THE QUALITY OF MATURE ROMANIJA'S KAJMAK

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ABSTRACT

Romanija's kajmak is an autochthonous dairy product, characterized by an extremely high content of milk fat, specific technology and unique sensory characteristics. It can be consumed as fresh (ripened up to 20 days) or mature (ripened for 2 months). Considering that today Romanija's kajmak is mostly consumed as matured, the aim of this research was to determine its physico-chemical composition and sensory properties at different time of ripening (30, 40 and 60 days). Total of 20 samples were collected from the region of Romanija mountain (B&H). However, since two samples did not meet requirements for hygienic quality, they were excluded from the study. According to defined quality parameters (minimum 70% of fat in dry matter and more than 65% dry matter) all investigated samples were categorized as mature kajmak. Time of ripening did not significantly affect dry matter and fat content ($p>0.05$). As expected, the highest ripening index (32.14%) was found in 60 days ripened samples of Romanija's kajmak. Due to proteolysis, in these samples the lowest protein content was observed – 5.31% ($p<0.05$). Also, degradation of proteins after 40 and 60 days of ripening led to higher pH values compared to kajmak ripened for 30 days, probably as a result of the formation of alkaline compounds. According to sensory evaluation, time of ripening had influenced appearance and structure of kajmak, but no differences were found in other sensory parameters. Overall quality of kajmak was not affected by the time of ripening and was in range 15.25-15.93.

Key words: kajmak, physico-chemical composition, sensory characteristics.

INTRODUCTION

Romanija's skorup-kajmak is produced from full-fat cow's milk from a defined territory, which abounds in pastures with a large number of plant species of exceptional nutritional potential. These plants are used in the nutrition of milking cows, which has a great influence on the quality of the milk.

The traditional production process involves heat treatment (cooking) of milk, pouring it into open shallow vessels and formation of the kajmak skin layer over a period of 36-48 hours, after which kajmak is removed, drained, salted and most often placed in wooden containers where ripening takes place. The special art and skill of the people of this region is the smoking of kajmak during its formation, which affects the obtaining of kajmak with specific sensory characteristics. This is one of the main characteristics and dominant sign of identification of Romanija's kajmak. Smoke is present evenly in the product and in the inner part, as well as on the surface (Riha & Wendorff, 1993; McCalman & Gibbons, 2005; Ridgway, 2007; Dozet et al., 2011; Jovanović et al., 2016).

The production process is based on separating the milk fat together with other ingredients, such as proteins, on the surface of the milk at boiling temperature. Separation of these components is a consequence of biochemical and physical changes that take place during heat treatment of milk and subsequent cooling (Dozet et al., 2004; 2011). The process of kajmak formation can be divided into a warm and a cold phase, where in the initial phase of heating the milk, the initial skin layer is formed, which will later form the upper layer of

the product (Radovanović, 2012). Intensive heat treatment of milk leads to the formation of complexes between casein and thermolabile whey proteins, known as milk protein coaggregates, which concentrate on the surface of milk together with other ingredients. In addition, there is an interaction with the adsorption layer of the fat globule, whereby the denatured whey proteins increase the density of the fat globules. The complexes created by the mentioned interactions are important for the formation of the skin layer (Jovanović et al., 2005; Macej et al., 2007; Huppertz et al., 2009). According to Radovanović (2012), in the cooling phase, there is a more extensive aggregation of fat globules in the already formed upper layer, whereby the lower layer, which consists of aggregates of milk fat and, to a lesser extent, proteins is formed. Investigations conducted by Radovanović et al. (2013) showed that milk fat is the dominant component of both layers of the skin, which is not the case for proteins. Namely, it was determined that the protein content is lower in the lower layer (1.76%), compared to the upper layer of cream (6.97%). The lower layer of kajmak is very viscous and liquid. Furthermore, significant difference in the protein content and the appearance of the skin layers themselves indicates that these two layers are formed in a completely different way.

