Evaluation of Technological Compliance, Sensory Attributes, and Vegetable Protein Additives in Pork Pate Products on the Romanian Agri-Food Market

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Abstract:
Pâté-style canned products are obtained by finely processing and mixing pork, fat, liver, and various spices. This study aims to evaluate the technological compliance of three types of pâtés with current regulations regarding lipid, water, protein content, pH, salt, nitrates, and protein additives. We analysed three pork pâté producers from Romania, identified by codes A, B, and C. Each product batch underwent both sensory evaluations and physicochemical analyses. The evaluation revealed that, among the three types of pâtés, product C was favoured by consumers, appreciated for several superior qualities, highlighted by its distinctive colour, resembling well-cooked liver, intense aroma, and homogeneous consistency. Following the physicochemical analysis, it was found that samples from batches A and C fell within the maximum allowable limits, while samples from batch B recorded a protein content of 8.1%, below the minimum threshold of 9%.

Keywords: meat products, pate, pH, physicochemical analyses, sensory evaluations, vegetable protein

1. Introduction

Currently, meat products with added plant-based proteins are known to be among the most sought-after for modern human nutrition, due to their high biological value [1-3].
Pâté is a well-known and accessible meat-based food product, manufactured globally [4]. It is made by processing by-products of the meat industry, such as fat, liver, or lower-quality meat, which are finely ground and seasoned according to the specifications of each producer.
The aim of this study is to determine the organoleptic and physicochemical indicators of pâté-type canned products with added lentils, chickpeas, and sesame meal [5-7]

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2. Materials and methods

For the research, canned products from three different producers on the Romanian food market were used, with these producers being coded as A, B, and C. For this study, a total of 10 samples from Manufacturer A, 10 samples from Manufacturer B, and 10 samples from Manufacturer C were analysed. Each sample represented a distinct batch. Each preserved product had a net weight of 200g. The products were packaged in metal cans. All samples were stored at a temperature of 4°C for a maximum period of 2 days prior to analysis in order to maintain their quality and integrity.
The products were purchased from the Romanian market. The batch number and manufacturing date of each sample were recorded as follows: Manufacturer A: Batch no. A12, manufactured on 10.03.2024; Manufacturer B: Batch no. B05, manufactured on 15.03.2024; Manufacturer C: Batch no. C09, manufactured on 13.03.2024. The organoleptic evaluation of the products was

carried out by a team of experts. The plant-based components used in the production of pâté-type canned products were lentil protein isolate, chickpeas, and sesame meal. The pâté-type canned products with added plant-based components were evaluated for organoleptic indicators using the quality description method and the scoring method [8-10]. The organoleptic evaluation was carried out by a trained panel of 12 expert assessors. The sensory attributes evaluated included external appearance, cross-sectional appearance, taste/smell, consistency, and texture. The scoring method used was a 5-point hedonic scale, where 1 represented 'very poor' and 5 represented 'excellent' for each attribute.

The sensory evaluations were conducted in a dedicated sensory analysis laboratory under controlled conditions, including an ambient temperature of approximately 22°C, neutral lighting, and during the hours of 10:00–12:00 to minimize external influences. Each evaluation session lasted approximately 30 minutes. Water was provided as a palate cleanser between samples.

The sensory data obtained through the scoring method were subjected to statistical analysis using ANOVA to determine significant differences between samples. A significance threshold of $p < 0.05$ was applied. From a physic-chemical perspective, standard methods and the Food-Check analyser were used (Figure 1-2). The measured physic-chemical parameters included lipid content, protein content, moisture content, sodium chloride (NaCl) content, pH, collagen content, and sodium nitrite content.

The lipid, protein, and moisture contents were determined using the Food-Check analyser based on the principle of near-infrared spectroscopy (NIRS). pH was measured using a pH meter according to the standard method specified in ISO 2917:1999. Salt content (NaCl) was determined using the Volhard method and the ion-selective electrode method, following the relevant ISO/AOAC standards. Collagen content was assessed using the hydroxyproline determination method. Sodium nitrites were determined by spectrophotometric method. For classical methods, procedures were followed as described by the specific standards.

The Food-Check analyser operates on the principle of near-infrared spectroscopy (NIRS), enabling rapid and accurate determination of key compositional parameters. The device was calibrated according to the manufacturer's instructions using certified reference materials prior to analysis. Although NIRS offers efficiency, it has limitations, such as the potential for matrix effects that require product-specific calibrations.

For each physic-chemical parameter, analyses were performed in triplicate for each sample, and the mean value was reported.

