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QUALITATIVE ANALYSIS OF STEAMED CHEESES OF SLOVAKIA AND NEIGHBORING COUNTRIES

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ABSTRACT

The work compared the quality of steamed cheese samples from Slovakia (group A – SR; unsmoked steamed, smoked steamed threads, oštiepok cheeses or salami cheeses, parenica cheeses) and neighboring countries (group B – CZ, C – HU, D – PL, E – UA). From the point of view of the sensory analysis, it turned out that the evaluators evaluated sample A1 as the best cheese (unsmoked threads from Slovakia). Their surface was smooth, shiny and of a slightly yellowish color, the consistency was flexible to stiffer, slightly brittle, with separating fibers. The smoked threads from Ukraine (E2) was the worst in the evaluation. The consistency was extremely firm, very hard, not very flexible, with poorly separating fibers. We determined the lowest dry matter content in sample A1 (44.27 ± 0.33), sample B1 did not reach the minimum required dry matter content of 48% declared (46.30 ± 0.24). The sample E2 had the highest dry matter content (65.97 ± 0.26) and also had the highest salt content (6.90 ± 0.09). Statistical significance in the "parenica" group was confirmed in the parameters: Dry matter, Fat in dry matter, Salt content, pH and Titratable acidity at the level of statistical significance $p < 0.001$. Coagulase-positive staphylococci were detected in all examined samples. Lactic acid bacteria were isolated in each cheese sample. Micromycetes were detected in five samples, where in the case of parenica samples (B4 – CZ; D4 – PL; E4 – UA). During the year, the growth of micromycetes in the samples represented a statistical significance of $p < 0.05$.

Keywords: steamed cheeses, quality, composition, sensory evaluation, protected designation of origin

INTRODUCTION

The production and consumption of steamed cheeses is typical for southern European countries in the Mediterranean Sea, especially for the Balkan states, Greece, but also for Central European states such as Slovakia or Poland. However, the cradle of steamed cheeses is considered to be Italy, where steamed cheeses were originally made from the milk of buffalo cows. From there, their production spread to other parts of the world, and cow's and sheep's milk began to be used for their production **(Fox *et al.* 2004)**.

The production of steamed cheese has a long tradition in Slovakia. According to the Regulation of the European Parliament and Council (EU) no. 1151/2012 **(Lewis, 2014)** on the quality system for agricultural products and foodstuffs includes steamed cheeses such as: Slovak oštiepok, Slovak parenica, Orava korbáčik, Zázrivský korbáčik, Tekovský salami cheese, Klenovecký cheese, Zázrivské vojky among the protected designation of origin (PDO) and among protected geographical indication (PGI). These cheeses are considered typical Slovak dairy specialties **(Gragnani, 2013).**

For the production of steamed cheese, lump cheese made from raw or pasteurized cow's milk with the addition of milk culture is used. Steamed cheeses are characterized by a unique production technology, which includes a heat treatment step with hot water (steaming, 75-85 °C). Thanks to this step, the cheese dough acquires plasticity and can be pulled into fibers or otherwise shaped. The importance of the steaming process lies mainly in improving the sensory properties of cheeses **(Keresteš 2007; Šnirc *et al.* 2016).**

The steaming process is followed by kneading, shaping and cooling. the next stage of the production of steamed cheeses is salting, and subsequently the plastic mass of the curd is manually or mechanically shaped duringinto the desired shape (threads, fibers, balls, etc.) **(Hui *et al.*, 2004)**. Salt plays an important role in cheese making. The salt content in cheese directly affects the taste of cheeses, promotes rennet syneresis and thus regulates the water content in cheese, reduces the water activity of cheese, affects the activity of native milk enzymes, rennet enzymes and enzymes of cultured and uncultured microorganisms. Salt also regulates the fermentation of residual lactose and thus the pH value in young cheese, as well as the ripening process and the quality of ripening cheeses **(Roginski, 2002; Fox *et al.*, 2004; Yu *et al.*, 2005; Bähler *et al.*, 2016; Keresteš 2016; Šnirc *et al.* 2016; Zimanová *et al.*, 2016;)**.

Fat losses in the production of steamed cheeses are greater because they are the sum of the losses incurred during the separation of the whey from the curd and the losses during the steaming in hot water **(Cipolat-Gotet *et al.*, 2020)**.

