum* muscle were carefully dissected from the half-carcass of lambs and sampled for chemical analysis (Tab.3). Lipid extraction was carried out using ethyl ether maintained at low temperature and the solvent was removed under vacuum. In order to perform the gas-chromatographic analysis, total lipid was extracted with a chloroform and methanol (2:1, v:v) mixture (Folch et al., 1957). Fatty acid methyl esters were prepared with 12% BF3-methanol and analyzed by a gas chromatography (Chrompack, model CP 9000) equipped with a fused-silica capillary column (50 m × 0.25 mm i.d. × 0.25 μm film thickness) programmed over 140-210°C. In order to take into account the different effects of the various fatty acids, two indices (Atherogenic index and Thrombogenic index) were calculated (Ulbricht & Southgate, 1991). Data were analyzed by using the GLM (General Linear Model) procedure of SAS (SAS, 1999/2000); the model included the fixed effect of diet. Differences between diets were analyzed with the use of Student's t test.

3. Results and discussion

The safflower supplementation did not induce significative changes in the final body weight and average daily gains of lambs (Tab.1). On the other hand, a lower feed intake and a better feed conversion ratio were observed in "Safflower cake" group in comparison with "Control" group, even if these data were not significant at statistical analysis. Dissection data were reported in Table 2: lambs fed experimental diet showed a higher percentage of fat in the rack-loin (18.15 *vs* 17.01% $P<0.05$). As illustrated in Table 3, no significative differences

were found by comparing the chemical composition of *Longissimus lumborum* muscle of lambs belonging to different groups.

The safflower cake supplementation affected meat fatty acids profiles (Tab.4): in particular safflower cake dietary supplementation decreased the level of saturated fatty acids (48.50 *vs* 46.74%, P<0.05); moreover it increased the level of monounsaturated fatty acid (51.40 *vs* 53.26%, P<0.05) and the unsaturated to saturated ratio (1.05 vs 1.40%; P<0.01) in lamb meat. Furthermore the safflower cake supplementation also affected atherogenic index and thrombogenic index. Both these indices were significantly lower in meat of lambs fed "Safflower cake" diet (atherogenic index 1.02 vs. 0.93, P<0.01; thrombogenic index 1.69 vs 1.56, P<0.05). A significant result was found by comparing the cholesterol level of meat from lambs fed different diets: cholesterol level was lower in meat obtained from "Safflower cake" group (68.62 vs. 77.30 mg/100g; P<0.05).

4. Conclusions

The use of safflower cake increased the level of UFA and decreased the level of SFA in lamb meat. The improvement of the intramuscular fat quality (n-6 to n-3 ratio, atherogenic index, thrombogenic index, unsaturated to saturated ratio) may be a very important target for meat production in order to protect the consumer health.

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Table 1 - Productive performances of Comisana lambs fed two different diets

		Control	Safflower cake	Root SEM
Initial weight	kg	16.21	15.96	1.292
Final weight	"	23.06	23.88	2.156
Average daily gain	kg/d	0.163	0.188	0.04
Feed intake	"	0.960	0.874	-
Feed conversion ratio		5.88	4.65	-

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Table 2 – Dissection data of Comisana lambs fed two different diets

		Control	Safflower cake	Root SEM
Leg	kg	1.66	1.78	0.370
lean	%	59.76	60.06	3.554
fat	"	10.74	11.24	0.667
bone	"	29.50	28.70	1.221
Rack-loin	kg	0.40	0.46	0.053
lean	%	50.25	49.22	2.988
fat	"	17.01 **b**	18.15 **a**	0.661
bone	"	32.74	32.63	1.190

On the row: a, b $P<0.05$

Table 3 – Chemical composition of *Longissimus lumborum* (LL) muscle

		Control	Safflower cake	Root SEM
Moisture	%	75.70	75.78	0.950
Protein	"	18.60	19.00	0.620
Fat	"	3.93	3.27	0.982
Ash	"	1.31	1.24	0.063

Table 4 – Fatty acids composition (% on total fatty acids) of *Longissimus lumborum* of Comisana lambs

	Control	Safflower cake	Root SEM
SFA	48.50 **a**	46.74 **b**	0.881
MUFA	42.89	44.45	1.200
PUFA	8.52	8.81	0.622
UFA	51.40 **b**	53.26 **a**	0.891
n-3	0.89	1.01	0.160
n-6	7.72	7.80	0.625
n-6/n-3	8.67	7.72	0.681

Unsaturated/Saturated	1.05 **B**	1.40 **A**	0.061
Atherogenic index	1.02 **A**	0.93 **B**	0.038
Thrombogenic index	1.69 **a**	1.56 **b**	0.045
Cholesterol (mg/100 g)	77.30 **a**	68.62 **b**	-

On the row: a, b $P<0.05$; A, B $P<0.01$