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Technology and composition of traditional and industrial Rugova cheese

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ABSTRACT

Rugova cheese is an endogenous dairy product in the Republic of Kosovo, which originates from the region of Peja, where it is traditionally produced from the raw milk of cows, sheep and goats. This research determined physicochemical characteristics such as dry matter, protein, fat, titratable acidity, pH and sensory attributes such as colour, taste, aroma, consistency and appearance. These parameters were determined in traditional and industrial cheeses from the Rugova region with an altitude of about 997.14 meters. These cheeses were analyzed on the first day, the 30th day and the 60th day of storage. The highest pH value was in traditional cheese. Traditional cheese had the highest value of dry matter on the end of ripening while the highest salt concentration was in industrial cheese. The significantly ($P<0.05$) higher protein and fat content was in traditional cheese. In conclusion, traditional cheese has a higher nutritional value but variable technological properties than industrial cheese and it needs to be standardized.

Keywords: traditional cheese, raw milk, standardization, physical-chemical properties

INTRODUCTION

Rugova cheese is an early tradition in the Rugova region and traditional cheese is produced from raw milk. Recently, this type of cheese is also produced in industrial conditions. This type of cheese is white brined cheese whose composition varies by many factors such as type and composition of milk, pre-treatment of milk, heat treatment and ripening conditions. Rugova is a mountainous district abundant with natural and cultural values which lies in the western part of Kosovo, above the city of Peja. Rugova cheeses as traditional food are attributes of this area and the society, which have a characteristic shape and unique sensory properties that may come from local ambient conditions particular to the region. It includes plant species of the grass as animal nutrition resulting in characteristic milk used for cheese production. All of the characteristics are also dependent on the production practices (Lajçi et al., 2022; Ajazi et al., 2018).

Cheese is among the most consumed dairy product in the world. It is just as important as milk in terms of protein, vitamins and minerals. In addition, protein solubility is increased due to proteolytic activity during cheese ripening (McSweeney, 2004). In the Northeastern Mediterranean area, white brined cheeses are the most popular cheeses produced by dry-salting, ripening, and brine storing (Terpou, 2018). The interest in white brined cheese manufacture has increased, leading to the high production of quantities. Cow pasteurized or mixed milk and (ii) a starter culture are the main components of white brined cheeses (Hayaloglu, 2017). Increasing cheese quality or enhancing cheese quality during ripening is achieved by adding select lactic acid bacteria in the milk for cheese production (Carafa et al., 2019). Using novel functional starter cultures can improve the quality characteristics for producing standard traditional white brined cheese, considering consumers' concerns regarding quality and safety (Plessas, 2021).

White cheese is very popular in Kosovo and has a relatively high consumption. Most of the white-cheese in Kosovo is imported from abroad. After the first challenges, Rugova cheese made from fresh milk collected in the mountains of Rugova has been very well received by consumers, a fact that is confirmed by the stable growth rates.

There are only a few studies related to Rugova cheese. Total mesophilic bacteria, anaerobic bacteria, lactic acid bacteria, enterobacteria as well as yeast and moulds were studied during the production of the traditional Rugova cheese by Vehapi et al. (2019). To the authors' knowledge, no previous study was done on the physical, chemical and sensorial properties of Rugova cheese obtained from industrial and traditional production. Thus, this study aims to characterize some properties of the traditional and industrial cheese produced in the Rugova region.