In addition to their shape and size, the range of steamed cheeses is also expanded by smoking. Smoking cheeses helps extend their shelf life thanks to the bacteriostatic, bactericidal, and antioxidant properties of smoke **(Trugo and Finglas, 2003)**. During smoking, specific sensory properties arise such as a smoky smell, taste and golden yellow color **(Selecký, 2013; Semjon, 2019)**. However, the smoking of cheeses in an insufficiently controlled process can lead to the formation of polycyclic aromatic hydrocarbons, the high concentration of which can threaten the product's safety **(Pluta-Kubica *et al.*, 2020)**.

The quality of steamed cheeses can also be affected by the way they are packaged. In particular, vacuum packaging can have a negative effect on the quality of cheeses **(Fuentes *et al.*, 2015)**.

The overall quality of the cheese depends on the composition of the microflora, which reflects the quality of milk and water, hygiene and contamination during production and subsequent storage conditions. Groups of microorganisms responsible for undesirable proteolysis and spoilage of steamed cheeses are mainly pseudomonads, various psychrotrophic bacteria (*Acinetobacter, Bacillus, Serratia*), coliform bacteria (*Klebsiella, Enterobacter, Escherichia coli*) and yeasts (*Kluyveromyces, Saccharomyces, Clavispora*) **(Aponte *et al.*, 2010; Bryden, 2012; Becker-Algeri *et al.*, 2016)**.

The main factors that affect the survival of microorganisms in cheese are pasteurization of milk, acidity and steaming of cheese. The amount and diversity of surviving microorganisms directly and indirectly affect most of the biochemical, chemical and physical processes taking place in milk, curd and cheese. These processes lead to the development of organoleptic and textural properties of cheeses **(Fox *et al.*, 2004)**.

Similar cheeses to our traditional ones are also produced in neighboring countries. In the Polish Tatras, for example under the name "Oscypek", in Hungary it is Parenyica or Bocskorka, in the Czech Republic the name "Slovak" is given in most labels. In Ukraine, "Przysmak Góralski", "Cheese bars", "Monashynski Syry" or smoked braided cheese "Chechil". Since Slovak cheeses have a protected designation of origin PDO, this means that if someone wants to produce cheese with this name, they must follow the exact recipe, including regional affiliation **(Majcher *et al.*, 2010)**.

Scientific hypothesis

The hypothesis we tested was that the sensory, physicochemical and microbiological properties of steamed cheeses may differ depending on the country of origin and thus the recipe used for production.

Scientific hypothesis: There is a statistically significant difference between samples of steamed cheeses produced in Slovakia and in Slovakia's neighboring states.

MATERIAL AND METHODS

Samples used for analysis

The work compared the quality of samples from Slovakia (group A) and similar cheeses sold in neighboring countries (group B – Czech Republic, C – Hungary, D – Poland, E – Ukraine). For the analysis, we used 4 types of steamed cheeses from five countries seasonally. We performed the analyses in two periods of time (in July 2023 and in December 2023; n = 20/20).

The quality of cheese were evaluated following sample groups:

- unsmoked steamed threads (A1, B1, C1, D1, E1),
- smoked steamed threads (A2, B2, C2, D2, E2),
- oštiepok cheeses or salami cheeses (A3, B3, C3, D3, E3),
- parenica cheeses (A4, B4, C4, D4, E4).

The total of experimental samples differed according to the market treatment (threads, oštiepok cheeses, parenica cheeses), the method of treatment (smoked or unsmoked) and the method of packaging (polyethylene bag, vacuum packaging, protective atmosphere).
We evaluated the samples in the laboratory at the Department of food hygiene, technology and safety at the University of veterinary medicine and pharmacy in Košice and in the Institute of Postgraduate Education of Veterinary Medicine in Košice.

Sensory analysis

The sensory examination according to **Mal'a (2012)** and **Lawless and Heymann (2010)** consisted in the evaluation of the packaging, taste, aroma, consistency and color of the samples by a selected group of evaluators by a ten person panel.
A panel of assessors were selected and trained according to ISO standards **(ISO, 1993)**, in the sensory laboratory set up according to ISO standards **(ISO, 1988)** in the Institute of postgraduate education of veterinary medicine in Košice, Slovakia. After panel training, the curd samples were served in random order to each panelist. The samples (Figure 1) were freshly prepared and kept in a refrigerator until serving **(Mal'a, 2012)**. Samples were served at 20 °C (temperature of consumption 20 ± 2 °C). Mineral water was provided for mouth-rinsing.

