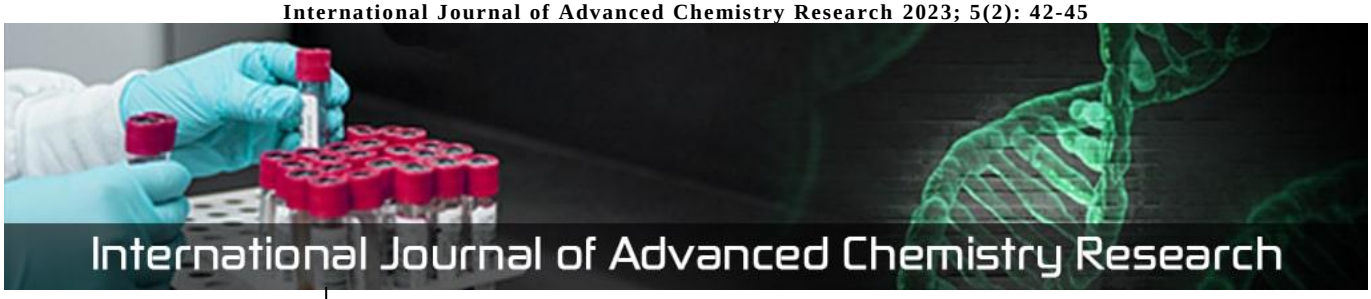

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Identification of sulfite and nitrite in the retail trade of fresh ground beef at Goiânia, Goiás, Brazil

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Abstract
Comminuted beef is widely consumed in Brazil and its quality is a reason for constant concern as preservatives like nitrite and sulfite are added to prolong commercial validity or even to mask odors. Thus, this work aimed to identify the presence of sulfite and nitrite from 42 samples of fresh ground and chilled beef acquired at retail companies (21 samples) and small grocery stores (21 samples) in the city of Goiânia, Goiás, Brazil. Official Methods for the Analysis of Products from Animal Origin and methods for food analysis from Instituto Adolfo Lutz were applied. 17 (40.47%) specimens demonstrated nitrite and 6 (14.28%) contained sulfite; that is, in 54.76% of the analyzed samples the presence of one from the two preservatives was observed. Noteworthy, in none of the samples were both additives simultaneously observed. The pH values were between 5.3 and 6.2. Regarding quality and freshness, 7 (16.66%) sampling presented ammonia and 5 (11.9%) unpleasant odors (ammonia or hydrogen sulfide) during cooking. After cooking the 17 samples in which nitrite was detected, significant depletion was found in all of them (Student's t test, $p<0.05$). Residual nitrite content average before cooking was 0.301 $mg.kg^{-1}$, and post-cooking 0.163 $mg.kg^{-1}$. Percentage, post-cooking reduction ranged from 14.53% to 64.34%. Conclusively, both sulfite and nitrite were observed in the retail trade of fresh ground beef; as well as nitrite levels varied before and after cooking. Finally, greater action and regulation by supervisory agencies is suggested.

Keywords: Fresh ground beef, additives, nitrite, sulfite, retail stores, Goiânia

Introduction
Beef is an important source of nutrients for human health, such as proteins, essential fatty acids, B-complex vitamins and minerals [1]. However, the quality of meat intended for consumption is a reason for constant concern around the world and especially in Brazil, a country considered one of the most important producers of beef and with a *per capita* consumption of around 30.4 kg/year [2]. After the comminution process, meat presents greater surface area of exposure, which, combined with excessive handling with low sanitary hygienic standards and a problematic artificial cold conservation system, favors lipid oxidation and microbial multiplication, causing rapidly deteriorate [3].

Due to the speed at which ground meat loses quality, traders have been using the fraudulent trick of adding preservative additives to the product, with the aim of prolonging commercial validity, or even masking a possible state of incipient putrefaction [4]. This illegal practice can cause adverse effects on the health of the consumer, due to the toxicity of some additives [5].

A food additive is any ingredient intentionally added to food without the purpose of nutrition, targeted in modifying physical, chemical, biological or sensory characteristics, during the manufacture, processing, preparation, treatment, packaging, transportation or handling [6]. Furthermore, preservatives are substances that prevent or delay the alteration of food caused by microorganisms or enzymes [7]. In Brazil, ANVISA Ordinance no. 1004 [8] provides for maximum residual limits of 0.015 g/100 g of nitrite in meat and meat products. However, this same legislation prohibits the use of any additives in fresh meat (Chilled and frozen).

