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Volatile organic compounds present in jerked beef, a traditional Brazilian meat product

Ana Paula Alexandre FREIXO[1], Ana Carolina Ramos da SILVA[2], Maria Luiza Reis de CASTRO[1], Simone Lorena QUITÉRIO[1], Renata Santana Lorenzo RAICES[1*]

Abstract

Jerked beef (JB) is a salty and dry meat product, which is considered the evolution of traditional *charque* (CH). Despite being a product subject to inspection by several government spheres, its production process may suffer some variations depending on the manufacturer, as the Technical Regulation of Identity and Quality of the product does not establish the time allocated to each processing step. The determination of volatile organic compounds (VOC) can reveal characteristic substances of the food and possible quality markers. The application of solid-phase microextraction in the headspace, in series with gas chromatography coupled with mass spectrometry (HS/SPME-GC/MS), allowed the detection of 103 VOC, among acids, ketones, aldehydes, amines, alcohols, hydrocarbons, ethers, esters and others. Acetic, butanoic and pentanoic acids were identified and associated with the characterization of the JB product, having already been correlated in previous studies to deterioration in fresh meat. Compounds possibly from the migration of plastic packagings, such as caprolactam and oxalic acid, were observed in the analyzed samples.

Keywords: jerked beef; VOC; HS/SPME-GC/MS.

Practical Application: The findings of this study reports lack of uniformity in jerked beef processing, due the raw material used or manufacturing time stipulated by each industry. Therefore they can be useful for Regulatory Agencies to discuss a legislation about jerkef beef.

1 Introduction

In Brazil, *carne-de-sol* (CS), *charque* (CH) and jerked beef (JB) are traditional salty meat products. About CS, this is slightly salty meat, which has characteristics more similar to fresh meat, when compared to CH and JB. It is a product with a high water activity (close to 0.96), high humidity (64 to 70%) and relatively low salt content (5 to 6%), having a shelf life of 3-5 days at room temperature (Carvalho, 2002; Ishihara et al., 2017). On the other hand, CH and JB are salty meat products of intermediate moisture, both have water activity up to 0.80 and contain at least 12% of salt. Regarding humidity, in CH a maximum humidity of 50% is tolerated and in JB, 60%. However, in the preparation of JB, the use of curing salts is allowed and vacuum packaging is mandatory (Brasil, 2020).

Both CH and JB can be preserved for 4-6 months at room temperature, making them excellent sources of animal protein for those living in regions lacking refrigeration facilities (Ishihara et al., 2017; Shimokomaki et al., 2016; Vidal et al., 2019). JB is considered the evolution of CH, with great growth potential in the Brazilian market by integrating the cultural load of consumption of its precursor to items related to industrialized foods, in addition to being an easily digestible food with high biological value (Zen et al., 2018; Shimokomaki et al., 2016).

According to data presented by the Brazilian Association of Slaughterhouses (ABRAFRIGO), in 2019, 2,107,817 kg of salted/in brine/dry/smoked beef were exported. At the time, Angola was responsible for 96.4% of imports. In 2020 there was an 83% reduction in the volume of exports, but in the first half of 2021, the sector showed recovery with a 326% increase in this volume. These Brazilian products have already been exported to Hong Kong, Panama, the Marshall Islands and the United Kingdom, among others (Abrafrigo, 2021).

In the production of JB, beef, salt and curing salts (nitrite and/or sodium and/or potassium nitrate) are mandatory ingredients. Furthermore, one can have, as optional ingredients, the intentional additives with stabilizer, acidulant, acidity regulator and antioxidant functions (Vidal et al., 2020a). However, the use of these additives must meet the limits defined by the Resolution of the Collegiate Board - RDC 272/2019 of the National Health Surveillance Agency (ANVISA) and authorized for use in animal products by the Ministry of Agriculture, Livestock and Supply (MAPA) (Brasil, 2019).