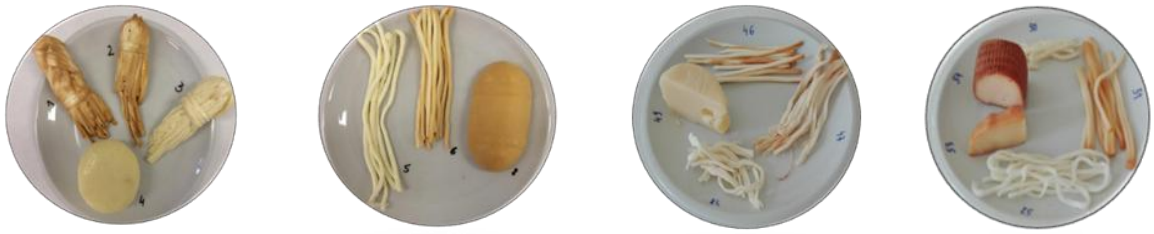

Figure 1 Demonstration of samples of steamed cheeses of various origins submitted anonymously

Physicochemical analysis

Samples were analyzed for: fat, fat in dry matter, salt content, pH, titratable acidity, and water activity (aw).
The fat content of curd was determined by Gerber's method.
Dry matter was detected by international standard methods **(International Dairy Federation, 1982)** and salt content was detected by Mohr method.
The pH of dispersion was measured potentiometrically using a digital inoLab® pH 340i meter (WissenschaftlichTechnische Werkstätten, Weilheim, Germany) **(International Dairy Federation, 1989).**
The Soxhlet-Henkel method (°SH.100 mL^{-1}) was used for analyses of acidity detection **(Parvin *et al.*, 2008).**
Water activity (aw) of curds was detected by using the LabMASTER-aw (Novasina AG, Lachen, Switzerland) regularly calibrated **(Regecová *et al.*, 2020)**.
For each sample, six measurements of physico-chemical parameters were performed and the obtained results were then statistically evaluated.

Microbial analysis

From all tested samples, basic suspensions and final dilutions were prepared according to ISO 6887-5. The presence of individual microorganisms from the Gram-positive and Gram-negative family was detected in the examined samples according to the relevant ISO standards.
The detection of the number of bacteria of the Enterobacteriaceae family was performed using the **STN EN ISO 21528-1** method. The number of coagulase-positive staphylococci (CoPS) in the examined samples was determined according to **STN EN ISO 6888-1** using the Baird-Parker selective-diagnostic medium (HiMedia, India). At the same time, the number of lactic acid bacteria (LAB) was determined according to **STN ISO 15214**, as well as yeasts and molds according to **ISO 21527**.
Microbiological values were logarithmically transformed (log10) to approximate the data to a normal frequency distribution in order to properly apply statistical testing methods (one-way analysis of variance).

RESULTS AND DISCUSSION

Results of sensory analysis

The results of the point evaluation of winter samples of steamed cheeses are shown in Figure 1. As the best cheese, the evaluators evaluated sample A1 (unsmoked threads from Slovakia), which received the highest rating of 30 points out of a maximum of 35 points. Their surface was smooth, shiny and slightly yellowish in color, the consistency was flexible to firmer, slightly brittle, with separating fibers. The product had high tensile strength. The smell and taste of sample A1 were pleasant milky, deliciously cheesy, and slightly salty.

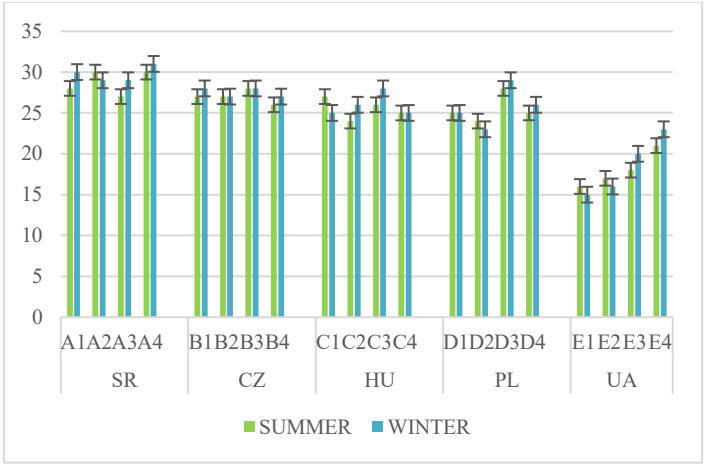

Figure 1 The results of the sensory evaluation of steamed cheese samples using a 5-point test for the observed parameters. A1 – E1- unsmoked steamed threads; A2 – E2 - smoked steamed threads; A3 – E3 - oštiepok cheeses or salami cheeses; A4 – E4 - parenica cheeses

