Studii şi Cercetări Ştiinţifice
Chimie şi Inginerie Chimică, Biotehnologii, Industrie Alimentară

Scientific Study & Research
Chemistry & Chemical Engineering, Biotechnology, Food Industry

2026, **27** (1), pp. 091 – 107

https://doi.org/10.29081/ChIBA.2026.652

ISSN 1582-540X

ORIGINAL RESEARCH PAPER

EVALUATION OF TURKEY LIVER PÂTÉ AND CANNED TURKEY HAM QUALITY THROUGH SENSORY, CHEMICAL AND MICROBIOLOGICAL ANALYSES

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Received: July, 11, 2025
Accepted: March, 27, 2026

Abstract: This study aimed to compare two canned turkey meat products, respectively turkey liver pâté and canned turkey ham, through sensory, physico-chemical, and microbiological analyses. Sensory evaluation was conducted using a 5-point scale across five parameters (appearance, color, taste, texture, and packaging), assessed by 12 panelists. The canned turkey ham achieved a higher average score (18.17 out of 25 points) compared to the liver pâté (17.25 out of 25 points), mainly in terms of texture and color. Physicochemical determinations included measurements of sodium chloride (NaCl), nitrites (NO_2^-) moisture, protein, and fat. The liver pâté presented higher fat content (24.80 g·100 g^{-1}), nitrites (5.64 mg·100 g^{-1}), and greater variability in moisture content (62.79-71.14 %), while the canned ham showed lower fat (3.92 g·100 g^{-1}), higher protein (14.80 g·100 g^{-1}), and more uniform composition. Both products were within the acceptable limits for NaCl content (1.35 g·100 g^{-1} in pâté; 1.19 g·100 g^{-1} in ham). Microbiological tests confirmed the absence of *Salmonella spp.* and *Escherichia coli* in all samples. Hermetic sealing was verified, indicating compliance with food safety requirements. In conclusion, both products meet quality and safety standards, but the canned turkey ham demonstrates better nutritional balance and technological consistency, while the liver pâté may benefit from improved standardization of fat, moisture, and salt content.

Keywords: *canned food, consumer safety, food safety, processed poultry products, quality poultry meat, turkey meat products*

INTRODUCTION

The poultry meat industry has experienced rapid growth in recent decades, becoming a highly competitive and technologically advanced sector. This evolution has been driven by the increasing global demand for white meat, which is often perceived as healthier, and by the modern consumer's growing awareness of food safety, animal welfare, nutritional quality, and environmental sustainability [1 – 3]. As a result, European standards have become stricter, placing additional pressure - on industrial processing practices to ensure compliance with high standards [2 – 4].
Within this context, turkey meat has emerged as a valuable source of high-quality protein, offering a favorable lipid profile and a nutritional composition well suited for balanced diets and specific dietary needs. Compared to other types of meat, turkey provides high protein content, reduced saturated fat levels, and significant amounts of water-soluble vitamins and essential minerals. These characteristics make turkey meat a versatile food suitable for all age groups and physiological states [5 – 9].
In response to changing nutritional needs and lifestyle preferences, the food industry has increasingly focused on processed, ready-to-eat products that ensure microbiological safety, extended shelf life, and convenience. Among these, canned poultry products hold an important place, due to their durability and wide range of culinary applications [9 – 13].
This paper aims to evaluate the quality of two representative processed turkey products respectively blended canned turkey liver pâté and blended canned turkey ham, manufactured at the poultry meat-processing unit from Vaslui. The study addresses sensory evaluation (color, taste, smell, texture), physico-chemical analysis (protein, fat, moisture, salt, residual nitrites), and microbiological safety (*Salmonella spp., Escherichia coli*).
The objectives of this study are represented by assess compliance of the selected products with national and European standards concerning food quality and safety, compare the nutritional and sensory properties of the two canned products, identify key technological factors influencing the stability, sensory appeal, and nutritional value of processed turkey meat products.
The products analyzed were sampled directly from the production line of the poultry meat-processing unit from Vaslui, a facility with longstanding tradition in the Romanian meat industry. It operates under a comprehensive quality management system that emphasizes traceability, hygiene, and a diverse product portfolio. The unit utilizes modern technologies for refrigeration, sterilization, packaging, and storage, meeting strict hygiene protocols and nutritional requirements.
The results obtained through standardized analytical methods allow for a comprehensive and objective characterization of the studied products, with particular attention to their nutritional profile and suitability for a health-conscious consumer market.

MATERIALS AND METHODS

To evaluate the quality of two processed turkey meat products, respectively canned turkey liver pâté and canned turkey ham, a comprehensive research methodology was employed, including sensory, physico-chemical, and microbiological analyses. The turkey pate and turkey ham samples were supplied by the same manufacturer. All tests were conducted in the specialized laboratory from Iasi University of Life Sciences, in accordance with national and international food quality standards.

Sensory analysis

Sensory evaluation aimed to assess key organoleptic characteristics relevant to consumer acceptability, including external and internal appearance of the packaging, content consistency, color, taste, and smell.

The analysis was conducted by a trained panel of 12 evaluators, using a standardized 25 point quality scoring system and individual assessment sheets.

Physico-chemical analysis

For each product type, 10 determinations were performed, covering the following parameters:

a. Sodium chloride ($NaCl$) content, determined by titrimetric method, using silver nitrate ($AgNO_3$) and potassium chromate (K_2CrO_4) as indicator [14 – 17].

