CHEMICAL COMPOSITION AND FATTY ACIDS PROFILE OF LAMB MEAT FED EXCLUSIVELY CONCENTRATED FOOD OR PASTURE.

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ABSTRACT- With the aim of evaluating the effect of feeding based exclusively on concentrated or pasture in the chemical composition and the fat acid profile of lamb meat 20 lambs crossbred Texel and Ile de France were used, distributed in two feeding systems: finished in feedlot with exclusive concentrated or natural pasture with finished Raygrass (*Lolium multiflorum* Lam). The experiment was performed in the Federal University of Santa Maria, from October 2012 to July 2013. The slaughter was made when the animals reached 35kg body weight. A portion of the muscle *Longissimus dorsi* was used to determine the chemical composition, cholesterol content and the fatty acids profile of the meat. The lambs fed exclusively pasture presented a decrease of 40.8% in the fat content, with higher protein percentage. Among the 36 fatty acids identified in the profile, 21 presented difference between the feeding systems. In conclusion, the feeding system changes the fat and cholesterol contents as well as the fatty acid profile of the meat lamb, resulting in important differences for the health of the consumer.

I. INTRODUCTION

The red meat has been associated to a negative image to health due to its fat content. However, it's an important source of iron, selenium, vitamins A and B12, folic acid, proteins and with its low carbohydrate content, contributes to a low glycemic índex, which is considered beneficial in relation to body weight excess and diabetes and cancer development (1). Studies have associated the use of red and processed meat with the development of cardiovascular diseases. (2). The component of the red meat responsible for this association is the fat content. Diets with high content of saturated fatty acids (SFA) are related to the increase of low density lipoprotein levels (LDL), which are associated with higher risk of cardiovascular diseases (3). The nutritional value is an important contributor to the total meat quality. The intramuscular fat levels and the fatty acids composition, together with the biologic value of the protein, elements and vitamins traces, are key-factors that contribute to nutritional value (4). Studies show that the animal feeding interferes in the fatty acids profile of products coming from ruminant animals and more specifically in the profile of fatty acids (5). This fact shows that ruminants fed with pasture present a higher level of polyunsaturated fatty acids (PUFA) n-3 in meat than the animals fed with grains only (6). The production systems based on pasture make it possible to obtain meats with lower intramuscular fat content and cholesterol, better ratio between fatty acids n-6:n-3 and higher concentration of Conjugated Linoleic Acid (LCA), which are all beneficial characteristics for the human health (7). The objective of this study was to evaluate the effect of the animal feeding based exclusively on concentrated or pasture in the chemical composition and fatty acids profile of lamb meat.

II. MATERIALS AND METHODS

The experiment was carried out in the Federal University of Santa Maria, from October 2012 to July 2013, in which 20 lambs were used. They were crossbred of Texel and Ile de France, and were distributed in two feeding systems: a) feedlot exclusively concentrated feeding (77.36% corn grain; 20.20% soybean meal; 1.42% limestone and 1.02% bicarbonate of sodium). b) natural pasture + raygrass pasture with exclusive pasture feeding. The

lambs were weaned with 20kg body weight (BW) and placed at the different feeding systems untill they reached 35kg BW, determined moment for the slaughter. Water and mineral salt were provided *ad libitum* for both the treatments. For the natural pasture management it was used (375°C-days), determined according to the thermal sum accumulated and for the raygrass pasture was the continuous grazing system, with variable number of regulator animals, aiming to mantain forrage mass between 1400-1600kg/ha of dry matter (DM). After the slaughter the carcasses were stored at 4°C during 24h. Later, they were subdivided in cuts and the muscle *Longissimus dorsi* was withdrawn from the half right carcass in the portion that comprises from the 6th to the 10th dorsal vertebra, vacuum packed and stored at temperature lower than -18°C for subsequent analyses. The meat samples were lyophilized and after being realized the moisture determination, ashes and total nitrogen (N) through Kjeldahl method (8). For the conversion of the N values in crude protein (CP) it was used the correction factor 6.25. The intramuscular fat was extracted according to (9). Subsequently, we proceeded to the derivatization in accordance with Christie (10). 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 rightly 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/100g (%). 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 level, using the GLM procedure of SAS, version 9.1.

III. RESULTS AND DISCUSSION

It was found that the diet did not change the moisture content and ash meat. However, lambs fed exclusively on pasture had higher crude protein and lower in fat and cholesterol *Longissimus dorsi* (Table 1).

Table 1 – Chemical composition and percentage of cholesterol in the *Longissimus dorsi* muscle of lambs fed exclusively concentrated feed or pasture.

