AgroLife Scientific Journal - Volume 13, Number 2, 2024
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

EFFECT OF THE ADDITION OF AROMATIC PLANTS ON THE QUALITY OF BRINED COW'S MILK CHEESE

Silviya IVANOVA[1], Daniela MITEVA[1], Tsonka ODZHAKOVA[2], Ayten SOLAK[1], Eli KOSTADINOVA[1]

[1]Agricultural Academy, Institute of Cryobiology and Food Technology, 53 Cherni Vrah Blvd, Sofia, 1407, Bulgaria
[2]Agricultural Academy, Research Centre of Stockbreeding and Agriculture, 35 Nevyastata Street, Smolyan, 4700, Bulgaria

Corresponding author email: sylvia_iv@abv.bg

Abstract

The purpose of the study is to determine the influence of biologically active additives in different concentrations on the organoleptic evaluation, physicochemical and fatty acid composition, antioxidant activity and total polyphenols of brine cheese from cow's milk obtained from highly productive Bulgarian Rhodope cattle. The technological processing of bulk tank cow's milk to brine cheese with the addition of additives from aromatic plants in different concentrations improves their qualitative and quantitative composition. The organoleptic evaluation of the examined cheeses gives us a clear idea that the application of a higher concentration of additives worsens the smell, taste, colour, aroma and consistency. The application of the additives in different concentrations enrich the brine cheese with fibres, minerals and fats, as a result of which their energy value also increases. Cheeses with the addition of aromatic plants in dry form were characterized by a decrease in saturated fatty acids and enrichment with biologically active fatty acids, which in turn leads to health benefits from their consumption, which is expressed by a decrease in AI and TI and an increase in the cholesterolemic index.

Key words: *fibber, oregano, rosemary, yield, soluble protein.*

INTRODUCTION

In addition to traditional cheeses, new functional types of cheeses are also produced to respond to the new lifestyle, to increase economic income and also for religious reasons (Gaglio et al., 2021a, 2021b; García-Gómez et al., 2021; Wei et al., 2020). In this direction, milk is mainly used for new cheese productions and to date, innovations in its production include the addition of fruit and vegetable by-products to obtain functional cheeses (Barbaccia et al., 2022; Lucera, 2018), natural food colourings' for production of more attractive coloured products (Jiao et al., 2021), the inclusion of cereals as prebiotics to support the development of probiotic bacteria in the gut (Plessas et al., 2021). Research on the physicochemical and biochemical changes in white brine cheese with plant additives is scarce and incomplete, which is of interest to science (Barak & Mudgil, 2022; Basant et al., 2018; El-Kholy et al., 2017; Gajarmal et al., 2024; Kumar Paswan et al., 2021; Oraon et al., 2017). Really the use of the whole plant in the form of dry substance in milk and dairy products has not been well researched. Most authors work on the issue of adding plant extracts or essential oils from aromatic plants, but not the dried version, which makes the development unique and innovative.

The judicious use of herbs in dairy products can lead to an increase in their nutritional and medicinal parameters and enable the development of the quality of dairy products. Fortification of dairy products with herbs would allow to obtain high quality functional dairy products and increase their consumption (Oraon et al., 2017). The antimicrobial and antioxidant properties of aromatic plants allow them to be used as preservatives (Kunnumakkara et al., 2009; Miraj et al., 2017; Aljabeili et al., 2018; Kamelnia et al., 2023; Elyemni et al., 2022; Walasek-Janusz et al., 2024). Peppermint, lemon balm, thyme, basil and rosemary are aromatic plants widely used in traditional Bulgarian cuisine, as well as their application in the form of infusions and herbal teas. Adding them to dairy products can improve a person's health status.

Curcuma longa L. or turmeric (of the *Zingiberaceae* family) was considered a universal panacea in herbal treatment with a wide pharmacological spectrum of action such as antioxidant activity, cardiovascular and antidiabetic effects, inflammatory and oedematous disorders, gastrointestinal effects, anticancer effect, antimicrobial activity, hepatoprotective and renoprotective function (Nasri et al., 2014; Verma et al., 2018). Turmeric contains 69.4% carbohydrates, 6.3% protein, 5.1% fat, 2.6% fibber, 3.5% minerals and 13.1% moisture (Nasri et al., 2014). Another important possible use of turmeric in the food industry is as a substitute for synthetic pigments and it is currently one of the most used natural colorants in the food industry (Fagundes et al., 2018).

Black pepper (*Piper nigrum* L.) is a tropical plant whose fruits are used as a spice and has been designated as the "king of spices". It has high antioxidant, antimicrobial, anticancer, anti-inflammatory, analgesic, antipyretic, hepatoprotective, bio enhancing and enzyme inhibitory activity (Milenković & Stanojević, 2021; Vijayakumar et al., 2004; Nahak & Sahu, 2011; Batubara et al., 2020; Stojanović-Radić et al., 2019; Prashant et al., 2017; Tasleem et al., 2014). The physicochemical composition of black pepper consists mainly of carbohydrates - 37.4%, proteins 25.5%, fibbers of 23.6%, moisture 4.7% and fats of 5.3%, as well as minerals, including 0.66% potassium (K), 0.20% calcium (Ca), 0.16% phosphorus and 0.16% magnesium (Mg) (Pradeep et al., 1993; Al-Jasass & Al-Jasser, 2012). It is characterized by a high content of polyphenols 1421.95 mg GAE/100 g, flavonoids 983.82 mg CE/100 g and piperine- 2352.19 mg/100 g (Lee et al., 2020).

The purpose of the study is to determine the influence of biologically active additives in different concentrations on the organoleptic evaluation, physicochemical and fatty acid composition, antioxidant activity and total polyphenols of brine cheese from cow's milk obtained from highly productive Bulgarian Rhodope cattle.

MATERIALS AND METHODS

Bulk tank milk from highly productive Bulgarian Rhodope cattle cows was used, taken every month for one year from the Research Centre of Stockbreeding and Agriculture, Smolyan. Pasteurization of milk (4 litters) and technological processing to cheese (Figure 1) was carried out, adding additives of aromatic plants in the form of a dry substance in a concentration 0% - control /K/ and 0.05%, 0.1%, 0.2% and 0.3%. The different types of additives and their concentration when added to brine cheese were presented in Table 1.

Table 1. Addition of aromatic plants in brine cheese

Additive	0.05%	0.1%	0.2%	0.3%
Oregano	O1	O2	O3	O4
Thyme	T1	T2	T3	T4
Basil	B1	B2	B3	B4
Lemon balm	M1	M2	M3	M4
Peppermint	P1	P2	P3	P4
Rosemary	R1	R2	R3	R4
Turmeric: black pepper 3: 1	C1	C2	C3	C4

The technological scheme is presented in Figure 1.

The addition of herbs is done after cooling the milk immediately before the curdling process. It has been added to the technological scheme.

An organoleptic evaluation of the white brine cheese and the cheese with the additive in different concentrations was performed to determine the most suitable concentration based on the sensory perceptions of the consumers (10 pcs). The parameters studied were based on cheese in brine. The analysis was performed after draining from the brine. They were not converted to absolute dry matter. An analysis of colour was performed to determine the differences after treatment with the additive compared to the original white brine cheese. The physicochemical and fatty acid composition of the control and treated cheese were performed at 45 days of ripening.

Water content - BNS 1109: 1989, ISO 9622,
Total solids - BNS 1109: 1989, ISO 9622,
Protein - ISO 9622, BNS EN ISO 8968-1: 2002
Fat - BNS EN ISO 1211: 2002, ISO 9622
Ash - BNS 6154:1974
Titratable acidity - BNS 1111:1980
Salt content (sodium chloride) BNS 8274:1982
pH - with pH- meter model MW102-FOOD

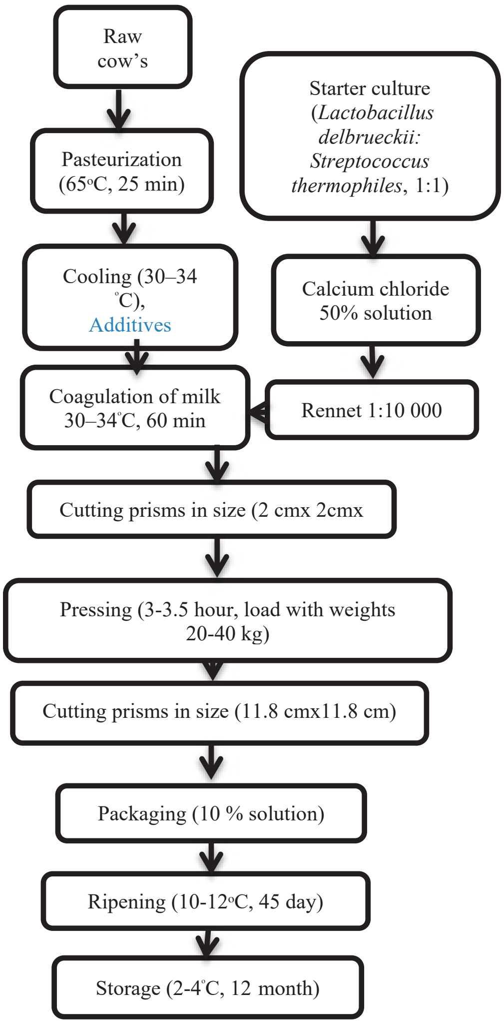

Figure 1. Technological scheme for obtaining cheese with additives

Fibber by Dosi-Fiber-Selecta automatic fibber extraction system, Spain Colour with a portable digital colorimeter NR200 (Huanyu, China), where L* corresponds to luminance (0 = black, 100 = white), a* red-green component value (-a = green, +a = red) and b * value (-b = blue, +b = yellow) represents yellow-blue component. The colour was directly measured on the surface of a standard amount of cheese that filled a Petri dish using a white background. Three parallel measurements were made on each sample. The extraction of total lipids was performed by the method of Roese & Gottlieb и Bligh & Dyer.

Fatty acid methyl esters (FAME) were analysed using a Shimadzu-2010 gas chromatograph (Kioto, Japan) equipped with a flame ionization detector and an automatic injection system (AOC-2010i). The analysis was performed on a CP 7420 capillary column (100 m x 0.25 mm i.d., 0.2 µm film, Varian Inc., Palo Alto, CA). Hydrogen was used as the carrier gas, and as a make-up gas - nitrogen. Four-step furnace mode was programmed - the column's initial temperature was 80°C / min, maintained for 15 minutes, then increased by 12ºC / min to 170ºC and maintained for 20 minutes, followed by a further increase of 4ºC/min, 186ºC for 19 minutes and up to 220ºC with 4ºC/min until the process is complete.

The qualitative assessment of the fat fraction of the resulting samples includes the following: lipid preventive score (LPS), atherogenic (AI) and thrombogenic index (TI) (Ulbricht & Southgate, 1991), the ratio between hyper- and hypocholesterolemic (h/H) fatty acids, trans fatty acids (TFA) and the amount of saturated fatty acids (Regulation (EC) No 1924/2006).

