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Research on the influence of horseradish addition on the properties of cream cheese

Beatrice Mihalescu[1], Lucia Mihalescu [1], Zorica Voșgan[1], Aurel Maxim[2], Anca Dumuța[1], Flavia Pop[1]

[1] [1]Technical University of Cluj-Napoca, North Universitary Center of Baia Mare, Faculty of Sciences, Department of Chemistry and Biology, 76 Victoriei Street, 430122 Baia Mare, Romania;
[2]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Agriculture, 3-5 Mănăștur St., 400372 Cluj-Napoca, Romania

**Corresponding author: beatrice_mihalescu@yahoo.com*

Abstract
Cream cheese is one of the most commonly used dairy products. It has a soft, smooth texture with a slightly tangy flavor, and a pleasant taste, specific to the added seasoning. Horseradish is a food additive due to its sharp flavor and has antibacterial properties. The aim of this study was to perform a comparative analysis of three types of cow's milk cream cheese: two homemade varieties (simple cream cheese – SCC, cream cheese with horseradish – SCH, and commercial cream cheese with horseradish – CCC). For all three samples, organoleptic, physicochemical, and microbiological analyses were conducted. The results showed that the most appreciated sample from an organoleptic standpoint was CCC, due to its texture, flavor, and uniformity. In terms of physicochemical properties, CCC had the highest dry matter content, followed by SCH due to the addition of horseradish. The highest acidity was observed in the SCC sample, while a slight reduction in acidity was noted in the samples with horseradish. Microbial contamination was evident in SCC, followed by SCH, and absent in CCC. The CCC sample proved to be the most appreciated, thanks to the added ingredients that significantly balance the taste and texture, matching consumer preferences.
Key words: cream cheese, horseradish, microorganism, assortment.

1. Introduction

Dairy products are a good source of proteins, minerals, vitamins, and fatty acids for humans [1]. Cream cheese is one of the most commonly used dairy products. It has a soft, smooth texture with a slightly tangy flavor and a pleasant taste, specific to the added seasoning [2]. By adding horseradish to cream cheese, its antibacterial properties can be enhanced. It can also be considered a medicinal ingredient, as it may help treat various ailments.

Horseradish (*Armoracia rusticana*) is a cruciferous vegetable native to Europe, which for over 3,000 years has been cultivated for its roots, used as a condiment, natural preservative, and medicinal plant [3]. It is primarily known as a food additive due to its sharp flavor and is also appreciated by some as an ornamental plant due to its attractive foliage [4].

Consumer interest in improving health through the consumption of plant-based nutraceuticals could increase the demand for products containing horseradish, due to the valuable compounds in this plant that promote human health. As the cells of the root are crushed, volatile compounds known as isothiocyanates are released, which give horseradish its characteristic smell and taste. These compounds are known to help reduce the risk of lung, stomach, colon, and rectal cancer [5].

Glucosinolate, specifically sinigrin, as a degradation product, provides antimicrobial and anti-inflammatory properties [6]. Horseradish can offer protection against

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various microbial pathogens, with some studies demonstrating its antibacterial capacity against *Pseudomonas spp*., *Escherichia coli*, *Serratia grimesii*, *Staphylococcus aureus*, and *Enterobacteriaceae* [7].

Isothiocyanates extracted from horseradish root have shown antimicrobial activity against six strains of anaerobic bacteria: *Streptococcus mutans, Streptococcus sobrinus*, *Lactobacillus casei*, *Staphylococcus aureus*, *Enterococcus faecalis*, and *Aggregatibacter actinomycetemcomitans*; one strain of yeast, *Candida albicans*; and three strains of anaerobic bacteria: *Fusobacterium nucleatum*, *Prevotella nigrescens*, and *Clostridium perfringens* [8].

Numerous horseradish products are available in grocery stores, such as prepared horseradish cream, horseradish sauce, and grated horseradish, while others may also contain horseradish, such as cream cheese, mustard, and hummus [9].

