

The Zarac smoked cheese from Majevica- production and quality characteristics

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Abstract

The Zarac smoked cheese from Majevica is a dairy product that is protected in Bosnia and Herzegovina by the protected label of origin (PDO). It received the label in 2024, which reveals a lot about the quality of this cheese. Therefore, the goal of this paper was to describe the technology, examine the chemical composition and physical properties, and evaluate the sensory properties of this cheese. It is produced from partially skimmed, raw milk, by spontaneous fermentation carried out by the natural microflora present in the milk. The production area of this cheese is north-eastern Bosnia. This cheese is characterised by a low pH value and high acidity, which have a preservative effect, while smoking, which is used in the technology of this cheese as one of the stages of the technological process, also has a preservative effect. The average chemical composition of this cheese is as follows (%): 31.41 of dry matter; 6.00 of fat, 19.10 of fat in dry matter, 73.00 moisture on a fat-free basis, 20.16 of proteins, and 1.30 of salt, which places it in the category of semi-fat soft cheeses. Specific physical characteristics, high water activity, low hardness, and adhesiveness are expected for this kind of cheese. Sensory evaluation showed the high quality of the Zarac smoked cheese, hence it can be ranked as first and extra

class according to the average rating. This research and the results obtained have confirmed the reputation and place attributed to this cheese among different cheeses in Bosnia and Herzegovina and beyond.

Key words: Cheese, Quality, Chemical composition, Physical properties, Sensory evaluation.

Introduction

The Zarac smoked cheese from Majevica is produced from raw, partially skimmed cow's milk by fermentation and acid coagulation in a defined geographical area of the Majevica region. This cheese belongs to acid cheeses, it is smoked and can be consumed immediately after production. It is usually packed in foils under vacuum or plastic containers, and it can also be produced with the addition of garlic or paprika. The Zarac smoked cheese originates from north-eastern Bosnia and covers the region of Majevica mountain. The area of cheese production is within the administrative boundaries of the municipalities of Lopare, Ugljevik, Čelić, Teočak, and Sapna. However, the main region is the territory of the municipality of Lopare (Poljoprivredna zadruga „Zarac“, 2023). In September 2024, the Zarac smoked cheese received a protected label of origin (Food Safety Agency of Bosnia and Herzegovina, 2024) and, thus, became part of the protected cultural heritage of Bosnia and Herzegovina and part of the European cheese labels of protected origin.

What is specific to the Zarac smoked cheese from Majevica is the smoking process, high acidity, and low pH, all of these giving it a characteristic flavour and a preservative effect. The first smokehouse was discovered by archaeologists in a Stone Age colony located in Zwierzyniec near Krakow, Poland. It is assumed that the Romans learned the smoking method from the Gauls and Celts, and European migrants spread this method to the rest of the world, although it is believed that the smoking process was also applied in other cultures and civilizations, only perhaps through some other techniques and methods (Ledesma et al., 2017). Sikorski and Sinkiewicz (2015) state that smoking was mainly used for meat, poultry, and fish, but that the range of smoked products expanded over time, so shellfish, cheese, plums, peppers, and malt used for the production of whiskey and certain types of beer also began to be smoked. Today, smoking has been replaced by modern methods such as controlled drying chambers, liquid smoke, etc. Migdal et al. (2022) state that smoke consists of several hundred components that contribute to the quality of the smoked product, and at the same time are neutral for consumers' health, while some components are harmful to human health. The tradition of producing smoked cheese is very widespread in Bosnia and Herzegovina. Bijeljac and Sarić (2005) describe sour cheese made from skimmed milk mostly in the area of northern Bosnia. For longer storage, it

is shaped into hemispherical pieces of smaller size and dried in smoke or air. The same authors state that a similar cheese called "Vareni sir" is produced in north-eastern Bosnia. To produce this cheese, coagulation is done by vinegar or acetic acid, and the cheese is dried in air or smoke. Sarić and Busovača (2005) specify the technology, and Sarić et al. (2005) report about the technology, chemical composition, and microbiological quality of "smoked" or "dry" cheese in the vicinity of Tuzla, in the area of Čelić, in northern Bosnia. The production of this cheese relies on spontaneous milk coagulation through the lactic acid fermentation of skimmed milk. The cheese is characteristically shaped and smoked. In addition, hard cheeses are produced in Bosnia and Herzegovina as smoked variants. One of these is the Kupreški cheese described by Rizvanović et al. (2018, 2019).

