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COMPARISON OF SELECTED CHEMICAL PROPERTIES OF POLISH OSCYPEK AND SLOVAK OŠTIEPOK

Miroslav Kročko[1], Adam Hanuska[1], Bartosz G. Sołowiej[2], Maciej Nastaj[2], Jagoda O. Szafrańska[2], Lukáš Jurčaga[1], Jana Tkáčová[1]*

Address(es):

[1] Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Science, Institute of Food Science, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

[2] University of Life Sciences in Lublin, Faculty of Food Sciences and Biotechnology, Department of Dairy Technology and Functional Foods, 8 Skromna Street, 20-704 Lublin, Poland.

*Corresponding author: miroslav.krocko@uniag.sk

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ABSTRACT

Traditional and regional cheeses are gaining popularity due to their unique taste, cultural significance, and perceived health benefits. Among these, Oscypek produced in Poland and Slovak oštiepok produced in Slovakia are well-known traditional cheeses with Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) status, respectively. Despite their similar names, they differ in production methods. This study aimed to analyse and compare the selected chemical properties of Oscypek and Slovak oštiepok, focusing on fat, salt (NaCl), protein, and dry matter content. A total of 28 cheese samples, including smoked and unsmoked variants, were purchased from various regions in Poland and Slovakia. The selected chemical properties were assessed using near-infrared (NIR) spectroscopy. Based on the dry matter and fat content was calculated the content of fat in dry matter. The results indicated that some Oscypek samples did not meet the European Union's regulations for dry matter (samples 1, 7, and 28) and fat in dry matter (samples 7, 26, and 27). Similarly, one sample of Slovak oštiepok (sample 9) did not comply with the dry matter and fat in dry matter requirements. Smoked samples showed higher fat (27.06%), and salt content (2.18%) compared to unsmoked samples (24.74% fat, 1.66% salt), although these differences were not statistically significant. However, dry matter content was significantly higher in smoked samples (59.80%) compared to unsmoked samples (55.06%). Comparing Oscypek and Slovak oštiepok, Polish Oscypek exhibited slightly higher fat, protein, and dry matter content than Slovak oštiepok, with the most significant difference observed in dry matter content for unsmoked samples. These findings highlight differences in the chemical composition of traditional cheeses from Poland and Slovakia, contributing to a better understanding of their nutritional profiles and supporting the preservation of traditional cheese-making techniques.

Keywords: fat, NaCl, protein, dry matter, Oscypek, Slovak oštiepok, Near-infrared spectroscopy

INTRODUCTION

The popularity of traditional and regional foods among consumers is steadily growing. Products prepared according to proven local recipes are perceived as tasty, unique and healthy **(Kawecka *et al.*, 2020).** Traditional cheeses represent an important cultural heritage, and their production is based on years of experience and knowledge. Each cheese is linked to its place of origin and the natural conditions there **(Zeleňáková *et al.*, 2020).** Traditional cheeses in Poland and Slovakia include Oscypek (Polish) and Slovak oštiepok (Slovak). Despite having the same name, they differ in the way they are produced, with both versions registered in the eAmbrosia database as Oscypek and Slovak oštiepok with Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) status respectively **(Nalepa & Markiewicz, 2022).**

Oscypek is hard scalded and smoked cheese produced from sheep's or mixed sheep's and cow's milk **(Najgebauer-Lejko *et al.*, 2021)**. Oscypek has a distinctive spindle or double-cone shape, with a length ranging from 17 to 23 cm, a width of 6 to 10 cm at its widest point, and a weight between 0.6 and 0.8 kg. When cut, it has a rich creamy colour, which may be darker near the rind, though a lighter, almost white shade is also acceptable. The rind is light brown with a straw-like sheen. Oscypek is produced exclusively between May and September and can only be sold as a whole piece. Its chemical composition varies depending on the smoking duration and the season, with a maximum water content of 44%, a minimum dry matter content of 56%, and at least 38% of fat in the dry matter **(Council of the European Union, 2006).**

