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Effects of Safflower Cake Dietary Supplementation on Growth Performances, Carcass Traits and Meat Quality of Garganica Kids

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***Abstract*—**Two group of kids ("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. The kids were slaughtered at 96 days of age. Dietary safflower cake did not affect the growth traits of kids. In addition, kids fed experimental diet showed a lower feed intake and consequently a better feed conversion ratio in comparison to the "Control" group. The use of safflower decreased the level of SFA and increased the level of MUFA in kid meat. The level of PUFA was higher in lipid extracted from animals feeding "Control" diet even if the UFA level was lower. Furthermore, lipid extracted from animals feeding control diet contained more ω6 fatty acids in comparison to kids feeding experimental diet while the opposite trend was observed for the level of ω3 fatty acids. The ω6 to ω3 ratio was significantly affected by diet and in particular this ratio decreased in meat of kids fed experimental diet. Our results indicate that intramuscular fatty acid composition of kid meat can be improved from a human health perspective by inclusion of safflower cake in the diet.

***Keywords*—**cake, fattyacids, meat, safflower

I. Introduction

In the recent years, the economic trend of consumers is mostly oriented to prefer healthy and wholesome products, with organoleptic characteristics consistent with the new wine and food trails [1]. 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. 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 [2-15]. Many byproduct from the vegetable oil industry, such as safflower byproducts, are rich in unsaturated fatty acids [16-23]. The lack of the development of the crop for safflower oil production in the Mediterranean environments is mainly due to the length of cropping cycle along with low seed yield potential and some protectionist agricultural policy in favor of different oil crops. Safflower has high adaptability to the low moisture condition of Mediterranean areas [24, 25] and it is important to underline that safflowers exhibit high genetic variability and the major part of genotypes (~90%) shows a high level of oleic and linoleic acids. [26] The aim of the present work was to study the effects of safflower cake incorporation in kids diet on their growth performances, carcass traits and meat quality of kids.

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II. Materials And Methods

The study was carried out on sixteen male kids belonging to Garganica breed reared at the experimental station of the Department of Animal Production (University of Studies of Bari Aldo Moro). The animals were divided in two equal groups ("Control" and "Safflower cake") balanced for body weight and age. Kids 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 kids 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.I). At the end of the feeding period, all kids were weighed after 24 h feed deprivation and slaughtered by exsanguination using conventional procedures.

TABLE 1
PRODUCTIVE PERFORMANCES OF GARGANICA KIDS FED TWO DIFFERENT DIETS

		Control	Safflower cake	Root MSE
Initial weight	Kg	11,95	12,07	1,196
Final weight	-	20,97	20,32	1,992
Averange daily gain	Kg/d	0,182	0,168	0,022
Feed intake	-	0,765 **A**	0,621 **B**	0,074
Feed conversion *ratio*		4,244 **a**	3,693 **b**	0,645

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) and 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 8 animals (four per treatment group) 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 [28]. Fatty acid methyl esters were prepared with 12% BF3-methanol and analyzed by a gas

TABLE 2
DISSECTION DATA OF *GARGANICA* KIDS FED TWO DIFFERENT DIETS

		Control	Safflower cake	Root MSE
Leg	Kg	1,26	1,20	0,151
- lean	%	63,97 **a**	61,34 **b**	1,458
- fat	-	7,27	7,47	0,562
- bone	-	28,75	31,18	1,521
Rack-loin	Kg	0,31	0,26	0,060
- lean	%	49,04	46,31	3,298
- fat	-	19,83	16,91	3,357
- bone	-	31,13	36,77	3,062

a b P<0.05

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 [29]. Data were analyzed by using the GLM (General Linear Model) procedure of SAS [30]; the model included the fixed effect of diet. Differences between diets were analyzed with the use of Student's t test

III. Results and Discussion

The safflower supplementation did not induce significative changes in the final body weight and average daily gains of kids (Tab.1). On the other hand, a lower feed intake was observed in "Safflower cake" group in comparison with "Control" group (0.621 vs 0.765 kg/d, P<0.05). As a consequence, the kids belonging to the "Safflower cake" group showed a better feed conversion ratio if compared to that of "Control" group (3.693 vs 4.244). Dissection data were reported in Table 2: kids fed experimental diet showed a lower percentage of lean in the leg (61.34% vs 63.97%, P<0.05). As illustrated in Table 3, no significative differences were found by comparing the chemical composition of Longissimus lumborum muscle of kids belonging to different groups. These results are similar to those reported by Marinova et al. [31] and Arguello et al. [32].

TABLE 3
CHEMICAL COMPOSITION OF *LONGISSIMUS LUMBORUM* MUSCLE (%)

	Control	Safflower cake	Root MSE
Moisture	75,81	74,80	0,930
Protein	19,72	18,98	0,639
Fat	3,17	3,73	0,972
Ash	1,08	1,00	0,059

The safflower cake dietary supplementation affected meat fatty acids profiles (Tab.4): in particular safflower cake dietary supplementation decreased the level of saturated fatty acids (38.65% vs 44.73%, P<0.01) and increased the level of monounsaturated fatty acid (54.54% vs 47.82%, P<0.01) in kid meat. Moreover the "Control" group showed higher level of polyunsaturated fatty acids if compared to "Safflower cake" group (7,43% vs 6,80%), even if the unsaturated fatty acids level was lower in *Longissimus lumborum* muscle of kids fed control diet (55.26% vs 61.34%) (P<0.01). In particular, lipid extracted from animals feeding "Control" diet contained more ω6 fatty acids in comparison to kids feeding experimental diet (6.61% vs 5.74% respectively) while the opposite trend was observed for the level of ω3 fatty acids (1.06% vs 0.82%). In the present work, the ω6 to ω3 ratio was significantly affected by diet and in particular this ratio decreased in meat of kids fed experimental diet (5.55 vs 8.05 for "Safflower cake" and "Control" group respectively, P<0.05) being closer to the value suggested by the Italian Society of Human Nutrition which recommend a ω6 to ω3 ratio of 4 [35, 36]. Furthermore the safflower cake diet supplementation also affected Atherogenic index and Thrombogenic index. Both these indices were significantly lower in meat of kids fed "Safflower cake" diet (Atherogenic index 0.50 vs 0.58, P<0.05; Thrombogenic index 1.06 vs 1.41, P<0.01).

TABLE 4
FATTY ACIDS COMPOSITION (% ON TOTAL FATTY ACIDS) OF *LONGISSIMUS LUMBORUM* OF GARGANICA KIDS

	Control		Safflower cake		Root MSE
SFA	44,73	A	38,65	B	0,944
MUFA	47,82	B	54,54	A	1,126
PUFA	7,43		6,80		0,721
UFA	55,26	B	61,34	A	0,944
ω-6	6,61		5,74		0,599
ω-3	0,82		1,06		0,150
ω-6/ω-3	8,05	a	5,55	b	0,621
Unsatured/Satured	1,24	B	1,58	A	0,056
Atherogenic index	0,58	a	0,50	b	0,041
Thrombogenic index	1,41	A	1,06	B	0,051

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

IV. Conclusion

The use of safflower cake in kids nutrition did not cause significative differences on live weight and average daily gain even if kids fed with "Safflower cake" diet showed a lower feed intake and a better feed conversion ratio. The use of safflower increased the level of UFA in kid meat. The improvement of the intramuscular fat quality (ω6 to ω3 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. However, further investigations are needed to optimize the level of safflower cake incorporation in the diet in order to reach a compromise between the yield of meat and its dietetic quality.

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