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The effects spicing on quality of mozzarella cheese

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Abstract

In this study, 3 different spice mixes were added just after blanching to mozzarella cheese produced by high moisture production method. The dough was kneaded and filled into to fibrous cases. After filling process, cheeses were stored for 28 days at 4 °C and 85 % of relative humidity. The following characteristics were measured: color parameters, milk acidity, total dry matter, maturation index, total aerobic mesophilic bacteria, coliform bacteria, coagulase positive staphylococci, lactic acid bacteria, species of *Lactococcus* bacteria, proteolytic bacteria, lipolytic bacteria and mold /yeast count were examined on 0, 5, 15,21 and 28 days after storage. Although L* (lightness) and a* (redness) values decreased during storage period, while moreover b* (yellowness) values increased. In addition acidity, dry matter and maturation index values increased during storage. Total aerobic mesophilic bacteria, lactic acid bacteria, *Lactococcus* spp., lipolytic bacteria and mold/ yeast counts decreased, but proteolytic bacteria count increased.

Key words: cheese, mozzarella, spices, ripening

Introduction

More than 4,000 cheese varieties are produced throughout the world. Most of these varieties do not have economic value due to their similarity to others (Demirci and Şimşek, 1997). Approximately193 cheese varieties are known to be produced in Turkey (Çetinkaya, 2008). One of these varieties is mozzarella, which belongs to the pasta filata cheese family and is consumed without ripening. It has many different variations, from yellow blocks produced from cow milk to white balls produced from buffalo milk. As a famous Italian cheese, mozzarella is produced around the world and is essential for pizza (Üçünçü, 2004; Harrbut, 2009).

Spices are defined as herbal products used as flavoring, coloring, and preserving agents in food and medication (Akgül, 1993). Although spices were initially used only for the development and preservation of food products, they were later used as agents for improving flavor and appearance. This shift occurred after the development of food additives in the food industry (Üner et al., 2000).

Using spice and plants to control microbial growth in processed dairy products has been a common practice. Cumin, thyme, mint, fennel have been the center of focus as a natural antimicrobial. Most research noted that antimicrobial properties of spices such as thyme, mint, cumin, fennel are attributed to their chemical contents as thymol, carvacrol, linalool, menthol, menthone, transanetole, estragol, p-cymene and the cumic aldehyde etc. (Rota et al. 2008; Singh et al., 2015; Senatore et al., 2013; Akrami et al., 2015; Prashanth et al.; 2001).

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Enhancing cheese flavor, prtolonging the shelf life of the cheese by decreasing the microbial content, achieving a healthier product, and preventing structural defects by reducing the salt content are some of the objectives for using spices and spice extracts (Ayar and Akyüz, 2003). Van otlu (herb) cheese is one of the most consumed traditional Turkish cheeses that produced with some natural plants. Van otlu cheese contains 0.1 % ingredients of plants, as Allium, Choerophyllum, Calamintha, Thymus and Ferula, which are added to the curd (Tekinşen and Özdemir, 2006). Zantar et al. (2014) added *Thymus vulgaris* and *Origanum compactum* essential oils in fresh goat cheese. Researcher reported that bacteria and mould counts decreased in fresh goat cheese produced with *Thymus vulgaris* and *Origanum compactum*. Surk is an another cheese produced with herb and plant which contained peppermint, thyme, mint, cumin, black pepper, cinnamon, ginger and chili pepper in southern area of Turkey (Güler, 2014).

The aim of the present study was to increase the functional properties of mozzarella cheese by addition of different spices. Cheese was filled into a fibrous materials, and ripened for 28 days. Physicochemical, chemical, microbiological, and sensorial properties were determined.