The E2 sample (smoked threads from Ukraine) was the worst in the evaluation. In the point test for consistency, they received the lowest rating (15 points). The consistency was firm, hard, not very flexible, with weakly separating fibers. There was a large amount of loose whey in the package. The surface was shiny and smooth, the color significantly brown after smoking, but uneven. The smell and taste were significantly musty, extremely salty. The E4 sample, which received 17 points, received an equally bad rating. It was extremely salty, slightly musty, sour, heavily smoky and not very typical. Both samples were assessed as unsatisfactory. No statistical significance was demonstrated for the observed samples within the period of the year ($p > 0.05$). Samples originating from Ukraine did not meet the requirements set for products from Slovakia and European Union products. The sensory profile results for taste and consistency are illustrated in Figure 2, highlighting the most notable deviations observed in the steamed thread samples.

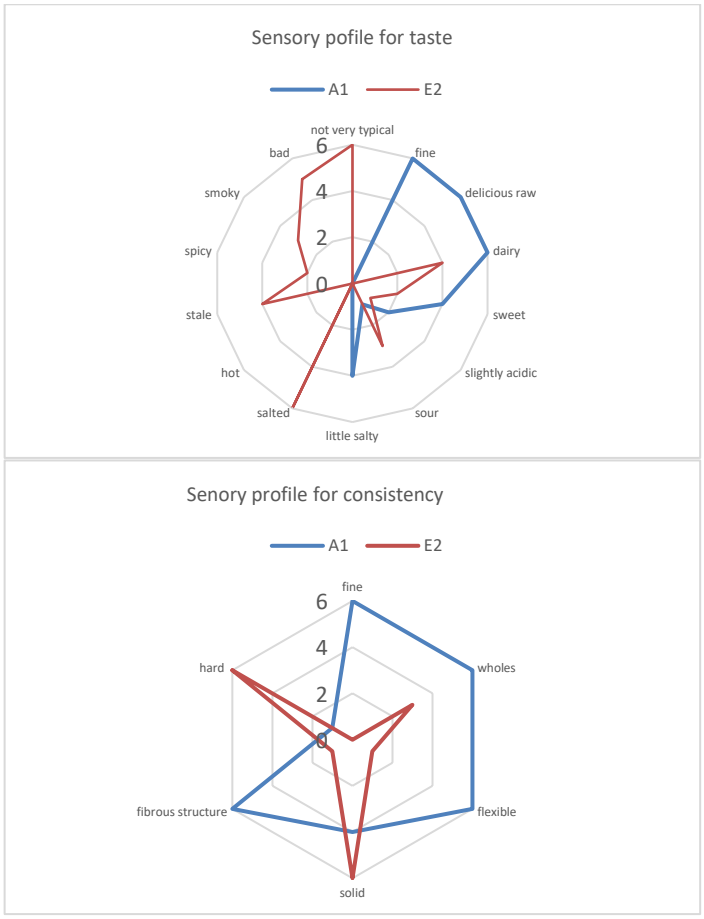

Figure 2 Comparison of the sensory profile for the evaluated characteristics a) taste of the best and worst evaluated sample; b) consistency of the best and worst rated sample

Steamed cheeses are widely different in taste from traditional guaranteed cheeses, depending on the type. The primary way to develop the different taste of different types of steamed cheeses is specific production. Traditional steamed cheeses have a very delicate taste ensured by lactic acid fermentation using starter cultures. Steamed cheeses that are produced using thermophilic cultures generally have a yogurt-like flavor due to the production of acetaldehyde by the species Lactobacillus delbrueckii ssp. bulgaricus. When mesophilic cultures are used, acetaldehyde is not produced and a mild sour milk flavor dominates **(Gobbetti, 2002)**.

Several studies evaluated the traditional steamed cheeses using sensory analysis **(Banks *et al.*, 1992; Lawlor *et al.*, 2001; Diezhandido *et.* al., 2016)**. Our results agree with the studies of **Forde and Fitzgerald (2000)**.