Nitrites and nitrates, added in the form of potassium or sodium salts, are additives used in processed foods and cured meats, intentioned for fixing the color, imparting characteristic flavor and aroma, delaying lipid oxidation and inhibiting the growth of some microorganisms. Organisms such as *Clostridium botulinum* [9]. However, nitrite ingested in excess can act on hemoglobin and create methemoglobin, which irreversibly binds to oxygen, being less effective in transporting it throughout the organism [10, 11]. Another important toxicological aspect in relation to the ingestion of nitrites is the possibility of them interacting with amines and amides, generating N-nitroso compounds, such as nitrosamines, which, under certain exposure conditions, are potentially mutagenic, carcinogenic and teratogenic agents [12].

Sulfite and its various forms are added to foods for several reasons, including the control of enzymatic and non-enzymatic browning in foods, due to their antimicrobial, antioxidant, reducing and clarifying actions [13]. The use of sulfite in meat is prohibited, as it suppresses unpleasant odors and returns the grey-green meat, which is undergoing alteration, to a bright red color, providing an attractive appearance to the altered meat [14]. The addition of sulfite to foods is the subject of debate due to potential health risks, such as inactivation of vitamin B1, hypersensitivity in asthmatics, as well as mutagenic and carcinogenic effects [15, 16].

In the Brazilian territory there are not many studies focused at evaluating the quality of ground beef sold, much less, whether there is the presence of additives. Therefore, this work aimed to identify the presence of the additive's sulfite and nitrite in the retail trade of fresh ground beef in the city of Goiânia, Goiás, Brazil.

Materials and Methods

During the period from February to June 2023, 42 samples of fresh ground and chilled beef were acquired from retail commercial establishments in the city of Goiânia, Goiás, Brazil, and immediately sent – under refrigerated conditions - to the Laboratory of Quality Control at the University Center Brasília de Goiás to carry out analyses.

The commercial establishments were classified as A (retail companies) for which 21 samples were acquired; and B (Small grocery stores) where another 21 samples were acquired.

In accordance with the recommended by Official Methods for the Analysis of Products from Animal Origin [17], analyzes of cooking test, pH, ammonia and quantitative nitrite (Spectrophotometry) were developed; and the qualitative test for sodium sulfite was carried out following the physical-chemical methods for food analysis from Instituto Adolfo Lutz [18].

To analyze nitrite depletion after meat cooking, 20 grams of seventeen nitrite-positive samples were cooked at 100 °C for 5 minutes and analyzed again for nitrite quantification.

Windows version of the GraphPad Prism 5.01 software was used to perform statistical tests. Chi-square test was applied to verify statistical difference between additives detection in commercial establishments classified as A and B; and Student's t test was used to compare the average nitrite values detected before and after cooking samples. Both tests with p values <0.05.

Results and Discussions

From the 42 samples of fresh ground beef studied, 17 (40.47%) demonstrated nitrite and 6 (14.28%) contained sulfite; that is, in 54.76% of the analyzed samples the presence of one from the two preservatives was observed. It should be noted, however, that in none of the samples were both additives observed simultaneously. These results disagree with the Normative Ordinance No. 1004 of December 11, 1998 [8] which prohibits the use of additives in meat and fresh meat products.

Regarding quality and freshness aspects, 7 (16.66%) samples of fresh ground beef presented ammonia and 5 (11.9%) unpleasant odors (ammonia or hydrogen sulfide) during cooking. The pH values of fresh ground beef samples were between 5.3 and 6.2; that is, in accordance with the Brazilian legislation [19].

About commercial establishments, in those classified as A, 12 samples (57.14%) contained nitrite, 4 (19.04%) sulfite, 4 (19.04%) ammonia and 3 (14.28%) an unpleasant odor. In fresh ground beef samples acquired from classification B establishments, nitrite was observed in 5 (23.8%), sulfite in 2 (9.52%), ammonia in 3 (14.28%) and 2 (9.52%) samples had an unpleasant odor. No statistically significant difference was observed for the presence of nitrite and sulfite by type of establishment (Chi-square test, p<0.05).