Materials and methods

Production of mozzarella

Milk was heated for 4 minutes at 68 °C and cooled, and then a starter culture containing lyophilized thermophilic bacteria including *Streptococcus salivarus* spp. *thermophilus*, *Lactobacillus delbrueckii* spp. *bulgaricus*, and *Lactobacillus helveticus* was added (1.5 %) as described by Özsunar (2010). The starter culture was preactivated for 45 minutes, and rennet (1/18.000 MCU/mL, Mayasan A.Ş., Turkey), was diluted 10 times with water. The coagulate was cut into 1.5-2 cm cubes after coagulation for 60 minutes in order to reach the ripening acidity (pH 5.40). When the coagulate collapsed after 5 minutes, 1/3 of the whey was separated and the curd was blanched at 42 °C for 15 minutes with the rest of the whey. After blanching, the whey was separated from the tank, the coagulates were put into curd cloths, and the curd was incubated at 42 °C. The curds were cut into four equal pieces of 60 kg/each when the pH reached 5.05, and they were then boiled in water for 1-2 minutes. While boiling, they were stirred with a wooden spoon. The dried spice mixes (Table 1) were added to the curds and kneaded for 4-5 minutes. The spice mix was dispersed homogeneously into the dough by kneading. The curds were cooled and filled into the fibrous case (30 Q, Oxygen permeability: 30-40 cm^3/m^2d bar, steam permeability: 470-540 g/m^2d bar) as 100 g/each.

Table 1. Quantities of spices used in production of mozzarella cheese (g/60 kg curd)

Sample No	Used Spices				
Control	No Added Spices				
M-KNK	Thyme (*Thymus serpyllum* L.) 22.2	Mint *(Mentha piperita)* 22.2	Cumin *(Cuminum cyminum)* 22.2	Bay *(Laurus nobilis)* 22.2	Basil *(Ocimum basilicum)* 11.1
M-TNR	Estragon (*Artemisia dracunculus*) 33.5	Mint *(Mentha piperita)* 33.5	Fennel *(Foeniculum vulgare)* 16.5	Cumin *(Cuminum cyminum)* 16.5	
M-NÇN	Garnet *(Punica granatumun)* 33.5	Mint *(Mentha piperita)* 33.5	Fennel *(Foeniculum vulgare)* 16.5	Cumin *(Cuminum cyminum)* 16.5	

Control: No added spices; M-KNK: Mozzarella with thyme, mint, cumin, bay, basil; M-TNR: Mozzarella with estragon, mint, fennel, cumin; M-NÇN: Mozzarella with garnet, mint, fennel, cumin

After being placed into its fibrous casing, the cheese was soaked in water at 0 °C for 10 minutes. The cheese was then drained and stored at 4 °C and 85 % relative humidity for 28 days. Physicochemical, chemical, and microbiological analyses were conducted on days 0, 5, 10, 15, 21, and 28 of storage.

Color analysis

The color parameters of the mozzarella cheese were analyzed with a Konica Minolta Chroma Meter CR-400 on the ripening days indicated above. L*(lightness), a*(redness), and b*(yellowness) values were determined by the Hunter color system (Voss, 1992; Metzger et al., 2008).

Titratable acidity

Acidity in mozzarella cheese was determined by a titration method (Anonymous, 1990). The acidity was calculated as lactic acid (%).

Dry matter

Changes in the dry matter of the samples during the 28-day storage period were evaluated according to Association of Official Analytical Chemists AOAC (1990).

Ripening index

The ripening index in the mozzarella cheese was determined as described by Gripon et al. (1975) using the formula (WSN/TN) x 100.

Microbiological analysis

Samples of 10 g were taken aseptically from the mozzarella cheese. A sterilized ringer solution at a dilution of 1:9 (w/v) was added, and the samples were homogenized for 3 minutes in a stomacher Lab-Blender 400 (London, UK). The serial decimal dilutions were plated for bacterial counts (Anonymous, 2001; Sekin and Karagözlü, 2004).

Total aerobic mesophilic bacteria (TAMB), yeast/mold, *Lactobacillus* spp., *Lactococcus* spp., lipolytic bacteria, proteolytic bacteria, and coliform were counted using a spread plate technique (Table 2) (Halkman, 2005).