Depending on the time of ripening, Romanija's skorup-kajmak is produced in 2 varieties: fresh and mature. Fresh skorup-kajmak is white to yellowish in color, with a characteristic pleasant smell and mild taste of milk and smoke; its structure is layered with traces of milk. Mature skorup-kajmak has a more intense color (light yellow to yellow), pronounced and typical aroma of milk and smoke, and its structure is granular or layered and very spreadable. A minimum content of milk fat in dry matter of 65% and a minimum content of dry matter of 60% is characteristic for fresh skorup-kajmak, while for mature skorup-kajmak the minimum content of milk fat in dry matter is 70% and a minimum content of dry matter is 65% (Dozet et al., 2011). The distinctiveness of Romanija's skorup-kajmak comes from four basic factors: physical and geographical features of the production area, characteristics of fresh cow's milk, traditional procedure of production and sensory properties of the skorup-kajmak.

Due to its unique and recognizable characteristics, in 2017 Romanija's kajmak received Protected Designation of Origin (PDO) (number IP 16001) by the Institute for Intellectual Property of Bosnia and Herzegovina. Hence, the aim of this study was to examine the quality of mature Romanija's kajmak regarding physico-chemical characteristics and sensory properties, which is made by kajmak producers who are members of "Romanija's Skorup-Kajmak" Association of Producers.

MATERIAL AND METHODS

Kajmak samples were obtained in the region of Romanija mountain. Total of 20 samples, produced during late summer period, were collected from different individual households. Sensory evaluation was performed right after sample collection, upon which samples were frozen until physico-chemical analysis. Since two samples did not meet requirements for hygienic quality (presence of mold on the surface of kajmak or mechanical impurities), they were excluded from the study. Based on the ripening time, the samples were divided into three groups: 30, 40 and 60 days mature Romanija's kajmak. There were six samples of kajmak in each group.

The composition of kajmak was determined by following methods: dry matter by standard drying method at 102±2ºC (IDF, 1982); fat content according to the Van-Gulik method (IDF, 1986), also expressed as fat in dry matter (FDM). Total nitrogen (TN) (expressed as protein content) and water-soluble nitrogen (WSN) contents were determined by the Kjeldahl method (AOAC, 1998). The ripening index (RI) was calculated as the ratio of soluble nitrogen to TN. NaCl content was determined according to the Volhard method (IDF,

1988). The pH was measured using digital pH-meter (Consort, Turnhout, Belgium) (Ardö & Polychroniadou, 1999). All physico-chemical analyses were performed in duplicate.

The overall sensory quality was determined by dairy experts using 20 point rating scale method presented in Table 1 (Dozet et al., 2011). Classification of Skorup based on sensory properties to the classes is presented in Table 2 (Dozet et al., 2011).

Table 1. Qualitative scale of sensory characteristics modified for kajmak (Dozet et al., 2011)

	Sensory property					
Maximum	Appearance	Color	Structure	Aroma	Taste	Overall score
score	2	2	4	4	8	20

Table 2. Classification of kajmak (Dozet et al., 2011)

Class	Score	Scores for taste and aroma, at least
Extra class	18.1 – 20.0	8
I class (excellent)	16.1 – 18.0	7
II class(very good)	13.0 – 16.0	6
III class (Good)	12.9 – 10.0	-
Satisfactory, not satisfactory	< 10.0	-

The effect of ripening time on kajmak characteristics was analyzed using analysis of variance (ANOVA) with Statistica 6.0 software (Stat Soft. Inc., Tulsa, USA). Mean comparisons of the parameters were performed by t-test, with the level of significance at 0.05.

RESULTS AND DISCUSSION

Physico-chemical analyses of mature Romanija's kajmak

Kajmak is a traditional dairy product with specific production technology, composition and sensory properties. According to the Rulebook on the quality of dairy products and starter cultures (2011) it is produced by separating the upper layer of heat-treated and cooled milk (cow's, sheep's, goat's and buffalo's milk or their mixtures). In the region of Romanija mountain kajmak is produced from full-fat cow's milk and mostly consumed as matured.

The results of physico-chemical analysis of mature Romanija's kajmak are presented in Table 3.