The technological steps present in the processing of JB, according to the Technical Regulation of Identity and Quality (RTIQ) of the product, available in Normative Instruction No. 92/2020, are deboning and maintenance, wet salting, dry

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[1] *Mestrado Profissional em Ciência e Tecnologia de Alimentos, Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro - IFRJ, Rio de Janeiro, RJ, Brasil*
[2] *Universidade Federal do Rio de Janeiro - UFRJ, Rio de Janeiro, RJ, Brasil*
*Corresponding author: renata.raices@ifrj.edu.br

salting, removal of excess salt, drying and packaging. However, JB processing time may vary between industries, as the RTIQ does not establish the duration of each step, only the physical-chemical parameters that the final product must present (Brasil, 2020). There are no data in the literature regarding its production and consumption (Zen et. al, 2018).

The salting process is responsible for changes in meat characteristics during desiccation and the consequent reduction in water activity. The most important are related to color, flavor, proteolysis and lipolysis. Sodium chloride (NaCl) is the most important ingredient used for the development of several functional and sensory characteristics in meat products, through the influence of water retention and its binding capacity, modifying the texture and providing a salty taste, resulting in better microbiological stability (Vidal et al., 2020b, Nachtigall et al., 2019).

Salt added to the production of meat products contributes to and accelerates lipid oxidation, which to some extent is a desirable phenomenon, as it produces active compounds that influence aroma and flavor. However, an intense oxidation process could make the food unacceptable for human consumption, being one of the main factors responsible for quality losses throughout the product's shelf life (Nachtigall et al., 2019). Salt has autochthonous microbiota, which is transferred to the meat during salting. Halotolerant bacteria present in the salt, such as *Staphylococcus xylosus* and *Staphylococcus saprophyticus*, can multiply at NaCl concentrations above 10% (Vidal et al., 2021). These microorganisms play an important role in the fermentation of dry salty meat products and are related to the development of characteristic flavors (Biscola et al., 2017).

The Solid Phase Micro Extraction (SPME) technique in Headspace (HS), followed by Gas Chromatography coupled with Mass Spectrometry (GC/MS) has already been used in studies to determine the profile of volatile organic compounds (VOC) in various meat products savory foods (Perea-Sanz et al., 2019; Domínguez et al., 2019; Sha et al., 2017; Salvá et al., 2012; Gianelli et al., 2012). Thus, this study aimed to determine the VOC profile of nine samples of different traditional brands of JB marketed in Rio de Janeiro, characterizing the product using the HS/SPME - GC/MS technique.

2 Materials and methods

Nine samples of JB from different brands and muscle portions were analyzed, from industries under federal inspection, acquired in the retail trade of the city of Rio de Janeiro and evaluated by the Instrumental Analysis Laboratory of the Federal Institute of Education, Science and Technology, Campus Rio de Janeiro. Volatile compounds were analyzed by HS/SPME - GC/MS. SPME was performed with the CTC Combi Pal Sampler auto-injector, an XYZ-type autosampler with compartment promoting temperature control and agitation for fiber activation and extraction in the headspace.

About 1 g of JB sample was transferred to 20 mL headspace vials. Vials were capped with PTFE/silicone septum and na aluminum screw cap. A blank was also done, with a 20 mL HS bottle containing only air, without the addition of the sample or any type of solvent or reagent. All extractions were performed using a 50/30 µm DVB/CAR/PDMS fiber. After an equilibrium time of 20 minutes at 80 ± 1.0 °C with stirring at 500 rpm, the septum covering the HP vial was perforated with the fiber retracted into the needle and then the fiber was exposed to the sample for 30 minutes, extracting volatiles from the HS under the same conditions.

