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QUALITY EVALUATION OF KORBAČIK CHEESE

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ABSTRACT

The aim of the present study was analysed the physical and chemical parameters in lump cheese and Korbáčik cheese. Sensory evaluation was performed only in Korbáčik cheese. There was compared quality of Korbáčik cheese made from lump cheese ripened one and three weeks. The statistical analysis of the moisture showed significant differences (p <0.001) among Korbáčik cheese made from raw material ripened one and three weeks. Average moisture of the Korbáčik made from cheese ripened one week was 44.73% and of the Korbáčik made from cheese ripened three weeks was 53.73%. The statistical analysis of the dry mater value showed significant differences (p <0.001) among the Korbáčik cheese made from raw material ripened one and three weeks. Average value of dry matter of the Korbáčik made from cheese ripened one week was 55.27% and of the Korbáčik made from cheese ripened three weeks was 46.27%. The statistical analysis of the fat content showed significant differences (p <0.01) among the Korbáčik cheese made from raw material ripened one and three weeks. Average fat content of the Korbáčik made from cheese ripened one week was 22.67% and of the Korbáčik made from cheese ripened three weeks was 20.20%. The statistical analysis of the fat content in dry matter showed significant differences (p <0.001) among Korbáčik cheese made from raw material ripened one and three weeks. Average NaCl content in the Korbáčik made from cheese ripened one week was 3.78% and in the Korbáčik made from cheese ripened three weeks was 2.93%. The statistical analysis of MDA content showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average MDA content in the Korbáčik made from cheese ripened one week was 0.29 $mg.kg^{-1}$ and in the Korbáčik made from cheese ripened three weeks was 0.36 $mg.kg^{-1}$. Korbáčik cheese made from cheese aged 3 weeks was practically in all sensory parameters better evaluated than the Korbáčik cheese made from cheese aged one week.

Keywords: physico-chemical parameters; sensory parameters; malondialdehide; lump cheese

INTRODUCTION

Korbáčik cheese is traditional Slovak products and is listed in Council Regulation (EC) No. 510/2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs. Korbáčik cheese belongs to the steamed cheese. Steamed cheese production has a long tradition in Slovakia, although originally made from sheep's milk. Steamed cheeses form a special group of cheeses whose production is especially typical for countries in southern Europe, countries located on the Balkan peninsula, Greece and Italy, which are called general Pasta filata. This term has been extended and is now used internationally as a term for a group of steamed cheeses.

Several studies have been carried out to describe the influence of pasteurization on the cheese proteolysis, but mainly in cow milk cheeses **(Rosenberg et al., 1995; Beuvier et al., 1997; Skeie and Ardö, 2000)**. These studies have shown that there is little consistency among different varieties of cheeses, in relation to the influence of milk pasteurization on the primary and secondary proteolysis of cheeses.

Raw milk cheeses represent a significant proportion of matured cheeses in most Mediterranean countries, mainly those made from goat and ewe milk. To knowledge, few studies have been made to compare cheeses made from raw or pasteurized milk.

Cheese ripening represents an important technological process, during which cheese occurs microbiological and biochemical changes. It is influenced by intensity of proteolysis, contents of dry matter, NaCl and fats and by pH **(Everard et al., 2006; Saint-Eve et al., 2009)**. Cheese functional, texture and sensory properties develop during the process of maturing; nevertheless, proper maturation is a costly process **(Forde and Fitzgerald, 2000)**. The length of cheese ripening depends on the type of cheese.

Manufacturers of cheese try to decrease time of ripening (due to reduction of production costs). Therefore, unripe cheeses can be supplied to distribution networks. Their organoleptic properties are different in the comparison with the qualities of the cheeses matured under standard conditions **(Pachlová et al., 2011)**. Milk quality, chemical composition (e.g. moisture, fat or NaCl contents), using of proper starter lactic acid bacteria (SLAB) and presence of

non-starter lactic acid bacteria (NSLAB) may also influence processes occurring in ripening cheeses **(Al-Otaibi and Wilbey, 2004; Fenelon and Guinee, 2000; Floury et al., 2009; Pachlová et al., 2011; Shakeel-Ur-Rehman et al., 2000)**.

