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Chemical composition and fatty acids quantification in commercial meat products processed in Brazil

Composição química e quantificação de ácidos graxos em derivados de carnes processados no Brasil

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Resumo

O presente trabalho teve por objetivo determinar e comparar a composição proximal e o teor em ácidos graxos presentes em diferentes produtos cárneos processados no Brasil. Foram analisados os seguintes derivados de carne: apresuntado, hambúrguer, mortadela, presunto, salame e salsicha; foram utilizadas três marcas diferentes para cada derivado e cinco lotes diferentes para cada marca. Os teores de lipídios totais encontrados variaram de 1,84% para o presunto da marca C até 31,61% para o salame da marca F. Os hambúrgueres apresentaram teores na faixa de 14% de lipídios totais sem nenhuma diferença significativa (P<0,05) entre as marcas analisadas. O ácido graxo encontrado em maior quantidade em todas as amostras de derivados de carne foi o ácido oléico (18:1n-9), com valores variando entre 0,79 para o presunto da marca A até 12,18 g/100g para o salame da marca C. Hambúrgueres apresentaram os menores teores de ácido oléico, com valores em torno de 5,2 g/100g. Os valores médios das razões n-6/n-3 e ácidos graxos poliinsaturados/saturados (AGPI/AGS) 26,28 e 0,68, para salsichas e 14,41 e 0,30 para hambúrgueres, respectivamente. Entre os derivados de carne, os salames apresentaram os maiores teores de gordura e os presuntos com menores teores entre os derivados analisados, tornando-se a melhor opção saudável entre os derivados de carnes.
Palavras-chave: Derivados de carne. Ácidos graxos. Composição química. Produtos cárneos

Abstract

This study aimed to determine and compare the proximate composition and the content of fatty acids in different meat products processed in Brazil. To this end, meat products (formed ham, hamburger, mortadella, ham, salami, sausage) from three different brands for each derivative and from five different lots for each brand have been examined. The total lipids ranged from 1.84% for the ham brand C to 31.61% for the salami brand F; hamburgers presented values in the range of 14% of total lipids, with no significant difference (P<0.05) between brands analyzed. The major fatty acid found for meat derivatives was the oleic acid (18:1n-9), whit values between 0.79% for the ham brand A to 12.18% for the salami brand C. Hamburguers showed the lowest variation in oleic acid content, with values around 5.2%. The mean values of n-6/n-3 and polyunsaturated/saturated fatty acids (PUFA/SFA) rations

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were 26.28 and 0.68, respectively, for the sausage, 14.41 and 0.30 for the hamburger; respectively. The Salami was the meat derivative with the highest content of fat and the ham was with the lowest content of fat between examined products, becoming the healthiest option among all products.
Keywords: Meat derivatives. Chemical composition. Fatty acids. Meat products.

Introduction

Meat products are widely consumed, and besides appreciable sensory aspects they also have a relatively low cost when compared with traditional cuts of meat (OLIVEIRA et al., 2011). By altering the demands of consumers and the increase in global competition are making the meat processing plants to use new processing techniques and systems with new ingredients (VERBEKE et al., 2010). These prod ucts are generally made from various meat raw materials (from different origins and suppliers), which are combined at the formulation stage in obedience to criteria of composition, technological factors, sensory characteristics, legal regulations and also economics (JIMÉNEZ-COLMENERO et al., 2010).

The international scientific community highlights the lipid fraction to define the quality characteristics of meat-based products (BAGGIO; BRAGAGNOLO, 2008). The content of total lipids in meat products is a measure used in several studies. Lipids in muscle foods are a blend of nonpolar components (especially acylglycerols and cholesterol), free fatty acids, polar lipids, such as phospholipids or sphingolipids (RUIZ et al., 2004). Lipids are also related to other sensory characteristics of appearance and texture (VENTANAS et al., 2007). Due to their importance, lipids are among the bioactive components (functional ingredients) that have received a special attention particularly (in quantitative and qualitative terms) considering the development of healthier meat-based products (JIMÉNEZ-COLMENERO, 2007).

Fatty foods are concentrated sources of energy and contribute to increase the energy density of the meal, supplying 2.25 times more energy than carbohydrates and proteins. Besides contributing with the energy for daily nutritional needs, they contain liposoluble vitamins, and some are also source of essential fatty acids and cholesterol (AMORIM; JUNQUEIRA; JOKL, 2010). Emulsified meat products, such as sausages and mortadellas, are very popular and consumed at home and in the fast food market, representing an important of the segment of meat industrialization. The per capita consumption is estimated at approximately 5 kg emulsified meat products, proving to be part of our diet and to have a significant importance in the economy (OLIVO; SHIMOKOMAKI, 2006).