2. Material and methods

For the preparation of cream cheese in a homemade system, the following ingredients were used: 500 g of fresh cow's cheese, 3 tablespoons of sour cream, 100 g of butter, and seasonings (salt, pepper). The cow's cheese and sour cream were obtained using the traditional recipe, using cow's milk with 3.6% fat, sourced from a family farm in the village of Buteasa, Maramureș.

To achieve the intended goal, three working samples were used in the research: two prepared according to traditional recipes (simple cream cheese, cream cheese with added horseradish), and the third sample was purchased from the store (cream cheese with horseradish).

For the preparation of simple cow' s milk cream cheese (figure 1), the following steps were followed: 500 g of fresh cow's cheese, 3 tablespoons of sour cream, and 100 g of butter were placed in a bowl and mixed until a smooth cream was obtained. Afterwards, seasonings were added to achieve a pleasant taste.

Regarding the second sample, cream cheese with added horseradish (figure 2), the following ingredients were used: 500 g of cheese, 3 tablespoons of sour cream, 2 grated horseradish roots (approximately 5%), 100 g of butter, and seasonings (salt, pepper).

Figure 1. Ingredients for simple cream cheese

The method of preparation was identical to the one described earlier, with the difference that the grated horseradish was added.

Figure 2. Ingredients for cream cheese with added horseradish

In figure 3, the commercial cream cheese with added horseradish is shown, which contains the following ingredients: fresh cow's cheese (provides a creamy texture and specific taste); 30% sour cream (richer, creamier taste); 5% horseradish (slightly spicy and fresh flavor); salt, sugar (to balance the flavors); lactose and milk proteins (contribute to the product's texture); nitrogen (for aeration).

Figure 3. Commercial cream cheese with added horseradish

The organoleptic analysis of soft cheeses aims to assess the homogeneous mass, the free drainage of whey, molds, and impurities. The analysis checked whether the cheese paste presented pressing cavities, fermentation bubbles, cracks, and whether it was clean and uniform. Additionally, the cheese was examined for softness, greasiness, non-crumbly texture, color shade, uniformity of color, and whether the taste and smell were specific to the variety, non-specific, or foreign (sour, bitter, salty, yeast-like, fermentation, moldy, or rancid).

In this context, a panel of 10 tasters assessed the organoleptic characteristics using a 0-5 rating scale, according to sensory analysis standards and in line with quality classes. For each organoleptic characteristic analyzed, the recorded values were entered into an individual sheet for each sample. The weighted average scores were then calculated, followed by their summation to obtain the overall average score for the taster panel for the tested variants [10].

The physicochemical analysis aimed to determine the amount of dry matter in the cheeses using the drying method in an oven and to determine the acidity using the Thorner method. For the dry matter, the procedure involved placing 10 g of sand into a weighing bottle, along with a glass rod, which kept the bottle cap slightly open. The sample was then dried at 102°C, cooled in a desiccator, weighed, and the process was repeated until a constant mass was achieved.

Subsequently, 3 g of cheese was placed in the bottle, and the drying continued at the same temperature for 2 hours, followed by a 30-minute cooling period in the desiccator, weighing, and repeating these steps until the sample reached a constant mass. The water content of the sample, expressed as a percentage, was determined using the following formula:

$$Water\% = \frac{m_1 - m_2}{m_1 - m} \times 100;$$

m = the mass of the bottle with sand and the glass rod, brought to constant mass (g); m1 = the mass of the bottle with the glass rod, sand, and sample before drying (g); m2 = the mass of the bottle with the glass rod, sand, and sample after drying (g)

The dry matter content, expressed as a percentage, was determined using the formula

$$Dry\ matter\% = \frac{m_2 - m}{m_1 - m} \times 100;$$

Regarding the Thorner method for determining acidity, approximately 10 g of the sample to be analyzed and about 40 ml of distilled water were added to a mortar and homogenized until a fine suspension was obtained. This suspension was quantitatively transferred into an Erlenmayer flask, 1 ml of 2% alcoholic phenolphthalein solution was added, and then it was titrated with 0.1 N NaOH until a pink color appeared, which should persist for 1 minute [11].

$$Acidity = \frac{V}{G} \times 100;$$

V = volume of 0.1 N NaOH used for titration (mL) G = weight of the sample taken for analysis (g)

The microbiological analysis involved determining the total number of microorganisms, yeasts, and molds, the number of coagulase-positive staphylococci, and the number of colony-forming units of β-glucuronidase positive *Escherichia coli*.