The production of Oscypek requires unique skills and experience, passed down from generation to generation. Thanks to this tradition, cheesemakers can preserve the authentic methods and maintain the high quality of the cheese. The production of Oscypek begins with the careful selection of raw materials. The milk used comes primarily from the Polish Mountain Sheep, while cow's milk, if included, is sourced from the Polish Red Cow **(Ceklarz, 2023).** The process begins with cold maturation (acidification), during which the milk is left at room temperature to naturally increase its acidity. This is followed by warm maturation, where soured milk is mixed with fresh sweet milk. The proportion of sheep's milk in the final product must not be less than 60%. Next, rennet is added to the mixture, initiating coagulation, where the milk forms lumps. The coagulated mass is then beaten using traditional tools, such as a "ferula", to achieve the desired consistency **(Danylenko *et al.*, 2023).** Following this, the cheese lumps naturally settle at the bottom of the container, after which up to 50% of the whey is removed. Once enough whey is extracted, the cheese is taken out by pressing the lump grains together. The lump is then ground by hand, formed into a ball, and placed in a container with whey. The ball is then pressed and pierced with a skewer to aid in shaping. The cheese is carefully shaped into a double cone, with a ring placed around its widest point to maintain its structure. After shaping, the final smoothing process takes place, where the ring is removed, and the cheese is hand-smoothed before being placed in cold water to set its shape. The cheese is then soaked in brine for up to 24 hours to enhance its flavour. The next stage involves drying the cheese, which takes between 12 and 24 hours. Finally, the cheese undergoes a smoking and maturation process using cold smoke, which lasts between 3 and 7 days, giving Oscypek its distinctive golden colour and smoky aroma **(Council of the European Union, 2006).**

Slovak oštiepok is a semi-fat, semi-hard cheese that can be either steamed or unsteamed, smoked or unsmoked. It is made from sheep's milk, a mixture of sheep's and cow's milk, or pure cow's milk **(Šnirc *et al.*, 2020).** During production, an original culture containing lactic acid bacteria of the *Lactococcus* genus is added, giving the cheese its distinctive characteristics. This culture was isolated from fresh sheep's milk and sheep's cheese traditionally produced on Slovak farms. Slovak oštiepok is manufactured using two methods - either the traditional way directly on a farms or through industrial production in dairies. This cheese is notable for its unique shape, resembling a large egg, pinecone, or ellipsoid with decorative relief. Its composition depends on the raw materials used and the production process, with a minimum dry matter content of 48% and at least 38% of fat in dry matter **(Zajác *et al.*, 2019).**

Over the years, the production technology of Slovak oštiepok has evolved significantly - from handcrafted production on farms and in households to modern methods in the dairy industry. The cheese is made from milk obtained from sheep grazing in Slovakia's mountainous regions, particularly the Wallachian, Improved Wallachian, and Tsigai breeds. Cow's milk is obtained either manually or mechanically and is processed immediately after milking **(Jarossová, 2015).** The

traditional method of producing Slovak oštiepok follows a carefully preserved process that includes several essential stages. The production begins with milk lumping, where fresh sheep's or cow's milk is allowed to coagulate with the help of rennet, forming lumps. These lumps are then shaped by hand or using wooden molds, giving the cheese its characteristic oval or spindle-like appearance. After shaping, the cheese undergoes salting, which enhances its flavour and helps with preservation. The next step is drying, during which the cheese is left in a cool, well-ventilated area to remove excess moisture. The final stage in the traditional process is smoking, where the cheese is exposed to cold smoke from burning hardwoods, usually beech or oak, for several days. This gives Slovak oštiepok its distinctive golden-brown colour and rich smoky aroma **(Herian, 2014)**
The composition of fresh milk varies over time and between animals depending on several factors such as lactation stage, social status, season, environmental temperature, age and nutrition of the animals, genetic predisposition (species and breed) or the presence of mastitis **(Claeys *et al.*, 2014).**

The aim of this study was to analyse and compare selected chemical properties of Oscypek produced in Poland and Slovak oštiepok produced in Slovakia.

