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SENSORY PROPERTIES OF JANJ CHEESE WITH THE ADDITION OF SELECTED PLANT SPECIES

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ABSTRACT

In many countries, cheese is a highly valued dairy product that, due to its high nutritional value, is recommended in the regular diet of every individual. Cheesesmade by the traditional method using indigenous technologies are especially valued and represent the culture and tradition of some country. Janj cheese has been produced by such a traditional technology and it is the research subject of this study. The aim of this study was to examine the influence of the addition of selected plant species (*Origanum vulgare, Ocimum basilicum*, *Petroselinum crispum*, *Rosmarinus officinalis* and *Allium schoenoprasum*) at concentrations of 0.5% and 1% on the sensory properties of Janj cheese. A team of five evaluators performed sensory analysis of the tested cheese samples using a 5-point scoring system (1 = very considerable deviation from expected quality to 5 = no deviation from expected quality) to assess appearance, color, odor, taste, and texture. The addition of selected plants gave positive results and had statistically significant ($p<0.05$) effects on the sensory properties of the tested cheeses. The highest scores were given to samples with *Origanum vulgare* and *Allium schoenoprasum* in both batches, i.e., with both concentrations (0.5 and 1%), and therefore the production of this type of cheese is recommended with the addition of these plant species.

Keywords: sensory properties, Janj cheese, plant species.

INTRODUCTION

Cheese is a food product that represents a complex combination of tradition and science, where specific milk processing techniques result in a product rich in nutritional value and characterized by unique sensory properties. It is not only a valuable staple food, but in recent times has become a product of high gastronomic value, particularly in countries with high living standards, where its consumption is steadily increasing (Popović-Vranješ, 2015).

Cheeses produced by traditional, indigenous technologies are especially appreciated, as they reflect the culture and heritage of a given country. These cheeses offer not only nutritional benefits but also cultural identity, preserving traditional production methods and the specific microclimatic conditions of their regions (Dozet & Maćej, 2006; Keskin & Dağ, 2020; Cardin et al., 2022), and they represent an important part of the gastronomic and cultural heritage of specific areas (Montel et al., 2014; Kochetkova et al., 2023). These cheeses are typically produced from the milk of local animal breeds using traditional methods passed down through generations. Such cheeses retain distinctive sensory properties as well as microbial biodiversity crucial for fermentation and ripening. They are commonly named after their place of origin, and many cities and regions have gained recognition precisely because of the cheeses bearing their names.

Indigenous cheeses have long played a vital role in the diet of local populations. Facing the risk of disappearance due to mass industrial production, traditional cheeses in many countries had

to be protected—France and Italy being countries with a long-standing tradition in this regard. In Bosnia and Herzegovina, several authors have contributed to the preservation and promotion of traditional dairy products through research and the affirmation of indigenous production technologies and traditional cheeses (Dozet, 2004; Bijeljac & Sarić, 2005; Dozet & Maćej, 2006). Production and consumption of these cheeses mostly continue to take place within rural households, with only a few indigenous products represented in industrial production (Bijeljac & Sarić, 2005).

Traditional cheeses are typically made from raw, unpasteurized milk, with or without the use of dairy cultures, and using natural rennet and herbs, involving considerable manual labor. Such cheeses are more difficult to produce under industrial conditions and differ from industrial cheeses in taste, aroma, and texture. They tend to have more complex and intense flavor and aroma profiles (Kalit, 2015). Janj cheese, which is the subject of this study, is made using one such traditional method preserved in households of the Šipovo municipality. Janj braided cheese is a unique product originating from the Janj region, produced from unpasteurized milk without any additives, and requiring approximately 12 liters of milk per kilogram of cheese. It is made in small rural households, where the production process is maintained through generations and primarily takes place within family units. This specific technology is most often practiced by younger women who traditionally inherit the knowledge of cheese production. The significance of this cheese is further enhanced by its production in the unpolluted ecological environment of Mount Vitorog and its surrounding pastures, which contributes to the unique quality of the milk and final product.

Today's market is increasingly saturated with products containing aromatic herbs, and a growing variety of plant species are being used in the production of cheese and other dairy products. These additions aim to develop new flavors, enhance aroma, and improve the nutritional and functional value of the products (Foda et al., 2010; Oraon et al., 2017; Alexa et al., 2018; Sukhikh et al., 2019; El-Sayed & Youssef, 2019; Arkan et al., 2024).