Acceleration of the maturing process is possible to solve the aforementioned problems of deteriorated cheese quality. It can compress the maturing period and, at the same time, ripeness of the products can reach a sufficient level. **Fox et al., (1996)** reported that the following factors can accelerate cheese ripening: elevated ripening temperatures, exogenous enzymes, chemically or physically modified cells, genetically modified starters, adjunct cultures, cheese slurries.

Increasing of temperature is regarded as the simplest method for acceleration of the ripening process from the technical point of view **(Sihufe et al., 2010a)**. Besides the quick growth of both SLAB and NSLAB, propagation of other undesirable contaminating microorganisms can occur and they can cause decreasing of quality of cheese and also cause alimentary intoxication or infection **(Iurlina and Fritz, 2004)**. **Sihufe et al., (2010b)** report possible double or triple decrease of ripening period by increase of ripening temperature by 6 °C.

Cheese ripening represents a very important technological process, during which cheese undergoes significant microbiological and biochemical changes. For consumers, texture plays a key role in cheese purchase. It is mainly influenced by intensity of proteolysis, contents of NaCl, dry matter and fats and by pH **(Everard et al., 2006 and Saint-Eve et al., 2009)**. Cheese texture and functional and sensory properties develop during the process of ripening; nevertheless, proper maturation is a costly process **(Forde and Fitzgerald, 2000)**. The length of cheese ripening depends on the type of cheese. Cheese manufacturers try to decrease ripening time (due to reduction of production costs). Therefore, insufficiently ripened cheeses can be supplied to distribution networks. Their organoleptic properties differ substantially from the qualities of the cheeses matured under standard conditions **(Pachlová et al., 2011)**. Acceleration of the ripening process is suggested to solve the aforementioned problems of deteriorated cheese quality. It can compress the ripening period and, at the same time, ripeness of the products can reach a satisfactory level. As reported by **Fox et al., (1996)**, the following factors can accelerate cheese ripening: elevated ripening temperatures, exogenous enzymes, chemically or physically modified cells, genetically modified starters, adjunct cultures, cheese slurries.

As reported by **Buňková et al., (2010); Komprda et al., (2007); Pachlová et al., (2011)**, the extent of microbiological and biochemical processes in individual parts of cheese might differ, that is why differences in development of texture parameters in individual cheese segments can be expected.

Salt had a significant effect on moisture, uptake of salt, pH, and hardness. Results indicated that higher percentages of salt in brine developed a harder cheese with higher salt content and higher pH values but lower moisture content. High rennet concentration had a significant effect on the uptake of salt. Increasing the concentration of rennet gave a softer cheese with higher salt content. Rennet level had no significant effect on the moisture or protein contents or pH of the cheese **(Prasad and Alvarez, 1999)**.

Prepared cheese is processed to mash by hot water. The recommended lower limit water temperature is 70 °C. The cheese is mixed with a paddle until the not achieve the correct structure of matter - suppleness, smoothness and elasticity. Recommended acidity of raw materials for steamed cheese is pH 5.1 to 5.0.

Cheese which is poorly fermented are difficult kneaded, small, and there is elastic enough - or at textured yarn cheese strip is torn and formed large differences in the thickness of the thread. In this case, the raw material is suitable and only after maturing may be produced from it.
It can be done manually or with the using of machines. In the production Korbáčik from the steamed cheese are forms to a thread (a diameter of 2-3 mm) that falls straight into cold water **(Konečná and Šustová, 2012)**. **Kunová et al., (2015)** found out **v**alues of TVC after 5 days of storage at temperature 4 °C were in range from 3.29 to 5.12×10^3 CFU.g^{-1}, but MFF were no found.

Oravas Korbáčik is a steamed cheese made from lump cheese contains especially thermoresistant lactic acid microflora of the genera: *Lactococcus*, *Streptococcus* and *Lactobacillus*. Chemical requirements: dry matter at least 40%. Fat in dry matter at least 25%, salt content of more than 4.5% unsmoked and 5.5% smoked. Microbiological characteristics: raw material for korbáčik the lump cheese, which contains mainly genera *Lactococcus*, *Lactobacillus* and *Streptococcus* - thermoresistant lactic acid microflora **(Council Regulation 510/2006)**.

The aim of the present study was analysed the quality of the Korbáčik cheese made of cheese aged 1 and 3 weeks.

