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ANALYSIS OF THE TECHNOLOGICAL PROCESS AND PHYSICOCHEMICAL QUALITY INDICATORS OF POULTRY BOLOGNA

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Abstract:

The present paper aims at the analysis of the technological manufacturing process and the evaluation of the physico-chemical quality indicators for an assortment of poultry bologna made in its own production. The technological flow followed the critical processing stages, starting with the preparation of the raw material and the formation of a stable emulsion, followed by the essential heat treatment carried out until the temperature of 72 ± 2°C was reached in the thermal center of the product, a vital parameter for microbiological safety and stability of the composition. The results of the laboratory analyses for the own production sample revealed a high quality product, with a moisture content of 65.32% and a protein fraction of 11.84%, values that comply with the reference norms (maximum 70% moisture and minimum 11% protein). The fat content of 12.08% indicates a balanced nutritional profile, being considerably below the maximum limit of 20% found in the literature. The slightly hydrolyzable nitrogen value (17.74 mg NH_3/100g) confirms a high degree of freshness, being well below the critical threshold of 35 mg/100g. Additional indicators, such as pH of 6.17, salt content of 1.9% and total ash of 2.7%, reflect a correct management of the recipe and the mixing process. With an energy intake of 188.32 kcal/100g, the analyzed bologna demonstrates that rigorous compliance with technological parameters allows obtaining a poultry meat product with optimal physicochemical properties and a high biological value.

Keywords: poultry, bologna, technological process, physico-chemical indicators, food quality.

• Introduction

The escalating global demand for cost-effective and nutritious protein sources has significantly elevated the importance of poultry-based processed meat products like bologna in the human diet [1]. This surge in consumption necessitates a thorough understanding of the technological parameters and quality indicators that ensure both safety and nutritional integrity [2]. Given the intricate nature of meat product manufacturing, strict adherence to technological processes is paramount for achieving high-quality outcomes [3]. For instance, the optimal cutting time for raw materials significantly influences the rheological, functional, and technological indicators of comminuted meat products, impacting aspects such as water holding capacity and oil holding capacity [4]. Similarly, the precise control of water temperature and emulsification speed during production plays a critical role in the final product's textural and chemical characteristics, particularly in chicken mortadella [5]. These factors, alongside the careful selection of raw materials, which inherently possess varying chemical compositions and functional properties [6], are crucial for developing products with desirable physicochemical and organoleptic attributes. The careful management of pH during processing, for example, is critical as it directly influences the water-binding capacity of the meat mixture, thereby affecting product yield and mass loss [7]. The pH value also serves as a critical indicator for classifying meat quality and assessing its suitability for incorporation into sausage technologies [8]. Moreover, the inclusion of specific protein-carbohydrate-mineral supplements can further enhance the physicochemical and functional parameters of cooked sausages, leading to improved quality characteristics in the final product [9]. Such additions can also optimize the biological and nutritional value of the product, enhance its structure, and improve its taste and aroma [10]. Beyond intrinsic compositional factors, external influences such as cold storage conditions critically impact the physical and nutritional attributes of perishable meat products, directly affecting consumer perception and purchasing appeal [11]. Therefore, stringent quality control measures throughout the production chain, from raw material sourcing to final product packaging, are indispensable to guarantee product safety, extend shelf life, and meet consumer expectations for wholesome and convenient food options [12]. Consequently, continuous research into the optimization of technological parameters and the precise measurement of physicochemical indicators is essential for advancing the production of high-quality poultry bologna. This study therefore systematically investigates the manufacturing process and evaluates the key physicochemical quality parameters of poultry bobologna, thereby contributing to the scientific understanding required for optimizing industrial production. This paper rigorously examines the technological process and quality indicators of poultry bologna, focusing on an in-house production sample to establish a comprehensive baseline for quality assurance and process optimization. The detailed analysis of these parameters provides critical insights into the efficacy of current production methodologies and identifies potential avenues for enhancing product consistency and sensory attributes. This includes assessing the impact of various processing steps on the physicochemical properties, such as moisture, fat, and protein content, as well as the pH and salt concentration, all of which are crucial for defining the overall quality profile of the final product. The rigorous evaluation of these indicators directly supports the development of quality control protocols and contributes to the broader understanding of food science in meat processing, aligning with regulatory standards for food safety and quality [13].