The total number of microorganisms (TNM/g) provides information about the general contamination level of the product under investigation. In this regard, decimal dilutions were performed in sterile physiological saline using 1 mL pipettes, carrying out the desired dilution series. In our case, the sample to be analyzed was homogenized beforehand, after which the dilution series was prepared. The time between preparing the initial suspension (dilutions) and the moment when the medium is poured into the plates should not exceed 45 minutes. The inoculum was carefully mixed with the medium by rotating the Petri dish and left to solidify, then placed in an incubator at 30°C ± 10°C for 72 hours.

After the incubation period, colonies on the plates were counted using specific equipment. The pair of plates that developed between 30 and 300 colonies was selected, the colonies were counted, and the sum was multiplied by the dilution factor, thus determining the TNM/g of the product [12].

To determine the number of yeasts and molds, the colony counting technique was applied at 25°C. From the initial sample and dilutions, 1 mL was transferred into each prepared Petri dish using a sterile pipette. The cream cheese was homogenized in physiological saline, and then decimal dilutions were performed. Two Petri dishes were used for each dilution. About 15 mL of yeast-dextrose-chloramphenicol-agar medium, previously liquefied and maintained at 45°C in a water bath, was poured into the dishes. The inoculum was mixed and then left

to solidify. After incubation, the yeast colonies were counted separately from the molds on the two dishes, each containing 10-100 colonies. The sum was multiplied by the dilution factor and divided by 2, thus identifying the number of yeasts, separate from molds, in one gram of the product [13].

To determine the number of coagulase-positive staphylococci, the medium was distributed in sterile Petri dishes, forming a 4 mm layer. After solidification, 1 mL of the sample from each dilution was inoculated in equal amounts on the surface of three Baird-Parker agar plates. The prepared plates were incubated for 24-48 hours at 37°C. Plates containing a maximum of 300 colonies, with 150 typical and/or atypical colonies, were considered at two successive dilutions. For estimating the number of coagulase-positive staphylococci, the plates containing both typical and atypical colonies were selected. The calculation formula was:

$$N = \frac{\sum a}{\mathrm{V}\,(n_1 + 0.1n_2)} \times d$$

where:

Σa = the sum of the coagulase-positive staphylococci colonies identified on all the selected plates; V = the volume of inoculum applied to each plate; n1 = the number of plates selected at the first dilution; n2 = the number of plates selected at the second dilution; d = the dilution factor corresponding to the first selected dilution [12].

Regarding the determination of the number of colony-forming units of *Escherichia coli* positive for β-glucuronidase, it was performed according to STAS ISO 16649-2/2007 [14].

3. Results and Discussion

To assess the external appearance, color, consistency, smell and taste of the product, three samples were evaluated and rated by a panel of 10 subjects. Each subject provided assessments by giving scores from 0 to 5 for each characteristic examined, and the average scores recorded for the 3 cheese samples analyzed can be seen in figure 4.

