FATTY ACID PROFILE OF *Longissimus dorsi* MUSCLE FAT IN NELLORE CATTLE USING HIGH RESOLUTION GAS CHROMATOGRAPHY

Anirene G. T. Pereira[1]*, Beatriz S. Menegali[1], Jair S. S. Pinto[1], Yuri T. Utsunomiya[2,] Fernanda M. de Rezende[3], Marina de N. Bonin[3], José Bento S. Ferraz[3], José Fernando Garcia[4], Carmen J.Contreras- Castillo[1]

[1] Escola Superior de Agricultura "Luiz de Queiroz", USP, Piracicaba, Brazil

[2] Faculdade de Ciências Agrárias e Veterinárias, UNESP, Jaboticabal, Brazil

[3] Faculdade de Zootecnia e Engenharia de Alimentos, USP, Pirassununga, Brazil

[4] Faculdade de Medicina Veterinária de Araçatuba, UNESP, Araçatuba, Brazil

*anirene_eng.alimentos@hotmail.com

Abstract – Despite the great nutritional benefits associated with meat consumption, there is still great controversy over red meat consumption, since research shows that its fat intake has been related to a higher incidence of cardiovascular disease and various types of diseases. Meat consumption might be more favorable to human health if strategies were applied to reduce the content of saturated fatty acids (SFA) and increase the concentration of polyunsaturated fatty acids (PUFA). Therefore, the objective of this study was to assess and describe the profile of fatty acids fats in Nellore cattle, using high-resolution gas chromatography with flame ionization detector (HRGC - FID) from methylation, separation and identification of fatty acids by high-resolution gas chromatography. The results are consistent with the literature and corroborate that more than 50% of fat in Nellore cattle is composed of unsaturated fatty acids.

I. INTRODUCTION

Concerns with food quality have increased among consumers, who, in turn, are interested in knowing what they are actually consuming. To attend this new market trend, breeders aim to produce healthier meats through animal breeding, changes in animal nutrition, among others (1).

From a nutritional standpoint, flesh displays excellence because it contains proteins of high biological value, with all essential amino acids at the correct rates required by the human body, it is a rich vitamin source, especially the B-complex, with high mineral content, mainly high iron bioavailability (2). However, there is great controversy over protein and fatty acid red meat consumption, and research shows that meat consumption is related to a higher incidence of cardiovascular disease and various cancers (3, 4,5). Saturated fatty acids C14:0 and C16:0 enrich the lipids of cell membranes, affect the normal function of the low density lipoprotein (LDL) receptor, and their removal reduces and increases their plasma concentration, being considered hypercholesterolemic (6). There is an increasing concern about fat consumption and its relationship to health problems, which has caused changes to beef fat composition.

Thus, this study aims to determine, quantify, and describe the fatty acids that compose fat of *Longissimus dorsi* muscle of Nellore.

II. MATERIALS AND METHODS

Total lipids extraction

Fat samples were extracted from subsamples of the tissue between the 12th and 13th ribs of *Longissimus dorsi* muscle 50 in Nellore cattle, according to the methodology described by Bligh and Dyer (7). The extracted lipids were preserved in an amber bottle in hexane solvent at -20ºC.

Methylation of fatty acids

The fatty acids were converted to methyl esters of fatty acids using the methodology described by Hartman and Lago (8), with adaptations based on the AOCS Ce 1b -89 method.

Analysis of fatty acid profiles

The fatty acid profile was determined by gas chromatography, high-resolution gas chromatograph using Shimadzu 2010- Plus (Kyoto, Japan) equipped with a fused silica capillary column Stabilwax Restek (Bellefonte, USA), 30 mx 0.53 mm id x 1.0 microns, and a flame ionization detector (FID). The chromatographic run showed the following temperature program: 180°C/3 min, followed by 180-210°C at a heating rate of 5°C/min, for 13 min. The split was 1:20, the linear speed was 36 cm/s, and the carrier gas was ultrapure nitrogen. The fatty acids were identified by comparing the retention times of standard commercial mixture of Supelco (Mix C8 to C22) of fatty acid methyl esters (FAME) with the samples.

The results were expressed as percentage of the area linking to each fatty acid and considering other unidentified peaks as noise analysis.