Different plants or their extracts can be used in the production of various dairy products in different ways: added directly to the curd, mixed into the cheese near the end of the production process before molding, or used to coat the cheese surface (Josipović et al., 2016). Herbs significantly enrich the diversity of flavors, aromas, and textures of cheese, increasing their appeal to consumers. Their specific aromas can make a cheese distinctive and recognizable (Kalit, 2015). Given the importance of traditional cheeses and the growing use of plant-based additives in dairy production, the aim of this study was to examine the influence of the addition of selected plant species (*Origanum vulgare*, *Ocimum basilicum*, *Petroselinum crispum*, *Rosmarinus officinalis*, and *Allium schoenoprasum*) on the sensory properties of Janj cheese.

MATERIAL AND METHODS OF WORK

The cheese samples used in this study were produced in a rural household in the village of Lipovača, located in the municipality of Šipovo, which has been engaged for many years in the production of milk, Janj cream (kajmak), and Janj braided cheese. Analyses of the final products were conducted at the Faculty of Technology, University of Banja Luka.

For the purposes of this research, two batches of six cheese samples were produced (a total of twelve samples). Each batch included one control sample without additives and five samples with the addition of different plant species: oregano (*Origanum vulgare*), basil (*Ocimum basilicum*), parsley (*Petroselinum crispum*), rosemary (*Rosmarinus officinalis*), and chives (*Allium schoenoprasum*). In the first batch, the concentration of plant additives was 0.50% relative to the cheese mass, while in the second batch it was 1.00%. For research purposes, the original cheese-making method was slightly modified: instead of shaping the cheese into the traditional braid, it was formed into a rolled shape incorporating the respective plant additives.

Following the evening milking, the milk was filtered and left to stand at room temperature overnight (14 hours). The milk's readiness for coagulation was assessed by heating 100 mL in a small metal container and observing characteristic changes, such as curd formation and whey separation. Once readiness was confirmed, the milk was heated to 38 °C, and 60 mL of rennet was added, corresponding to 0.2% of the total milk volume (30 L). The container was then left in a

warm place for 20 minutes to allow coagulation. Afterward, the temperature was raised to 50 °C, and the coagulated mass was gently stirred with a spoon for 10 minutes to cut the curd.

When the curd began to separate, the cheese mass was hand-pressed against the container walls for 10 minutes to expel the whey. The temperature of the whey at this stage was 48 °C. This step is essential for achieving the desired elasticity of the cheese mass. The curd was then gradually removed from the whey and further pressed to eliminate excess liquid. Each portion of the cheese mass was weighed (500 g) and manually flattened on a flat surface to a thickness of 1 cm. Salt was evenly distributed over the surface at a concentration of 1.50%, while plant additives were added in quantities of 0.50% for the first batch and 1.00% for the second batch (Table 1). For this purpose, commercially available, packaged, and crushed dried herbs (KOTANYI GmbH, Wolkersdorf, Austria) purchased from a local store were used. The finished cheese rolls were placed on an inclined surface for 30 minutes to allow excess whey to drain. Afterward, the cheese was wrapped in plastic film, cooled to +4 °C, and stored at the same temperature until analysis.

Table 1. Type and concentration of herbs in the tested samples.

	Sample	Plant species	Concentration (%)
Batch 1	1.1	-	-
	1.2	Oregano (*Origanum vulgare*)	0.50
	1.3	Basil (*Ocimum basilicum*)	0.50
	1.4	Parsley (*Petroselinum crispum*)	0.50
	1.5	Rosemary (*Rosmarinus officinalis*)	0.50
	1.6	Chives (*Allium schoenoprasum*)	0.50
Batch 2	2.1	-	-
	2.2	Oregano (*Origanum vulgare*)	1.00
	2.3	Basil (*Ocimum basilicum*)	1.00
	2.4	Parsley (*Petroselinum crispum*)	1.00
	2.5	Rosemary (*Rosmarinus officinalis*)	1.00
	2.6	Chives (*Allium schoenoprasum*)	1.00

Sensory properties and cheese quality were assessed using descriptive sensory analysis, a method that quantitatively evaluates multiple quality attributes of food products. Sensory evaluation was conducted by a panel of five assessors for each production batch. The sensory attributes evaluated included appearance, color, odor, taste, and texture, using a scoring system on a scale from 1 to 5 (1 = significant deviation from expected quality; 5 = no deviation) (BAS ISO 22935-2:2011; BAS ISO 22935-3:2011**).**

The results of all measurements were processed using Microsoft Excel 2013 and IBM SPSS Statistics 22.0 for Windows (Armonk, NY, United States). The data obtained from analyses conducted in this study are presented as mean values of individual results from three randomly selected product samples ± standard deviation (SD). The significance of differences between arithmetic means was determined by one-way analysis of variance (One-way ANOVA), followed by the Tukey HSD multiple range test, and expressed at a 95% confidence level ($p < 0.05$).