Calculation formula:

$$NaCl\ (g \cdot 100\ g^{-1}) = \frac{0.00585 \cdot V \cdot 10}{m} \cdot 100 \quad (1)$$

where: V = volume of $AgNO_3$ used (mL), m = mass of the sample (g).

b. Sodium nitrite ($NaNO_2$) content, determined by colorimetric-Griess method) [9 – 13].

Calculation formula:

$$NaNO_2 (mg \cdot 100\ g^{-1}) = \frac{m_1 \cdot 100}{m \cdot V} \cdot 100 \quad (2)$$

where:

m_1 = nitrite content from the standard tube (mg), m = sample mass (g), V = filtrate volume used (mL).

c. Moisture content, determined by oven drying method at 103 - 105 °C until constant weight [18 – 21].

Calculation formula:

$$H_2O\ (g \cdot 100\ g^{-1}) = \frac{m_2 - m_1}{m} \cdot 100 \quad (3)$$

where: m_1 = final weight after drying (g), m_2 = initial weight (g).

d. Protein content, determined by Kjeldahl method, involving mineralization, distillation, and titration.

Calculation formula:

$$protein\ (g \cdot 100\ g^{-1}) = \frac{V \cdot 0.0014 \cdot 6.25}{g} \cdot 100 \quad (4)$$

where: V = volume of 0.1N HCl used for titration (mL), g = sample weight (g).

e. Fat content, determined by Soxhlet method extraction using petroleum ether [20 – 22].

Calculation formula:

$$fat\ (g \cdot 100\ g^{-1}) = \frac{G_3 - G_2}{m} \cdot 100 \quad (5)$$

where: G_3 = weight of the cup with extracted fat (g), G_2 = weight of the empty cup (g), m = sample mass (g).

Microbiological analysis

a. *Salmonella spp*. detection

Method: 25 g of homogenized sample was incubated in enrichment media (1:5 sample-to-media ratio). After incubation at 37 °C for 18 - 21 h, the samples were transferred to selective media. Colonies with suspected morphology were further analyzed using Gram staining, slide agglutination with anti-*Salmonella* sera, and biochemical tests [22 – 24].

b. *Escherichia coli* detection

Method: Seeding on sodium deoxycholate lactose agar (DCL), followed by incubation at 37 °C for 18 - 21 h. Suspected colonies were confirmed through morphological and biochemical identification procedures [24 – 25].

RESULTS AND DISCUSSION

Sensory analysis

Each of the 12 panelists received an individual sensory analysis form for the two food products, and they were informed that they had to assign a score to each sensory parameter listed in the table on the form. According to the evaluation guidelines, the maximum score that could be awarded for each parameter was five points. The sensory analysis was conducted in the Food Quality Control Laboratory, under optimal conditions as specified by the relevant standards.

Results regarding sensory analysis of canned turkey liver pâté

The sensory analysis of canned turkey liver pâté, conducted by a panel of 12 evaluators, focused on five essential attributes: exterior appearance, color, taste, texture, and packaging (Figure 1). The maximum score for each attribute was 5 points, and the average total score per product was 17.25 out of 25, which represents approximately 69 % of the ideal score.

Among the assessed attributes, packaging received the highest average score of 4, indicating that the product is perceived as attractively and practically presented, likely due to the metal can, clear labeling, and easy-open system [26].

Taste was the second-highest rated attribute, with a mean score of 3.75, indicating a consistently positive perception across the panel. This stability suggests that the current recipe is well balanced and aligns with consumer preferences.

Texture scored an average of 3.33, indicating moderate acceptability. Some panelists noted minor issues with spreadability and uniformity, which could potentially be improved by adjusting the emulsification process or fat particle size.

In addition, exterior analysis of canned appearance received a mean score of 3.17. This result points to notable differences in individual perception, possibly due to air pockets, surface irregularities, or color inconsistencies visible.

Color was the lowest-rated characteristic, which indicates a mismatch between consumer expectations and the product's actual color. Some evaluators expected a lighter, uniform pink shade typical of poultry pâtés [26].

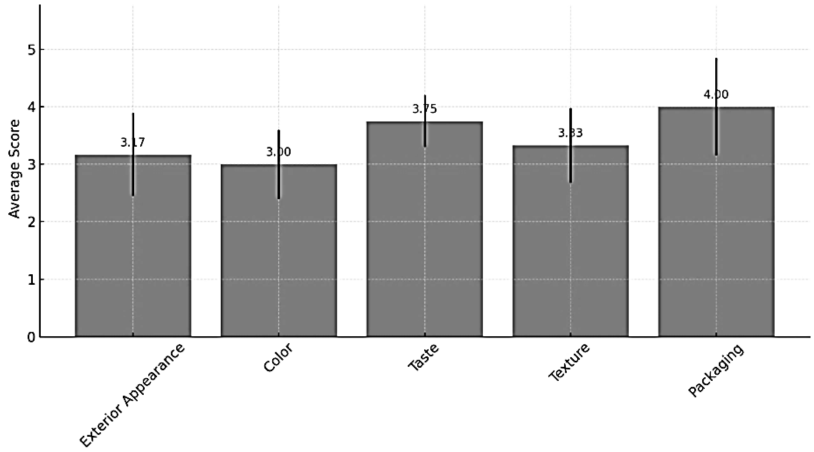

Figure 1. *Average attribute scores (panel evaluation) for turkey liver pâté*

Results regarding sensory analysis of canned turkey ham

The sensory evaluation of canned turkey ham revealed generally favorable perceptions across the five key attributes examined. The average total score reached 18.17 out of 25, equivalent to approximately 73 % of the maximum possible score, indicating a high level of overall acceptability (Figure 2).