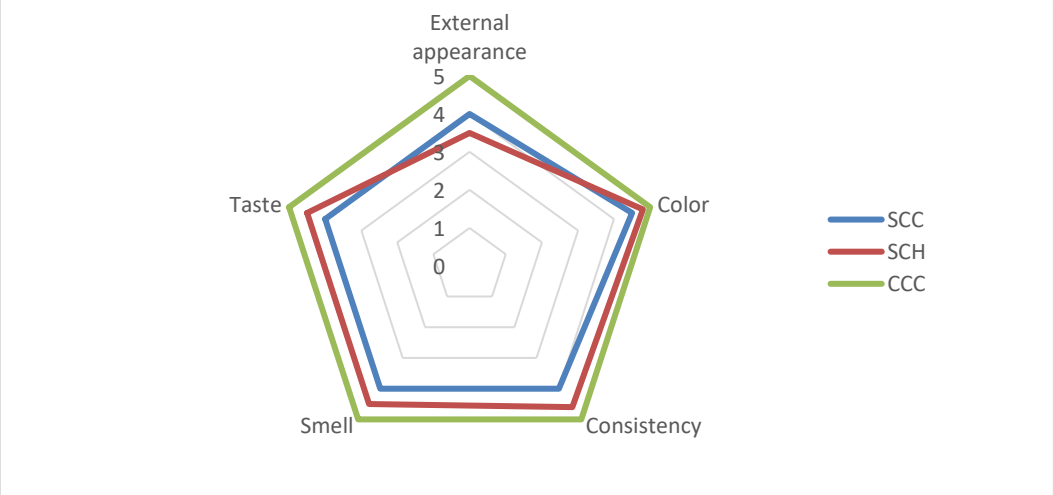

Figure 4. Results of the organoleptic analysis

According to the graph, it can be observed that the most appreciated in terms of external appearance, color, consistency, smell, and taste is the commercial cream cheese with horseradish (CCC), likely due to the addition of sugar, sunflower oil, and lactic acid, components that are not present in the other two samples tested. Other studies have demonstrated that by adding extracts, plant powders, and essential oils to cheese, the sensory properties of the product can be improved [15].

When analyzing the homemade samples, simple cream cheese (SCC) and cream cheese with horseradish (SCH), the most appreciated was SCH, except for the external appearance, which received lower scores due to the presence of plant material, giving it a less smooth and uniform appearance, which appeared unusual compared to its fine texture.

Similar studies were conducted by testing *Allium roseum* paste and powder extract on cheese paste. The 3 samples, represented by simple cheese, flavored cheese with powder, and flavored cheese with paste, were evaluated by a group of 50 people. The results showed

that the simple cheese received the lowest score for overall acceptability, followed by the cheese flavored with powder, which was less preferred due to its pungent and spicy taste and darker color. The paste-flavored cheese was the most preferred by all evaluators [16].

Through the physico-chemical analysis (determination of dry matter, determination of acidity), the results can be observed in figures 5 and 6.

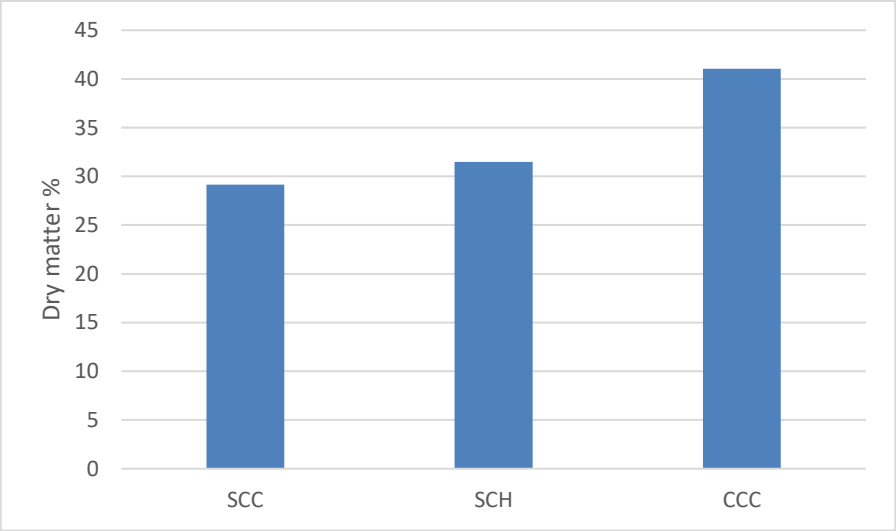

Figure 5. Determination of dry matter

In figure 5, it can be observed that the commercial cream cheese with horseradish has the highest dry matter content, at 41.05%, followed by the homemade cream cheese with horseradish (31.47%), and the simple cream cheese with 29.17%.

The result obtained for the commercial cream cheese regarding this parameter is due to the addition of 5% dehydrated horseradish in the composition, while the lower values (9.58% less) are attributed to the fact that the horseradish added in the homemade recipe was in its raw state, which is known to have a high water content.