The Zarac smoked cheese from Majevica is described by Filipović (1969), who states that it is a cheese "that is made from milk from which the butter has previously been removed and the pieces are dried in smoke or in the sun". According to Filipović (1969), "Zarac is a cheese, slightly larger than a fist, dried in the sun and very hard" and is particularly linked to the customs of local population. The production of the Zarac smoked cheese from Majevica represents an important activity of local producers, because in hilly and mountainous rural areas rural households usually have no other regular sources of income other than milk and milk products (Pavlović et al., 2020). In his description of traditional products of Bosnia and Herzegovina, Brenjo (2022) describes characteristics and the production process of the Zarac smoked cheese from Majevica.

Based on the above, the aim of this paper was to describe the technology, and to examine the physico-chemical and sensory characteristics of the Zarac smoked cheese.

Material and Methods

The technology of the Zarac smoked cheese was monitored in this research. It has small dimensions, such that a larger number of cheese blocks are produced from one batch of milk per day. Therefore, three samples were taken for this research and the values represent the average of these three samples. Chemical analyses were performed on cheese samples. The dry matter content was determined by drying at $102\pm 2^{\circ}\text{C}$ in a Heraeus dryer (International Organization for Standardization [ISO] & International Dairy Federation [IDF], 2004), while the fat content was determined by the Van Gulik method (ISO & IDF, 2008). The proportion of fat in the dry matter (fat in DM) was calculated (Bylund, 2003) as well as moisture on a fat-free basis (MFFB) (Codex Alimentarius Commission, 2021). The amount of protein in milk was determined

by the Kjeldahl method – expressed as N (nitrogen) content multiplied by the milk protein factor - 6.38 (ISO & IDF, 2014). Digestion of the samples was done on the Büchi Digest system K - 437 apparatus, distillation on the Büchi, KjelFlex, K - 360 distillation apparatus and titration on the Methrom Herisau titration apparatus, the E 526 titrator with a 665 dispenser. The salt content in the cheese samples was determined by the "Norwegian method" potentiometrically using the "MK II chloride Analyser 926, Sherwood" apparatus, and the salt in moisture (S/M) content was calculated (Scott, 1998; Guinee & Fox, 2004). Lactic acid content was determined by titration (AOAC International, 1995). In regards with the physical properties, pH value, water activity, and cheese texture were analysed. The pH value of the cheese samples was determined with a Metrohm 632 pH meter. The measurement was performed with a stabbing electrode for cheese, WTW – SenTix Sp. Water activity (a_w) was determined with the help of the Rotronic Hygrolab 3 device (Rotronic AG, Bassersdorf, Switzerland), and the texture of the cheese samples was determined using a texture analyser, i.e., TA.XT Plus Texture Analyzer. Using a texturometer, the texture expressed through hardness and adhesiveness was determined on the prepared samples. Values are expressed as force in N (Newton) units. For a better comparison, the results were converted to G (force) units.

To analyse its quality, sensory evaluation of the Zarac smoked cheese included the evaluation of appearance, colour, consistency, odour, and taste of the samples using a scoring method out of a maximum total of 20 points. The sensory evaluation was conducted by an expert panel consisting of 7 expert evaluators and the scores represent the average value of all evaluators.

Results and Discussion

Technology of the Zarac smoked cheese from Majevisa

The Zarac smoked cheese is produced from the milk of a single milking, i.e., morning or evening milk. The milk comes from cows kept in specific conditions in the area of the Municipality of Lopare and comes from the farmer's own farms. The milk is first strained through sterile gauze and then poured into pots. Milk ferments in pots for 24-48 hours, during which part of the fat, i.e., cream, rises up and is separated. Partially skimmed milk is slightly heated. The coagulum is cut into cubes and left for an hour so that the whey comes out of it. Then the curd is placed in colanders and squeezed at room temperature. The time of squeezing depends on the season. Draining in the summer lasts half as long as in the winter, when it lasts up to 24 hours. After squeezing, the entire quantity of one batch of milk is placed in bags, and then in the freezer where, depending on the quantity being prepared, it stays for at least 3 days. The cheese mass is thawed and salted with a maximum of 2% salt per cheese mass. After salting, the cheese

is kneaded with hands to obtain a loose, creamy mass without lumps. If necessary, kneading of the cheese can take up to 1 hour. If the cheese is made with special additives such as garlic or paprika, then these are added at this stage. After kneading, 320 g of cheese is weighed into previously prepared mesh bags (“socks”) and used for the smoking process. The cheese is further shaped in those bags. After shaping, the cheese is left for another 12 hours on a towel or cloth at room temperature so that the rest of the whey can come out. This is when acidity increases, which further preserves it naturally (Poljoprivredna zadruga „Zarac“, 2023).