The present study determined the proximate composition and quantified the fatty acids of the three major brands of each meat derivative (formed ham, ham, hamburger, mortadella, salami, sausage) marketed in Brazil

Material and methods

Sampling

Meat-based products were purchased in different supermarkets of the city of Maringá (Paraná State). Five different lots from three brands of each product were acquired (each brand received a designation letter from A to F, according to the manufacturer), each lot was analyzed in triplicate (n=15) to determine the proximate composition and fatty acids. In the quantification of fatty acids, each replicate was injected three times. Each lot acquired was homogenized and separated into two portions, one for analysis and the other was stored for a possible further analysis. Samples after homogenization were stored in labeled polyethylene bags and vacuum packaged, wrapped in aluminum foil and stored at -24ºC, under nitrogen atmosphere until the analyses.

Methods

The content of moisture and ash was determined by gravimetry through oven drying at 105°C for 4 hours, and by incineration in a muffle furnace at 600°C for 6 hours, respectively (CUNNIFF, 1998). The content of crude protein was measured by the Kjeldahl method (CUNNIFF, 1998). Total lipids were extracted and separated according to Bligh and Dyer (1959) and gravimetrically quantified. The transesterification of fatty acids from total lipids was performed as recommended by Hartman and Lago adapted by Maia (1993). A standard solution (300 µL) of 1 mg/mL methyl tricosanoate (internal standard) in isooctane was placed in a glass tube with screw cap. Afterwards, the solvent was completely removed by a stream of N_2 gas; 30mg of total lipids were weighed in the tube containing the internal standard and to this was added 5.0 mL of methanol solution of 0.5 mol/L NaOH. Then the solution was heated in water bath at 100°C for 5 minutes and cooled at room temperature. After this, 5.0 mL of an esterifying solution (sulfuric acid/ammonium chloride) in methanol was poured into the tube and heated again in water bath at 100°C for 5 minutes and cooled at room temperature. Then, 2 mL of isooctane was added, followed by stirring for 30 seconds, and added five mL of saturated aqueous NaCl. The esterified sample was kept in refrigerator until phase separation. The supernatant was collected and stored in freezer for posterior chromatographic analysis. The esters of fatty acids were separated in a Varian gas chromatograph, equipped with a flame ionization detector and fused silica capillary column (CP, Select FAME) (100 m length, 0.25 mm internal diameter and 0.25 µm) of cyanopropyl (CP-7420). The H2 flow (carrier gas) was 1.4 mL/min., with 30mL/min. N_2 (make up); and 30 and 300 mL/min., for H_2 and synthetic air, for the flame detector. The volume injected was 2.0 µL, using a sample splitter 1:80, with temperatures of the injector and detector at 220 and 240ºC, respectively, while the column temperature was 165ºC for 12 minutes and raised to 240° at 15°C/minute for 18.62 minutes under 40 psi pressure. The peak areas were determined by the software Varian Workstation Star 5.0. The identification of the fatty acid methyl esters (FAME) was performed by comparing the retention time of the sample constituents with a mixture of 37 standards of fatty acid methyl esters from Sigma and by comparing with some individual standards.

The fatty acid methyl esters were quantified in relation to the internal standard, methyl tricosanoate (23:0) from Sigma (USA). The amounts of fatty acids in the samples were calculated using the equation proposed by Joseph and Ackman (1992).

$$MX = \frac{A_X \cdot Mp \cdot F_{CT}}{A_P \cdot M_A \cdot F_{CEA}}$$

where:

M_x = Mass of the fatty acid X in mg g^{-1} lipids.

M_P = Mass of the internal standard in milligrams.

M_A = Mass of the sample in grams.

A_X = Area of the fatty acid X.

A_P = Area of the internal standard.

F_{CT} = Theoretical correction factor.

F_{CEA} = Factor of conversion of fatty acid methyl esters.

The theoretical correction factor (F_{CT}) is based on the internal standard (23:0) used, which is considered a FCT = 1.0000 and the others are found by dividing the% C 23:0 by % of the carbon of the fatty acid X.

The conversion factor for fatty acid methyl ester (F_{CEA}) is determined by dividing the molecular weight of the methyl ester by the molecular weight fatty acid.

The results were submitted to an analysis of variance (ANOVA) at 5% level of significance using Tukey's test in the software Statistica 7.0 (STATSOFT, 2004).

Results and discussion

The table 1 lists the results of the proximate composition found for formed ham, hamburger, mortadella, ham, salami, sausage, respectively.