MATERIAL AND METHODS

Cheese production

The study was conducted during the period from February to the end of 2020. Industrial Rugova cheese was manufactured in triplicate from pasteurized cow's milk in a local dairy plant "Rugova". Raw cow's milk from the region was pasteurized at a temperature of 80 - 85 °C for over 3 min. (Figure 1). The pasteurized and cooled milk at a temperature of 35 - 38 °C is placed in a semi-automatic processing vat and the culture (Christian Hansen, DVS-direct vite set, mesophilic/thermophilic, 100 units per 1000 litres of milk) is inoculated. Then, $CaCl_2$ (40g - 100 litres) is added with continued mixing. Once the semi-automatic vat is filled, the enzyme chymosin is added and the mass is mixed immediately to distribute the enzyme. The coagulation of the milk lasted for 30 - 40 min. (depending on the quality of the milk, the temperature and the amount of the enzyme). After the coagulation cutting process is continued and was allowed to settle for 20 min with gentle agitation for 10-15 min to avoid fusion of cubes. After that, the curd was placed into the cheese moulds and rotated three times to remove the whey.

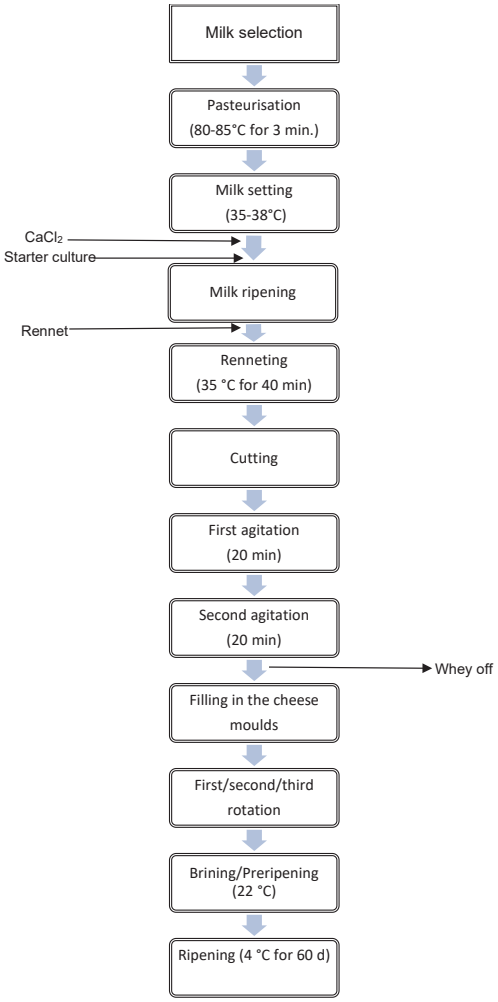

Figure 1. Flow chart of the industrial cheese production process

After the last rotation, the mass was held until the next morning at room temperature. The next day the cheese curd was controlled for sensory properties and pH (ideally 4.85 - 4.90). Brining is done with adjusted brine at 10% salt and pH 4.

The ripening is continued at a temperature of 22 - 24 °C until the proper taste, firmness and structure. Once these parameters are reached the cheese is packaged with brine. The yield ranged from 5.8 - 6.8 litres of milk per 1 kg of cheese. The traditional cheese production methodology was similar to that described in the previous study (Ajazi et al., 2018). Briefly, the fresh cow's milk is placed in the container and clotted with powder enzyme. In ten litres of milk 1.5 gr of enzyme and eight gr of salt were added. From this amount of milk, two kg of cheese was obtained. Depending on the ambient temperature

and the season, the clotting time varies. At the highest temperature, the coagulation takes about one hour. The formed curd mass is rotated to the other side and a weight press is used to remove the whey for about two hours. Then the following process was cutting the cheese and placing it in the tins or pans and dry salting. After salting, the cheese is folded and packed. The cheeses were ripened for 60 days in brine at 5 ± 1 °C and samples were taken after 1, 30 and 60 day of ripening. Two cheese-making trials were carried out for manufacturing of Industrial and Traditional Rugova cheese.

