INCREASING LEVELS OF LIPIDS, USING SUNFLOWER MEAL IN THE DIET OF FINISHING LAMBS ON MEAT QUALITY

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Abstract – The experiment was conducted in order to evaluate the effect of including bran and sunflower oil in diets providing different levels of ether extract on the meat quality of finishing lambs. Twenty Santa Ines males slaughtered at 45 ± 2 kg, in a completely randomized design were used. Animals were divided into 4 treatments with 5 replicates per treatment, being: 1) 2.07% ether extract (EE), 2) 4.88% ether extract, 3) 8.13% ether extract and 4) 11.24% ether extract. Analyzes of proximate composition, fatty acid profile, color (L*, a*, b*), cooking weight loss, shear force-WBSF, cholesterol and estimated the activity of some enzymes, were done. Data were analyzed by PROC MIXED and PROC REG procedures of the Statistical Analysis System (SAS). The ether extract, a*, C18:0, C18:2 C9 t11, C18:1 t11 and elongase enzyme activity increased with the increase of lipids in the diet, while the C16:0, C16:1, the estimated activity of Δ9 desaturase enzymes C16 and C18 and atherogenicity index decreased under the influence of increased lipids. It is concluded that the use of sunflower oil in diets of finishing lambs containing increasing levels of sunflower meal, can improve the profile of meat fatty acids.

I. INTRODUCTION

In Brazil, despite the consumption of lamb meat is considered low, can be observed an increase of this in recent years. But we have the requirement with regards to product quality, specialized cuts, standardization and the constant presence of the same in the market. The final consolidation and the opening of new markets require production of sheep meat with high quality. Thus, it is necessary to search for managements, especially the nutrition management, providing a product that meets consumer demands.

The factors that determine the meat quality include the chemical composition, especially the amount and quality of fat components, and sensory characteristics, directly related to the taste or to the taste qualities.

Recently, there has been observed a great interest for manipulating the fatty acid composition of meat in general. This interest stems from the fact that meat is the main source of dietary fat, particularly saturated fatty acids, involved in coronary heart disease and cancer, diseases associated with modern life. In addition, the nutritional importance of the fatty acid profile for human health has been justified by the fact that the fatty acid profile generally has little influence on the carcass market value compared to the total fat content.

Therefore, the experiment was conducted in order to evaluate the effect of including bran and sunflower oil in diets providing different levels of ether extract on the meat quality of finishing lambs.

II. MATERIALS AND METHODS

The experiment was conducted in the Sheep Sector at the Federal University of Lavras for 132 days. The first 10 days of confinement were considered as pretrial period for adaptation to the diets and to the confinement conditions.

Twenty not castrated Santa Ines males were used in a completely randomized design. Animals were divided into 4 treatments with 5 replicates per treatment. Four levels of sunflower bran were tested (0%, 11%, 22% and 33%) which associated to levels of sunflower oil (0,0; 2,72; 5,72 and 8,72%) result on diets with different levels of EE: 2,07; 4,88; 8,13 and 11,24%, respectively.

Animals were slaughtered at a live weight of 45 ± 2 kg followed by the removal of the skin, evisceration and separation of the head and extremities.

After 24 hours of slaughter, from the left cold carcass the *Longissimus dorsi* (LD) was obtained, being packed in aluminum paper,

identified, placed in plastic bags and frozen at -18 ° C for physicochemical analyzes.

To perform the analyzes, samples of the muscles were thawed at refrigeration temperature (5°C) for a period of approximately 16 hours and used for the determination of color, weight loss during cooking and shear force. The pH readings values were made directly on the carcasses at 1, 3, 6, 24 and 30 hours after slaughter.

The *LD* muscle was adequately prepared to perform the chemical composition analysis. All analyzes to determine the chemical composition were performed according to the Association of Official Analytical Chemists - AOAC (2006) (1).

The cholesterol was determined by a high performance liquid chromatography according to Bragagnolo (1997) (2).

Samples for the determination of fatty acid profiles were extracted from the *Longissimus dorsi* (LD) muscle (free of visible fat and connective tissue) taken from the carcass left half. The extraction was made according to the method of Hara and Radin (1987) (3) and methylation according to the method of Christie (1982) (4).

The percentages of fatty acids were analyzed in the lipid fraction of the LD after extraction of all lipids that are part of the muscle (intramuscular fat, phospholipids and fat-soluble vitamins). The activities of Δ9 desaturase enzymes and elongases were determined as described by Malau-Aduli *et al.* (1997) (5), by mathematical ratios. The atherogenicity index was calculated as an indicator for the risk of cardiovascular disease. Data were analyzed by PROC MIXED and PROC REG procedures of the Statistical Analysis System (SAS) (6).

III. RESULTS AND DISCUSSION

Table 1 shows the data relating to the ether extract content, color, saturated and unsaturated fatty acids and their relationship, from the LD muscle and the activity of the enzymes Δ9 desaturase 16, Δ9 desaturase 18, Elongase and atherogenicity index (AI) of lambs fed with diets containing increasing levels of EE.

Tabla 1- Chemical composition, color, saturated and unsaturated fatty acids and their relationship, from the *Longissimus dorsi* muscle and enzymes activity Δ9 desaturase16, Δ9 desaturase 18, Elongase and atherogenicity index (AI) of lambs fed with diets containing increasing levels of ether extract .