Sensory analysis

Sensory evaluation of the mozzarella cheese was carried out on days 0, 15, and 28 of storage. Samples were scored by 20 trained panelists from the Food Engineering Department of Afyon Kocatepe University. The samples were served to panelists in daylight

Table 2. Analysis of the microorganism groups and reproduction conditions

Microorganisms	Medium	Incubation conditions	Method used
TAMB	Plate Count Agar	30 °C-48/72 hour-aerobic	ISO 4833 (Anonymous, 2003)
Yeast/Mold	Potato Dextose Agar	22 °C-4/5 day-aerobic	Pinchardt (Pichhardt, 1993)
Lactic acid bacteria	MRS (Man Rogasa) Agar	30 °C-24/48 hour-anaerobic	Kneifel and Berger (Kneifel and Berger, 1994)
Lactococcus spp.	M17 Agar	30 °C-24/48 hour-anaerobic	Corroler (Corroler et al., 1998)
Lipolytic bacteria	Tributyrin Agar	30 °C-48/72 hour-aerobic	Halkman (Halkman, 2005)
Proteolitic bacteria	Plate Count Agar	21 °C-72 hour-aerobic	Frank (Frank et al., 1985)
Coliform group bacteria	Violet Red Bile Agar	30 °C-24/48 hour-aerobic	ISO 4832 (Anonymous, 1991)
Micrococcus/Staphylococcus	Baird Parker Agar	37 °C-24/48 hour- aerobic	ISO 6888-1 (Anonymous, 1999)

TAMB: Total Aerobic Mesophilic Bacteria

at room temperature in random order. The panelists were evaluated the samples for appearance, color, structure, taste, and odor and to express the general acceptability with a hedonic scale between 1 and 9 as follows: 1-3 (not acceptable), 4-5 (fairly acceptable), 6-7 (good, acceptable), 8-9 (very good) (Bodyfelt et al., 1988).

Statistical analysis

The experimental design consisted of a completely randomized design in a factorial arrangement: four treatments (Control, M-KNK, M-TNR, or M-TNR), six storage periods (0, 5, 10, 15, 21, 28 days), and three replicates. Statistical analysis of the data was made by using the analysis of variance of the SPSS program, version 17.0.1 (Anonymous, 2008). Mean values with a significant difference were compared by Duncan's multiple rangle tests.

Results and discussion

Color values

L* (lightness) values of the cheese with casing are shown in Table 3. L* values of all the samples decreased during storage (P<0.05). This decrease could be related to the decline of the moisture content (Özsunar, 2010). Similarly, Metzger et al. (2001) and Johnston and Darcy (2000) reported a decrease in L* values. The control sample had the highest L* value of 79.58 at the end of the storage period, while M-TNR had the lowest L* value (P<0.05). This could be due to the spice mix that was added during production. The mozzarella cheese lost moisture during ripening, and thus the bright white color was lost and the color became dull yellow, which can be attributed to the decrease in L* values (Özsunar, 2010).

Changes in the a* values of the samples (redness) are shown in Table 3. The a* values of all samples decreased during storage (P<0.05).The difference in a* values could be caused by the spice mixes, production, and storage conditions (Akbulut, 2007; Özsunar, 2010). Although Akbulut (2007) reported a similar decrease in a* values, Johnston and Darcy (2000) did not report a significant decrease in a* values. At the end of the storage period, the M-NÇN sample had the highest a* value, while the control sample had the lowest a* value. A high a* value could be due to the spice mix containing a reddish orange color. On the other hand, the spice mix was not added to the control sample during production, which could lead to difference in the a* value.