LPS=FAT+2xSFA-MUFA-0.5PUFA,

AI=12:0+4×14:0+16:0/[ΣMUFAs+PUFA n-6+PUFAn-3]

TI=(14:0+16:0+18:0)/[0.5×ΣMUFAs+0.5×PUFAn-6+3×PUFAn-3+PUFAn-3/PUFA n-6]

h/H=(C18:1n-9+C18:1n-7+C18:2n-6+C18:3n-3+C18:3n-6+C20:3n-6+C20:4n-6+C20:5n-3+C22:4n-6+C22:5n-3+C22:6n-3)/(C14:0+C16:0).

The samples of cheese were extracted with 95% ethanol at a ratio of sample: extragent - 1:5 (w/v) for 6 h at room temperature and in the dark. All samples after centrifugation (10°C, 4000 rpm, 10 min) and filtration (Whatman No. 4 paper) were stored at (-20) °C for subsequent analyses.

The antioxidant capacity of the samples was evaluated by determining the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging capacity according to the method of Brand-Williams et al. (1995) it is accepted as a method for studying antioxidant activity and in reality the results were obtained by applying it with a modification of the method for the purposes of the study: 0.6 mL of a 0.2 mM solution of DPPH in methanol was mixed with 0.9 mL of methanol and 0.5 mL of the corresponding sample dilution. Absorbance was measured after standing (60 min) at room temperature in the dark with a UV-Vis spectrophotometer (Biochrom Libra S20, UK) at 517 nm against methanol. In the control, the sample solution was replaced by 0.5 mL of 80% methanol. Different concentrations of Trolox were used as standards for calibration, and the results were expressed as milligrams of TE per 100 g of sample.

For the quantitative determination of the total phenolic content (TPC) the method of Singleton et al. (1999) was used. with modification of Valyova et al. (2012). Briefly, 3.0 ml of distilled water and 0.25 ml of Folin-Ciocalteu reagent were added to 0.5 ml of the sample (with the corresponding dilution). After standing for 2 minutes, 0.75 ml of 20% sodium carbonate solution and 0.5 ml of distilled water were added to the mixture. Absorbance was measured at 765 nm (on a UV-Vis spectrophotometer, Biochrom Libra S20, UK) after standing in the dark at room temperature for 120 minutes. TPC was calculated according to the standard law of gallic acid and expressed as equivalents of gallic acid (GA) in mg/100 g fresh sample.

Statistical analysis

Research results were analysed using the statistical program MiniTab 17. ANOVA and Tukey's post hoc test were used. Data are presented as mean and standard deviation (SD). A significance level of $p < 0.05$ was accepted for all comparisons.

RESULTS AND DISCUSSIONS

The organoleptic research carried out by consumers gives us information about the change of five indicators when using different types of aromatic plant additives. Application of oregano and basil, had the most acceptable smell at 0.1 and 0.2% supplementation, while taste, consistency, aroma and colour were most acceptable at 0.1% supplementation.

The use of thyme, lemon balm also resulted in the most acceptable to the senses smell, taste, consistency, aroma and colour at 0.1% addition and unacceptable smell and aroma at 0.2 and 0.3%.

Putting peppermint in the brine cheese gives the best evaluation of the smell at 0.5% concentration, the taste and aroma at 0.1; 0.2 and 0.3%, in terms of consistency at 0.5 and 0.3% and for colour in all variants. The inclusion of rosemary in the brine cheese had the most sensory-acceptable indicators at 0.5%, followed by 0.2% and 0.3% addition. The application of a combination of turmeric and black pepper had the most acceptable smell when applied at 0.1 and 0.2% addition, the taste, consistency, aroma and colour were most acceptable at 0.1% addition (Table 2).

The L* colour of the cheese with additions of different types of aromatic plants leads to its decrease, with the lowest values recorded at the addition of 0.3% in all variants, and the highest at 0.05%. The a* was lower when using oregano compared to the cheese of control group at all concentrations. The application of 0.5% thyme had a lower a* component, while with increasing concentration it increased and the highest value was found at 0.3% thyme. The use of basil and lemon balm leads to an increase in the red-green component at 0.1%, while at the other concentrations it is lower compared to the control cheese. The application of peppermint as an additive in the brine cheese leads to a decrease in a*, compared to the control group of cheese, except for the addition of a 0.3% additive, where it was found to increase. The a* decreases in the brine cheese when adding rosemary and at the four concentrations relative to the control cheese and increase when using the different types of additives. The b* was lowest in the control group of cheeses. The application of supplements of aromatic plants in different concentrations causes its increase. In oregano the highest value for b* was found at 0.1%, thyme -0.2 and 0.3%; basil-0.2%; lemon balm - 0.1%; peppermint- 0.2%; rosemary- 0.3% and turmeric/black pepper- 0.2% (Table 3).

The yield of cheese after pressing in the control group was 494 %. The use an oregano supplement of 0.05; 0.1 and 0.2% leads to technological losses and a decrease in the yield compared to the original cheese until the yield increases when adding 0.3% oregano. The protein content in the brine cheese with 0.2 and 0.3% addition of oregano leads to technological losses of protein and its decrease compared to the original cheese. Soluble protein with the addition of oregano increases with an increase in the percentage of the addition and accordingly with the degree of maturity of the cheese. The increase in soluble protein with increasing oregano concentration is most likely due to hydrolysis and proteolytic processes. The amount of fat increases as a result of the use of plant additives, which also contain fat.

The richest in fat is turmeric. The concentration of the added additive is small, but because it is in a dry and whole form, it leads to their increase and the change of fatty acids. Fat, total solids and ash content increased with increasing oregano supplementation. The cheeses were enriched with fibber, which is not present in the natural white brine cheese and improves the health benefits of the product in the human diet. The amount of salt in the brined cheese did not undergo significant changes compared to the control group of cheeses. The active acidity of the oregano-supplemented cheese was higher than the control cheese at 0.05 and 0.1%, which indicates its preservative ability. Low active acidity is a prerequisite for deterioration of cheese quality. The use of aromatic plants influences the deterioration processes and in general their application even in milk gives higher values for the indicator. The titratable acidity is highest at 0.5% addition - 166ºT and decreases with increasing concentration of added oregano, but is higher compared to the white brine cheese - 158ºT. The energy value of the newly obtained cheeses increases regularly depending on the added concentration of oregano and is higher than the original white brine cheese. The energy value of the newly obtained cheeses increases regularly depending on the added concentration of oregano and is higher than the original white brine cheese. The use of various types of additives leads to an increase in the energy value of cheese, which is due to an increase in the fat and fiber content.

The introduction of thyme in the production of brine cheese leads to technological losses and the yield is the lowest at 0.05 and 0.1%, while at 0.2 and 0.3% it is higher compared to the starting cheese, respectively 525 and 527 %. Protein losses between 3 and 5% were found, with the highest at 0.05% thyme supplementation. Soluble protein at 0.05 and 0.1% addition of thyme is higher compared to the original cheese - 3.65 and 3.19%, while at 0.2 and 0.3% addition it suffers a decrease and is lower compared to the control group. The fibber and ash content of cheese with additives increases with increasing their concentration in the cheese.

Table 2. Organoleptic evaluation of brine cheese with the addition of aromatic plants, n = 10

	Smell		Taste		Aroma		Consistency		Colour	
	X	SD	X	SD	X	SD	X	SD	X	SD
K	4.0	1.0	4.4	0.5	4.2	0.8	4.6	0.5	4.4	0.9
O1	3.4	0.9	3.4	0.9	3.2	1.1	3.8	0.8	4	1.0
O2	3.8	0.8	4.2	0.8	4	1.0	4.2	0.8	4.2	0.8
O3	3.8	0.8	4	0.7	3.8	0.8	4	1.2	4.2	0.8
O4	3.2	0.4	3.6	0.5	3.4	0.5	3.6	1.1	3.4	0.5
T1	3.6	0.9	3.8	0.9	3.6	1.0	4	0.8	4.1	0.9
T2	3.8	0.8	4.1	0.8	3.9	0.9	4.1	1.0	4.2	0.8
T3	3.5	0.6	3.8	0.6	3.6	0.7	3.8	1.2	3.8	0.7
T4	3.4	0.7	3.7	0.7	3.5	0.8	3.8	1.0	3.7	0.7
B1	3.4	0.9	3.4	0.9	3.2	1.1	3.8	0.8	4.0	1.0
B2	3.8	0.8	4.2	0.8	4.0	1.0	4.2	0.8	4.2	0.8
B3	3.8	0.8	4.0	0.7	3.8	0.8	4.0	1.2	4.2	0.8
B4	3.2	0.4	3.6	0.5	3.4	0.5	3.6	1.1	4.4	0.5
M1	3.6	0.9	3.8	0.9	3.6	1.0	4.0	0.8	4.1	0.9
M2	3.8	0.8	4.1	0.8	3.9	0.9	4.1	1.0	4.2	0.8
M3	3.5	0.6	3.8	0.6	3.6	0.7	3.8	1.2	4.3	0.7
M4	3.4	0.7	3.7	0.7	3.5	0.8	3.8	1.0	4.3	0.7
P1	3.5	0.7	3.6	0.7	3.4	0.8	3.9	1.1	4.1	0.8
P2	3.4	0.5	3.7	0.6	3.5	0.6	3.8	1.2	4.3	0.6
P3	3.3	0.5	3.7	0.6	3.5	0.6	3.7	1.2	4.3	0.6
P4	3.5	0.7	3.7	0.7	3.5	0.7	3.9	1.1	4.2	0.7
R1	4.0	1.0	4.4	0.5	4.2	0.8	4.6	0.5	4.4	0.9
R2	3.4	0.9	3.4	0.9	3.2	1.1	3.8	0.8	4.0	1.0
R3	3.8	0.8	4.2	0.8	4.0	1.0	4.2	0.8	4.2	0.8
R4	3.8	0.8	4.0	0.7	3.8	0.8	4.0	1.2	4.2	0.8
C1	3.4	0.9	3.4	0.9	3.2	1.1	3.8	0.8	4.0	1.0
C2	3.8	0.8	4.2	0.8	4.0	1.0	4.2	0.8	4.2	0.8
C3	3.8	0.8	4.0	0.7	3.8	0.8	4.0	1.2	4.2	0.8
C4	3.2	0.4	3.6	0.5	3.4	0.5	3.6	1.1	4.4	0.5

1 - unacceptable; 2 - acceptable; 3 - I like it; 4 - I really like it; 5 - I like it very much

The total solids were higher compared to the control group of cheeses, with the highest value recorded at 0.3% addition of thyme. The amount of sodium chloride is higher compared to the original cheese, with a 0.2% addition of thyme being the highest at 6.02%. Active acidity was lower than control cheese at all concentrations of thyme adding, while titratable acidity increased with increasing additive concentration and was higher than that of white brine cheese. The energy value of the cheese with the addition of 0.5% thyme is lower than the control cheese, while with the other concentrations it increases and T4 has the highest energy value - 260.94 kcal. The use of various types of additives leads to an increase in the energy value of cheese, which is due to an increase in the fat and fiber content. The energy value of the cheese with the addition of 0.5% thyme is lower than the control cheese, while with the other concentrations it increases and T4 has the highest energy value - 260.94 kcal.