The identification analysis of VOC was performed using the GC/MS (Agilent Technologies, 7890A-5975C), with a sampler (CTC Combi PAL Sampler 120, Agilent Technologies) and with an appropriate liner for SPME analysis. The chromatographic conditions adopted were: fiber injection, with no mobile phase flow division ratio in the injector (splitless), injector temperature of 240 °C; mobile phase flow of 1 mL min^{-1}; programming the chromatographic oven (45 °C for 5 minutes, with a temperature ramp from 10 °C min^{-1} to 80 °C, followed by a new ramp at 5 °C min^{-1} up to 240 °C, holding for 15 minutes), CP-Wax 52 CB 60 mx 0.25 mm x 0.25 µm column and MS detector with mass range 40-400 m/z.

The composition of the samples was determined from the mass spectra obtained with the aid of the Agilent Mass Hunter Qualitative Analysis software (Agilent Technologies version B.04.00), using the NIST 11 spectra library as reference. The components were also identified according to the index of linear retention of each substance, calculated from a calibration standard of 8 to 40 carbon alkanes (Sigma standard, 40147-U) using the Van der Dool and Kratz equation.

3 Results and discussion

3.1 Characterization of JB samples

As a result of the analysis of nine JB samples submitted to the HS/SPME - GC/MS technique, a total of 103 volatile organic compounds were obtained. Among these compounds, the most relevant were organized in Table 1, which shows the area percentage according to the organic function (acids, aldehyde alcohols, esters, ketones, amines, hydrocarbons, ethers and others)

Acids were present in all analyzed samples, with na area percentage between 7 and 77%. Acids such as acetic acid, butanoic acid and pentanoic acid play important roles in determining the spoilage of fresh vacuum-packed beef (Mansur et al., 2019). Acetic acid has also been cited as one of the most promising volatile organic compounds used as spoilage markers in chicken breast (Mikš-Krajnik et al., 2015). Among the nine samples analyzed in the current study, acetic acid and butanoic acid were detected in seven samples, but this does not mean that for salted meat these compounds are markers of deterioration, as the studies mentioned above were carried out in fresh meat. When analyzing dry-cured meat products, Domínguez et al. (2019) associated these acids with the odor and aroma that characterize these products.

Aldehydes were detected in eight samples, ranging from 1 to 51%, identified as nonanal, 2-nonenal, benzeneacetaldehyde, benzaldehyde, hexanal, 3-methylhexanal, pentadecanal and 16-heptadecenal, among others. Linear aldehydes such as nonanal and hexanal were previously identified in salted meat (Gianelli et al., 2012).

Table 1. Profile of volatile compounds in jerked beef.

