PE9.34 Nutritional value of lipids in three Portuguese certified beef 268.00

Ana Cristina Gonçalves Monteiro (1) amonteiro@fmv.utl.pt, Magda Aguiar Fontes(1), José Pedro Lemos(1) , José A. Mestre Prates (1)
(1)CIISA, Faculty of Veterinary Medicine, TULisbon

The aim of this trial was to study the nutritional value of lipids in three certified meat types, "Vitela Tradicional do Montado"-PGI, Mertolenga-PDO beef and Mertolenga-PDO veal, raised under the typical production systems and slaughtered at their usual commercial age and weight. For this, cholesterol and α-tocopherol content, fatty acid ratios and Conjugated Linoleic Acid (CLA) isomeric profile were studied. Meat groups showed no differences in cholesterol and α-tocopherol content. Mertolenga-PDO veal had higher MUFA and lower total and n-6 PUFA content than the two other meat groups, but also higher MUFA/SFA and lower *n-6/n-3* ratios than Mertolenga-PDO beef. Mertolenga-PDO veal presented also the highest value in total and specific CLA content and also in the *t9,t11* and *t11,c13* isomers and the lowest value in the *c11,t13* and *t7,c9* isomers content. From a nutritional point of view and Mertolenga-PDO veal seems to be the healthier one.

***Keywords*: Beef, Cholesterol, CLA, Nutritional Value, Vitamin E**

I. INTRODUCTION

The changes in the world meat markets over the past decade and the improvement in the educational and economical conditions of most consumers have increased the demand for high quality in meat they consume [1]. Consequently, consumers are searching for meat with characteristics that differ from the most consumed meat [2]. Many authors have shown that more extensive productions systems based on pasture are beneficial to the lipid profile, CLA isomeric profile and α-tocopherol content of meat [3]. The n-6/n-3 PUFA ratio is beneficial low in these meats since grass contains high levels of linolenic acid in opposition to cereal based diets which are rich in linoleic acid producing an undesirably high n-6/n-3 ratio [4]. Protected Denomination of Origin (PDO) and Protected Geographic Indication (PGI) meat products are certified by European Union legislation and are supposed to present unique quality and organoleptic characteristics, especially associated with the specific properties of their lipid fraction (Council Regulation no. 2081/92 of 14/7, EEC). These lipid properties are linked to the production system applied. One such example is Mertolenga breed, which could be marketed purebred as Mertolenga-PDO beef and veal or crossbred as "Vitela Tradicional do Montado"-PGI. These animals are raised in a traditional semi-extensive production system in the Alentejo region of southern Portugal, characterized by natural pastures under holm and cork oak, which is referred to as "Montado".

The aim of this work was to study the nutritional value of lipids in Portuguese "Vitela Tradicional do Montado" PGI veal and Mertolenga-PDO beef and veal, raised under the typical production systems and slaughtered at their usual commercial age and weight.

II. MATERIALS AND METHODS

This study was performed on 23 crossbred veals "Vitela Tradicional do Montado-PGI" (VTM; age <12 month), 22 purebred Mertolenga-PDO young bulls (PDO beef; age<30 month), and 23 purebred Mertolenga-PDO veals (PDO veal; age<15 months). All animals were raised on a semi-extensive grazing system based on natural pastures under holm and cork oak, only supplemented in periods of grass scarcity.

Immediatly after slaughter, carcasses were electrically stimulated. Samples of *longissimus lomborum* muscle were removed 3-5 days *post-mortem* (pm) and kept at 0-1 ºC. Six days pm samples were minced, vaccum packaged and frozen to -18ºC.