Compositional analysis

The pH of cheese was measured according to AOAC 981.12 method with a digital pH meter (Mettler Toledo, USA). Protein (based on total nitrogen, TN) fat and moisture contents of cheeses were determined according to the method in AOAC (2000). Acidity values were conducted by the titrimetric method (expressed as lactic acid %) (AOAC, 1995). The salt content in the cheeses was determined by the potentiometric titration method (ISO-IDF, 2006). For pH measurements, the samples were diluted with water (1:2) and homogenized and the values were obtained by using a pH/ion meter. All compositional analyses were done in triplicate. The colour of the white cheese samples was measured by using a colourimeter (Konica Minolta, Japan).

Sensory evaluation

Sensory evaluation of two types of cheese was applied on day 60-th of ripening with the usage of the correction point system and ranging method (Sulejmani et al., 2011). Briefly, sensory analyzes were performed by a methodology which describes and distinguishes cheeses through sensory evaluators. The sensory analysis is performed directly by the panelists, with an assessment of appearance, colour, aroma, consistency and taste from one to 15 points.

Statistical analysis

SPSS for Windows statistical software (SPSS 16, 2007) was used for all statistical analyses in this study. All data are shown as mean ± standard deviation of means. Correlations between the chemical and physical properties were determined using the Pearson correlation method with the SPSS package program.

RESULTS AND DISCUSSION

The chemical compositions of the ripened white cheese samples are given in Table 1. According to the Dairy Codex, all examined cheese samples at the end of ripening belonged to the full-fat and soft cheese category (Codex Alimentarius, CXS 283-1978). The pH value plays an important role in the preservation of dairy products and is also an important criterion in the production of cheeses as it affects the growth of microorganisms and the activity of enzymes.

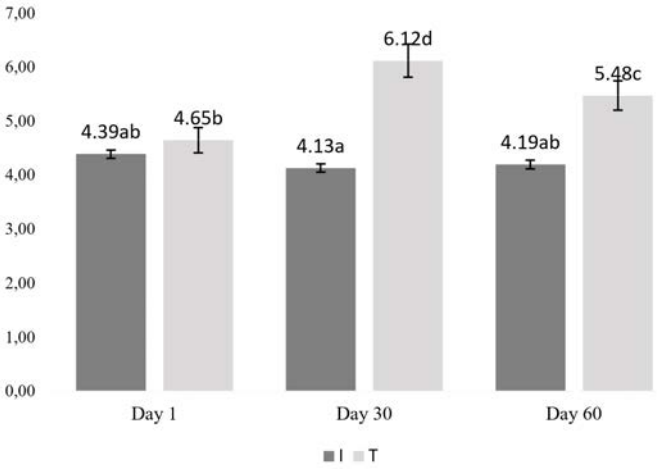

Figure 2. Dynamics of pH in industrial (I) and traditional (T) cheeses

The higher pH value during the first day of ripening was in traditional cheese (4.65), while on the 60th day of ripening there was an increase (5.48). pH values at industrial cheese samples showed no significant (P>0.05) changes over the ripening time. According to the obtained results, it seems that constant pH over time may attribute to the same rate of lactose fermentation, proteolysis, and lipolysis reactions which neutralizes their effect on the cheese pH. Traditional cheese samples showed significant variability in pH values at (P>0.05) over the ripening time. This is mainly due to the absence of starter culture and the higher temperature of production and storage.

The higher pH is due to the slow solubility of calcium phosphate during ripening (Masoud et al., 2008; Lucey et al., 2003). Similarly, Sulejmani, (2010) stated that the increase in cheese pH occurs due to the metabolism of lactic acid to weaker acids or other compounds caused by intensive proteolysis or breakdown of cheese proteins and ammonia formation. It is a direct result of the extinction phase of lactic acid bacteria and the appearance of yeast. Also, it may attribute to the association of lactic acid bacteria to fat globules due to agglutinin activity and rising with cream over resting milk, which may, in turn, inhibit acidification (Psoni et al., 2006). This is in opposition to the study of Lighvan cheese during the ripening period which showed a reduction in pH value (Aminifar et al. 2014). The reduction in pH is attributed to the fermentation of lactose to lactic acid, as well as the formation of free fatty and amino acid by proteolysis and lipolysis (Lavasani et al., 2012). The comparison of the pH values between the two types of cheeses exhibited a lower pH value for industrial cheeses compared with the traditional one (Figure 2).

