INFLUENCE OF SELECTED PLANT ADDITIVES ON THE FATTY ACID PROFILE OF TRADITIONAL JANJ CHEESE

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ORIGINAL SCIENTIFIC PAPER

Received: 29 Jun 2026.
Accepted: 14 August 2026.
Published: 16 November 2026.
DOI: https://doi.org/10.63395/STEDConf15022026129S453

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Citation: Savanović, D. et al. (2026). Influence of selected plant additives on the fatty acid profile of traditional Janj cheese. In Kojić, D. & Sredić. D. (eds.) *Conference proceedings, XV XV International Conference on Social and Technological Development: STED 2026* (pp. 453-462). Trebinje, B&H: University PIM.

ABSTRACT

Janj cheese is a traditional dairy product produced from raw cow's milk in the mountainous Janj region of Bosnia and Herzegovina, where cattle are mainly fed on natural mountain pastures. This study investigated the effect of adding selected plant additives (oregano, basil, parsley, rosemary, and chives) at a concentration of 0.50% on the fatty acid composition of Janj cheese. Six cheese samples were produced, including one control sample without additives and five experimental samples with plant additions. Fatty acid composition was determined by gas chromatography with flame ionization detection (GC–FID), and data were analyzed using one-way ANOVA at $p<0.05$. The results showed that saturated fatty acids (SFA) were dominant in all samples (59.34–61.48%), with palmitic (C16:0), stearic (C18:0), and myristic acid (C14:0) as the most abundant. Monounsaturated fatty acids (MUFA) ranged from 33.39% to 34.86%, with oleic acid (C18:1) as the major component. Polyunsaturated fatty acids (PUFA) ranged from 4.81% to 6.52%, with linoleic (C18:2) and α-linolenic acid (C18:3 n-3) as the major components. α-Linolenic acid was markedly higher in most treated samples compared to the control, indicating a potential nutritional benefit of plant enrichment. Lipid quality indices (atherogenic index (AI), thrombogenic index (TI), h/H ratio, and desirable fatty acids (DFA)) showed slight modifications

in treated samples, indicating subtle changes in lipid nutritional quality. These findings suggest that the addition of plant additives at 0.50% can slightly modify the fatty acid profile of Janj cheese, particularly contributing to an increase in the n-3 PUFA fraction.

Keywords: Janj cheese, plant additives, fatty acids, lipid quality indices.

INTRODUCTION

Traditional food products are recognized as an important component of cultural heritage, reflecting specific production practices adapted to local environmental conditions. In addition to their nutritional importance, traditional foods contribute to the preservation of regional identity, biodiversity, and traditional knowledge transmitted through generations. They are closely associated with local customs, geographical origin, and sustainable food production systems, which further increases their cultural and economic significance [1], [2].

Dairy products occupy an important place in the human diet due to their high nutritional value and richness in essential nutrients, including proteins, fats, calcium, vitamins, and trace elements. Milk and dairy products are recognized as one of the most important dietary sources of highly bioavailable calcium and high-quality proteins, which are essential for bone health, muscle function, and overall metabolic processes [3], [4]. In addition to their nutritional importance, dairy products contain numerous bioactive compounds that may positively influence human health, including bioactive peptides, conjugated linoleic acid, and beneficial fatty acids [3], [5]. The transformation of milk into cheese is considered an efficient method for preserving these nutrients through fermentation and ripening processes, which additionally contribute to the development of characteristic texture, flavor, and aroma [6]. During cheese ripening, complex biochemical and microbiological changes occur, resulting in improved digestibility and the formation of compounds associated with the sensory and functional quality of cheese [7].

Milk fat is composed of a large number of fatty acids, and more than 400 different fatty acids have been identified in milk fat [8]. The diversity of fatty acids contributes to the high biological value of milk fat because the human organism can selectively utilize the required fatty acids, although many cannot be synthesized endogenously. Fatty acids differ in chain length and degree of saturation, ranging from short-chain to long-chain fatty acids with varying numbers of double bonds [9]. Milk fat contains saturated and branched-chain fatty acids, monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). A typical milk fat composition includes approximately 62% saturated fatty acids, 29% monounsaturated fatty acids, and 4% polyunsaturated fatty acids [10]. Although diets rich in saturated fatty acids have traditionally been associated with an increased risk of cardiovascular diseases, unsaturated fatty acids, particularly cis-monounsaturated and n-3 polyunsaturated fatty acids, are considered beneficial due to their protective effects on cardiovascular health [11]. In addition, polyunsaturated fatty acids play important physiological and functional roles in the human body [12]. The fatty acid composition of milk and dairy products may also be modified during processing and storage through physical and chemical reactions such as oxidation and the formation of trans fatty acids [13].