MATERIAL AND METHODOLOGY

There were analysed samples of Korbáčik cheese quality, which were made from lump cheese aged 1 and 3 weeks. There were analysed 10 samples of Korbáčik cheese made from lump cheese aged 1 week and 10 samples aged 3 weeks.

Chemical composition analysis

The chemical composition of the raw material (cheese) and Korbáčik cheese was measured (50 g) by the FT IR method using the device Nicolet 6700. The total proteins in g/100g, the intramuscular fat in g/100g and total water in g/100g were analysed. The infra-red spectrum was carried out by the molecular spectroscopy method. The principle of this method is the absorption of the infra-red spectrum during the sample transition. There is a change of the rotary vibrating energetic conditions of the molecule depending on the changes of the dipole momentum molecule.

Determination of salt (NaCl)

Samples of approximately 2 g with 2 ml of indicator potassium chromate were titrated by solution of silver nitrate until a light orange color. The amount of silver nitrate was divided by weight of sample.

Determination of titratable acidity

The samples were homogenised, total 50 g of sample were used for analysis. Titratable acidity was determined by titration with 0.25 mol.L^{-1} NaOH and phenolphthalein was added before titration. Acidity was determined as 2 times the volume of NaOH used in titration. The results were expressed as titration activity in °SH (Soxhlet-Henkel).

Determination of malondialdehyde

The degradation products of Korbáčik cheeses were analysed. Malondialdehyde (MDA) was measured in the Korbáčik cheese. MDA number was determined according to **Marcinčák et al. (2006)**. Absorbance of samples was measured at a wavelength of 532 nm on UV-VIS spectrophotometer Jenway 7305 (United Kingdom - JENWAY). Results will be calculated as the mg of MDA in 1 kg of sample.

Sensory analysis

These organoleptic characteristics were evaluated in sensory analysis: aroma and taste, consistency, color and appearance. Sensory analysis was performed using the sensory evaluation using scale. A five-point scale was used to the characteristics of each point. Assessment system was chosen, the highest number of points (5) was evaluated as, excellent "and 1 point as "unacceptable".

Statistical analyse

The data were subjected to statistical analysis using the Statistic Analysis System (SAS) package (SAS 9.3 using of application Enterprise Guide 4.2). Differencies between groups were analysed by t-test.

RESULTS AND DISCUSSION

Korbáčik cheese is traditional Slovak products and it belongs to the steamed cheese. Physical and chemical parameters were evaluated in lump cheese and Korbáčik cheese. Sensory evaluation was performed only in Korbáčik cheese.

Average moisture of lump cheese was 44.77% and ranged from 44.20 to 45.10% after first week of ripening. Average moisture of lump cheese was 45.17% and ranged from 44.60 to 45.40% after third week of ripening (Table 1). **Okpala et al., (2010)** found out moisture in the fresh cheese 63.10% on the 1st day and 59.9% on the 8th day after processing.

Average value of dry matter was 55.23% in the lump cheese after first week of ripening and 54.88% after third week of ripening.

Average fat content was 25.33% in the lump cheese after first week of ripening and 22.07% after third week of ripening. Fat content ranged from 25.20 to 25.50% after first week and from 21.90 to 22.30% after third week of ripening in the lump cheese. **Okpala et al., (2010)** found out fat content 16.02% in the fresh cheese.

The statistical analysis of the fat content in dry matter showed significant differences (p <0.05) among the lump cheese after first week of ripening and after third week of ripening. Average content of fat in dry matter was 45.87 after first week of ripening and 40.21% after third week after ripening in the lump cheese. Content of fat in dry matter was in range from 45.34 to 46.36% after first week and from 39.53 to 40.81% after third week of ripening in the lump cheese. Fresh cheese is classified as semi-soft cheeses **(Bozoudi et al., 2015)**.

Average content of NaCl was 0.39 after first week of ripening and 0.38% after third week of ripening in the lump cheese. Content of NaCl in the lump cheese ranged from 0.31 to 0.43% after first week and from 0.30 to 0.45% after third week of ripening.

Table 1 Physical and chemical parameters of raw materials (lump cheese) after the first and third week of ripening.