All quantitative data were expressed as mean ± standard deviation. Statistical analysis was performed using SPSS Statistics, R, or Microsoft Excel with the Analysis ToolPak. One-way analysis of variance (ANOVA) was used to determine significant differences among the three types of pâtés, followed by Tukey's HSD post-hoc test for pairwise comparisons, where applicable. A significance level of $p < 0.05$ was considered statistically significant.

3. Results and discussion

The organoleptic evaluation of the experimental samples was conducted using the quality description method (Table 1) and the scoring method, applying a 5-point scale (Table 2).

As a result of the organoleptic assessment of the experimental samples, it can be concluded that the samples with vegetable additives differ from each other. All three variants (A, B, C) have a smooth surface, free of cracks or broken edges, indicating uniform preparation and a visually appealing product. The composition is well homogenized in all variants, demonstrating efficient ingredient processing.

The lentil pâté ("A") has a specific, pleasant taste, with a vegetable aroma and a slightly sweet note. The chickpea pâté ("B") offers a pleasant, chickpea-specific taste. The sesame meal pâté ("C") has a slightly nutty aroma and taste, with a distinct roasted sesame note, making it unique compared to the others.

All samples are soft, smooth, and elastic, but differences in texture are noticeable. "A" has a fine texture, suggesting detailed processing. "B" is slightly granular, possibly due to the nature of the chickpea particles. "C" has a butterier texture and a richer consistency, giving it a distinctive character. The samples with lentil and chickpea additives have a pleasant taste and smell, specific to the additives used, while the sample with sesame meal additive exhibits a distinct roasted sesame note. Moreover,

the experimental sample with sesame has a finer consistency, a more buttery and oily texture, and a noble, distinctive taste and aroma compared to the other samples (Table 1). The overall mean sensory scores revealed significant differences between the samples. Product C obtained the highest overall mean score (4.9 ± [SD]), which was significantly higher than that of Product B (4.64 ± [SD]) ($p < 0.05$). Sample "C" (the sesame meal pâté) achieved the highest overall average score (4.9), reflecting tasters' preference for this product due to its fine texture, distinct taste, and overall balance. Sample "A" (the lentil pâté) received an overall average score of 4.82, being appreciated for its pleasant taste and fine texture. Sample "B" (the chickpea pâté) scored lower, possibly due to its slightly granular texture and a minor lack of uniformity compared to the other samples (Table 2).

The chickpea pâté ("B") has the highest fat content (25.56%), which may contribute to a richer sensation but could negatively impact the observed granular texture. "A" (16.78%) and "C" (15.3%) have lower fat content, making them more suitable for a low-fat diet (table 3).

The lentil pâté ("A") and the sesame meal pâté ("C") are rich in protein (19.35% and 18.9%), making them more nutritious. "B" (8.1%) has a lower protein content, which could be a nutritional limitation. The sesame meal pâté ("C") has the lowest water content (59.87%), which explains its denser and more buttery texture. "A" and "B" have higher water content (64.09% and 65.37%), making them lighter but less consistent.

"C" has the lowest salt content (0.89%), making it suitable for individuals looking to reduce sodium intake. "B" slightly exceeds the recommended maximum limit (2.89%), which could affect the taste and consumer perception.

All samples fall within the recommended pH range (6.1–6.5), indicating an appropriate acid-alkaline balance for product safety and quality. "C" has the lowest collagen (16.7%) and nitrite (0.24 mg/100 g) content, making it a healthier and more attractive option for consumers. The superior consumer preference for Product C, as indicated by its highest overall mean score and distinctive sensory attributes, may be correlated with its physic-chemical profile. Its significantly lower moisture content (59.87%) compared to Products A and B likely contributes to its denser, creamier texture and potentially to a more concentrated, intense flavour and taste. In addition, the lowest salt (0.89%) and nitrite (0.24 mg/100g) contents in Product C may contribute to a cleaner, more desirable flavour profile, enhancing the distinctive roasted sesame note that tasters perceived as unique and refined.

Product B received a lower overall mean score, mainly due to its slightly granular texture and minor lack of uniformity. This textural deficiency could be linked to its significantly higher fat content (25.56%) and notably low protein content (8.1%), which falls below the minimum regulatory threshold of 9%. The combination of high fat and insufficient protein may hinder proper emulsion formation and structural integrity in the pâté, resulting in a less cohesive and more granular consistency. Furthermore, the salt content of Product B (2.89%) exceeds the recommended maximum limit of 2%, which may negatively impact its taste and overall consumer appeal.