The content of total lipids for formed hams varied from 5.23 for the brand D to 12.80g/100g for the brand F, within the maximum range allowed by Brazilian legislation (12%) (BRASIL, 2000a). Baggio (2004) found values of total lipids between 39 and 80g/Kg for formed hams. The values of total lipids for the three brands of hamburgers were not statistically different, with values between 14.11 and 14.64g/100g, also within the maximum allowed by law (BRASIL, 2000b). Baggio and Bragagnolo (2006) observed for chicken hamburger mean lipid values of 9.7g/100g. Baggio and Bragagnolo (2008) registered lipid values between 109 and 165g/Kg. Hadorn et al. (2008) verified the mean value of 144 g/Kg for hamburger. The values of total lipids for mortadella were 15.38 g/100g for the brand B and 21.25g/100g for the brand A, values within the allowed by the Brazilian law, which is 30% (BRASIL, 2000c). Baggio and Bragagnolo (2006) found mean values of 19.1g /100g for chicken mortadella. Baggio and Bragagnolo (2008) registered values between 185 and 236g/Kg. The total lipids observed for ham remained between 1.84 and 2.64g/100g. No mention is made on the maximum values of total lipids for this product in the Brazilian legislation (BRASIL, 2000d). Baggio and Bragagnolo (2008) verified values between 21 and 37g/Kg. Baggio, Miguel and Bragagnolo (2005) registered the mean value of 3.7g/100g.

Table 1 - Proximate composition (g/100g) of meat derivatives of different brands.

		Total lipid	Protein	Moisture	Ash	Carbohydrate*
Formed ham	B	$10.94^{b} \pm 0.403$	$19.43^{a} \pm 0.698$	$64.33^{b} \pm 1.198$	$3.79^{b} \pm 0.219$	$1.51^{b} \pm 0.112$
	D	$5.23^{c} \pm 0.465$	$17.30^{ab} \pm 0.254$	$73.35^{a} \pm 0.219$	$3.17^{c} \pm 0.124$	$0.95^{c} \pm 0.037$
	F	$12.80^{a} \pm 1.016$	$15.96^{b} \pm 0.621$	$63.68^{b} \pm 0.393$	$4.25^{a} \pm 0.028$	$3.31^{c} \pm 0,065$
Hamburger	B	$14.11^{a} \pm 0.267$	$13.14^{b} \pm 0.222$	$60.76^{c} \pm 0.758$	$2.99^{a} \pm 0.122$	$9.00^{a} \pm 0.103$
	C	$14.64^{a} \pm 0.316$	$11.66^{c} \pm 0.305$	$65.98^{a} \pm 0.235$	$2.47^{b} \pm 0.048$	$5.25^{b} \pm 0.034$
	D	$14.38^{a} \pm 0.182$	$14.74^{a} \pm 0.298$	$62.37^{b} \pm 0.601$	$3.02^{a} \pm 0.028$	$5.49^{b} \pm 0.056$
Mortadella	A	$21.25^{a} \pm 1.317$	$15.09^{a} \pm 0.885$	$46.16^{c} \pm 0.335$	$3.95^{a} \pm 0.159$	$13.55^{a} \pm 0.245$
	B	$15.38^{b} \pm 0.910$	$16.20^{a} \pm 0.174$	$56.31^{a} \pm 0.220$	$3.58^{a} \pm 0.438$	$8.53^{c} \pm 0.076$
	D	$15.77^{b} \pm 0.512$	$16.26^{a} \pm 0.265$	$52.74^{b} \pm 1.063$	$4.14^{a} \pm 0.169$	$11.09^{b} \pm 0.178$
Ham	C	$1.84^{b} \pm 0.202$	$19.94^{a} \pm 0.030$	$74.36^{a} \pm 0.218$	$3.48^{b} \pm 0.086$	$0.38^{b} \pm 0.026$
	D	$2.63^{a} \pm 0.363$	$18.88^{b} \pm 0.085$	$73.64^{a} \pm 0.310$	$3.62^{ab} \pm 0.100$	$1.23^{a} \pm 0.053$
	E	$2.64^{a} \pm 0.333$	$19.18^{b} \pm 0.276$	$73.90^{a} \pm 0.332$	$3.97^{a} \pm 0.215$	$0.31^{b} \pm 0.032$
Salami	A	$25.88^{b} \pm 0.588$	$32.52^{a} \pm 0.405$	$31.76^{b} \pm 0.318$	$7.03^{a} \pm 0.191$	$2.81^{a} \pm 0.112$
	C	$31.71^{a} \pm 1.757$	$28.43^{b} \pm 1.621$	$30.92^{b} \pm 0.891$	$6.46^{b} \pm 0.323$	$2.48^{a} \pm 0.078$
	D	$23.96^{b} \pm 0.835$	$33.79^{a} \pm 0.157$	$33.88^{a} \pm 0.691$	$5.94^{b} \pm 0.087$	$2.43^{a} \pm 0.056$
Sausage	B	$18.70^{b} \pm 0.356$	$11.37^{b} \pm 0.102$	$61.09^{a} \pm 0.231$	$3.79^{a} \pm 0.148$	$5.05^{c} \pm 0.076$
	D	$23.79^{a} \pm 0.405$	$11.89^{a} \pm 0.080$	$53.15^{b} \pm 0.740$	$3.18^{b} \pm 0.074$	$7.99^{a} \pm 0.234$
	E	$17.77^{b} \pm 0.472$	$11.49^{ab} \pm 0.249$	$61.00^{a} \pm 0.358$	$3.23^{b} \pm 0.144$	$6.51^{b} \pm 0.135$