Cheese is a significant source of readily digestible fats, containing a wide range of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA) [14], [15]. Although dairy fats are often associated with a high proportion of SFAs, research indicates that cheeses also contain bioactive components such as short-chain fatty acids and natural trans isomers, primarily vaccenic acid (VA) and conjugated linoleic acids (CLA) [5], [16]. These fatty acids have been shown to possess a variety of health-promoting properties, including anticarcinogenic, antiatherogenic, antioxidant, and anti-inflammatory effects [12], [17]. The fatty acid profile of cheese is not identical to that of the raw milk, as it is influenced by technological processes, microbial activity, and lipolytic changes during ripening [18], [19].

The composition of fatty acids in dairy products depends on numerous factors, including the breed of animals, stage of lactation, season, and diet [20], [19]. Studies have shown that grazing on mountainous pastures with specific plant cover significantly improves the lipid profile, increasing the proportion of unsaturated fatty acids, particularly PUFAs, compared to conventional feeding

systems [21]. In addition to dietary factors, modern food technology explores strategies to enhance nutritional quality through the direct addition of functional ingredients. For example, cheese fortification with walnut paste significantly increases the content of omega-3 fatty acids while reducing the proportion of saturated fatty acids [22].

The use of aromatic and medicinal plants in traditional cheese production serves a dual purpose: improving sensory characteristics by forming specific aromas and acting as a natural preservative [23], [24], [25]. Plant species such as oregano, basil, parsley, and rosemary are rich in volatile compounds that contribute to the unique taste and aroma of the product [23], [24]. In addition, certain plant species contain notable amounts of polyunsaturated fatty acids, particularly alpha-linolenic acid (C18:3 n-3), which may contribute to modifications in the fatty acid profile of enriched dairy products [22]. In Southeastern Europe, traditional brined cheeses are the most commonly consumed type of cheese and are often named after the regions where they are produced [16].

Among the traditional cheeses of Bosnia and Herzegovina, Janj cheese stands out due to its distinctive sensory characteristics and traditional artisanal production. Originating from the mountainous area surrounding the Janj River in Bosnia and Herzegovina (Šipovo municipality, Republika Srpska), this cheese is traditionally produced from cow's milk, either raw or mildly heat-treated, without the use of commercial starter cultures. Such production practices enable the development of indigenous microflora, which contributes significantly to the characteristic flavor and overall sensory profile of the cheese [24], [25].

Given that the fatty acid profile directly influences the nutritional value and lipid quality indices of cheese, understanding the effect of plant additives on this profile is of considerable scientific and practical interest. The aim of this study was to investigate the effect of adding oregano, basil, parsley, rosemary, and chives on the fatty acid composition of traditional Janj cheese.

MATERIALS AND METHODS

Sample preparation and experimental design

The production of Janj cheese samples was carried out in a rural household in Lipovača (Šipovo municipality), a region recognized for its long-standing tradition of artisanal dairy processing.

For this study, six cheese samples were produced, including a control sample (without additives) and five samples enriched with different plant additives: oregano (*Origanum vulgare*), basil (*Ocimum basilicum*), parsley (*Petroselinum crispum*), rosemary (*Salvia rosmarinus*), and chives (*Allium schoenoprasum*). The plant additives were incorporated at a concentration of 0.50%.

After evening milking, the milk was filtered and allowed to rest at room temperature for 14 h. Milk readiness for coagulation was assessed empirically by heating a 100 mL milk sample until visible curd and whey separation occurred. After confirming readiness, the milk was heated to 38 °C and rennet (0.2% of total milk volume) was added. The mixture was left undisturbed at this temperature for 20 min to allow curd formation.

Following coagulation, the temperature was increased to 50 °C. The curd was gently stirred for 10 min to facilitate cutting and manually pressed against the vessel walls for an additional 10 min to expel whey, which reached 48 °C during this step. The resulting cheese mass was divided into 500 g portions and flattened to a thickness of approximately 1 cm. Salt was evenly applied at 1.5%, together with the respective concentrations of plant additives.