REGRESSION ANALYSIS						
	Diets (%EE)					
Variables	2.07	4.88	8.13	11.24	EQUATION	P
EE (%MN)	6.42	7.00	7.10	7.88	Y=6.86+0.14X	0.0073
Color parameter a*	14.44	13.96	15.02	15.29	Y = 13.97 + 0.21 X	0.0268
C 16:0	23.40	22.38	19.76	18.16	Y=24.19–0.68X	<0.0001
C 18:0	15.57	14.71	17.53	18.22	Y=14.76+0.33X	0.0058
Poli[1]	4.85	6.64	8.50	10.72	Y=5.014+0.56X	<0.001
C 16:1	2.33	2.36	1.75	1.47	Y=2.47–0.11X	0.0001
C9t11	0.46	0.97	1.97	2.77	Y=0.36+0.27X	<0.0001
t11	1.16	2.08	4.82	5.80	Y=0.97+0.56X	<0,0001
AGP/AGS[2]	0.11	0.16	0.20	0.27	Y=0.088+0.0154X	0,002
AGM/AGP[3]	11.10	8.11	5.94	4.80	Y=12.235–0.72X	<0.001
C18:2 C9 T11	0.46	0.97	1.97	2.77	Y=-0.154+ 0.26X	<0.001
C18:2 C9 C12	2.62	3.83	4.66	5.90	Y=1.63+0.336X	<0.001
Δ9 D 16[4]	9.10	9.81	8.14	7.46	Y=9.61–0.23X	0.0384
Δ9 D 18[5]	73.21	73.33	68.20	66.79	Y=74.21–0.77X	0.0013
Elongase	69.32	67.26	71.90	73.74	Y=67.88+ 0.62X	0.0005
A I[6]	0.67	0.68	0.56	0.52	Y = 0.69 – 0.02 X	0.0003

[1]Poli- Polyunsaturated; [2]AGP/AGS- polyunsaturated/ saturated relation; [3]AGM/AGP- monounsaturated/ polyunsaturated relation; [4]Δ9 D 16- Δ9 Dessaturase 16, [5]Δ9 D 18- Δ9 Dessaturase 18 e [6] AI- aterogenic index

It is observed in the literature that the ether extract from lamb's meat show great variation, mainly due to diet, weight, slaughter age, race, sex and muscle (Madruga *et al.*, 2005) (7). The percentage of ether extract in the LD, which is a good indication of the percentage of intramuscular fat of the carcass, increased linearly as it increased the inclusion of EE in the diets.

Data of the color parameter a* were positively and linearly affected by the increasing level of

EE in the diets. This fact is probably due to different amounts of myoglobin in animal's meat, which is directly affected by the amount of iron present in their diet. The amount of the nutrient that was consumed cannot be reported, because one was not measured.

The values found in this study relating to the lambs meat fatty acid profile were influenced by diet. This may be due to the fatty acid composition of sunflower oil which is 68.5% of C18: 2cis9, cis12; 21.7% of C18: 1; 5.5% of C16: 0; 3.5% of C18: 0 and a small amount of C18: 3 and C20: 0 (Palmquist, 2004) (8). This could explain the reason for the use of this product to manipulate the composition of the meat through the diets used.

The fatty acid profile generally has little influence on the carcass market value compared to the fat content. However, the physical and chemical properties of lipids affect the nutritional, sensory and preserving characteristics of the meat (Mottram, 1998) (9) characteristics. Macedo *et al.* (2008) (10) evaluated the increasing inclusion of sunflower seed in the diet of sheep and found a decrease in palmitic saturated fatty acid (C16: 0) and increase in meat unsaturation by the introduction of oleic fatty acid (18:1 c9) and linoleic (C18: 2c9c12) in LD muscle of lambs. In this study the same behavior can be observed.

High concentration of oleic acid in the intramuscular fat composition of ruminants has been reported in the literature (Enser *et al*, 1996) (11). Two other fatty acids, palmitic and stearic, are also excelled in lamb's lipid profile. According to Gaili & Ali (1985) (12), these three acids are responsible for approximately 90% of total fatty acids in ruminant meat. The lipid profile of meat from Santa Ines sheep, composed predominantly of C18:1, C16:0 and C18:0, has been reported by Rosales (2003) (13). Macedo (2003) (14) tested sunflower seed inclusion levels in the diet of lambs and observed linear effect on the reduction of saturated fatty acids and increase in oleic and linoleic acids in lambs meat.

The data showed the possibility to change the fatty acid profile of meat, increasing the proportion of unsaturated, condition favorable to the consumer. The same can be observed in this study which, although not statistically evidence, there is a strong tendency to occur. Levels of enzymes activity of Δ9 desaturase C16 and C18, are responsible for converting the saturated fat acid with 16 and 18 carbon atoms respectively, in their corresponding monounsaturated with double bond in the 9 carbon, as described by Malau-Aduli *et al.* (1997) (5). This ratio expresses the amount of product (monounsaturated fatty acid) as a percentage of substrate available for conversion. The atherogenicity index lists the pro-and anti-atherogenic acids and indicate the potential to stimulate platelet aggregation, ie, the smaller the values of the atherogenicity index, the greater the amount of atherogenic fatty acids present in fats and, consequently, the greater the potential preventing the onset of coronary heart disease (Arruda, 2010) (15).

According to Bauman *et al.* (2013) (16) diet can influence the synthesis of CLA in ruminants in three ways: diets that have lipids available for CLA and vaccenic acid synthesis in the rumen, such as those containing oils, diets that alter the rumen environment and modify the bacterial population responsible for biohydrogenation and diets associated with lipid substrates that alter the bacterial population.

IV. CONCLUSION

It is concluded that with the use of sunflower oil in diets of finishing lambs containing increasing levels of sunflower meal, can improve the profile of fatty acids due to the increase of polyunsaturated, including C18:2 C9 t11, providing improvement in the estimates of atherogenicity index, without any major changes in the main physical and chemical parameters of the meat.

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