

QUALITY AND TECHNOLOGY OF KAJMAK AND SKIMMED MILK CHEESE IN THE AREA OF ROMANIJA MOUNTAIN

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Abstract

Kajmak is an autochthonous dairy product that has been produced in the mountainous Dinaric system of the Balkans for centuries. It is consumed as "young" or "mature" which is obtained after the ripening process. It is characterized by high fat content and significant protein content, primarily casein. Smoked Kajmak from the area of the Romanija mountain is of special quality, which acquires a mild taste and smell from the smoke. In this paper, the technology, chemical composition and sensory quality of Kajmak from the wider area of Romania were investigated. Kajmak is produced from cow's milk. Within the framework of these studies, the content of dry matter and fat of milk for the production of Kajmak was examined, as well as the influence on the content of dry matter, fat and fat in dry matter and also the yield of Kajmak. The technology of Skimmed milk cheese, which is made from skimmed milk after removing of fat layer - Kajmak, was also investigated. The yield, content of dry matter, fat and fat in dry matter of Skimmed milk cheese were tested. The distribution of milk ingredients in Kajmak, Skimmed milk cheese and whey was analyzed.

The results showed a good quality of Kajmak, with a high content of fat and fat in dry matter. The technology varied depending on the production conditions and the raw material, so this caused considerable variations in the chemical composition, yield and sensory properties of Kajmak. By analyzing the distribution of milk ingredients in production, it was established that the largest percentage of milk dry matter turned into whey due to generation of its largest quantity in Kajmak/Skimmed milk cheese production. Correlation analysis showed that the production parameters of Kajmak and Skimmed milk cheese were interrelated. Correlation analysis showed that the yield of Kajmak was influenced by dry matter content of the milk, and the content of fat and fat in the dry matter of the Kajmak is influenced by the fat content of the milk.

Keywords: *Kajmak, Skimmed milk cheese, fat, dry solids, quality*

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INTRODUCTION

It is assumed that Skorup-Kajmak originated as a stage in the development of the butter production process in primitive conditions. The indigenous technology of young or unripe Kajmak is, in its basic principles, very similar to the traditional method of producing sour cream in households. In principle, it represents a fat layer removed from the surface of cooled boiled milk after a certain period of standing. In terms of fat content, Kajmak is between butter, on the one hand, and cream and full-fat cheeses, on the other hand. By undergoing the ripening process, old or mature Kajmak is formed from young. In terms of fat content, only butter and anhydrous milk fat are richer than it. In terms of a certain amount of protein, the ripening process and the development of acidity and other compounds, it approaches cheeses (Sarić, 1995; Bijeljic and Sarić, 2005).

Kajmak is a product that has been produced in Bosnia and Herzegovina and the wider region since ancient times. The word "kajmak" is of Turkish origin and means „cream“. The term "skorup" is of Slavic origin and comes from the word "kora" (Bijeljic and Sarić, 2005). In the mountainous areas of the Dinaric system, the name Skorup was retained for a longer time, and in cities and markets, Kajmak (Dozet *et al.*, 2010). As stated by Zdanovski (1947), the term Skorup is more commonly used in Croatia, and the name Kajmak in Serbia and Macedonia. In Montenegro, the name Skorup is used exclusively and in Bosnia and Herzegovina mostly Kajmak. The more precisely Kajmak is a specific autochthonous dairy product for the area of the Dinaric mountain system and some authors stated it is produced in some parts of Croatia (Lika), Bosnia and Herzegovina, Montenegro, Macedonia and Serbia (Zdanovski, 1962; Dozet and Stanišić, 1972; Bijeljic and Sarić, 2005; Puđa *et al.*, 2008). Zdanovski *et al.* (1966) state that Kajmak is produced in all areas of Bosnia and Herzegovina except northern Bosnia and the wider area of the Vlašić Mountains. In Bosnia and Herzegovina, it is produced in western, central and eastern Bosnia and also Herzegovina. The regions of eastern Herzegovina (Gacko-Kajmak from animal skin bag) and eastern Bosnia (Romanija-Rogatica) – smoked Kajmak are distinguished by the quantity and quality of the product (Dozet and Stanišić, 1972). Dozet *et al.* (1981) state that the production of Kajmak is best in the area of eastern Bosnia in the regions bordering Montenegro and Serbia. Mountain Romanija is a typical Kajmak producing region.

The specificity of Kajmak from the wider area of Rogatica and Romanija mountain is smoking, so it turns more yellow and acquires a specific pleasant taste and smell from the smoke, and by smoking, a kind of preservation of Kajmak is done. Another characteristic of Kajmak technology from Romanija is that the cream rises when the milk under it curdles (Dozet, 1962; Zdanovski *et al.*, 1966, 1970; Bijeljic and Sarić, 2005; Dozet *et al.*, 2010). Zdanovski (1956) states in his work that "Kajmak is famous from Romanija mountain, which is smoked with smoke from beech wood". The technology, yield and quality of Kajmak from the area of Rogatica and Romanija mountain were examined by Dozet *et al.* (1981, 1996, 2010), and Zdanovski *et al.* (1966), while the chemical composition of Kajmak from the area of eastern Bosnia

