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Fatty acid profile of humpback muscle (*Rhomboideus* m.) from zebu breed (Nellore cattle)

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ABSTRACT. The objective of this paper was to characterize the lipidic profile of the *Rhomboideus* muscle (humpback) present in the Nelore breed, and compare it to the *Longissimis dorsi* muscle (tenderloin). Male animals with 24 months of age, raised in pasture were slaughtered in a regional slaughterhouse and the *Longissimus dorsi* (LD) and *Rhomboideus* (RH) muscles were excised from the remaining of the carcass and analyzed after 24 hours refrigeration. Moisture, protein and total lipids were quantified and the fatty acid profile was analyzed. The results obtained show significant differences ($p < 0.05$) in the characterization between the muscles analyzed in relation to their composition. Most of the fatty acids detected were monounsaturated (MUFA), with the oleic acid (C18:1n-9) being the fatty acid with the largest amount present, with the value of 48.11% for the *RH* muscle and 45.58% for *LD*. For saturated fatty acids (SFA), palmitic acid (C16:0) were quantified in largest quantity with 25.67 and 25.19% content for *RH* and *LD* muscles, respectively. Regarding saturation, *RH* muscle has greater quantity of MUFA, 56.46%, but lower PUFA/SFA ratio, with 0.081.

Keywords: lipids, Nellore cattle, meat quality.

Perfil lipídico de "cupim" (músculo *Rhomboideus*) de gado Nelore (linhagem zebuína)

RESUMO. O objetivo deste trabalho foi caracterizar o perfil lipídico do músculo *Rhomboideus* (cupim) presente na raça Nelore e compara-lo com o músculo *Longissimis dorsi* (contra filé). Animais machos com 24 meses de idade, criados em pasto foram abatidos em frigorífico regional e os músculos *Longissimus dorsi* (LD) e *Rhomboideus* (RH) retirados do restante da carcaça e analisados após 24 horas de refrigeração. Foram quantificados umidade, proteína, lipídios totais e analisado o perfil de ácidos graxos. Os resultados obtidos mostraram diferenças significativas ($p < 0,05$) na caracterização entre os músculos analisados em relação a sua composição. A maioria dos ácidos graxos detectados foram monoinsaturados (MUFA), sendo o ácido graxo presente em maior quantidade o ácido oleico (C18:1n-9) com valor de 48,11% para o músculo *RH* e 45,58% para o *LD*. Os ácidos graxos saturados (SFA) com o ácido palmítico (C16:0) em maior quantidade com teores de 25,67 e 25,19%, para os músculos *RH e LD*, respectivamente. Em relação à saturação, o músculo *RH* tem maior quantidade de MUFA, 56,46%, mas menor razão PUFA/SFA com 0,081.

Palavras-chave: lipídeos, gado Nelore, qualidade da carne.

Introduction

The lipid composition both for adipose tissue and muscular tissue provides palatability and other sensory attributes expected in meat (CHRISTENSEN et al., 2011). According to Yang et al. (1999), the composition of fatty acids and triacylglycerol have direct influence on tenderness, as well as presenting aspects related to the human health, more specifically cardiovascular diseases (ENSER et al., 1996). Red meats do not present a good ratio between saturated and polyunsaturated fatty acids, and are not ideal for the organism.

The composition of lipid material varies among animals in different ways, such as with feeding (ROWE et al., 1999), genetic material and gender (ZEMBAYASHI; NISHIMURA, 1996), with the kind of digestion between ruminants and non-ruminants (ELLIOT et al., 1999). The marbling is also one of the main factors for the development of tenderness and juiciness in meat, where studies performed by Nishimura et al. (1999) with Japanese Black Cattle indicate that marbling can influence in up to 10% the texture of the meat. In Brazil, the Nellore cattle presents high quantity of marbling in the *Rhomboideus* muscle, which is popularly known as "cupim", and thus it becomes a tender and juicy meat, much appreciated by Brazilians.