Parameters	Moisture (%)	Dry matter (%)	Fat (%)	Fat in dry matter (%)	NaCl (%)	Acidity °SH	MDA (mg/kg)
The raw materials (lump cheese) after the first week of ripening							
mean	44.77	55.23	25.33	45.87	0.39	98.27	0.37
S. D.	0.49	0.49	0.15	0.51	0.07	0.70	0.02
S. E.	0.28	0.28	0.09	0.29	0.04	0.41	0.01
Min.	44.20	54.90	25.20	45.34	0.31	97.60	0.36
Max.	45.10	55.80	25.50	46.36	0.43	99.00	0.40
CV%	1.10	0.89	0.60	1.11	17.22	0.71	6.18
The raw materials (cheese) after the third week of cheese ripening							
mean	45.17	54.88	22.07	40.21	0.38	108.33	0.59
S. D.	0.45	0.45	0.21	0.64	0.08	2.08	0.13
S. E.	0.26	0.26	0.12	0.37	0.04	1.20	0.07
Min.	44.60	45.60	21.90	39.53	0.30	106.00	0.51
Max.	45.40	55.40	22.30	40.81	0.45	110.00	0.73
CV%	0.99	0.82	0.94	1.60	19.92	1.92	21.49
t - test	-	-	-	+	-	+	+

Note: °SH – Soxhlet-Henkel, MDA – malondyaldehyde, p >0.05; + $p \leq 0.05$.

Table 2 Physical and chemical parameters of a Korbáčik cheese made from raw materials after the 1st and 3rd week of cheese ripening.

Parameters	Moisture (%)	Dry matter (%)	Fat (%)	Fat in dry matter (%)	NaCl (%)	°SH	MDA (mg/kg)
The Korbáčik cheese made after the first week of cheese ripening							
mean	44.73	55.27	22.67	40.35	3.78	99.00	0.29
S. D.	0.55	0.55	0.76	0.34	0.33	2.00	0.03
S. E.	0.32	0.32	0.44	0.19	0.19	1.15	0.02
Min.	44.10	54.90	22.00	40.07	3.40	97.00	0.27
Max.	45.10	55.90	23.50	40.72	4.00	101.00	0.32
CV%	1.23	1.00	3.37	0.83	8.80	2.02	10.51
The Korbáčik cheese made after the third week of cheese ripening							
mean	53.73	46.27	20.20	43.66	2.93	109.73	0.36
S. D.	0.68	0.68	0.26	0.57	0.76	4.06	0.07
S. E.	0.39	0.39	0.15	0.33	0.45	2.34	0.04
Min.	52.95	45.80	19.90	43.31	2.15	107.00	0.31
Max.	54.20	47.05	20.4	44.32	3.70	114.4	0.43
CV%	1.27	1.48	1.31	1.30	26.43	3.70	18.5
t - test	+ + +	+ + +	+ +	+ + +	-	+	+

Note: p >0.05; + $p \leq 0.05$; ++ $p \leq 0.01$; +++ $p \leq 0.001$.

Table 3 Sensory evaluation of Korbáčik cheese made from raw materials after 1st week and 3rd week of cheese ripening.

Parameters	**Smell**	**Taste**	**Color**	**Consistency**	**Appearance**
The Korbáčik cheese made after the first week of cheese ripening					
mean	4.17	4.33	4.67	5.00	3.83
S.D.	0.29	0.29	0.29	0.00	0.29
S.E.	0.17	0.17	0.17	0.00	0.17
min	4.00	4.00	4.50	5.00	3.50
max	4.50	4.50	5.00	5.00	4.00
CV%	6.93	6.66	6.19	0.00	7.53
The Korbáčik cheese made after the third week of cheese ripening					
mean	5.00	5.00	4.83	5.00	4.83
S. D.	0.00	0.00	0.29	0.00	0.29
S.E.	0.00	0.00	0.17	0.00	0.17
min	5.00	5.00	4.50	5.00	4.50
max	5.00	5.00	5.00	5.00	5.00
CV%	0.00	0.00	5.97	0.00	5.97
t - test	+	+	-	-	+

Note: p >0.05; + $p \leq 0.05$.

The statistical analysis of the acidity (°SH) showed significant differences ($p < 0.05$) among the lump cheese after first week of ripening and after third week of ripening. Average acidity was 98.27 °SH after first week of ripening and 108.33 °SH after third week of ripening in the lump cheese.