(Romanija-Rogatica) is reported by Zdanovski *et al.* (1970), Dozet and Stanišić (1972), Dozet *et al.* (1973; 1974; 1983; 2007a,b,c and Pandurević *et al.* (2008). Sarić (1995), Dozet *et al.* (2004) and Bijeljac and Sarić (2005) described in detail the quality and technology of Kajmak from the wider area of Romanija mountain. Stanišić *et al.* (1990) and Sarić (1995) established the interdependence of the fat content in milk and the fat content in Kajmak and the fat in the dry matter of Kajmak in the production of Kajmak from the area of Romanija mountain, and Dozet *et al.* (1981) between the fat content of milk and the amount of Kajmak. The influence of the length of creaming on the yield of Kajmak from Romanija mountain was determined by Đurković (1975) and Sarić (1995). Skimmed milk cheese is produced from the milk that remains after removing the cream crust. Zdanovski *et al.* (1966) and Dozet *et al.* (1996, 2004) showed the technology, yield and composition of fresh Skimmed milk cheese, while Dozet (1962) and Zdanovski *et al.* (1972) described the composition of Skimmed milk cheese. The aim of the work was to examine the technology, yield and chemical composition of Kajmak in the area of Romanija mountain. Also, technology and yield were monitored, and the chemical composition of fresh Skimmed milk cheese in the production of "Romanijski" Kajmak was tested. The main goal was to investigate the influence of the content of dry matter and fat in milk as a starting raw material for the production of "Romanijski" Kajmak on the content of dry matter, fat and fat in the dry matter, and on the yield of Kajmak. Since it is a production with two co-products (Kajmak and Skimmed milk cheese), the dependence of the content of dry matter, fat and fat in the dry matter of fresh Skimmed milk cheese, and the yield on the content of dry matter and fat in milk, as well as the distribution of dry matter in the production of Kajmak, were examined.

MATERIAL AND METHODS

The wider area of Romanija mountain (the municipality of Rogatica and the municipality of Pale) was selected for the tests. A total of 12 households were included in the research, 6 from the area of the municipality of Rogatica (localities Osovo, Borike, Barakovac) and 6 from the area of the municipality of Pale (localities Barakovac and Krivače). Kajmak technology was monitored in all households and samples of milk, young Kajmak and fresh Skimeed milk cheese were taken. During all the research, the indicators and stages in the technological process were monitored, and in order to obtain data on the yield ($Y = \text{kg obtained Kajmak-Skimmed milk cheese} \times 100 / \text{kg of milk used}$) and quantity of milk/kg of product ($100/R$), the total quantities of milk, Kajmak and Skimmed milk cheese were measured.

Chemical and sensory analyses were done in the Dairy Laboratory of the Faculty of Agriculture and Food Sciences, University of Sarajevo. Since the total content of dry matter and fat are the most important factors in the production of Kajmak, the analyses included testing the content of dry matter and fat in milk, and dry matter, fat and fat in the dry matter of Kajmak and Skimmed milk cheese. The dry matter content of milk was determined gravimetrically, by drying in an oven at $102\pm 2^{\circ}\text{C}$ (ISO 23318:2022), and the milk fat content was determined by the Gerber method (ISO 19662:2018). The content of dry matter in Skimmed milk cheese was determined gravimetrically by drying in an oven at $102\pm 2^{\circ}\text{C}$ (ISO 5534:2004), and the fat content by the Van Gulik method (ISO 3433:2008), whereby for Kajmak, modified methods were used according to Pravilnik o metodama uzimanja uzoraka i metodama hemijskih i fizičkih analiza mlijeka i proizvoda od mlijeka (1983). The fat content in the dry matter of Kajmak and Skimmed milk cheese was determined by calculation according to Bylund (2003). The sensory evaluation of Kajmak and Skimmed milk cheese was performed by an expert panel composed of 7 members using a system of maximum 20 points where the following characteristics were evaluated: appearance, color, consistency, smell and taste. The distribution of individual ingredients from milk and their transfer to Kajmak implies the calculation of the percentage of dry matter of Kajmak as well as Skimmed milk cheese. By calculating the distribution of dry matter, the quantity of milk, Kajmak and Skimmed milk cheese with the dry matter of milk, Kajmak and Skimmed milk cheese were taken into account. The rest that remains in the whey is obtained by summing the distribution of Kajmak and Skimmed milk cheese and subtracting the value from 100.

Quantity of milk x % dry matter of milk

Quantity of Kajmak x % dry matter of Kajmak

Quantity of Skimmed milk cheese x % dry matter of Skimmed milk cheese

$$\begin{array}{rcl} \text{Obtained milk value} & & 100\% \\ \text{Obtained Kajmak value (Skimmed milk cheese)} & & \underline{\quad x \quad} \end{array}$$

$$x = \frac{\text{obtained Kajmak value (Skimmed milk cheese)} \times 100\%}{\text{obtained milk value}}$$

Mathematical-statistical analysis of data referred to the calculation of basic parameters of descriptive statistics. The correlation between the values of the chemical parameters of raw milk, Kajmak and Skimmed milk cheese and the yield in production was tested using the Pearson's correlation coefficient. The Microsoft Excel 2010 program was used to calculate the basic parameters of descriptive statistics and Pearson's correlation coefficient.

RESULTS AND DISCUSSION

In all chosen households, the technology of Kajmak and Skimmed milk cheese was followed. Indigenous production is of small capacity and differs quite a bit in terms of production methods and parameters. Therefore, the quality of products on the market is often uneven.

Autochthonous technology of Kajmak and Skimmed milk cheese in the area of Romanija mountain

The most important factor in the production of any dairy product is quality milk. For the production of Kajmak, cow's, sheep's or mixed milk is used. In all surveyed households, cow's milk was used as a raw material for the production of Kajmak. Of all the ingredients, milk fat has the greatest influence on the quantity and quality of Kajmak, because Kajmak is a product that can contain almost and over 90% of fat in the dry matter. Therefore, only the content of dry matter and fat was analyzed in milk for the production of Kajmak.