Although Janj cheese is traditionally formed into braids, the process was slightly modified in this study by shaping the cheese into rolls to better incorporate the plant additives. The finished cheese rolls were placed on an inclined surface for 30 min to allow final whey drainage. Finally, the samples were wrapped in plastic foil and stored at +4 °C until laboratory analysis.

Table 1. Concentration of plant additives used in Janj cheese production

Plants	Sample	Concentration (%)
-	1.1	-
Oregano (*Origanum vulgare*)	1.2	0.50
Basil (*Ocimum basilicum*)	1.3	0.50
Parsley (*Petroselinum crispum*)	1.4	0.50
Rosemary (*Salvia rosmarinus*)	1.5	0.50
Chives (*Allium schoenoprasum*)	1.6	0.50

Fatty acid analysis

Fatty acid methyl esters (FAMEs) were prepared from the cheese samples through direct esterification using a saturated solution of potassium hydroxide (KOH) in methanol. The fatty acid composition was determined using a Clarus 680 gas chromatograph (Perkin Elmer) equipped with a flame ionization detector (FID) and an Elite-wax L capillary column (60 m length, 0.32 mm internal diameter, 0.5 μm film thickness). A Sigma Aldrich Supelco 37-component FAME MIX was utilized as the analytical standard. The injector and detector temperatures were maintained at 250 °C, with a sample injection volume of 1 μL. The oven temperature program began at 60 °C for 2 minutes, increased to 200 °C at a rate of 10 °C/min, and then reached 240 °C at a rate of 5 °C/min, with a final hold time of 30 minutes. The total analysis duration was 54 minutes. Nitrogen served as the carrier gas at a flow rate of 1.5 mL/min, while hydrogen and air were used for the FID. Fatty acid content is expressed as a weight percentage of the total identified fatty acids (g/100 g of total fatty acids).

Based on the obtained fatty acid profiles, key indices were calculated to evaluate the nutritional quality and the impact of the lipid fraction on human health. The Atherogenicity Index (AI) and the Thrombogenicity Index (TI) were determined using the following equation [16], [17]:

$$AI=[\sum C12:0+(4\times C14:0)+C16:0]/\sum UFA$$

$$TI=(C14:0 + C16:0 + C18:0)/[(0.5\times\Sigma MUFA) + (0.5 \times\Sigma n\text{-}6\ PUFA) + (3\times\Sigma n\text{-}3\ PUFA) + (n\text{-}3/n\text{-}6)]$$

Additionally, the ratio of hypocholesterolemic to hypercholesterolemic fatty acids (h/H) was calculated according to the formula:

$$h/H= (cis\text{-}C18:1 + \Sigma PUFA)/(C12:0 + C14:0 + C16:0)$$

Furthermore, the proportion of desirable fatty acids (DFA), representing the sum of all unsaturated fatty acids and stearic acid, was calculated to assess the nutritional impact of plant additives [22], [14], [18]:

$$DFA=\sum MUFA+\sum PUFA+C18:0$$

Statistical analysis

Statistical processing of the experimental data was conducted using the Microsoft Excel 2013 software package and the IBM SPSS Statistics 22.0 computer program for Windows (Armonk, NY, United States). All analyses were performed in triplicate and results are presented as mean values ± standard deviation (SD) based on three randomly selected samples. The significance of differences between arithmetic means was determined using one-way analysis of variance (ANOVA) followed by Tukey HSD post-hoc tests for multiple comparisons. Statistical significance was defined at a 95% confidence level ($p < 0.05$).

RESULTS AND DISCUSSION

Analysis of the lipid profile of Janj cheese samples enriched with selected plant additives confirmed the characteristic predominance of saturated fatty acids (SFA), which accounted for more than 59% of total fatty acids in all analyzed samples (Table 4). Among SFAs, palmitic acid (C16:0), stearic acid (C18:0), and myristic acid (C14:0) were the most abundant, which is consistent with the fatty acid profiles previously reported for traditional brined cheeses from the Balkan region [14], [21]. The proportion of total SFA ranged from 59.34% in the oregano-treated sample (1.2) to 61.48% in the rosemary-treated sample (1.5), while the control sample contained 59.39% SFA. Slight increases in SFA content observed in samples containing parsley, rosemary, and chives were primarily associated with higher proportions of palmitic and stearic acids.