Table 3. Composition of mature Romanija's kajmak

Parameter	Time of ripening (days)		
	30	40	60
DM (%)	77.78±1.63^{a}	73.92±7.36^{a}	74.20±4.45^{a}
Fat (%)	64.58±1.49^{a}	60.08±7.50^{a}	63.29±4.17^{a}
FDM (%)	83.03±0.78^{b}	81.35±6.35^{b}	85.29±1.42^{a}
Proteins (%)	7.16±0.66^{a}	6.84±1.48^{a}	5.31±0.96^{b}
NaCl (%)	0.87±0.24^{b}	1.27±0.23^{a}	1.08±0.41^{ab}
Acidity (°SH)	53.84±2.99^{a}	42.00±6.49^{b}	37.81±20.11^{b}
pH	4.26±0.06^{b}	4.55±0.11^{a}	4.46±0.27^{a}

DM - dry matter, FDM - fat in dry matter. Means in the same row followed by different letters were significantly different ($p < 0.05$)

Dry matter (DM) and fat in dry matter (FDM) content in all samples of mature Romanija's kajmak were in agreement with requirements defined by Bosnian regulations (Rulebook on the quality of dairy products and starter cultures, 2011). Since kajmak samples were collected from different households, in which milk quality and production process are

not uniformed, composition of kajmak varies in samples of the same maturity. Dry matter content was in the range of 73.92% (40 days mature kajmak) to 77.78% (30 days mature kajmak). However, there was no significant difference in DM content between kajmak samples investigated at different time of ripening. The average content of DM was higher than in similar products from Serbia and Montenegro (Vučić et al., 2008; Mirecki et al., 2017).

Fat is the most abundant component of DM of kajmak, and was in the range 60.08-64.58%, respectively. Also, ripening time had no effect on fat content. On the other hand, different time of ripening affected FDM content. 60 days mature kajmak had the highest values of FDM – 85.29%, respectively. As the result of absence of standardized technology, a wide variation and differences in NaCl content was established in samples of Romanija's kajmak, which was in the range 0.87-1.27% ($p<0.05$). Results regarding fat in dry matter and salt content obtained in this study were in accordance with the content of the same parameters specified by Dozet et al. (2011).

Considering that dry matter of kajmak consists mainly from milk fat and to a lesser extent proteins, it may be classified between cheese and butter (Pudja et al., 2008). Thus, similar as in cheese, formation of specific flavor, aroma and texture of kajmak is the result of complex biochemical processes during ripening (McSweeney, 2004, Vučić et al., 2008). Due to serum separation and slow proteolysis kajmak's protein content decreases during ripening (Pudja et al, 2008; Barać et al., 2022). Hence, significantly lower protein content ($p<0.05$) was determined in 60 days mature kajmak (5.31%). However, there was no difference in protein content between 30 and 40 days ripened kajmak samples. The average content of proteins was 7.16% (30 days ripened kajmak) and 6.84% (40 days ripened kajmak), respectively. Also, higher pH values after 40 and 60 days compared to kajmak ripened for 30 days are probably a result of degradation of proteins during ripening and formation of alkaline compounds. Furthermore, a higher value of pH is correlated with higher NaCl content (Guven et al., 2006). The highest acidity (53.84°SH) was determined in 30 days mature kajmak. Significantly lower acidity ($p<0.05$) established in more mature kajmak samples is a consequence of proteolytic and lipolytic changes which induced liberation of low molecular weight compounds which are alkaline in nature.

Proteolysis in kajmak can be determined by the ripening index (RI) which presents the ratio of water soluble nitrogen to total nitrogen content. The use of severe heat treatment, the absence of rennet enzymes and the absence of starter-culture addition, which are specific for kajmak production indicate slow proteolysis during ripening (Barać et al., 2022). According to the results presented in Figure 1., slow proteolysis is determined in kajmak matured for 30 days in which RI was 11.17%, respectively. Regarding this parameter, kajmak samples ripened for 30 days investigated in this study could be classified as semi-mature kajmak (Dozet et al., 2011). Since during ripening degradation of proteins leads to higher content of water soluble nitrogen, as expected, significantly higher levels ($p<0.05$) of RI were found in more mature kajmak samples, and the highest ripening index (32.14%) was found in 60 days mature Romanija's kajmak.