Table 1. Chemical composition of cow milk for Kajmak manufacture

Tabela 1. Hemijski sastav mlijeka za proizvodnju Kajmaka

Indicators (%)	Min.	Max.	Mean	St. dev.	CV (%)
Dry matter	10.65	17.62	12.45	1.78	14.29
Fat	1.90	5.50	3.77	0.93	24.66
Non-fat dry matter (NFDM)	7.29	12.12	8.68	1.26	13.89

It can be seen that fat is the most variable component with the highest coefficient of variation and varies in a wide range from 1.90 to 5.50%. The dry matter and non-fat dry matter (NFDM) content is more uniform. The average fat content and NFDM meet the provisions of the Regulation on the quality of fresh raw milk (2011), while individual values deviate from the prescribed ones. Dozet *et al.* (1975) state that the dry matter content for milk from hilly and mountainous areas ranges from 10.40 to 14.30%. For cow's milk for the production of Kajmak from the area of eastern Bosnia, the average dry matter and fat content was recorded as 13.08 and 3.68%. The average NFDM content was 9.40% (Dozet *et al.*, 1974a). Milk from the experimental production of Kajmak had 12.10, 8.20 and 4.10% dry matter, NFDM and fat (Dozet *et al.*, 1996). The fat content depends on the year and period, i.e. diet, and is lower at the beginning of the grazing season, and higher as the end of the season approaches.

In the cow's milk for the production of Kajmak in the area of Romanija mountain in the summer period (2007-2008), it varied in average from 3.75% in May to 3.82% or 4.10% in September (Dozet *et al.*, 2010). For cow's milk for the production of Kajmak from the area of Romanija mountain, the average fat content was 3.75% (Zdanovski *et al.*, 1972) or 4.05% with variations from 2.80 to 5.10% (Sarić, 1995). Cow's milk for the production of Kajmak from the hilly-mountainous area of the wider Sarajevo region had a fat content of 3.20% to 5.30% (hilly area) and from 2.65 to 5.90% (mountainous area). It can be stated that the content of dry matter, fat and NFDM is somewhat lower, but that it corresponded to the values reached by other authors examining the production of Kajmak from the area of Romanija mountain.

Kajmak is produced in huts specially designed for this purpose, which are usually located near the house. They are made of wood so that they allow better air circulation, and the floors are earthen or concrete. The advantage of a hut is that the milk does not come into contact with other products, which means there are fewer opportunities for it to absorb foreign odors. Since this is a mountainous area with a large number of days with low temperatures, there is a stove or hearthstone in the huts where the fire burns. Milk is boiled on the stove or it is done in the house, and the fireplace, in addition to heating, has the main function, which is to produce smoke. The presence of smoke is a characteristic of Kajmak from this area. Oak, beech or spruce wood is burned on the fireplace. Smoking makes the kajmak more yellow and gives it a smoky taste and smell, and this is how preservation is done. The season for producing Kajmak in huts is from early May to early November, but it can last longer.



Figure 1. Huts for Kajmak manufacture (old building-left and a newer one-right)
 Slika 1. Kolibe za proizvodnju Kajmaka (stara gradnja-lijevo i novija-desno)



Figure 2. Interior of hut - chimney and smoking of Kajmak
Slika 2. Unutrašnjost kolibe – ognjište i dimljenje Kajmaka

The production of Kajmak begins with fresh raw cow's milk, which is strained into larger, deeper containers in which the milk is boiled. The container with the milk is placed on an already heated stove and stirred occasionally to prevent burning. After boiling, the milk is left to boil for another 5-15 minutes, stirring occasionally. This also achieves the appropriate dry matter content in the milk. This is especially necessary during the grazing period in May, June and July, when the dry matter content in the milk is lower. After boiling, the milk is poured into prepared shallow containers where the Kajmak is separated. Most housewives do the cooking at home, and after pouring, the containers with the milk are then transferred to huts for cooling and crust formation. In another variant, everything is done in the same containers, both cooking and creaming, which are then shallower and smaller. Creaming or forming is the process of separating cream on the surface of boiled milk that occurs when the milk gradually cools. This operation has the greatest range of time variation. The duration of the creaming process is from 1 to 3 days, depending on the weather conditions and the season. In Romanija, the formed crust of Kajmak is removed when the milk underneath has curdled. However, on warmer days, the milk curdles more quickly, which is too short a period to separate the entire amount of Kajmak, which is why its quantity is lower. In colder weather conditions, the hut must be heated, and the separation of Kajmak is prolonged and a larger quantity is obtained. The crust is removed and Kajmak is placed in containers to drain.

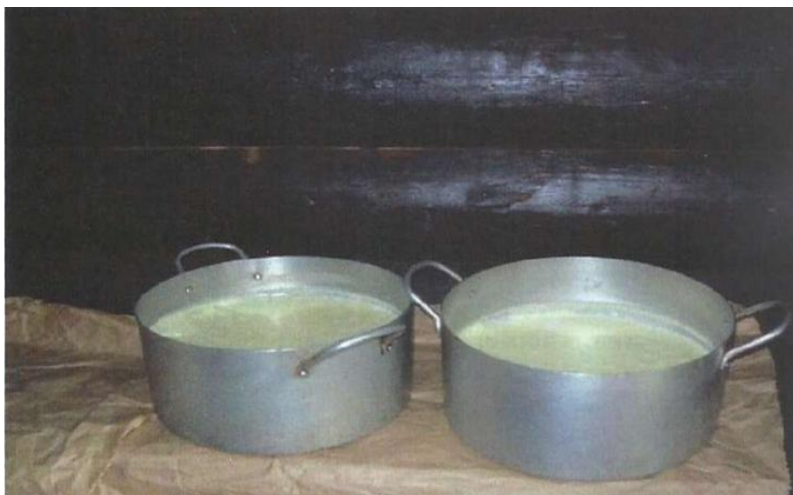


Figure 3. Posude sa mlijekom - formiranje kore

Slika 3. Milk containers – crust formation



Figure 4. Formed crust – Kajmak (left) and draining of Kajmak (right)