	Feeding System			
Composition	Concentrated	Pasture	P*	MSE
Moisture (%)	75,21	75,95	0,3035	1,6188
Ash (%)	1,92	1,46	0,0932	0,5479
Crude Protein (%)	18,56	20,04	0,0013	0,7240
Fat (%)	4,31	2,55	0,0074	1,1437
Cholestetol (mg/100g)	71,07	51,90	<0,0001	6,3839

*Probability

The values of chemical composition may fluctuate with the state of completion of the animal, resulting in decreased percentages of protein and water, and increase the fat content in meat. Thus, with higher slaughter weight there is a tendency to increase in fat and decrease of water in the meat (11). The slaughter criterion used in this study was the body weight. Thus the state of completion of animals can be assigned to the diet. In this case, considering the Brazilian legislation reduction of 40.8% in fat content, one can propose the use of the term "*light*" for lamb meat produced in pasture. According BRASIL (12) from 2014 "*light*" indication shall be released only where the food has at least 25% less of a particular nutrient than conventional products of the same brand. Lip ids are very important to the quality of the meat, as it is positively correlated with the degree of marbling and palatability and negatively with the process of thawing meat (13). On the other hand, the highest percentage of intramuscular fat influences the ratio of membrane lipids and lipid droplet in adipocytes. Whereas the lipid droplet is mainly composed of SFA and monounsaturated (MUFA) while the membrane lipids by PUFA, this fact may lead to a higher proportion of PUFA and/or n-3 in meats with lower concentration of intramuscular fat affects the profile of fatty acids in meat. In the present study, the animals finished pasture had a lower percentage of fat ($P<0.0074$) which may explain the higher

proportion of PUFA n-3. It is essential to observe the profile of meat fatty acids, since, according to World Health, 2003 (14), human dietary recommendation is to reduce the consumption of saturated fat. Thus, there is an increased interest by consumers in meat containing higher content of PUFA, especially n-3, and conjugated linoleic acid (CLA) and lower SFA (15). In the meat, many that make up the fat fraction fatty acids are identified. In the present study eight fatty acids were found in the meat of animals fed concentrate and eleven in meat from animals fed on pasture, with values greater than 1%, which represent about 95% of total identified fatty acids (Table 2). Among the fatty acids found it is important to note C18:2 n-7 c9, t11 (CLA) only in ruminant product, which was superior in meat derived from animals fed on pasture only (P <0.0001). The amounts of n-3 PUFA, particularly α-linolenic acid (18:3 n-3 c9, c12, c15), but also EPA (20:5 n-3 c5, c8, c11, c14, c17), and DHA (22:6 n-3 c4, c7, c10, c13, c16, c19) were higher for lamb meat produced on pasture, these acids are considered the omega3 for purposes of meeting the resolution providing for the technical regulation on the information on supplementary nutrition (12). With the values found in the profile, according to the law, the sheep meat produced on pasture can be considered with a high content of omega3 and meat produced with concentrates as a source of omega3 foods. These values will also result in a smaller ratio n-6:n-3, beneficial to human health. It is also worth mentioning that not all SFA are considered hypercholesterolemic. French et al (16) reported that it would be most undesirable fatty acid myristic acid (C14:0). In the present study, this represented 2.47% of the total in the meat of lambs fed concentrate and smaller value 1.67 % for those fed on pasture (P<0.0139). C18:1 n-9 c9 (oleic acid) showed the highest percentage in the fatty acid profile followed by palmitic acid (C16:0) for lamb meat produced with concentrated and stearic acid (C18:0) for lamb meat produced pasture.

Table 2 Fatty acid profile of intramuscular fat in the *Longissimus dorsi* muscle of lambs fed exclusively concentrate or pasture

Fatty Acids	Feeding system		P*	MSE
	Concentrated (g/100g)	Pasture (g/100g)		
C10:0	0.20	0.12	0.0007	0.0381
C12:0	0.12	0.07	0.0300	0.0381
C13:0	0.01	0.01	0.2393	0.0011
C14:0	2.47	1.67	0.0139	0.5895
C15:0	0.28	0.49	<0.0001	0.0589
C16:0	26.17	19.69	0.0001	2.2058
C17:0	1.16	1.22	0.6404	0.2537
C18:0	16.46	22.28	<0.0001	1,6255
C20:0	0.10	0.15	0.0040	0.0215
C22:0	0.15	0.56	0.0015	0.2022
C14:1 n5-c9	0.07	0.02	0.0003	0.0120
C15:1 n5-c10	0.04	0.01	0.0142	0.0155
C16:1 n7-c9	1.41	1.09	0.0038	0.1891
C17:1 n7-c10	0,58	0,59	0.8345	0.1537
C18:1 n9-t9	0,07	0,64	<0.0001	0.1065
C18:1 n7-t11	3,70	5,42	0.0911	2.0342
C18:1 n9-c9	38,30	32,69	0.0013	2,7258
C20:1 n9-c11	0,11	0,12	0.5204	0.0375
C22:1 n9-c13	0,11	0,02	0.4699	0.1240
C24:1 n9-c15		0,10		0.1674
C18:2 n6-t9,t12	0,10			0.0389
C18:2 n6-c9,c12	6,59	5,07	0.2083	2,5014
C18:2 n7-c9,t11	0.39	1.69	<0.0001	0.1928
C18:2 n5-c11,t13	0,06	0,05	0.2855	0,0243
C18:2 n6-t10,c12	0,02	0,18	<0.0001	0.0306
C18:2 n5-t11,t13	0,02	0,12	0.0071	0,0331
C18:2 (t8,t10+t9,t11+t10,t12)	0,02	0,04	0.3371	0.0367
C20:2 n6c11,c14	0,08	0,10	0.2090	0,0377
C22:2 n6c13,c16	0,02	0,07	0.0266	0.0195
C18:3 n6c6,c9,c12	0,10	0,10	0.9733	0.0787
C18:3 n3c9,c12,c15	0,50	2,33	0.0001	0,6270
C20:3 n6c8,c11,c14	0,24	0,22	0.8386	0,2019
C20:3 n3c11,c14,c17	0,10	0,30	0.0118	0,1423
C20:4 n6 c5,c8,c11,c14	0,25			0.2089
C20:5 n3 c5,c8,c11,c14,c17	0,19	1,20	<0.0001	0,3169
C22:6 n3 4,c7,c10,c13,c16,c19	0,09	0,34	0.0003	0,1010