Results in Mean ± Standard deviation from analysis in triplicate of 5 different lots (n=15). Different letters in the same row indicate significant difference by Tukey's test at 5% level. *Total carbohydrates were calculated by the difference: 100 - (% moisture + % ash + % crude protein + % total lipids).

Fonte: Autor

For salami, values between 23.96 and 31.71g/100g were detected for total lipids, which met the recommended by the Brazilian law, where the maximum for total lipids is set at 35% (BRASIL, 2000e). Hadorn et al. (2008) found the value of 342g/Kg. Baggio and Bragagnolo (2008) verified for salami values varying from 225 to 278g/Kg. For sausages, values of total lipids ranged from 17.77 to 23.79g/100g, also within the allowed by the Brazilian legislation, 30% (BRASIL, 2000f). Pereira et al. (1998) observed values varying between 11.02 and 21.94g/100g. Pereira et al. (2000) examined common sausages and found values around 17.0g/100g. Baggio and Bragagnolo (2008) registered values between 134 and 290g/Kg.

The table 2 presents the values in g/100g fatty acids registered for different brands of formed hams, hamburgers, mortadellas, ham, salami, and sausages. The main fatty acids detected for all meat products were: oleic acid (18:1n-9), palmitic acid (16:0), linoleic acid (18:2n-6) and stearic acid (18:0). The fatty acid with the greatest amount among the formed ham brands was the oleic acid (18:1n-9), with values between 2.12 and 4.89g/100g. Only the brands B and E presented a good value of PUFA/SFA ratio, higher than 0.45, value recommended by the English health department (DEPARTMENT OF HEALTH, 1994). Baggio (2004) found a ratio of 0.5. The products have presented a satisfactory quantity of monounsaturated, where a diet rich in these fatty acids makes the LDL cholesterol particles to be enriched, becoming less susceptible to oxidation (COSTA; BORÉM, 2003), but the n-6/n-3 ratio was not adequate, with values above 12:1, for meat derivatives analyzed, in agreement with Simopoulos (1991), the ideal ratio is from 1:1 to 2:1 and this is repeated for the other derivatives examined.

Table 2 - Composition of fatty acids in different meat-based products from different brands (g/100g food)