The b* (yellowness) values of the cheese samples increased during the storage period (P>0.05). An increase in b* values could be explained by a

Table 3. Changes in color values during storage period of mozzarella cheese

	Sample	0^{th} day	5^{th} day	10^{th} day	15^{th} day	21^{st} day	28^{th} day
L*Value	Control	87.08^{aA}	86.01^{aAB}	84.4^{aABC}	83.38^{aBC}	81.68^{aCD}	79.58^{aD}
	M-KNK	80.5^{bA}	79.12^{bAB}	76.83^{bABC}	74.53^{bABC}	72.7^{bBC}	71.27^{bC}
	M-TNR	81.67^{bA}	79.72^{bA}	76.7^{bB}	73.83^{bC}	72.78^{bC}	68.46^{Db}
	M-NÇN	80.47^{bA}	79.16^{bAB}	77.6^{bBC}	76.52^{bCD}	75.45^{bDE}	72.50^{bE}
a*Value	Control	1.66^{bA}	1.39^{bAB}	1.07^{bAB}	0.88^{bBC}	0.27^{bCD}	0.09^{bD}
	M-KNK	1.54^{bA}	1.27^{bAB}	1.16^{bAB}	0.91^{bB}	0.80^{bBC}	0.25^{bC}
	M-TNR	1.53^{bA}	1.04^{bA}	0.96^{bA}	0.87^{bA}	0.59^{bA}	0.36^{aB}
	M-NÇN	3.77^{aA}	3.37^{aAB}	3.05^{aABC}	2.77^{aCB}	2.48^{aCB}	2.15^{aC}
b Value	Control	12.37^{aC}	13.56^{BC}	14.04^{BC}	14.78^{BC}	15.88^{AB}	17.67^{A}
	M-KNK	13.50^{a}	14.63	15.37	15.92	17.3	18.26
	M-TNR	13.26^{aC}	14.5^{BC}	15.59^{ABC}	16.24^{AB}	16.61^{AB}	17.40^{A}
	M-NÇN	10.09^{b}	11.22	12.05	12.64	13.11	14.64

A - E: Values with the same capital letters in the same rows for each analysis differ significantly (P<0.05)
a - d: Values with the same capital letters in the same column for each analysis differ significantly (P<0.05)
L* (Lightness), a* (redness) and b* (yellowness)

loss of moisture during storage (Akbulut, 2007; Özsunar, 2010). Similarly, Johnston and Darcy (2000) reported an increase in the b* values of their mozzarella cheese samples. While the b* value of M-KNK was 18.26, the b* value of M-NÇN was 14.64. The reason for these changes could be due to the differences between the formulations of the spice mixes.

Acidity

The acidity of the control and spice-mixed samples increased during the storage period (P<0.05) (Table 4). The M-TNR sample had the highest acidity at 3.06, but this increase was not significant (P>0.05). Similarly, Metin and Öztürk (1996), Çağlar and Çakmakçı (1998), and Yaşar (2007) reported an increase in acidity in kaşar cheese stored for 90 days. Starter and non-starter bacteria in the cheese that can ferment lactose metabolize lactic acid, which could increase the acidity of cheese during the storage period.

Dry matter

The dry matter of the mozzarella cheese increased during the storage period (P<0.05). While the control sample had the highest increase, M-TNR had the lowest increase (Table 4). The increase of dry matter in the mozzarella cheese could be attributed to the loss of moisture due to the permeable properties of the fibrous case used during ripening.

Ripening index

The ripening index of the mozzarella cheese increased during the storage period (P>0.05). Although the control sample had the largest ripening index rate, M-KNK had the highest increase during ripening (53.09 %). Ripening is affected by rennin, starter and non-starter lactic acid bacteria, yeast/mold, and proteolytic enzymes synthesized by psychrophilic bacteria (Dağdemir, 2006). Similarly, Yaşar (2007) reported an increase in the ripening index ratio for four different samples during storage for 90 days. At the end of the storage period, the ripening index rate of the samples was between 33 % and 66 %, and the cheese was classified as ripened cheese (Table 4) (Griponet al., 1975).

