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Salt Content and Microbiota of Meat Preparations in Small and Large Commercial Establishments†

Sofia Godinho [1], Ana Leite [1], Carla Gonçalves [2,3,4,5], Sónia Saraiva [1,6,7], Juan García-Díez [1,6,7] and Cristina Saraiva [1,6,7] *

[1] Department of Veterinary Sciences, University of Trás-os-Montes e Alto Douro (UTAD), 5000-801 Vila Real, Portugal sophie.letters.91@gmail.com; aleite@utad.pt
[2] Department of Biology and Environmental, UTAD, 5000-801 Vila Real, Portugal carlagoncalves@utad.pt
[3] CITAB–Centre for the Research and Technology of Agro-Environmental and Biological Sciences, UTAD, 5000-801 Vila Real, Portugal;
[4] CISAS—Center for Research and Development in Agrifood Systems and Sustainability, Insituto Politécnico de Viana do Castelo, 44900-347 Viana do Castelo, Portugal
[5] EPIUnit - Epidemiology Research Unit – Associate Laboratory for Integrative and Translational Research in Population Health (ITR), University of Porto, Porto, Portugal
[6] Centro de Ciência Animal e Veterinária (CECAV), UTAD, 5000-801 Vila Real, Portugal. soniasaraiva@utad.pt ; juangarciadiez@gmail.com; crisarai@utad.pt
[7] Associate Laboratory for Animal and Veterinary Sciences (AL4AnimalS), Portugal
* Correspondence: crisarai@utad.pt
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Abstract: This work aims to evaluate salt content and contamination of meat preparations acquired in small and large commercial areas of the city of Vila Real, Portugal. 51 samples of meat preparations from hypermarkets and small traditional local shops, was undertaken, and tested for pH, chlorine amount, and microbiological analysis. The effects of "type of product" and "type of establishment" were assessed to know the potential factors associated with the sale of these preparations. Hamburgers and meatballs were the products with the highest amount of salt. All products showed higher levels of microbiological contamination in small local establishments compared to hypermarkets.

Keywords: Meat; Meat preparations; Spoilage; Salt content; Microbiology.

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1. Introduction

Meat and meat preparations are a significant part of the diet for many people, including the Portuguese population. With the expected increase in global consumption of these products, it is important to consider the microbiota within them. [1,2] Microorganisms present in meat can lead to spoilage, causing changes in color, texture, odor, and taste. This can result in economic losses for the meat industry and contribute to food waste. Proper handling, storage, and processing techniques are essential in minimizing spoilage [2,3]. Salt is a common ingredient used in meat preparation for various purposes, including enhancing flavor, preserving meat, and improving texture [4,5]. However, excessive salt consumption has been associated with health issues, such as high blood pressure and cardiovascular diseases [6]. The global average salt intake is estimated by 10.8 g per day, more than 5g/ day, which is the recommended by the World Health Organization (WHO). The high intake of salt is the top risk factor for diet and nutrition-related deaths [7]. Therefore, it is important to regulate and monitor the salt content in meat products to ensure they meet acceptable levels for consumer health [6,7]. This can be achieved through appropriate labeling, nutritional guidelines, and industry practices that promote responsible salt usage in meat preparation.

The aim of this study is to aims to evaluate the salt content and spoilage microorganisms' levels in meat preparations obtained in small and large commercial areas of the city of Vila Real, from the North of Portugal.

2. Materials and Methods

2.1. Sample Collection

Fifty-one samples of meat preparations were collected from hypermarkets (N=26) and local butcheries (N=25). Samples included meat puffs (N=8), meat loaves (N=9), hamburgers and meatballs (N=25) and breaded beef (N=9).

2.2. Analyses Performed

Samples were evaluated for pH value, salt content and microbiological examination. Mesophilic microorganisms (MES), Enterobacteriaceae (ENT), *B. thermosphacta* (BT), Lactic Acid Bacteria (LAB), *Pseudomonas* spp. (PSEUD) Moulds and Yeasts were counted, according to ISO standards. Counts were expressed in Log CFU/g.