Fatty acids	Brands of formed hams			Brands of hamburgers			Brands of mortadellas		
	B	D	E	B	C	D	A	B	D
10:0	-	-	-	-	-	-	-	-	-
12:0	-	-	-	-	-	-	-	-	-
14:0	0.08 ± 0.003^{a}	0.06 ± 0.004^{b}	0.14 ± 0.011^{a}	0.28 ± 0.006^{b}	0.46 ± 0.023^{a}	0.21 ± 0.015^{c}	0.17 ± 0.017^{a}	0.11 ± 0.006^{b}	0.13 ± 0.015^{b}
14:1n-9	-	-	-	0.04 ± 0.006^{b}	0.13 ± 0.021^{a}	-	-	-	-
15:0	-	-	-	0.03 ± 0.003^{b}	0.06 ± 0.014^{a}	-	-	-	-
16:0	2.65 ± 0.071^{b}	1.29 ± 0.090^{c}	3.19 ± 0.178^{a}	3.73 ± 0.027^{b}	4.00 ± 0.061^{a}	3.52 ± 0.051^{c}	4.70 ± 0.259^{a}	3.67 ± 0.165^{b}	3.68 ± 0.150^{b}
16:1n-9	-	-	-	0.03 ± 0.002^{b}	0.03 ± 0.007^{b}	0.04 ± 0.013^{a}	0.06 ± 0.005^{a}	0.05 ± 0.003^{b}	0.05 ± 0.002^{b}
16:1n-7	0.43 ± 0.020^{a}	0.11 ± 0.007^{c}	0.38 ± 0.012^{b}	0.47 ± 0.023^{b}	0.61 ± 0.035^{a}	0.65 ± 0.037^{ab}	0.70 ± 0.029^{b}	0.83 ± 0.021^{a}	0.67 ± 0.050^{b}
17:0	-	-	0.04 ± 0.002	0.05 ± 0.012^{b}	0.09 ± 0.056^{a}	0.03 ± 0.011^{c}	0.05 ± 0.001^{a}	0.03 ± 0.003^{b}	-
17:1n-9	-	-	-	-	-	-	0.03 ± 0.002	-	-
18:0	0.90 ± 0.029^{b}	0.60 ± 0.044^{c}	1.30 ± 0.070^{a}	1.78 ± 0.082^{a}	2.03 ± 0.149^{a}	1.35 ± 0.079^{b}	2.13 ± 0.224^{a}	1.29 ± 0.109^{b}	1.11 ± 0.033^{b}
18:1n-9t	-	-	-	0.09 ± 0.017^{b}	0.18 ± 0.017^{a}	0.03 ± 0.008^{c}	-	-	-
18:1n-9c	4.01 ± 0.096^{b}	2.12 ± 0.150^{c}	4.89 ± 0.269^{a}	5.09 ± 0.156^{c}	5.38 ± 0.079^{a}	5.20 ± 0.171^{b}	8.20 ± 0.537^{a}	5.92 ± 0.372^{b}	5.86 ± 0.270^{b}
18:1n-7	0.44 ± 0.071^{a}	0.24 ± 0.041^{b}	0.58 ± 0.060^{a}	0.15 ± 0.007^{b}	0.14 ± 0.010^{b}	0.23 ± 0.017^{a}	0.82 ± 0.010^{a}	0.68 ± 0.050^{b}	0.66 ± 0.029^{c}
18:2n-6	2.17 ± 0.091^{a}	0.72 ± 0.097^{b}	2.03 ± 0.255^{a}	2.14 ± 0.098^{b}	1.36 ± 0.072^{c}	2.81 ± 0.017^{a}	3.96 ± 0.428^{a}	2.54 ± 0.180^{b}	3.30 ± 0.221^{a}
18:3n-3	0.10 ± 0.016^{a}	0.03 ± 0.005^{b}	0.09 ± 0.009^{a}	0.13 ± 0.013^{a}	0.11 ± 0.004^{b}	0.13 ± 0.003^{a}	0.20 ± 0.028^{a}	0.10 ± 0.007^{b}	0.15 ± 0.018^{a}
20:0	-	-	-	-	-	-	-	-	-
20:1n-9	0.05 ± 0.005^{b}	0.03 ± 0.004^{c}	0.05 ± 0.002^{a}	0.04 ± 0.026^{a}	0.03 ± 0.005^{b}	0.04 ± 0.001^{a}	0.09 ± 0.027^{a}	0.05 ± 0.006^{b}	0.05 ± 0.011^{b}
20:3n-6	0.06 ± 0.001^{b}	0.03 ± 0.003^{b}	0.05 ± 0.005^{a}	-	-	0.04 ± 0.004	-	-	-
20:3n-3	-	-	-	-	-	-	0.07 ± 0.016^{a}	0.05 ± 0.010^{b}	0.05 ± 0.008^{b}
20:4n-6	-	-	-	-	-	-	0.07 ± 0.003^{a}	0.06 ± 0.004^{b}	0.06 ± 0.009^{a}
22:0	0.05 ± 0.003^{c}	-	0.06 ± 0.007^{a}	0.06 ± 0.003^{ab}	0.03 ± 0.011^{b}	0.10 ± 0.006^{a}	-		--
24:0	-	-	-	-	-	-	-	-	-
SFA	3.68 ± 0.087^{b}	1.95 ± 0.120^{c}	4.73 ± 0.189^{a}	5.93 ± 0.015^{b}	6.67 ± 0.052^{a}	5.21 ± 0.024^{c}	7.05 ± 0.292^{a}	5.10 ± 0.231^{b}	4.92 ± 0.110^{b}
MUFA	4.93 ± 0.122^{b}	2.50 ± 0.159^{c}	5.90 ± 0.240^{a}	5.91 ± 0.032^{b}	6.50 ± 0.029^{a}	6.19 ± 0.044^{ab}	9.90 ± 0.378^{a}	7.53 ± 0.287^{b}	7.29 ± 0.212^{b}
PUFA	2.33 ± 0.086^{a}	0.78 ± 0.086^{b}	2.17 ± 0.129^{a}	2.27 ± 0.098^{b}	1.47 ± 0.072^{c}	2.98 ± 0.017^{a}	4.30 ± 0.297^{a}	2.75 ± 0.165^{b}	3.56 ± 0.207^{a}
n-3	0.10 ± 0.004^{a}	0.03 ± 0.005^{b}	0.09 ± 0.010^{a}	0.13 ± 0.013^{a}	0.11 ± 0.004^{b}	0.13 ± 0.003^{a}	0.20 ± 0.022^{a}	0.10 ± 0.008^{b}	0.15 ± 0.016^{a}
n-6	2.23 ± 0.074^{a}	0.75 ± 0.082^{b}	2.08 ± 0.125^{a}	2.14 ± 0.098^{b}	1.36 ± 0.072^{c}	2.85 ± 0.017^{a}	4.10 ± 0.276^{a}	2.65 ± 0.157^{b}	3.41 ± 0.192^{a}
PUFA/SFA	0.63 ± 0.011^{a}	0.40 ± 0.024^{b}	0.46 ± 0.013^{b}	0.38 ± 0.047^{b}	0.22 ± 0.049^{c}	0.57 ± 0.006^{a}	0.61 ± 0.024^{b}	0.54 ± 0.012^{b}	0.72 ± 0.056^{a}
n-6/n-3	22.30 ± 1.708^{a}	25.00 ± 1.083^{a}	23.11 ± 1.610^{a}	16.46 ± 0.060^{b}	12.36 ± 0.054^{c}	21.92 ± 0.006^{a}	20.50 ± 0.884^{b}	26.50 ± 0.150^{a}	22.73 ± 0.646^{b}