It is common knowledge that certain changes occur in the structure of steamed cheeses during the steaming process. The raw material becomes elastic, flexible and stretchable. If too high a steaming temperature is used (above 85 °C), the raw material becomes a slushy mass that cannot be shaped. Conversely, if too low a steaming temperature is used (below 60 °C), the curd is not steamed enough, so the finished product cannot be shaped. Insufficiently heat-treated cheese is hard and tears when you try to shape it **(Roginski, 2002)**.

Results of physicochemical analysis

The results of the measurements of the “unsmoked threads" category are presented in Table 1. In this group, we noted statistically significant differences in the monitored parameters at the level of statistical significance $p < 0.001$.

We determined the lowest dry matter content in sample A1 (44.27 ± 0.33) originating from Slovakia, sample B1 did not reach the minimum required dry matter content of 48% declared by the manufacturer on the package (46.30 ± 0.24).

Table 1 Means and their standard deviations (SD) of the physical and chemical indicators of unsmoked steamed threads

Sample	Dry matter	Fat	Fat in dry matter	NaCl	pH	Titratable acidity
A1	44.27 ± 0.33^{e}	$13.48 \pm 0{,}84^{d,e}$	28.83 ± 1.51^{e}	3.58 ± 0.15^{b}	$5.32 \pm 0.10^{b,c}$	40.08 ± 1.8^{a}
B1	46.30 ± 0.24^{d}	13.28 ± 0.54^{d}	$28.50 \pm 1.18^{e,f}$	3.50 ± 0.06^{b}	$5.27 \pm 0.10^{c,d}$	$39.25 \pm 0.99^{a,b}$
C1	46.10 ± 0.28^{d}	13.40 ± 0.42^{e}	43.15 ± 1.75^{b}	3.22 ± 0.28^{c}	5.13 ± 0.10^{a}	36.75 ± 0.52^{c}
D1	51.35 ± 0.78^{c}	22.79 ± 0.64^{c}	$43.33 \pm 0.92^{d,c}$	2.47 ± 0.12^{d}	$5.30 \pm 0.09^{c,b}$	$38.22 \pm 0.35^{b,c}$
E1	54.48 ± 0.35^{b}	24.63 ± 0.45^{b}	$45.40 \pm 0.38^{c,b}$	6.03 ± 0.12^{a}	5.30 ± 0.06^{c}	$39.83 \pm 0.52^{a,b}$

$^{a, b, c, d, e, f}$ – Means within a column different superscript differ ($p < 0.05$)

Even in the group of cheeses of the "smoked steamed threads" type, we recorded statistically significant differences in the monitored parameters (Table 2) at the level of statistical significance $p < 0.001$.

Among all analyzed samples, sample E2 recorded the highest dry matter content (65.97 ± 0.26). This sample also had the highest NaCl content (6.90 ± 0.09). The salt content in Ukrainian smoked and unsmoked samples (E1, E2) ranged from 7.2 to 9.2%. The salt content was higher in summer by up to 2.3%.

The fat content ranged from 13 to 30%. Slovak samples of smoked and unsmoked steamed cheeses met the amounts of salt declared by the manufacturer on the packaging, and the salt content in them ranged from 1.5 to 2.5%.

Table 2 Means and their standard deviations (SD) of the physical and chemical indicators of smoked steamed threads

Sample	Dry matter	Fat	Fat in dry matter	NaCl	pH	Titratable acidity
A2	54.08 ± 0.68^{c}	22.67 ± 0.53^{b}	41.17 ± 0.98^{b}	1.70 ± 0.18^{d}	5.57 ± 0.05^{a}	33.58 ± 0.58^{c}
B2	60.28 ± 0.51^{a}	30.28 ± 0.40^{a}	49.17 ± 0.98^{a}	2.07 ± 0.12^{e}	5.10 ± 0.06^{e}	40.50 ± 0.77^{a}
C2	55.17 ± 0.12^{c}	25.03 ± 0.64^{b}	37.32 ± 12.41^{b}	2.15 ± 0.08^{c}	5.33 ± 0.05^{b}	37.80 ± 0.51^{c}
D2	50.87 ± 0.50^{d}	21.53 ± 0.80^{c}	40.67 ± 3.67^{b}	2.47 ± 0.10^{c}	5.42 ± 0.08^{b}	38.38 ± 0.45^{b}
E2	65.97 ± 0.26^{a}	20.60 ± 0.49^{c}	31.25 ± 1.99^{c}	7.90 ± 0.09^{a}	5.28 ± 0.04^{c}	41.50 ± 1.05^{a}