Slika 4. Formirana „kora“ Kajmaka (lijevo) i cijedenje Kajmaka (desno)

Drained Kajmak contains a lower moisture content and is of better quality, but this is not often practiced, especially if it is to be consumed young. Kajmak obtained can be consumed immediately or sold on the market as "young". A ripening phase is necessary for the production of "mature" Kajmak. The „young“ Kajmak is stacked for ripening in traditional wooden containers - tubs. As it is stacked, salt is added layer by layer and a cloth, wooden lid and a stone are placed on top. In order to create anaerobic ripening conditions, it is necessary to pour whey from fresh cheese or brine over the Kajmak. The minimum ripening process is 7-10 days, full maturity is achieved after 2-3 months, but it can last and be stored for up to a year. Storage is in cool places such as basements

or huts. This way, „mature“ Kajmak is obtained, which is most often collected in the fall to be consumed in the winter.

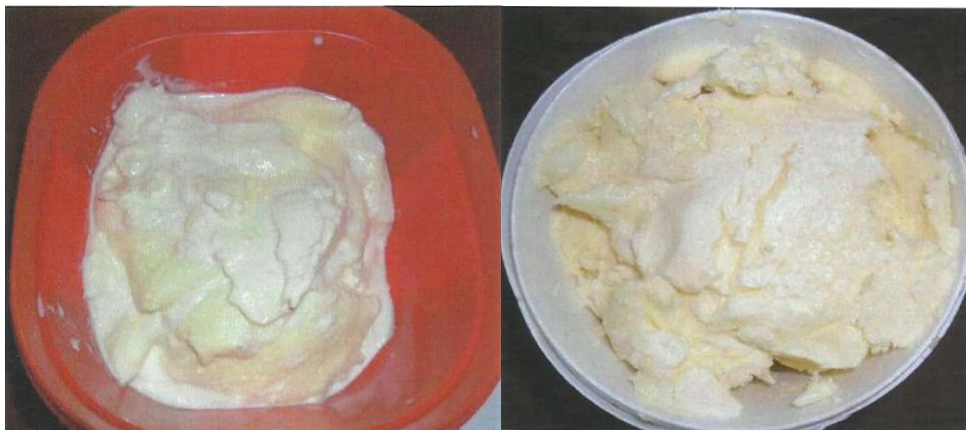


Figure 5. “Young” Kajmak (left) and “mature” Kajmak (right)
Slika 5. Mladi Kajmak (lijevo) i zreli Kajmak (desno)

It can be stated that certain stages and conditions of the production process play a key role in achieving high yield and quality of Kajmak. For research in this work, samples of „young“ Kajmak were used, so the measured yield and the analyzed chemical composition refer to it.

After removing the Kajmak, skimmed milk remains, from which, through appropriate processing, Skimmed milk cheese is produced. It has different names in different parts of Bosnia and Herzegovina (Vareni sir, Torotan, Tarenik, Tučenik, etc.). After the Kajmak has been removed, milk can, depending on the degree of acidity, coagulate in different ways: spontaneously with the help of heat, by adding vinegar, and by adding a small amount of rennet. During the research in this paper, spontaneous milk coagulation was most often used, but in a small number of cases when spontaneous coagulation did not occur, it was done by adding rennet or vinegar. In any case, the milk is placed on a warm stove over low heat.



Figure 6. Spontaneous milk coagulation (left) and milk coagulation with added rennet (right)

Slika 6. Spontana koagulacija mlijeka (lijevo) i koagulacija mlijeka sa dodatkom sirila (desno)

The lactic acid that has formed in the milk allows for curdling in approximately 30 minutes. In the case when the milk has not coagulated, rennet is added to speed up the curdling process. After that, it is left on the stove for a few minutes for the whey to come to the surface, and then it is removed to let the cheese mass cool slightly, not completely, because then squeezing would be difficult. Squeezing is done by pouring the cheese mass into a linen bag that is placed over a strainer where it is squeezed for a while. The cheese obtained in this way is called Skimmed milk cheese („Posni sir“). It is mainly used fresh for household needs or for sale. It can be left to ripen. At this time, the cheese is chopped, salted, mixed, placed in vats and weighed in the same way as Kajmak to create anaerobic conditions.

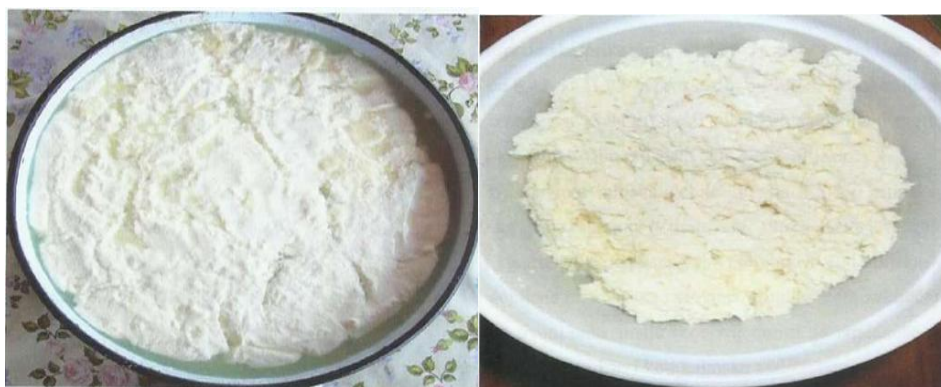


Figure 7. Spontaneously formed curd (left) and fresh Skimmed milk cheese (right)