continuation of Table 2

Fatty acids	Brands of hams			Brands of salami			Brands of sausages		
	C	D	E	A	C	D	B	D	E
10:0	-			-	0.06 ± 0.009	-	-	-	-
12:0	-			-	0.06 ± 0.001	-	-	-	-
14:0	-	0.03 ± 0.003^{a}	0.03 ± 0.003^{a}	0.29 ± 0.013^{b}	0.52 ± 0.008^{a}	0.28 ± 0.011^{b}	0.12 ± 0.002^{b}	0.20 ± 0.002^{a}	0.13 ± 0.005^{b}
14:1n-9	-			-	-	-	-	-	-
15:0	-			-	-	-	-	-	-
16:0	0.45 ± 0.046^{b}	0.62 ± 0.068^{a}	0.60 ± 0.079^{a}	5.94 ± 0.223^{b}	6.93± 0.423^{a}	5.50 ± 0.112^{b}	4.48 ± 0.035^{b}	5.66 ± 0.172^{a}	3.98 ± 0.104^{b}
16:1n-9	-	-	-	0.09 ± 0.008^{a}	0.13 ± 0.060^{a}	0.07 ± 0.005^{b}	0.05 ± 0.001^{b}	0.06 ± 0.002^{a}	0.08 ± 0.002^{c}
16:1n-7	0.04 ± 0.004^{b}	0.05 ± 0.007^{ab}	0.06 ± 0.007^{a}	0.59 ± 0.014^{b}	0.77 ± 0.033^{a}	0.49 ± 0.030^{b}	0.69 ± 0.012^{a}	0.70 ± 0.014^{a}	0.53 ± 0.017^{b}
17:0	-	-	-	0.11 ± 0.016^{a}	0.13 ± 0.060^{a}	0.08 ± 0.006^{b}	0.03 ± 0.001^{c}	0.05 ± 0.002^{a}	0.06 ± 0.001^{b}
17:1n-9	-	-	-	0.07 ± 0.010^{a}	0.10 ± 0.004^{a}	0.05 ± 0.003^{b}	-	0.03± 0.001^{b}	0.03 ± 0.001^{c}
18:0	0.19 ± 0.022^{b}	0.30 ± 0.028^{a}	0.29 ± 0.038^{a}	2.72 ± 0.084^{a}	2.73 ± 0.245^{b}	2.55 ± 0.063^{b}	1.30 ± 0.011^{b}	2.24 ± 0.153^{a}	1.49 ± 0.028^{b}
18:1n-9t	-	-	-	-	0.05 ± 0.029^{a}	0.03 ± 0.006^{a}	-	-	-
18:1n-9c	0.79 ± 0.063^{b}	1.18 ± 0.176^{a}	1.15 ± 0.134^{a}	10.13 ± 0.307^{b}	12.18± 0.344^{a}	9.61 ± 0.263^{b}	7.07 ± 0.086^{b}	9.58 ± 0.119^{a}	6.90 ± 0.185^{b}
18:1n-7	0.08 ± 0.009^{b}	0.12 ± 0.020^{a}	0.15 ± 0.005^{a}	0.88 ± 0.010^{a}	0.33 ± 0.001^{c}	0.67 ± 0.015^{b}	0.60 ± 0.024^{b}	0.76 ± 0.019^{a}	0.59 ± 0.014^{b}
18:2n-6	0.29 ± 0.047^{a}	0.33 ± 0.051^{a}	0.36 ± 0.054^{a}	4.16 ± 0.096^{b}	6.79 ± 0.448^{a}	3.80 ± 0.172^{b}	3.99 ± 0.002^{a}	4.09 ± 0.067^{a}	3.65 ± 0.109^{b}
18:3n-3	-	-	-	0.12 ± 0.009^{b}	0.30 ± 0.021^{a}	0.22 ± 0.002^{b}	0.19 ± 0.003^{a}	0.16 ± 0.003^{b}	0.14 ± 0.005^{c}
20:0	-	-	-	0.04 ± 0.008^{a}	-	0.04± 0.003^{a}	-	-	-
