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Effect of Extruded Cotton Seed and Canola Seed on Carcass Traits and CLA Content of Longissimus Dorsi Muscle in Mehraban Lambs

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Abstract: Effects of supplementary extruded oil seed on carcass characteristics and Conjugated Linoleic Acid (CLA) content of muscle in Mehraban male lambs were studied. The treatments included Control (C) diet C + 6% ECAS diet C + 6% ECOS diet C + 12% ECAS diet C + 12% ECOS diet C + 6% ECAS + 6% ECOS diet C + 12% ECAS + 6% ECOS diet C + 6% ECAS + 12% ECOS diet C + 12% ECAS + 12% ECOS diet C + 18% ECAS + 18% ECOS. About 60 Mehraban male lambs were used with the initial live weight of 34.3±2.12 kg and 5-6 months of age. The experimental period was 90 days and arranged in the completely randomized design. Carcass traits Dry Matter Intake (DMI) and CLA content in the muscle were significantly affected by different levels of ECOS and ECAS. There were linear and quadratic increments in the CLA content due to increasing in ECAS or ECOS from 0-12% of diet. Increasing of the ECOS and ECAS inclusion from 0-18% caused to increase in the CLA content but had negative influence on the carcass traits liver weight and DMI of lambs.

Key words: Lamb, extruded cotton seed, extruded canola seed, carcass traits, CLA, Iran

INTRODUCTION

Health professionals recommend diets low in saturated fatty acids cholesterol energy and with a good n-6/n-3 ratio among other numerous important factors to reduce the risk of chronic atherosclerosis and thrombosis (Beynen and Katan, 1989). Research data of (McGuire and McGuire, 2000) consistently showed that low levels of CLA can have marked positive effects on human health. The 9-cis 11-trans CLA is the major isomer found in ruminant products and appear to be largely responsible for their anti-caracinogenic effects (Bauman *et al*., 2000). In view of the progressive human demand for vegetable oils high in monounsaturated fat and low in ratio of n-6-n-3 polyunsaturated fatty acids. Canola seed contains approximately 20% protein and 38% fat; therefore they could serve as both protein and energy sources for livestock (Kercher *et al*., 1990a, b).

About 65% of canola oil is oleic acid. Because of the health attributes of oleate (Mattson and Grundy, 1985) increasing its concentration in animal fat could improve the nutritional quality of red meat. Cotton seed meal is used in dairy diets because of its lower price limited use in non-ruminant diets and greater escape protein when compared with soybean meal (Coppock *et al*., 1987). Moore *et al*. (1986) showed that fatty acid composition of the plasma lipids of ruminants can be influenced by the diet. It is possible to increase the level of polyunsaturated fatty acids in meat of leaner carcasses of cattle and sheep using oil seeds. Linseed is easy to incorporate in production rations and despite of extensive biohydrogenation in the rumen; it has been demonstrated to increase linolenic acid content significantly in both milk (Loor *et al*., 2005) and meat (Kronberg *et al*., 2006; Maddock *et al*., 2006).

Furthermore, it showed that animal products following linseed intake are enriched in C18:2 cis-9 trans-11 which is an isomer of Conjugated Linoleic Acid (CLA) that may have a positive effect on human health by decreasing the incidence of cancer (Bauman *et al*., 2005). Oil seeds can be either given as whole seeds or processed by different techniques which the most common is extrusion.

Theoretically, since the extrusion process breaks down plant cells it is expected that cytosolic triglycerides are more accessible to rumen bacteria than nourished with whole seed content meaning they are more rapidly available for lipolysis and biohydrogenation (Maddock *et al*., 2006). Gonthier *et al*. (2004) found that although, extrusion increased the disappearance of linolenic acid but also increased the proportion of intermediate compounds such as trans 18:1 FA in duodenal flow. The experiment was conduct to quantify

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Table 1: Ingredients and composition of the experimental concentrates

Ingredients (% in diet)	[1]Concentrates Control	6% ECAS	6% ECOS	12% ECAS	12% ECOS	6%ECAS +6% ECOS	12%ECAS +6% ECOS	6%ECAS +12% ECOS	12% ECAS +12% ECOS	18%ECAS +18% ECOS
Corn silage	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Ifalfa hay	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Extruded	-	-	6.00	-	12.00	6.00	6.00	12.00	12.00	18.00
Cotton seed										
Extruded	-	6.00	-	12.00	-	6.00	12.00	6.00	12.00	18.00
Canola seed										
Barley	53.20	49.20	52.20	46.30	46.30	46.30	40.30	40.30	34.30	17.20
Wheat bran	5.00	3.00	-	-	-	-	-	-	-	5.00
Limestone	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45	0.45	0.55
Vitamin/minera	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix*										
Urea	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Chemical analysis (on DM basis)										
Dry matter (%)	59.20	59.20	59.30	59.30	59.30	59.30	59.30	59.40	59.40	59.40
Crude protein (%)	13.50	15.20	15.10	16.80	16.80	16.90	18.50	18.60	20.30	24.00
Metabolizable energy (Mcal kg^{-1})	2.22	2.20	2.22	2.20	2.19	2.19	2.16	2.16	2.13	2.04