*Probability

IV. CONCLUSION

The reduction in fat content of meat produced on pasture allows it to be classified as "*light*" in accordance with Brazilian legislation. The values of the polyunsaturated fatty acid α-linolenic acid found in sheep meat indicate

that lamb produced on pasture can be considered with a high content of omega 3 and meat produced with concentrated foods as a source of omega 3. Feeding system modifies the profile of lamb meat fatty acids, resulting benefits for consumer health in meat produced on pasture.

REFERENCES

1. BIESALSKI, H. K. (2005). Meat as a component of a healthy diet – are there any risks or benefits if meat is avoided in the diet? Meat Science 70:509-524.

2. Kontogianni, M. D., Panagiotakos, D. B., Pitsavos, C., Chrysohoou, C., Stefanadis, C. (2008). Relationship between meat intake and the development of acute coronary syndromes: The CARDIO 2000 case–control study. European Journal of Clinical Nutrition 62:171–177.

3. WEEBB. C.; O'Neill, H. A. (2008). The animal fat paradox and meat quality. Meat Science 80:28–36

4. Wyness, L. (2013). Nutritional aspects of red meat in the diet. In J.D.Wood; C. Rowlings (Eds.), Nutrition and climate change: Major issues confronting the meat industry (pp.1–22). Nottingham University Press.

5. Woods V. B.; Fearon A. M. (2009). Dietary sources of unsaturated fatty acids for animals and their transfer into meat, milk and eggs: A review Livestock Science 126:1-20.

6. ENSER, M.; SCOLLAN, N.D.; CHOI, N.J. (1998). Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. Meat Science 49:329-341.

7. TANAKA, K. (2005). Occurrence of conjugated linoleic acid in ruminant products and its physiological functions REVIEW ARTICLE Animal Science Journal 76:291-303

8. ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (1997). Official Methods of Analysis, 16th, 3. ed. AOAC INTERNATIONAL, Gaithersburg, MD.

9. HARA, A.; RADIN, N. S. (1978). Lipid extraction of tissues of low toxicity solvent. Analytical Biochemistry 90:420-426.

10. CHRISTIE, W. W. (1982). A simple procedure for rapid transmethylation of glicerolipids and cholesterol esters. Journal of Lipid Research 23-. 1072.

11. BONAGURIO, S. et al. (2001). Composição centesimal de cordeiros Santa Inês puros e mestiços com Texel abatidos com diferentes pesos. In: SIMPOSIO LATINOAMERICANO DE CIÊNCIA DOS ALIMENTOS. Campinas. **Anais...** Campinas: Unicamp. p 175.

12. BRASIL (2012). Agência Nacional de Vigilância Sanitária. Resolução - RDC nº 54, de 12 de novembro de 2012.

13. LOBATO, J.F.P.; FREITAS, A.K. (2006). Carne Bovina: Mitos e Verdades. In: Pecuária Competitiva, Esteio. Anais... Esteio: FEDERACITE, p.28, 2006.

14. World Health, Organization (2003). Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert. Who technical report series no.916Geneva: World Health Organization.

15. Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Sheard, P. R., & Richardson, R. I. (2008). Fat deposition, fatty acid composition and meat quality: A review. Meat Science, 78,343–358.

16. FRENCH, P.; O'RIORDAN, E.G.; MONAHAN, F.J. et al. (2003). Fatty acid composition of intra-muscular triacylglycerols of steers fed autumn grass and concentrates. Livestock Production Science, v. 81, p. 307–317, 2003.