Table 3. Colour of brine cheese with additive, n=6

	L*		a*		b*	
	X	SD	X	SD	X	SD
K	91.44	1.13	-1.26	0.06	17.35	0.27
O1	91.76 A	0.54	-4.12	0.64	56.30	0.61
O2	88.49	0.48	0.26	0.08	66.73	0.90
O3	81.93	1.21	-2.63	0.83	64.24	0.78
O4	78.92	0.91	-1.48	0.16	61.71	0.39
T1	90.94	0.61	-2.93	0.18	22.44	0.99
T2	80.67 B	0.70	1.20	0.34	49.59	0.45
T3	78.52	1.42	3.49	0.44	75.39	0.48
T4	78.58	0.85	3.53	0.28	75.28	0.14
B1	92.03	0.14	-1.76	0.68	58.57	1.20
B2	88.76 C	0.49	0.98	0.05	68.07	0.92
B3	82.41	1.67	-2.59	0.80	63.45	1.14
B4	79.81	0.58	-1.39	0.01	61.55	0.17
M1	91.85	0.39	-1.47	0.27	45.08	0.99
M2	89.55 D	0.67	0.12	0.40	51.36	0.42
M3	85.74	0.53	-2.00	0.93	47.88	0.42
M4	83.79	0.62	-1.35	0.06	46.80	0.46
P1	90.94	1.61	-2.93	0.18	22.44	0.99
P2	87.03 E	0.44	-1.48	0.60	69.74	1.97
P3	82.19 F	1.95	-1.80	0.39	70.77	0.52
P4	80.67	1.70	1.20	0.34	49.59	1.45
R1	91.98	0.51	-2.82	0.17	20.46	2.07
R2	90.02 G	1.20	-4.26	0.12	34.13	1.54
R3	89.02 H	1.15	-6.48	0.55	49.31	0.90
R4	85.16 I	0.47	-3.95	0.58	58.13	1.11
C1	84.53	1.31	-0.67	0.07	72.47	0.79
C2	88.67	1.62	1.57	0.46	65.82	0.83
C3	82.53	1.48	2.52	0.91	76.22	0.92
C4	89.96	0.37	8.48	0.33	70.95	1.25

L - lightness, a - red-green component, b - yellow-blue component; *Means not sharing any letter are significantly different by the Tukey-test at the 5% level of significance.

The addition of basil to the brine cheese leads to technological losses and the yield is the lowest at 0.2% and 0.3% addition compared to the original cheese. Protein losses between 3 and 6% were found. Soluble protein is two times lower compared to the original cheese in B1 and B2, while in B3 and B4 it is 0.3 to 0.6% lower. The degree of maturity in cheese with basil is 1.6 times lower in B1, 1.23 times in B2, 1.4 times higher in B3 and does not change compared to the original cheese in B4. The fat content in B1 and B2 does not change in B3 and B4, which speaks of technological losses of fat. Despite the established losses of protein and fat, total solids increased with increasing of additive concentration, which was due to an increase in fibber and ash content. The sodium chloride content is close to that of the control cheese. The energy value of the cheese with the addition of basil increases with an increase in its concentration. The application of lemon balm as an additive in the brine cheese leads to technological losses of protein in the range of 1.26 to 2.45 times depending on the concentration, hence the yield, total solids and energy value of the products compared to the starting cheese. The degree of maturity of the cheese increases with increasing content of the additive, with the exception of M2, where a degree of maturity identical to the control cheese was found - 16.82%. The fat content in the examined cheeses increases proportionally with the increase by concentration additive. The active acidity when lemon balm was added to the brined cheeses was higher than the control cheese, while the titratable acidity was lower. Identical results regarding all the investigated indicators were also obtained for peppermint. The addition of rosemary leads to a lower yield compared to the original cheese except for R3, which is caused by technological protein losses. Soluble protein is higher when adding 0.5% rosemary, while it decreases two-fold at other concentrations. The degree of maturity in cheese with the addition of 0.5% rosemary was two times higher than the control series of cheeses, while at the higher concentrations it was marginally higher. Fat, fibber, total solids and mineral content increased relative to the control cheese as the concentration of rosemary supplement increased. The sodium chloride content is lowest at R4-4.98% and highest at R1-5.73%. The active acidity was close in values to that of the control cheese, while the titratable acidity at all concentrations was lower than that of the control cheese. The energy value of R1 is lower compared to K and increases to 212.52 kcal as the concentration of added rosemary increases (Table 4). The application of the combined addition of turmeric and black pepper resulted in a high yield compared to the control group of cheeses, but protein losses of up to twofold were found in C1 and C2. Soluble protein in C1, C2, C3 is lower than K. Despite the technological losses of protein, the application of the additive leads to a good ripening of the cheese, which is established by the degree of maturity in the range of 18.97% in C1 to 26, 51% in C4 compared to K. The fat content increases with an increase in the input additive from 11.42% in C1 to 17.78% in C4 compared to K- 9.06%. The amount of fibber and ash content also increased with increasing additive content.

The total solids were low compared to the starting white brine cheese and ranged from 32.79% for C1 to 39.31% for C4. Active acidity at different concentrations of turmeric/black pepper increased from 5.50 at C1 to 5.52 at C4 and was higher than K-5.25. The titratable acidity in C1 is lower, and in C2 it is the same as that of the control cheese, while in C3 and C4 it increases compared to K. The energy value of the cheese with the addition of turmeric and black pepper is higher than the original cheese at 0, 1%, 0.2% and 0.3% and lower at 0.05%. Each herb is unique and has a different composition of fat, fiber, protein, and ash content, etc., which is why when added to cheese, different energy values were obtained using the same concentration. The use of aromatic plants does not have a negative effect on the ripening of cheese and supports the activity of microorganisms and affects the rennet enzyme for its readiness, even supporting them. The degree of maturity according to BNS 15:2010 for cow cheese is a minimum of 16%, according to which the control and treated cheeses are well matured. The activate acidity of ripened cheese is in the range from 4.2 to 4.4. The active acidity when adding additives in different concentrations is higher compared to the original white brine cheese, which is a prerequisite for a more intense fermentation process during ripening (Ivanov et al., 2015). Cheese is a dynamic biochemical product that undergoes changes during the ripening process compared to a number of processed foods. Mijačević & Bulajić (2008), found protein content- 17%, water content- 55% and total solids- 45% in the cheese after ripening for 30 days. Shahab Lavasani et al., (2013) found that the amount of protein decreased in the ripening process from 15.81 to 11.52%, fat from 15.7 to 13.15%, dry matter from 40.15 to 13, 05% for sheep's milk cheeses. Cheese is a dynamic product, the indicators of which depend on a number of environmental indicators, milk quality, technological regime, etc., for this reason, each author may obtain lower or higher values for a given indicator, which is not reliable. Even pure brine cheese depends on biotic and abiotic environmental factors.

Bioactive peptides can be released by enzymes derived from microorganisms or plants (Korhonen & Pihlanto, 2007). Milk and cheese are an important part of a balanced human diet with a positive role when consumed in moderation. Demand for high quality, healthy dairy products is increasing as consumers become more aware of the link between diet and health.

Saturated fatty acids in the control group of cheeses were 66.35 g/100 g fat and decreased with the addition of oregano from 59.79 at O1 to 57.49 at O3 g/100 g fat and rose again at D4 to 59.43 g/ 100 g fat. The addition of 0.05% thyme decreased the content of saturated fatty acids in the brine cheese compared to the control, while with an increase in the concentration by 0.1 and 0.2% it increased to 60.25 g/100g fat and 60.73 g/100 g fat and with 0.3% addition were the same as the control group - 66.35 g/100 g fat. The use of peppermint, rosemary and the combination of turmeric with black pepper leads to a decrease in the content of saturated fatty acids in the low concentrations - 0.05 and 0.1%, while at 0.2 and 0.3%, they increase again. The lowest content of saturated fatty acids when applying a supplement of aromatic plants was recorded at all concentrations of peppermint, rosemary and a combination of turmeric with black pepper. Monounsaturated fatty acids in the control group cheeses were 27.87 g/100 g fat.

Table 4. Physicochemical composition of white brine cheese and cheese with additives, n = 6

	Yield, %	TP, %	SP, %	DM, %	Fat, %	Fibber, %	TS, %	Ash, %	NaCl, %	pH	Acidity, °T	E, kcal
K	494	16.16	2.72	16.83	9.06	0.00	43.66	4.40	5.15	5.25	158.00	146.19
O1	486	16.08	2.76	17.16	16.29	2.02	46.47	5.01	5.31	5.67	166.00	215.00
O2	409	16.89	3.22	19.06	17.21	4.03	47.45	5.61	5.36	5.30	164.00	230.47
O3	431	15.94	3.31	20.80	19.78	8.06	48.50	6.82	5.42	5.17	163.00	257.89
O4	511	15.83	3.52	22.23	24.47	12.09	49.14	8.03	5.48	5.18	161.00	307.75
T1	410	11.39	3.65	32.04	8.84	1.85	46.23	4.99	5.87	5.25	174.00	128.79
T2	413	12.98	3.19	24.60	15.52	3.70	46.72	5.57	5.94	5.16	177.00	199.02
T3	525	13.69	2.59	18.93	15.75	7.40	47.23	6.75	6.02	5.11	181.00	211.27
T4	571	12.90	2.51	19.45	20.79	11.10	47.68	7.92	5.64	4.96	184.00	260.94
B1	527	13.00	1.32	10.15	13.36	1.85	46.91	5.14	4.19	5.70	168.00	175.99
B2	505	13.64	1.00	13.64	13.61	3.71	48.26	5.89	4.71	5.25	160.00	184.45
B3	469	10.61	2.42	22.90	17.44	7.41	49.39	7.37	5.23	5.56	152.00	214.20
B4	479	13.51	2.19	16.22	17.79	11.12	50.65	8.86	5.75	5.36	144.00	236.41
M1	495	12.82	3.26	25.43	10.30	1.67	39.05	4.96	5.82	5.50	150.00	147.34
M2	448	8.68	1.46	16.82	13.70	3.34	35.74	5.52	5.64	5.49	143.00	164.67
M3	436	6.61	5.16	34.92	14.32	6.68	37.41	6.64	5.73	5.40	135.00	168.70
M4	445	7.66	3.10	40.37	15.17	10.02	34.11	7.77	5.55	5.50	128.00	187.17
P1	433	9.04	3.20	35.51	10.50	1.49	34.89	4.94	5.92	5.51	135.00	133.67
P2	480	9.82	3.32	33.82	12.40	2.98	35.76	5.47	5.81	5.53	131.00	156.88
P3	436	6.24	3.01	36.52	14.53	5.96	36.59	6.54	5.72	5.49	128.00	167.64
P4	467	7.77	2.30	29.51	15.11	8.94	37.62	7.61	5.63	5.42	124.00	184.91
R1	478	8.17	4.01	46.13	10.66	2.13	38.95	4.73	5.73	5.58	122.00	132.89
R2	428	10.67	1.91	17.95	12.83	4.26	39.38	5.05	5.48	5.43	127.00	166.65
R3	537	11.14	1.99	17.91	13.64	8.52	39.23	5.71	5.23	5.38	133.00	184.37
R4	477	13.07	2.22	17.03	14.96	12.78	40.24	6.36	4.98	5.46	138.00	212.52
C1	593	8.75	1.66	18.97	11.42	1.17	32.79	4.72	5.38	5.50	145.00	140.13
C2	683	9.46	2.07	21.48	12.55	2.34	34.96	5.04	5.40	5.47	148.00	155.49
C3	557	10.17	2.48	23.99	14.18	4.67	37.43	5.69	5.42	5.38	152.00	177.63
C4	583	10.90	2.89	26.51	17.78	7.01	39.31	6.33	5.44	5.52	156.00	217.60