Microbiological analysis

The TAMB count of the samples decreased during the storage period (P>0.05) (Table 5). Similarly, Çelebi (2011) reported a decrease of the TAMB count of örgü cheese (traditional cheese) produced with coagulation enzymes. A decrease in the TAMB count of mozzarella cheese during ripening could be

Table 4. Changes in acidity, dry matter and maturation index ratio during the storage period of mozzarella cheese

	Sample	0^{th} day	5^{th} day	10^{th} Day	15^{th} day	21^{st} day	28^{th} day
Acidity	Control	1.90^{E}	2.06^{D}	2.23^{C}	2.34^{bBC}	2.43^{AB}	2.55^{A}
	M-KNK	2.02^{D}	2.24^{CD}	2.39^{BCD}	2.52^{aABC}	2.62^{AB}	2.87^{A}
	M-TNR	2.04^{D}	2.24^{CD}	2.33^{CD}	2.52^{aBC}	2.72^{AB}	3.06^{A}
	M-NÇN	2.05^{D}	2.35^{CD}	2.5^{BC}	2.58^{aBC}	2.8^{AB}	3.00^{A}
Dry Matter Content	Control	50.22	54.32	55.87	59.04	61.38	63.6
	M-KNK	50.83	54.72	56.51	59.19	60.09	61.92
	M-TNR	51.3^{C}	53.5^{BC}	55.23^{ABC}	57.89^{ABC}	59.9^{AB}	61.79^{A}
	M-NÇN	51.09	53.46	55.3	57.76	60.19	62.64
Ripening Index Ratio	Control	23.5^{C}	25.48^{C}	29.71^{C}	40.19^{aB}	$44.26a^{AB}$	48.19^{aA}
	M-KNK	19.59^{A}	23.14^{A}	29.93^{B}	37.66^{aA}	40.11^{abA}	41.76^{aA}
	M-TNR	21.16^{E}	25.22^{D}	31.02^{C}	37.54^{aB}	41.95^{aA}	$43.85a^{A}$
	M-NÇN	18.02^{D}	22.86^{C}	27.21^{BC}	30.51^{bAB}	33.54^{bA}	34.82^{bA}

A - E: Values with the same capital letters in the same rows for each analysis differ significantly (P<0.05)
a - d: Values with the same capital letters in the same column for each analysis differ significantly (P<0.05)

due to a decrease of a_w and an increase of cheese acidity. The count of M-NÇN decreased from 6.45 log/g to 5.43 log/g constituting the highest decrease. This decreased could be explained by antimicrobial compound of garnet, mint, fennel and cumin (Prashanth, 2001; Singh, 2015; Diao, 2014; Bisht et al., 2014). Protective effect of essential of cumin against food-borne and spoilage pathogenic bacteria was reported by Bish et al. 2014. Essential oil's components such as -terpin-7-al, terpene, pinene and cumin aldehyde could be responsible for this activity. Similarly, the antibacterial activities mint oil were reported by Rasooli et al. (2008) and Singh et al. (2015).

The yeast/mold count of the mozzarella cheese decreased during the storage period (P<0.05). Similarly, Şengül et al. (2010) and Karaman and Akbulut (2006) reported a decrease in the yeast/mould count during storage. A decrease in a_w and an increase in cheese acidity during storage led to the decrease in yeast and mould. M-NÇN had the highest decrease in yeast/mould count (Table 5). Similarly, a reduction in yeast and mold with addition herb and plant was reported in fresh goat cheese (Zantar et al., 2014).

