NUTRITIONAL VALUE OF RETAIL BEEF LIPID FRACTION

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Abstract – The fatty acid composition of beef has been stigmatized due to studies that relate beef lipid composition with several diseases. However such studies are based on beef lipid composition and consumption in USA, Canada and England, where beef composition and consumption habits are very different from the Portuguese ones. In Portugal beef intramuscular fat content is much lower than in the aforementioned countries varying usually between 1-3% in fresh muscle.. The present study intends to demonstrate that beef is a nutritious and healthy food when included in a balanced diet. The beef proportions of SFA and TFA are below the recommendations. The 18:2*n*-6 values in beef ranged from 70.6 to 167.8 mg, whereas the 18:3*n*-3 values ranged from 5.0 mg to 21.9 mg. The beef content in both FA (18:2 *n*-6 and 18:3 *n*-3) are below the recommendations. A 100 g serving beef contribution for the daily intake will be 37% of protein and only 2.3% of fat, whilst the nutritional quality index is 8.1 for protein and only 0.51 for fat. The saturated and trans fatty acid content were beneath the recommended value, however the LC-fatty acid content were below the recommendation, indicating that the low intramuscular fat consumption can compromise the positive LC-PUFA adding value of beef, as well as the sensorial attributes. However, beef can be considered a nutritious and healthy food when included in a balanced diet.

Key Words – beef, meat quality, lipid composition

I. INTRODUCTION

The fatty acid (FA) composition plays an important role in meat quality. It is known that not only the amount but also the structure of the FA plays a major role in maintaining human health [1]. Beef consumption has been affected by the negative publicity on media, especially with regard to its composition in saturated and *trans* fatty acids (SFA and TFA), cholesterol, and nutritional indexes imbalance. However, the use of those nutritional indexes questioned, based on recent research concerning FA physiological effects on human health. Recent dietary guidelines from FAO/WHO are more focused on the absolute amounts of specific PUFA intake rather than on FA ratios, recommending the increased consumption of long chain (LC) PUFA, mainly EPA and DHA [2]. The FAO and WHO organizations had jointly prepared a document with the recommendations for daily intake of lipids, which has stipulated that the total fat consumption should not exceed 30% of energy consumption, whilst cholesterol consumption should not exceed 300 mg *per* day [2]. Moreover, the intake of SFA should not exceed 10% energy to keep cholesterolaemic levels in a normal range and to reduce the risk of coronary heart disease (CHD), and TFA values should not exceed 1% energy [2]. Also, the minimum recommended intake levels for essential fatty acids are 2.5% energy of linoleic acid (18:2*n*-6) plus 0.5% energy of linolenic acid (18:3*n*-3) to prevent deficiency symptoms. For chronic disease prevention, the effective intake levels lie between 6 and 11% energy of total PUFAs (*n*–6 and *n*–3, respectively) [2].
Detailed information on lipid composition of beef (cholesterol, vitamins and fatty acids with the greatest impact on health) is necessary to estimate the contribution of beef to daily intake requirements. Thus the aim of this study was to evaluate fatty acid contribution to the daily recommended intake of beef from the Portuguese market place.

II. MATERIALS AND METHODS

This study was performed on 46 retail beef samples which were collected during 6 month in a supermarket chain from Lisbon. The samples were representative of all batches (1 sample per batch) marketed in the

supermarket during the trial period. Total cholesterol was extracted from homogenised meat samples, after saponification with KOH solution freshly prepared as described by Monteiro et al.[3].

The intramuscular fat content was measured according to the AOAC official method [4], and expressed as mg/g muscle. FAME were directly extracted and methylated from 250 mg of lyophilised meat samples by a one-step procedure and the FA were converted to their methyl esters (FAME) by a combined transterification procedure with NaOH in anhydrous methanol (0.5 M) followed by HCl/methanol (1/1 v/v) at 50 °C, during 30 and 10 min, respectively [3].

III. RESULTS AND DISCUSSION

The contents of intramuscular fat (mg/g muscle), total cholesterol (mg/g muscle), and FA composition in *longissimus lumborum* muscle are presented in Table 1. The value reported here for total cholesterol (0.40 mg/g muscle) was under the recommendation. Considering the serving beef with 100 g, the beef studied will only supply modest cholesterol content (40 mg), representing about 13% of the recommended daily cholesterol intake in adults (300 mg per day). This value was similar to those presented by Monteiro and co-workers [3] (averaging 0.42 mg/g muscle) in Mertolenga-PDO *longissimus lumborum* muscle. The contents of individual and sum of fatty acids with recommended intake values in a 100 g steak from beef were determined. The SFA and TFA contents in a 100 g steak averaged mg and 64.8 mg, respectively. Concerning the proportion of the energy intake from SFA in a 100 g steak it averaged 7.5% and 0.6%, respectively. The beef proportion of SFA and TFA is below the recommendations, showing that this beef is a safe eating product. In a 100 g beef, the 18:2*n*-6 values averaged 132. mg, whereas the 18:3*n*-3 values averaged 10.6 mg. The beef content in both FA (18:2 *n*-6 and 18:3 *n*-3) are below the recommendations.

The sum of ecosapentaenoic acid (EPA) and docosapentaenoic acid (DPA) averaged 0.6 g/100 g total FA. The sum of EPA and DPA presented in beef represents 11.8 mg/100 g of muscle and EPA represents 5.8 mg/100 g of muscle.

Table 1 Cholesterol, intramuscular fat (IMF) and fatty acid content (mg/g muscle) and composition (g/100 g total FA) of the *longissimus lumborum* muscle.

