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INFLUENCE OF ADDITION OF SELECTED SPICES ON MINERAL COMPOSITION OF FRESH CREAM CHEESE

Danica Savanović[1], Ana Velemir[1], Aleksandar Savić[1], Jovo Savanović[2], Jelena Sekulić[1]

[1]University of Banja Luka, Faculty of Technology, Vojvode Stepe Stepanovića 73, 78000 Banja Luka, Bosnia and Herzegovina, danica.savanovic@tf.unibl.org
[2]MI "DIM-DIM" d.o.o., Glamočani bb, 78250 Laktaši, Bosnia and Herzegovina

ABSTRACT

Milk and dairy products, especially cheeses, are a good source of minerals that play an important role in maintaining health. Minerals are necessary for biological processes and normal growth and development of the organism. Various spices have been used for centuries to improve the taste of food. The aim of this study was to examine the influence of the addition of selected spices on the mineral composition of fresh cream cheese. Six different samples of fresh cream cheese were produced in the milk processing plant (mini cheese factory). The first sample was marked as a control, without spices, and the rest were produced with the addition of different spices (oregano, basil, parsley, rosemary, and chives), in the amount of 1%. The content of total ash in the tested cheese samples was determined by mineralization of the samples at 550ºC. The ICP-OES was used to determine the content of macroelements and microelements in the tested samples. Based on the obtained results, it was concluded that the addition of spices the statistically significant ($p<0.05$) effect on the mineral composition of the produced cheeses. The element concentrations (in mg/100g) were determined in the following order: calcium 64.38-112.72; sodium 272.34-363.30; potassium 71.67-117.34; magnesium 8.35-14.51; phosphorus 33.35-119.40. Other identified minerals were found in smaller quantities.

Keywords: cheese, spices, minerals.

INTRODUCTION

Cheese is a milk product used directly for human consumption or as an integral part of other foods or ready meals. According to the Rulebook on dairy products and starter cultures (Official Gazette of BiH, 21/11), cheese is a fresh product or a product with different degrees of maturity produced by separating whey after coagulation of milk (cow, sheep, goat, buffalo, and/or their mixtures), skimmed or partially skimmed milk, sour cream, whey, or a combination of these raw materials. There are many different types of cheese on the market today. Fresh cream cheese contains from 69% to 85% water in a non-fat substance, has a creamy texture, and does not go through the ripening process. As a highly valued product, cheese is a concentrated source of protein of high biological value, and its daily consumption is recommended to almost everyone, regardless of age (Walther et al., 2008; Kwak et al., 2011). In addition to protein, cheeses are a good source of fat-soluble vitamins (A, D, E, K) and water-soluble vitamins (B1, B2, B6, B9, B12), as well as mineral materials, especially calcium, phosphorus, and magnesium. There is a lot of evidence that minerals, independently or in proper balance with other minerals, have structural, biochemical, and nutritional functions that are very important for overall human health, both mental and physical (Vahčić et al., 2010). In addition, they act as catalysts for many biological reactions in the body, including muscle contraction, nerve impulse transmission, and easier absorption of nutrients from food (Anonymous, 2010; Vahčić et al., 2010). The most significant mineral elements necessary for the human diet are sodium, potassium, chlorine, calcium, manganese, selenium, iodine, chromium, cobalt, molybdenum, fluorine, arsenic, nickel, silicon, and boron (Cashman, 2002). Minerals can be classified into two groups: main elements (macrominerals) and trace elements (microminerals). Milk contains all essential mineral elements because it contains the nutrients necessary for young growth (Bates and Prentice, 1996). Milk and dairy products, especially cheeses, are a good source

of macrominerals and trace elements. Minerals in the diet are necessary for biological processes in metabolic functions, for normal growth and development. There are six macrominerals (sodium, potassium, calcium, phosphorus, magnesium, chlorine) and eight trace elements (iron, iodine, copper, manganese, zinc, cobalt, selenium, chromium) recognized as essential elements for growth and metabolism and their disorder can cause the development of pathological processes in the body (Park, 2009).