The lactic acid bacteria count of the samples decreased by approximately 1 log, and M-KNK had the highest decrease (P<0.05) (Table 5). Similarly, Özsunar (2010) reported a decrease in the lactic acid bacteria of cheese produced with buffalo milk, cow milk, and a mix of buffalo and cow milk. During ripening index, the lactic acid bacteria of mozzarella

Table 5. Changes in microbial composition of mozzarella cheese during storage time (cfu log/g)

	Sample	0th day	5th day	10th day	15th day	21st day	28th day
TAMB	Control	6.42	6.29	6.17	6.12	5.89	5.60
	M-KNK	6.54	6.34	6.27	6.14	5.95	5.68
	M-TNR	6.40	6.30	6.24	6.04	5.88	5.73
	M-NÇN	6.45	6.22	6.09	6.01	5.81	5.43
Yeast/Mold count	Control	5.54^{A}	5.14^{AB}	5.09^{AB}	4.93^{B}	4.85^{B}	4.70^{B}
	M-KNK	5.68^{A}	5.26^{B}	5.12^{BC}	5.05^{BC}	4.91^{CD}	4.69^{D}
	M-TNR	5.54	5.34	5.18	4.99	4.64	4.49
	M-NÇN	5.66	5.37	5.22	4.97	4.72	4.44
Lactic acid bacteria count	Control	7.04^{A}	6.71^{AB}	6.55^{ABC}	6.44^{BC}	6.35^{BC}	6.13^{C}
	M-KNK	6.83	6.73	6.59	6.44	6.28	6.05
	M-TNR	7.01^{A}	6.75^{AB}	6.51^{BC}	6.43^{BC}	6.38^{BC}	6.24^{C}
	M-NÇN	6.97^{A}	6.89^{A}	6.75^{AB}	6.56^{BC}	6.36^{CD}	6.13^{D}
Lactococcus genus bacteria count	Control	7.16	6.95	6.78	6.65	6.48	6.17
	M-KNK	7.18	6.89	6.83	6.72	6.42	6.04
	M-TNR	7.17	6.93	6.83	6.55	6.45	6.35
	M-NÇN	7.19	7.00	6.83	6.74	6.56	6.23
Lipolytic bacteria count	Control	6.19	6.12	5.98	5.85	5.73	5.52
	M-TNR	6.33	6.20	6.07	5.86	5.71	5.51
	M-TNR	6.14	6.01	5.88	5.87	5.73	5.38
	M-NÇN	6.26	6.09	5.96	5.81	5.60	5.37
Proteolytic bacteria count	Control	5.81	5.87	5.95	5.98	6.02	6.05
	M-TNR	5.69	5.81	5.86	5.88	5.90	6.01
	M-TNR	5.66	5.77	5.89	5.96	5.99	6.04
	M-NÇN	5.68	5.80	5.92	5.95	5.97	5.98

A - D: Values with the same capital letters in the same rows for each analysis differ significantly (P<0.05) cheese decreased. This decrease could be due to a decrease in a_w and an increase in cheese acidity.

The *Lactococcus* content of mozzarella cheese samples decreased during the storage period (P>0.05). M-TNR had the highest decrease (Table 5). Similarly, Fenelon et al. (2000) reported a decrease in the *Lactococcus* content of low-fat cheddar cheese produced with different starter cultures.

The TAMB count is affected by the microbial quality of raw milk, heat treatment norms, and processing and ripening conditions (Fontecha et al., 1990).

The lipolytic bacteria count of the samples decreased during the storage period (P>0.05). M-NÇN sample had the highest decrease (Table5). Moreover, Ceylan (1998) reported an increase in the lipolytic bacteria count in Erzincan tulum cheese produced with a different spice mix. A decrease in the a_w value during storage could lead to a decrease in the lipolytic bacteria count.

The proteolytic bacteria count of the mozzarella cheese increased during the storage period (P>0.05). While M-TNR had the highest increase, M-NÇN had the lowest increase (Table 5). Proteolytic bacteria that contain *Clostridium* genus bacteria with spores are resistant to unfavorable conditions and survive despite their surroundings. Their ability to grow under poor conditions led to the increase during the ripening of the mozzarella cheese.

Sensorial analysis

Sensorial analyses were performed during the ripening period at 0, 15, and 28 days. On day 0, M-TNR had the highest general acceptability scores (P<0.05). Higher general acceptability scores were reported on day 15 than day 0, except in M-NÇN. On the last day of ripening, the scores were lower. M-TNR had the highest scores on days 15 and 28 (P<0.05). According to the sensorial panel, the scores at 15 days were higher than at 0 days, except for M-NÇN. On day 28, the samples were generally less accepted (Table 6).