TP - total protein; SP - soluble protein; DM - degree of maturity; F - fat; A - ash; TS - total solids; A - titratable acidity according to Turner

The use of oregano leads to an increase in their content at a concentration of 0.05 to 0.2% and a decrease at 0.3%. Application of thyme increased the content of monounsaturated fatty acids by about 5% without significant changes at 0.05, 0.1 and 0.3%, with the lowest value found at T3-0.2%. Identical results were obtained for monounsaturated fatty acids in basil. Adding lemon balm to the brine cheeses leads to an increase in monounsaturated fatty acids, with the highest values recorded for M1-35.03 g/100g fat, and the lowest for M2-31.58 g/100g fat. The use of peppermint led to an increase in monounsaturated fatty acids, with the highest content reported in P2, followed by P3, P4 and P1. Rosemary as a supplement also led to an increase in monounsaturated fatty acids in general, but the highest values were obtained at the low concentrations - 0.05 and 0.1%, respectively 35.98 and 35.94 g/100 g fat. Some types of plant supplements significantly affect the content of saturated fatty acids, while others have no effect; each plant affects in a different way and is unique and different in its own way in the technological process. The addition of the combination of turmeric with black pepper leads to an increase in the content of monounsaturated fatty acids compared to the control group of cheeses, and the highest values were reported compared to the other types of additives at the same concentrations. The addition of 0.05% has the strongest influence on increasing the content of monounsaturated fatty acids - 36.38 g/100 g fat. An inverse correlation was found between the concentration of the supplement and the

content of monounsaturated fatty acids and at 0.1 and 0.2% of the supplement, their content decreased compared to C1, but did not change significantly - 35.16 and 35.77 g/100 g fat, while at C4- 34.54 g/100 g fat. PUFA in white brine cheese were 4.09 g/100 g fat. The use of oregano as an additive in the production of cheese leads to their decrease compared to the control group, and the lowest value was recorded at 0.05% additive - 3.75 g/100 g fat.
The use of low concentrations of thyme - 0.05% slightly lowers the content of polyunsaturated fatty acids, at 0.1% it was preserved compared to the control group, while at 0.2 and 0.3% it increases slightly to 4.24 and 4.28 g/100g fat. Basil in different concentrations does not significantly change the content of polyunsaturated fatty acids, while in the case of lemon balm, their insignificant increase was found at 0.1(4.67) and 0.3% (4.37) addition compared to the original white brine cheeses. Peppermint caused a slight increase in polyunsaturated fatty acids at 0.05; 0.01 and 0.2%, while at 0.3% it decreases slightly to 3.95 g/100 g fat compared to their content in the control group of cheeses. The total content of biologically active trans fatty acids in the control white brine cheese was 4.22 g/100 g fat. The application of the different additives in four concentrations leads to their increase, which is probably caused by microbiological and enzymatic processes during ripening causing lipolytic processes. The biologically active cis isomers of oleic acid in the control cheeses have a 20.86 g/100 g fat content. Adding oregano with a concentration of 0.05%, 0.1% and 0.2% led to their increase and decreased to 24.81 g/100 g fat at the highest concentration-0.3%. Identical results with the application of thyme. When basil When basil was used, an increase in cis isomers of oleic acid was found at 0.05 and 0.1%, while at 0.2 and 0.3 it decreased to 22.90 and 21.88 g/100 g fat. The brine cheese with the addition of lemon balm at a concentration of 0.1 and 0.2% is 24.97 and 24.68 g/100 g of fat, while at the lowest concentration of the additive, their content is close to the original cheese - 20.84 g /100 g fat and 21.99 g/100 g fat when adding 0.3%. The application of peppermint as an additive in the brine cheese increased the content of cis isomers of oleic acid except at 0.2% addition, where their lowest content was found at 21.67 g/100 g fat. Identical results were obtained using rosemary- 23.55 g/100 g fat at 0.2% addition. The addition of the combination of turmeric and black pepper leads to an increase in the content of cis isomers of oleic acid to 28.92 g/100 g fat at 0.05%, a decrease to 24.11 g/100 g fat at 0.1% and 24 .02 g/100 g fat at 0.2% and increased at 0.3% to 25.52 g/100 g fat. The addition of the combination of turmeric with black pepper leads to an increase in the content of monounsaturated fatty acids compared to the control group of cheeses, and the highest values were reported compared to the other types of additives at the same concentrations. It has actually been found that this combination increases monounsaturated fatty acids. The different types of additives, regardless of the applied concentration, lead to an increase in the biologically active cis and trans isomers of oleic acid. Biologically active omega-3 and omega-6 fatty acids in the studied white brine cheeses were 0.76 g/100 g fat and 3.00 g/100 g fat, respectively (Table 5). The addition of oregano leads to a decrease in omega-3, with the lowest values found at 0.1% supplementation, while omega-6 fatty acids at the lowest and highest concentration of the supplement are decreased, and at 0.1 and 0.2% increased slightly. The use of thyme leads to an increase in the content of omega-3 fatty acids at 0.3%, preservation of their content at 0.1% and 0.2% and a decrease in their content at 0.05%. Omega-6 fatty acids with added thyme increased slightly at 0.05 and 0.3% and decreased at 0.1 and 0.2% compared to the original cheese. Application of basil at a concentration of 0.05% and 0.2% did not affect the content of omega-3 fatty acids, while at 0.1 and 0.3% it led to a slight decrease compared to the control group of cheeses. Omega-6 fatty acids in the basil-infused cheeses decreased slightly compared to the control cheese, except for B2, which increased to 3.19 g/100 g fat. The use of lemon balm in the brine cheese leads to a decrease in the content of omega-3 and an increase in omega-6 fatty acids. The highest content of omega-3 fatty acids was found at 0.1% lemon balm - 0.64 g/100 g fat and the lowest content of omega-6 fatty acids at 0.05% - 3.31 g/100 g fat. The addition of

peppermint and the combination of turmeric with black pepper in the cheese led to a decrease in omega-3 fatty acids at all concentrations, identical results were obtained with the addition of rosemary except for the addition of 0.2% - 0.79 g/100 g fat. Omega-6 fatty acids increased when peppermint, rosemary and turmeric were added with black pepper compared to the control cheese, regardless of concentration.

The use of additives of plant origin in different concentrations during the technological processing of milk to brine cheese leads to a multiple reduction of the content of short-chain fatty acids from 4 to 47 times. Probably due to the destruction of microorganisms or blocking their production of branched-chain fatty acids. The lipid preventive score in the examined cheeses from the control group was 18.37. Adding oregano leads to its increase in the brine cheese, with the lowest value found at 0.3% addition - 27.11. The use of thyme, basil and a combination of turmeric with black pepper gave the lowest value for the lipid preventive score at 0.05% of the supplements, 16.16, respectively; 16.98 and 19.95. Adding 0.1% lemon balm, 0.2% peppermint and 0.3% rosemary resulted in the lowest lipid score - 15.84, 17.1 and 16.50. In the other variants, the LPS exceeds that in the control group. The atherogenic index in white brine cheese is 2.19, and the thrombogenic index is 2.28. The application of oregano in a different concentration in the brine cheese leads to a decrease in both indices compared to the control cheese. The lowest AI and TI was found at 0.3% addition of oregano - 1.56 and 1.72. Adding thyme to the brine cheese also leads to a decrease in both indices, and the lowest values were recorded at 0.05% addition - 1.86 and 2.13. Basil also reduced AI, but no significant reductions were found in thrombogenic.

The introduction of lemon balm at 0.2% in the brine cheese gave the lowest values in the group for AI and TI - 1.81 and 1.85. The use of peppermint also lowered both indices and they were low at all concentrations except for 0.02% addition where the AI was 3.0. When using rosemary, the lowest values were obtained for AI and TI at 0.3% addition - 1.28 and 1.56, while the combination of turmeric and black pepper gave the lowest value for AI at 0.1% addition - 1.63 and for TI at 0.05% additive - 1.80. The atherogenic index gives the correlation between the sum of the main saturated fatty acids and the unsaturated fatty acids, the former being considered proatherogenic (favoring the adhesion of lipids in the cells of the immune and circulatory system) and the second are anti-atherogenic (inhibit plaque aggregation and decrease levels of esterified fatty acids, cholesterol and phospholipids, thus preventing the occurrence of micro- and macro-coronary diseases). The thrombogenic index has the tendency to clot formation in blood vessels and is defined as the ratio between prothrombogenic (saturates) and antithrombogenic (monounsaturated and polyunsaturated omega-3 and omega-6 fatty acids) fatty acids (Ghaeni et al., 2013).

The thrombogenic and atherogenic index as indicators, should not exceed 1.00 while the cholesterol index is above 1.00 (Ivanova & Hadzhinikolova, 2015). The hypo-hyperulistic index of the white brine cheese was 0.60 and increased slightly with the addition of oregano, thyme, basil, peppermint, rosemary and the combination of turmeric and black pepper. It retains its value at all concentrations of lemon balm except for 0.1% additive. The addition of 0.3% rosemary gave the highest value for h/H - 0.97. Cholesterolemic index was low (below 1.0) in all variants of supplements and concentrations. Trans fatty acids have the lowest concentration with 0.5% addition of basil - 0.12 g/100 g product, while saturated fatty acids with 0.3% rosemary - 1.57 g/100 g product. The introduction of the additives from various aromatic plants leads to an improvement of the fatty acid profile and the quality indicators of the brine cheese compared to the control untreated white brine cheese (Table 6).

Antioxidants can delay or inhibit oxidative damage to proteins, nucleic acids and lipids caused by free radicals that cause oxidative stress (Baardseth, 1989; Zheng & Wang, 2001; Norshazila et al., 2010) by autoxidation. Lipid oxidation leads to undesirable changes in the taste, texture and nutritional value of foods (Wang et al., 2006).

Milk proteins were characterized by their ability to scavenge reactive oxygen species or free radicals (Karakaya et al., 2001; Hambraeus & Lönnerdal, 2003; Lindmark-Månsson & Åkesson, 2000; Wang et al., 2006; Suetsuna et al., 2000) and were used as natural antioxidants in the food industry due to the fact that they have no taste and smell, but are nutritious. Phenolic compounds are widely present in dairy products, but literature data regarding their study in milk and dairy foods is scarce. Ertan et al. (2017) were found an increase in antioxidant activity and polyphenol content in milk with increasing fat content in UHT-milk.