Different spices can be added to improve the quality of cheese, which have positive effects and affect the improvement of product quality (Alijagić et al., 2009; Licón et al., 2012; Olmedo et al., 2013; Josipović et al., 2015; Lobacz et al., 2016; Tarakçı and Deveci, 2019; Salih et al., 2019; Sohany et al., 2022). Spices give physiological and psychological balance to the body. They have a therapeutic effect in treating various health disorders. Many are also effective act as: carminative, antioxidant, expectorant, stomachic, diuretic, antiviral, anticancer, antifungal, antidepressant, antiseptic, etc. (Savić et al., 2008). The use of plants in nutrition and healing is as old as humanity itself. Many historical data speak of the use of herbs in the production of various food products. Spices have been used throughout history to enrich the taste of food but also as medicinal plants for various ailments. This study aimed to determine the content of macro and microelements in cheeses produced using different spices.

MATERIAL AND METHODS

Samples of fresh cream cheese were produced in a milk processing plant (mini cheese) according to the procedure for the production of fresh cream cheese (Popović-Vranješ, 2015). Cow's milk purchased from a nearby dairy farm was used to make the cheese. Fresh milk was filtered and then heated in a duplicator at 85°C. When the target temperature was reached (controlled by a thermometer), the milk was left for 15 minutes at the same temperature for pasteurization. The milk was then cooled to 25°C and 33% $CaCl_2$ was added in an amount of 0.02%. After mixing for 10 minutes, mesophilic microbiological cultures (Di-prox M195 20UA, manufactured by BIOPROX) were added to the milk. After 30 minutes, microbial rennet in tablets (Fromase 50-endopeptidase) dissolved in water (1 tablet of rennet was added to 50 mL of milk) was added. After stirring, the mass was left for 24 h at room temperature, and curd formed. On the second day, the curd was cut with a curd harp, and then the previously prepared cheese molds coated with gauze were filled. At the same time, whey was collected in a previously prepared container. Squeezing the curd took 24 hours. The drained curd was weighed and salted by adding 1% salt (NaCl) to the curd. The mass was mixed well for the salt to be evenly distributed in the cheese. After salting, the cheese samples were weighed and placed in 6 special containers previously marked with numbers. The first sample was marked as a control sample, without the addition of spices, and in the other five ones, 1% of selected spices were added (Table 1). Packaged chopped spices (manufacturer: AD Food Industry "Aleva", Novi Kneževac, Republic of Serbia), purchased at a nearby market, were used. After adding the spices, the cream cheese was lightly mixed for the spices to be evenly distributed in the cheese. Until the analysis, cheese samples were stored in closed containers at a temperature of 4°C.

Table 1. Type of spices and their amount in fresh cream cheese.

Sample	Spice	Amount of spice (%)
1	-	-
2	Oregano	1
3	Basil	1
4	Parsley	1
5	Rosemary	1
6	Chives	1

The total content of ash in tested cheeses was determined gravimetrically after heating of sample in a muffle furnace (Micronal) at 550°C. The ash is an inorganic residue left after incineration of the sample. The ash content in the tested samples is expressed in g/100g, i.e., in percentage (%) (Carić et al., 2000).

Sample preparation for determining minerals was performed by burning with a mixture of nitric and perchloric acid in the digestion thermoblock according to the prescribed temperature regime. An Optical Emission Spectrophotometer (ICP OES Optima 8000, Perkin Elmer) was used to determine the mineral content of the samples (Savanović et al., 2021).

The analytical parameters of the ICP-OES Optima 8000 instrument are given in Table 2.

Table 2. The analytical parameters of the ICP-OES Optima 8000.

RF Power (W)	1500
Plasma Ar flow (L/min)	8
Auxiliary Ar flow (L/min)	0.2
Nebulizer Ar flow (L/min)	0.7
Sample flow (mL/min)	1
Plasma view	Axial and radial
View distance (mm)	15
Processing Peak	Area (7 points per peak)
Number of replicates	3
Read delay (s)	45
Calibration	Linear Calculated Intercept
Spray chamber	Scott
Nebulizer	Perkin-Elmer cross-flow
Injector i.d (mm)	2.0 (Alumina)
Quartz torch	1-slot

Certificate reference standard solution, instrument calibration standard, was used for calibration of a spectrophotometer (Perkin Elmer TruQms - Instrument Calibration Standard 2 (multi-elemental) LOT CL3-144MJY1; Perkin Elmer Pure - Wave Cal Solution (multi-elemental) LOT 43-71AS).

The parameters for individual elements are presented in Table 3.

Statistical processing of the obtained results was performed using the Microsoft Excel 2013 software package and the IBM SPSS Statistics 22.0 computer program for Windows (Armonk, NY, United States). The results obtained in this paper are presented as mean values of the individual results of three randomly selected product samples ± standard deviation (SD). The significance of differences between arithmetic means was determined by analysing the variance with one independent variable (One way ANOVA) and multiple interval tests (*Tukey HSD – test*) and expressed with 95% probability ($p<0.05$).

