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RESEARCH ARTICLE

NITRITE AND SORBATS SODIUM QUANTIFICATION IN CURED MEAT PRODUCTS

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ABSTRACT

Meat products are widely consumed and appreciated by general population due to their diversity of flavors, use in food preparations, associated with their low cost. Major problem of these foods is constant use of nitrite and sodium sorbate, which although additives allowed by Brazilian and other countries legislation are associated with toxic effects on body. Aim of this work was to quantify nitrite and sodium sorbate levels in cured meat products. Additive levels were quantified using UV-Vis spectrophotometry, calibration curves of sodium nitrite and sorbic acid, values found were compared with Brazilian legislation, with daily intake index. Sodium nitrite contents were found in range 0.004 to 0.019 g^{-1} and sodium sorbate ranged from 0.03 to 0.10 g 100 g^{-1}. These data show that in many products content of additives used exceeds values allowed by law, this warns population that they should consume these products in a moderate way because of risks that may cause their health.

INTRODUCTION

Manufacture of cured meat products represents an important segment of processed meat. Products obtained from emulsion of meat from one or more butcher's animal species, added with different ingredients, wrapped in natural or artificial wrappings, subjected to a suitable thermal process are considered to be embedded. They may also contain: edible lumps (stomach, heart, tongue, liver, kidneys and brains), tendons, skin and fats (MAPA, 1997). This class includes sausages, paio, pantry, ham, salami, sausage, mortadella, among other products, which are widely consumed by considerable portion of Brazilian population. These products are sources of protein, fatty acids, several important constituents for health maintenance, have low price in market, being accessible to majority of population (Borges *et al*., 2019). Nitrite is preservative widely used to cure meat in form of sodium ($NaNO_2$) and potassium (KNO_2) salts. It acts as multifunctional food additive, providing specific sensory attributes such as color fixation, taste, aroma, delayed lipid oxidation reactions, antimicrobial properties and inhibit growth of *Clostridium botulinum* (Silva *et al*., 2009; Feng *et al*., 2016). In addition, they may contribute to increased shelf life, decreased deteriorating microbiota (Mologoni *et al*., 2019). Problem with sausages is use of additives such as nitrite and sodium sorbates that are associated with development of various types of cancer and health problems.

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International Cancer Research Agency (IARC) has classified N-nitrous compounds, which are consumed in processed meats as human carcinogens, group I. This classification is based on evidence that consumption of processed meat can cause colorectal cancer following evaluation of more than 800 epidemiological studies worldwide (IARC, 2015; Mologoni *et al*., 2019). This IARC concern is because in acidic environment such as stomach, nitrite binds to amines, amides forming nitrosamides, nitrosamines that are carcinogenic, mutagenic, proving to be a real health risk to consumers (Nikodinoska *et al*., 2019 Borges *et al*., 2020). When ingested nitrite can also act on hemoglobin, give rise to methemoglobin. Patients with methemoglobinemia have more formation in their oxidized iron (Fe^{3+}) hemoglobins from Fe^{2+}, thus reduced blood oxygen carrying capacity (Zhang *et al*., 2018), which can lead to insufficiency breathing, fainting in more severe cases deaths. In Brazil, when it comes to food, sorbic acid, its salts can be used as preservatives, antimicrobials, stabilizers, antioxidants in a variety of products (BRAZIL, 1998). They are usually used in combination with sodium nitrite due to its antimicrobial action. Although considered safe for human consumption, studies on toxic compounds generated by interaction of sodium nitrite and sorbate, associated hazards when both exceed limits allowed by national legislation are lacking. Aim of this work was to quantify nitrite and sodium sorbate contents in cured meat products.

MATERIALS AND METHODS

Sample location and preparation: Physicochemical analyzes of meat products were performed at General Chemistry and Analytical Laboratories of Federal University of Valley of São Francisco, Petrolina, Pernambuco, Brazil.

Sixteen types of meat sausages (six sausages, eight sausages, two loins) of different brands were purchased. Preservation was carried out in refrigerated environment at 4 °C. Samples were individually ground in a meat grinder at time of analysis.

Sodium nitrite content: Sodium nitrite quantification test was performed in two steps: obtaining meat extracts and quantification by UV /Vis absorption spectroscopy. Extraction and quantification of sodium nitrite content were performed based on official methodology described by Adolfo Lutz Institute. (2005). Each extract was prepared in triplicate, its absorbance was read in visible region at 540 nm in spectrophotometer (Nova Instruments, model 1600UV) (IAL, 2005). To quantify nitrite content in samples, a sodium nitrite calibration curve was constructed in range of 0.32 to 2.4 µg. mL^{-1} ($y = 0.3296X + 0.0807$, $R^2 = 0.9956$).

Sodium Sorbate Content: Extractions were performed based on methodology described by Cecchi. (1988). Crushed and homogenized samples (1 g) were added with 30 mL of absolute ethanol, shakered for 30 min. They were then filtered on filter paper, extracts collected in volumetric flask. Extracts were obtained in triplicate, on day analyzes were performed, to avoid ethanol evaporation, possible alteration of results. Sorbate determination was performed by UV /Vis absorption spectroscopy, reading at 255 nm (maximum absorption length of sorbic acid). Extracts obtained were diluted (1:10) for identification and quantification. To quantify sorbate content in samples, a sodium sorbate calibration curve was constructed in range of 0.25-3.3 µg. mL^{-1} ($y = 0.2955x - 0.0197$, $R^2 = 0.9987$). Absorbances were read on spectrophotometer (Nova Instruments, model 1600UV). All extracts were analyzed in triplicate.

Statistical analysis: Statistical analysis was performed by One-way ANOVA, using STATISTICA® 7.0 program, values considered significant with $p > 0.05$. All determinations were performed in triplicate (N = 3, data were expressed as average ± standard deviation. Results were compared using Tukey test to identify significant differences between test results, with a significance level of 95% for each parameter evaluated.