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6

	K		O1		O2		O3		O4		T1		T2		T3		T4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	66.35	0.08	59.79	0.61	58.66	0.63	57.49	0.37	59.43	0.44	58.78	1.80	60.25	0.21	60.73	0.09	60.13	0.09
MUFA	27.87	0.03	32.56	0.06	34.31	0.41	35.53	0.03	33.46	0.25	32.73	0.83	32.28	0.11	31.79	0.05	32.16	0.05
PUFA	4.09	0.00	3.75	0.01	3.85	0.05	4.09	0.00	3.81	0.03	3.94	0.40	4.03	0.01	4.24	0.01	4.48	0.01
ΣC-18:1Trans-FA	4.22	0.01	6.76	0.01	6.00	0.07	3.85	0.00	5.83	0.04	8.77	1.83	6.48	0.02	5.36	0.01	7.37	0.01
ΣCLA	0.68	0.00	0.53	0.00	0.43	0.01	0.67	0.00	0.51	0.00	0.37	0.04	0.44	0.00	0.68	0.00	0.59	0.00
C-16:0/C-18:1cis9	1.45	0.00	1.38	0.00	1.23	0.00	1.00	0.00	1.22	0.00	1.53	0.11	1.33	0.00	1.34	0.00	1.42	0.00
C-16:0/C-18:1 ges.	1.14	0.00	1.02	0.00	0.97	0.00	0.84	0.00	0.95	0.00	1.03	0.02	1.01	0.00	1.06	0.00	1.03	0.00
Σn-3	0.76	0.00	0.61	0.00	0.44	0.01	0.58	0.00	0.62	0.00	0.66	0.03	0.76	0.00	0.72	0.00	0.80	0.00
Σn-6	3.00	0.00	2.88	0.01	3.19	0.04	3.13	0.00	2.97	0.02	3.14	0.45	2.96	0.01	2.98	0.00	3.18	0.00
ΣMCT(C-10>C-14)	15.66	0.02	13.26	0.02	12.19	0.10	12.93	0.01	14.05	0.11	12.88	1.16	14.73	0.05	14.77	0.02	14.38	0.02
ΣSCT(C-4>C-8)	8.11	0.01	0.91	0.55	0.93	0.01	0.38	0.42	0.16	0.00	0.13	0.02	0.19	0.00	0.24	0.00	0.22	0.00
CLA 9c,11t	0.53	0.00	0.24	0.00	0.13	0.00	0.38	0.00	0.25	0.00	0.15	0.02	0.11	0.00	0.35	0.00	0.29	0.00
Σn-6/Σn-3	3.96	0.00	4.71	0.00	7.32	0.00	5.43	0.00	4.77	0.00	4.75	0.47	3.91	0.00	4.16	0.00	4.00	0.00
Σ C-18:1cis-FA	20.86	0.03	23.11	0.04	25.91	0.31	28.92	0.03	24.81	0.19	21.17	1.31	22.87	0.08	23.37	0.03	21.86	0.03
BFA	3.18	0.00	3.31	0.01	2.60	0.03	2.82	0.00	3.17	0.02	3.23	0.14	3.04	0.01	3.10	0.00	3.12	0.00

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	B1		B2		B3		B4		M1		M2		M3		M4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	60.38	0.09	59.71	0.17	60.56	0.14	60.28	0.17	57.49	0.23	60.60	0.24	58.72	1.13	58.93	0.39
MUFA	32.33	0.05	32.53	0.09	31.88	0.07	32.48	0.12	35.03	0.11	31.58	0.15	32.49	0.53	33.37	0.22
PUFA	4.00	0.01	4.00	0.01	4.11	0.01	3.89	0.01	3.98	0.30	4.67	0.02	4.08	0.10	4.37	0.03
ΣC-18:1Trans-FA	4.64	0.01	4.51	0.01	5.92	0.01	7.54	0.03	11.36	0.05	4.15	0.02	5.03	0.57	8.42	0.06
ΣCLA	0.53	0.00	0.43	0.00	0.58	0.00	0.53	0.00	0.29	0.19	0.37	0.00	0.28	0.04	0.42	0.00
C-16:0/C-18:1cis9	1.27	0.00	1.24	0.00	1.37	0.00	1.42	0.00	1.42	0.00	1.17	0.00	1.23	0.01	1.27	0.00
C-16:0/C-18:1 ges.	1.03	0.00	1.02	0.00	1.05	0.00	1.01	0.00	0.88	0.00	0.97	0.00	0.97	0.01	0.88	0.00
Σn-3	0.71	0.00	0.61	0.00	0.72	0.00	0.63	0.00	0.56	0.04	0.64	0.00	0.62	0.08	0.58	0.00
Σn-6	2.94	0.00	3.19	0.01	2.94	0.01	2.93	0.01	3.31	0.07	3.88	0.02	3.45	0.11	3.61	0.02
ΣMCT(C-10>C-14)	14.20	0.02	13.06	0.04	14.69	0.03	14.52	0.05	13.55	0.06	17.14	0.05	14.94	0.43	16.12	0.11
ΣSCT(C-4>C-8)	0.16	0.00	0.17	0.00	0.19	0.00	0.41	0.00	0.28	0.00	0.31	0.00	0.12	0.01	0.56	0.00
CLA 9c,11t	0.30	0.00	0.15	0.00	0.29	0.00	0.26	0.00	0.09	0.15	0.14	0.00	0.08	0.01	0.14	0.00
Σn-6/Σn-3	4.12	0.00	5.24	0.00	4.10	0.00	4.66	0.00	5.90	0.23	6.05	0.00	5.68	0.92	6.20	0.00
Σ C-18:1cis-FA	24.74	0.04	25.29	0.07	22.90	0.05	21.88	0.08	20.84	0.08	24.97	0.12	24.68	0.38	21.99	0.15
BFA	3.08	0.00	3.11	0.01	3.16	0.01	3.17	0.01	2.81	0.01	2.85	0.01	2.76	0.16	2.91	0.02

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	P1		P2		P3		P4		R1		R2		R3		R4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	59.50	0.27	56.38	0.97	58.77	0.26	58.93	0.31	56.94	0.64	57.05	0.16	59.09	1.10	57.12	1.19
MUFA	33.01	0.18	35.64	0.62	34.11	0.18	33.73	0.17	35.98	0.39	35.94	0.10	30.94	0.59	34.47	0.73
PUFA	4.48	0.02	4.26	0.07	4.38	0.02	3.95	0.02	3.72	0.25	3.88	0.01	6.40	0.12	4.04	0.09
ΣC-18:1Trans-FA	7.03	0.04	7.74	0.13	10.19	0.05	5.40	0.03	7.97	2.34	7.69	1.74	4.78	0.09	6.86	0.14
ΣCLA	0.35	0.00	0.46	0.01	0.34	0.00	0.31	0.00	0.47	0.01	0.46	0.02	0.71	0.01	0.53	0.01
C-16:0/C-18:1cis9	1.29	0.00	1.13	0.00	1.35	0.00	1.24	0.00	1.16	0.11	1.14	0.07	1.28	0.00	1.12	0.00
C-16:0/C-18:1 ges.	0.95	0.00	0.82	0.00	0.87	0.00	0.98	0.00	0.84	0.01	0.84	0.01	0.96	0.00	0.84	0.00
Σn-3	0.57	0.00	0.55	0.01	0.51	0.00	0.54	0.00	0.42	0.05	0.47	0.02	0.79	0.02	0.47	0.01
Σn-6	3.81	0.02	3.57	0.06	3.73	0.02	3.41	0.02	3.10	0.17	3.22	0.12	5.40	0.10	3.35	0.07
ΣMCT(C-10>C-14)	16.02	0.09	12.06	0.21	15.27	0.08	12.29	0.06	10.96	2.08	12.67	0.51	16.49	0.31	14.50	0.31
ΣSCT(C-4>C-8)	0.31	0.00	0.15	0.00	0.44	0.00	0.29	0.00	0.60	0.43	0.18	0.02	1.01	0.01	0.30	0.02
CLA 9c,11t	0.17	0.00	0.24	0.00	0.21	0.00	0.10	0.00	0.13	0.06	0.24	0.01	0.23	0.00	0.32	0.01
Σn-6/Σn-3	6.70	0.00	6.51	0.00	7.36	0.00	6.33	0.00	7.39	0.38	6.84	0.53	6.80	0.00	7.16	0.00
Σ C-18:1cis-FA	23.69	0.13	25.77	0.45	21.67	0.12	25.40	0.13	25.80	2.69	25.78	1.46	23.55	0.45	25.28	0.53
BFA	2.80	0.02	2.45	0.04	2.69	0.01	2.86	0.01	2.41	0.14	2.95	0.06	2.77	0.05	2.87	0.06

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	K		O1		O2		O3		O4		T1		T2		T3		T4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	66.35	0.08	59.79	0.61	58.66	0.63	57.49	0.37	59.43	0.44	58.78	1.80	60.25	0.21	60.73	0.09	60.13	0.09
MUFA	27.87	0.03	32.56	0.06	34.31	0.41	35.53	0.03	33.46	0.25	32.73	0.83	32.28	0.11	31.79	0.05	32.16	0.05
PUFA	4.09	0.00	3.75	0.01	3.85	0.05	4.09	0.00	3.81	0.03	3.94	0.40	4.03	0.01	4.24	0.01	4.48	0.01
ΣC-18:1Trans-FA	4.22	0.01	6.76	0.01	6.00	0.07	3.85	0.00	5.83	0.04	8.77	1.83	6.48	0.02	5.36	0.01	7.37	0.01
ΣCLA	0.68	0.00	0.53	0.00	0.43	0.01	0.67	0.00	0.51	0.00	0.37	0.04	0.44	0.00	0.68	0.00	0.59	0.00
C-16:0/C-18:1cis9	1.45	0.00	1.38	0.00	1.23	0.00	1.00	0.00	1.22	0.00	1.53	0.11	1.33	0.00	1.34	0.00	1.42	0.00
C-16:0/C-18:1 ges.	1.14	0.00	1.02	0.00	0.97	0.00	0.84	0.00	0.95	0.00	1.03	0.02	1.01	0.00	1.06	0.00	1.03	0.00
Σn-3	0.76	0.00	0.61	0.00	0.44	0.01	0.58	0.00	0.62	0.00	0.66	0.03	0.76	0.00	0.72	0.00	0.80	0.00
Σn-6	3.00	0.00	2.88	0.01	3.19	0.04	3.13	0.00	2.97	0.02	3.14	0.45	2.96	0.01	2.98	0.00	3.18	0.00
ΣMCT(C-10>C-14)	15.66	0.02	13.26	0.02	12.19	0.10	12.93	0.01	14.05	0.11	12.88	1.16	14.73	0.05	14.77	0.02	14.38	0.02
ΣSCT(C-4>C-8)	8.11	0.01	0.91	0.55	0.93	0.01	0.38	0.42	0.16	0.00	0.13	0.02	0.19	0.00	0.24	0.00	0.22	0.00
CLA 9c,11t	0.53	0.00	0.24	0.00	0.13	0.00	0.38	0.00	0.25	0.00	0.15	0.02	0.11	0.00	0.35	0.00	0.29	0.00
Σn-6/Σn-3	3.96	0.00	4.71	0.00	7.32	0.00	5.43	0.00	4.77	0.00	4.75	0.47	3.91	0.00	4.16	0.00	4.00	0.00
Σ C-18:1cis-FA	20.86	0.03	23.11	0.04	25.91	0.31	28.92	0.03	24.81	0.19	21.17	1.31	22.87	0.08	23.37	0.03	21.86	0.03
BFA	3.18	0.00	3.31	0.01	2.60	0.03	2.82	0.00	3.17	0.02	3.23	0.14	3.04	0.01	3.10	0.00	3.12	0.00