Table 3. Determination of element concentration using ICP-OES.

Element	Wavelength	Detection limit (µg/L)	R^2	Calibration concentration (mg/L)
Na	589.592	0.5	0.9951	1-15
Ca	317.933	0.05	0.9869	1-15
K	766.490	1	0.9969	1-15
P	213.617	4	0.9989	0.1-5
Mg	285.213	0.04	0.9998	0.1-5
Zn	206.200	0.2	0.9920	0.1-5
Fe	238.204	0.1	0.9996	0.1-5
Mn	260.568	0.1	0.9999	0.1-5
Al	396.153	1	0.9489	0.1-5
Cu	327.393	0.4	0.9998	0.1-5
Cr	267.716	0.2	0.9998	0.1-5
Mo	202.031	0.5	0.9998	0.1-5
Se	196.026	2	0.9997	0.1-5

RESULTS AND DISCUSSION

The ash is the residue consisting of minerals left after burning the samples. The results of the ash content are shown in Table 4.

Table 4. Ash content in the tested cheese samples.

Sample	Ash content (%)
1	$1.50^{a} \pm 0.02$
2	$1.60^{ab} \pm 0.05$
3	$1.57^{ab} \pm 0.03$
4	$1.65^{b} \pm 0.03$
5	$1.55^{ab} \pm 0.05$
6	$1.54^{ab} \pm 0.02$

$^{a-b}$ mean values with different letters in the same column differ statically significantly with 95% probability ($p < 0.05$)

The ash content in the tested cheese samples ranged from 1.50% in the control sample, to 1.65%, in sample 4, with parsley added. Statistical analysis of the results of the ash content showed that the samples were statistically significantly different ($p<0.05$). Savanović et al. (2021) concluded that coagulation conditions have a statistically significant effect ($p<0.05$) on the content of total ash, and compared to other cheese samples, the samples produced with acetic acid had statistically significantly higher ($p<0.05$) amounts of total ash.

The obtained results in this study showed that the content of macroelements in the all examined samples of fresh cream cheese with spices is significantly higher than the content of microelements (Figure 1; Figure 2). The total macronutrient content ranged from 451.95 mg/100g (sample 1) to 667.07 mg/100g (sample 5). The largest proportion is sodium from 272.34 mg/100g (sample 1) to 363.30 mg/100g (sample 2), potassium content from 71.67 mg/100g (sample 1) to 117.34 mg/100g (sample 3). The highest calcium (Ca) content was recorded in samples 2 (112.72 mg/100g) and 3 (111.38 mg/100g). Sample 1 had the lowest phosphorus (P) content (33.35

mg/100g), and the highest had sample 5 (119.40 mg/100g). And the magnesium (Mg) content ranged from 8.35 mg/100 g (sample 1) to 14.51 mg/100 g (sample 5), as shown in Table 5.

The micronutrient content ranged from 2.103 mg/100g (sample 6) to 6.156 mg/100g (sample 2). The largest proportion is copper from 0.035 mg/100g (sample 6) to 3.629 mg/100g (sample 2), followed by zinc from 0.524 mg/100g (sample 3) to 1.712 mg/100g (sample 2). The content of other elements ranged from mg/100g: aluminum (Al) 0.061-0.717; manganese (Mn) 0.027-0.214; molybdenum 0.00-0.002; iron 0.010-0.066, and is shown in Table 6.