• Material and method

The technological process of obtaining poultry bologna includes the following main stages [14], [15]: reception and quality control of the raw material (chilled or frozen poultry meat, poultry bacon), followed by storage at temperatures of 0-4 degrees C until processing; rotating the meat at the volf through the 3 mm sieve, in order to increase the contact surface for brining; brining (bradting) by mixing with the mixture of salts (table salt, sodium nitrate, polyphosphates) and chilled water or ice flakes, for 15-20 minutes, followed by maturation at 2-4 degrees C for 12-24 hours, for the development of the specific color and flavor [14]; emulsification in a cutter or colloidal mill, by gradually adding salted and chopped fats, spices (white pepper, geranium, dehydrated garlic), auxiliary materials (starch, vegetable protein) and chilled water, until a fine and homogeneous paste is obtained, with a maximum temperature of 12 degrees C [15]; filling the composition in artificial collagen or polyamide membranes with a diameter of 60-80 mm, with the help of vacuum spray, followed by tying or clipping the ends; hot smoking at 55-65 degrees C for 20-40 minutes, in the smoking cell, to form the specific color and aroma and reduce the microbial load on the surface; boiling (pasteurization) in the thermal cell at 72-80 degrees C, until the temperature of 72 plus or minus 2 degrees C is reached in the thermal center of the product, a critical parameter for microbiological safety and stability of the composition [14]; rapid cooling under a cold water shower or in a water basin at a maximum of 15 degrees C, up to a center temperature below 10 degrees C, to prevent the multiplication of heat-resistant microorganisms; storage in refrigerated spaces at 0-4 degrees C, in conditions of relative humidity of 75-85%, until delivery [15]. The samples were subjected to physicochemical analyses for the determination: moisture (by oven-drying, SR ISO 1442 [19]), fat content (Soxhlet method, SR ISO 1443 [20]), total protein (Kjeldahl method, SR ISO 937 [21]), salt (Mohr titrimetry, SR ISO 1841-2 [22]), pH (potentiometry, SR ISO 2917 [23]), easily hydrolyzable nitrogen (Conway method, SR ISO 2918 [24]), total ash (calcination at 550 degrees C, SR ISO 936 [25]) and energy intake (calculated based on Atwater factors: protein 4 kcal/g, fat 9 kcal/g, carbohydrates 4 kcal/g) [16], [17].

• Results and discussions

The results of the physico-chemical analyses of the bologna sample of our own production as well as the results of other bologna samples taken from the literature are presented in Table 1.

Table 1 Results of the physicochemical analyses of the bologna sample of own production and the results of the bologna samples taken from the specialized literature

No.	Evaluated bologna samples	Moisture (%)	Fat content (%)	Total protein (%)	Salt (NaCl, %)	pH	Easily hydrolysable / ammoniacal nitrogen (mg NH_3/100 g)	Total ash (%)	Energy value (kcal/100 g)
1.	Bologna (own sample)	65.32	12.08	11.84	1.9	6.17	17.74	2.7	188,32
2.	Bologna 1	64.8	15.2	12.4	1.8	6.25	18.5	2.6	185
3.	Bologna 2	67.1	11.0	13.6	1.6	6.32	16.2	2.4	158
4.	Bologna 3 (low-fat)	70.5	6.8	14.1	1.5	6.35	14.0	2.2	128
5.	Bologna 4 (with skin/MDM)	63.2	18.9	11.2	1.9	6.18	22.4	2.9	210
6.	Permissible limits	66.0	13.5	12.9	1.7	6.28	17.6	-	-

Evaluation of the moisture content (%) of bologna samples

The following figure shows the variation in humidity in the evaluated bologna samples.