Results evaluation

The atherogenic index was calculated as described by Ulbrichit and Southgate (9) from the following equation:

$$IA = \frac{4C14{:}0 + C16{:}0}{\Sigma MUFA + \Sigma PUFA}$$

where:
C14:0 is the total amount of myristic fatty acid in the sample;
C16:0 is the total amount of palmitic fatty acid in the sample;
MUFA is monounsaturated fatty acids; and
PUFA is polyunsaturated fatty acids.

Descriptive statistical analysis

Statistical techniques were applied to describe and summarize the data set, generating the following information:
- Mean, median, mode;
- Dispersion measures: variance and standard deviation;
- Position: 1st and 3rd quartiles;
- Width: minimum and maximum;
- Asymmetry;
- Kurtosis.

III. RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics for the most common fatty acids in the fats evaluated, except for the mode value (most frequent number), which was equal to zero for fatty acids that were not found in all samples, or that could not be calculated for not having repeated or most frequent values.

Table 1. Descriptive Statistics of the major fatty acids present in fats evaluated

Measure	Palmitic	Stearic	Oleic	Linoleic
Mean	222.256	125.081	440.101	63.872
Median	224.901	122.174	44.215	63.159
SD	35.302	16.422	3.794	24.219
Variance	124.628	26.969	143.948	58.657
Maximum	272.808	165.678	520.406	127.465
Minimum	0.738	98.077	340.146	22.361
1st quartile	215.012	115.182	411.251	45.798
3rd quartile	236.479	136.557	465.801	79.094
Kurtosis	286.848	-0.1341	0.0278	-0.1116
Asymmetry	-46.905	0.6397	-0.2139	0.504

SD - standard deviation

Figure 1 shows the average composition of fatty acids identified in meat samples.

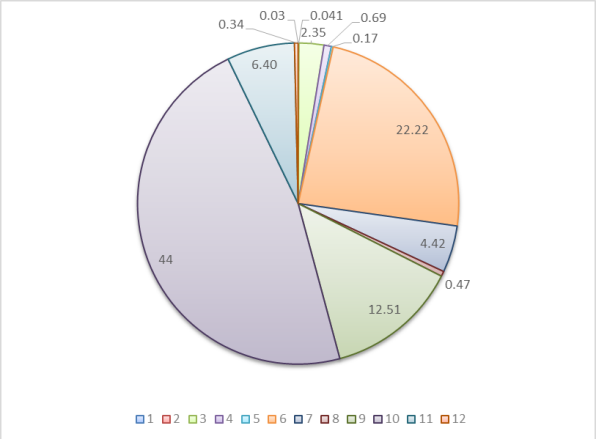

Fig 1. Average distribution of fatty acids 1.C10:0, 2. C12:0, 3.C14:0, 4. C14:1, 5. C15:0, 6. C16:0, 7.C16:1, 8. C17:0, 9. C18:0, 10. C18:1, 11.C18:2, 12. C18:3

The tested samples showed, on average, 39.90% of saturated fatty acids (SFA), 51.26% monounsaturated (MUFA) and 8.84% polyunsaturated (PUFA).

The ratio between unsaturated and saturated was equal to 1.5 and the ratio of ω3: ω6 showed values of 1:18, approximately, with an

ideal recommendation for daily consumption equal to 1:4 ratio found in the Japanese diet, according to Ulbricht and Shouthgate (9).

The proportions of fatty acids are found according to the obtained Rossato et al. (6) and Pedrão et al (10), who evaluated the lipid profile of *Longissimus thoracis* and *Rhomboideus* of Nellore, respectively. The results of these studies presented averages 40-47% of SFA and 42-55% of MUFA, oleic acid was responsible for more than 30% in both cases.

Variations found between these studies may be attributed to different muscles, which showed average values for fat content equal to 3.39 g/100g (10) and average approximately 2.2 g/100g in Rossato et al. (6). Variations are also attributed to conditions of animal husbandry. The sample analyses show that approximately 60% of the fat that composes the Nellore muscles are unsaturated fatty acids, including linolenic acid in approximate 0.35%, which is associated to benefits for human health (2).