20:1n-9	-	-	-	0.20 ± 0.004^{a}	0.17 ± 0.017^{b}	0.20 ± 0.006^{ab}	0.05 ± 0.001^{c}	0.09 ± 0.001^{a}	0.06 ± 0.003^{b}
20:3n-6	-	-	-	0.17 ± 0.003^{ab}	0.19± 0.012^{a}	0.18 ± 0.006^{b}	0.04 ± 0.001^{c}	0.08 ± 0.001^{a}	0.06 ± 0.003^{b}
20:3n-3	-	-	-	0.05 ± 0.005^{b}	0.09 ± 0.020^{a}	0.03 ± 0.006^{c}	-	-	-
20:4n-6	-	-	-	0.27 ± 0.040^{a}	0.25 ± 0.010^{a}	0.13 ± 0.006^{b}	-	-	-
22:0	-	-	-	-	-	-	0.09 ± 0.002^{a}	0.09 ± 0.007^{ab}	0.07 ± 0.007^{b}
24:0	-	-	-	0.05 ± 0.001^{a}	0.06 ± 0.015^{b}	0.03 ± 0.004^{b}	-	-	-
SFA	0.64 ± 0.046^{b}	0.95 ± 0.008^{a}	0.92 ± 0.011^{a}	9.15 ± 0.274^{ab}	10.49 ± 0.440^{a}	8.48 ± 0.106^{b}	6.07 ± 0.003^{b}	8.24 ± 0.055^{a}	5.73 ± 0.017^{b}
MUFA	0.91 ± 0.080^{b}	1.35 ± 0.038^{a}	1.36 ± 0.025^{a}	11.96 ± 0.268^{b}	13.73 ± 0.410^{a}	11.12 ± 0.177^{b}	8.46 ± 0.009^{b}	11.22 ± 0.017^{a}	8.19 ± 0.037^{b}
PUFA	0.29 ± 0.047^{a}	0.33 ± 0.051^{a}	0.36 ± 0.054^{a}	4.77 ± 0.116^{b}	7.62 ± 0.529^{a}	4.36 ± 0.137^{b}	4.22 ± 0.002^{a}	4.33 ± 0.067^{a}	3.85 ± 0.109^{b}
n-3	-	-	-	0.17 ± 0.011^{b}	0.39 ± 0.010^{a}	0.25 ± 0.004^{c}	0.19 ± 0.003^{a}	0.16 ± 0.003^{b}	0.14 ± 0.005^{c}
n-6	0.29 ± 0.047^{a}	0.33 ± 0.051^{a}	0.36 ± 0.054^{a}	4.60 ± 0.114^{b}	7.23 ± 0.520^{a}	4.11 ± 0.141^{b}	4.03 ± 0.002^{a}	4.17 ± 0.067^{a}	3.71 ± 0.109^{b}
PUFA/SFA	0.47 ± 0.168^{a}	0.35 ± 0.159^{b}	0.39 ± 0.159^{b}	0.52 ± 0.003^{b}	0.73± 0.074^{a}	0.51 ± 0.011^{b}	0.69 ± 0.001^{a}	0.52 ± 0.017^{c}	0.67 ± 0.031^{b}
n-6/n-3	-	-	-	27.06 ± 1.361^{a}	18.54 ± 1.032^{a}	16.44 ± 1.712^{a}	21.21 ± 0.001^{c}	26.06 ± 0.018^{a}	26.50 ± 0.033^{b}

Results in Mean ± Standard deviation from analysis in triplicate of 5 different lots (n=15). Different letters in the same row indicate significant difference by Tukey's test at 5% level. SFA=saturated fatty acid; MUFA=monounsaturated fatty acid; PUFA=polyunsaturated fatty acid; n-3 = omega 3 fatty acid; n-6 = omega 6 fatty acid.