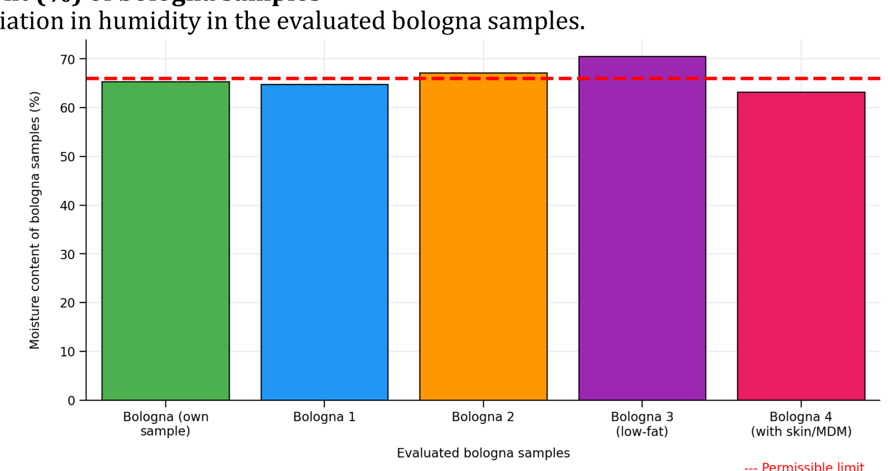

Figure 1. Humidity variation in bologna samples

Water content is one of the main factors influencing the texture, juiciness and stability of meat products. The determined values indicate a fairly wide range of variation, between 63.2% and 70.5%, which suggests marked differences between the recipes of the analyzed products. Bologna 3 (low-fat) has the highest moisture content (70.5%), which can be explained by reducing the lipid fraction and compensating for it by adding water. This practice is specific to dietary products, where the texture must be maintained in the absence of fat. In contrast, Bologna 4 (63.2%) indicates a more concentrated product with a higher proportion of dry matter. This may suggest using a raw material that is richer in lipids or collagen. The own sample (65.32%) is in the middle zone, which indicates a balanced formulation, without technological extremes.

Evaluation of the fat content (%) of bologna samples

The following figure shows the variation of fatty substances in the evaluated bologna samples

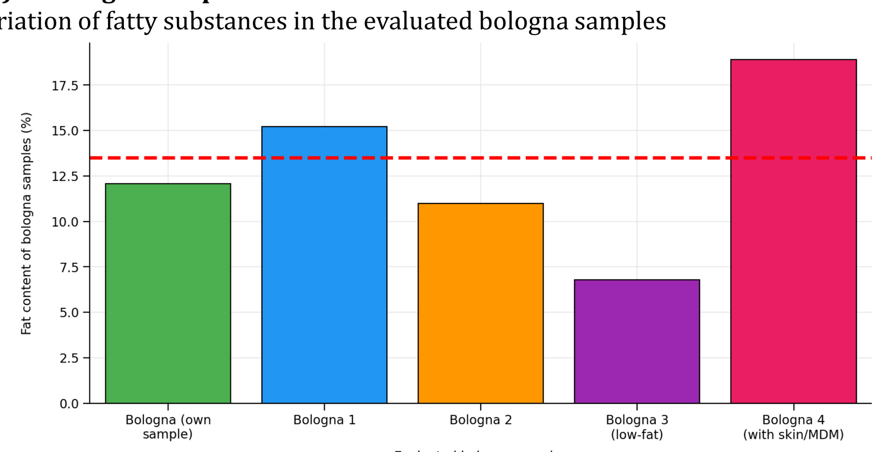

Figure 2. Variation of fats in bologna samples

The lipid content has a major influence on the sensory characteristics and nutritional value of the product. The determined range, between 6.8% and 18.9%, highlights the existence of distinct types of products. Bologna 4 (18.9%) has a high lipid content, which indicates a rich structure and a possible impact on the texture, which is softer and more greasy. Bologna 3 (6.8%) represents the type of dietary product. The own sample (12.08%) is characterized by a moderate level. Technologically, the grease contributes to the stability of the emulsion. High levels may indicate the use of adipose tissue or low-quality raw materials. From a nutritional point of view, there is a direct correlation between fat content and energy value.

Evaluation of the total protein content (%) of bologna samples.