Slika 7. Spontano izdvojeni gruš (lijevo) i svježi Posni sir (desno)

Yield of Kajmak and Skimmed milk cheese in the area of Romanija Mountain

To calculate yield and quantity of milk/kg of product, the amount of milk before cooking and the quantity of "young" Kajmak and fresh Skimmed milk cheese were taken into account. Yield and quantity of milk/kg of Kajmak and Skimmed milk cheese are shown in table 2.

Table 2. Yield in Kajmak and fresh Skimmed milk cheese manufacture

Tabela 2. Randman u proizvodnji Kajmaka i Posnog sira

Indicators	Min.	Max.	Mean	St. dev.	CV (%)
Yield (kg Kajmak/100kg milk)	2.91	10.38	5.16	2.18	39.56
Kg milk for 1 kg of Kajmak	10.38	34.36	20.52	7.24	35.28
Yield (kg Skimmed milk cheese/100kg milk)	8.41	21.03	13.84	4.02	29.03
Kg milk for 1 kg of Skimmed milk cheese	4.75	11.89	7.81	2.31	29.56

Values for yield of Kajmak are quite low, and milk consumption is high. From 100 liters of milk, an average of 5.16 kg of Kajmak and 13.84 kg of Skimmed milk cheese is obtained, and 1 kg of Kajmak requires an average of 20.52 liters of milk, while an average of 7.81 liters of milk is used to produce 1 kg of Skimmed milk cheese. A partial explanation for this is that the tests were carried out in the period of May, June and July when the content of fat and dry matter of milk is lower, which can be seen in table 1. D o z e t *et al.* (2010) emphasize that the fat content in milk significantly affects the quality and total quantity of Skorup-Kajmak produced. Producers make Skorup-Kajmak in the period when the composition and quality of milk allows for maximum production. According to a survey conducted among the producers of "Romanijski Skorup-Kajmak" from 10 liters of milk in the period up to July, about 600 g of Skorup-Kajmak (16.67 liters of milk/1 kg of Kajmak) is obtained, and in the period from August to mid-October, 1 kg of Skorup-Kajmak is obtained from 10 liters of milk (10 liters of milk/1 kg of Kajmak). High coefficients of variation for Kajmak yield and quantity of milk/kg of product, in addition to the variability in milk composition, point to significant differences in the procedures and conditions of Kajmak production. Variability is lower in Skimmed milk cheese compared to Kajmak, which can be seen from the lower coefficients of variation.

According to the literature (Jovanović, 1933) from 100 liters of milk, 4.66 kg of Kajmak is obtained (21.46 liters/1 kg of Kajmak), and since 1.27% of fat remains in skim milk after creaming, another 1.36 kg of butter and 66 kg of cheese are obtained from skimmed milk. Zdanovski (1962) states that 100 litarske of cow's milk yield about 4.50

kg of Kajmak (22.22 liters of milk/1 kg of Kajmak) and about 10 kg of „vareni“ (skimmed milk) cheese. From 100 liters of cow's milk with 3.50% fat, 6.16 kg of Kajmak (16.23 liters for 1 kg of Kajmak) and 11.5 kg of Skimmed milk cheese were obtained (Zdanovski *et al.*, 1966). Other sources report similar data. From 100 liters of cow's milk with an average of 3.50% fat, an average of 6.73 kg of Kajmak was obtained, and an average of 15.78 liters of milk was used for 1 kg of Kajmak (the amount of milk after cooking was taken into account). As the content of fat in milk increased from 3.00 to 3.90%, the amount of milk needed for 1 kg of Kajmak decreased (from 21.06 to 11.62 liters), and the yield increased (from 4.75 to 8.61). At the same time, an average of 12.24 kg of Skimmed milk cheese was obtained from 100 liters of cooked milk (Dozet *et al.*, 1981). In experiments in households at Romanija mountain, an average of 6.06 kg of Kajmak was obtained from 100 liters of cow's milk, that is, an average of 17.41 liters of milk/1 kg of Kajmak was used. The interdependence of the fat content in milk and the length of creaming with yield was established (Sarić, 1995). By comparison with the data from the literature, it can be said that the determined yield of Kajmak in this work approaches the lower limits, while, in contrast, the yield of fresh Skimmed milk cheese is close to the maximum values. This makes sense, especially considering the relatively short length of creaming (1-3 days).

In the production of Kajmak from sheep's or mixed cow's or sheep's milk, the yield is higher and milk quantity/kg of Kajmak is lower compared to the production from cow's milk. According to some data, 0.80% fat remains in the skimmed milk after removing the Kajmak obtained from milk with 5.90% fat (probably mixed op. aut.) (Bajčetić, 1955). Đurković (1975) established that in the area of Romanija, from 100 liters of milk, on average, 9.04 kg of Kajmak (11.06 liters of milk/kg of Kajmak) can be obtained. Kajmak was produced from cow's and sheep's milk. Tests in the same field showed that from 100 liters of mixed cow's and sheep's milk with 6.50% fat, 11.83 kg of Kajmak was obtained (8.45 liters/1 kg of Kajmak), and from skimmed milk with 1.10% fat, 31.66 kg of fresh Skimmed milk cheese was obtained (Zdanovski *et al.*, 1966). According to some data, Kajmak producers at Romanija consume 7-14 liters of milk/1 kg of Kajmak (probably mixed sheep's and cow's milk or only cow's milk, not stated rem. authors). At the same time, 10-14 kg of Skimmed milk, „vareni“ cheese can be produced from 100 liters of milk from skimmed milk after removing Kajmak (Dozet *et al.*, 1996).