$^{a, b, c, d}$ – Means within a column different superscript differ ($p < 0.05$)

Statistically significant differences in the observed parameters (Table 3) at the level of statistical significance $p < 0.001$ were recorded in the group of cheeses of the type "oštiepok cheeses". Despite the fact that of the Ukrainian samples, sample E3 had the lowest salt content (3.65 ± 0.18), so this value was higher compared to samples from other countries. The most significant difference in the fat content was observed in sample A3 (30.28 ± 0.40) and B3 (only 13.40 ± 0.42), $p < 0.001$.

Table 3 Means and their standard deviations (SD) of the physical and chemical indicators of oštiepok cheeses

Sample	Dry matter	Fat	Fat in dry matter	NaCl	pH	Titratable acidity
A3	60.28 ± 0.51^{a}	30.28 ± 0.40^{a}	49.17 ± 0.98^{a}	2.07 ± 0.12^{c}	5.10 ± 0.06^{c}	40.50 ± 0.77^{b}
B3	46.12 ± 0.28^{f}	13.40 ± 0.42^{e}	46.15 ± 1.75^{ab}	3.22 ± 0.28^{a}	5.55 ± 0.10^{a}	36.67 ± 0.52^{d}
C3	56.43 ± 0.39^{b}	24.12 ± 0.26^{c}	45.47 ± 0.61^{ab}	$2.53 \pm 0.25^{b,d}$	$5.43 \pm 0.08^{b,a}$	37.57 ± 0.50^{d}
D3	51.63 ± 0.84^{d}	23.83 ± 0.52^{c}	45.67 ± 0.88^{ab}	$2.23 \pm 0.21^{d,c}$	5.38 ± 0.10^{b}	42.42 ± 0.61^{a}
E3	48.25 ± 0.53^{e}	22.47 ± 0.34^{d}	46.42 ± 2.46^{ab}	3.65 ± 0.18^{b}	5.35 ± 0.05^{b}	37.83 ± 0.52^{c}

$^{a, b, c, d, e}$ – Means within a column different superscript differ ($p < 0.05$)

Table 4 Means and their standard deviations (SD) of the physical and chemical indicators of parenica cheeses

Sample	Dry matter	Fat	Fat in dry matter	NaCl	pH	Titratable acidity
A4	54.00 ± 0.64[b]	22.63 ± 0.48	42.98 ± 0.62[b]	2.11 ± 0.15[b]	5.35 ± 0.14[b]	36.77 ± 1.13[b]
B4	54.08 ± 0.68[b]	22.67 ± 0.53	41.00 ± 0.89[c]	1.80 ± 0.13[a]	5.58 ± 0.08[a]	33.42 ± 0.38[c]
C4	54.70 ± 0.37[b]	22.70 ± 0.68	45.17 ± 0.41[a]	2.32 ± 0.19[b]	5.37 ± 0.08[b]	41.75 ± 1.93[a]
D4	55.60 ± 0.40[a]	22.53 ± 0.54	43.32 ± 0.75[b]	2.35 ± 0.14[b]	5.57 ± 0.05[a]	38.58 ± 1.77[b]
E4	59.28 ± 0.74[b]	25.90 ± 0.51[a]	47.62 ± 0.94[a]	4.60 ± 0.14[b]	5.10 ± 0.05[d]	42.350 ± 0.60[a]

[a, b, c, d, e] – Means within a column different superscript differ ($p < 0.05$)

The smallest differences in the analyzes were confirmed in the "parenica cheeses" group (Table 4). These steam samples were the most similar in composition, with minimal deviations. Statistical significance was confirmed in the observed parameters: Dry mater, Fat in dry mater, Salt content, pH and Titratable acidity at the level of statistical significance $p < 0.005$. The fat content was determined in the range from 22.53 ± 0.54 (D4) to 25.90 ± 0.51 (C2), which did not confirm statistical significance in this parameter ($p > 0.05$). Within the monitored period (summer, winter), statistical significance was confirmed only in the monitored parameter salt content ($p < 0.005$), for the other parameters the season was not significant ($p > 0.05$).

Acidity is determined by the excess of hydrogen ions in the solution, alkalinity by the excess of hydroxyl ions in the solution. If the concentration of one component increases, the concentration of the other component will decrease proportionally. Achieving the correct pH value is crucial for the production of steamed cheeses.