Table 6. The values of sensory analysis of mozzarella cheese

Appearance	Control	6.75^{abA}	7.25^{bA}	5.54^{abB}
	M-KNK	6.25^{b}	7.13^{b}	6.00^{a}
	M-TNR	7.50^{aB}	8.38^{aA}	6.50^{aC}
	M-NÇN	5.87^{b}	5.75^{c}	4.75^{c}
Color	Control	7.25^{A}	7.38^{bA}	6.00^{aB}
	M-KNK	7.37^{AB}	7.88^{abA}	6.38^{aB}
	M-TNR	7.50	8.63^{a}	7.00^{a}
	M-NÇN	6.63^{A}	5.25^{cB}	4.38^{bB}
Structure	Control	7.63^{A}	7.75^{bA}	4.87^{bB}
	M-KNK	7.00^{A}	7.63^{abA}	5.38^{bB}
	M-TNR	7.75^{A}	8.50^{aA}	6.75^{aB}
	M-NÇN	7.50^{A}	5.50^{cB}	3.75^{cC}
Taste and smell	Control	7.75^{bA}	7.00^{bAB}	6.54^{aB}
	M-KNK	7.63^{b}	7.88^{ab}	6.75^{a}
	M-TNR	8.90^{aA}	8.42^{aB}	7.38^{aC}
	M-NÇN	6.37^{c}	5.88^{c}	4.88^{b}
General acceptability	Control	7.34^{abA}	7.22^{bA}	5.74^{bB}
	M-KNK	7.18^{bA}	7.63^{bA}	6.13^{bB}
	M-TNR	7.94^{aB}	8.48^{aA}	6.91^{aC}
	M-NÇN	6.59^{cA}	5.60^{cB}	4.44^{cC}

A - C: Values with the same capital letters in the same rows for each analysis differ significantly (P<0.05)
a - c: Values with the same capital letters in the same column for each analysis differ significantly (P<0.05)

Conclusion

Different spices were used in the production of mozzarella cheese and functional properties of the cheese were improved. The spices used inhibit health problems, but are not well known neither frequently consumed. Some functional properties and overall acceptability properties were improved to the mozzarella cheese, that can be defined as the new type of mozzarella. Casing of mozzarella should be preferred by dairy producers if they would like to expand their offer in the cheese markets.

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Utjecaj dodataka začinskog bilja na kvalitetu mozzarele

Sažetak

U ovom radu istražen je utjecaj 3 različite mješavine začinskog bilja u proizvodnji mozzarella sira. Sirno tijesto gnječeno je i punjeno u sirne marame, i uskladišteno 28 dana na 4 °C i relativnu vlagu 85 %. Istraženi su parametri boje, kiselosti mlijeka, ukupne suhe tvari i indeks zrenja. Također je istražen ukupan broj aerobno mezofilnih bakterija, te broj koliformnih bakterija, koagulaza pozitivnih stafilokoka, bakterija mliječne kiseline, proteolitičkih i lipolitičkih bakterija, te kvasaca i plijesni. Mikrobiološke analize su provedene 0., 5.,15., 21., i 28. dana skladištenja. Intenzitet žute boje povećao se tijekom skladištenja sira, dok se intenzitet bijele i crvene boje smanjivao. Parametri kiselosti, suhe tvari i indeksa zrenja povećani su tijekom zrenja. Utvđeno je smanjenje ukupnog broj aerobno mezofilnih bakterija, bakterija mliječne kiseline, *Lactoccus spp*., lipolitičkih bakterija te broja kvasaca i plijesni tijekom skladištenja, dok je broj proteolitičih bakterija porastao.

Ključne riječi: sir, mozzarella, začini, zrenje

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