Quality of Kajmak and Skimmed milk cheese in the area of Romanija mountain

Analyses of the chemical composition were performed on samples of young Kajmak and fresh Skimmed milk cheese. In addition to the amount of Kajmak and Skimmed milk cheese produced, the amount of dry matter and fat in milk also affects their composition and sensory properties. As can be seen from the data in table 3, Kajmak has a high content of fat in dry matter above the minimum limits stipulated by Rulebook on dairy products and starter cultures (2011), which requires a minimum of 65.00% fat

in dry matter. In terms of average dry matter content, it is at the very limit stipulated by Rulebook on dairy products and starter cultures (2011) (minimum 60.00%), and some samples are even below the limit. The extremely high fat content and the relatively low proportion of dry matter can be linked to the relatively low yield and the short period of creaming, as well as the production season (May, June, July).

Table 3. Chemical composition of Kajmak and Skimmed milk cheese

Tabela 3. Hemijski sastav Kajmaka i Posnog sira

Indicators	Min.	Max.	Mean	St. dev.	CV (%)
Kajmak					
Dry matter (g/100g)	54.28	66.19	59.93	4.35	7.25
Fat (g/100g)	39.00	63.00	54.38	7.65	14.06
Fat on dry matter basis (DM - %)	71.48	99.18	90.49	9.09	10.04
Skimmed milk cheese					
Dry matter (g/100g)	14.55	31.92	26.44	5.31	20.08
Fat (g/100g)	1.50	9.00	5.25	2.40	45.71
Fat on dry matter basis (DM - %)	10.30	28.67	18.98	6.24	32.88

Young Kajmak contains a high percentage of dry matter (66.04%), fat (57.51%) and fat in dry matter (87.17%), and mature 67.73, 58.56 and 85.51% resp. This places it in the group of dairy products with an extremely high energy value, ranging from 2000 to 2500 kJ (Bijeljac and Sarić, 2005). The chemical composition of Kajmak varies due to differences in specific technology and initial raw materials (Dozet and Stanišić, 1972). According to the way dairy animals are fed, the composition of milk changes, which affects the quantity and quality of the product (Dozet *et al.*, 2010). Therefore, the chemical composition of Kajmak varies depending on the period of production, so for Kajmak from the area of Rogatica, Borik and the Sjemeč mountain, a higher content of dry matter and fat was found in the autumn period compared to period spring-summer (69.16% and 59.70% resp. 66.61% and 56.67%) (Zdanovski *et al.*, 1970), which can be attributed to differences in nutrition and composition of grazing in different periods of production of "Romanijski Skorup-Kajmak". Fat content in dry matter is a very important component that is fairly constant regardless of the degree of maturity of Kajmak or the period of production (85.99% autumn and 85.15% spring-summer) (Zdanovski *et al.*, 1970). In the samples of young and mature Kajmak from the area of

Romanija-Rogatica-eastern Bosnia, the content of dry matter varied in the range 66.31-71.48%, fat 57.50-61.08% and fat in dry matter 85.24-87.80% (Dozet and Stanišić, 1972; Dozet *et al.*, 1987, 2007a,b,c, 2010; Sarić, 1995; Pandurević *et al.*, 2008). All data indicate the constancy of fat in dry matter content regardless of season and maturity. It seems that the content of fat in milk and the length of creaming are very important in this regard, because it was established that there is a connection between them and the content of fat and fat in the dry matter of Kajmak (Sarić, 1995).

The content of the basic components of Skimmed milk cheese corresponds to some data from the literature, but compared to most data, the content of dry matter is lower, and compared to some others, the content of fat and fat in dry matter is higher. According to the content of fat in the dry matter, it is actually in the group of semi-fat cheeses (Rulebook on dairy products and starter cultures, 2011) which shows that a significant part of the fat has passed into the cheese and partly explains the relatively low yield of Kajmak. This shows that for good control in the production of Kajmak, it is necessary to monitor the yield and composition of Skimmed milk cheese. The average composition of sour fresh cheese made from skimmed milk after removing Kajmak is as follows: 30.28% dry matter, 5.36% fat, 16.78% fat in dry matter, 20.28% protein, 1.42% salt, 2.32% ash and 1.00% lactic acid (Jovanović, 1964). The composition of the Skimmed milk cheese in Kajmak production from the Romanija area is following: dry matter 35.00%, fat 3.50%, fat in dry matter 10.00%, protein 32.40%, ash 0.68% (Zdanovski *et al.*, 1966) while the average composition of Skimmed milk cheese after the production of Kajmak from cow's milk is as follows: 33.57% dry matter, 1.75% fat and 5.23% fat in dry matter (Dozet *et al.*, 1981). Zdanovski *et al.* (1972) and Dozet *et al.* (1974a) give data for the content of dry matter, fat and fat in the dry matter of Skimmed milk cheese: 30.75 and 39.42%, 4.35 and 6.80% and 13.47 and 16.10% resp. Sensory analysis of Kajmak and Skimmed milk cheese was performed (Table 4 and Table 5). Young Kajmak should meet the following quality requirements: it should be white or yellowish in color; it should have a pleasant smell and a mild taste; it should have a flaky structure with pieces of boiled milk curd (Rulebook on dairy products and starter cultures, 2011).