	Mean	Min	Max	SD
Cholesterol	0.40	0.36	0.48	0.026
IMF	19.4	10.5	38.9	6.40
Total FA	14.0	5.22	26.3	5.17
16:0	23.4	17.7	28.7	2.331
16:1*c*9	2.87	1.80	4.21	0.633
18:0	15.34	9.80	20.6	2.361
18:1*c*9	32.74	26.3	40.6	3.729
18: *t*	3.17	1.66	6.18	1.072
18:2*n*-6	6.93	2.20	14.7	3.384
18:3*n*-3	0.53	0.09	3.19	0.521
CLA	0.35	0.16	0.63	0.115
20:4*n*-6	1.59	0.49	3.56	0.786
20:5*n*-3	0.28	0.03	1.03	0.233
22:4*n*-6	0.16	0.06	0.29	0.068
22:5*n*-3	0.42	0.12	1.50	0.287
SFA	42.85	36.7	54.1	4.184
MUFA	37.2	30.1	45.9	4.266
PUFA	10.0	3.89	19.4	4.115
TFA	3.35	1.74	6.28	1.071

The recommendations of long chain polyunsaturated fatty acids consumption (EPA plus docosahexaenoic acid (DHA)) in the present study concerns just to EPA, as only a few samples presented DHA value above the detection limit. Therefore the value presented in this study is only from EPA. In a 100 g steak EPA content was much lower than the minimum recommended intake value in the humans' diet (250 mg/day) [2], ie around 2.3%, a very low value. The value presented in this study for 18:2*n*-6 (132 mg) is lower than the mean value (200 mg) observed in lean beef according to EFSA [5], whilst the value presented for TFA (3% total fatty acids) and 18:3 *n*-3 (11 mg) are close to the values observed in lean beef [5]. However, both total *n-6* and *n-3* LC-PUFA are far from the minimum daily recommendations.

The adult guideline amounts (2600 kcal/day) were based on the daily energy intake of an active man with 170 cm. The SFA contribution in a 100 g serving beef represents 0.3% of total daily calories intake for men (2600 calories daily intake). Beef presented a SFA and TFA energy value proportion lower than the recommended value (in a 100 g steak).

The energy contribution from beef to the total energy daily intake was also determined. The percentage of carbohydrates in beef is nearly inexistent, for the present determinations we

considered 0.4%, the value presented in the Portuguese Food Composition Table of the National Health Institute Doutor Ricardo Jorge [5]. The percentage of fat in beef ranged between 1.8% and 2.1% and the protein ranged between 23.9% and 24.4%. The energy content of a 100 g steak can be easily calculated using the energy conversion factors for food components: Energy (kcal) = protein (g/100 g) * 4 kcal/g + carbohydrate (g/100 g) * 4 kcal/g + fat (g/100 g) * 9 kcal/g. Thus a 100 g steak will have 113.4-118.1 kcal from which 16.0-18.9 kcal are from fat. The proportion of fat in the total energy value of the aforementioned 100 g steak is only 14.3% to 16%, which is below the 30% from the recommendations, meaning that beef in a balanced diet can be beneficial for an adequate intake level of fat.

Table 2 Proportional composition and energy value (E) of a 100 g (raw) steak from beef.

Composition	Proportion	E (kcal)
Water	73.5%	0
Protein	24.1%	96.4
Carbohydrates	0.4%	1.6
Intramuscular fat	2.0%	17.7
Total	100.0%	115.7

Considering the daily energy intake recommendations for men, the protein contribution for the daily intake (10% in a balanced diet) should be 65 g (10% of 2600/4), and the fat contribution (30% in a balanced diet) should be 87 g (30% of 2600/9). The contribution of a steak with 100 g to the protein and fat requirements is:
Protein contribution = 24.1/65 *100 = 37%
Fat contribution = 2/87 *100 = 2.3%.
A 100 g steak contributes with 37% of the daily protein intake needs and only with 2.3% total fat, indicating it is a good source of protein at low fat expenses.
The nutritional quality index (NQI, *i.e.*, the ratio between the percentage of the reference intake of each nutrient and the percentage of the average requirement for energy provided by meat) [7] was calculated for the two principal nutrients of meat, protein and fat, considering the adult guideline daily amounts (GDA) as follow:
NQI = (g of nutrient/GDA for that nutrient) / (total kcal meat/2600)
NQI protein = (24/65)/(118/2600) = 8.1
NQI fat = (2/87)/(118/2600) = 0.51

The nutrient density (NQI) showed values higher and lower than 1 for protein and fat, respectively, which is in accordance with the results presented by other authors [8]. A NQI value higher or lower than one can be desirable depending on the nutrient, i.e., for protein content it is desirable a value higher than 1, whilst for fat content is desirable a NQI value lower than 1 [7], which is in accordance with the results of the present study, indicating that beef in a balance diet is a good source of such nutrients.

IV. CONCLUSION

Beef present desirable low intramuscular fat, cholesterol, saturated and *trans* fatty acids content. Moreover, the cholesterol, saturated and *trans* fatty acids content were lower than the minimum recommended values by FAO/WHO. However, beef also presented lower value of LC-PUFA than the recommendations, which is not desirable from health point of view. It should be take into consideration that the low intramuscular fat content can compromise the positive LC-PUFA adding of beef, and can compromise the sensory attributes of beef. Considering the global composition of beef, it can be considered a nutritious and healthy food when included in a balanced diet, being a good protein source for the daily intake and having a low intramuscular fat content.

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