Johnson (2003) [17] showed that by adding powder from a plant called Rose Garlic (originating from Tunisia) to cream cheese, an increase in dry matter content was observed, results that were also noted in this study.

The purpose of determining the acidity for the 3 samples was to check if the raw material had high acidity. The results obtained can be seen in figure 6.

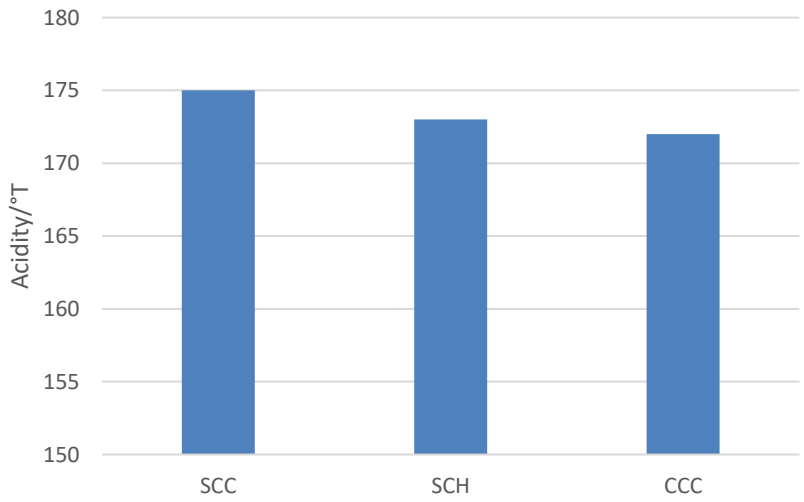

Figure 6. Determination of acidity in the cream cheese

Based on the recorded data, it can be observed that the highest acidity was found in the SCC sample, which had a value of 175 °T. In the case of the samples with added fresh horseradish and dehydrated horseradish, a slight decrease was noted, with reductions of 2°T and 3°T, respectively.

The addition of horseradish to the cream cheese slightly influences the product's acidity due to the active compounds and the specific pH profile of horseradish. Horseradish has a relatively low pH (5.5–6.5), making it mildly acidic, but still higher than that of cream cheese, which has a pH of 4.5–4.7.

It can be stated that while adding horseradish does not measurably change the pH, it provides a sensation of acidity and intensity in taste. Horseradish contains isothiocyanates (sulfur compounds), which are perceived as having a higher acidity due to their pungent smell and spicy taste.

Phadungath (2005) [18] demonstrated that by treating cream cheese with plant extracts in the form of powder, paste, etc., the pH values were slightly modified compared to the untreated variant, with values being slightly lower, giving the cheese a mild acidic taste, similar to the results obtained in this study.

The microbiological analysis conducted on the 3 cream cheese samples aimed to assess the antimicrobial effect of horseradish root (*Armoracia rusticana*), added both in its fresh state in the SCH sample and in its dehydrated state in the CCC sample.

The results regarding the total number of germs (TNG), yeasts and molds (YM), coagulase-positive staphylococci (CPS), and the number of colony-forming units of β-glucuronidase-positive *Escherichia coli*, can be observed in figure 7.