The addition of preservatives such as sulfite to fresh meat sold in Brazil is an illicit practice that has already been reported by other authors [20-22]. Complementarily, the addition of nitrite is common in cured meat products and sausages, but not in fresh ground beef samples. Several authors support the thesis that the residual amount of nitrite detected in meat is reduced in relation to the added content, as nitrite reacts with amine radicals in meat during storage [23-25]. Established studies state that more than 50% of the added nitrite disappears within the first 24 hours, even when in concentrations of up to 150 ppm [26, 27].

After cooking the 17 samples of fresh ground beef in which nitrite was detected, significant depletion was found in all of them (Student's t test, p<0.05). Before cooking, samples had an average residual nitrite content of 0.301 $mg.kg^{-1}$, and post-cooking of 0.163 $mg.kg^{-}1$. Percentage, post-cooking reduction ranged from 14.53% to 64.34%. The European Food Safety Authority (2003) [28] state that the reduction in nitrite concentration due to heat treatment in meat products is dependent on a series of factors, including heating of the product. Pérez-Rodriguez *et al.* (1996) [24] and Duarte (2006) [29] observed in their work a significant reduction in the average residual nitrite content after commercial sterilization and high heating. And, da Silva (2009) [22] also found an average reduction in the amount of nitrite after heat treatment at 100 °C for 5 minutes. Approaches such as those reported, and the results of this research are socially important for informing the consumer about the dangers of purchasing meat previously ground and exposed for sale with the presence of additives, and for alerting regulatory agencies regarding non-compliance with quality and safety standards established by retail stores in the territory of Goiás.

Conclusion

It could be observed irregular practices in the retail trade of fresh ground beef in the city of Goiânia, Goiás, Brazil, both

due to the addition of sulfite and nitrite. Variations in nitrite levels before and after cooking were also observed, suggesting that heat treatment significantly reduces this substance. Finally, greater action and regulation by supervisory agencies is suggested, given the chemical risk that sulfite and nitrite pose when ingested in excess.

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Declaration of interest statement
Authors report no declarations of interest.