*Each kg of Vitamin/mineral premix contained: 500000 IU vitamin A, 100000 IU vitamin D3, 100 mg vitamin E, 190 g Ca, 90 g Mg, 50 g Na, 2 g Mn, 3 g Fe, 0.3 g Cu, 3 g Zn, 0.1 g Co and 1 mg Se 1. Each lamb was fed 1.4 kg day^{-1} of Total Mixed Ration (TMR), made of 20% corn silage +20% alfalfa hay + 60% concentrate for 90 days

the effect of the inclusion of up to 18% extruded cotton seed and canola seed in diet on carcass characteristics and CLA content in muscles of mehraban male lambs.

MATERIALS AND METHODS

This experiment was carried out at the Animal Research Station Agricultural Technical Schools Fasa Shiraz, Iran. About 60 Mehraban male lambs of 5-6 months of age with the initial weight of 34.3±2.1 kg were individually placed in 60 pens (1×1.5 m) and randomly assigned to one of the 10 dietary treatments to have 6 lambs per treatment. The animals were under natural day light and their health was monitored throughout the experiment.

A 12 day adaptation period was used for animals fed diets containing ECOS or ECAS. Lambs were fed twice daily with the amount of 1.4 kg day^{-1}. Each diet was offered as a Total Mixed Ration (TMR) made of 20% corn silage +20% alfalfa hay +60% concentrate. The composition of the concentrates containing various levels of extruded oil seeds is shown in Table 1. Chemical analysis of the ration ingredients was determined using the standard methods (AOAC, 1990).

At the end of the experiment, the feed and water were removed for 18 h after which the lambs were weighed and slaughtered according to the local practices (Zamiri and Izadifard, 1997). The dressing percentage was calculated as follows (weight of carcass/live weight at slaughter) ×100. Cold carcass weight was determined after 24 h at 4°C and the cross sectional area of the muscle (longissimus dorsi) was measured on both sides of the carcass between the 12 and 13th ribs. Intramuscular fats of muscle were extracted according the method proposed by Folch *et al.* (1957). The methyl esters of the fatty acids (Hawke *et al.*, 1977) were analyzed by gas chromatography with a Omegawax 320™ fused silica capillary column (30 m×0.32 mm i.d. 0.25 μM film thickness); the column temperature was held at 150°C for 4 min then gradually brought up to 240°C in increments of 1.5°C min^{-1}, the injector/detector temperatures were 250°C. The carrier gas nitrogen was applied at a pressure of 70 kPa and 1 μL of sample solution was injected. The data were analyzed using the General Linear Model (GLM) procedure of SAS for windows (SAS, 2004).

The effects of treatment (oil seed) were included in the model. Initial weight was used as the covariate for analysis of data. Means were compared using least square means adjusted for Duncan ($p \leq 0.05$). The single degree of freedom orthogonal contrasts were used to compare the effects of ECOS vs. ECAS as well as ECOS vs. ECOS + ECAS and ECAS vs. ECOS + ECAS.

RESULTS AND DISCUSSION

The effects of diets contained ECOS or ECAS and mixture of the 2 on the carcass traits of the Mehraban lambs is shown in Table 2. As data shown final body weight dressing percentage hot and cold weights liver weight DMI and CLA content in muscle (Longissimus dorsi) were significantly ($p<0.05$) affected by dietary treatments (Table 2). The highest and lowest rates of the FBW and hot weight were found in treatments 1, 2, 6 and

Table 2: Carcass characteristics and CLA content in muscle of mehraban male lambs fed diets with different levels of extruded cotton seed (ECOS) and Extruded Canola Seed (ECAS)