Total cholesterol and lipid-soluble antioxidant vitamins were extracted from samples, after saponification with KOH solution, according to the procedure described by Prates *et al.* [5]. Cholesterol and *α*-tocopherol were separated by normal phase HPLC (Zorbax Rx-Sil with the corresponding 12.5 mm analytical guard column, 250 mm x 4.6 mm ID, 5 μm particle size), using a HPLC system (Agilent 1100 series, Agilent Technologies Inc.), as described by Monteiro *et al.* [6]. Meat samples for fatty acid composition and CLA isomeric profile analyses were previously lyophilised. Intramuscular fat were extracted as described by

Christie *et al.* [7], modified by Raes *et al.* [8]. Gas chromatography analyses of FAME were performed using a GC Varian 3800 (Varian Inc, USA) fitted with a flame ionization detector and an OmegaWax 250 (Supelco,USA) capillary column (30 m x 0.25 mm i.d., 0.20 μm film thickness). Fatty acids were expressed as a percentage of the sum of identified fatty acids.

The methyl esters of CLA isomers were individually separated by triple silver-ion columns in series (ChromSpher 5 Lipids, 250 mm x 4.6 mm internal diameter, 5 μm particle size, Chrompack, USA), using a HPLC system (Agilent 1100 Series). The chromatographic conditions of FAME and CLA isomeric profile were as described by Alfaia *et al.* [9].

The effect of the type of meat was studied by analysis of variance using the Proc Means procedure of SAS.

III. RESULTS AND DISCUSSION

Data are presented in Table 1. No significant differences in cholesterol and α-tocopherol content were observed between groups ($P>0.05$). The values showed for cholesterol content were similar to those obtained by Alfaia *et al.* [9], in Mertolenga-PDO LD muscle (0.44 mg/g muscle), and by Monteiro *et al.* [6] in Carnalentejana-PDO LT muscle (0.40 mg/g muscle). Some of the differences obtained in cholesterol content in the literature, are probably due to the use of different muscles, since an increase of fibre number within a muscle would increase the total sarcolemma perimeter to fibre per volume ratio and, therefore, cholesterol content. This hypothesis springs from the fact that oxidative muscles are richer in phospholipids and the higher the phospholipid content of the muscle, the higher the cholesterol content. The α-tocopherol values of the three meat groups studied were a bit lower than the value of 3.0 μg/g muscle, reported as the minimum value needed to retard metmyoglobin formation, and to protect from lipid oxidation [10]. Our work group, in another study obtained a value for α-tocopherol content (3.22 μg/g) in LT muscle of Alentejana-PDO beef a bit higher than the presented here [6]. Also Prates *et al.* [5] in a study with Barrosã-PDO veal reported levels of α-tocopherol higher than ours (3.3-3.9 μg/g). Diet has a significant effect on meat quality. Pasture consumed by cattle is known to supply vitamin E requirements in addition to other natural antioxidants [11]. However, cereal based diets also affects meat composition, usually decreasing α-tocopherol content, unless when supplementation with vitamin E is made. Animals were grazed on Alentejo, a Portuguese region where grass is scarce in the hottest months of the year, and the common practice is to supplement cattle with concentrates. The low values obtained in our study could be due to vitamin E low content of the diet.