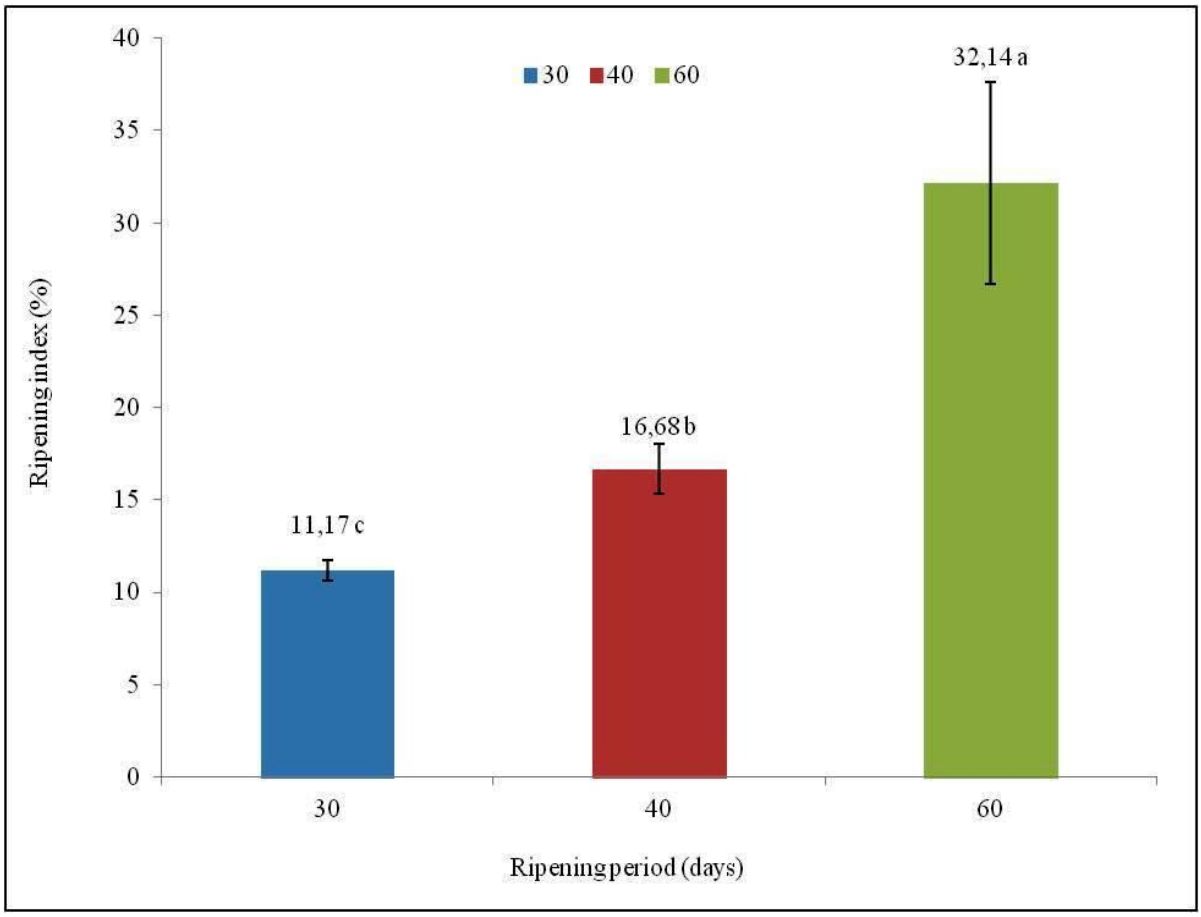

Figure 1. Ripening index of mature Romanija's kajmak

Sensory evaluation of mature Romanija's kajmak

Kajmak is a dairy product with unique sensory characteristics. During ripening lipolytic changes result in the formation of a large number of volatile compounds, which are responsible for very intense taste and aroma of mature kajmak. In addition, products of proteolysis, which occurs during ripening, also contribute to the formation of the sensory characteristics of the product.

Some sensory properties of mature kajmak are defined by Bosnian regulations (Rulebook on the quality of dairy products and starter cultures, 2011): light yellow color, pronounced typical aroma and taste of mature kajmak and granular structure.

The results of sensory evaluation of Romanija's kajmak are presented in Figure 2.