According to the average total score, Kajmak was classified as Class I. Three samples were in the extra class (above 18.10 points), and most ones were in the first class, while one sample did not receive even the minimum number of points (out of class), which significantly lowered the average score. For taste, this sample received only 4.50 points due to the pronounced bitterness. The ratings of the remaining samples for taste were good. The smell and taste of most samples were mild, typically milky with a specific smell and taste of smoke.

Table 4. Sensory evaluation of Kajmak

Tabela 4. Senzorna ocjena Kajmaka

Property	Min.	Max.	Mean	St. dev.	CV (%)
Appearance	0.50	2.00	1.60	0.39	24.37
Color	1.00	2.00	1.73	0.31	17.91
Consistency	1.00	3.00	2.56	0.52	20.31
Odor	1.00	3.00	2.44	0.62	29.56
Taste	4.50	9.25	8.19	1.30	15.87
Total	8.50	18.50	16.50	2.76	16.72

Table 5. Sensory evaluation of Skimmed milk cheese

Tabela 5. Senzorna ocjena Posnog sira

Property	Min.	Max.	Mean	St. dev.	CV (%)
Appearance	0.75	0.50	0.69	0.11	22.00
Color	1.50	2.00	1.92	0.16	10.67
Consistency	3.00	3.75	3.52	0.29	9.67
Odor	2.00	3.00	2.60	0.36	18.00
Taste	4.50	9.50	8.27	1.32	29.33
Total	13.25	19.00	17.00	1.63	12.30

Even Skimmed milk cheese is classified in the first class according to the average overall rating, like Kajmak, the ratings are still slightly higher compared to Kajmak. Three samples were in the extra class, one was on the very border, while there were no samples outside the class, and only one sample was in the Class II. The appearance of the cheese was uneven, and the color and consistency quite uniform and regular. The results of chemical analyzes and sensory evaluation showed quite uneven quality.

Distribution of dry matter and correlation relationships in Kajmak and Skimmed milk cheese manufacture in the area of Romanija mountain

Calculating the distribution of milk dry matter as the initial raw material in the production of Kajmak is a good indicator of the correctness of the technology and profitability in production. The distribution shows how much dry matter of milk goes into Kajmak, Skimmed milk cheese and whey in the production of Skimmed milk cheese after removing Kajmak. In the literature, data for the distribution in production of different types of cheese can be found.

Jovanović *et al.* (2006) examined the distribution in the production of semi-hard cheeses based on milk protein aggregates and found that the average distribution of dry matter between cheese and whey was 57.37:42.63%. Dozet *et al.* (1978a) are in the production of Travnik cheese, and Seratlić *et al.* (2006) in the production of Gorgonzola type cheeses with blue-green molds found the distribution of dry matter in cheese and whey to be 46.11:53.89% and 63.06:36.91%, resp. Some authors have shown that there were differences in the distribution of dry matter between cheese and whey in white brine cheeses produced from sheep's and cow's milk. In the production of Travnik cheese from sheep's milk, the distribution of dry matter in cheese and whey was on average 50.66:49.34%, and from cow's milk it was higher in favor of whey, 39.12:60.88% (Dozet *et al.*, 1979). Similar results were obtained by Savić *et al.* (2015) in the autochthonous production of Sjenica cheese from sheep's and cow's milk. The distribution of dry matter in cheese and whey was more favorable in the case of sheep's milk (61.14:38.85%) compared to cow's milk (48.68:51.32%). The dependence of the distribution on the fat content in milk in the production of Travnik cheese was monitored by Dozet *et al.* (1978b). Reducing the fat content in milk from 3.75 to 3.00% did not significantly change the distribution of dry matter in cheese and whey. In the production of stretched curd cheeses, the distribution of dry matter in cheese and whey was from 40.68:59.32% to 42.86:57.14 (Dozet *et al.*, 1974b). Bijeljac (1987) also found significant differences in the distribution of milk dry matter components in the production of hard cheese of the Livno type and white brine cheese of the Travnik type.

Table 6. Distribution of milk dry matter in production of Kajmak (%)

Tabela 6. Distribucija suhe materije u proizvodnji Kajmaka (%)

Products	Min.	Max.	Mean	St. dev.	CV (%)
Kajmak	15.17	62.31	33.53	12.20	36.38
Skimmed milk cheese	14.81	37.76	26.62	6.20	23.29
Whey	15.67	63.05	40.67	12.31	30.27

The distribution of milk ingredients in the production of Kajmak has not been studied so far. The calculation is somewhat more complicated than in the production of cheese,

because in the traditional production, Kajmak, Skimmed milk cheese and whey are produced (product, co-product and by-product), while in traditional cheese production only whey is still taken into account. The distribution data varies significantly and, if looking at the average values, the proportion of dry matter that goes in the whey is quite high. However, if one bear in mind that most of the lactose and a good part of the mineral matter, and some of the whey protein that may remain after cooking the milk go into whey, and the fact that whey has the highest amount of all (and the amount must also be taken into account), then this is not surprising. Finally, similar results were obtained in cow's milk cheese production, as can be seen from the results found in literature. However, Kajmak and Skimmed milk cheese taken together make up a larger portion. In an effort to determine the relationship between the content of dry matter and fat of milk with the content of dry matter, fat and fat in the dry matter of Kajmak and Skimmed milk cheese, and the yield of Kajmak and Skimmed milk cheese, correlations were examined using the Pearson's correlation coefficient.