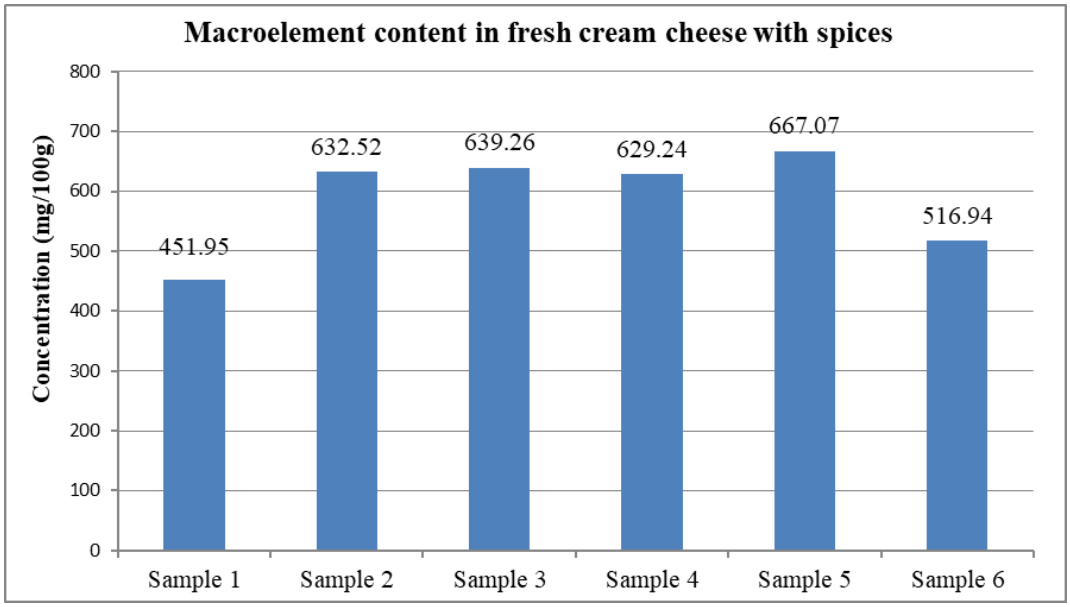

Figure 1. Content of macroelements in the tested samples of fresh cream cheese with spices.

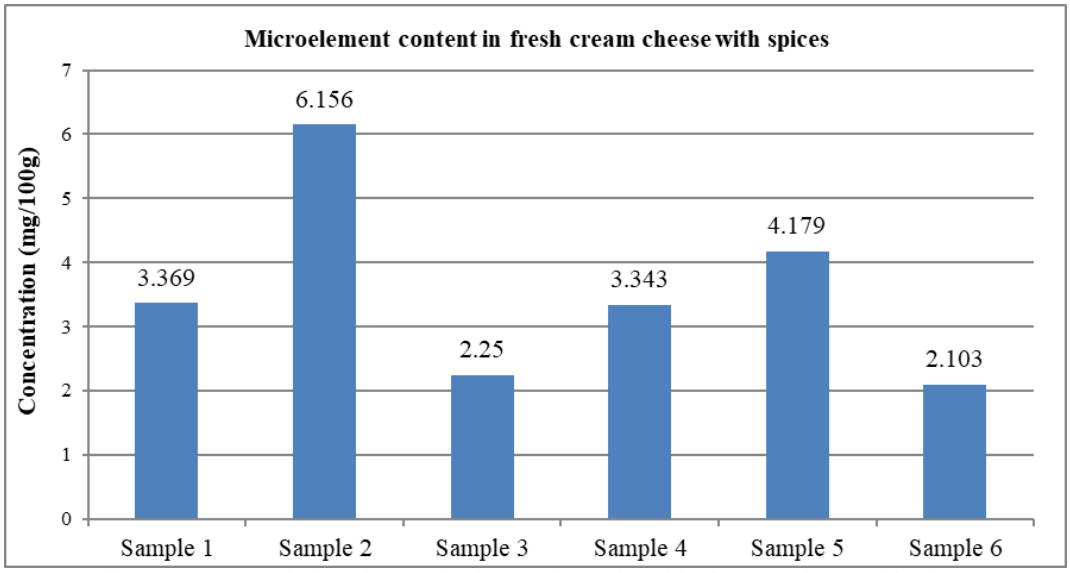

Figure 2. Content of microelements in the tested samples of fresh cream cheese with spices.

Table 5. Mean values of macroelement content in fresh cheese with spices.

Elements	Concentration (mg/100g)					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Ca	66.24^{a} ± 1.32	112.72^{b} ± 6.85	111.38^{b} ± 10.60	68.92^{a} ± 8.76	68.64^{a} ± 15.76	64.38^{a} ± 7.27
Na	272.34^{a} ± 2.52	363.30^{b} ± 42.75	341.92^{abc} ± 7.80	324.80^{abc} ± 10.19	356.33^{bc} ± 9.43	288.23^{ac} ± 22.31
K	71.67^{a} ± 1.39	103.92^{bc} ± 11.51	117.34^{b} ± 0.20	109.22^{bc} ± 2.49	108.19^{bc} ± 0.77	95.55^{c} ± 6.44
Mg	8.35^{a} ± 0.24	14.08^{b} ± 0.39	10.21^{c} ± 0.07	13.76^{b} ± 0.32	14.51^{b} ± 0.36	12.36^{d} ± 0.13
P	33.35^{a} ± 6.73	38.50^{ab} ± 3.91	58.41^{ab} ± 3.97	112.54^{ab} ± 12.03	119.40^{b} ± 13.86	56.42^{ab} ± 1.32

$^{a-d}$ mean values with different letters in the same row differ statically significantly with 95% probability ($p < 0.05$)

Table 6. Mean values of microelement content in fresh cheese with spices.