Saturated Fatty Acids (SFA) content ($P>0.05$) was similar in all three groups. PDO veal showed the highest proportion of Monounsaturated Fatty Acids (MUFA) ($P<0.05$) and the lowest proportions of Polyunsaturated Fatty Acids (PUFA) ($P<0.05$) and n-6 fatty acids ($P<0.05$). The higher MUFA content is mainly due to the higher 18:1c9 content ($P<0.05$), but also by the higher 16:1c9 content ($P<0.05$) (data not shown). The lower proportions of PUFA and n-6 fatty acids can be explained by lower proportions of 18:2n-6 ($P<0.001$), 20:4n-6 ($P<0.05$) and 20:6n-6 ($P<0.05$) fatty acids (data not shown). All groups had similar values of PUFA/SFA ratio ($P>0.05$). This ratio in the human diet should be above 0.45 (Department of Health, 1994). The values obtained for the meat groups, with the exception of PDO veal, are near to the recommended value. The trend for a lower value presented by PDO veal is due to the lower content of PUFAs. PDO beef showed the highest n-6/n-3 fatty acid ratio (16.28; $P<0.001$). Alfaia *et al.* [9] also presented high values for this ratio in Mertolenga-PDO beef (14.9) from early autumn animals, despite a bit lower in late spring animals (7.11). Recent research has focused on the nutritional relevance of the n-6/n-3 fatty acid ratio in the human diet, since a high n-6/n-3 fatty acid ratio is a risk factor in cancers and coronary heart disease. This ratio is much influenced by the diet fed to the animals. The use of cereals (rich in n-6 PUFA) in concentrates shifts the meat fatty acid composition to an increased ratio of n-6/n-3 when compared with animals produced on pasture [8]. Furthermore, it was also shown that finishing cattle exclusively on pasture enhances the unsaturated fatty acid profile of beef fat, decreasing n-6/n-3 and increasing PUFA/SFA ratios [12]. The values obtained in the three groups are higher than the nutritional recommendations of a n-6/n-3 ratio below 4.0. PDO veal presented the lowest value, and consequently was the healthier one concerning this ratio.

Concerning total CLA content, VTM had the lowest value ($P<0.01$), despite not different from PDO beef, while PDO veal presented the highest ($P<0.01$) specific CLA content (Table 1). The CLA isomeric profile

showed a clear predominance of the bioactive c9,t11 CLA isomer in all groups, followed by t7,c9 and t9,t11 CLA isomers. PDO veal showed the lowest value of the former and the highest value of the latter. PDO veal also presented the highest value of the t11,c13 (2.81 mg/100g CLA) and the lowest value of the c11,t13 (0.89 mg/100g CLA) CLA isomers.

IV. CONCLUSION

There were no differences between groups in most of the variables studied. PDO veal had the highest MUFA and the lowest PUFA and n-6 fatty acids content, though. This was reflected in a lower n-6/n-3 ratio value, despite not different from VTM. The values obtained in n-6:n-3 ratio by all meat groups were much higher than the current nutritional recommendations. PDO veal also had higher specific CLA content. From our results we can conclude that the lipid composition of PDO veal seems to be healthier, from a nutritional point of view.

ACKNOWLEDGEMENT

Financial support AGRO/2004/422 and an individual grant to Ana Cristina G Monteiro (SFRH/BD/31091/2006) are acknowledged.

REFERENCES

[1] –Andersen, J. H., Oksbjerg, N. & Therkildsen, M. (2005). Potential quality control tools in the production of fresh pork, beef and lamb demanded by European society. Livestock Production Science, 94, 105-124.

[2] –Vieira, C., Cerdeño, A., Serrano, E., Lavín, P. & Mantecón, A. R. (2007). Breed and ageing extent on carcass and meat quality of beef from adult ateers (oxen). Livestock Production Science, 107, 62-69.

[3] –Scollan, N., Hocquette, J. F., Nuernberg, K., Dannenberger, D., Richardson, I., Moloney, A. (2006). Innovations in beef production systems that enhance the nutritional and health value of beef lipid and their relationship with meat quality. Meat Science, 74, 17-33.

[4] –Wood, J. D., Richardson, R. I., Nute, G. R., Fisher, A. V., Campo, M. M., Kasapidou, E., Sheard, P. R. & Enser, M. (2003). Effects of fatty acids on meat quality: a review. Meat Science, 66, 21-32.

[5] –Prates, J. A. M., Quaresma, M. A. G., Bessa, R. J. B., Fontes, C. M. G. A. & Alfaia, C. M. P. M. (2006). Simultaneous HPLC quantification of total cholesterol, tocopherols and b-carotene in Barrosã-PDO veal. Food Chemistry, 94, 469-477.

[6] – Monteiro, A. C. G., Fontes, M. A., Lemos, J. P. C., Prates, J. A. M. (2009). Contents of L-carnitine, cholesterol, tocopherols and β-carotene in three types of beef commercialized in Portugal. Submitted to Meat Science.