Organic Function		Samples[1]								
		1	2	3	4	5	6	7	8	9
Identified VOC's	LRI[4]	Area percentage (%)[2]								
		Identification of the presence of organic function (X)[3]								
Acids		13%	21%	77%	7%	34%	38%	50%	40%	54%
Pentanoic acid, 2-methyl-, anhydride	1390	-	-	-	-	-	-	x	-	-
Acetic acid	1433	-	x	-	x	x	x	x	x	x
Butanoic acid	1609	-	x	x	-	x	x	x	x	x
Butanoic acid, 3-methyl-	1651	x	x	x	-	x	-	x	x	x
Hexanoic acid	1828	-	-	-	-	-	-	-	x	-
Octanoic acid	2044	x	x	-	-	-	x	-	x	-
Nonanoic acid	2141	x	-	-	x	-	-	-	-	-
n-Decanoic acid	2246	-	-	-	x	-	-	-	x	-
Tetradecanoic acid	2656	-	-	x	x	-	-	-	-	-
Oxalic acid	2875	-	-	-	-	-	-	-	-	x
Acetic acid, cesium salt	3268	-	-	-	-	-	-	x	-	-
Alcohols		14%	5%	2%	3%	23%	16%	3%	17%	0%
1-Pentanol	1235	-	-	-	-	-	-	-	x	-
Ethanol, 2-(1-methylethoxy)-	1278	-	-	-	-	-	x	-	-	-
2-Cyclopentylethanol	1311	-	-	-	-	-	x	-	-	-
1-Hexanol	1330	-	-	-	-	-	x	-	-	-
3-Methyl-1-pentanol	1355	-	-	-	x	-	-	-	-	-
1-Pentanol, 3,4-dimethyl-	1381	x	-	-	x	-	-	-	-	-
1-Hepten-4-ol	1550	-	-	x	-	-	-	-	x	-
1-Butanol, 3-methyl-, acetate	1556	-	-	-	-	-	x	-	-	-
1-Octanol	1584	x	-	-	-	-	-	-	-	-
3-Ethyl-4-methylpentanol	1589	-	-	-	-	-	-	-	x	-
1-Nonanol	1696	-	x	-	x	-	-	-	-	-
Z-4-Dodecenol	1946	-	-	-	x	-	-	-	-	-
Phenol	1973	-	-	-	-	x	-	-	-	-
1,14-Tetradecanediol	2172	-	-	-	-	-	-	x	-	-
Aldehydes		0%	51%	4%	1%	5%	2%	1%	15%	15%
Hexanal	1109	-	-	-	-	-	-	-	x	-
Hexanal, 3-methyl-	1243	-	-	-	x	-	-	-	-	-
Nonanal	1441	-	x	-	-	-	-	-	-	-
Benzaldehyde	1544	-	x	x	-	-	x	-	x	-
2-Nonenal	1580	-	x	-	-	-	-	-	-	-
Benzeneacetaldehyde	1668	-	x	x	-	x	-	x	-	x
Pentadecanal-	2151	-	-	-	x	-	-	-	-	x
16-Heptadecenal	2172	-	-	-	-	x	-	-	-	-
Amines		0%	5%	0%	0%	0%	12%	0%	0%	0%
2-Propen-1-amine	1060	-	-	-	-	-	x	-	-	-
3,5-Diamino-1,2,4-triazole	1375	-	x	-	-	-	-	-	-	-
2-Amino-1,3-propanediol	1612	-	-	-	x	-	-	-	-	-
Ketones		0%	0%	1%	0%	0%	5%	0%	14%	32%
3,4-Hexanedione, 2,2,5-trimethyl-	1063	-	-	-	-	-	-	-	-	x
3-Octanone	1463	-	-	-	-	-	-	-	x	-
3,5-Dimethyl-4-octanone	1789	-	-	x	-	-	-	-	-	-
1,3-Cyclobutanedione, 2,2,4,4-tetramethyl-	1939	-	-	-	-	-	x	-	-	-
2,4-Imidazolidinedione, 3-methyl-	2679	-	-	-	-	-	x	-	x	-
Hydrocarbons		20%	10%	3%	3%	4%	8%	2%	0%	0%
Pentane, 3-methyl-	1059	-	x	-	-	-	-	-	-	-
Pentane, 3,3-dimethyl-	1063	x	-	-	x	-	-	-	-	-

[1]Samples numbered in sequence from 1 to 9; [2]Percentage (%) of the chromatographic area of the analytes that make up the indicated organic function; [3]Indication (X) of the compounds present in each sample; [4]Linear Retention Index.

Table 1. Continued...

