EFFECT OF FEEDING SYSTEM OF LAMBS ON INDEXES AND RELATIONS BETWEEN THE FATTY ACIDS OF INTRAMUSCULAR FAT FROM MEAT

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Abstract – In order to evaluate the effect of feeding system on indexes and relations between fatty acids of intramuscular fat from meat, 20 lambs Texel crossbred and Ile de France were used, divided into two feeding systems : feedlot finished diet with exclusive concentrated food or natural pasture finished grazing ryegrass (*Lolium multiflorum* Lam). The experiment was conducted at the Federal University of Santa Maria, from October 2012 to July 2013. Slaughter was performed with 35kg bodyweight. *Longissimus dorsi* muscle was used to determine the profile of meat fatty acids. From the fatty acids identified in the sample were calculated indices and their relationships. Lambs fed exclusively on pasture showed meat with higher proportions of unsaturated n3 fatty long and very long chain fatty acids, as well as better ratio n-3:n-6 and better rates of atherogenicity and thrombogenicity concluding that the lamb meat produced pasture is healthier compared to lamb meat produced with concentrated food.

I. INTRODUCTION

Over many years of evolution, humans have adapted to consume large amounts of lean red meat (1). The meat is seen as an important source of dietary fat and especially saturated fatty acids, and this has been implicated in diseases associated with modern life, especially in developed countries, and include several types of cancer and heart diseases, especially coronary (2) Several studies indicate that a diet rich in saturated fatty acids (SFA) is associated with high levels of cholesterol in the blood which in turn are connected to the high incidence of coronary heart disease (3). Cardiovascular diseases in most cases, occur due to the obstruction of the coronary arteries, atherosclerosis or thrombosis, alone or in combination. The primary or initial cause of atherosclerosis is unknown, but one hypothesis is that the main event is the damage of free radicals in low density lipoproteins (LDL) (4). It is possible to recognize seven dietary factors involving in cardiovascular diseases. Two are promoters of the development of cardiovascular diseases: atherogenic SFA and thrombogenic SFA. Five are protective of cardiovascular diseases, which are: polyunsaturated (PUFA) fatty acids of the series n-6 acid (linoleic acid), the series PUFA n-3 (linolenic acid), monounsaturated fatty acids (MUFA), dietary fiber and antioxidants (4). Moreover, the beneficial effects of longer chain to reduce the risk of cardiovascular disease are well recognized (5). Thus, the present study was conducted to evaluate the effect of feeding system on indexes and relations between fatty acids of intramuscular fat from meat.

II. MATERIALS AND METHODS

The experiment was conducted at the Federal University of Santa Maria, from October 2012 to July 2013. Twenty lambs crossbred between Texel and Ile de France were used , divided into two feeding systems: a) System 1 (S1) with finished diet exclusively concentrated (77.36 % corn grain, 20.20% soybean meal, 1.42 % for limestone and 1.02% sodium bicarbonate); b) System 2 (S2) natural + grazing ryegrass pasture with forage diet exclusively . After slaughter, the carcasses were stored at 4°C for 24 h. *Longissimus dorsi* muscle was removed from the right half carcass portion comprising the 6th to the 10th dorsal vertebra, vacuum packed and stored at below -18°C for subsequent analysis. Intramuscular fat was extracted according to Hara; Radin (6). Subsequently, we proceeded to the derivatization in accordance with Christie (7). The methyl esters of fatty acids were analyzed in the gas chromatograph model 6890N (Agilent Technologies, Santa Clara, CA, USA) equipped with flame ionization detector, G4513A automatic injector (Agilent Technologies, Santa Clara, CA, USA) and capillary column fused silica SP-2560 (Supelco, Bellefonte, PA, USA) 100m×0.25mm×0.20µm ciano silicone with highly polar stationary phase . The injection volume was 1µL ratio 1:50. The identification of the peaks was performed by comparison with the retention times of the methyl esters of standards (Sigma-Aldrich, St. Louis, MO, USA) fatty acids. Quantification was determined by the peak area of interest in relation to the total area of peaks identified, expressed in g/100 g (%). The relations were evaluated due to the degree of saturation in saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA); and short chain length (ΣC4-C10), medium (ΣC12 -C16), long (ΣC18- C20), very long (ΣC22- C24) and odd. We also calculated n6 fatty acids [Σ (C18:2 n-6 t9, t12; C18:2 n-6 c9, c12; C18:2 n6 t10, c12; C20:2 n6 c11, c14; C22:2 n6 c13, c16; C18:3 n6 c6, c9, c12; C20:3 n6 c8, c11, c14; C20:4 n-6 c5, c8, c11, c14)] and n-3 [Σ (C18:3 n-3 c9, c12, c15; C20:3 n-3 c11, c14, c17; C20:5 n3 c5, c8, c11, c14 , c17; C22:6 n3 c7, c10, c13, c16, c19] In addition, the activities of enzymes Δ^9desaturase 14; Δ^9 desaturase 16; Δ^9 desaturase 18; Δ^9 desaturase CLA; elongase and thioesterase were calculated according to Mello (8). Additionally, the indices of atherogenicity and thrombogenicity were computed according to Ulbricht;Southgate (4), and nutritional ratio according Estévez (9). The experimental design was completely randomized with two food systems and ten repetitions. After the normality test, the data were subjected to analysis of variance and the F test level 5 % significance, using the GLM procedure of SAS, version 9.1.