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	B1		B2		B3		B4		M1		M2		M3		M4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	60.38	0.09	59.71	0.17	60.56	0.14	60.28	0.17	57.49	0.23	60.60	0.24	58.72	1.13	58.93	0.39
MUFA	32.33	0.05	32.53	0.09	31.88	0.07	32.48	0.12	35.03	0.11	31.58	0.15	32.49	0.53	33.37	0.22
PUFA	4.00	0.01	4.00	0.01	4.11	0.01	3.89	0.01	3.98	0.30	4.67	0.02	4.08	0.10	4.37	0.03
ΣC-18:1Trans-FA	4.64	0.01	4.51	0.01	5.92	0.01	7.54	0.03	11.36	0.05	4.15	0.02	5.03	0.57	8.42	0.06
ΣCLA	0.53	0.00	0.43	0.00	0.58	0.00	0.53	0.00	0.29	0.19	0.37	0.00	0.28	0.04	0.42	0.00
C-16:0/C-18:1cis9	1.27	0.00	1.24	0.00	1.37	0.00	1.42	0.00	1.42	0.00	1.17	0.00	1.23	0.01	1.27	0.00
C-16:0/C-18:1 ges.	1.03	0.00	1.02	0.00	1.05	0.00	1.01	0.00	0.88	0.00	0.97	0.00	0.97	0.01	0.88	0.00
Σn-3	0.71	0.00	0.61	0.00	0.72	0.00	0.63	0.00	0.56	0.04	0.64	0.00	0.62	0.08	0.58	0.00
Σn-6	2.94	0.00	3.19	0.01	2.94	0.01	2.93	0.01	3.31	0.07	3.88	0.02	3.45	0.11	3.61	0.02
ΣMCT(C-10>C-14)	14.20	0.02	13.06	0.04	14.69	0.03	14.52	0.05	13.55	0.06	17.14	0.05	14.94	0.43	16.12	0.11
ΣSCT(C-4>C-8)	0.16	0.00	0.17	0.00	0.19	0.00	0.41	0.00	0.28	0.00	0.31	0.00	0.12	0.01	0.56	0.00
CLA 9c,11t	0.30	0.00	0.15	0.00	0.29	0.00	0.26	0.00	0.09	0.15	0.14	0.00	0.08	0.01	0.14	0.00
Σn-6/Σn-3	4.12	0.00	5.24	0.00	4.10	0.00	4.66	0.00	5.90	0.23	6.05	0.00	5.68	0.92	6.20	0.00
Σ C-18:1cis-FA	24.74	0.04	25.29	0.07	22.90	0.05	21.88	0.08	20.84	0.08	24.97	0.12	24.68	0.38	21.99	0.15
BFA	3.08	0.00	3.11	0.01	3.16	0.01	3.17	0.01	2.81	0.01	2.85	0.01	2.76	0.16	2.91	0.02

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	P1		P2		P3		P4		R1		R2		R3		R4	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
SFA	59.50	0.27	56.38	0.97	58.77	0.26	58.93	0.31	56.94	0.64	57.05	0.16	59.09	1.10	57.12	1.19
MUFA	33.01	0.18	35.64	0.62	34.11	0.18	33.73	0.17	35.98	0.39	35.94	0.10	30.94	0.59	34.47	0.73
PUFA	4.48	0.02	4.26	0.07	4.38	0.02	3.95	0.02	3.72	0.25	3.88	0.01	6.40	0.12	4.04	0.09
ΣC-18:1Trans-FA	7.03	0.04	7.74	0.13	10.19	0.05	5.40	0.03	7.97	2.34	7.69	1.74	4.78	0.09	6.86	0.14
ΣCLA	0.35	0.00	0.46	0.01	0.34	0.00	0.31	0.00	0.47	0.01	0.46	0.02	0.71	0.01	0.53	0.01
C-16:0/C-18:1cis9	1.29	0.00	1.13	0.00	1.35	0.00	1.24	0.00	1.16	0.11	1.14	0.07	1.28	0.00	1.12	0.00
C-16:0/C-18:1 ges.	0.95	0.00	0.82	0.00	0.87	0.00	0.98	0.00	0.84	0.01	0.84	0.01	0.96	0.00	0.84	0.00
Σn-3	0.57	0.00	0.55	0.01	0.51	0.00	0.54	0.00	0.42	0.05	0.47	0.02	0.79	0.02	0.47	0.01
Σn-6	3.81	0.02	3.57	0.06	3.73	0.02	3.41	0.02	3.10	0.17	3.22	0.12	5.40	0.10	3.35	0.07
ΣMCT(C-10>C-14)	16.02	0.09	12.06	0.21	15.27	0.08	12.29	0.06	10.96	2.08	12.67	0.51	16.49	0.31	14.50	0.31
ΣSCT(C-4>C-8)	0.31	0.00	0.15	0.00	0.44	0.00	0.29	0.00	0.60	0.43	0.18	0.02	1.01	0.01	0.30	0.02
CLA 9c,11t	0.17	0.00	0.24	0.00	0.21	0.00	0.10	0.00	0.13	0.06	0.24	0.01	0.23	0.00	0.32	0.01
Σn-6/Σn-3	6.70	0.00	6.51	0.00	7.36	0.00	6.33	0.00	7.39	0.38	6.84	0.53	6.80	0.00	7.16	0.00
Σ C-18:1cis-FA	23.69	0.13	25.77	0.45	21.67	0.12	25.40	0.13	25.80	2.69	25.78	1.46	23.55	0.45	25.28	0.53
BFA	2.80	0.02	2.45	0.04	2.69	0.01	2.86	0.01	2.41	0.14	2.95	0.06	2.77	0.05	2.87	0.06

Table 5. Fatty acid groups in brine cheese with the addition of aromatic plants in different concentrations, g/100 g fat, n = 6 (continue)

	C1		C2		C3		C4	
	X	SD	X	SD	X	SD	X	SD
SFA	56.97	0.85	55.87	0.96	57.42	0.20	57.85	0.20
MUFA	36.38	0.02	35.16	0.60	35.77	0.13	34.54	0.12
PUFA	4.35	0.00	3.76	0.06	3.69	0.01	4.47	0.02
ΣC-18:1Trans-FA	4.51	0.00	8.31	0.14	9.91	0.04	6.23	0.02
ΣCLA	0.43	0.00	0.49	0.01	0.29	0.00	0.44	0.00
C-16:0/C-18:1cis9	0.98	0.00	1.18	0.00	1.21	0.00	1.12	0.00
C-16:0/C-18:1 ges.	0.81	0.00	0.85	0.00	0.83	0.00	0.88	0.00
Σn-3	0.52	0.00	0.40	0.01	0.49	0.00	0.65	0.00
Σn-6	3.60	0.00	3.04	0.05	3.06	0.01	3.47	0.01
ΣMCT(C-10>C-14)	11.49	0.01	12.47	0.21	11.70	0.04	14.81	0.05
ΣSCT(C-4>C-8)	1.35	0.83	0.10	0.00	0.22	0.00	0.12	0.00
CLA 9c,11t	0.21	0.00	0.42	0.01	0.11	0.00	0.25	0.00
Σn-6/Σn-3	6.92	0.00	7.68	0.00	6.27	0.00	5.33	0.00
Σ C-18:1cis-FA	28.92	0.02	24.11	0.41	24.02	0.09	25.52	0.09
BFA	2.85	0.00	3.10	0.05	2.55	0.01	2.85	0.01

Table 6. Qualitative characteristics of brine cheese fat with additives in different concentrations, n = 6

	K	O1	O2	O3	O4	T1	T2	T3	T4	B1	B2	B3	B4	M1	M2	M3	M4
LPS	18.37	30.16	31.17	32.16	27.11	16.16	28.90	29.54	32.29	16.98	25.17	32.64	33.11	24.33	15.84	26.11	27.88
AI	2.19	1.92	1.80	1.92	1.56	1.86	1.92	1.99	1.93	2.08	1.88	1.97	1.90	1.92	2.09	1.81	1.98
TI	2.28	2.17	1.93	2.08	1.72	2.13	2.19	2.22	2.19	2.32	2.12	2.23	2.13	2.16	2.23	1.85	1.92
h/H	0.60	0.63	0.71	0.66	0.79	0.59	0.66	0.65	0.64	0.73	0.71	0.64	0.62	0.65	0.39	0.68	0.67
TFA (g/ 100 g product)	0.38	1.10	1.03	0.84	0.40	0.78	1.01	0.84	0.87	0.12	0.61	1.03	1.34	1.00	0.37	1.21	1.07
SFA+TFA (g/ 100 g product)	6.39	10.84	11.13	9.45	2.66	5.97	10.36	10.41	8.91	2.58	8.74	11.59	12.07	10.80	1.82	9.64	10.09

Table 6. Qualitative characteristics of brine cheese fat with additives in different concentrations, n = 6 (continue)

	P1	P2	P3	P4	R1	R2	R3	R4	C1	C2	C3	C4
LPS	18.37	23.19	17.10	26.60	18.79	23.61	23.77	16.50	19.95	22.24	25.37	27.58
AI	1.56	1.81	3.06	1.56	1.65	1.87	1.68	1.28	1.65	1.63	1.81	1.70
TI	1.80	1.87	2.19	1.82	1.83	1.78	1.81	1.56	1.80	1.92	1.94	1.89
h/H	0.79	0.70	0.50	0.76	0.75	0.72	0.75	0.97	0.74	0.72	0.76	0.74
TFA (g/100 g product)	0.81	1.03	0.20	1.20	0.82	0.61	0.88	0.30	0.95	1.24	0.88	1.03
SFA+TFA (g/100 g product)	6.73	8.82	1.85	9.81	6.90	8.19	8.30	1.57	7.33	8.45	9.09	8.29

According to Calligaris et al. (2003) the application of different temperature regimes for pasteurization of milk increased the antioxidant activity. Fardet & Rock (2017) found that the antioxidant activity in cheese was determined by the production process depending on the technological losses and the cheese ripening time during which proteolysis and microbiological activity processes take place.

The antioxidant activity in the investigated white brine cheeses was 4.16 TE mg/100 g product (Table 7). Cheeses with additives are characterized by different antioxidant activity depending on their type and concentration applied in the technological process. Adding oregano in a minimum concentration of 0.05% in the brine cheese increases twice the antioxidant activity in the cheese - 8.95 TE mg/100 g product. As the concentration of added dry oregano increases so does the antioxidant activity.

The use of 0.1% oregano supplement increased the antioxidant activity in the cheese by 4.5 times, at 0.2% by 19.5 times and at 0.3% by 24.24 times compared to the control cheese group. The addition of thyme in dry form in the low concentrations - 0.05 and 0.01% reduced the antioxidant activity in the brine cheese to 1.67 and 3.82 TE mg/100 g product, while at 0.2% addition the antioxidant activity was preserved activity compared to the control group of white brine cheese - 4.07 TE mg/100 g product and at 0.3% it increased 6 times. The application of thyme in dry form as a preservative and antioxidant agent is good to use in a higher concentration, but it in turn worsens the organoleptic indicators of the brined cheeses. The effect of basil addition in brine cheese in terms of preservation at 0.1% and increase in antioxidant activity was found at 0.2 and 0.3% concentration, where the antioxidant activity increased by 3 and 8 times compared to the original brine cheese.