The determination of the chloride content of the samples was based on the ISO 1841-1/1996 standard for determining the chloride content of meat preparations containing 1.0% (m/m) or more sodium chloride (NaCl).

2.3. Data Analysis

One-way analysis of variance (ANOVA) was conducted to test the effect of "type of product" and "type of establishment" on microbiological counts, using the SPSS 22.0 software (SPSS, IBM, Armonk, NY, USA) at 5% level of probability.

Portuguese legislation (Decree-Law No 147/2006) defines a salt limit of 1% for minced meat. This value was used as a term of comparison and reference for the salt concentration in the samples in this work.

3. Results and Discussion

From microorganisms' levels (Table 1), the highest were Mesophiles and *Pseudomonas* spp. and the lowest were Moulds and Yeasts. Hamburgers and Meatballs were the ones that presented the highest values of *B. thermosphacta*, *Pseudomonas* spp., Molds and Yeasts. The highest values in Mesophiles, LAB and *B. thermosphacta* were obtained in Meatloaves. Meat puffs had the highest counts of Enterobacteriaceae. Meat breading was always the type of product with lowest microbial concentrations.

Table 1. Levels of microorganisms (means and standard deviation (sd)), expressed in Log CFU/g, according to the type of product.

Product type	N	MES		ENT		LAB		BT		PSEUD		YEASTS		MOULDS	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Meat puffs	8	7.18a	0.60	3.91a	0.47	6.08a	0.83	5.64	1.59	6.86	1.02	4.47	0.57	0.72	0.84
Meat loaves	9	7.37a	0.34	2.88b	0.58	5.54ab	1.89	5.9	1.61	6.32	1.06	4.45	1.1	0.53	0.65
Hamburgers and meatballs	25	6.87a	1.06	3.88a	0.94	5.17b	0.77	6.33	1.37	7.12	1.56	5.02	0.73	0.94	0.83
Breaded beef	9	5.72b	0.62	2.88b	1.23	4.33b	0.58	4.83	1	6.04	1.09	4	0.78	0.41	0.86
P-value	-	***		**		**		*		*		*		NS	

In each column, means with different letters differ significantly: P < 0.05; ** P< 0.01; *** P<0.001; NS – not significant.

All products showed higher levels of microbiological contamination in small local establishments compared to hypermarkets. These differences were significant in Hamburgers and Meatballs for Mesophiles, *B. thermosphacta* and Molds and Yeasts, and in Meat

breading for Molds and Yeasts and Enterobacteriaceae. In *Pseudomonas* spp., the differences observed in Meat breading were very significant.

In terms of acceptability, hypermarkets had an overall acceptability of 8.6% in their samples, whilst small local had 68.9%. Overall, samples showed 75.4% of acceptability, with Meat breading showing the best results and Hamburgers and Meatballs, the worst. All types of products obtained acceptable ratings for their concentration of LAB, Molds and Yeasts.

The physicochemical analysis displayed similar results for pH among different products and establishments ($p>0.05$) without exceeding 6.00. Regarding NaCl content, no statistical differences were observed among different products and establishments. However, hamburgers and meatballs purchased from local butcheries displayed the highest NaCl content. Twenty per cent of the samples had a salt content higher than 1%. All these samples were from small local shops.

4. Conclusions

This study concludes that the amount of chlorides present in meat preparations in Vila Real is satisfactory, and that the pH values do not indicate production defects. However, the microbiological analysis shows that there are parameters that still need to be improved. This study exhibits the need in microbiological quality improvement, namely in the case of Mesophiles, Enterobacteriaceae and *B. thermosphacta*. In these, particularly, the microbial concentrations found are unsatisfactory, since the averages of the various types of products are all or almost all considered unacceptable.

The results obtained for small local establishments are always qualitatively lower than those observed in hypermarkets, although these differences are not always significant. This fact reinforces the need to continue to implement upgrades in the quality control of products from traditional local commerce.

It is important to implement the necessary measures in the quality control of products from small local businesses, namely through the obligation to carry out training actions for improving hygiene and safety habits in the production, transport, storage and exposition of this type of product.

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Conflicts of Interest: The authors declare no conflict of interest.

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