The following figure shows the variation of protein substances in the evaluated bologna samples

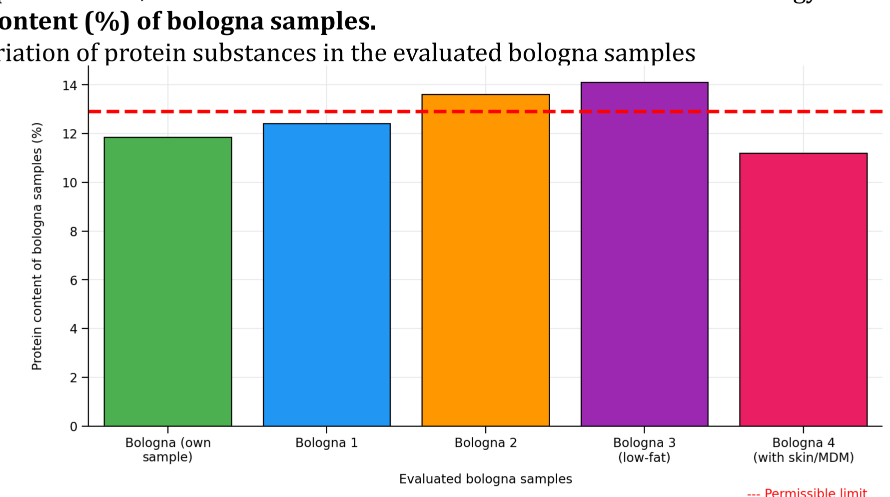

Figure 3. Variation of protein substances in bologna samples

Protein is essential for the biological value of meat products. The observed variability, with values between 11.2% and 14.1%, reflects important differences in their composition. Bologna 3 (14.1%) has the highest protein content, which indicates the use of a higher amount of lean meat. Bologna 4 (11.2%) has a low content, which may suggest dilution by adding fats or raw materials with lower biological value, e.g. mechanically separated meat. The own sample (11.84%) is located at the lower limit of the range. Increased protein content is frequently associated with reduced lipid content and vice versa.

Evaluation of the NaCl salt content (%) of bologna samples

The following figure shows the variation of salt in the evaluated bologna samples.

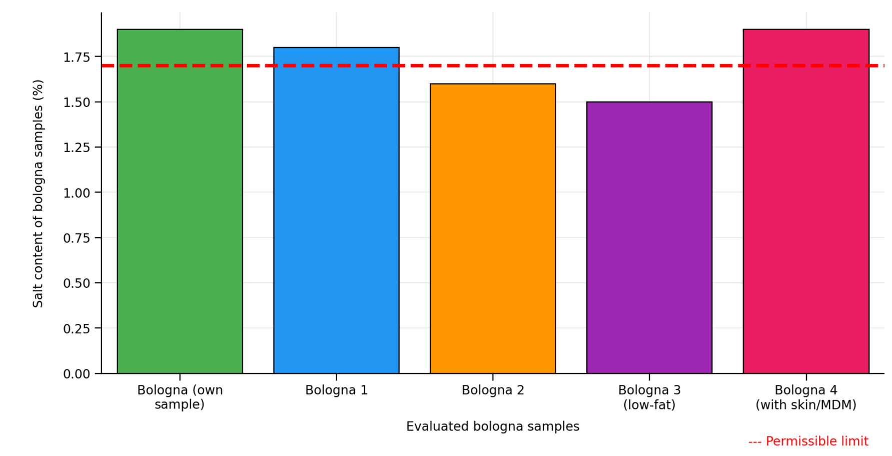

Figure 4. NaCl variation in bologna samples

The relatively close values, between 1.5% and 1.9%, indicate the controlled use of sodium chloride in the technological process. Salt fulfills multiple roles, including intensifying the taste, stabilizing the protein emulsion and providing a preservative effect. The small differences between the samples suggest the existence of a technological standardization, specific to the food industry.

Evaluation of the pH of bologna samples

The following figure shows the pH variation in the Bologna samples evaluated.

