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Physico-chemical and sensory characterization of fresh cheeses

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Abstract

Fresh cheese is valued for its nutritional benefits, geographical origin protection, preservation of traditional methods, and standardization. This study focuses on the examination of the production technology, chemical composition, and sensory properties of three types of whey cheeses over a 20-day storage period. The cheeses were made in triplicate using whey from Beaten (B), Kashkaval (K), and yogurt (Y), following traditional methods. The AOAC methods were utilized to measure the titratable acidity of the cheese samples. The Kjeldahl method was employed to determine protein content, while the Gerber method was used for fat content assessment. The evaluation of the cheese included an analysis of flavor, color, texture, and appearance, conducted according to established standards. Significant changes are shown in the chemical composition of the samples. It was found that the dry matter content of Beaten whey cheese was 40.00%, which was higher than other types. Also, fat and protein content of Beaten whey cheese was 12.50±0.01 and 32.37±0.01, which was significantly ($P<0.05$) higher than in other types at the first day of production. An increase in the values of certain properties was observed with the extended storage time for both the Kashkaval and Beaten samples. In contrast, there was a decrease in pH and protein percentage across all samples, with statistical significance ($P < 0.05$). Correlations between physico-chemical and sensory properties determined by bivariate correlation showed that increase of the dry matter content did not result in desirable sensory properties such as aroma and taste. In conclusion, Kashkaval whey cheese received the highest evaluation from sensory panelists, demonstrating superior overall sensory characteristics. This cheese is widely regarded for its nutritional value, offering a substantial contribution to a balanced diet. Additionally, it exemplifies an effective strategy for the valorization of whey, repurposing it from a byproduct into a valuable food resource.

1. Introduction

Fresh cheese is a traditional dairy product that falls under the category of dry-cured cheese. It is made from milk, yogurt, buttermilk, or whey, which are coagulated and drained after being boiled. In the Pollog region of North Macedonia, fresh cheese has a long-standing tradition as a popular dairy product in Southeast Europe. Typically, it is consumed fresh and unsalted, but it can also be stored for a longer period and used as baked "curd." This dairy product holds significant cultural importance in the countries of the former Yugoslavia, where it is known by various names, including “hurda,” “cvarog,” “skuta,” “bjelava,” “furda,” and “provara.” Bojanic *et al*. (2017) refer to the product as "provara," which derives from the process of boiling the milk whey—referred to as "provari"—during its production. The manufacturing of curd relies on the fact that heating the mixture to a temperature of 85-90^{o}C causes the denaturation of whey proteins, which constitute about 18 -20% of the total milk proteins. These proteins, primarily globulin and albumin, are positioned above the curds and have high nutritional value and utility for the body (Antunac *et al*., 2011). Paskaš *et al*. (2019) reported that small changes in the cheese production steps can result in product with different compositions and therefore the production of quality whey cheese is challenging. The composition of curd retained during cheese production varies depending on the coagulation method, the type of cheese being made, and the type of whey used. As a result, cheeses made from whey do not share the same exact composition. Generally, fresh cheeses are distinct enough in their composition and properties to be classified as a separate group of dairy products (Popović, 2015). One well-known cheese made from whey is