Titratable acidity and pH of industrial cheese during the 60th day of ripening ranged from 0.73 to 1.32% and 4.39 to 4.2, respectively. These values were in line with those reported in the literature for ripened white cheeses (Makarijoski et al., 2016, Akalin and Karaman, 2010; Kamber, 2007; Çelik and Uysal, 2009). Hayaloglu et al. (2002) reported that the titratable acidity values of ripened Turkish white cheeses were in the range of 0.7 to 3.8%. Monitoring the dynamics of acidity in the individual stages of production and ripening of the cheese depends on the used starter culture. The course of the acidity at cheese production is usually indicated by the acidity curve. To obtain a quality product, the acidity curve can be characterized as a roadmap for proper management of the production process. The titratable acidity of the cheese increases very rapidly starting from the first day of ripening and is different depending on the varieties of cheeses. Differences in the protein values at the beginning and the end of the ripening were not significant (P<0.05). On the 30th day, an increase in the value of proteins was determined in the traditional cheese. On day 60 both types showed a decrease where industrial cheese decreased to 19.47% while traditional cheese to 20.59%. The protein value was higher than the study by Sahingil et al. (2014). In an article series about the traditional cheeses manufactured in Turkey, Kamber (2008) stated that the moisture and protein contents of white cheese varied between 41.5 to 66.1% and 13.0 to 38.2%, respectively. In another study, the values of moisture, fat, salt, ash, pH and titratable acidity of ripened white cheeses were in the range 48.6 to 62.6%, 14.6 to 21.2%, 3.0 to 8.7%, 6.4 to 10.0%, 4.5 to 5.3%, and 0.2 to 2.4%, respectively (Çelik and Uysal, 2009). The composition results obtained in the present study varied in a narrower range by the values reported in the literature.

On 30 and 60 days of ripening, the protein and fat content of the traditional (T) cheese was higher than

Table 1. Composition of the Rugova cheese types[a]

Ripening (days)	Cheese type	Titratable Acidity (g/100g)	Moisture (g/100g)	Fat (g/100g)	Fat in DM (g/100g)	Salt (g/100g)	Salt in DM (g/100g)	Protein (g/100g)
1	I	0.73±0.07^{b}	57.30±0.21^{d}	16.00±0.24^{a}	37.47±0.19^{a}	4.50±0.17^{c}	10.55±0.34^{b}	18.65±0.18^{a}
	T	0.83±0.05^{b}	55.18±0.52^{cd}	23.50±0.23^{c}	52.43±1.31^{cd}	3.33±0.33^{b}	7.44±1.23^{a}	18.65±1.01^{a}
30	I	0.93±0.05^{b}	54.12±0.25^{cd}	20.00±0.41^{b}	43.60±0.24^{b}	5.47±0.06^{c}	11.92±0.06^{b}	20.75±0.51^{b}
	T	0.43±0.03^{a}	50.58±0.37^{a}	26.50±0.33^{e}	53.62±0.41^{d}	3.23±0.54^{a}	6.54±1.11^{a}	25.84±1.19^{c}
60	I	1.32±0.14^{c}	53.41±0.21^{c}	24.00±0.12^{d}	51.51±0.27^{c}	5.29±0.70^{c}	11.37±1.57^{b}	19.47±0.52^{ab}
	T	0.46±0.06^{a}	52.75±0.48^{b}	27.50±0.22^{f}	58.20±0.59^{e}	1.96±0.21^{a}	4.15±0.40^{a}	20.59±0.33^{b}

[a] Abbreviations: DM, dry matter. Values are means ± SD; means within a column with different superscript letters differ significantly (P<0.05). *I-industrial, T- traditional

industrial (I) cheese (P≤0.05). Proteins have an essential role in cheese production so their content in cheese varies depending on the amount of casein and cheese production techniques. The results showed that the traditional cheese on the first day has the lowest dry matter value compared to the industrial cheese and this difference is significant (*P*<0.05).