RESULTS AND DISCUSSION

The addition of selected plant species led to measurable changes in the sensory profile of Janj sir, affecting all evaluated characteristics. These variations highlight the importance of both the type of herb and its compatibility with the cheese in shaping overall sensory quality.

Table 2 presents the average values of the sensory analysis of the tested cheese samples, confirming statistically significant differences between the samples for all evaluated parameters ($p<0.05$). The sensory evaluation included the following attributes: appearance, color, odor, taste, and texture, which are key sensory characteristics relevant to the acceptability of dairy products. The assessment of cheese appearance was conducted through visual inspection prior to consumption or preparation, considering color uniformity, surface consistency, the presence of

larger curds, and overall textural structure. Appearance represents a fundamental multimodal stimulus that strongly influences consumer expectations and can dominate the perception of other sensory modalities, especially taste and odor (Budimir et al., 2004). The color of fresh cheese should be homogeneous and light white, which indicates a proper technological process and the absence of contamination or undesired reactions (Mandić & Perl, 2006). Deviations in color may signal the presence of undesirable substances or inadequacies in the technological procedure, potentially compromising the safety and quality of the product (Fox et al., 2017).

Samples 1.1 and 2.1, produced without the addition of plant species and serving as control samples for the first and second batches, exhibited optimal sensory characteristics. Based on the conducted sensory evaluation, these control samples met relevant quality standards and received the highest possible scores from evaluators, without significant deviations, confirming the consistency and high sensory quality of the base product.

The tested cheese variant enriched with 0.50% oregano received lower scores for appearance and color (4.00), which can be attributed to uneven color distribution and non-uniform dispersion of the oregano additive. However, odor, taste, and texture were rated with the maximum score (5.00), indicating that the visual inconsistency did not adversely affect other sensory attributes. The inconsistency in the distribution of plant components negatively affected the visual quality of the product, resulting in a reduced overall sensory impression. Based on the sensory analysis results, an increased concentration of oregano above the tested 0.50% is recommended to achieve more homogeneous distribution and improved sensory characteristics of the product.

In the case of the tested cheese supplemented with 0.50% basil, the odor (4.25) and taste (3.50) were rated lower, although texture remained unaffected (5.00). This sensory profile indicates an insufficient synergy between the aromatic components of basil and dairy ingredients, which may result in a perception of weak aroma intensity and a “bland” taste. This suggests incompatibility of basil with the specific dairy matrix, indicating that basil may not be a suitable additive for this type of cheese.

The variant of the tested cheeses containing 0.50% parsley was characterized by lower scores for odor and taste (3.50 and 3.62, respectively), indicating a lack of sensory intensity, potentially due to the limited release of aromatic substances or their inadequate interaction with the dairy matrix. The intensity of odor and taste in cheeses often depends on the concentration and type of additive, as well as its ability to interact with core dairy components (Andriot et al., 2024; Pluta-Kubica et al., 2024).

The rosemary-enriched cheese variant at the same concentration exhibited a slightly rubbery and drier cross-sectional appearance, which was reflected in a marginally lower texture score (4.50). Furthermore, the uneven distribution of rosemary particles negatively affected both appearance and color (each scored 4.00), resulting in a non-uniform surface and noticeable color inconsistency. As uneven mixing and irregular additive dispersion can impair cheese texture (Tarakçı & Deveci, 2019), improving the homogeneity of rosemary incorporation is recommended to enhance sensory qualities, particularly in terms of appearance, color, and texture.

The tested cheese containing 0.50% chives received a suggestion for improved dispersion of the chive additive, which affected slightly lower scores for appearance (4.00) and color (4.00) compared to maximum values. Despite these moderate visual scores, this sample received the maximum score (5.00) for odor, taste, and texture, indicating strong sensory acceptance in these critical categories. The high odor and taste scores suggest that the added plant species contributed positively to the cheese’s aromatic and flavor profile without overpowering the characteristic dairy notes. The texture score of 5.00 further indicates that the additive was well integrated into the cheese matrix without adversely affecting mouthfeel, elasticity, or structural integrity.