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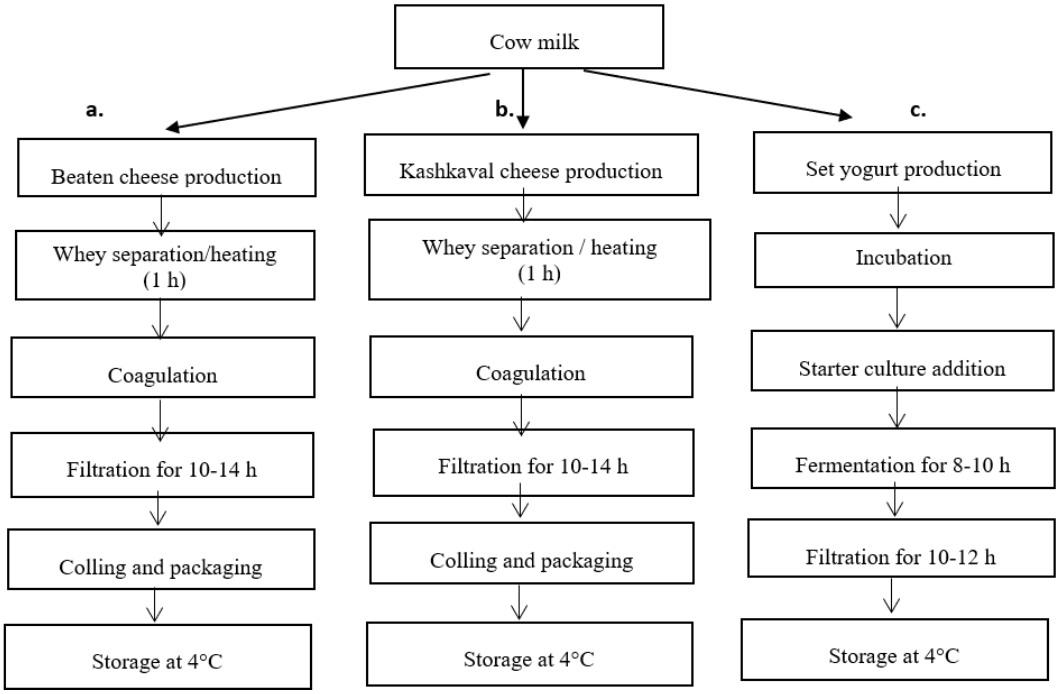

Figure 1. The main steps for the production of three types of fresh cheeses.

Ricotta, which originates from Italy. Ricotta is recognized as a soft, creamy whey cheese with a pleasant flavor and is produced specifically from any type of sweet whey (Davies *et al*., 1997; El Sheikh, 2010). In Turkey, a similar fresh cheese known as Çökelek cheese is analogous to yogurt-based fresh cheeses. The texture and taste resemble a sour ricotta, but it can be enriched with garlic, herbs, salt, or other spices (Şimşek and Sağdiç, 2012). There are two methods of producing: one is to combine the ingredients, put them in a cheese cloth, and let it hang for five to six hours. The other method involves heating the combined yogurt and citrus juice in a pan and simmering it on low heat. The proteins bind together quickly and release some excess liquid, so it takes less time for yogurt to curdle and become cheese. It can be consumed as it is, used as a filling for pies "burek", or as a part of another typical dish. It is also known as Curd Cheese, which holds a special place in the country's culinary heritage. It is a fresh, unripened cheese made from cow's milk, sheep's milk or a combination of these. Fresh cheese has a soft and spreadable consistency, as well as a creamy and delicate aroma. It is a versatile ingredient in Balkan cuisine, often enjoyed on its own as a cheese, spread on bread, or served alongside traditional products like honey or olives (da Silva Rocha *et al*., 2025). In North Macedonia culinary traditions, it is also incorporated into various dishes, commonly found in omelets and flavorful salads, where it adds a creamy element to the recipes. So, it is a beloved cheese that embodies the simplicity and freshness of traditional flavors. According to Regulation (2011), Fresh cheese (albumin cheese) is a semi-solid or solid fresh or solid mature product obtained by separating the proteins from whey or concentrated whey with or without the addition of milk, cream, or other dairy products. It is marketed as albumen cheese (urda, scuta) or according to the production specification and as: fat albumen cheese if it contains 33% milk fat in dry matter; semi-fat albumen cheese if it contains less than 10% and more than 33% milk fat in dry matter and lean albumen cheese if it contains less than 10% milk fat in dry matter. When placed on the market, the following names are exclusively reserved for dairy products: cheese, kashkaval, and urda (Regulation, 2011). It represents one of the most important dairy products for low-income families, which is produced by draining yogurt or buttermilk, acidified and heated. It is low in fat, calories and high in protein and is cheap (Kalayci *et al*., 2023). Since this topic was examined for the first time and due to the growing popularity of Fresh cheese among North Macedonian population, the purpose of the

Figure 2. Appearance of fresh cheese produced from a) Beaten cheese whey b) Kashkavall whey and c) Yogurt.

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investigation was to study the physico - chemical composition of three types of Fresh cheese, produced by Kashkaval whey, hard cheese whey under industrial conditions and Yogurt under traditional conditions. Furthermore, sensory profiles were evaluated and based on these results; an evaluation and correlation of their physico-chemical and a sensory property was performed.