Currently, MUFA-rich diets are effective in reducing serum cholesterol such as PUFA-rich diets, however, contrasting to the omega 6 effect, MUFA does not reduce HDL levels.

According Rossato et al (6), polyunsaturated long chain fatty acids in the phospholipids are associated with muscle cell membranes, whose values are little affected by the species, breed, age, and nutrition to maintain the membrane properties and functions. These fatty acids are antiatherogenic by reducing the quantity of low-density proteins (LDL) and raise the levels of high-density lipoproteins (HDL) (9).

Ulbrichit and Southgate (9) attribute atherogenic effect to 3 fatty acids in the fat, lauric (C12: 0) effect, myristic (C14: 0) and palmitic (C16: 0), and myristic which has four times the atherogenic potential palmitic acid. With the thrombogenic effect, these authors also report myristic and palmitic fatty acids, like stearic (C18: 0), found at high concentrations in the bovine fat. It is believed that high intake of saturated fatty acids raise serum cholesterol and thus increasing the occurrence of cardiovascular diseases.

The atherogenic index was calculated and we obtained the average value of 0.5257, higher than that found for olive and sunflower oil, however, but lower than the rates reported for coconut oil, dairy foods, and sheep meat (9).

IV. CONCLUSION

The results show that Nellore fat is composed mainly of unsatured fatty acid and the atherogenic index has an intermediary level compared to other food products. Six hundred animals will be analyzed to confirm these data.

ACKNOWLEDGMENTS

Sao Paulo Research Foundation, FAPESP, for the financial support from labor, and the Group of Animal Breeding FZEA-USP, for providing the samples.

REFERENCES

1. Bragagnolo, N. (2001). Aspectos Comparativos entre carnes segundo a composição de ácidos graxos e teor de colesterol. In 2ª Conferência Internacional Virtual sobre Qualidade de Carne Suína. Concórdia, SC, Brasil.

2. Padre, R.G.; Aricetti, J.A.; Moreira, F.B.; Mizubuti, I.Y.; Do Padro, I.N.; Visentainer, J.V.; De Souza, N.E.; Matsushita, M. (2006). Fatty acid profile, and chemical composition of Longissimus muscle of bovine steers and bulls finished in pasture system**.** Meat Science 74: 242-248.

3. Krause, M. V.; Mahan, L.K. (2012). Alimentos, Nutrição e Dietiterapia. Roca LTDA.

4. Roussell, M.A.; Hill, A.M.; Gaugler, T.L. West, S.G.; Heuvel, J.P.V., Alaupovic, P.; Gillies, P.J.; Kris-Etherton, P.M. (2012). Beef in a optimal lean diet study: effects on lipids, lipoproteins, and apolopoproteins. Am J Clin Nutr, 12:.9-16.

5. Saatchi, M.; Garrick, D.J.; Tait JR, R.G.; Mayes, M.S.; Drewnoski, M.; Schoonmaker, J.; Diaz, C.; Beitz, D.C.; Reecy, J.M. (2013). Genome-wide association and prediction of direct genomic breeding values for composition

of fatty acids in Angus beef cattle. **BMC Genomics** 14: 1-15.

6. Rossato, L.V.; Bressan, M.C.; Rodrigues, E.C.; Da Gama, L.T.; Bessa, R.J.B.; Alvez, S.P.A. (2010). Parâmetros físico-químicos e perfil de ácidos graxos da carne de bovinos Angus e Nelore terminados em pastagem. Revista Brasileira de Zootecnia 39:1127-1134.

7. Bligh, E.G.; Dyer, W.J. (1959). A rapid method of total lipid extract and purification. Canadan Journal of Biochemistry and Physiology 37: 911-917.

8. Hartman, L.; Lago, R. (1973). Rapid preparation of fatty methyl esters from lipid. Laboratory Practice 22: 475-476.

9. Ulbricht, T.L.V.; Southgate, D.A.T. (1991). Coronary heart disease: seven dietary factores. The Lancet 338: 985-992.

10. Pedrão, M.R.; Coró, F.A.G.; Youssef, E.Y.; Kato, T.; Shimokomaki, M. (2012). Fatty acid profile of humpback muscle (*Rhomboideus*m.) from zebu breed (Nellore cattle). Acta Scientiarum 34: 473-476.