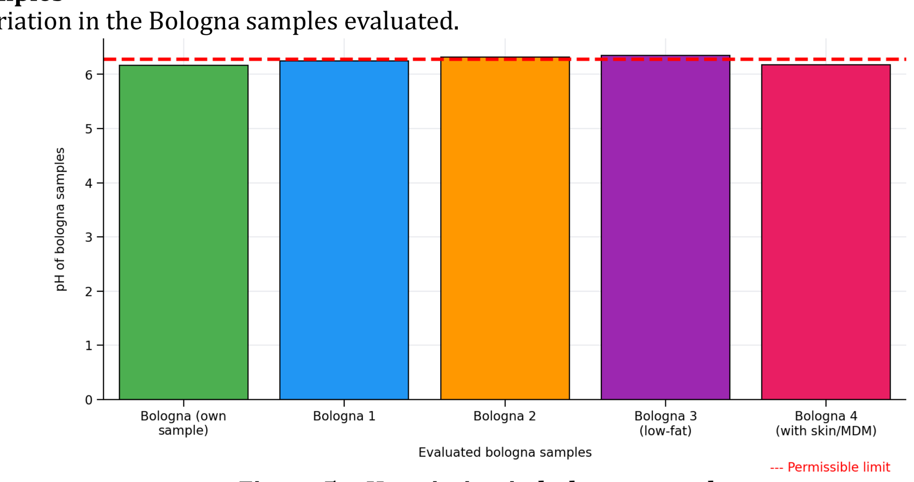

Figure 5. pH variation in bologna samples

The pH of the analyzed products is within a narrow range, between 6.17 and 6.35, characteristic of processed meat products. The variations are minor, indicating a similar composition of the protein system. The absence of significant deviations suggests a relatively uniform stability of the products. This parameter does not significantly differentiate the samples, but confirms the homogeneity of this product category.

Evaluation of easily hydrolyzable nitrogen (mg NH_3/100 g) of bologna samples.

The following figure shows the variation of easily hydrolyzable nitrogen in the Bologna samples evaluated.

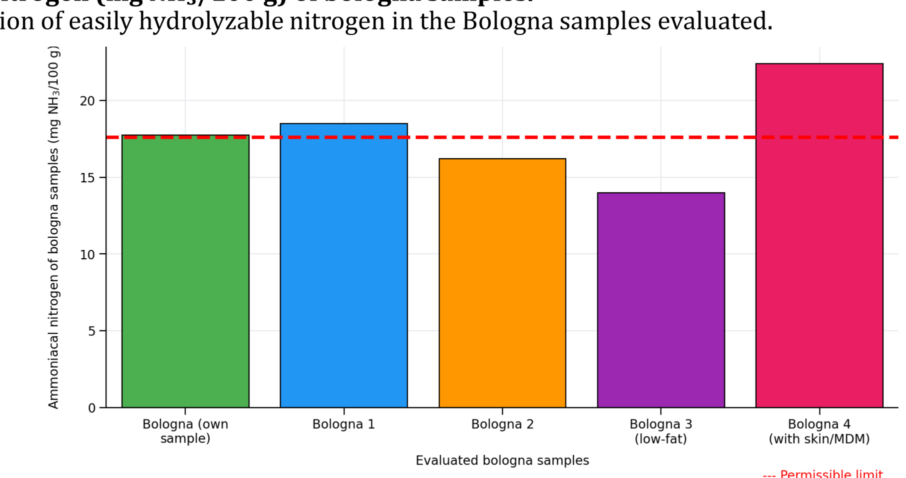

Figure 6. Variation of easily hydrolyzable nitrogen in bologna samples

This indicator is particularly important because it reflects the degree of protein degradation and biochemical processes in the product. Bologna 4 (22.4 mg NH_3/100 g) has the highest value, indicating a possible marked protein degradation. Bologna 3 (14.0 mg) has the lowest value, suggesting higher protein stability. The own sample (17.74 mg) is at an average level. The increase in ammonia nitrogen can be correlated with the quality of the raw material, the duration of storage and the enzymatic processes. Thus, Bologna 4 differs significantly by this parameter.

Evaluation of the total ash content (%) of bologna samples

The following figure shows the variation of total ash in the Bologna samples evaluated.