2. Materials and methods

2.1 Production of fresh cheese

Production of fresh cheese occurs at the Eko-Shar factory in Poroj (Tetovo). After the production of hard cheese, Kashkaval cheese, and yogurt, the whey obtained from the first two was collected in the tank and then transferred to the curd boiler and heated to 90-98°C until the formation of curd (approximately 1 hour). After the curd is formed, it was pre-filtered, pressed by placing a weight on it, salted and placed in vacuum-sealed nylon foil packaging, and stored at 4°C. Cheese analyses were performed on 1, 10, and 20 days of storage. The production flow chart of Freshcheese is given in Figure 1. Images of the final products obtained are shown in Figure 2. In contrast to the whey curd of Kashkaval cheese and the whey curd of Beaten cheese that is produced in the factory industrially, the yogurt curd is produced in domestic conditions, which means traditionally. For the production of yogurt curd, milk was first boiled and then cooled to a certain temperature. After the milk has reached the set temperature, 5 tablespoons of yogurt (the measure is 1 tablespoon per liter of milk) is added and mixed well and kept at the optimal temperature (at room temperature) for 8-10 hours. After the required time, the mixture was checked with a knife, and the draining process began to separate the whey. This process uses a strainer, in which the curd is placed while the whey drains into a designated container. The duration of draining depends on the desired thickness of the curd, typically lasting between 10 to 12 hours. Once drained, the curd is collected in a specific container and stored in the refrigerator at a temperature of 4°C.

2.2 Titratable acidity

The AOAC (2012) methods were employed to determine the titratable acidity of cheese samples. Briefly, 10 grams of each sample were diluted in 100 mL of water, and then 10 mL of this dilution was transferred into a 100 mL flask. Six drops of the phenolphthalein indicator were added, and titration was performed using 0.1 N NaOH until a permanent rose color was achieved. The titratable acidity was expressed as a percentage of lactic acid.

2.3 Protein content

To measure protein percentages in cheese samples, the Kjeldahl method was used (AOAC, 2012). The cheese is first cut and grated, then mixed thoroughly, and a sample weight of 0.2 to 0.5 grams is taken (sensitivity 0.0001 g). 1-2 grams of a catalyst mixture (1 part $CuSO_4 \cdot 5H_2O$ to 30 parts K_2SO_4) and 10 mL of concentrated sulfuric acid is added. The tubes are placed in a combustion unit and activated the gas removal systems. The samples are burned at 430°C and the color is checked until lemon yellow or light green if not the burning is continued. After combustion, the tubes were allowed to cool and connect them to a distillation unit. 100 mL Erlenmeyer flask with 0.20 mL of an indicator solution (0.01 g of methyl red and 0.15 g of bromocreasol green in 100 mL of 70% ethanol) and 25 mL of 4% boric acid was prepared. The flask is placed in the distillate collection container and added 20-25 mL of 10 M NaOH to the flask (this will turn the contents black). The distillation unit was opened and continued until the boric acid solution turned in to the light blue and the flask volume reaches 55-60 mL. Finally, the distilled solution was titrated with a 0.1 N or 0.05 N HCl solution until the rose color returns, indicating the end of the titration.

2.4 Fat content

To determine the fat percentages in cheese samples, the Gerber method (AOAC, 2012) was utilized. First, 3 g of cheese samples were accurately weighed and placed into a butyrometer beaker, which has a sensitivity of 0.005 g. Then, 10 mL of H_2SO_4 solution (density = 1.522±0.005 g/mL at 20°C) was added to the beaker, and it was sealed tightly with a special stopper. The butyrometer was occasionally turned upside down and placed in a water bath at 65°C to ensure complete dissolution of the cheese. Once the cheese was completely dissolved, the stopper was removed and 1 mL of amyl alcohol (density = 0.82 g/mL) was added. The mixture was gently shaken, and the butyrometer was turned upside down several times before being returned to the 65°C water bath to ensure thorough mixing. Next, the butyrometers were placed in a centrifuge opposite each other and centrifuged for 10 minutes at a speed of 1000-1200 rpm. After centrifugation, the butyrometers were kept in the water bath at 65-70°C for 4-5 minutes. The percentage of fat content could then be read directly from the scale on the butyrometer. While reading the results, it is important to hold the butyrometer upright. The final reading provides the percentage of fat in 100 g of cheese.