The statistical analysis of the MDA content showed significant differences ($p < 0.05$) among the lump cheese after first week of ripening and after third week of ripening. Average concentration of malondyaldehyde (MDA) was 0.37 $mg.kg^{-1}$ after first week and 0.59 $mg.kg^{-1}$ after third week of ripening in the lump cheese. Variability of MDA concentration was higher in the lump cheese after third week after ripening (CV% 21.49) and it ranged from 0.51 to 0.73 $mg.kg^{-1}$.

Physical and chemical parameters of the Korbáčik cheese are shown in the Table 2. The statistical analysis of the moisture showed significant differences ($p < 0.001$) among

Korbáčik cheese made from raw material ripened one and three weeks. Average moisture of the Korbáčik made from cheese ripened one week was 44.73% and of the Korbáčik made from cheese ripened three weeks was 53.73%. Similar with our results, **Owni and Osman (2009)** reported values of moisture between 45.4 and 48.5% for steamed cheese. **Maldonado et al. (2013)** found out opposite our results higher moisture content (48.12 – 53.55%).

The statistical analysis of the dry mater value showed significant differences (p <0.001) among the Korbáčik cheese made from raw material ripened one and three weeks. Average value of dry matter of the Korbáčik made from cheese ripened one week was 55.27% and of the Korbáčik made from cheese ripened three weeks was 46.27%. Dry matter content of the Korbáčik made from cheese ripened one week ranged from 54.90 to 55.90% and of the Korbáčik made from cheese ripened three weeks ranged from 45.80 to 47.05%

The statistical analysis of the fat content showed significant differences (p <0.01) among the Korbáčik cheese made from raw material ripened one and three weeks. Average fat content of the Korbáčik made from cheese ripened one week was 22.67% and of the Korbáčik made from cheese ripened three weeks was 20.20%.

The statistical analysis of the fat content in dry matter showed significant differences (p <0.001) among Korbáčik cheese made from raw material ripened one and three weeks. Average fat content in dry matter of the Korbáčik made from cheese ripened one week was 40.35% and of the Korbáčik made from cheese ripened three weeks was 43.66%. Fat content in dry matter in the Korbáčik made from cheese ripened one week ranged from 40.07 to 40.72% and in the Korbáčik made from cheese ripened three weeks ranged from 43.31 to 44.32%.

Maldonado et al. (2013) found out opposite our results higher fat content in dry matter (49.52 – 54.94%) in the steamed cheese.

Average NaCl content in the Korbáčik made from cheese ripened one week was 3.78% and in the Korbáčik made from cheese ripened three weeks was 2.93%. Variability of NaCl content was higher in the Korbáčik cheese made from raw material ripened three weeks (CV% 26.43) and it ranged from 2.15 to 3.70%. Higher variability of salts content associated with more variable thickness raw thread. **Ma et al. (2013)** found out opposite our results lower content of NaCl from 1.07 to 1.29% in the steamed cheese.

The statistical analysis of the acidity (°SH) showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average acidity of the Korbáčik made from cheese ripened one week was 99.00 °SH and of the Korbáčik made from cheese ripened three weeks was 109.73 °SH.

The statistical analysis of MDA content showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average MDA content in the Korbáčik made from cheese ripened one week was 0.29 mg.kg^{-1} and in the Korbáčik made from cheese ripened three weeks was 0.36 mg/kg. MDA content was reduced by salting of the cheese in hot water. **Papastergiadis et al. (2014)** found out content of MDA in steamed cheese in range from 0.20 to 0.66 mg.kg^{-1}.

Results of sensory evaluation of Korbáčik cheese made from raw materials ripened 1 week and 3 weeks are shown in table 3. The sensory quality was analysed by Sensory descriptors and was defined from the appearance, aroma, flavor and texture evaluation by commission. Sensory evaluation was performed by 5 points system. The statistical analysis of the smell showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average point numbers for smell of Korbáčik cheese made from raw materials ripened 1 week was 4.17 and of Korbáčik cheese made from raw materials ripened 3 weeks was 5.00.

The statistical analysis of the taste showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average point numbers for taste of Korbáčik cheese made from raw materials ripened 1 week was 4.33 and of Korbáčik cheese made from raw materials ripened 3 weeks was 5.00.