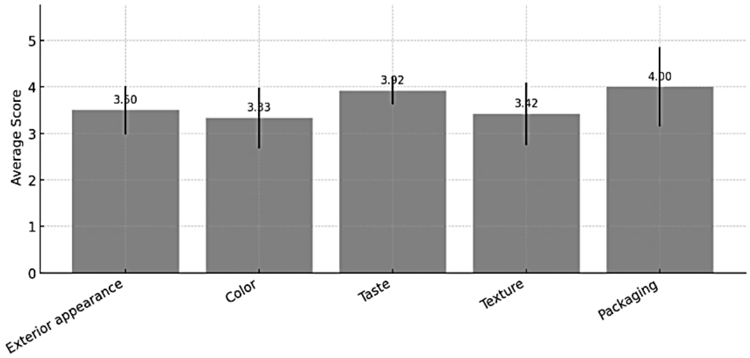

Figure 2. *Average attribute scores (panel evaluation) for turkey ham*

Packaging remained the most appreciated feature, with a constant average score of 4. The clear labeling, functional design, and easy-open metal can were positively perceived.

Taste emerged as the most consistent and well-received attribute, with the highest average score of 3.92, which reflects a uniformly positive flavor profile, indicating that the formulation aligns well with consumer preferences.

Exterior appearance achieved an average score of 3.5. Most assessors, showing good process consistency, perceived the product's surface as visually uniform and appealing.

Texture was rated at 3.42, indicating moderate to good acceptability. While panelists noted improved spreadability and firmness, some inconsistency in mouthfeel was still observed.

Color, though still the lowest-rated parameter scored 3.33, an improvement relative to comparable products such as canned liver pâté. The shade was closer to the expected light-pink tone typical of poultry-based products.

Physico-chemical analysis

Results regarding NaCl content

The sodium chloride (NaCl) content was determined for 10 samples of each product: canned turkey liver pâté and canned turkey ham. All 10 samples were obtained from the same manufacturer and the same batch.

For the turkey liver pâté, the NaCl values ranged between 1.28 and 1.44 g·100 g^{-1}, with a sample mean of 1.354 g·100 g^{-1}. All samples remained below the regulatory limit of 1.5 g·100 g^{-1}, indicating full compliance [27 – 29]. The highest value (1.44 g) is still comfortably within the allowed threshold, while the lowest (1.28 g) shows some underuse, possibly due to minor process deviations or mixing inconsistency (Figure 3). The variation among samples is moderate, suggesting a generally stable process with some room for fine-tuning salt dispersion. Also, the observed differences between the results can be attributed to natural variability in the product, as well as experimental and analytical variations.

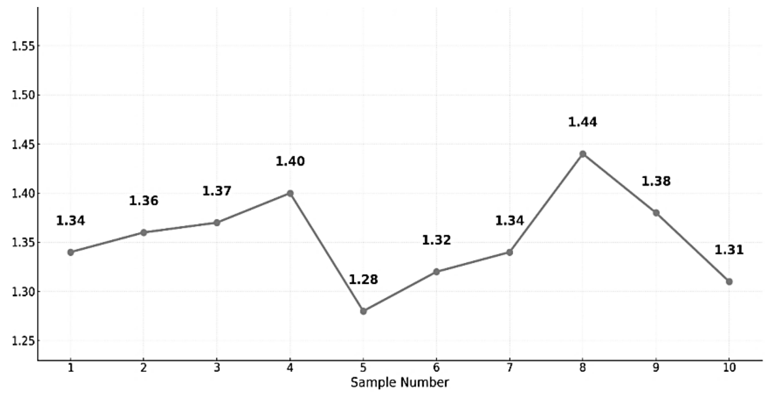

Figure 3. *NaCl content per sample – turkey liver pâté (g·100 g^{-1})*

In the case of the canned turkey ham, the sodium levels were more homogeneous and consistently lower. The measured values ranged from 1.16 - 1.26 g·100 g^{-1}, with a sample mean of 1.190 g·100 g^{-1}, compared to a maximum allowed value of 1.3 g·100 g^{-1} [27 – 33]. The dataset reflects a tighter salt control, with all samples well below the legal threshold. The limited spread among the values (mostly clustered around 1.19 g) demonstrates an efficient formulation process and high reproducibility across units (Figure 4).