The sensory analysis of the tested cheeses enriched with different plant species at a concentration of 0.50% indicates a significant influence of the distribution and compatibility of plant components with the dairy matrix on product quality. Uneven distribution of plant additives adversely affects the appearance, color, and texture of the cheeses, while inadequate synergy between plant aromas and dairy components may lead to a weaker expression of odor and taste. In certain cases, such as the use of basil, incompatibility was observed, which diminished the sensory

attributes of the product. To achieve optimal sensory properties, it is recommended to carefully adjust the concentration and ensure homogeneous spatial uniformity of the plant additives, as well as to consider the compatibility of specific plant species with the particular dairy formulation.

Table 2. Average sensory scores of Janj cheese with 0.50% plant species.

Sample	Appearance	Color	Odor	Taste	Texture
1.1	$5.00^{c}\pm0.00$	$5.00^{c}\pm0.00$	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$
1.2	$4.00^{a}\pm0.00$	$4.00^{a}\pm0.00$	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$
1.3	$4.50^{b}\pm0.00$	$4.50^{b}\pm0.00$	$4.25^{b}\pm0.29$	$3.50^{a}\pm0.00$	$5.00^{b}\pm0.00$
1.4	$5.00^{c}\pm0.00$	$5.00^{c}\pm0.00$	$3.50^{a}\pm0.00$	$3.62^{a}\pm0.25$	$5.00^{b}\pm0.00$
1.5	$4.00^{a}\pm0.00$	$4.00^{a}\pm0.00$	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$4.50^{a}\pm0.00$
1.6	$4.00^{a}\pm0.00$	$4.00^{a}\pm0.00$	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$

$^{a-c}$ Means within the same column by different letters differ significantly at the 95% confidence level ($p<0.05$)

Table 3 presents the sensory evaluation results for the second batch of Janj cheese samples. The sensory analysis **of** the tested cheese variant enriched with 1% oregano indicated the presence of a higher amount of the plant component in the cross-section of the product, which resulted in a lower score for the appearance parameter (4.00) compared to the maximum values. Additionally, the texture of the sample was rated lower (4.50), reflecting a slightly increased firmness relative to the desired sensory profile. Considering that sample 1.2. contained 0.5% oregano, while sample 2.2 had an increased concentration of 1%, where excessive presence of the herbal additive was observed, the recommendation based on the sensory evaluation results is to optimize the oregano concentration to an intermediate value of 0.75%**.** This adjusted concentration is expected to contribute to improved homogeneity of distribution and enhanced visual and textural characteristics, while maintaining an acceptable overall sensory profile.

The basil-enriched tested cheese (1%) received a lower score for appearance (4.50), which can be attributed to the presence of a higher amount of the plant additive in the cross-section compared to the recommended quantity. Nevertheless, the odor and taste remained characteristically "bland," with a score of 4.50 and 3.50, respectively. This aligns with the sensory profile of the 0.5% basil sample from the first batch, indicating a consistent incompatibility of this plant species with the dairy matrix of the tested cheese. Based on the obtained results, the production of Janj cheese with basil at either tested concentration is not recommended due to an inadequate sensory profile.

The tested cheese sample with 1% parsley showed reduced scores for odor, taste, and texture (3.50; 4.00; 4.50). Sensory evaluation indicated a weakly expressed aroma and flavor, despite the higher quantity of the additive, while the texture was rated lower due to a less desirable and more difficult cross-section. A similar sensory profile was observed in sample 1.4 from the first batch, with 0.5% parsley. Based on these results, the use of fresh parsley instead of dried is recommended, as it is presumed that fresh parsley may contribute more significantly to aroma and flavor intensity, thereby improving the overall sensory quality of the product.

The cheese variant supplemented with 1% rosemary exhibited a slightly firmer texture (score 4.50) than optimal, likely as a result of the higher concentration of the additive. The elevated rosemary content also negatively influenced appearance and color (4.70 and 4.00, respectively), whereas odor and taste were rated highly (5.00 each), confirming a favorable aromatic profile.

The cheese sample containing 1% chives achieved maximum scores (5.00) for all evaluated sensory parameters. This sample represents the most acceptable product of the second batch, and compared to the first batch—where no sample besides the control received maximum scores—it can be concluded that sample 2.6 possesses the best overall sensory profile among all tested samples.

Among the second batch of samples, chives emerged as the most favorable additive, achieving the highest sensory scores across all evaluated parameters. Oregano also received positive assessments, particularly in flavor and aroma, although further optimization of its concentration is advised. In contrast, basil consistently demonstrated poor integration with the

dairy matrix, while parsley yielded weak aroma and flavor expression. Rosemary contributed positively to aroma but slightly compromised texture and appearance at higher concentrations. Based on the overall sensory impressions, the additives can be ranked in the following order of acceptability: chives, oregano, rosemary, parsley, and basil. Consequently, further development of Janj cheese with the addition of chives and oregano, at precisely optimized concentrationsis, is recommended to achieve superior sensory quality and consumer acceptance.