2.5 Sensory evaluation

A sensory evaluation of the cheese samples was conducted by a panel of eight members from the academic staff and students of the Department of Food Technology at Tetova University. The evaluation assessed flavor, color, texture, and appearance according

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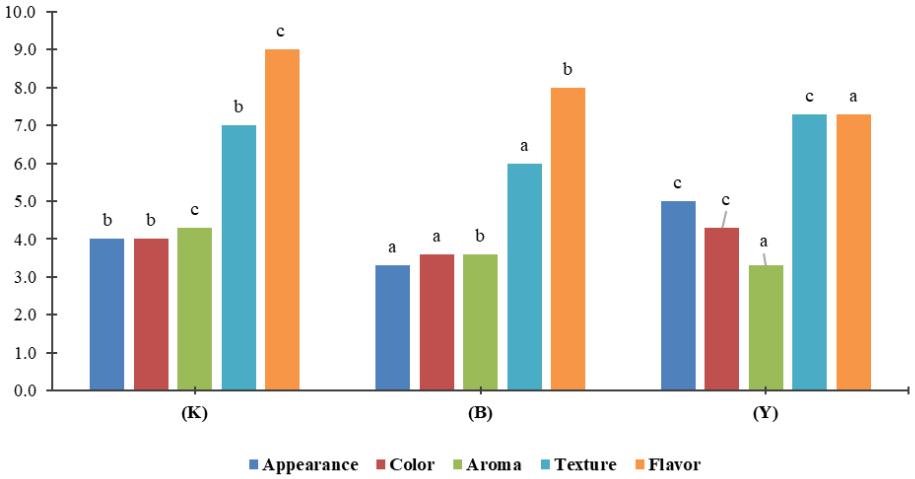

Figure 3. Sensory properties of fresh cheeses from Kashkavall whey (K), Beaten cheese whey (B) and Yogurt (Y). Different superscripts are significantly different (P<0.05) for the same sensory properties.

to the methodology outlined by Sulejmani *et al*. (2021) and Clark *et al*. (2009).

2.6 Statistical analysis

Statistical analyses for this study were performed using SPSS for Windows software (version 16, released in 2007). All data are expressed as means±standard deviations. The correlations between chemical and physical properties were assessed using the Pearson correlation method within the SPSS software.

3. Results and discussion

This study represents an introductory investigation into the production of fresh cheese through various methods, aiming to provide a comprehensive comparison with the limited findings of previous research on different types of fresh cheeses. By exploring these diverse production techniques, the data obtained contributes to the understanding of the unique properties and sensory attributes that distinguish each variety of fresh cheese. The average dry matter content in Fresh cheese was 27.0 - 40.0%, and is higher than the results of Qader *et al*. (2023) and Wu *et al*. (2020) for Ricotta cheese but lower than values recorded for Cream cheese (Phadungath, 2005). Dry matter content of samples varied between 40.0% and 37.0% during storage in hard cheese whey curds. It was determined that storage time had a significant effect on the dry matter content of the samples.Titratable acidity values of the samples varied between 2.51±0.01, and 0.31±0.02 during storage. Fresh cheese samples (except K sample) had higher titrable acidity compared to the findings of Bierzuńska *et al*. (2017). During the storage period, the three Fresh cheese samples had their lowest value on the 20th day of storage. As in the study of Szkolnicka (2021), the value of titratable acidity decreased for the cheeses (B) and (K) from day 1 to day 20 of storage.

The pH values of the samples varied between 5.39 in Beaten whey Fresh cheese on day 1 and up to 2.98 in Yogurt Fresh cheese on day 20, during storage. It was determined that different storage times had a significant effect (P<0.05) on pH values. The pH value in yogurt is lower because of an acidification process through lactic acid formation by the starter culture. The results show that Fresh cheese from Beaten cheese whey, curd from Kashkaval cheese whey, and curd from Yogurt differed significantly in terms of their composition. The value of fat in the curd produced from the whey of Beaten cheese in the sample of day 20 was higher (14.5%) than in the sample of day 1 (12.5%).

Table 1. Physico-chemical parameters of different fresh cheeses.