Fig. 1. and 2. The cross-section and outer appearance of the Zarac smoked cheese from Majevisa



Fig. 3. and 4. The Zarac smoked cheese packed in foil and plastic containers

After salting and shaping, the cheese is smoked. Smoking is done in round or square metal barrels. They have a fire door at the bottom. Beech, plum, and sometimes cherry wood is usually burned. Sometimes beech sawdust is also burned. It is important that the wood is dry. A fire is lit that creates smoke used to dry the cheese. It is very important to emphasise that the cheese is dried and smoked with smoke, not with fire. A stainless steel grate is placed on the upper part of the barrel, and gauze is placed on it to prevent direct contact of the smoke with the cheese. The cheese is placed on a cheesecloth and paper is placed on top of the barrel to make smoking more efficient. Smoking lasts from 2 to 4 hours. After that, the cheese is taken out of the bags and packed in foil under vacuum or in plastic containers. The shelf life of cheese in such plastic containers is up to 30 days, and the cheese in vacuum packaging can last up to 60 days at a temperature of 4-8°C. Packages weighing 200-250 g and "mini" cheese weighing 30-40 g are available on the market (Poljoprivredna zadruža „Zarac“, 2023).

Chemical composition of the Zarac smoked cheese from Majeвица

Data on chemical composition are shown in Table 1. There are no significant variations, which is expected because the cheese is made from the same milk. The Zarac smoked cheese belongs to the group of fresh cheeses with a low content of dry matter, fat, and fat in dry matter (fat in DM). As stated in the Rulebook on Milk Products and Starter Cultures (2011), according to the content of fat in the dry matter, it belongs to the category of semi-fat cheeses (from 10 to 25% fat in DM), which is expected because it is produced from partially skimmed milk. Namely, the traditional method of harvesting milk cannot remove fat to the extent that it can be done in industrial facilities using centrifugal separators. According to the content of the moisture on a fat-free basis (MFFB), this cheese is classified as soft cheese (over 67%) in the Rulebook on Milk Products and Starter Cultures (2011). The salt content is very moderate as well as salt in moisture (S/M) and similar to the values of some longer-ripening hard cheeses measured on the 1st day after production. Thus, Sarić et al. (2022) and Barać et al. (2024) established the salt and S/M content of the Kupreški cheese and the Lider cheese to be 0.71% and 1.78%, and 1.93% and 3.54%, respectively.

Tab. 1 - Chemical composition of the Zarac smoked cheese from Majeвица

Value/ Component	Dry matter - DM (g/100 g)	Fat (g/100 g)	Proteins (g/100 g)	Fat in DM (%)	MFFB (%)	Salt (g/100 g)	S/M (%)
Min.	31.00	6.00	19.51	18.92	73.40	1.30	1.88
Max.	31.72	6.00	20.62	19.35	72.64	1.30	1.90
Mean	31.41	6.00	20.16	19.10	73.00	1.30	1.89

Pavlović et al. (2020) state the following chemical composition of the Zarak smoked cheese (%): 31.40 of dry matter; 6.00 of fat, 19.00 of fat in DM, 19.10 of proteins, and 1.80 of salt, which is very similar to the results obtained in this work. Sarić et al. (2005) determined the following average chemical composition for "dry" cheese: 35.29% of dry matter, 5.20% of fat, 15.37% of fat in DM, and 23.56% of proteins. Bijeljac and Sarić (2005) report a wider range of variations in the chemical composition of dried sour cheese (28.09-34.55% of dry matter; 12.75-23.75% of fat; 17.78-33.00% of fat in DM; 33.00-40.20% of proteins, and 1.30-3.82% of salt). It can be stated that the results obtained are within the limits established by other authors.

Physical properties of the Zarak smoked cheese from Majeвица

For better clarity, the data on the acidity of the cheese, i.e., the lactic acid content, is shown in Table 2 along with the pH value, as these two properties are related. In addition, the water activity and textural properties, i.e., the hardness and adhesiveness of the Zarak smoked cheese were analysed. The pH value of this cheese is extremely low, and the amount of lactic acid is extremely high, which indicates a strong activity of lactic acid bacteria during its production, which takes place in situations of spontaneous acidification due to the work of autochthonous microflora. The pH value of most “rennet” cheeses, with the exception of white brine cheeses, is above 5.00, and the lactic acid content is significantly lower. Sarić et al. (2022, 2025) found that after production the hard Kupreški cheese had an average pH of 5.28, while the lactic acid content was on average 0.22%. For the hard Lider cheese, these values were 5.25 and 0.18% (Sarić et al., 2024a). Bijeljac and Sarić (2005) report a range of 0.50 to 1.64% lactic acid in the dried smoked cheese, which is again lower than the values obtained in this work. On the other hand, water activity had high values due to the high water content. However, it is obvious that the presence of smoke, low pH, and high acidity are preserving factors in this cheese. Although microbiological testing was not performed in this study, the results obtained by Sarić et al. (2005), where sulfite-reducing Clostridia were found in only one of 10 samples, confirm these assumptions.