Organic Function		Samples[1]								
		1	2	3	4	5	6	7	8	9
Identified VOC's	LRI[4]	Area percentage (%)[2]								
		Identification of the presence of organic function (X)[3]								
Ethene, fluoro-	1073	-	-	-	-	-	-	x	-	-
Bicyclo[4.1.0]heptane, 7-(1-methylethylidene)-	1167	-	-	-	-	-	x	-	-	-
Heptane, 3,3,4-trimethyl-	1323	-	x	-	-	-	-	-	-	-
Nonane, 1-iodo-	1583	-	-	x	-	-	-	-	-	-
1-Octene, 6-methyl-	1589	-	-	-	x	-	-	-	-	-
Hexane, 3,3-dimethyl-	1613	x	-	x	-	-	-	-	-	-
Decane, 3,3,4-trimethyl-	1640	-	x	-	-	x	-	-	-	-
2-Butene, 1,4-diethoxy-	1765	-	-	-	x	-	-	-	-	-
1-Undecene, 9-methyl-	1796	-	-	-	x	-	-	-	-	-
Octane, 2,4,6-trimethyl-	1844	-	-	-	x	-	-	-	-	-
Octane, 4,5-dimethyl-	1872	-	-	-	-	-	x	-	-	-
Heptane, 3,4-dimethyl-	1880	-	x	-	-	-	-	-	-	-
1-Decene, 8-methyl-	1944	-	x	-	-	-	-	-	-	-
2,2-Dimethyl-propyl 2,2-dimethyl-propanesulfinyl sulfone	2022	-	x	-	-	-	-	-	-	-
Methane, bis(neopentyloxy)-	2071	-	-	x	-	-	-	-	-	-
Ethers		8%	0%	0%	2%	0%	0%	0%	4%	0%
Hydroperoxide, hexyl	1061	-	-	-	x	-	-	-	-	-
Methyl propargyl ether	1224	-	-	-	-	-	x	-	-	-
Hexane, 1-(hexyloxy)-5-methyl-	1702	-	-	-	-	-	-	-	x	-
Esters		17%	0%	3%	80%	0%	10%	41%	1%	0%
Acetic acid ethenyl ester	1057	-	-	-	-	-	x	-	-	-
n-Caproic acid vinyl ester	1299	-	-	-	-	-	x	-	-	-
Acetic acid, trifluoro-, 3-methylbutyl ester	1373	-	-	-	-	-	x	-	-	-
Acetic acid, trifluoro-, 2,2-dimethylpropyl ester	1635	-	-	-	-	-	x	-	-	-
Acetic acid, phenylmethyl ester	1735	x	-	-	-	-	-	-	-	-
Acetic acid, trifluoro-, nonyl ester	1793	x	-	-	-	-	-	-	-	-
Benzeneacetic acid, ethyl ester	1798	x	-	-	-	-	-	-	-	-
Oxalic acid, allyl hexadecyl ester	1902	-	-	-	x	-	-	-	-	-
Carbonic acid, octyl phenyl ester	1979	-	-	-	-	-	-	-	x	-
Methyl tetradecanoate	2016	-	-	-	x	-	-	-	-	-
Decanoic acid, methyl ester	2054	-	-	-	x	-	-	-	-	-
Pentadecanoic acid, methyl ester	2107	-	-	-	x	-	-	-	-	-
Hexadecanoic acid, methyl ester	2201	-	-	-	x	-	-	-	-	-
Pentanoic acid, 5-hydroxy-, 2,4-di-t-butylphenyl esters	2279	-	-	-	-	-	x	-	-	-
Heptadecanoic acid, methyl ester	2300	-	-	-	x	-	-	-	-	-
Phthalic acid, isobutyl 4-octyl ester	2539	x	x	-	-	-	-	x	-	-
Phthalic acid, 6-ethyl-3-octyl butyl ester	2540	-	-	x	-	-	x	-	x	-
Phthalic acid, 3-methylbutyl pentyl ester	2750	x	-	-	-	-	-	-	-	-
Acetic acid, methoxy-, methyl ester	2929	-	-	x	-	-	-	-	-	-
Ethanedioic acid, dimethyl ester	2946	-	-	-	-	-	-	x	-	-
Others		28%	8%	10%	4%	34%	9%	3%	9%	0%
Oxirane, methyl-, (S)-	1064	-	-	-	-	x	-	-	-	-
4-Methyloxazolidine	1084	x	x	-	-	-	-	-	-	-
Tetraethyl ammonium fluoride	1091	-	-	-	-	x	-	-	-	-
Disulfide, dimethyl	1093	-	-	-	-	x	-	-	-	-
1,2-Dimethylaziridine	1109	-	-	-	x	-	-	-	-	-

[1]Samples numbered in sequence from 1 to 9; [2]Percentage (%) of the chromatographic area of the analytes that make up the indicated organic function; [3]Indication (X) of the compounds present in each sample; [4]Linear Retention Index.