Elements	Concentration (mg/100g)					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Al	0.061^{a} ± 0.006	0.604^{bc} ± 0.076	0.360^{abc} ± 0.294	0.545^{bc} ± 0.016	0.717^{b} ± 0.015	0.200^{ac} ± 0.002
Zn	1.307^{a} ± 0.186	1.712^{a} ± 0.189	0.524^{b} ± 0.128	1.365^{a} ± 0.006	1.490^{a} ± 0.056	1.631^{a} ± 0.017
Mn	0.027^{a} ± 0.001	0.171^{bc} ± 0.001	0.169^{bc} ± 0.006	0.154^{bc} ± 0.067	0.115^{ab} ± 0.002	0.214^{c} ± 0.002
Cu	1.952^{ab} ± 0.501	3.629^{a} ± 0.699	1.130^{ab} ± 0.233	1.267^{ab} ± 0.869	1.836^{ab} ± 0.741	0.035^{b} ± 0.000
Mo	0.001^{ab} ± 0.000	N.D.	0.001^{ab} ± 0.000	0.002^{b} ± 0.000	0.001^{ab} ± 0.000	N.D.
Fe	0.021^{ab} ± 0.016	0.040^{bc} ± 0.008	0.066^{c} ± 0.002	0.010^{a} ± 0.001	0.020^{ab} ± 0.02	0.023^{ab} ± 0.000

$^{a-c}$ mean values with different letters in the same row differ statically significantly with 95% probability ($p < 0.05$)

N. D - not detected

Bilandžic et al. (2014) determined higher concentrations of macrominerals and microelements in different samples of cheese using the inductively coupled plasma emission method (ICP-OES). The following concentrations of elements (in mg/kg) were determined: calcium 802.2-7449, potassium 294.5-2014, sodium 414.6-11502, magnesium 85.1-288.2 zinc 21.8-63.1, iron 2.01-5.10, copper 2.06-2.84, selenium 0.075-0.56. Also, Holland et al. (1995) determined slightly higher content of sodium 300-1440 mg/100 g, potassium 77-160 mg/100 g, calcium 73-1200 mg/100 g, phosphorus 100-810 mg/100 g, magnesium 9-45 mg/100g in different types of cheese. Savanović et al. (2021) were found that the coagulation temperature and the type of coagulant statistically significantly ($p<0.05$) affect the content of macroelements and microelements in the produced cheeses. They obtained similar results and the following element concentrations were determined (in mg/100 g): calcium 84.10-246.62; sodium 79.07-114.09; potassium 29.96-40.28; magnesium 5.88-11.22; phosphorus 56.86-209.23; zinc 2.75-3.41.

Technological processes for producing dairy products affect the content of Ca, Na, K, and Mg in milk products. These elements participate in coagulation processes, and whey separation affects the thermal stability and the coagulating ability of milk, as well as the texture of the cheese. Calcium chloride is added to milk to compensate for the Ca loss during pasteurization and improve the cheese-making process. Sodium chloride can also be added during processing to compensate for lost Na (Bilandžić et al., 2014). The mineral composition of milk is not constant and depends on the stage of lactation, animal nutrition, environmental conditions, and genetic factors. Mineral elements are found in the form of inorganic ions and salts in milk and dairy products, or as part of

organic molecules such as proteins, fats, carbohydrates, and nucleic acids. The chemical form in which the mineral elements are present is very important because it affects the absorption in the stomach and thus their biological utilization (Zamberlin et al., 2012). Each cheese is characterized by a certain mineral composition that affects the nutritional values and sensory properties of the product.

CONCLUSIONS

Spices are specific products, which are obtained from certain plants, they are used as additives in food, with the aim of improving its taste or color and increasing the nutritional and medicinal value of food because they contain nutritionally valuable components. The addition of spices in cheeses contributes to increasing the nutritional value of cheese.

Based on the obtained results in this study, it can be concluded that the content of mineral substances varies depending on adding different spices to the produced cheeses. In the tested cheeses, the content of macroelements was significantly higher than that of microelements.

Differences in the content of mineral substances in the tested cheeses are due to the addition of selected spices to the produced cheeses.

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