During the measurement of pH values, no major differences were noted, there were no significant differences between the samples.

Milk quality, chemical composition (moisture, lactose, fat), use of the right starter lactic acid bacteria (SLAB) can also affect the processes occurring during cheese ripening **(Al-Otaibi and Wilbey, 2004; Floury *et al.*, 2009; Pachlová *et al.*, 2011)**. By accelerating the ripening process, it is possible to solve the problems of cheese quality degradation. It is influenced by the intensity of proteolysis, the content of dry matter, fat, NaCl and the pH level **(Everard *et al.*, 2006; Saint-Eve *et al.*, 2009; Šnirc, 2016)**. The ripening time depends on the type of cheese, which is reflected in the organoleptic parameters **(Pachlová *et al.*, 2011)**.

There are many other factors that can cause differences in quality – milk pasteurization temperature, salting, drying as well as smoking temperature **(Zajác *et al.* 2019)**.

Results of microbiological analysis

The results of the microbiological examination of steamed cheese samples are presented in Table 5. Coliform bacteria were not detected in four samples (10%) (A3, B2, D1, E3), their numbers ranged from 1.91 ± 0.40 – 3.70 ± 0.16 log CFU/g. Coagulase-positive staphylococci (CoPS) were detected in all examined samples, but their number reached the highest values (1.15 ± 0.65 – 6.13 ± 0.82 log CFU/g) in samples of unsmoked and smoked threads from Ukraine. Lactic acid bacteria (LAB) were isolated in each cheese sample. Micromycetes were detected in five samples, where in the case of parenica samples (B4 – CZ; D4 – PL; E4 – UA) they ranged from 1.15 ± 0.36 – 1,95 ± 0.37 log CFU/g).

Despite the confirmed results, it is interesting that the samples came from commercial chains, originally packaged by the manufacturer, not from markets or local farmers. During the year, the growth of micromycetes in the samples represented a statistical significance of $p < 0.05$.

Table 5 Microbiological examination of samples of steamed cheeses **(**log CFU/g)

	Sample	Enterobacteriaceae	CoPS	LAB	Mold
Slovakia	A1	1.91 ± 0.40	1,15 ± 0.65	6,59 ± 0.42	ND
	A2	0,14 ± 0.78	3 ±0.70	6 ± 0.75	1,16 ± 0.43
	A3	ND	2,35 ± 0.75	7,65 ± 0.63	ND
	A4	0,30 ± 0.50	1,33 ± 0.42	6,10± 0.48	ND
Czech republic	B1	1.15 ± 0.80	2.98 ± 0.10	6.90 ± 0.62	ND
	B2	ND	3 ± 0.19	6 ± 0.73	ND
	B3	1.42 ± 0.93	1.65 ± 0.61	6.52 ± 0.39	ND
	B4	0.23 ± 0.84	1.20 ± 0.70	6.14 ± 0.40	1.15 ± 0.36
Hungary	C1	2.14 ± 0.35	3.75 ± 0.12	6.73 ± 0.17	1.55 ± 0.92
	C2	1.87 ± 0.48	3.47 ± 1.05	6.45 ± 0.24	ND
	C3	1.19 ± 0.63	2.38 ± 0.87	6.98 ± 0.60	ND
	C4	1.22 ± 0.55	2.58 ± 0.47	7.25 ± 0.68	ND
Poland	D1	ND	1.33 ± 0.46	6.10 ± 0.69	ND
	D2	2.40 ± 0.80	3 ±0.88	7.82 ± 0.84	ND
	D3	1,98 ± 0.28	2.25 ± 0.50	6.20 ± 0.85	ND
	D4	2,22 ± 0.60	2.90 ± 0.17	6.58 ± 1.13	1.83 ± 0.70
Ukraine	E1	2,17 ± 0.80	5,23 ± 0.64	6 ± 0.46	ND
	E2	0.20 ± 0.35	3,95 ± 0.85	6 ± 0.66	ND
	E3	ND	6,13 ± 0.82	7,74 ± 0.43	ND
	E4	3.70 ± 0.16	2,97± 0.70	7,73 ±1.07	1,95 ± 0.37

Legend: ND – not detected; CoPS - coagulase-positive staphylococci; LAB - lactic acid bacteria

A1 – E1 - unsmoked steamed threads; A2 – E2 - smoked steamed threads; A3 – E3 - oštiepok cheeses or salami cheeses; A4 – E4 - parenica cheeses

Defects that can manifest in the cheeses include the growth of surface molds that cause color changes in the cheeses. Fungi of the genus *Penicillium* (green coloration), *Cladosporium* (green to black coloration), but also yeasts of the genus *Candida* (black coloration) are most often involved in color changes **(Forsythe *et.* al., 2000; Zhang, 2009)**.