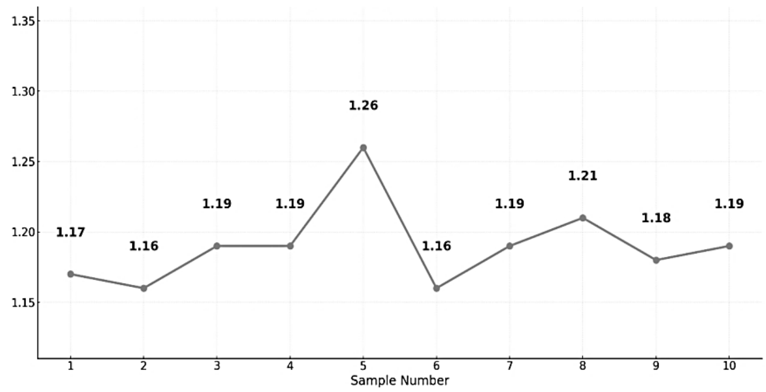

Figure 4. *NaCl content per sample – canned turkey ham (g·100 g^{-1})*

The comparative bar chart highlights that both products comply with their NaCl standard limits. However, turkey liver pâté displays a higher average sodium content (1.354 g) than canned turkey ham (1.190 g). From a nutritional perspective, this may be relevant for consumers seeking reduced-sodium options, as the canned turkey ham offers a lower-sodium profile. Conversely, the higher salt level in the pâté may contribute more to flavor intensity and shelf stability but should still be monitored to avoid exceeding legal or nutritional thresholds in future batches (Figure 5).

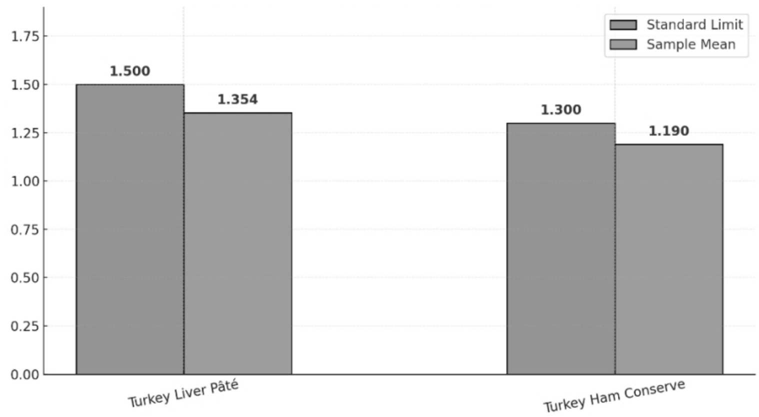

Figure 5. *NaCl - standard limit vs. sample mean: turkey liver pâté, canned turkey ham (g·100 g^{-1})*

Numerous studies in the specialized literature reports that salt (NaCl) content in liver pâtés is typically around 1 g·100 g^{-1}, while turkey ham products show values ranging from 1.1-2.6 g·100 g^{-1}, depending on formulation and sodium reduction strategies. Therefore, our findings (1.28 - 1.44 g·100 g^{-1} for pâté and 1.16 - 1.26 g·100 g^{-1} for ham) align with current trends toward salt reduction and fall within the lower ranges reported in recent studies, indicating nutritionally balanced formulations [4 – 10].

Further process standardization in the liver pâté line could help reduce sample variation and possibly lower the mean NaCl level slightly, contributing to a cleaner label and improved health positioning. Maintaining flavor balance while optimizing salt use remains an important goal for product quality and consumer satisfaction.

Results regarding nitrites content NO_2

The nitrite content (expressed as mg $NO_2 \cdot 100$ g^{-1} product) was analyzed for 10 individual samples of both canned turkey liver pâté and canned turkey ham, with the goal of assessing compliance with the maximum allowable limit of 15 mg·100 g^{-1} and comparing product formulation consistency [30 – 33].

In the case of turkey liver pâté, the nitrite levels ranged from 12.90 - 14.12 mg·100 g^{-1}, with a calculated sample mean of 13.262 mg·100 g^{-1}. All values remained safely below the 15 mg legal threshold, indicating full regulatory compliance. The peak value of 14.12 mg, observed in sample 4, approaches the upper tolerance limit, but still lies within acceptable bounds. The observed fluctuation among samples suggests moderate variability, likely attributable to small differences in curing agent dispersion or heat treatment conditions during processing (Figure 6).

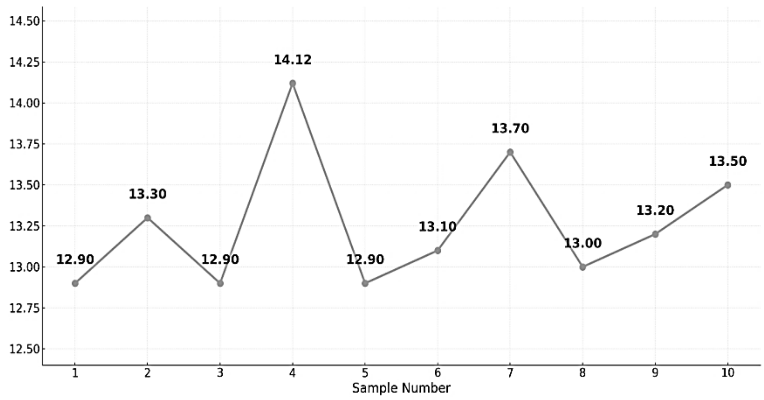

Figure 6. *NO_2 content per sample – turkey liver pâté (mg·100 g^{-1})*

By contrast, the canned turkey ham exhibited slightly lower nitrite levels and greater uniformity. Individual values ranged between 12.09 mg·100 g^{-1}, with a lower mean of 12.739 mg·100 g^{-1}. This reduced average, along with a narrower distribution of values, reflects a more controlled and consistent nitrite incorporation process. The highest value observed (13.42 mg) is still comfortably within the legal margin, and the product's overall lower nitrite profile may be better aligned with clean-label or reduced-additive consumer trends (Figure 6).