In production of Kajmak, a strong positive correlation was established between: dry matter and fat content of milk ($r=0.740$), dry matter and fat content of Kajmak ($r=0.795$), fat and fat in dry matter content of Kajmak ($r=0.874$) and dry matter content in milk and Kajmak yield ($r=0.718$). A moderately strong positive correlation coefficient exists between fat content in milk and fat content in Kajmak ($r=0.500$), dry matter content in milk and fat in dry matter content in Kajmak ($r=0.372$), fat content in milk and dry matter content in Kajmak ($r=0.416$). There were no other significant correlations with yield or they were negative. In the case of Skimmed milk cheese, the correlations were weaker, and a strong ones were recorded between: content of dry matter and fat of cheese ($r=0.861$) and fat in dry matter of cheese ($r=0.732$) and content of fat and fat in dry matter of cheese ($r=0.977$). A moderately strong positive correlation coefficient were recorded between: dry matter content of Kajmak and cheese ($r=0.404$) and dry matter content of Kajmak and fat content of cheese ($r=0.569$). High negative correlation coefficients were determined in the relationships between yield of Kajmak and dry matter content of cheese ($r=-0.767$) and fat content of cheese ($r=-0.610$), yield and dry matter content of cheese ($r=-0.730$), yield and fat content of cheese ($r=-0.716$) and yield and fat in dry matter content of cheese ($r=-0.633$). This shows as the mass of Kajmak or Skimmed milk cheese increases, the content of fat and dry matter in the cheese decreases. Correlation results are in agreement with the results obtained by Sarić (1995), who established a strong dependence of fat and fat content in the dry matter of Kajmak on the fat content in milk, and a slightly weaker relationship was established with yield (Stanišić *et al.*, 1990). It can be concluded that the indicators of Kajmak and Skimmed milk cheese are mutually dependent and intertwined. Yield of Kajmak and to a lesser extent fat in the dry matter of Kajmak depend on the dry matter content of the milk, and the content of fat depend to a good extent on the fat content of the milk, as shown by the correlation analysis.

CONCLUSIONS

Kajmak is an autochthonous product of the Balkan countries, which is characterized by a high fat content and can be consumed both as "young" and "mature". The region of Romanija mountain is known by the production of Kajmak of high and special quality. What distinguishes it from Kajmak from other region is the smoking process, so it is characterized by a mild smell and smoky taste. Kajmak from Romanija mountain in research had good quality, with a high content of fat and fat in dry matter. Due to non-standardized technology and uneven content of dry matter in milk, the chemical composition and yield of Kajmak varies considerably. Skimmed milk cheese is produced from the milk that remains after removing the "crust" of Kajmak. Due to the non-uniformity of technological parameters and raw materials, the composition and yield of Skimmed milk cheese also varied. By analyzing the distribution of milk ingredients in Kajmak, Skimmed milk cheese and whey, it was established that the largest percentage goes into whey due to the large mass of whey in production. It was determined that the fat content of milk for the production of Kajmak has a significant influence on the fat content of Kajmak, and the dry matter content of milk has an effect on the yield and fat in dry matter content of Kajmak. It can be stated that Kajmak is a high-quality, specific dairy product that deserves a special place in the classification of dairy products. Research has shown that standardization of the parameters of the technological production process is necessary in order to achieve a more uniform quality and yield of Kajmak.

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KVALITET I TEHNOLOGIJA KAJMAKA I POSNOG SIRA NA PODRUČJU PLANINE ROMANIJE

Sažetak

Kajmak je autohtoni mliječni proizvod koji se proizvodi u planinskom Dinarskom sistemu Balkana već vijekovima. Konzumira se kao “mladi” ili “zrel” koji nastaje nakon procesa zrenja. Karakterizira ga visok sadržaj masti i značajan sadržaj proteina, prvenstveno kazeina. Posebno je kvalitetan dimljeni Kajmak sa područja planine Romanije koji dimljenjem poprima blagi okus i miris po dimu.

U ovom radu je istraživana tehnologija, hemijski sastav i senzorni kvalitet Kajmaka sa šireg područja Romanije. Kajmak je proizveden od kravljeg mlijeka. U okviru ovih istraživanja ispitan je sadržaj suhe materije i masti mlijeka za proizvodnju Kajmaka, te uticaj na sadržaj suhe materije, masti i masti u suhoj materiji kao i randman Kajmaka. Takođe je istražena tehnologija Posnog sira koji se pravi od obranog mlijeka nakon skidanja masnog sloja – Kajmaka. Ispitan je njegov randman, sadržaj suhe materije, masti i masti u suhoj materiji, Analizirana je distribucija sastojaka mlijeka u Kajmak, Posni sir i surutku.

Rezultati su pokazali dobar kvalitet Kajmaka, sa visokim sadržajem masti i masti u suhoj materiji. Tehnologija varira zavisno od uslova proizvodnje i sirovine pa je to uslovilo i prilična variranja u sastavu, randmanu i senzornim svojstvima Kajmaka. Analizom distribucije sastojaka mlijeka u proizvodnji ustanovljeno je da najveći procenat suhe materije mlijeka pređe u surutku zbog toga što se u proizvodnji Kajmaka/Posnog sira generiraju najveće količine surutke. Korelaciona analiza je pokazala da su parametri proizvodnje Kajmaka i Posnog sira međusobno povezani. Korelaciona analiza je pokazala da je randman Kajmaka je pod uticajem suhe materije mlijeka, a na sadržaj masti i masti u suhoj materiji Kajmaka utiče sadržaj masti mlijeka.

Ključne riječi: *Kajmak, Posni sir, mast, suha materija, kvalitet*