MATERIAL AND METHODS

Description of the samples

Individual samples of Oscypek and Slovak oštiepok were collected in different regions of Poland and Slovakia. Samples from Slovakia (n=12) came from the regions of Liptov, Orava, Horehronie, Gemer, Horná Nitra, Podpoľanie, Turiec and samples from Poland (n=16) mainly from the region of Podhale and Bieszczady. The samples came from farms, shepherd's huts as well as small dairies specialising in the production of these traditional cheeses.
A total of 24 samples of Oscypek and Slovak oštiepok from raw milk (16 from Poland and 8 from Slovakia) and 4 samples from pasteurised milk (1 from Poland and 3 from Slovakia) were analysed. Out of the total of 28 samples, 9 smoked samples were from Poland and 7 smoked samples were from Slovakia. At each sampling point, separate samples from the same production batch were purchased for analyses in Slovakia as well as in Poland. The sampling took place 1 to 2 days before the meeting of the two research teams in Slovakia or Poland.
In early June 2024, sampling of Polish Oscypek was conducted by the foreign partners. Seven samples were taken from farms in Busa, Gogoli, Maly gazda and from dairy SM Mlekovita (Oscypek type cheese). At the end of June 2024, sampling of Slovak oštiepok in Slovakia was conducted from our side. Before the working trip and during the trip to Poland, 7 samples of Slovak oštiepok were taken from farms (Koliba - Kraľovany, Koliba - Revišné Veličná) and dairies (Gemerské ovečky - Revúca, Milsy a.s. - Bánovce nad Bebravou, Syrex - Zázrivá, Liptov - Liptovský Mikuláš and Krivá). In September 2024, prior to the arrival of the Polish research team, sampling of Slovak oštiepok was conducted in selected regions of Slovakia (domestic working trip). Five samples of Slovak oštiepok were taken from the farms Polun - Čremošné, Agrospol Hradová - Tisovec and Zlatý vŕšok - Detva. In September, Polish researchers brought 9 samples of Oscypek from the Bieszczady region.

Analysis of selected chemical properties

To analyse the selected chemical properties of the samples was used MPA-type NIR spectrometer (Bruker Optics GmbH & Co. KG, Germany). NIR spectroscopy has become one of the most effective methods to assess the quality of milk and dairy products. This technique is used to monitor rennet-induced milk coagulation and to predict the physicochemical properties of cheese and butter **(Karoui, 2017).** Measurement of selected chemical properties such as dry matter, fat, NaCl and protein was conducted. The cheese was first homogenized to a fine powder, then transferred to a petri dish (Duraplan type) in amount of 20 g and placed in the device. Calibration of the hard cheese NIR equipment was in the measurement ranges: fat (5-43.6%), NaCl (0.04-2.85%), protein (13.6-37.10%) and dry matter (24.2-72.6%). The sample measurement was repeated twice. Based on the dry matter and fat content, the content of fat in dry matter was calculated.

Statistical analysis

In our study we performed analysis of variance (ANOVA) deploying Bonferroni's test to determine the statistical differences among samples at significance level $\alpha = 0.05$ using XLSTAT software (Addinsoft, France).

RESULTS AND DISCUSSION

According to **Council of the European Union (2006)**, the dry matter content in Oscypek must not be lower than 56% and fat in dry matter must not be lower than 38%. Of the Oscypek samples, samples 1, 7 and 28 did not meet the legislation's requirements for dry matter content and samples 7, 26 and 27 did not meet the requirements for fat in dry matter content.