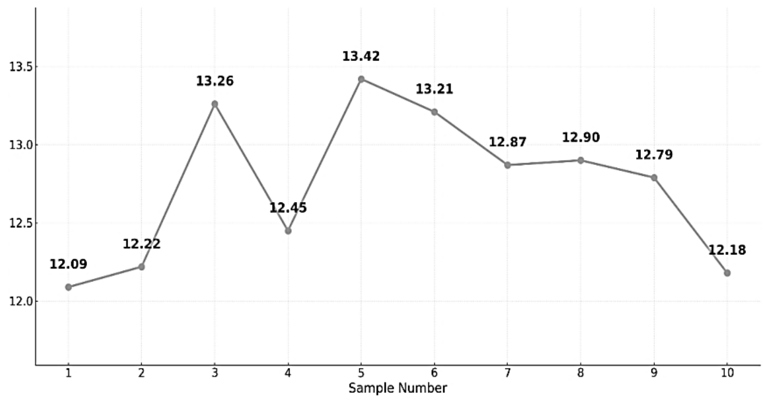

Figure 7. *NO_2^- content per sample – canned turkey ham (mg·100 g^{-1})*

The comparative bar chart highlights that both products meet the regulatory standard, but the canned turkey ham contains less nitrite on average than the liver pâté. From a technological standpoint, nitrite plays a crucial role in color stabilization and microbial control. The slightly higher levels in the pâté may reflect a higher curing demand due to the presence of liver, which is more prone to discoloration and oxidation. Nonetheless, the values in both products suggest adequate curing without excessive nitrite use.
Both the canned turkey liver pâté and canned turkey ham comply with the legal limits for nitrite content. The canned turkey ham demonstrates better consistency and a lower average nitrite concentration, which may be advantageous from a nutritional and marketing perspective (Figure 8).

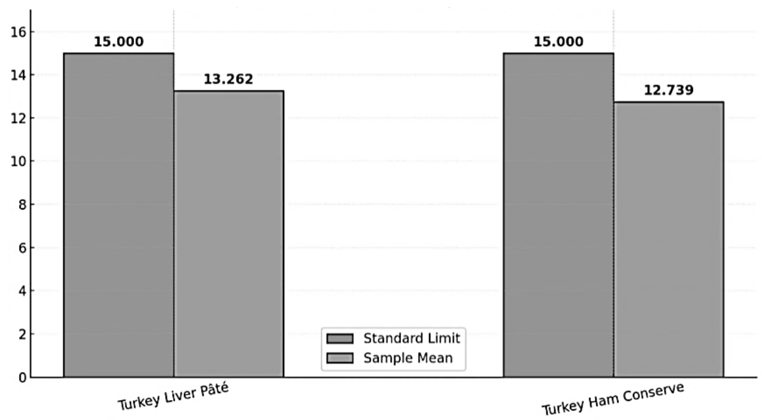

Figure 8. *NO_2^- standard limit vs. sample mean: turkey liver pâté, canned turkey ham (mg·100 g^{-1})*

A recent study on nitrite content in processed meat reports that residual nitrite (NO_2^-) levels in processed meat products range from 2.93 - 13.9 mg·100 g^{-1}, based on an extensive analysis of deli meats and canned meats [14 – 18].
Continued monitoring and process optimization, especially for the pâté line could help minimize variability and ensure long-term safety, color stability, and consumer acceptance while maintaining regulatory compliance.

Results regarding water content

Protein content of meats varies widely, with raw turkey breast containing approximately 25 g protein per 100 g, while liver pâtés (including turkey or poultry-based ones) provide on average between 13 - 18 g protein·100 g^{-1}, depending on formulation and added ingredients [2 – 5].
In the case of turkey liver pâté, water content ranged from 62.79 - 71.14 %, reflecting a relatively wide variability. The highest value, 71.14 % (sample 3), suggests a possible overhydration or unbalanced emulsification, which could lead to a softer, less cohesive texture. Lower values (e.g. 62.79 % in sample 8 and 63.09 % in sample 7) may indicate water loss during thermal treatment or less efficient binding. This fluctuation may influence the texture stability and microbial shelf life, especially in a product that relies heavily on emulsified fat and water interaction (Figure 9).

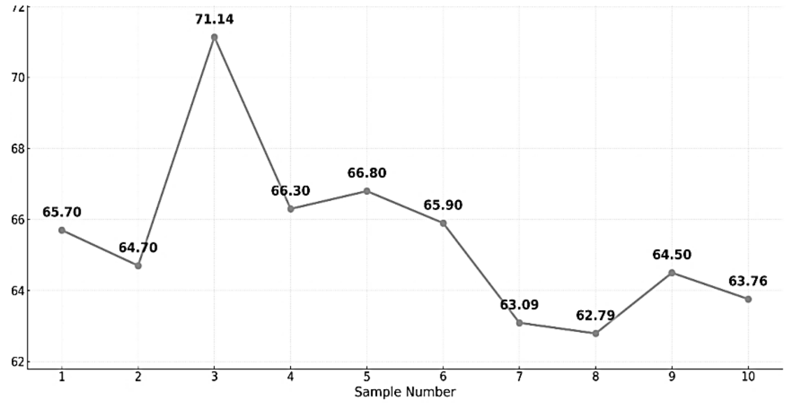

Figure 9. *Water content per sample – turkey liver pâté (g·100 g^{-1})*

By comparison, the canned turkey ham exhibits slightly more compact and centered values, with moisture ranging from 62.69 - 70.64 %. Although the maximum value is close to that of the pâté (sample 3: 70.64 %), the rest of the samples are better clustered around 64 - 66.7 %, showing greater uniformity in water retention. This suggests more consistent processing, likely due to better control over brining, meat-to-fat ratio, and thermal stabilization (Figure 10).