Average point numbers for color of Korbáčik cheese made from raw materials ripened 1 week was 4.67 and of Korbáčik cheese made from raw materials ripened 3 weeks was 4.83.

Average point numbers for consistency of Korbáčik cheese made from raw materials ripened 1 and 3 weeks was the same 5.00.

The statistical analysis of the appearance showed significant differences (p <0.05) among the Korbáčik cheese made from raw material ripened one and three weeks. Average point numbers for taste of Korbáčik cheese made from raw materials ripened 1 week was 3.83 and of Korbáčik cheese made from raw materials ripened 3 weeks was 4.83. **Romeih et al. (2002)** evaluated steamed cheese by 7 points method and they found out appearance 5.8 points, consistency 3.7, flavour 4.9 and odour 4.8 points.

Korbáčik cheese made from cheese aged 3 weeks was practically in all sensory parameters better evaluated than the Korbáčik cheese made from cheese aged one week.

CONCLUSION

The aim of this study was analysed the physical and chemical parameters in lump cheese and Korbáčik cheese. Sensory evaluation was performed only in Korbáčik cheese. There was compared quality of lump cheese and Korbáčik cheese made from lump cheese ripened one and three weeks. The statistical analysis of the moisture showed significant differences among Korbáčik cheese made from raw material ripened one and three weeks. The statistical analysis of the dry mater value showed significant differences among the Korbáčik cheese made from raw material ripened one and three weeks. The statistical analysis of the fat content showed significant differences among the Korbáčik cheese made from raw material ripened one and three weeks. Average fat content in dry matter of the Korbáčik made from cheese ripened one week was lower in comparison with the Korbáčik made from cheese ripened three weeks. Average NaCl content in the Korbáčik made from cheese ripened one week was higher in comparison with the Korbáčik made

from cheese ripened three weeks. The statistical analysis of the acidity showed significant differences among the Korbáčik cheese made from raw material ripened one and three weeks. Average MDA content in the Korbáčik made from cheese ripened one week was significantly lower in comparison with the Korbáčik made from cheese ripened three weeks. Korbáčik cheese made from cheese aged 3 weeks was practically in all sensory parameters better evaluated than the Korbáčik cheese made from cheese aged one week.

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REFERENCES

Al-Otaibi, M. M., Wilbey, R. A. 2004. Effect of temperature and salt on the maturation of white-salted cheese. *International Journal of Dairy Technology*, vol. 57, no. 1, p. 57-63. http://dx.doi.org/10.1111/j.1471-0307.2004.00123.x

Beuvier, E., Berthaud, K., Cegarra, S., Dasen, A., Pochet, S., Buchin, S., Duboz, G. 1997. Ripening and quality of Swiss-type cheese made from raw, pasteurized or microfiltered milk. *International Dairy Journal*, vol. 7, no. 5 p. 311-323. http://dx.doi.org/10.1016/s0958-6946(97)00015-0

Bozoudi, D., Kotzamanidis, Ch., Hatzikamari, M., Tzanetakis, N., Menexes, G., Litopoulou-Tzanetaki, E. 2015. A comparison for acid production, proteolysis, autolysis and inhibitory properties of lactic acid bacteria from fresh and mature Feta PDO Greek cheese, made at three different mountainous areas. *International Journal of Food Microbiology*. vol. 200, p. 87-96. http://dx.doi.org/10.1016/j.ijfoodmicro.2015.02.008

Buňková, L., Buňka, F., Mantlová, G., Čablová, A., Sedláček, I., Švec, P., Pachlová, V., Kráčmar, S. 2010. The effect of ripening and storage conditions on the distrinution of tyramine, putrescine and cadaverine in Edam-cheese. *Food Microbiology*, vol. 27, no. 7, p. 880-888. http://dx.doi.org/10.1016/j.fm.2010.04.014

Council regulation (EC) No 510/2006 of 20 March 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs. (OJ L 93, 31.3.2006, p. 12–25).