References
1. McAfee AJ, McSorley EM, Cuskelly GJ, Moss BW, Wallace JM, Bonham MP, *et al*. Red meat consumption: an overview of the risks and benefits. Meat Science. 2010;84(1):1-13.
2. Companhia Nacional de Abastecimento (Conab). Oferta de carnes tende à recuperação no mercado interno, atingindo maior nível na série histórica; c2023. [Internet]. Available from: https://www.conab.gov.br/ultimas-noticias/4983-oferta-de-carnes-tende-a-recuperacao-no-mercado-interno-atingindo-maior-nivel-na-serie-historica.
3. Rajic S, Simunovic S, Djordjevic V, Raseta M, Tomasevic I, Djekic I. Quality Multiverse of Beef and Pork Meat in a Single Score. Foods. 2022;11(8):1154.
4. Wolk A. Potential health hazards of eating red meat. Journal of Internal Medicine. 2017;281(2):106-122.
5. Huang Y, Cao D, Chen Z, Chen B, Li J, Guo J, *et al*. Red and processed meat consumption and cancer outcomes: Umbrella review. Food Chemistry. 2021;356:129697.
6. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Portaria número 540, Brasília, 27 out. 1997. Aprova o Regulamento Técnico: Aditivos alimentares; c1997. p. 1-5.
7. Horbańczuk OK, Kurek MA, Atanasov AG, Brnčić M, Rimac Brnčić S. The Effect of Natural Antioxidants on Quality and Shelf Life of Beef and Beef Products. Food Technology and Biotechnology. 2019;57(4):439-447.
8. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Portaria número 1004, Aprova o Regulamento Técnico: Atribuição da função de aditivos, aditivos e seus limites máximos de uso para a categoria 8 - carne e produtos cárneos. Brasília, 11 dez. 1998; c1998. p. 1-18.
9. Lee S, Lee H, Kim S, Lee J, Ha J, Choi Y, *et al*. Microbiological safety of processed meat products formulated with low nitrite concentration - A review. Asian-Australasian Journal of Animal Sciences. 2018;31(8):1073-1077.
10. Bruning-Fann CS, Kaneene JB. The effects of nitrate, nitrite and N-nitroso compounds on human health: a review. Veterinary and Human Toxicology. 1993;35(6):521-538.
11. Picetti R, Deeney M, Pastorino S, Miller MR, Shah A, Leon DA, *et al*. Nitrate and nitrite contamination in drinking water and cancer risk: A systematic review with meta-analysis. Environmental Research. 2022;210:112988.
12. Song P, Wu L, Guan W. Dietary Nitrates, Nitrites, and Nitrosamines Intake and the Risk of Gastric Cancer: A Meta-Analysis. Nutrients. 2015;7(12):9872-9895.
13. D'Amore T, Di Taranto A, Berardi G, Vita V, Marchesani G, Chiaravalle AE, *et al*. Sulfites in meat: Occurrence, activity, toxicity, regulation, and detection. A comprehensive review. Comprehensive Reviews in Food Science and Food Safety. 2020;19(5):2701-2720.
14. Smaoui S, Echegaray N, Kumar M, Chaari M, D'Amore T, Shariati MA, *et al*. Beyond Conventional Meat Preservation: Saddling the Control of Bacteriocin and Lactic Acid Bacteria for Clean Label and Functional Meat Products. Applied Biochemistry and Biotechnology; c2023.
15. Gunnison AF, Jacobsen DW. Sulfite hypersensitivity. A critical review. CRC Critical Reviews in Toxicology. 1987;17(3):185-214.
16. Vally H, Misso NL, Madan V. Clinical effects of sulphite additives. Clinical & Experimental Allergy. 2009;39(11):1643-1651.
17. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Métodos Oficiais para Análise de Produtos de Origem Animal/Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária, Brasília: MAPA; c2022. p. 1-184.
18. Instituto Adolfo Lutz. Métodos físico-químicos para análise de alimentos - São Paulo: Instituto Adolfo Lutz; c2008. p. 161-278.
19. Brasil. Ministério da Agricultura Pecuária e Abastecimento. Secretaria de Defesa Agropecuária. Departamento de Inspeção de Produtos de origem Animal. Regulamento da Inspeção Industrial e Sanitária de Produtos de Origem Animal (RIISPOA): Decreto número 9.013, de 29 de março de; c2017. p. 1-76.
20. Mantilla SPS. *Listeria* spp. em carne pré-moída bovina: isolamento, sorologia, sensibilidade das cepas aos antimicrobianos e relação com a presença de sulfito de sódio. Dissertação (Mestrado) - Faculdade de Medicina Veterinária – Universidade Federal Fluminense; c2006. p. 1-115.
21. Tancredi RCP, Silva Y. Fraude por sulfito de sódio (SO_2) em carnes bovinas comercializadas na cidade do Rio de Janeiro, RJ. Higiene Alimentar. 2007;21(149):62-66.
22. Da Silva C, Monteiro MLG, Ribeiro ROR, Guimarães CFM, Mano SB, Pardi HS, *et al*. Presença de aditivos conservantes (nitrito e sulfito) em carnes bovinas moídas, comercializadas em mercados varejistas. Revista Brasileira de Ciência Veterinária. 2009;16(1):33-36.
23. Pinho O, Ferreira IMPLVO, Oliveira MBPP, Ferreira MA. FIA evaluation of nitrite and nitrate contents of liver pâtés. Food Chemistry. 1998;62(3):359-362.
24. Pérez-Rodriguez WL, Bosch-Bosch N, Garciá-Mata M. Monitoring nitrite and nitrate residues in frankfurters during processing and storage. Meat Science. 1996;44(1-2):65-73.
25. Jay JM. Microbiologia de alimentos. 6 ed, Porto Alegre: Artmed; c2005. p. 1-711.
26. Araújo ACP, Mídio AF. Nitratos, nitritos e compostos N-nitrosos em alimentos: Onde está o problema?. Ciência e Cultura. 1989;41(10):947-956.

27. Pardi MC, Dos Santos IF, Souza ER, Pardi HS. Ciência, higiene e tecnologia da carne. 2 ed, Goiânia: UFG; c2006. p. 1-623.
28. The European Food Safety Authority (EFSA). Opinion of the Scientific Panel on Biological Hazards on a request from the commission related to the effects of Nitrites/Nitrates on the Microbiological Safety of Meat Products. The EFSA Journal. 2003;14:1-34.
29. Duarte MT. Avaliação da depleção do nitrito em "Corned Beef" fabricado em estabelecimentos sob inspeção federal, em Barretos, São Paulo, Brasil. Dissertação (Mestrado), Faculdade de Veterinária. Universidade Federal Fluminense; c2006. p. 1-75.