	Concentrates[1]										
Parameters	Control	6% ECAS	6% ECOS	12% ECAS	12% ECOS	6% ECAS +6% ECOS	12%ECAS +6% ECOS	6%ECAS + 12% ECOS	12%ECAS + 12% ECOS	18%ECAS +18% ECOS	SEM
IBW (kg)	34.310	34.59	34.33	34.40	34.58	34.78	34.05	33.40	33.630	34.32	0.5412
FBW (kg)	53.950^{a}	53.82^{a}	53.17^{ab}	51.62^{bc}	52.25^{abc}	53.88^{a}	49.85^{de}	50.63^{cd}	48.420^{e}	48.98^{e}	0.5412
DP (%)	55.200^{a}	54.72^{a}	54.61^{a}	54.83^{a}	53.53^{b}	55.25^{a}	52.27^{c}	52.68^{c}	52.020^{c}	52.09^{c}	0.3103
CW (kg)	28.620^{ab}	27.82^{c}	27.93^{bc}	26.62^{d}	27.47^{c}	28.79^{a}	23.66^{f}	24.48^{e}	22.290^{g}	23.47^{f}	0.2633
HW (kg)	29.860^{a}	29.55^{a}	29.61^{a}	27.41^{c}	28.60^{b}	29.69^{a}	24.57^{de}	25.28^{d}	23.460^{f}	24.18^{ef}	0.2674
LW (kg)	1.173^{ab}	1.15^{ab}	1.14^{ab}	0.84^{c}	1.07^{b}	1.19^{a}	0.73^{d}	0.79^{cd}	0.719^{d}	0.73^{d}	0.0324
DMI (kg day^{-1})	1.540^{a}	1.52^{a}	1.50^{a}	1.40^{b}	1.41^{b}	1.42^{b}	1.30^{c}	1.26^{c}	1.230^{d}	1.15^{e}	0.0255
CLA Muscle	80.580^{g}	84.17^{f}	83.59^{f}	89.19^{c}	88.52^{d}	86.14^{e}	90.79^{b}	88.97^{cd}	91.130^{b}	93.55^{a}	0.5210

$^{a, b, c, d, e, f, g}$Means in a row with no common superscript are significantly different ($p<0.05$). DP = Dressing Percentage; CW = Cold Weight; HW = Hot Weight; FBW = Final Body Weight; LW = Liver Weight; DMI = Dry Matter Intake; FCR = Feed Conversion Rate; CLA = Conjugated Linoleic Acid. SEM: Standard Error of Mean; Data presented are means. 1. Each lamb was fed 1.4 kg day^{-1} of total mixed ration (TMR), made of 20% corn silage + 20% alfalfa hay + 60% concentrate for 90 days

9 and 10, respectively (Table 2). The negative effect of supplementation on hot carcass FBW in the present study was contrast to that reported by Okello and Obwolo (1994) in goats supplemented with cotton seed meal and maize bran. The highest and lowest amounts of dressing percentage were resulted from treatments 1, 2, 3, 4, 6 and 7, 8, 9, 10, respectively (Table 2). Dressing percentage is an important parameter assessing meat production potential in animals and it may be influenced by age sex and nutrition (Devandra and Burns, 1983). Brand *et al.* (2001) found that an increase in the inclusion of canola seed from 6-18% had no negative effect on growth rate feed conversion rate and dressing percentage of lambs.

Zinn *et al.* (1997) also reported that different levels of cotton seed meal supplementation to cattle did not affect dressing percentage. In the present study final body weight dressing percentage hot and liver weight Dry Matter Intake (DMI) were not affected by 6% ECOS and ECAS supplementation. Similar to the results, Lough *et al.* (1991) found no effect of 6% full fat canola inclusion in a finishing diet for ram lambs on either dressing percentage. Similar to the values reported by Kott *et al.* (2003) for lambs supplemented with safflower cake. Cold weight and liver weight was significantly higher ($p<0.01$) for lambs fed the diet 6 (6% ECOS + 6% ECAS) in comparison with those fed the other diets. The lowest in cold weight and liver weight were obtained in treatment 10 (Table 2). Consistent to the present study, Kandylis *et al.* (1998) observed that increasing levels of whole cotton seed (0, 5, 10, 15, 20 and 30%) had no effect on the cold weight and significantly increased liver weight in lambs. There were significant differences among treatments in DMI (Table 2). Increase in ECOS and/or ECAS inclusion of up to 18% had negative influence on the DMI of lamb. The DMI was lower for lambs fed diet 9, 10 and higher for lambs fed on the diet 1, 2 and 3.