Table 1 Results of selected chemical properties in the samples of Oscypek and Slovak oštiepok [%]

Sample	Country of origin	Type of milk	Fat	NaCl	Protein	Dry matter	Fat in dry matter
1	**Poland**	cow	25.43	2.25	18.88	51.96	48.94
2	**Poland**	cow	33.21	3.52	20.55	62.54	53.1
3	**Poland**	mixed	26.26	1.94	26	58.73	44.71
4	**Poland**	mixed	31.25	4.61	30.8	72.67	43
5	**Poland**	cow	30.6	1.81	24.96	59.53	51.4
6	**Poland**	cow	29.86	1.7	25	58.77	50.81
7	**Poland**	cow	15.85	0.73	29.55	52.38	30.26
8	**Slovakia**	sheep	24.98	3.1	24.9	62.34	40.07
9	**Slovakia**	sheep	8.54	0.9	31.64	44.53	19.18
10	**Slovakia**	cow	22.6	1.6	23	50.39	43.78
11	**Slovakia**	sheep	24.79	2.16	21.22	55.23	44.89
12	**Slovakia**	sheep	23.12	1.88	20.1	52.23	44.27
13	**Slovakia**	cow	26.23	0.66	23.45	50.72	51.72
14	**Slovakia**	sheep	28.62	2.31	16.72	54.37	52.64
15	**Slovakia**	sheep	29.6	1.94	21.6	57.69	51.31
16	**Slovakia**	sheep	31.55	2.3	23.95	62.3	50.64
17	**Slovakia**	sheep	27.42	1.37	21.52	54.83	50.01
18	**Slovakia**	sheep	28.79	1.91	22.62	58.55	49.17
19	**Slovakia**	sheep	26.15	2.31	23.26	59.2	44.17
20	**Poland**	sheep	29.7	2.2	26.57	62.04	46.86
21	**Poland**	sheep	29.47	2.48	29.2	66.48	44.33
22	**Poland**	sheep	25.4	1.2	25.71	56.18	45.21
23	**Poland**	sheep	26.85	2.7	24.91	60.09	44.68
24	**Poland**	sheep	30.33	1.6	21.57	57.1	53.12
25	**Poland**	sheep	31.15	2.21	23.75	61.63	50.54
26	**Poland**	sheep	19.2	2.2	32.64	62.36	30.79
27	**Poland**	sheep	18.3	1.55	32.45	58.5	31.28
28	**Poland**	cow	25.7	1.4	22.77	54.26	47.36

The dry matter content in Slovak oštiepok must not be lower than 48% and fat in dry matter must not be lower than 38% **(Council of the European Union, 2007).** Among the samples of Slovak oštiepok, sample 9 did not meet the legislation's requirements for dry matter content and content of fat in dry matter.

Table 2 Comparison of selected chemical properties of smoked and unsmoked samples *(mean±S.D.)* [%]

Type	Fat	NaCl	Protein	Dry matter
smoked	27.06±4.63[a]	2.18±0.91[a]	24.86±3.50[a]	59.80±5.24[a]
unsmoked	24.74±5.8[a]	1.66±0.53[a]	24.19±4.55[a]	55.06±4.57[b]

Note: a, b = groups within a column with different superscripts differ significantly at p ≤ 0.05, one-way ANOVA.

Comparison of selected chemical properties of smoked and unsmoked samples **(Table 2)** showed that smoked samples showed higher fat content (27.06%) compared to unsmoked samples (24.74%), although the difference was not statistically significant. The salt content was also higher in smoked samples (2.18%) compared to unsmoked samples (1.66%), but this difference was not significant. The protein content was similar for both types of samples (smoked: 24.86%, unsmoked: 24.19%). There was a significant difference in dry matter content, with smoked samples showing higher values (59.80%) compared to unsmoked samples (55.06%), which was statistically significant ($p \leq 0.05$).

Table 3 Comparison of selected chemical properties of smoked Oscypek (PL) and Slovak oštiepok (SK) samples *(mean±S.D.)* [%]

Type	Fat	NaCl	Protein	Dry matter
smoked PL	27.46±5.60[a]	2.33±1.07[a]	26.36±3.93[a]	61.56±5.4[a]
smoked SK	26.53±2.84[a]	1.99±0.6[a]	22.92±1.20[a]	57.55±4.02[a]

Note: a, b = groups within a column with different superscripts differ significantly at p ≤ 0.05, one-way ANOVA.