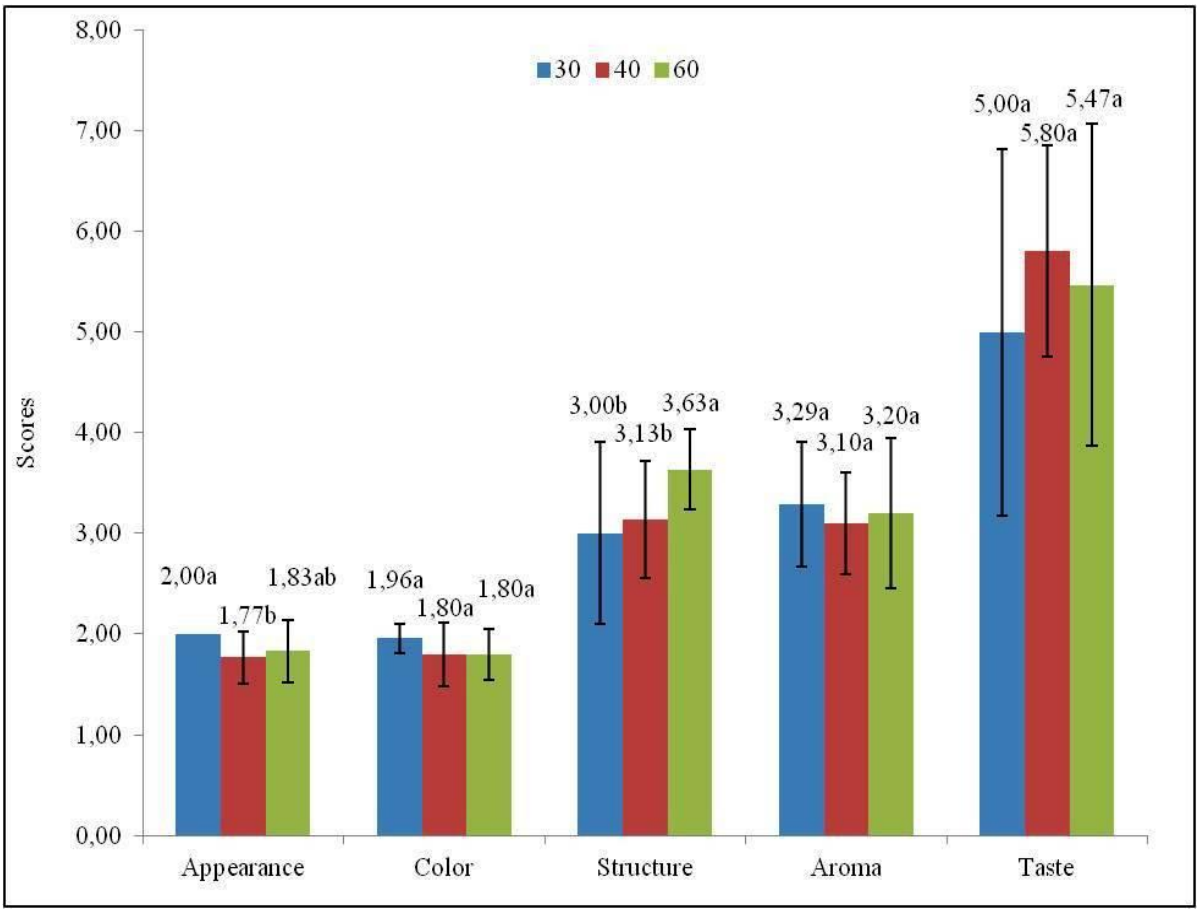

Figure 2. Sensory evaluation of mature Romanija's kajmak

Since kajmak samples used in this research were produced during summer, it could be assumed that higher ripening temperatures in production cottages induced faster formation of kajmak aroma and taste compounds. Therefore, specific sensory properties in less mature kajmak (30 and 40 days) were expected.

The appearance and color of food products are often the primary indicators of quality, especially by consumers. In smoked products, most often color is sensory parameter which affects mostly acceptance of product by consumers. Specific color for smoked kajmak is golden yellow, which depends on smoking period and gives the impression that kajmak contains higher levels of milk fat. Color intensity is also affected by type of the wood used for smoking, as well as temperature developed during smoking (Dozet et al., 2011). However, golden yellow color of kajmak should not be too intense. Significant difference ($p<0.05$) in scores obtained for the appearance was established between 30 and 40 days mature kajmak. The highest score for the appearance received samples of 30 days mature kajmak – 2.0, respectively. Also, there were no variations in appearance scores between kajmak samples ripened for 30 days. Typical gold yellow color was observed in all kajmak samples, so they did not differ regarding this sensory parameter. Nevertheless, some more mature kajmak samples (40 and 60 days) had intense yellow color, so the color scores of these samples were slightly lower (1.80).