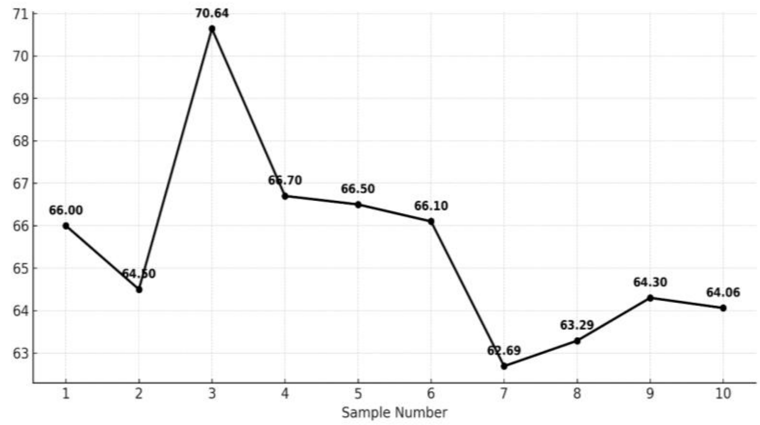

Figure 10. *Water content per sample – canned turkey ham (g·100 g^{-1})*

Results regarding protein content

The protein content was analyzed in 10 individual samples from each of the two products, with reference values of 9.00 g·100 g^{-1} for pâté and 15.08 g·100 g^{-1} for ham, as indicated by product specifications or labeling standards.

For the turkey liver pâté, protein levels ranged between 8.66 - 9.16 g·100 g^{-1}, with a calculated sample mean of 0.822 g·100 g^{-1}. This average is slightly below the reference value (9.00 g), indicating a marginal underperformance in protein content. While most individual values fall within a tight range (± 0.2 g), the result may reflect formulation variability, possibly due to inconsistent ratios of liver, meat, or fillers. Although not critical, a slight shortfall in protein may influence nutritional claims, and could raise labeling concerns if verified repeatedly (Figure 11).

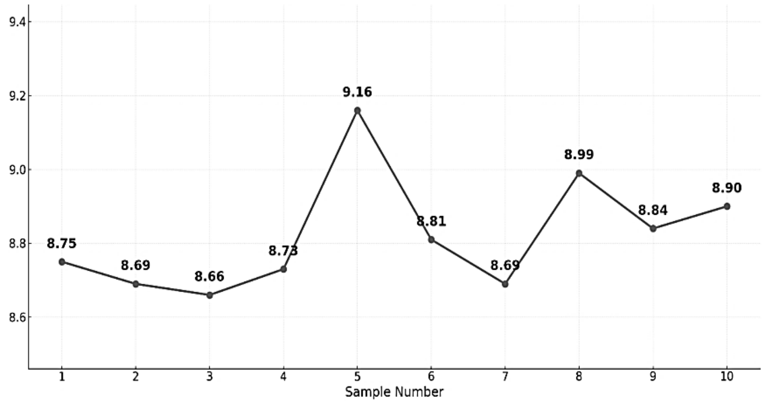

Figure 11. *Protein content per sample – turkey liver pâté (g·100 g^{-1})*

In contrast, the canned turkey ham shows significantly higher protein values, ranging to 14.21 - 15.17 g·100 g^{-1}, with a mean of 14.795 g·100 g^{-1}, very close to the 15.08 g reference. The values are more consistent overall, with less fluctuation, indicating better control over formulation and raw material content. This aligns with the expected composition of a restructured meat product, typically rich in lean meat and with limited inclusion of fat or non-meat binders (Figure 12).

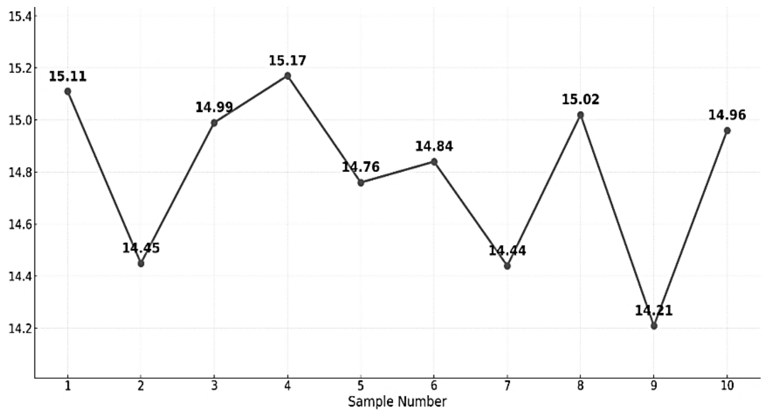

Figure 12. *Protein content per sample – canned turkey ham (g·100 g^{-1})*

The comparative bar chart clearly shows that the canned turkey ham meets its protein specification more accurately than the liver pâté. From a nutritional and labeling perspective, this consistency strengthens the product's appeal, especially for protein content conscious consumers and supports reliable quality assurance (Figure 13).