Despite the dominance of saturated fatty acids, all samples contained notable levels of unsaturated fatty acids (UFA), ranging from 38.53% to 40.66% (Table 4). Monounsaturated fatty acids (MUFA) represented the largest fraction of UFA, with oleic acid (C18:1) identified as the predominant component. The highest MUFA content was observed in basil-treated cheese (1.3; 34.86%), followed by oregano-treated cheese (1.2; 34.79%), whereas rosemary-treated cheese (1.5) showed the lowest value (33.39%). These findings are in agreement with previous studies indicating that traditional cheeses produced from raw milk and pasture-fed animals are naturally rich in oleic acid and other nutritionally relevant MUFAs [19].

The addition of plant additives influenced the polyunsaturated fatty acid (PUFA) fraction, particularly the content of α-linolenic acid (C18:3 n-3). While the control sample (1.1) contained only 0.13% α-linolenic acid, markedly higher values were detected in samples enriched with basil (1.3), parsley (1.4), rosemary (1.5), and chives (1.6), reaching values above 1.20% (Table 3). This increase contributed to a marked reduction in the n-6/n-3 ratio. The control sample exhibited relatively high n-6/n-3 ratio of 39.75, whereas samples enriched with parsley, rosemary, and chives showed considerably lower values ranging from 2.43 to 2.72. The oregano-treated sample (1.2) exhibited a lower n-6/n-3 ratio than the control (15.31 vs. 39.75), although its improvement was less pronounced compared to the other plant-treated samples, likely due to the lower n-3 fatty acid content of oregano. Contemporary nutritional recommendations emphasize the importance of maintaining a lower n-6/n-3 ratio in order to reduce inflammatory and cardiovascular risks. Excessive amounts of n-6 polyunsaturated fatty acids (PUFA) and a very high n-6/n-3 ratio promote the pathogenesis of many diseases, including cardiovascular disease, cancer, and inflammatory and autoimmune diseases, whereas increased levels of n-3 PUFA (a low n-6/n-3 ratio) exert suppressive effects [12]. Therefore, the observed reduction in this ratio suggests that the incorporation of selected herbs may positively influence the nutritional quality of Janj cheese.

The PUFA/SFA ratio ranged from 0.08 to 0.11, while the UFA/SFA ratio varied between 0.63 and 0.68 (Table 4). Although these values remain below the ratios generally recommended for a more favorable lipid profile, they are comparable to those reported for many traditional full-fat cheeses produced from cow's milk [17], [18]. The relatively low PUFA/MUFA ratio observed in all samples additionally confirms the predominance of monounsaturated fatty acids within the unsaturated lipid fraction.

Lipid quality indices provided additional insight into the nutritional characteristics of the analyzed cheeses. The atherogenicity index (AI) ranged from 1.51 to 1.65, while the thrombogenicity index (TI) varied from 2.05 to 2.32 (Table 4). The lowest AI and TI values were observed in oregano-treated cheese (1.2) and basil-treated cheese (1.3), indicating a slightly more favorable lipid profile compared to the control and other treated samples. These values were lower than those reported for commercial cow's milk cheeses, where AI reaches up to 3.06 and TI up to 3.87 [17]. Furthermore, the obtained values are comparable to those reported for traditional Mediterranean and Balkan cheeses produced under pasture-based systems, such as Greek Tsalafouti (AI: 1.65–2.99; TI: 1.99–3.06) [18] and Kupres cheese (AI: 1.55–1.76) [16]. The ratio of hypocholesterolemic to hypercholesterolemic fatty acids (h/H) ranged from 0.88 to 0.97, with the highest value observed in the oregano-treated sample. This range suggests an improvement in the balance of nutritionally desirable fatty acids, as the values for Janj cheese are comparatively

higher than the average reported for Tsalafouti cheese (0.695) and considerably above the levels for commercial cow's milk cheeses, which range from 0.43 to 0.49 [17], [18].