III. RESULTS AND DISCUSSION

The percentages of SFA present in intramuscular fat of *Longissimus dorsi*, had no influence in the animal's diet. However, the diet based exclusively on pasture promoted an increase in the amount of fatty acids of long and very long chain (Table 1, P <0 05).

Table 1 – Relationship between fatty acids by their chain length and degree of saturation, the Δ^9desaturase activity indices atherogenicity and thrombogenicity, and nutritional ratio in intramuscular fat of Longissimus dorsi of lambs in different feeding systems.

	Feeding System			
Variables	Concentrated	Pasture	P*	MSE
SFA	47,11	46,26	0,5926	3,45
MUFA	44,29	40,56	0.0829	4,28
PUFA	8,59	11,79	0.0657	3,42
Short chain	0,20	0,12	0,0007	0,04
Medium chain	30,24	22,54	0.0002	2,94
Long chain	67,23	72,56	0,0050	3,23
Very long chain	0,27	1,09	<0.0001	0,26
Odd chain	2,05	2,32	0.1879	0,42
n-6	7,25	5,73	0.2361	2,66
n-3	0,87	4,17	<0.0001	1,08
MUFA:SFA	0,95	0,88	0.3154	0,13
PUFA:SFA	0,19	0,26	0.0875	0,08
n6:n3	9,15	1,39	0.0003	3,11
Δ^9desaturase (14)	2,88	1,40	<0.0001	0,41
Δ^9desaturase (16)	5,10	5,29	0.5154	0,61
Δ^9desaturase (18)	69,91	59,38	<0.0001	3,36
Δ^9desaturase (CLA)	11,02	27,22	0.0078	10,63
Elongase	66,53	72,77	0.0001	2,21
Thioesterase	11,55	11,98	0.7243	2,61
Atherogenicity	0,69	0,51	0.0102	0,12
Tthrombogenicity	1,59	1,22	0.0056	0,23
Nutritional ratio	0,59	0,47	0.0240	0,09

*Probability

The Dietary Guidelines for Americans (10) recommends reducing intake of SFA to less than 10 % of calories by replacing them with PUFA and MUFA. Replacing carbohydrate SFA lowers LDL. However, comparing the substitution of MUFA and PUFA carbohydrates decrease HDL and increase triglycerides, which are factors associated with increased cardiovascular risk. Studies have shown that by replacing SFA MUFA and PUFA improves blood lipid profiles reducing the risk of cardiovascular diseases, as opposed to replacing carbohydrate (3). The beneficial effects of longer chain PUFA n3 in reducing the risk of cardiovascular disease are well recognized (5). There was no difference between feeding systems for n6 polyunsaturated (P=0.2361) fatty acids.

Neverthless, the feed system promoted increased ($P < 0.0001$) for n-3 polyunsaturated fatty acids in lamb meat produced exclusively pasture affecting the ratio n6:n3. This was 9.15 for meat produced exclusively with concentrated food, and 1.39 for meat produced on pasture, which is considered very good. According to Simopoulos (11) the optimal dose or ratio of omega-6/omega-3 varies from 1/1 to 4/1 depending on the disease under consideration. Meat and other ruminant products are important dietary sources of conjugated linoleic acid (CLA), of which the best known is C18:2 c9 t11, which presents beneficial properties for health (12). The values obtained were higher ($P < 0.003$) for animals with pasture diet exclusively (27.22%) compared to animals with diet exclusively concentrated (11.02%). The ruminant tissues, especially liver and adipose tissue, have Δ^9 desaturase enzyme which converts C18: 1n-7 - vaccenic acid to CLA t11 (13). The vaccenic acid that is not transformed into C:18 (stearic acid) is transported by the blood to the tissues, where it is desaturated by the enzyme action Δ^9 desaturase and converted into conjugated linoleic acid (CLA). This fact explains the higher concentration of CLA in products from animals fed on pasture, because this food has a lower rate of degradation in the rumen compared with concentrate based diet. Although it is customary to consider these factors independently, in most cases, the response to dietary factors should be assessed in an integrated manner. In this sense, Ulbricht and Southgate (4) propose the use of the index of atherogenicity and thrombogenicity index as a way to compare foods. These indices take into account the percentage of PUFA of the n6 series (linoleic acid), the series PUFA n3 (linolenic), MUFA and SFA. Sinclair (14) repeatedly emphasized that the processes of atherosclerosis and coronary thrombosis are different: the former does not necessarily lead to the second. The thrombogenicity and atherogenicity index were higher than for the meat produced from concentrate ($P < 0.05$).

IV. CONCLUSION

The measured fatty acids values, relations and indices calculated showed that the lamb meat produced on pasture is healthier compared to lamb meat produced with concentrated food.

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