Over the maturation period, dry matter of kajmak rises and its structure progressively becomes granular with light serum separation. Due to the collapse of the protein structure, it also becomes more spreadable (Puđa et al., 2008). During production, kajmak is collected and drained, followed by placing it layer by layer into wooden vessels, where ripening takes place. Well drained and properly layered kajmak should have distinctive layered structure. According to the results of sensory analysis, significantly higher scores for structure were

attributed to 60 days mature kajmak ($p<0.05$). However, lack of layered structure and presence of curd were found in kajmak samples regardless of their level of maturity. Prolonged time of kajmak formation increases acidity which induces curd formation. This phase of kajmak production is especially affected by weather conditions, air flow, smoking process and period of kajmak production. Many producers collect kajmak layers before curd is formed, but some of them collect kajmak after curd formation (Dozet et al., 2011). Layering of such kajmak gives product in which structure and taste are atypical due to the presence of curd. According to Dozet et al. (2011) the most favorable period of kajmak formation is 2-3 days. In the group of 30 days mature kajmak one sample had layers of different maturity, while in one sample fresh kajmak was placed as top layer over mature kajmak. Overall scores for structure were in the range 3.00-3.63, respectively.

During formation of kajmak skin layer, smoking of kajmak is performed. Smoke affects sensory characteristics of Romanija's kajmak, especially aroma which distinguishes it from products of the same name, originating from different geographical areas. As the result of diffusion of smoke particles in product and formation of new compounds which are the result of the reactions of smoke components with milk proteins and other kajmak constituents, smoking of kajmak affects aroma and taste (Dozet et al., 2011). As previously mentioned, samples of Romanija's kajmak investigated in this study were produced during summer. Due to the high temperatures during the day, in some households smoking of kajmak is practiced only in the evening. Consequently, kajmak samples from those households had mild smoky aroma or its total absence. Apart from smoky aroma, Romanija's kajmak is characterized with pleasant mild milky-sour aroma. In this study, less pronounced milky-sour and smoky aroma, as well as recognizable aromas typical for Romanija's kajmak were determined in samples of different maturity levels. Therefore, scores for aroma were similar and in the range 3.10-3.29.

The most important sensory property of food is taste. Numerous volatile and aromatic compounds formed during ripening as a result of lipolysis and proteolysis, as well as smoking of kajmak during its production, influence very specific taste of Romanija's kajmak which can be described as pleasant, smoky and mild milky-sour. Also, added amount of salt gives it moderately salty taste.

Regardless of the time of ripening, in each group of determined degree of maturity, taste was the sensory parameter which showed the widest variations. Due to these variations, medium scores obtained for taste were not significantly different between kajmak samples of different maturity ($p>0.05$). Scores for taste established for 30, 40 and 60 days mature kajmak were 5.00, 5.80 and 5.47, respectively. In 40 days mature kajmak, evaluated as the best regarding taste, two samples had pronounced saltiness which was in agreement with compositional analysis (Table 3). One sample of 60 days mature kajmak had mild cheese taste due to the presence of curd. In kajmak ripened for 30 days lower values of taste scores were attributed to some samples due to higher acidity (confirmed by chemical analysis, Table 3) and slightly bitter taste. Specific production process of kajmak such as long heat treatment and slow cooling of milk significantly reduce non-starter lactic bacteria (NSLAB), favor formation of WPC-CN complexes and induce the release of heat-stable plasmin (Barać et al., 2022). Since peptidases of the microbiota are responsible for degradation of of small- and medium-sized hydrophobic peptides, their reduced presence in kajmak contributes to the bitter taste. The presence of hydrophobic peptides in bitter cheeses is related to high salt-in-moisture and low moisture contents which limits the enzymatic activities of the microflora (Recio & López-Fandiño, 2009). Since kajmak has a high content of dry matter, higher NaCl content in some kajmak samples (Table 3) may have led to bitter taste as well. Furtermore, the action of plasmin on β-casein results in production of bitter hydrophobic peptides. Indeed,

degradation of β-casein in kajmak during ripening, probably by the action of residual plasmin, was established by Barać et al. (2022).