Table 1. Continued...

Organic Function		Samples[1]								
		1	2	3	4	5	6	7	8	9
Identified VOC's	LRI[4]	Area percentage (%)[2]								
		Identification of the presence of organic function (X)[3]								
Propane, 2-nitro-	1127	-	-	-	-	-	-	-	x	-
Oxirane, (3-methylbutyl)	1269	-	-	-	-	-	x	-	-	-
4H-Imidazol-4-one, 2-amino-1,5-dihydro-	1373	-	-	-	-	-	-	-	x	-
Heptanonitrile	1449	-	-	-	x	-	-	-	-	-
(1H)Pyrrole-2-carbonitrile, 5-methyl-	1549	-	-	-	-	-	-	x	-	-
1-(2-Hydroxyethyl)-1,2,4-triazole	1559	-	-	-	x	-	-	-	-	-
Bicyclo[3.1.0]hexan-3-one, 4-methyl-1-(1-methylethyl)-,1S-(1. alpha.,4.beta.,5. alpha.)	1686	x	-	-	-	-	-	-	-	-
2,2,3,3,4,4-Hexamethyltetra hydrofuran	1807	-	x	-	-	-	-	-	-	-
Estragole	1844	x	-	-	-	-	-	-	-	-
Benzonitrile, 2-methyl-	1930	-	-	-	-	-	-	-	x	-
3,4-Dihydroxy-5-methyl -dihydrofuran-2-one	1932	x	-	-	x	-	x	-	-	-
Valeric anhydride	1940	-	-	-	x	-	-	-	-	-
2-Pentoxy-tetrahydropyran	2056	x	-	-	-	-	-	-	-	-
p-Cresol	2059	-	-	-	-	-	-	x	-	-
Isoamyl nitrite	2124	-	-	-	-	-	x	-	-	-
Caprolactam	2197	x	x	x	x	-	x	x	-	-
Indole	2417	-	x	x	-	x	-	-	-	-

[1]Samples numbered in sequence from 1 to 9; [2]Percentage (%) of the chromatographic area of the analytes that make up the indicated organic function; [3]Indication (X) of the compounds present in each sample; [4]Linear Retention Index.

The percentages of total areas of alcohols, present in eight samples, ranged between 2 and 23%. Some alcohols detected in JB samples, such as 1-octanol, 1-hexanol and 1-pentanol, were associated with lipid oxidation in beef jerky by Gianelli et al. (2012), having also been found by Domínguez et al. (2019) on other dry-cured meat products.

The esters, verified in six samples, had the greatest variation, with values between 1 and 80% of the total area percentage. Oxalic acid dimethyl ester, heptadecanoic acid methyl ester, vinyl caproate and acetic acid 1-(trifluoromethyl) nonyl ester, were some of the compounds found belonging to this group. Esters are formed by esterification reactions between carboxylic acids and ethanol and may be linked to the presence of certain microorganisms. The carboxylic acids involved in these reactions arise from the oxidation of aldehydes generated in the sample during processing (Sha et al., 2017).

In the samples analyzed in this study, there was a large variation in the volatile profile of JB samples, corroborating the work of Salvá et al. (2012), Gianelli et al. (2012), Sha et al. (2017), Perea-Sanz et al. (2019) and Dominguez et al. (2019), who analyzed samples of salted meat and also obtained great variability of VOC in these products.

3.2 Packaging contaminants

Among the technological innovations introduced in *charque* processing that gave rise to JB, the use of vacuum packaging allowed reaching a larger consumer market. The finished product is packaged, under pressing, in polypropylene wrapping, ensuring better appearance and durability to the product (Silva et al., 2018).