The proportion of desirable fatty acids (DFA), representing the sum of unsaturated fatty acids and stearic acid, exceeded 51% in all analyzed samples and reached the highest value in oregano-treated cheese (53.32%). These values are notably higher than those reported for commercial cow's milk cheeses (38.14–40.89%) [17] and various traditional white brined cow's milk cheeses from the Balkan region (34.45–46.34%) [16]. Furthermore, the DFA content in Janj cheese exceeds the values calculated for traditional Tsalafouti cheese, which range from approximately 35.6% to 49.7% [18]. These results indicate that the addition of selected plant additives may contribute to a modest improvement in the nutritional quality of Janj cheese without causing substantial alterations in its traditional lipid composition.

Overall, the obtained results suggest that the incorporation of aromatic and medicinal plants at a concentration of 0.50% may contribute to subtle but nutritionally relevant modifications in the fatty acid profile of Janj cheese, particularly through the enhancement of the n-3 PUFA fraction and improvement of the n-6/n-3 ratio. Such findings support the potential application of plant additives in the production of traditional dairy products while preserving their characteristic composition and regional identity.

Table 2. Content of saturated fatty acids in Janj cheese samples

Fatty acid	1.1	1.2	1.3	1.4	1.5	1.6
C4:0	$2.06^{b} \pm 0.04$	$1.61^{a} \pm 0.38$	$2.20^{b} \pm 0.02$	$2.22^{b} \pm 0.01$	$2.24^{b} \pm 0.06$	$2.22^{b} \pm 0.01$
C6:0	$1.19^{ab} \pm 0.04$	$1.08^{a} \pm 0.15$	$1.29^{b} \pm 0.02$	$1.29^{b} \pm 0.01$	$1.30^{b} \pm 0.02$	$1.29^{b} \pm 0.01$
C8:0	$0.71^{b} \pm 0.01$	$0.68^{a} \pm 0.01$	$0.75^{b} \pm 0.00$	$0.76^{b} \pm 0.00$	$0.76^{b} \pm 0.02$	$0.75^{b} \pm 0.00$
C10:0	$1.37^{a} \pm 0.05$	$1.45^{a} \pm 0.04$	$1.56^{b} \pm 0.00$	$1.58^{b} \pm 0.02$	$1.57^{b} \pm 0.03$	$1.56^{b} \pm 0.02$
C11:0	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
C12:0	$1.84^{ab} \pm 0.05$	$1.80^{a} \pm 0.03$	$1.88^{bc} \pm 0.00$	$1.92^{c} \pm 0.01$	$1.91^{bc} \pm 0.04$	$1.88^{bc} \pm 0.03$
C13:0	$0.11^{b} \pm 0.00$	$0.11^{b} \pm 0.01$	$0.08^{a} \pm 0.00$	$0.08^{a} \pm 0.00$	$0.08^{a} \pm 0.00$	$0.08^{a} \pm 0.01$
C14:0	$8.08^{ab} \pm 0.16$	$8.03^{a} \pm 0.02$	$8.14^{abc} \pm 0.02$	$8.23^{bc} \pm 0.05$	$8.31^{c} \pm 0.08$	$8.27^{c} \pm 0.13$
C15:0	$1.74^{ab} \pm 0.04$	$1.73^{a} \pm 0.00$	$1.76^{abc} \pm 0.00$	$1.77^{bcd} \pm 0.02$	$1.81^{d} \pm 0.01$	$1.80^{cd} \pm 0.02$
C16:0	$27.53^{a} \pm 0.78$	$27.61^{a} \pm 0.14$	$27.69^{a} \pm 0.01$	$27.99^{ab} \pm 0.28$	$28.53^{b} \pm 0.22$	$28.47^{b} \pm 0.33$
C17:0	$1.45^{c} \pm 0.07$	$1.33^{b} \pm 0.01$	$1.24^{a} \pm 0.03$	$1.24^{a} \pm 0.04$	$1.28^{ab} \pm 0.02$	$1.24^{a} \pm 0.05$
C18:0	$12.44^{a} \pm 0.53$	$12.66^{ab} \pm 0.05$	$12.63^{a} \pm 0.00$	$12.78^{abc} \pm 0.19$	$13.14^{c} \pm 0.09$	$13.12^{bc} \pm 0.14$
C20:0	0.42 ± 0.05	0.45 ± 0.00	0.43 ± 0.01	0.44 ± 0.01	0.45 ± 0.01	0.45 ± 0.01
C21:0	$0.14^{b} \pm 0.09$	$0.09^{b} \pm 0.00$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
C22:0	$0.03^{a} \pm 0.01$	$0.20^{ab} \pm 0.01$	$0.16^{ab} \pm 0.01$	$0.25^{b} \pm 0.22$	$0.10^{ab} \pm 0.01$	$0.16^{ab} \pm 0.07$
C23:0	0.00 ± 0.00	$0.19^{bc} \pm 0.01$	$0.15^{b} \pm 0.03$	$0.20^{c} \pm 0.04$	0.00 ± 0.00	0.00 ± 0.00
C24:0	$0.28^{b} \pm 0.02$	$0.32^{b} \pm 0.01$	$0.36^{bc} \pm 0.00$	$0.47^{c} \pm 0.14$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$