The investigation of Rotaru et al. (2008) showed slightly lower values than the sample results of this investigation.

The concentration of salt in the cheese depends on the initial state of the cheese, brine, the type of salt, the temperature and the pH of the cheese (Pavia et al., 2000). The concentration of salt in the cheese on the first day of ripening in industrial cheese was 4.5% and continued to increase and reached 5.47%. On the 60th day of ripening was 5.29% and this difference was insignificant. However traditional cheese had a lower percentage of salt compared to industrial cheese and during the 60 day of ripening it was insignificant differences (*P*>0.05). The values of salt content in the investigation of Rysha and Delaš (2014) were higher compared to the values of our investigation. There are no significant differences in fat in cheeses produced in industrial cheese during the three times of ripening, whereas traditional cheese had significantly (*P*<0.05) higher fat compared to industrial cheese. The results of Mojsova et al. (2013) were lower compared to the results of this investigation.

Nowadays, the spectrophotometer is most often used for a quick evaluation of the colour of the product. They convert the energy reflected by an object into numbers that define colour. This system represents the quantitative relationship of colours in three axes: the value L indicates whiteness, a (with negative green values) and b (yellow) are the coordinates of chromatism (Chudy et al., 2020). Colour measurement as technological changes can be implemented to maintain or adjust the colour settings to the client's expectations (Simões et al., 2013). Figure 3 shows the effect of different ripening times on the Hunter colour values (CIELab) of Rugova cheeses. Statistical analysis of the comparison of the whiteness of traditional (71.05) and industrial cheese (84.9) on the first day of their ripening showed significant differences (*P*<0.05). Also, the chroma coordinates on the 30th and 60th days had significant differences (*P*<0.05).

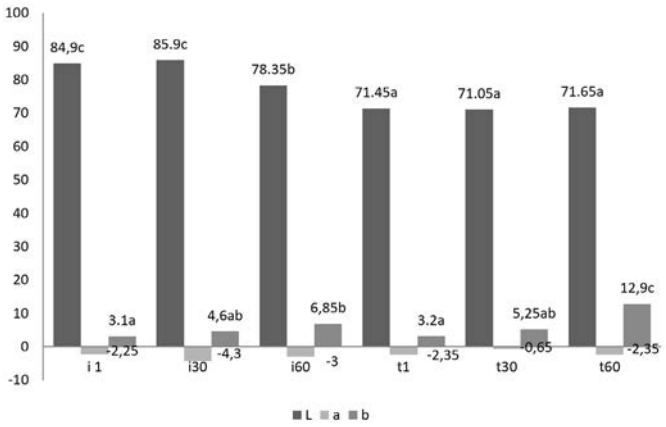

Figure 3. Colour profile of (i) industrial and (t) traditional cheeses

Table 2 and 3 shows the correlation coefficients of 13 parameters of Rugova cheese. It has been determined that there are important correlations between variables.

Table 2. Correlation of the composition of the cheese[a]

	pH	TA	DM	M	Fat	FDM	Salt
pH	1	-0.518	0.327	-0.516	**0.681***	0.259	**-0.931****
TA		1	-0.234	0.385	-0.101	0.108	0.485
DM			1	**-0.963****	0.226	**-0.647***	-0.089
M				1	-0.272	**0.586***	0.306
Fat					1	**0.595***	**-0.680***
FDM						1	-0.448

[a] Abbreviations: TA, titratable acidity; DM,dry matter; M, moisture; FDM, fat in dry matter. Values are means ± SD; (**P*<0.05; ** *P*<0.001)

Table 3. Continued correlation between the composition and color parameters[a]