Everard, C. D., O'Callagan, D. J., Howard, T. V., O'Donnell, C. P., Sheehan, E. M., Delahunty, C. M. 2006. Relantionships between sensory and rheological measurements of texture in maturing commercial Cheddar cheese over a range of moisture and pH at the point of manufacture. *Journal of Texture Studies*, vol. 37, no. 4, p. 361-382. http://dx.doi.org/10.1111/j.1745-4603.2006.00057.x

Fenelon, M. A., Guinee, T. P. 2000. Primary proteolysis and textural changes during ripening in cheddar cheese manufactured to different fat contents. *International Dairy Journal*, vol. 10, no. 3, p. 151-158. http://dx.doi.org/10.1016/s0958-6946(00)00040-6

Floury, J., Camier, B., Rousseau, F., Lopez CH., Tissier, J. P. Famelart, M. H. 2009. Reducing salt level in food: Part 1. Factors affecting the manufacture of model cheese systems and their structure–texture relantionships. *Lebensmittel-Wissenschaft und Technologie – Food Science and Technology*, vol. 42, no. 10, p. 1611-1620. http://dx.doi.org/10.1016/j.lwt.2009.05.026

Forde, A., Fitzgerald, G. F. 2000. Biotechnological approaches to the understanding and improvement of mature cheese flavour. *Current Opinion in Biotechnoloby*, vol. 11, no. 5, p. 484-489. http://dx.doi.org/10.1016/s0958-1669(00)00130-0

Fox, P. F., Wallace, J. M., Morgan, S., Lynch, C. M., Niland, E. J., Tobin, J. 1996. Acceleration of cheese ripening. *Antonie van Leeuwenhoek*, vol. 70, no. 2-4 p. 271-297. http://dx.doi.org/10.1007/bf00395937

Iurlina, M. O., Fritz, R. 2004. Microbiological quality of Port Salut Argentino cheese stored at two temperature treatments. *Lebensmittel-Wissenschaft und Technologie – Food Science and Technology*, vol. 37, no. 7, p. 739-748. http://dx.doi.org/10.1016/j.lwt.2004.02.011

Komprda, T., Smělá, D., Novická, K., Kalhotka, L., Šustová, K., Pechová, P. 2007. Content and distribution of biogenic amines in Dutch-type hard cheese. *Food Chemistry*, vol. 107, no. 1, p. 129-137. http://dx.doi.org/10.1016/j.foodchem.2006.04.041

Konečná, H., Šustová, K. 2012. *Výroba pařených sýrů. Farmářská výroba sýru a kysaných mléčnych výrobků IX*. p. 9-12. ISBN 978-08-7375-613-0.

Kunová, S., Kačániová, M., Čuboň, J., Haščík, P., Lopašovský, Ľ. 2015. Evaluation of microbiological quality of selected cheeses during storage. *Potravinarstvo*, vol. 9, no. 1, p. 143-148. http://dx.doi.org/10.5219/463

Ma, X., James, B., Balaban, M. O., Zhang, L., Emanuelsson-Patterson, E. A. C.. 2013. Quantifying blistering and browning properties of Mozzarella cheese. Part II: Cheese with different salt and moisture contents. *Food Research International*, vol. 54, no. 1, p. 917-921. http://dx.doi.org/10.1016/j.foodres.2013.05.029

Maldonado, R., Melendez, B., Arispe, I., Boeneke , C., Torrico, D., Prinyawiwatkul, W. 2013. Effect of pH on technological parameters and physicochemical and texture characteristics of the pasta filata cheese Telita. *Journal of Dairy Science*, vol. 96, no. 12, p. 7414-7426. http://dx.doi.org/10.3168/jds.2013-6887

Marcinčak , S. *et al.* 2004. Determination of lipid oxidation level in broiler meat by liquid chromatography. *Journal of AOAC International*, vol. 87, no. 5, p.1148-1152.

Okpala, Ch. O. R., Piggott, J. R., Schaschke, C. J. 2010. Influence of high-pressure processing (HPP) on physico-chemical properties of fresh cheese. *Innovative Food Science & Emerging Technologies*. vol. 11. no. 1, p. 61-67. http://dx.doi.org/10.1016/j.ifset.2009.10.003

Owni, O., Osman, S. 2009. Evaluation of chemical composition and yield of Mozzarella cheese using two different methods of processing. *Pakistan Journal of Nutrition*, vol. 8, no. 5, p. 684-687. http://dx.doi.org/10.3923/pjn.2009.684.687