The risk of mold growth arises especially when packing cheeses in plastic films, when an air space can form between the surface of the cheese and the film, and the oxygen present will support the germination of mold spores. When contaminated with yeast, cheeses acquire the typical yeasty taste and smell of bread dough. Their lipolytic activity leads to the hydrolysis of fats and the release of fatty acids, which results in a bitter taste. The subsequent esterification of free fatty acids creates a fruity taste and aroma. Salt baths pose a risk of contaminating the cheeses with yeast, therefore it is necessary to thoroughly dry the surface of the cheeses after salting, as yeasts reproduce mainly on the surface of cheeses with higher humidity. It is accompanied by a sliminess of the surface **(Valík and Görner, 2004)**.

Coliform bacteria, in particular *Enterobacter aerogenes* and *E. coli*, are responsible for the formation of unwanted eyes and cracks in cheeses. Microorganisms *Micrococcus luteus* and *Aspergillus flavus* cause the formation of yellow spots, non-cultured propionic fermentation bacteria and *Penicillium casei* cause the formation of brown spots, enterococci and yeasts cause the softening of cheeses and the formation of white spots, *Clostridium sporogens* and *Clostridium putrefaciens* are responsible for the so-called white rot (limited whitish spots with a darker center) **(Dudriková *et al.* 2014)**.

In **Fink *et al.* (2008)** study, they dealt with specific mycotoxins and metabolites present in Slovak cheeses. Among the 28 target mycotoxins and metabolites investigated in the analyzed samples, they did not confirm AFM1 in any case, the only mycotoxin regulated in milk and milk products.
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Statistical analysis

In the statistical evaluation, we compared the differences in the quality of steamed cheeses from several countries. In the statistical evaluation, we used their origin, sensory, physicochemical and microbiological properties for the overall impact of quality. To evaluate these differences in quality, we used the method of two-way analysis of variance (Two-Way ANOVA) and Student's T-test to determine differences between samples from different countries at the $p < 0.05$ significance level.

CONCLUSION

When evaluating the overall quality of the obtained samples of steamed cheese, we were based on the requirements of valid European as well as Slovak legislation. Although steamed cheeses belong to Slovakia's traditional cheese specialties and have a permanent place on the market, the Slovak consumer increasingly encounters various types of steamed cheeses from foreign producers as well.
Using sensory analysis, we evaluated the indicators perceived and analyzed by the average consumer during consumption and on the basis of based on which he evaluates the quality of the purchased products. Since we should not take into account only their taste properties or their digestibility, we also based the quality of the purchased products. An important factor from a nutritional point of view is their fat content in dry matter, protein content but also vitamins A and B2, calcium and phosphorus content. Another factor can be the salt content, which in excessive amounts can have an adverse effect on the health of the consumer.
The analyzed samples of Slovak smoked and unsmoked samples of steamed cheeses met the requirements imposed on cheeses labeled "PGI" (i.e. dry matter at least 40% by weight, solids at least 25% by weight and salt content at most 4.5% by weight for unsmoked and 5.5% mass for smoked). These criteria were not met by the samples of Ukrainian producers, which exceeded the values set for salt content by up to three times.
The European Union quality policy is a philosophy of developing the quality of original, traditional agricultural products and foodstuffs and supporting cultural traditions and regions in which these products are produced. The system was created as a response to the increasing counterfeiting of products and the abuse of traditional names, which built on the good reputation of traditional regional products.
Although the European Union accepts, protects, supports, registers and controls products from the category protected designation of origin, protected geographical indication and traditional specialty guaranteed (TSG), it is available on the market in neighboring countries many similar products that try to approximate the given product and its quality with their sensory properties.
Currently, it is very difficult to impossible to trace the origin of the raw material and the method of production.
The results showed that not all samples met the quality parameters set for Slovak products, which distinguished them by their precisely defined requirements for their raw material composition and technological production process. However, this does not mean that the quality has deteriorated, only possible differences in the recipe and processing.

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