However, the chemical compounds that make up a package should not migrate to foods that are directly in contact, in a way that could potentially harm the health of consumers (Tsochatzis et al., 2020). According to the constant definition of the RDC 91/2001, "migration is the transfer of components of the material in contact with food to these products, due to physicochemical phenomena" (Brasil, 2001; Andrade et al., 2021). The migration results from the interaction between the packaging material and the components of the food and can be optimized by factors related to the physicochemical characteristics of the food, such as the lipid content and pH, the time and contact temperature, the relationship between the contact surface and food volume, for example (Andrade et al., 2021).

The constituents of materials intended to come into contact with food must be included in the positive lists, which are lists of "substances that have proven to be physiologically innocuous in animal tests and whose use is authorized for the manufacture of materials that will come into contact with food" (Brasil, 2001; Andrade et al., 2021). RDC 56/2012 has a positive list of authorized monomers and polymers for the preparation of plastic packaging and equipment in contact with food. According to the resolution, the verification of the specific migration limits (SLM) can be carried out with instrumental analytical techniques of adequate sensitivity, such as spectrometry and gas chromatography, for example (Brasil, 2012).

Caprolactam (CAP), a monomeric compound that originates a polymer called nylon 6, is used to make various plastic food packaging (Bomfim et al., 2009; Tsochatzis et al., 2020). Bomfim et al. (2009) reviewed the effects of CAP on human health, after verifying in tests carried out by the National Institute for Quality Control in Health of the Oswaldo Cruz Foundation (INCQS/Fiocruz) that 37.5% of nylon 6 packaging samples destined to package animal products presented compost migration values that ranged from 52 to 198% above the LME. The epidemiological studies analyzed by the group showed that PAC could promote skin, ocular, respiratory inflammation and that circulatory, urinary, reproductive, neurological and hematological disorders could also occur. Most studies were carried out with people occupationally exposed to CAP (Bomfim et al., 2009).

Oxalic acid or oxalate, often found in plant tissues, is not metabolized by humans and is eliminated through the urine. Although the lethal oral dose of oxalate is high (500 to 3000 mg for adults), high intake of the compound can be toxic to the body and its undesirable effects often involve gastrointestinal reactions, hypocalcemia, and renal toxicity (Higashijima et al., 2020; Pereira et al., 2021). Both caprolactam and oxalic acid have migration limits established in RDC 56/2012. The LMEs referring to the compounds are 15 and 6 $mg.kg^{-1}$ of food, respectively, in line with European regulation 10/2011 (Brasil, 2012; Commission of the European Communities, 2011).

Caprolactam was detected in 6 and oxalic acid in 1 of 9 JB samples. It should be noted that in the vial destined for the blank, containing only air, without the addition of sample or any solvent, there was no detection of these compounds. Thus, due to the above, it is essential to effectively control the packaging used to package food.

4 Conclusion

Even though the analyzed products have a federal inspection seal, the samples presented varied volatile composition profiles, possibly due to the lack of uniformity in processing, either about the raw material used or the manufacturing time stipulated by each industry.

The analyzes performed using the HS/SPME-GC/MS technique allowed the identification of compounds that some authors relate to deterioration processes in fresh meat, but that are naturally present in salted meat such as acetic acid, butanoic acid and pentanoic acid . The alcohols 1-octanol, 1-hexanol and 1-pentanol, resulting from lipid oxidation, were also detected in the samples analyzed in this study and in several other studies on dry salted meat products, which can be considered characteristic of these. Variations in the lipid composition of the meat cuts used as raw material, related to the muscle portion, age and sex of the animal or the food provided to it before slaughter, were not considered.

The presence of caprolactam and oxalic acid in some samples highlights the importance of controlling plastic packaging used in food, with no studies on the health effects caused by ingestion of foods packaged with materials consisting of these compounds, but the extent of this contamination should be characterized in future studies.

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