RESULTS AND DISCUSSION

Table 1 show results obtained in nitrite and sodium sorbate quantification tests. In analyzed products sodium nitrite content ranged from 0.004 to 0.019 g 100 g^{-1}, some samples did not show significant differences when compared by Tukey test.

Four of sixteen samples mentioned exceeded values allowed by Brazilian legislation without all samples of cured meat products of different trademarks. In Brazil, sodium or potassium nitrite, used alone or combination, maximum allowed limit is 0.015 g 100 g^{-1} of product for cured meat products, except beef jerky, infant food, expressed as nitrite ion (BRAZIL, 1998). Acceptable Daily Intake (ADI) for nitrite, established according to Joint Expert Committee on Food and Agriculture (JECFA), is 0- 0.06 g 100 g^{-1} body weight, for nitrate is 0 - 0.037 g 100 g^{-1} body weights. Both should not be consumed by children less than 3 months of age (FAO, 2013; Oliveira *et al*., 2015). Dangers associated with sodium nitrite consumption have already been made explicit even within limits established by law, when these values are not respected expose consuming population to various harms to their health. Borges *et al*. (2020) when analyzing 33 different trademarks of different meat products found contents ranging from 0.001 to 0.023 g 100 g^{-1}, 14 samples were in disagreement with Brazilian legislation. Chetty *et al*. (2019) in analyzing nitrite and nitrate content in meat samples from Fiji, found nitrate levels ranging from 0.00 to 0.12 g 100 g^{-1}, while for nitrite rates from 0.00 to 0. 16 g 100 g^{-1}. These are below the maximum level proposed by European Union legislation, but above limit set by Food Standards Australia and New Zealand.

These data serve as warning because they often show that dosage of these additives exceeds value allowed by law. Meat product legislation varies widely between countries, but effective enforcement ensures that these industries do not exceed legally permitted values, cause harm to health of population (Borges *et al*., 2020). Sorbate content ranged from 0.03 to 0.10 g 100 g^{-1}, in loin sample highest value of additive was found. In all analyzes were found values that exceeded Brazilian legislation. Use of sodium, potassium and calcium sorbate in cured meats is allowed by Brazilian law, with a maximum limit of 0.02 g 100 g^{-1} meat, for external use only, surface treatment, for use in combination or alone, expressed as sorbic acid (BRAZIL, 1998). IDA for sorbic acid, its sodium and potassium salts, established according to JECFA, is 0-25 mg Kg^{-1} body weight (FAO, 2013). Results found in this study are worrisome, since in most samples three or more additives were found, which is considered safe by law. Borges *et al*. (2020) in analysis of sodium sorbate values in meat products found values ranging from 0.02 to 0.11 g 100 g^{-1}, which means that 23 of 33 samples analyzed are in disagreement with Brazilian legislation. It is noteworthy that 14 samples had triple or more sorbate allowed by law.

Table 1. Nitrite and sodium sorbate levels in measures.

Samples	Sodium nitrite (g 100 g^{-1})	Sodium Sorbate (g 100 g^{-1})
Chicken Sausage A	$0.019^{a} \pm 0.00$	$0.06^{d} \pm 0.01$
Chicken sausage B	$0.019^{a} \pm 0.00$	$0.04^{f} \pm 0.01$
Chicken sausage C	$0.015^{b} \pm 0.00$	$0.05^{e} \pm 0.01$
Chicken sausage D	$0.011^{d} \pm 0.00$	$0.06^{d} \pm 0.01$
Chicken sausage E	$0.008^{e} \pm 0.00$	$0.04^{f} \pm 0.01$
pepperoni sausage F	$0.019^{a} \pm 0.00$	$0.04^{f} \pm 0.01$
smoked pepperoni sausage. G	$0.019^{a} \pm 0.00$	$0.06^{d} \pm 0.01$
Pork Sausage H	$0.014^{c} \pm 0.00$	$0.06^{d} \pm 0.01$
Sausage A	$0.004^{g} \pm 0.00$	$0.08^{c} \pm 0.01$
Sausage B	$0.011^{d} \pm 0.00$	$0.06^{d} \pm 0.01$
Sausage C	$0.005^{f} \pm 0.00$	$0.05^{e} \pm 0.01$
Sausage D	$0.011^{d} \pm 0.00$	$0.05^{e} \pm 0.01$
Sausage E	$0.011^{d} \pm 0.00$	$0.06^{d} \pm 0.01$
Sausage F	$0.001^{h} \pm 0.00$	$0.09^{b} \pm 0.01$
Loim A	$0.014^{c} \pm 0.01$	$0.03^{g} \pm 0.00$
Loim B	$0.015^{b} \pm 0.01$	$0.10^{a} \pm 0.01$

*Values expressed as average and standard deviation. Equal letters in same column indicate that there is no statistically significant difference between values at the 95% significance level (Tukey test).

Oliveira *et al*. (2015) when analyzing sorbate in Brazilian meat products found for mortadela, contents ranging from 0.094 to 0.175 g 100 g^{-1}, values that also exceeded current laws similar to some samples of this study. Comparing this study with others cited, it is noted that over-dosing of sorbate in meat products is not an isolated case, does not occur in only one type of byproduct.

Conclusion

Cured meat products are widely consumed by population due to being an accessible source of animal protein associated with low consumption prices. Additives such as nitrite and sodium sorbate are added to these products as preservatives, antimicrobials, to differentiate some sensory characteristics from fresh meat. Four samples of sausages were at odds with Brazilian legislation, all samples analyzed showed sorbate above those permitted by law. These data show the importance of being cautious and avoiding excessive consumption of these foods.

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