Tab. 2 - Physical properties of the Zarak smoked cheese from Majeвица

Value/ Property	pH	Lactic acid (g/100 g)	Water activity (<i>a_w</i>)	Hardness (g)	Adhesiveness (g)
Min.	3.80	2.54	0.932	254.16	-15.44
Max.	4.04	2.50	0.934	623.55	-20.66
Mean	3.94	2.53	0.933	467.96	-18.35

Water activity, hardness, and adhesiveness had values similar to those determined by Sarić et al. (2024b) for white brine cheeses. The water activity values determined by these authors for hard, semi-hard, white mold, and blue veined cheeses were lower, and for hardness and adhesiveness higher compared to the Zarac smoked cheese from Majevisa.

Sensory evaluation of the Zarac smoked cheese from Majevisa

The standard Zarac smoked cheese without additives has a specific, sour, and moderately salty taste with a hint of smoke. The smell is also characteristic, milky, but the smoky note dominates. On cross-section, the colour of the cheese is white to pale yellow. Its consistency is uniform, without holes in the section, but there may be some mechanical holes. The cheese dough is quite compact, without traces of crumbling (Poljoprivredna zadruža „Zarac“, 2023). Sensory evaluation of the Zarac smoked cheese was performed after production. The evaluators defined a clean sour, slightly pronounced note on the taste, without foreign admixtures but with a slight lack of complexity. The consistency was described as slightly softer.

Tab. 3 - Sensory evaluation of the Zarac smoked cheese from Majevisa

Value/ Characteristics	Appearance	Colour	Consistency	Odour	Taste	Total
Min.	1.00	2.00	3.50	2.50	7.00	17.00
Max.	1.00	2.00	4.00	3.00	9.50	19.00
Mean	1.00	2.00	3.60	2.90	8.45	17.95

According to the overall average sensory rating, the Zarac smoked cheese belongs to the high first class. Some evaluators classified it as extra class, and some as first class, but no evaluator classified it as lower class. Similar results were obtained by Sarić et al. (2005) in the sensory evaluation of "dry" cheese, where the samples received high ratings ranging from 17.00 to 18.50.

Conclusion

The aim of this work was to describe the technology, examine the chemical composition and physical properties, and evaluate the sensory properties of the Zarac smoked cheese from Majevisa. It can be stated that this cheese, which is produced from partially skimmed, raw milk by acid coagulation, has a composition typical for the group of fresh, semi-fat cheeses. Due to its low fat content, it has dietary properties, and the preservative effect is due to the low pH

and high acidity of this cheese, as well as the smoking used in its production. The physical properties of this cheese were characteristic for this group of cheese, while the sensory evaluation placed it in the high first to extra class. It can be stated that the Zarac smoked cheese is characterised by high quality and specific characteristics that distinguish it from other cheeses, thus contributing to its high value.

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Мајевички димљени сир Зарац – производне и квалитативне карактеристике

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⁵Агенција за сигурност хране, Мостар, Босна и Херцеговина

Сажетак

Мајевички димљени сир Зарац је млијечни производ који је заштићен у Босни и Херцеговини ознаком заштите поријекла (ЗОП). Ознаку је добио 2024. године што довољно говори о квалитету овог сира. Стога је циљ овог рада био да се опише технологија, испита хемијски састав и физичке особине, те сензорно оцијени овај сир. То је сир који се производи од дјелимично обраног, сировог млијека, спонтаном ферментацијом коју проводи природна микрофлора присутна у млијеку. Подручје производње овог сира је сјевероисточна Босна. Мајевички димљени сир се карактерише ниском рН вриједности и високом киселости које дјелују конзервирајуће док исти учинак има и димљење које се примјењује у технологији овог сира као једна од фаза технолошког процеса. Просјечан хемијски састав овог сира је следећи (%): суха материја 31,41; маст 6,00, маст у СМ 19,10, ВБМС 73,00, протеини 20,16 и со 1,30 што га сврстава у категорију полумасних меких сирева. Физичке карактеристике, висок активитет воде, ниска тврдоћа и љепљивост су очекивани за ову категорију сирева. Сензорна оцјена је показала висок квалитет Мајевичког димљеног сира па је он по просјечној оцјени на граници прве и екстра класе. Сprovedена истраживања и добивени резултати оправдавају репутацију и мјесто које овај сир заузима међу сиревима Босне и Херцеговине па и шире.

Кључне ријечи: сир, квалитет, хемијски састав, физичка својства, сензорна оцјена

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