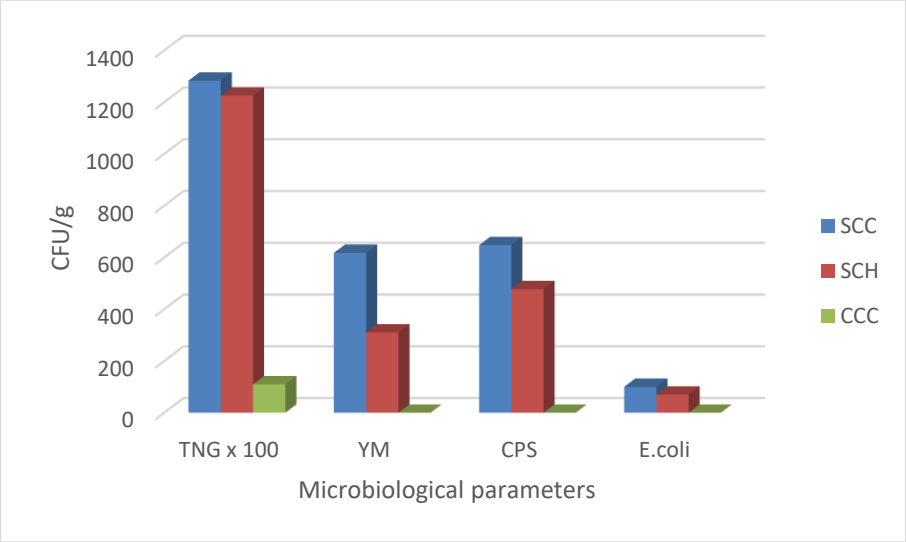

Figure 7. Results of the microbiological analysis of the tested samples

In terms of the total number of germs (TNG), it is observed that the values are higher in the samples prepared in a domestic setting, exceeding the maximum allowed limit of 100,000 CFU/g, whereas the sample containing the store-bought cream cheese with horseradish has much lower values.

Other studies have shown that iberin, a biologically relevant compound present in horseradish, helps provide natural prophylaxis against bacterial infections, an effect also noted in our study [19].

The differences observed between the homemade horseradish cream cheese and the commercial one regarding TNG are attributed to hygiene and sterilization conditions, which are more difficult to control in a home setting. Ingredients, surfaces, and utensils may be exposed to microorganisms from the air or the preparation environment, influencing the growth of TNG in the final product.

For the samples prepared at home, the values for yeast and mold were below 1000 CFU/g, while in the comercial cream cheese with horseradish, no yeast or mold was detected. These results suggest that horseradish has antifungal properties.

The presence of coagulase-positive staphylococci was noted in both the simple and horseradish-added homemade cream cheese

samples, whereas they were absent in the comercial sample.

Contamination with *Enterobacteriaceae* was tested for the detection of *E. coli*. A maximum of 100 CFU/g colonies were counted in the simple cream cheese sample without additives, followed by the horseradish-added sample, which showed a reduced count of 70 CFU/g. *E. coli* was not detected in the commercial sample.

Josipovic et al. (2015) [20] explained that the addition of fresh or dried garlic to cream cheese reduced the number of foodborne pathogens, contributing to the shelf life of the treated cheese. Similar effects were noted when fresh and dehydrated horseradish was added to the cream cheese in our study.

Thus, the recorded results demonstrate the antimicrobial effectiveness of horseradish added to the product, both in the homemade cream cheese and in the commercially purchased one. The reduction or absence of contamination in the commercially available horseradish-added sample is due to the fact that it was subjected to thermal treatments and contains certain additives, resulting in a much higher preservation level.

4. Conclusion

The results of the research conducted on the three cream cheese samples tested from an organoleptic perspective show that the most appreciated, regarding appearance, color, consistency, smell, and taste, was the commercially purchased horseradish-added cream cheese (CCC).

The CCC sample was more appreciated organoleptically due to better control over texture, flavors, stability, and product uniformity. Additionally, the ingredients added to balance taste and texture significantly contribute to a final product that aligns with the preferences of most consumers.

The physicochemical analysis regarding the dry matter content revealed that the commercially purchased cream cheese with horseradish had the highest dry matter content, at 41.05%, followed by the homemade horseradish-added cream cheese (31.47%), while the simple cream cheese registered 29.17%. This can be explained by the fact that the commercial product contains thickeners, dehydrated horseradish, and, due to processing, its moisture content is reduced, along with concentrated proteins and fats.

Regarding acidity determination, it was observed that the highest acidity was recorded in the SCC sample, with 175°T, while in the samples with fresh horseradish and dehydrated horseradish, there was a slight decrease of 2°T and 3°T, respectively.

Microbiological contamination was more evident in the homemade samples compared to the commercially purchased sample. The TNG values were significantly lower in the CCC sample compared to the other two samples tested. The presence of staphylococci, *E. coli*, yeasts, and molds was absent in the CCC sample, while in the SCC sample, these were present, with higher values than in the SCH sample, where values were lower due to the addition of fresh horseradish, which has an inhibitory effect due to its antimicrobial and antifungal properties.

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