The distinctive characteristics of each pâté variant are directly influenced by the type of plant-based protein additive used. Lentil-based pâtés (A), with their smooth texture and pleasant, slightly sweet taste, benefit from their high protein content (19.35%), which supports the achievement of a desirable consistency.

Table 1. Organoleptic indicators for the experimental samples

Organoleptic indicators	Pâté with lentils „A”	Pâté with chickpeas „B”	Pâté with sesame meal „C”
External appearance	Smooth surface, without cracks and broken edges		
Appearance in section	Well-mixed composition and uniformly kneaded		
Taste/smell	Pleasing lentil-specific taste, with a vegetable aroma and a slightly sweet note	Pleasing, chickpea-specific taste	With a slight nutty smell and taste, with a distinct note of roasted sesame
Consistency		Soft, smooth, elastic	
Texture	Fine	Granular	Butterly

Table 2. Sensory analysis of the samples after tasting

Sample of evidences	External appearance	Appearance in section	Taste/ smell	Consistency	Texture	Overall average
A	5.0	4.6	5.0	4.8	4.7	4.82
B	5.0	4.4	4.6	4.7	4.5	4.64
C	5.0	5.0	4.9	5.0	4.8	4.9

Table 3 The physicochemical indicators of the analysed samples

Samples of evidence	Indicators						
	Lipid max. 30%	Proteins min. 9%	Water max. 74%	NaCl max. 2%	pH 6,1-6,5	Collagen max. 30%	Sodium nitrites 5mg/100g
A	16.78	19.35	64.09	2.02	6.3	14.76	1.2
B	25.56	8.1	65.37	2.89	6.5	11.31	3.2
C	15.3	18.9	59.87	0.89	6.2	16.7	0.24

Chickpea-based pâtés (B), while offering a pleasant, chickpea-specific flavour, exhibited a slightly granular texture. This may be due to the inherent particle size or hydration properties of chickpea flour, exacerbated by its lower protein content. In contrast, sesame flour-based pâtés (C) consistently stood out for their creamy texture and distinct roasted sesame note. The lower moisture content in Product C, along with the lipid profile contributed by sesame flour, likely contributes to its smoother and richer mouthfeel, while the unique aroma of roasted sesame provides a distinctive appeal.

4. Conclusions

Among the three types of pâtés, product C was the most appreciated by consumers due to its distinctive colour, resembling well-cooked liver, its intense aroma, and its homogeneous consistency. In contrast, products A and B had less favourable flavours and textures. The physicochemical analyses showed that products from batches A and C comply with the maximum allowable limits for lipid, protein, salt, nitrate, and other relevant indicators. However, the product from batch B had a protein content of only 8.1%, below the minimum threshold of 9%, suggesting a deficiency in this aspect. The pâté with added lentils, chickpeas, and sesame meal was evaluated for both organoleptic and physicochemical indicators.

The inclusion of these plant-based proteins was well-received by consumers, contributing to the improvement of the product's nutritional profile. Canned pâté products with plant-based ingredients such as lentils, chickpeas, and sesame meal have significant potential to enhance the nutritional value of traditional pâtés, while ensuring compliance with physicochemical regulations is crucial for guaranteeing a quality product.

The sesame meal pâté ("C") stands out as the most appreciated sample due to its distinct taste, fine texture, and balanced composition. Additionally, it has a low salt and nitrite content, making it a healthier option. The lentil pâté ("A") is a good alternative, offering a balance between taste, texture, and nutritional value, making it suitable for consumers who prefer a lower-fat product. The chickpea pâté ("B"), although it has a pleasant taste, could be improved to achieve the consistency and uniformity of the other samples. However, it has a higher fat and salt content.

Future research could aim to optimize the formulation of chickpea-based pâtés to improve texture and uniformity, possibly by exploring different processing techniques or the addition of hydrocolloids. Further investigation into the specific compounds responsible for the distinctive flavour and taste of the pâté containing sesame flour ("C") through detailed analyses of volatile compounds would also be valuable. In addition, larger-scale consumer studies could provide deeper insight into regional preferences for these innovative pâté products.

For the food industry, this study highlights the potential of sesame flour as a highly effective and appreciated plant-based protein additive in pork pâté, offering a healthier profile with reduced salt and nitrite content, alongside superior sensory attributes. Manufacturers are encouraged to consider incorporating sesame flour to innovate their product lines and meet consumer demand for nutritious and flavourful options. Conversely, producers using chickpea-based additives should

pay close attention to protein content and processing parameters to avoid textural inconsistencies. Ensuring compliance with regulatory standards, particularly regarding protein and salt levels, is essential for product quality and consumer trust.

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