Fonte: Autor

The oleic acid was the fatty acid found in the greatest amount for the different brands of hamburger, with values between 5.09 and 5.38 g/100g. Only the brand D presented a suitable PUFA/SFA ratio, higher than 0.45, the other brands have had values lower than recommended. The concentration of oleic acid registered by Baggio, Miguel and Bragagnolo (2005) was 4672mg/100g sample.

The oleic acid was the fatty acid found in the greatest amount in hams, with values ranging from 0.79 to 1.18g/100g. Only the brand C presented an adequate PUFA/SFA ratio, higher than 0.45, which is recommended by the English health department (DEPARTMENT OF HEALTH, 1994), the other brands presented values lower than recommended. It was not possible to evaluate the n-6/n-3 ratio, once n-3 fatty acids were not detected in the hams. Baggio (2004) recorded the following quantities of saturated, monounsaturated and polyunsaturated fatty acids for the ham, respectively: 1.1; 1.4 and 0.5g/100g sample. This author also found PUFA/SFA ratio of 0.4 and obtained the value of 0.02g/100g n-3 for the ham. Clariana et al. (2011) observed 3969.0 mg/100g for the oleic acid. In salami, the oleic acid (18:1n-9), was also the one with the greatest amount, with values between 9.61 and 12.18g/100g sample. Herranz et al. (2008) registered values ranging from 38.13 to 44.26% for the oleic acid. Saturated, monounsaturated, and polyunsaturated fatty acids presented the following values, respectively: 9.7; 11.5 and 3.7g/100g sample (BAGGIO, 2004). All the brands had a suitable PUFA/SFA ratio, all higher than 0.45. Baggio (2004) achieved a ratio of 0.38. while the saturated fatty acids of animal origin represented risk dietary factors for developing atherosclerotic coronary disease, monounsaturated fatty acids, especially the oleic acid showed a protective effect (NAVARRO et al., 1992). The n-6/n-3 ratio is not adequate with values above 20:1. The ideal ratio is 1:1 - 2:1, according to Simopoulos (1991). Baggio (2004) registered a n-6/n-3 ratio of 30 and obtained for n-3, 0.1g/100g for the salami. The fatty acid in the greatest amount among brands of sausage was the oleic acid (18:1n-9), with values between 6.90 and 9.58g/100g. Hadorn et al. (2008) observed the value of 83g/Kg for the oleic acid. Baggio (2004) verified the following values for saturated, monounsaturated, and polyunsaturated fatty acids, respectively: 5.9; 7.7 and 4.3g/100g sample. All the brands of sausages analyzed have presented a suitable ratio of PUFA/SFA, all above 0.45. Baggio obtained 0.73 for the PUFA/SFA ratio in sausages. The values of the n-6/n-3 ratio observed for all brands of sausages were higher than recommended. Baggio (2004) estimated a n-6/n-3 ratio of 17.8, and the content of n-3 at 0.2g/100g sample. For the ham it was not found a n-6/n-3 ratio since it was not identified values for n-3 fatty acids, but a 0.37 was registered for the PUFA/SFA ratio. All meat-based products had a suitable PUFA/SFA ratio, and a not-satisfactory n-6/n-3 ratio. It has been well documented in literature that Mediterranean populations have a high intake of oleic acid, and present a lower prevalence of obesity, metabolic syndrome, type 2 diabetes and cardiovascular events (DE LORGERIL, 2006).

Conclusion

There are differences in the proximate composition among brands and even between lots of the same brand of meat based products herein examined. Ham was the derivative with the lowest content of total lipids and salami had the highest, but also had the greatest content of protein. Salami was the product with the highest quantity of salts, while hamburger presented the lowest values. Hypertensive consumers should avoid eating salami given its high content of salts. The major fatty acids found in all products were: oleic acid (18:1n-9), palmitic acid (16:0), linoleic acid (18:2n-6) and stearic acid (18:0). Hams and formed hams were the best meat derivatives regarding the PUFA/SFA ratio. Regarding the n-3/n-6 ratio, none of the products presented a suitable value. For all products analyzed in the present study, the proximate composition was satisfactory concerning the Brazilian legislation. In relation to the content of total lipids, salts, and PUFA/SFA ratio, it is recommended the consumption of ham.

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