Table 3. Average sensory scores of Janj cheese with 1% plant species.

Sample	Appearance	Color	Odor	Taste	Texture
2.1	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$
2.2	$4.00^{a}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$4.50^{a}\pm0.00$
2.3	$4.50^{b}\pm0.00$	$5.00^{b}\pm0.00$	$4.50^{b}\pm0.00$	$3.50^{a}\pm0.00$	$5.00^{b}\pm0.00$
2.4	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$3.50^{a}\pm0.00$	$4.00^{a}\pm0.00$	$4.50^{a}\pm0.00$
2.5	$4.70^{b,c}\pm0.00$	$4.00^{a}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$4.50^{a}\pm0.00$
2.6	$5.00^{c}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$	$5.00^{b}\pm0.00$

[a-c] Means within the same column by different letters differ significantly at the 95% confidence level ($p<0.05$)

The utilization of selected plant species in the dairy industry represents an increasingly important approach to enhancing the quality of dairy products, particularly cheeses. Through their bioactive compounds, herbs not only enrich the sensory profile of dairy products but also exhibit notable antioxidant properties, contributing to improved product stability and extended shelf life (Sagun et al., 2006**;** Lee et al., 2016; Ebid et al., 2024). In this context, research aimed at identifying the optimal concentrations and types of plant additives plays a key role in the development of functional and high-quality dairy products.

According to Josipović et al. (2015), the incorporation of herbs in cheese production significantly enhances sensory characteristics, increases microbiological stability, and prolongs shelf life, while also improving the nutritional value of the product. Cheeses enriched with herbal additives such as red pepper, parsley, garlic, lavender, dill, and chives exhibit higher biological and nutritional value as well as favorable sensory properties. These improvements are primarily attributed to the presence of antioxidant and antimicrobial substances, which vary in concentration among different plant species.

Among traditional Croatian cheeses, fresh cheese produced from raw milk, such as Janj cheese, is particularly notable. This type of cheese requires stringent hygienic standards due to its perishable nature. To extend its shelf life, the use of ground red pepper has been introduced as a natural preservative and flavor enhancer (Josipović et al., 2015).

Alijagić et al. (2009) reported that the addition of culinary herbs has a minimal effect on the physico-chemical properties of dairy products, which is consistent with the findings of the present study. Sensory evaluation demonstrated a positive impact of herbal additives, with the highest scores observed in samples supplemented with oregano and chives at both tested concentrations (0.5% and 1%), indicating the potential of these plant species for further product development. However, it is important to note that excessive concentrations of herbal additives may adversely affect the sensory attributes of the final product. Previous studies (Tarakçı, 2004; Tarakçı & Kuçukoner, 2006) suggest that a concentration of approximately 1% represents an optimal level for achieving the most favorable sensory profile in cheeses.

CONCLUSIONS

Based on the conducted research, it was confirmed that Janj cheese can be successfully produced using a modified technological process incorporating the addition of various plant species. The experimental samples of Janj cheese, supplemented with oregano, basil, parsley, rosemary, and chives at concentrations of 0.50% and 1.00%, demonstrated that both the type and concentration of the added herbs had a statistically significant impact on the sensory attributes of the products ($p < 0.05$). Analysis of the overall sensory scores supports the recommendation to produce Janj cheese with the addition of chives and oregano, as these samples achieved the most favorable sensory profiles.

The findings of this study carry important implications for the advancement of Janj cheese production, confirming the feasibility of enhancing a traditional product by incorporating herbal additives without compromising its sensory quality. The inclusion of herbs such as chives and oregano not only improves flavor and aroma but also adds market value in line with contemporary consumer preferences for natural and functional foods. This strategy may encourage diversification within the traditional cheese sector, support the preservation of local food heritage, and foster rural development through improved competitiveness and product distinctiveness.

Furthermore, these results provide a foundation for future research focused on optimizing the technological parameters involved in Janj cheese production with herbal additions, as well as on evaluating the effects of various herb species and concentrations on the physicochemical and microbiological properties of the product. Implementing such innovations in traditional dairy processing can contribute to the development of functional dairy products with improved sensory and nutritional profiles, ultimately enhancing the market potential of Janj cheese both domestically and internationally.

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DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

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