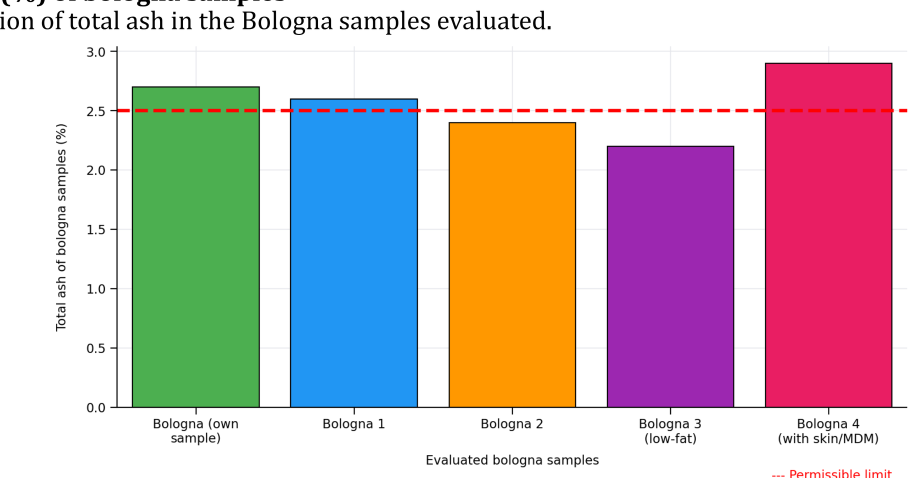

Figure 7. Variation of total ash content in bologna samples

Total ash reflects the mineral content of the product. Bologna 4 (2.9%) has the maximum value, Bologna 3 (2.2%) has the minimum value, and the own test (2.7%) has a relatively high value. Higher values may indicate additions of salts and additives, as well as the use of raw materials with a high mineral content.

Evaluation of the energy intake (kcal/100 g) of bologna samples

The following figure is the energy value of the evaluated bologna samples.

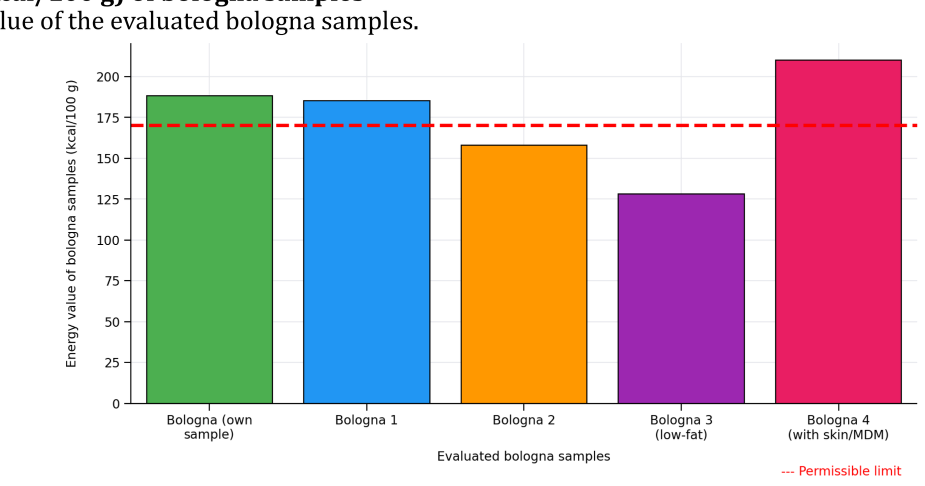

Figure 8. Variation in the energy value of bologna samples

The energy value is the direct result of the chemical composition. Bologna 4 (210 kcal) has the highest energy value, correlated with its high fat content. Bologna 3 (128 kcal) has the lowest value, characteristic of dietary products. The own sample (188.32 kcal) is close to the general average of the analyzed samples. Fat is a major contributor to calorie intake, while a high moisture content leads to a decrease in energy density.

• Conclusions

Overall, the comparative analysis highlights that poultry bologna samples show significant physicochemical differences, mainly generated by variations in formulation, raw materials, and processing technologies. Three main product types can be identified: a dietetic product (Bologna 3), characterized by low fat content and reduced energy value; a high-fat product with possible indications of lower quality (Bologna 4); and an intermediate group (own sample, Bologna 1 and 2) with balanced compositions.

The analyzed sample falls within the category of conventional products, showing values close to the reference for most parameters, which indicates good quality and a well-balanced formulation. In conclusion, the nutritional composition and stability of these products are strongly influenced by moisture, fat, protein content, and the quality of raw materials, confirming the importance of technological control in obtaining safe and nutritionally balanced poultry bologna products.