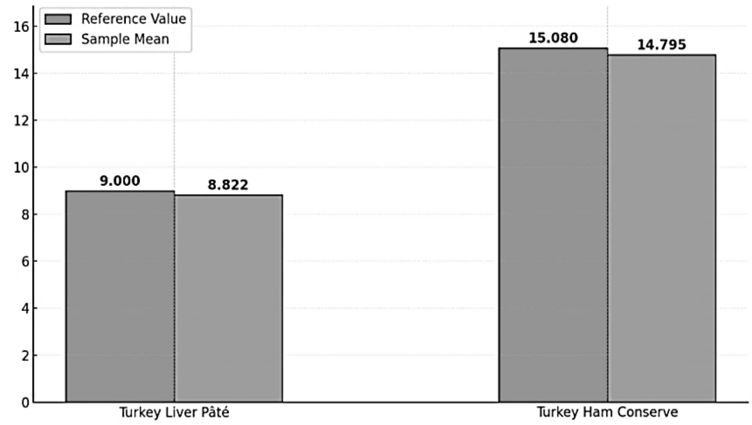

Figure 13. *Protein content – reference value vs. sample mean: turkey liver pâté, canned turkey ham (g·100 g^{-1})*

While both products demonstrate acceptable protein content, the canned turkey ham outperforms the liver pâté in terms of protein density and consistency. The liver pâté comes close to its target but would benefit from minor adjustments in formulation or raw material standardization to meet its stated protein value more reliably.

Results regarding fat content

Fat content is a critical indicator in meat products, affecting nutritional value, sensory characteristics, and labeling accuracy.

For the turkey liver pâté, fat content across the 10 analyzed samples ranged to 24.22 - 25.73 g·100 g^{-1}, with a mean of 24.803 g·100 g^{-1}, only slightly below the reference value of 25.370 g·100 g^{-1}. These values demonstrate a high fat density typical of liver pâtés. The variation across samples remains relatively small, indicating a good level of formulation consistency, and all values stay within a nutritionally acceptable range for such a product category. From a technological perspective, the fat content supports the expected creamy mouthfeel and spreadability associated with pâtés (Figure 14).

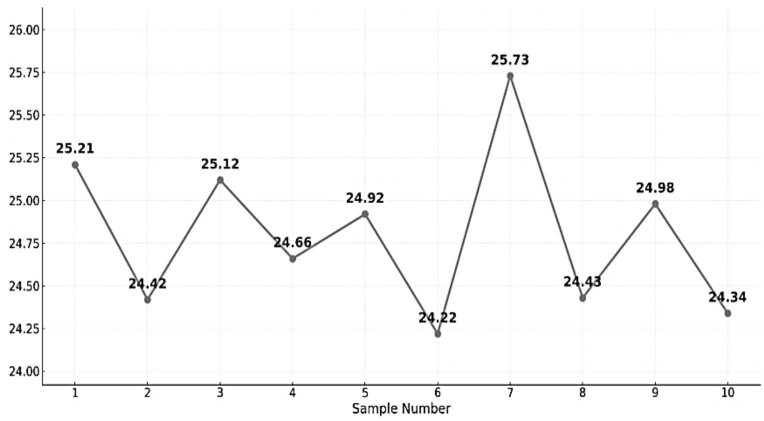

Figure 14. *Fat content per sample – turkey liver pâté (g·100 g^{-1})*

By contrast, the canned turkey ham shows a significantly lower fat content, consistent with its product profile. The sample values range to 3.45 - 4.34 g·100 g^{-1}, with an average of 3.920 g·100 g^{-1}, matching precisely the declared/reference value. These results indicate excellent formulation control and suggest that the product was designed to meet lean meat standards, appealing to consumers looking for low-fat alternatives. Despite a slight fluctuation in sample 7, the values remain stable and well within target (Figure 15).

Most studies on turkey liver pâté reports a total fat content of approximately 28 g·100 g^{-1}, typical for this creamy product type, while canned turkey ham contains on average between 3.5 - 5 g fat·100 g^{-1}, depending on lean meat content and added water [17 – 22].

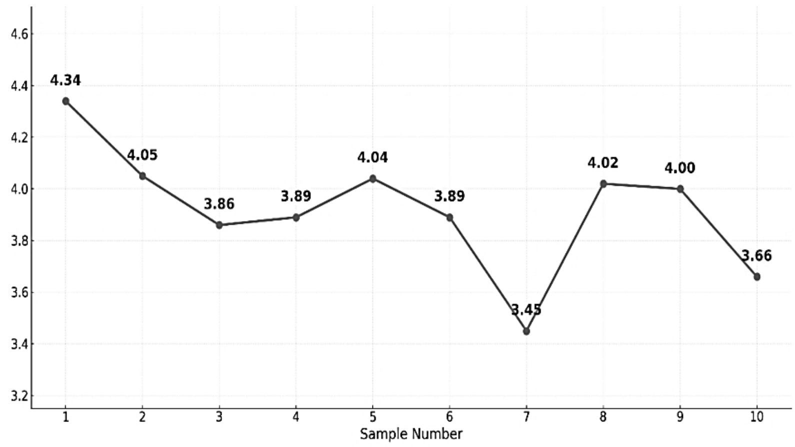

Figure 15. *Fat content per sample – canned turkey ham (g·100 g^{-1})*

The comparative bar chart highlights the major nutritional difference between the two products: the liver pâté is over six times richer in fat compared to the canned turkey ham. This has implications for energy value, shelf life, and target market positioning. While the pâté is aligned with indulgent, full-fat spreads, the canned turkey ham fits better in health-conscious diets.