Table 7. Antioxidant activity and total polyphenols in brine cheese with additives, n = 6

	DPPH, TE mg/100 g product	TPC, GAE mg/100 g product
K	$4.16 \pm 0.67^{NOP*}$	$44.83 \pm 1.25^{IJ*}$
O1	8.95 ± 1.26^{J}	91.67 ± 0.57^{E}
O2	18.73 ± 0.11^{GH}	96.50 ± 2.60^{DE}
O3	81.09 ± 1.31^{B}	142.33 ± 1.44^{B}
O4	100.83 ± 0.58^{A}	204.00 ± 7.21^{A}
T1	1.67 ± 0.44^{P}	12.67 ± 0.57^{N}
T2	3.82 ± 0.11^{OP}	27.00 ± 0.50^{M}
T3	4.07 ± 0.51^{NOP}	27.33 ± 2.02^{M}
T4	24.76 ± 1.51^{E}	57.17 ± 1.15^{GH}
B1	2.04 ± 0.44^{P}	36.67 ± 2.31^{KL}
B2	3.93 ± 0.00^{NOP}	42.17 ± 0.29^{JK}
B3	12.34 ± 1.36^{I}	76.50 ± 2.18^{F}
B4	33.86 ± 0.550^{D}	90.67 ± 1.15^{E}
M1	3.86 ± 0.25^{OP}	16.17 ± 2.25^{N}
M2	7.96 ± 0.31^{JKL}	24.17 ± 1.53^{M}
M3	8.68 ± 0.120^{JK}	30.83 ± 1.52^{LM}
M4	22.46 ± 0.57^{EF}	44.33 ± 0.29^{IJ}
P1	1.70 ± 0.06^{P}	39.67 ± 1.89^{JK}
P2	6.65 ± 0.18^{JKLMN}	55.00 ± 1.73^{GH}
P3	6.92 ± 1.26^{JKLM}	57.83 ± 3.01^{G}
P4	17.93 ± 0.06^{H}	109.67 ± 1.16^{C}
R1	5.47 ± 0.19^{LMNO}	55.50 ± 1.73^{GH}
R2	8.24 ± 0.50^{JK}	59.50 ± 2.50^{G}
R3	18.54 ± 0.89^{GH}	70.33 ± 2.75^{F}
R4	60.58 ± 1.65^{C}	100.17 ± 2.47^{D}
C1	4.22 ± 1.77^{MNOP}	43.33 ± 4.04^{IJK}
C2	6.05 ± 1.64^{KLMNO}	49.74 ± 0.21^{HI}
C3	9.34 ± 0.12	75.50 ± 3.50^{F}
C4	20.93 ± 0.58^{FG}	93.63 ± 1.09^{DE}

*Means not sharing any letter are significantly different by the Tukey-test at the 5% level of significance.

The inclusion of lemon balm in the brine cheese at a concentration of 0.05% had a lower antioxidant activity compared to the control group of cheeses, while at 0.1 and 0.2% it increased two-fold and by 5.4 times at 0.3% addition. Rosemary increased the antioxidant capacity of the brine cheese to 5.47 TE mg/100 g product at 0.5% compared to the control group of cheeses, twice at 0.1% addition, 4.5 times at 0.2% addition and 14.5 times at 0.3% additive. The use of a combination of turmeric with black pepper at 0.05% supplementation did not change the antioxidant activity in the brine cheese, but at 0.1% it increased to 6.05 TE mg/100 g product, at 0.2% it increased twice, and at 0.3% fivefold. All types of additives lead to improvement of the antioxidant activity of the brine cheese, with the highest values obtained with oregano. Basil and thyme should be used at a concentration of 0.2 and 0.3% to increase the antioxidant activity in the brine cheese.

Total polyphenols in the investigated white brine cheese were 44.83 GAE mg/100 g product. Adding oregano to the brine cheese leads to a two-fold increase in their content at 0.05 and 0.1% addition, a 3.2- fold increase in their content at 0.2% and 4.5 times at 0.3% addition. The use of thyme in the low concentrations gave fourfold at 0.05% and twofold at 0.1 and 0.2% lower values for polyphenols and at 0.3% addition increased compared to the control cheese to 57.17 GAE mg/100 g product. The addition of basil to the brined cheeses led to an increase in the content of total polyphenols at a concentration of 0.2 and 0.3% addition to 76.50 and 90.67 GAE mg/100 g product. The brined cheese supplemented with lemon balm at all concentrations had lower total polyphenols than the control group of white brined cheese. The addition of 0.05% peppermint in the brine cheese leads to a decrease in the content of polyphenols compared to the control group of cheeses, while at the other concentrations it increases, being less pronounced at 0.1 and 0.2% addition and 2.5 times higher 0.3% additive. The cheese with the addition of 0.05%

rosemary has a higher content of total polyphenols compared to the control series - 55.50 GAE mg/100 g product and they increase depending on the concentration of the additive, with the highest value recorded at 0, 3%- 100.17 GAE mg/100 g product. The use of low concentrations of turmeric and black pepper additive preserves the polyphenol content compared to the original brine cheese. The addition of 0.2 and 0.3% of the supplement increased the content of total polyphenols to 75.50 and 93.63 GAE mg/100 g product. Regarding the total content of polyphenols, the best results were obtained with the oregano supplement and the worst with the lemon balm supplement (Table 7).

Branciari et al. (2015) in the supplementation of sheep with rosemary leaves, found that the high antioxidant activity leads to a decrease in proteolysis and lipolysis in cheese. Oxidative processes and fermentation stability were investigated by Fernandes et al. (2018) in the application of essential oils of oregano and rosemary as a natural antioxidant in cream cheese, where the acidity is lower and the pH is higher compared to the original cheese and allows storage for a period of 30 days in refrigerated conditions. A number of studies on the application of essential oils leads to the preservation of dairy products and prolongation of their shelf life (Caleja et al., 2015; Hala et al., 2010; Bukwicki et al., 2018; Mohamed et al., 2018).

CONCLUSIONS

The technological processing of bulk tank cow's milk to brine cheese with the addition of additives from aromatic plants in different concentrations improves their qualitative and quantitative composition. The organoleptic evaluation of the examined cheeses gives us a clear idea that the application of a higher concentration of additives worsens the smell, taste, colour, aroma and consistency. The application of the additives in different concentrations enrich the brine cheese with fibbers, minerals and fats, as a result of which their energy value also increases. Cheeses with the addition of aromatic plants in dry form were characterized by a decrease in saturated fatty acids and enrichment with biologically active fatty acids, which in turn leads to health benefits from their consumption, which is expressed by a decrease in AI and TI and an increase in the cholesterolemic index. The antioxidant activity of the brined cheeses was improved and the total content of polyphenols was increased, with the highest values obtained with the addition of oregano.

ACKNOWLEDGEMENTS

The study was carried out with the financial support of the National Science Fund, Ministry of Education and Science, within the framework of the implementation of the Project "Study of the influence of aromatic plants and their essential oils on the quality of milk and milk products" (Contract with NSF No. KP - 06-N56/ 3/10.11.2021).

REFERENCES

Al-Jasass, F. M., & Al-Jasser, M. S. (2012). Chemical composition and fatty acid content of some spices and herbs under Saudi Arabia conditions. *The Scientific World Journal*, 859892. DOI: 10.1100/2012/859892.

Aljabeili, S., Barakat, H., & Abdel-Rahman, A. (2018). Chemical Composition, Antibacterial and Antioxidant Activities of Thyme Essential Oil (*Thymus vulgaris*). *Food and Nutrition Sciences*, *9*, 433-446.

Baardseth, P. (1989). Effect of selected antioxidants on thestability of dehydrated mashed potatoes. *Food Additives &Contamination, 6*, 201-207.

Barak, S., & Mudgil, D. (2022). Application of Bioactives from Herbs and Spices for Improving the Functionality and Shelf Life of Dairy Products-A Review. *Biointerface Research in Applied Chemistry,13*(2), 141.

Barbaccia, P., Busetta, G., Barbera, M., Alfonzo, A., Garofalo, G., Francesca, N., Moscarelli, A., Moschetti, G., Settanni, L., & Gaglio, R. (2022). Effect of grape pomace from red cultivar "Nero d'Avola" on the microbiological, physicochemical, phenolic profile and sensory aspects of ovine Vastedda-like stretched cheese. *Journal of Applied Microbiology*, *133*, 130-144.

Basant, B., Lokesh, T., & Jorawar, S. (2018). Herbs a way to enhance functionality of traditional dairy products. *Journal of Dairy and Veterinary Sciences*, *6*, 555689.

Batubara, I., Rafi, M., & Yolanda, M. L. (2020). Antioxidant, antibacterial, and degradation *Streptococcus mutans* biofilms activities of black pepper (*Piper nigrum*) seed extract. *AIP Conference Proceedings*, *2243*(1), 030003.

Branciari, R., Ranucci, C., Trabalza, M., & Codini, M. (2015). Evaluation of the antioxidant properties and oxidative stability of pecorino cheese made from the raw milk of ewes fed *Rosmarinus officinalis* L. leaves. *International Journal of Food Science and Technology*, *50*(2), 558-565.

Brand-Williams, W., Cuvelier, M. E., & Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT – Food Science and Technology*, *28*, 25–30.

Bukvicki, D., Giweli, A., Stojkovic, D., Vujisic, L., Tesevic, V., Nikolic, M., Sokovic, M., & Marin, P. D. (2018). Cheese supplemented with *Thymus algeriensis* oil, a potential natural food preservative. *Journal of Dairy Science*, *101*(5), 3859-3865.

Caleja, C., Lillian, B., Amilcar, L. A., Ana, C., João, C. M., Marina, S., Oliveira, M. B. P. P., Celestino, S. B., & Isabel, C. F. R., (2015). Development of a functional dairy food: Exploring bioactive and preservation effects of chamomile (*Matricaria recutita* L.). *Journal of functional foods*, *16*(1), 114-124.

Calligaris, S., Manzocco, L., & Anese, M. (2003). Effect of heat-treatment on the antioxidant and pro-oxidant activity of milk. *International Dairy Journal*, *14*, 421-7.

El- Kholy, W. M., Aamer, R. A., & Mailam, M. A. (2017). Effect of some essential oils on the quality of uf-soft cheese during storage. *Alexandria Journal of Food Science and Technology*, *14*, 13-27.

Elyemni, M., El Ouadrhiri, F., Lahkimi, A., Elkamli, T., Bouia, A., Eloutassi, N. (2022). Chemical composition and antimicrobial activity of essential oil of wild and cultivated *Rosmarinus officinalis* from two Moroccan localities. *Journal of Ecological Engineering*, *23*(3), 214-222.

Ertan, K., Bayana, D., Gokce, O., Alatossava, T., Yilmaz, Y., & Gursoy, O. (2017). Total antioxidant capacity and phenolic content of pasteurized and UHT-treated cow milk samples marketed in Turkey. *Akademik Gıda, 15*, 103-8.