[a-c] Statistically significant differences ($p < 0.05$) are indicated by different lowercase letters within rows

Table 3. Content of unsaturated fatty acids in Janj cheese samples

Fatty acid	1.1	1.2	1.3	1.4	1.5	1.6
C14:1	$0.64^{b} \pm 0.09$	$0.55^{a} \pm 0.00$	$0.56^{a} \pm 0.01$	$0.57^{a} \pm 0.02$	$0.60^{ab} \pm 0.01$	$0.65^{b} \pm 0.03$
C15:1	0.50 ± 0.02	0.51 ± 0.01	0.51 ± 0.01	0.51 ± 0.00	0.52 ± 0.00	0.52 ± 0.01
C16:1	$0.99^{ab} \pm 0.12$	$1.99^{b} \pm 0.00$	$2.00^{b} \pm 0.02$	$0.05^{a} \pm 0.00$	$0.06^{a} \pm 0.01$	$0.06^{a} \pm 0.02$
C17:1	$0.75^{d} \pm 0.05$	$0.69^{c} \pm 0.04$	$0.61^{a} \pm 0.00$	$0.63^{ab} \pm 0.01$	$0.66^{abc} \pm 0.01$	$0.67^{bc} \pm 0.01$
C18:1	$29.19^{a} \pm 1.94$	$30.55^{ab} \pm 0.31$	$30.72^{ab} \pm 0.05$	$31.15^{b} \pm 0.40$	$31.02^{ab} \pm 0.34$	$31.14^{b} \pm 1.22$
C20:1	$1.33^{b} \pm 0.49$	$0.39^{a} \pm 0.07$	$0.31^{a} \pm 0.01$	$0.28^{a} \pm 0.05$	$0.28^{a} \pm 0.04$	$0.47^{a} \pm 0.25$
C22:1	$0.69^{b} \pm 0.06$	$0.11^{a} \pm 0.03$	$0.15^{a} \pm 0.03$	$0.27^{a} \pm 0.20$	$0.25^{a} \pm 0.00$	$0.30^{a} \pm 0.14$
C18:2 c+t	$1.30^{a} \pm 0.23$	$2.25^{ab} \pm 0.04$	$2.82^{b} \pm 0.03$	$2.85^{b} \pm 0.07$	$2.54^{ab} \pm 0.33$	$1.69^{ab} \pm 0.87$
C18:3 n-6	$0.36^{c} \pm 0.03$	$0.32^{bc} \pm 0.01$	$0.24^{a} \pm 0.01$	$0.30^{b} \pm 0.06$	$0.27^{ab} \pm 0.01$	$0.26^{ab} \pm 0.01$
C18:3 n-3	$0.13^{a} \pm 0.05$	$0.09^{a} \pm 0.01$	$1.20^{b} \pm 0.00$	$1.24^{bc} \pm 0.01$	$1.28^{d} \pm 0.01$	$1.27^{cd} \pm 0.01$
C20:2	$4.28^{c} \pm 2.04$	$2.60^{b} \pm 0.00$	$0.31^{a} \pm 0.01$	$0.54^{a} \pm 0.03$	$0.95^{ab} \pm 0.11$	$1.53^{ab} \pm 0.52$
C20:3 n-6	0.28 ± 0.18	0.19 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
C20:3 n-3	0.00 ± 0.00	0.07 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
C20:4	0.14 ± 0.08	0.15 ± 0.01	0.08 ± 0.01	0.17 ± 0.10	0.00 ± 0.00	0.00 ± 0.00
C20:5	$0.03^{a} \pm 0.01$	$0.20^{ab} \pm 0.01$	$0.16^{ab} \pm 0.01$	$0.25^{b} \pm 0.22$	$0.10^{ab} \pm 0.01$	$0.16^{ab} \pm 0.07$