In zebu cattle, mainly *Bos indicus*, there is the development of a singular muscle named *Rhomboideus (RH)*, which is the popular humpback. This muscle is developed in the fetus stage in the early weeks, and becomes defined in the newborn animal (SANTIAGO, 1989). According to this same author, the humpback is formed due to modifications in the *Rhomboideus* and *Trapezio* muscles, with these muscles presenting locomotion functions (SANTIAGO, 1989). According to Heath (1979), the humpback is the best phenotypical characteristic to distinguish *Bos indicus*, and this muscle is nothing more than a cervical portion that becomes fibrous with the increase in age.

This paper is aimed to characterize the lipid profile of *Rhomboideus* (humpback) muscle present in the Nelore cattle and compare it to the *Longissimis dorsi* (tenderloin) muscle, with the latter being used as comparison standard.

Material and methods

Materials

The samples are originated from male animals aged 24 months, kept in pasture, that is, their feed was basically constituted of grass. Six samples of both *Rhomboideus* m. (RB) and *Longissimus dorsi* m. (LD) muscles were excised from each carcass. Aponevrosis tissues were carefully removed by dissection and intramuscular samples were analyzed.

Methods

Moisture, ash and protein contents were determined according to AOAC (1996). In order to determine lipid concentration, the method described in Folch et al. (1957) was used.

Identification of fatty acids:

The trans-esterification was carried out according to ISO method 5509 (ISO, 1978) using KOH 2 mol L^{-1} in methanol. Fatty acid methyl esters were analyzed using gas chromatography with flame ionization detector and fused silica capillary column (50 m x 0.25 mm and 0.20 μm of Carbowax 20 M). The column temperature was set to 10 K $min.^{-1}$ from 423 to 513 K.

Statistical analysis

The data were statistically analyzed using a one-way ANOVA. The results were expressed as mean ± standard error of the mean and considered significantly different when $p < 0.05$ was obtained (STATSOFT, 2004).

Results and discussion

According to the results obtained, it can be observed that there is a contrast in relation to chemical composition in the different muscles. *LD* and *RH* belong to the same animal with 24 months of age, and the percentage of fat significantly differs from one to the other. According to the work published by Wheeler et al. (1996), the *LD* muscle from Nellore animals with 46 months of age presented for *in natura* meat 4.0; 22.6 and 73.4% for lipids, protein and moisture, respectively.

For Angus animals with 20 months of age, Morris and Cullen (1995) found 22.9, 4.2, 73 and 0.97% for proteins, lipids, moisture and ashes, respectively. Arboitte et al. (2011), analyzing Angus *LD*, obtained 4.43% lipids. Macedo et al. (2008) obtained 2.4% for total lipids in cattle.

Thus, the results presented in Table 1 for *LD* are in agreement with the literature. However, there are no available data in literature for the comparison of chemical composition in *RH* muscle, since it is a muscle that has not yet been characterized in relation to its quality and chemical profile. As a consequence of the high fat content present in the humpback, the remaining components are found in lower amounts, mainly moisture and proteins.

Table 1. Chemical composition* of *Longissimus dorsi* and *Romboideus* muscle from Nelore cattle.

	L. dorsi	*Rhomboideus*
Moisture (%)	73.34^{a} (± 1.77)	36.97^{b}(± 1.49)
Ash (%)	0.994^{a} (± 0.0004)	0.989^{a}(± 0.002)
Lipids (%)	3.39^{a} (± 1.34)	48.82^{b} (± 6.8)
Proteins (%)	21.18^{a} (± 2.12)	12.60^{b} (± 2.70)

*Values are analysis means of 6 animals performed in triplicates (n = 18). Means with different letters in the same line have significant differences between them at 5%. Same letters in the same line show no differences between them at 5% significance.

Table 2 indicates the fatty acid profile of the analyzed muscles. Most of the fatty acids detected were monounsaturated (MUFA), with the oleic acid (C18:1n-9) the fatty acid present in largest quantity, with a value of 48.11% for *RH* muscle and 45.58% for *LD*. Similar values for palmitic, stearic and oleic acids for the *LD* muscle were found by Silva et al. (2003). Following, saturated fatty acids (SFA) with palmitic acid (C16:0) with largest amount, with 25.67 and 25.19% content for *RH* and *LD* muscles, respectively. Among the polyunsaturated fatty acids (PUFA), gamma linoleic acid (C18:3n3) were quantified with concentration of approximately 1% for both muscles. Data obtained by Macedo et al. (2008) indicate percentages of C 18:3 *n*-3, C 20:4 *n*-6, C 20:5 *n*-3, AGPI, *n*-6 and *n*-3 of 0.53, 0.93, 0.26, 5.16, 4.37 and 0.79%, respectively.