Fagundes, T. S. F., Pacheco, C. M., Martins, P. R. C., Valverde, A. L., & Ribeiro, C. M. R. (2018). Análise de alimentos contendo cúrcuma: uma sequência experimental simples para a sala de aula e divulgação científica. *Revista Virtual de Química*, *10*, 841-850.

Fardet, A., & Rock, E. (2017). In vitro and in vivo antioxidant potential of milks, yoghurts, fermented milks and cheeses: a narrative review of evidence. *Nutrition Research Reviews*, Cambridge University Press (CUP), 2017, Epub ahead of print (1), 1-19.

Fernandes, R., Botrel, D. A., Monteiro, P. S., & Borges, S.V. (2018). Microencapsulated oregano essential oil in grated parmesan cheese conservation. *International Food Research Journal*, *25*(2), 661-669.

Gaglio, R., Barbaccia, P., Barbera, M., Restivo, I., Attanzio, A., Maniaci, G., Grigoli, A. Di., Francesca, N., Tesoriere, L., & Bonanno, A. (2021b). The use of winery by- products to enhance the functional aspects of the ovine "Primosale" cheese. *Foods, 10*, 461.

Gaglio, R., Todaro, M., & Settanni, L. (2021a). Improvement of raw milk cheese hygiene through the selection of starter and non-starter lactic acid bacteria: The successful case of PDO Pecorino Siciliano cheese. *International Journal of Environmental Research and Public Health*, *18*, 1834.

Gajarmal, A. A., Baheti, S., Mane, S., & Rath, S. (2024). A comprehensive review of herbs utilized in milk products of dairy industry: Insights from Ayurveda. *Pharmacological Research - Natural Products,* 100074. https://doi.org/10.1016/j.prenap. 2024.100074

García-Gómez, B., Vázquez-Odériz, M. L., Muñoz-Ferreiro, N., Romero-Rodríguez, M. A., & Vázquez, M. (2021). Novel cheese with vegetal rennet and microbial transglutaminase: Effect of storage on consumer acceptability, sensory and instrumental properties. *International Journal of Dairy Technology International Journal of Dairy Technology, 74*, 202-214.

Ghaeni, M., Ghahfarokhi, K. N., & Zaheri, L. (2013). Fatty acids profile, atherogenic (IA) and thrombogenic (IT) health lipid indices in *Leiognathusbindus* and *Upeneussulphureus. Journal of Marine Science: Research & Development*, *3*(4), 1-3.

Hala, M., Ebtisam, I., Sanaa, G., Badran, M. A., Gad, A. S., & Marwa El-Said, M. (2010). Manufacture of low fat UF-soft cheese supplemented with rosemary extract (as natural antioxidant). *Journal of American Science, 6*(10), 570-579.

Hambraeus, L., & Lönnerdal, B. (2003). The Physiological role of lactoferrin. *Medical*, Nutritional Aspects: International Dairy Federation, 2003. Chap 18.

Ivanov, G., Balabanov, T., Baltadzhieva, M., & Vassilev, K. (2015). Effect of ripening temperature on the fermentation process in Bulgarian white brined cheese produced from cow and buffalo milk. *Journal of Mountain Agriculture on the Balkans*, *18*(1), 47-60.

Ivanova, A., & Hadzhinikolova, L. (2015). Evaluation of nutritional quality of common carp (*Cyprinus carpio L.*) lipids through fatty acid ratios and lipid indice. *Bulgarian Journal of Agricultural Science, 21*, 180–185.

Jiao, J., Liu, Z., Zheng, Y., & Liu, J. (2021). A novel application of *Monascus purpureus* in semi-soft cheese making. *Journal of Food Processing and Preservetion*, *45*, e15209.

Kamelnia, E., Mohebbati, R., Kamelnia, R., El-Seedi, H. R., Boskabady, M. H., (2023). Anti-inflammatory, immunomodulatory and anti-oxidant effects of *Ocimum basilicum* L. and its main constituents: A review. *Iranian Journal of Basic Medical Sciences*, *26* (6), 617-627.

Karakaya, S., EI, S. N., & Tas, A. A. (2001). Antioxidant activity ofsome foods containing phenolic compounds. *International Journal of Food Science and Nutrition*, *52*, 501-508.

Korhonen, H., & Pihlanto, A. (2007). Fermented milks popular in Europe and North America. In: Hui, Y.H. (ed. *Handbook of food products manufacturing 2*). Hoboken, New Jersey, John Wiley and Sons, 411-426.

Kumar Paswan, V., Rose, H., Shekhar Singh, C., Yamini, S., & Rathaur, A. (2021). Herbs and Spices Fortified Functional Dairy Products. IntechOpen. doi: 10.5772/intechopen.98775.

Kunnumakkara, A. B., Chung, J. G., Koca, C., & Dey, S. (2009). Mint and its constituants. In B.B. Aggarwal, and A.B. Kunnumakkara, *Molecular targets and therapeutic uses of spices*, World Scientific, Singapore; Hackensack, NJ, 373–401.

Lee, J. G., Chae, Y., Shin, Y., & Kim, J. (2020). Chemical composition and antioxidant capacity of black pepper pericarp. *Applied Biological Chemistry, 63*, 35.

Lindmark-Månsson, H., & Åkesson, B. (2000). Antioxidative factorsin milk. *British Journal of Nutrition, 84*,103-110.

Lucera, A., Costa, C., Marinelli, V., Saccotelli, M. A., Del Nobile, M. A., & Conte, A., (2018). Fruit and vegetable by-products to fortify spreadable cheese. *Antioxidants, 7*, 61.

Mijačević, Z., & Bulajić, S. (2008). Sensory evaluation and microbiological characterization of autochthonous sombor cheese. *Acta Veterinaria (Beograd)*, *58*, 531-541.

Milenković, A. N., & Stanojević, L. P. (2021). Black pepper - chemical composition and biological activities. *Advanced technologies*, *10*(2), 40-50.

Miraj, S., Rafieian-Kopaei, & Kiani, S. (2017). Melissa officinalis L: A Review Study with an Antioxidant Prospective. *Journal of Evidence-Based Integrative Medicine, 22*(3), 385-394.

Mohamed, F. A. E. F., Salama, H. H., El-Sayed, S. M., El-Sayed, H. S., & Zahran, H. A. (2018). Utilization of natural antimicrobial and antioxidant of Moringa oleifera leaves extract in manufacture of cream cheese. *Journal of Biological Sciences, 18*(2), 92-106.

Nahak, G., & Sahu, R. K. (2011). Phytochemical evaluation and antioxidant activity of *Piper cubeba* and *Piper nigrum. Journal of Applied Pharmaceutical Science*, *1*(8), 153-157.

Nasri, H., Sahinfard, N., Rafieian, M., Rafieian, S., Shirzad, M., & Rafieian-kopaei, M. (2014). Turmeric: A spice with multifunctional medicinal properties. *Journal of HerbMed Pharmacology*, *3*, 5-8.

Norshazila, S., Syed Zahir, I., Mustapha Suleiman, K., Aisyah, M. R., & Kamarul Rahim, K. (2010). Antioxidant levels and activities of selected seeds of Malaysian tropical fruits. *Malays Journal of Nutrition*, *16*, 149-59.

Oraon, L., Atanu, J., Prajapati, P. S., & Suvera, P. (2017). Application of herbs in functional dairy products - a review. *Journal of Dairy Veterinary and Animal Resource*, *5*, 109–115.

Plessas, S., Ganatsios, V., Mantzourani, I., & Bosnea, L. (2021). White brined cheese production by incorporation of a traditional milk-cereal prebiotic matrix with a candidate probiotic bacterial strain. *Applied Science*, *11*, 6182.

Pradeep, K. U., Geervani, P., & Eggum, B. O. (1993). Common indian spices: nutrient composition, consumption and contribution to dietary value. *Plant Foods for Human Nutrition*, *44*, 137–148.

Prashant, A., Rangaswamy, C., Yadav, A. K., Reddy, V., Sowmya, M. N., & Madhunapantula, S. (2017). In vitro anticancer activity of ethanolic extracts of *Piper nigrum* against colorectal carcinoma cell lines. *International Journal of Applied and Basic Medical Research*, *7*(1), 67-72.

Shahab Lavasani, A. R. (2013). Effect of different concentrations of rennet on some parameters of white brine cheese. *Advvances in. Environmental Biology, 8*, 235- 238.

Singleton, V., Orthofer R., & Lamuela-Raventós, R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent. In: *Methods Enzymology*, Academic Press, USA, 299, 152- 178.

Stojanović-Radić, Z., Pejčić, M., Dimitrijević, M., Aleksić, A., Anil Kumar, N. V., Salehi, B., Cho, W. C., & Sharifi-Rad, J. (2019). Piperine-a major principle of black pepper: a review of its bioactivity and studies. *Applied Sciences, 9*(20), 4270:1-29. https://doi.org/10.3390/app9204270.

Suetsuna, K., Ukeda, H., & Ochi, H. (2000). Isolation andcharacterization of free radical scavenging activities peptides derived from casein. *Journal of Nutrition and Biochemistry*, *11*, 128-131.

Tasleem, F., Azhar, I., Ali, S. N., Perveen, S., & Mahmood, Z. A. (2014). Analgesic and anti-inflammatory activities of *Piper nigrum* L. *Asian Pacific Journal of Tropical Medicine*, *7*, S461-S468.

Ulbricht, T. L., & Southgate, D. A. (1991). Coronary heart disease: Seven dietary factors. *Lancet*, *338*, 985-992.

Valyova, M., Stoyanov, S., Markovska, Y., & Ganeva, Y. (2012). Evaluation of in vitro antioxidant activity and free radical scavenging potential of variety of *Tagetes erecta* L. flowers growing in Bulgaria. *Int. J. Appl. Res. Nat. Prod.*, *5,* 19–25.

Verma, R. K., Kumari, P., Maurya, R. K., Kumar, V., Verma, R. B., & Singh, R. K. (2018). Medicinal properties of turmeric (*Curcuma longa* L.): A review. *International Journal of Chemical Studies*, *6*, 1354-1357.

Vijayakumar, R. S., Surya, D., & Nalini, N. (2004). Antioxidant efficacy of black pepper (*Piper nigrum* L.) and piperine in rats with high fat diet induced oxidative stress. *Redox Report*, *9*, 105-110.

Walasek-Janusz, M., Grzegorczyk, A., Malm, A., Nurzyńska-Wierdak, R., & Zalewski, D. (2024). Chemical composition, and antioxidant and antimicrobial activity of oregano essential oil. *Molecules,* 29(2), 435.

Wang, Y. C., Yu, R. C., & Chou, C. C. (2006). Antioxidative activities of soymilk fermented with lactic acid bacteria and bifidobacteria. *Food Microbiology, 23*, 128-135.

Wei, F., & Yano, H. (2020). Development of "New" bread and cheese. *Processes*, *8*, 1541.

Zheng, W., & Wang, S. Y. (2001). Antioxidant activity and phenolic compounds in selected herbs. *Journal of Agricultural and Food Chemistry, 49*, 5165-70.

***Regulation (EC) No 1924/2006 of the European Parliament and of the Council, 20 December 2006: On nutrition and health claims made on foods. Trans fatty acids and insulin resistance. *Atherosclerosis*, 7, 37–39.