Based on the comparison of selected chemical properties of smoked Oscypek (PL) and Slovak oštiepok (SK) **(Table 3)**, the fat content was slightly higher in the Polish samples (27.46%) compared to the Slovak samples (26.53%). The salt content was higher in the Polish samples (2.33%) compared to the Slovak samples (1.99%). The protein content was higher in the Polish smoked samples (26.36%) than in the Slovak samples (22.92%). The dry matter content was higher in the Polish samples (61.56%) than in the Slovak samples (57.55%). The difference among the samples was not statistically significant.

Table 4 Comparison of selected chemical properties of unsmoked Oscypek (PL) and Slovak oštiepok (SK) samples *(mean±S.D.)* [%]

Type	Fat	NaCl	Protein	Dry matter
unsmoked PL	25.82±3.60[a]	1.74±0.41[a]	25.33±3.80[a]	57.31±3.16[a]
unsmoked SK	23.22±7.67[a]	1.54±0.64[a]	22.59±5.01[a]	51.91±4.37[b]

Note: a, b = groups within a column with different superscripts differ significantly at p ≤ 0.05, one-way ANOVA.

When comparing unsmoked Oscypek (PL) and Slovak oštiepok (SK) **(Table 4)**, a higher fat content was recorded in the Polish samples (25.82%) compared to the Slovak samples (23.22%). The salt content was similar in both samples (PL: 1.74%, SK: 1.54%). Protein content was higher in the Polish samples (25.33%) than in the Slovak samples (22.59%). A significant difference was found in dry matter content, where Polish samples showed higher values (57.31%) compared to Slovak samples (51.91%), and this difference was statistically significant ($p \leq 0.05$).

Table 5 Overall comparison of selected chemical properties (not based on smoking) of Oscypek (PL) and Slovak oštiepok (SK) samples *(mean±S.D.)* [%]

Type	Fat	NaCl	Protein	Dry matter
PL	26.75±4.90[a]	2.07±0.90[a]	25.91±3.91[a]	59.70±5.03[a]
SK	25.15±5.65[a]	1.80±0.66[a]	22.79±3.37[b]	55.20±5.01[b]

Note: a, b = groups within a column with different superscripts differ significantly at p ≤ 0.05, one-way ANOVA.

Overall, regardless of whether the samples were smoked or unsmoked **(Table 5)**, the average fat content was higher for Polish samples (26.75%) compared to Slovak samples (25.15%). The salt content was also higher in the Polish samples (2.07%) compared with the Slovak samples (1.80%). The protein content was statistically significantly higher in the Polish samples (25.91%) compared to the Slovak samples (22.79%). The dry matter content was also statistically significantly higher in the Polish samples (59.70%) compared to the Slovak samples (55.20%), indicating differences in the technological processing or composition of the raw materials.

Our results regarding the content of dry matter, protein, and fat are similar to the data obtained by **Przygoda *et al.* (2009)**, who concluded that Oscypek made from sheep's milk and mixed sheep's and cow's milk had an average dry matter content of 66%, protein 29% and fat 27%. The chemical composition of Oscypek and Slovak oštiepok is influenced by production conditions, with the most significant differences related to the production season and smoking duration. A study by **Mikulec *et al.* (2008)** demonstrated a higher content of chemical components in sheep cheeses. Traditional Croatian sheep cheese contained 63.86-66.02 g of total solids per 100 g, with fat in dry matter ranging from 53.65-55.22%, protein between 36.08-37.79%, and salt between 2.52-2.61%. **Bonczar *et al.* (2009)** stated that there is no direct correlation between the chemical composition of the milk and the final composition of the cheese.