Table 2. Fatty acids profile* present in *Longissimus dorsi* and *Rhomboideus* muscles in Nelore cattle.

Fatty Acid	*Rhomboideus*	*L. dorsi*	*Fatty Acid*	*Rhomboideus*	*L. dorsi*
C12:00	0.0302	0.0286	C18:1 n-9	48.1071	45.5787
C14:00	3.2087	2.2456	C18:1 n-7	0.6698	2.8114
C14:1n-5	1.3912	x	C18:1 n-5	0.1368	0.4364
Ci15:0	0.202	0.6927	C18:2 n-6	0.3991	1.4944
C15:00	0.1926	0.2437	C18:2 n-4	0.4058	0.267
C15:1n-10	x	0.0658	C18:3 n-6	0.4929	x
Ci16:0	0.3972	0.2639	C19:00	0.3021	x
C15:2n-5	0.2758	0.0987	C19:1 n-9	0.1198	x
C16:00	25.6675	25.1937	C18:3 n-3	0.856	0.9213
C16:1n-11	0.1168	0.1124	C18:4 n-3	0.2106	0.0782
C16:1 n-9	0.0961	0.2439	C19:2 n-6	0.0721	x
C16:1 n-7	4.5897	4.7464	C20:00	0.1504	x
C16:1 n-5	0.4005	0.4236	C20:3 n-9	x	0.0446
Ci17:0	0.0491	0.3207	C21:00	x	0.0879
Cai17:0	0.4842	0.5431	C20:4 n-6	x	0.3585
C16:2 n-4	0.0246	x	C20:5 n-3	x	0.0612
C17:00	0.6742	0.2512	C20:1 n-9	x	0.3612
C17:1 n-9	0.8279	0.3633	C22:4 n-6	0.0184	0.0579
C16:4 n-3	0.5187	0.3809	C22:5 n-3	x	0.1374
C18:00	8.9123	11.0133	C24:1 n-9	x	0.0723

*The results are analysis means in triplicate from 6 animals (n = 18). X – indicates very low or inexistent concentrations of fatty acids.

Analysing the fatty acids regarding saturation (Table 3), the *RH* muscle has greater amount of MUFA, 56.67%, but lower PUFA/SFA ratio, with 0.068. One difference can be observed in relation to the amount of polyunsaturated fatty acids. The ratio between PUFA/SFA obtained in a study conducted by different researchers for *LD* was of 0.42. Enser et al. (1996) obtained for the same muscle, a ratio of 0.11. The ratio indicated should be around 0.45 according to recommendations by the British Health Department. The ratio obtained in the present work is 6.7-fold greater than the indicated.

Table 3. Relation between polyunsaturated (PUFA) and saturated (MUFA) fatty acids in *Longissimus dorsi* and *Rhomboideus* muscle in Nellore cattle.

	Rhomboideus	*L. dorsi*
PUFA	2.77[a]	4.36[b]
MUFA	56.67[a]	40.10[b]
SFA	40.56[a]	55.53[b]
PUFA/SFA	0.068[a]	0.080[b]
n-6	1.54[a]	2.36[b]
n-3	1.23[a]	1.99[b]
n-6/n-3	1.25[a]	1.19[b]

*Values are analysis means of 6 animals performed in triplicates (n = 18). Means with different letters in the same line have significant differences between them at 5%. Same letters in the same line show no differences between them at 5% significance.

Conclusion

Due to the results obtained in the present study, it can be stated that there is difference in terms of lipid profile between the two muscles. In dietary terms, the lipid content of *RH* muscle is approximately 15-fold higher than that for *LD*. Thus, the ingestion of *RH* muscle must be made with criteria, since it may be associated with the development of coronary illnesses. However, the flavor and texture of this type of meat are appreciated. Therefore, further studies must be performed with this kind of meat consumed in Brazil and Latin America, since it is a habit in the population.

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