	SM	SDM	Protein	*L*	*a*	*b*
pH	**-0.873****	**-0.947****	**0.779****	-0.410	-0.029	0.163
TA	0.421	0.520	-0.517	0.023	0.284	-0.298
DM	0.065	-0.466	**0.587***	**-0.786****	0.468	0.221
M	0.133	**0.644***	**-0.662***	**0.735****	-0.405	-0.233
Fat	**-0.730****	**-0.690***	0.502	**-0.686***	0.048	0.460
FDM	**-0.618***	-0.145	-0.069	0.110	-0.361	0.155
Salt	**0.968****	**0.922****	-0.567	0.244	0.224	-0.226
SM	1	**0.832****	-0.505	0.176	0.282	-0.242
SDM		1	**-0.715****	0.519	0.032	-0.306
Protein			1	-0.562	0.098	-0.104
L				1	-0.44	-0.371
a					1	0.067
b						1

[a] Abbreviations: TA, titratable acidity;DM,dry matter; M, moisture; FDM, fat in dry matter; SM, salt in moisture; SDM, salt in dry matter. Values are means ± SD; (*P<0.05; ** P<0.001)

For instance, pH, fat, salt, protein and L showed a significant positive and negative correlation with physical and chemical properties. The objective colour description is necessary, especially where slight colour differences are important. Measuring the colour of finished dairy products makes it possible to determine their quality and monitor changes that occur during storage.

A significant positive correlation was found between pH, fat and protein content whereas strong negative correlations were found between L, dry matter and fat. Similarly, in the study of Kose et al. (2022) positive correlation between pH and fat and a strong negative correlation between L and dry matter were found.

Figure 4 shows the average of the total points of sensory analysis of cheeses.

The industrial cheese had higher points (31.25), but the appearance and aroma of both kinds of cheese were the almost the same. There were differences in the flavour with industrial cheeses being evaluated with higher points 14. Traditional cheese had lower points, and a slight change was also observed in the aroma where industrial cheese had 3.75 points while traditional 3.25 points. Traditional cheese samples exhibited lower sensory and overall acceptance evaluation because the raw milk cheese ripens quickly and develops a more powerful flavour than industrial cheese produced with milk pasteurization. Frequently, the expanded enzyme activity of non-starter lactic acid bacteria (NSLAB) causes cheese bitterness and off flavour (Beresford, 2003).

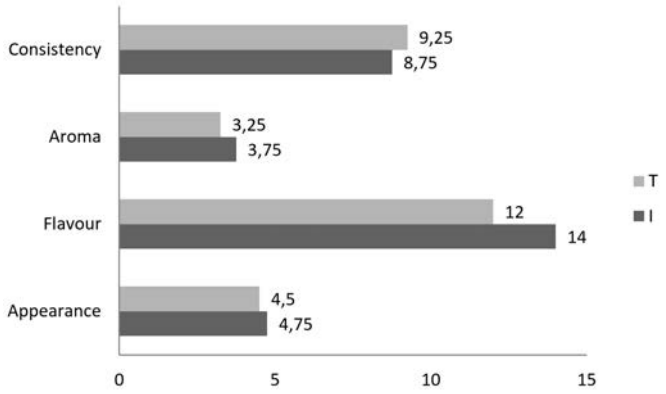

Figure 4. Sensory profile of traditional (T) and industrial (I) cheeses

CONCLUSIONS

Some basic properties of the industrial and traditional Rugova cheese were determined. Considering the higher sensory points, instrument colour properties of industrial cheese and composition of Rugova cheese samples it can be concluded that industrial standard production technique should be used in the manufacturing of this cheese to increase consumer acceptability and perception. The results also indicate the need for greater hygiene during cheese production and of course milking. Additionally, an attempt should be made to control the traditional cheese production i.e., to set it under industrial conditions and to use pasteurized milk or starter cultures to attain a standard of uniform quality.

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