Scharma *et al.* (1986) reported no significant differences in DMI between calves fed canola meal or 18% whole canola seed. Tesfa *et al.* (1992) on the other hand found that the addition of rapeseed oil (0, 5 and 10%) to diets of lactating dairy cows depressed DMI. Brand *et al.* (2001) found similar daily dry matter intake in lambs consuming the four different level of canola (0, 6, 12 and 18%). A depression in intake was also observed by Spratt and Leeson (1985) for lactating sows fed raw full-fat canola seed. There were significant differences among treatments in CLA content of muscle (Table 2). In these trials the proportion of CLA was higher in supplementary treatments than control lambs.

CLA content of muscle was significantly higher in treatment 10 (18% ECAS and 18% ECOS) and lower in control (Table 2). There were linear and quadratic increments ($p<0.001$) in CLA content due to increases in ECAS or ECOS from 0-12% (Table 3). CLA content ($p<0.01$) was significantly higher in supplementary treatments of ECOS + ECAS than treatments of ECOS or ECAS (Table 3). The fatty acid composition of the muscles reflected the influences of the diet (Bolte *et al.*, 2002). High content of CLA was found in lambs receiving diets in ECOS and ECAS which may be related to high linoleic content of diets.

The extent to which dietary unsaturated escape hydrogenation appears to depend on microbial growth conditions that influence rates of lipolysis and BH. In the trial dietary addition of extruded oil seed seemed to be the better strategies for delivery of unsaturated fatty acids. Wachira *et al.* (2000) showed that increases of linolenic acid content of diet to 20 g kg^{-1} DM resulted in 2-fold increases of linolenic acid content in duodenal flow. It is suggested that the part of the dietary linolenic acid from oil seed could escape BH and be taken up by the tissues. Supplementation of ECOS treatments increased the final body weight hot and cold weights and liver weight DMI compared to ECAS significantly (Table 3).

Consistent to the present study, Khan *et al.* (1997) observed that canola meal diets were significantly better protein sources for lamb growth than cotton seed meal. Higher FBW dressing percentage liver weight hot and cold weights DMI were observed for supplementary ECOS or ECAS compared to the treatments consisted of ECOS + ECAS (Table 3). There was a linear correlation

Table 3: The orthogonal contrast for the effect of extruded canola seed (ECAS) and extruded cotton seed (ECOS) or the mixture of two on characteristics and CLA Content in muscle

	Contrasts						
	ECOS. vs ECAS	ECOS vs. ECOS + ECAS	ECAS vs. ECOS+ ECAS	Linear		Quadratic	
Parameter				ECOS group	ECAS group	ECOS group	ECAS group
FBW	0.0083	0.0004	0.0004	***	***	NS	NS
DP	0.4459	0.0017	0.0017	NS	**	NS	NS
CW	0.0008	<.0001	<.0001	***	NS	NS	***
HW	<.0001	<.0001	<.0001	***	***	NS	***
LW	<.0001	<.0001	<.0001	***	***	NS	NS
DMI	0.0038	<.0001	<.0001	***	***	***	***
CLA	<.0001	<.0001	<.0001	***	***	***	***

P-values of single degree of freedom orthogonal contrasts;**=P<0.01; ***=P<0.001; NS= not significant; ECOS= extruded Cotton seed; ECAS = extruded canola seed; DP=dressing percentage; CW= cold weight; HW= hot weight; FBW=final body weight; LW=liver weight; DMI = dry matter intake; FCR = feed conversion rate; CLA = Conjugated Linoleic Acid

among different levels of ECAS or ECOS with final body weight liver weight hot and cold weight and DMI (Table 3). Table 2 showed that final body weight liver weight hot and cold weight DMI decreased as ECAS or ECOS rates increased from 0-12%. On the other hand, dressing percentage (linear; p<0.001) prone to decrease with increment of ECOS from 0-12%. Low dressing percentage with increment of ECOS could be due to high gut fill which accordingly reduced the dressing percentage. The equal DMI of cows fed cotton seed meal was in accord with De Peters and Bath (1986) who found no effects of using canola meal as 13% of dietary DM on DMI.

CONCLUSION

The results of this study suggest that the inclusion of high linoleic extruded cotton seed and canola seed in the ration of lambs can have positive effects on fatty acid profile of meat resulting in a healthier product. Improved CLA levels in muscle tissue of extruded cotton seed and canola seed supplemented lambs may positively influence the on set and severity of several chronic diseases in humans including arteriosclerosis various cancers and diabetes. Final body weight dressing percentage hot and liver weight DMI were not affected by 6% ECOS and ECAS supplementation. Increase in ECOS and ECAS inclusion of up to 18% had negative influence on the final body weight dressing percentage hot and cold weights liver weight and DMI of lamb.

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