Pachlová, V., Buňka, F., Buňková, L., Weiserová, E., Budinský, P., Žaludek, M., Kráčmar, S. 2011. The effect of three different ripening/storage conditions on the distribution of selected parameters in individual parts of Dutch-type cheese. *International Journal of Food Science and Technology*, vol. 46, no. 1, p. 101-108. http://dx.doi.org/10.1111/j.1365-2621.2010.02460.x

Papastergiadis, A., Fatouh, A., Jacxsens, L., Lachat, C., Shrestha, K., Daelman, J., Kolsteren, P., Van Langenhove, H., De Meulenaer, B. 2014. Exposure assessment of Malondialdehyde, 4-Hydroxy-2-(E)-Nonenal and 4-Hydroxy-2-(E)-Hexenal through specific foods available in Belgium. *Food and Chemical Toxicology*, vol. 73, p. 51-58. http://dx.doi.org/10.1016/j.fct.2014.06.030

Prasad, N., Alvarez, V. B. Effect of Salt and Chymosin on the Physico-Chemical Properties of Feta Cheese During Ripening. *Journal of Dairy Science*. vol. 82, no. 6, p. 1061-1067. http://dx.doi.org/10.3168/jds.s0022-0302(99)75327-0

Romeih, E. A., Michaelidou, A., Biliaderis, C. G., Zerfiridis, G. K. 2002. Low-fat white-brined cheese made from bovine milk and two commercial fat mimetics: chemical, physical and sensory attributes. *International Dairy Journal*, vol. 12, no. 6, p. 525-540. http://dx.doi.org/10.1016/s0958-6946(02)00043-2

Rosenberg, M., Wang, Z., Chuang, S. L., Shoemaker, C. F. 1995. Viscoelastic property changes in Cheddar cheese during ripening. *Journal of Food Science*, vol. 60, no. 3, p. 640-644. http://dx.doi.org/10.1111/j.1365-2621.1995.tb09846.x

Sant'Ana, A. M. S., Bezerril, F. F., Madruga, M. S., Batista, A. S. M., Magnani, M., Souza, E. L., Queiroga, R. C. R. E. 2013. Nutritional and sensory characteristics of Minas fresh cheese made with goat milk, cow milk, or a mixture of both. *Journal of Dairy Science*. vol. 96, no. 12, p. 7442-7453. http://dx.doi.org/10.3168/jds.2013-6915

Saint-Eve, A., Lauverjat, C., Magnan, C., Déléris, I., Souchon, I. 2009. Reducing salt and fat content: Impact of composition, texture and cognitive interactions on the perception of flavoured model cheeses. *Food Chemistry*, vol. 116, no. 1, p. 167-175. http://dx.doi.org/10.1016/j.foodchem.2009.02.027

Shakeel-Ur-Rehman, Banks, J. M. McSweeney, P. L. H., Fox, P. F. 2000. Effect of ripening temperature on the growth and significance of non-starter lactic acid bacteria in Cheddar cheese made from raw or pasteurised milk. *International Dairy Journal*, vol. 10, no. 1-2, p. 45-53. http://dx.doi.org/10.1016/s0958-6946(00)00022-4

SAS. 2008. 9.3 Enhanced Logging Facilities, Cary, NC: SAS Institute Inc., statistic program SAS 9.3 with application of Enterprise Guide 4.2

Sihufe, G. A., Zorrilla, S. E., Perotti, M. C., Wolf, I. V., Zalazar, C. A., Sabbag, M. G., Cpsta. S. C., Rubiolo, A. C. 2010a. Acceleration of cheese ripening at elevated temperature. An estimation of the optimal ripening time of a traditional Argentinean hard cheese. *Food Chemistry,* vol., 119, no. 1, p. 101-107. http://dx.doi.org/10.1016/j.foodchem.2009.06.001

Sihufe, G. A., Zorrilla, S. E., Sabbag, N. G., Costa, S. C., Rubiolo, A. C. 2010b. The influence of ripening temperature on the sensory characteristics of Reggianito Argentino cheese. *Journal of Sensory Studies*, vol. 25, no. 1, p. 94-107. http://dx.doi.org/10.1111/j.1745-459x.2009.00248.x

Skeie, S., Ardö, Y. 2000. Influence from raw milk flora on cheese ripening studied by different treatments of milk to model cheese. *Lebensmittel-Wiss u-Technol,* vol. 33, no. 7, p. 499-505. http://dx.doi.org/10.1006/fstl.2000.0700

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