As the most important sensory property, taste scores have the highest impact on overall quality of kajmak (Figure 3). Since 60 days mature kajmak had higher score for structure ($p<0.05$), while the taste was not affected by the time of ripening, the highest overall score was established in these samples – 15.93, which is slightly lower than score reported for Montenegrin skorup-kajmak produced from cow's milk (Mirecki et al., 2017). Based on the results of sensory analysis, time of ripening had no influence on the overall quality of Romanija's kajmak ($p>0.05$). According to the classification, investigated samples of Romanija's kajmak belonged to II class, which means that they had very good sensory characteristics. However, regardless of the maturity level, the largest number of samples belonged to II class, but one sample of 30 days mature kajmak and two samples of kajmak ripened for 60 days belonged to extra class.

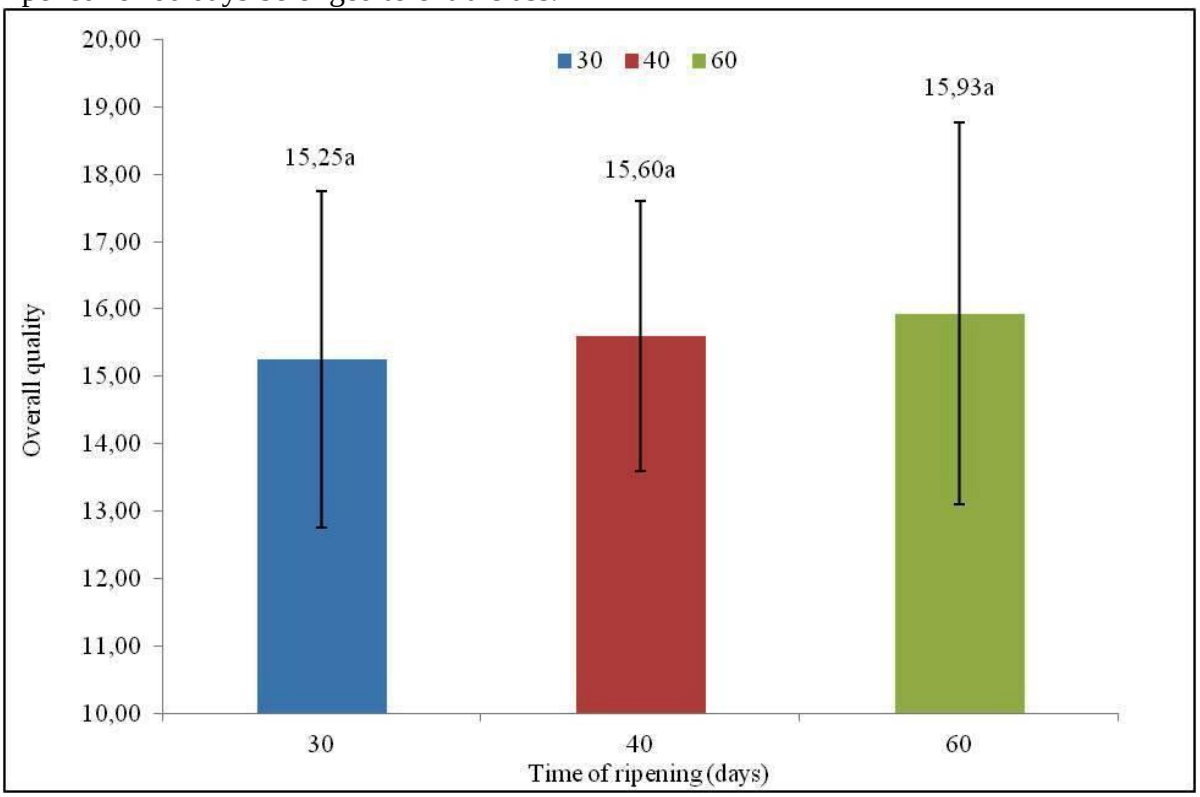

Figure 3. Overall quality of mature Romanija's kajmak

CONCLUSIONS

Traditional dairy products have a special significance in preserving the traditions and characteristics of a nation.

The results of the research obtained in this study showed that the physico-chemical quality of the analzyed samples of Romanija's kajmak was in accordance with regulations, while the average sensory score showed that the investigated samples had very good quality, regardless of the level of maturity (15.25-15.93). This indicates that there is room for the quality improvement, through continuous education of producers in order to standardize the technological production process, especially since Romanija's kajamak is a dairy product that has Protected Designation of Origin.

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