[a-c] Statistically significant differences ($p < 0.05$) are indicated by different lowercase letters within rows

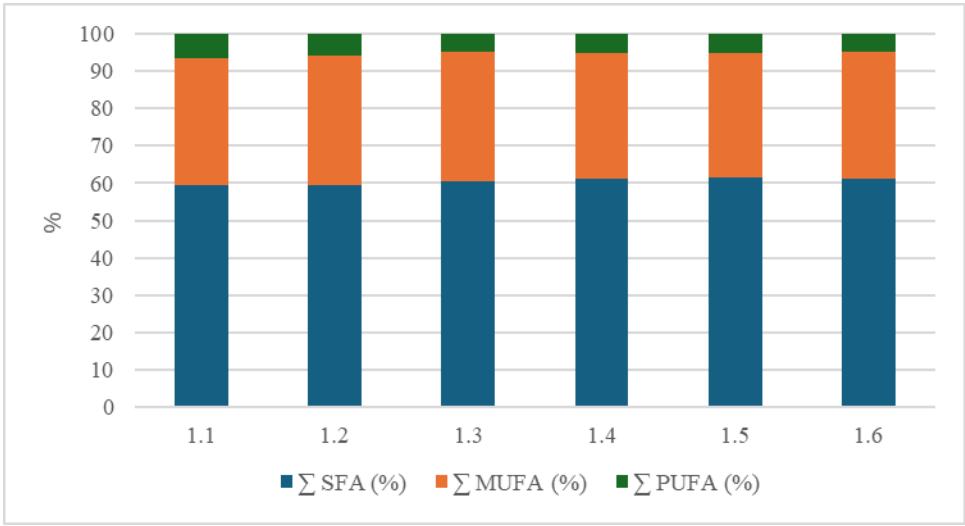


Figure 1. Distribution of fatty acids in Janj cheese samples

Table 4. Fatty acid profile and lipid quality indices of Janj cheese samples

Parameter / Sample	1.1	1.2	1.3	1.4	1.5	1.6
∑ SFA (%)	59.39	59.34	60.34	61.22	61.48	61.29
∑ UFA (%)	40.61	40.66	39.67	38.81	38.53	38.72
∑ MUFA (%)	34.09	34.79	34.86	33.46	33.39	33.81
∑ PUFA (%)	6.52	5.87	4.81	5.35	5.14	4.91
UFA/SFA	0.68	0.68	0.66	0.63	0.63	0.63
PUFA/MUFA	0.19	0.17	0.14	0.16	0.15	0.15
PUFA/SFA	0.11	0.10	0.08	0.09	0.08	0.08
n-6/n-3	39.75	15.31	2.54	2.59	2.72	2.43
DFA (%)	53.05	53.32	52.30	51.59	51.67	51.84
AI	1.52	1.51	1.57	1.62	1.65	1.64
TI	2.32	2.27	2.05	2.08	2.17	2.14
h/H	0.95	0.97	0.94	0.96	0.93	0.93

CONCLUSION

The results of this study indicate that the addition of selected plant additives can modify the fatty acid composition of traditional Janj cheese. Although all samples retained the typical fatty acid profile of ruminant milk cheeses, characterized by a predominance of saturated fatty acids, the addition of plant additives, particularly basil, parsley, rosemary, and chives, contributed to modifications in the polyunsaturated fatty acid fraction, especially n-3 fatty acids, as well as to a more favorable n-6/n-3 ratio. Improvements in the fatty acid profile were also reflected in lipid quality indices, with slightly lower atherogenicity and thrombogenicity indices and favorable h/H ratios observed in several enriched samples compared to the control. These findings suggest that the incorporation of plant additives may represent a simple and sustainable approach for enhancing certain nutritional aspects of Janj cheese while preserving its traditional production technology and authentic characteristics.

ACKNOWLEDGEMENTS

This paper is a part of the project titled ”Improvement of functional properties of autochthonous milk products using selected plant species“, co-financed by the Ministry of Scientific and Technological Development and Higher Education of the Republic of Srpska.

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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