A study by **Wszołak & Bonczar (2002)** showed that Oscypek made from a mixture of cow's and sheep's milk had similar moisture content (36.16%), protein content (29%), fat in dry matter (47.46%), and salt (2.18%). The authors emphasized that the most significant factor influencing the quality of Oscypek was the processing method, specifically the variable temperature of milk coagulation and lump handling, rather than the type of milk used. Research by **Kawecka & Sikora (2020**) revealed significant differences in the chemical composition of cheeses made from cow's milk (Gołka), goat's milk (Ser Podkarpacki), and sheep's milk (Oscypek). Oscypek had the highest dry matter, fat, and crude ash content, while Gołka and Oscypek contained similar levels of total proteins. These cheeses are often produced on farms that adhere to traditional animal husbandry practices. The feeding method of ruminants significantly affects milk quality, its chemical composition, and its suitability for cheese production. In particular, the use of bulk feeds, especially green pasture, plays a crucial role in this process **(Martin *et al.*, 2005).** The quality of milk intended for processing influences the physicochemical and sensory properties of cheese as well as its yield **(Fekadu *et al.*, 2005).** Studies on various cheeses highlight the significant impact of pasture type on cheese characteristics **(Carpino *et al.*, 2004).** The composition of cheeses, particularly the content of fat-soluble compounds (fatty acids, carotenoids, retinol, α-tocopherol), is largely determined by milk production conditions **(Lucas *et al.*, 2008)** and the type of animals from which the milk is obtained **(Chilliard & Lamberet, 2001; Lucas *et al.*, 2006).** Research by **Kędzierska-Matysek *et al.* (2014)** reported that Oscypek contained 64.07% of dry matter, 29.09% of protein, and 47.22% of fat in dry matter, while **Drożdż (2001)** obtained similar results (29.09% of protein and 22.54% of fat). **Kawęcka & Sosin-Bzducha (2014)**, on the other hand, reported that Oscypek cheeses made from other mountain sheep breeds, such as the Coloured Mountain Sheep and Podhale Zackel, contained 59.29-60.46% of dry matter, 21.3-27.06% of fat, and 25.47-31.85% of protein. **Benešová *et al.* (2018)** focused on the analysis of Slovak oštiepok, reporting average composition values: 58% of dry matter, 49% of fat in dry matter, 28.42% of fat, 22.62% of protein, and 2.85% of NaCl. **Madalozzo *et al.* (2015)** investigated ricotta cheeses by the NIR method, finding an average fat, protein, and moisture content of 10.63%, 12.37% and 70.23%, respectively. **Margolies & Barbano (2018)** analyzed Cheddar cheeses using the MIR technique and measured an average fat, protein, moisture, and salt content of 34.0%, 24.0%, 36.82% and 1.8%, respectively. **Manuelian *et al.* (2017)** used the NIT method to analyse commercial cheeses and found an average moisture, fat, and protein content of 43.24 ± 0.97%, 27.24 ± 0.47%, 24.87 ± 0.54% and 24.87 ± 0.54%, respectively. **Jo *et al.* (2018)** investigated the sensory and chemical properties of Gouda cheeses that had water content below 45% and fat content above 46%. The salt content of cheeses varies by type, ranging from 0.5-0.7% in sour curd and Emmental cheeses to 4-6% in pickled cheeses such as Domiati and feta **(Guinee, 2004).**

CONCLUSION

Based on the results of the analysis of selected chemical properties, some samples of Oscypek and Slovak oštiepok did not meet the EU legislative requirements for dry matter and fat content in dry matter. Samples 1, 7 and 28 of Oscypek did not comply with the requirement for dry matter content, while samples 7, 26 and 27 did not comply with the requirement for fat in dry matter content. In the case of Slovak oštiepok samples, sample 9 did not meet the required values for dry matter content and fat in dry matter content. The smoked samples were characterized by a higher fat, salt and dry matter content compared to the unsmoked samples, with a significant difference only in the dry matter content. When comparing Polish Oscypek and Slovak oštiepok samples, it was found that the Polish samples generally contained more fat, salt, protein, and dry matter. Statistically significant differences ($p \leq 0.05$) were noted in protein and dry matter content, with the Polish samples showing higher values. These differences may be due to different technological processes or to the different composition of the raw materials used in the production of the two types of cheese.

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