[7] – Christie, W. W., Sébédio, J. L. & Juanéda, P. (2001). A practical guide to the analysis of conjugated linoleic acid (CLA). Inform, 12, 147-152.

[8] - Raes, K., De Smet, S. & Demeyer, D. (2001). Effect of double-muscling in Belgian Blue young bulls on the intramuscular fatty acid composition with emphasis on conjugated linoleic acid and polyunsaturated fatty acids. Animal Science, 73, 253-260.

[9] – Alfaia, C. M. M., Quaresma, M. A. G., Castro, M. L. F., Martins, S. I. V., Portugal, A. P. V., Fontes, C. M. G. A., Bessa, R. J. B. & Prates, J. A.M. (2006). Fatty acid composition including isomeric profile of conjugated linoleic acid and, cholesterol in Mertolenga-PDO beef. Journal of the Science of Food and Agriculture, 86, 2196-2205.

[10] –Faustman, C., Cassens, R. G., Schaefer, D. M., Buege, D. R., Williams, S. N., & Scheller, K. K. (1989). Improvement of pigment and lipid stability in Holstein steer beef by dietary supplementation on vitamin E. Journal of Food Science, 54, 858–862.

[11] –Descalzo, A. M., Insani, E. M., Biolatto, A., Sancho, A. M., Garcia, P. T., Pensel, N. A., Josifovich, J. A. (2005). Influence of pasture or gain-based diets supplemented with vitamin E on antioxidant/oxidative balance of Argentine beef. Meat Science, 70: 35-44.

[12] –Realini, C. E., Duckett, S. K., Brito, G. W., Dalla Rizza, M. & De Mattos, D. (2004). Effect of pasture vs. Concentrate feeding with or without antioxidants on carcass characteristics, fatty acid composition, and quality of Uruguayan beef. Meat Science, 66: 567-577.

[13] –Monteiro, A. C. G., Santos-Silva, J., Bessa, R. J. B., Navas, D. & Lemos, J. P. C. (2006). Fatty acid composition of intramuscular fat of bulls and steers. Livestock Production Science, 99, 13-19.

Table 1
Cholesterol (mg/g), α-tocopherol (µg/g), partial sums of fatty acids, fatty acid ratios and major CLA isomers (>5%) of longissimus lomborum muscle of "Vitela Tradicional do Montado"-veal, PDO-beef and PDO-veal

	VTM	***PDO beef***	PDO veal	SEM	P[A]
Total cholesterol	0.41	0.43	0.42	0.013	ns
α-Tocopherol	2.62	2.58	2.17	0.220	ns
Total Fatty Acids					
ΣSFA	43.69	44.27	44.58	0.561	ns
ΣMUFA	35.65 [a]	34.66 [a]	38.95 [b]	1.061	*
ΣPUFA	17.74 [b]	18.44 [b]	14.00 [a]	1.295	*
Σ *n-6*	15.69 [a]	17.03 [a]	12.34 [b]	1.144	*
Σ *n-3*	2.04	1.41	1.66	0.229	ns
Ratios					
PUFA/SFA	0.42	0.42	0.32	0.036	ns
n-6/ n-3	8.70 [a]	16.28 [b]	8.52 [a]	1.077	***
CLA					
Total	0.02 [a]	0.03[a,b]	0.03 [b]	0.003	**
Specific	4.17 [a]	4.77 [a]	6.15 [b]	0.442	**
t9,t11	6.13 [ab]	5.10 [a]	7.23 [b]	0.034	*
c9,t11	63.25	66.29	63.67	1.707	ns
t7,c9	14.34 [b]	13.75 [b]	9.76 [a]	1.323	*

[A] Statistical probability of treatment: ns, P>0.05; *, P<0.05; **,P<0.01; ***, P<0.001; means in the same row with different subscripts are significantly different (P<0.05); SEM= standard error of the mean