Both products meet their respective fat content requirements but cater to different nutritional niches (Figure 16).

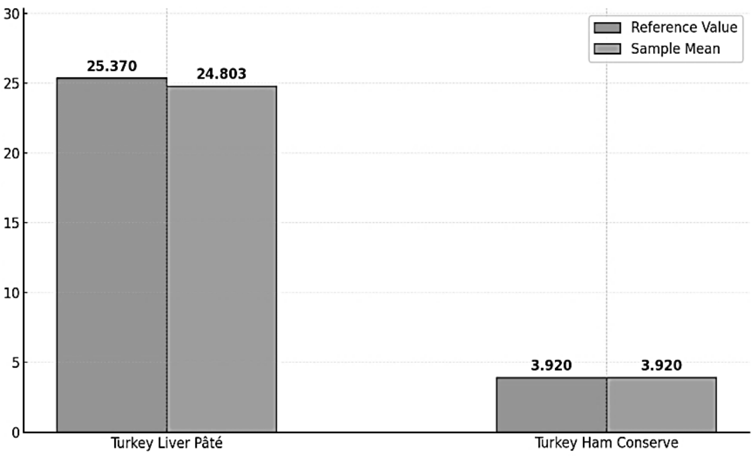

Figure 16. *Fat content – reference value vs. sample mean: turkey liver pâté, canned turkey ham (g·100 g^{-1})*

The turkey liver pâté offers high-fat density appropriate for its category, whereas the canned turkey ham stands out for its low-fat formulation and consistency, making it a suitable choice for calorie-restricted or lean-diet preferences.

Microbiological analysis

Microbiological analyses were conducted on the two products to detect aerobic bacteria from the *Enterobacteriaceae* family, specifically *Salmonella* and *Escherichia coli*. The samples were collected and processed under sterile conditions, using specific growth media for aerobic microorganisms.
To detect the presence of *Salmonella* species, five distinct stages were followed, including four types of specific agglutination tests using different serums: anti-*Salmonella* O serum, anti-Vi serum, H-type serum, and group O-type serum. Finally, agglutination of the specific strain was verified in physiological saline, which helped eliminate non-specific agglutination reactions [34, 35].
For the microbiological examination aimed at detecting *Escherichia coli* and isolating microorganisms from the coliform group, samples were inoculated on lactose agar with sodium deoxycholate in Petri dishes and incubated at 37 °C for 18 - 21 h.
The identification of the isolated strains was performed by analyzing their morphological and biochemical characteristics.
The results obtained from the microbiological analyses for the detection of Salmonella and E. coli are presented in Table 1.

Table 1. *Microbiological analysis results for Salmonella and E. coli germs*

Microbial agent	Airtightness	*Salmonella spp. in [25 g]*	*E. coli [CFU·g^{-1}]*
Reference Standard	-	SR EN ISO 6579-1:2017 SR EN ISO 7251:2009	
Sample			
1	suitable	absent	absent
2	suitable	absent	absent
3	suitable	absent	absent
4	suitable	absent	absent
5	suitable	absent	absent

Microbiological testing was conducted on five product samples to evaluate the presence of *Salmonella spp.* and *Escherichia coli*, two key indicators of food safety and hygienic processing. All samples were verified for container hermeticity, and each was found to be satisfactory, with no signs of compromised sealing or contamination risk due to packaging failure.
In accordance with SR EN ISO 6579-1:2017 [34], none of the samples showed the presence of *Salmonella* in 25 g of product, meeting regulatory safety standards applicable to ready-to-eat canned foods. Similarly, *E. coli* was not detected in any of the samples, with counts below the detection limit (<1 CFU·g^{-1}), as per SR EN ISO 7251:2009 [35]. The absence of both *Salmonella* and *E. coli* confirms that the applied sterilization processes were effective and that production was carried out under appropriate hygienic conditions [36, 37].

These results demonstrate that the microbiological quality of both the canned turkey liver pâté and the canned turkey ham comply with relevant food safety standards, posing no risk to consumers. The findings also indicate consistent process control and validate the thermal treatment parameters used during manufacturing.

CONCLUSIONS

The results of this study showed that both products analyzed meet food safety standards, with no detection of *Salmonella* or *E. coli*, and all packaging units were confirmed to be hermetically sealed.

From a sensory perspective, both products were generally well accepted, but the turkey ham received higher average scores, particularly for texture and appearance. The pâté showed more variation in consistency and color, indicating possible areas for technological improvement.

Physico-chemical analyses revealed key differences: the turkey liver pâté had a higher content of fat and nitrites, along with greater moisture variability, which could affect its shelf stability. In contrast, the turkey ham showed a more balanced nutritional profile, with higher protein content, lower fat levels, and better consistency across samples.

These findings suggest that, from both a technological and nutritional standpoint, the canned turkey ham is better standardized and more aligned with the expectations of consumers. The pâté, while richer and more traditional in character, would benefit from certain adjustments in formulation to enhance consistency and overall product quality. The results may support future research focused on formulation optimization and technological standardization in canned poultry products.

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