	Days	Titratable acidity (%)	pH	Dry matter (g/100 g)	Protein (g/100 g)
	1	0.51±0.01^{b}	5.31 ±0.00^{c}	30.0±0.02^{b}	18.15±0.01^{a}
(K)	10	0.62±0.00^{c}	5.27 ±0.01^{a}	27.0±0.01^{a}	n.a
	20	0.31±0.02^{a}	5.28±0.01^{ab}	31.5±0.04^{c}	17.98±0.00^{a}
	1	1.70±0.01^{c}	5.39±0.01^{b}	37.0±0.03^{a}	32.37±0.01^{c}
(B)	10	1.01±0.02^{b}	5.35±0.00^{a}	37.5±0.05^{a}	n.a.
	20	0.51±0.00^{a}	5.38±0.01^{b}	40.0±0.02^{b}	20.89±0.02^{c}
	1	1.41±0.00^{a}	3.08±0.01^{c}	37.0±0.05^{c}	21.45±0.00^{b}
(Y)	10	2.51±0.01^{c}	3.01±002^{b}	31.0±0.03^{a}	n.a.
	20	1.80±0.02^{b}	2.98±0.01^{a}	35.0±0.01^{b}	18.95±0.02^{b}

[1] Fresh cheese from Kashkavall whey. [2] Fresh cheese from whey from Beaten cheese
[3]Fresh cheese from yogurt. The mean +SE in the same column for each type
with different superscripts are significantly different (P<0.05). n.a. not analyzed

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Table 2. Heat map of the sensory and physico-chemical properties of different fresh cheeses.

1		color	aroma	texture	flavor	titratable	pH	fat	dry matter	protein	appearance
color	Pearson Corr.	1	-0.212	0.976**	-0.333	-0.319	-0.822*	-0.999**	-0.082	-0.787	0.983**
	Sig. (2-tailed)		0.686	0.001	0.519	0.538	0.045	0.000	0.877	0.063	0.000
aroma	Pearson Corr.		1	0.005	0.992**	-0.858*	0.731	0.163	-0.956**	-0.435	-0.388
	Sig. (2-tailed)			0.993	0.000	0.029	0.099	0.757	0.003	0.389	0.448
texture	Pearson Corr.			1	-0.12	-0.517	-0.679	-0.986**	-0.297	-0.902*	0.92**
	Sig. (2-tailed)				0.82	0.293	0.138	0.000	0.568	0.014	0.009
flavor	Pearson Corr.				1	-0.787	0.811	0.286	-0.912*	-0.319	-0.5
	Sig. (2-tailed)					0.063	0.05	0.583	0.011	0.538	0.313
titratable	Pearson Corr.					1	-0.277	0.366	0.971**	0.836*	-0.14
	Sig. (2-tailed)						0.595	0.475	0.001	0.038	0.791
pH	Pearson Corr.						1	0.792	-0.5	0.296	-0.912*
	Sig. (2-tailed)							0.06	0.313	0.569	0.011
fat	Pearson Corr.							1	0.132	0.817*	-0.973**
	Sig. (2-tailed)								0.803	0.047	0.001
dry matter	Pearson Corr.								1	0.679	0.101
	Sig. (2-tailed)									0.138	0.848
protein	Pearson Corr.									1	-0.661
	Sig. (2-tailed)										0.153
appearance	Pearson Corr.										1
	Sig. (2-tailed)										

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Lowest Midpoint Highest

Curd obtained from the whey of hard cheese has a higher fat content than all other curds. It can be assumed that this is a consequence of the mechanical processing that takes place during the processing of the coagulate. The changes observed in the protein content of the samples during storage are given in Table 1. The protein content ranged from 21.45±18.95% in yogurt cheese to 32.37±17.98% in Beaten whey cheese ($P<0.05$). The average protein values determined in this investigation are higher than those reported by Paskaš *et al*. (2019).

Data from the literature show that the average content of fat and dry matter for fresh Montenegrin, Serbian urda, is 16.52%, 11.70%, 47% and 70%, respectively (Bojanic *et al*., 2017). Recent data for Urda ash cheese indicates a dry matter content of 22% (Paskaš *et al*., 2019), whereas the results for ash cheese from Greece show that the dry matter ranges from 30% to 35% (Alichanidis and Polychroniadou, 2008).

The acceptability of the Fresh cheese by consumers was explained by sensory evaluation. The results are illustrated in Figure 3, along with their significance. Sensory properties and consumer perception are key factors influencing the commercial success of the product (Drake *et al*., 2017). The sensory quality of the fresh refrigerated cheeses is shown in Figure 3. The values shown are the sums of the appearance, color, taste, smell, and consistency scores, and the maximum sensory quality score is 40 points. It can be observed from Figure 3 that the highest scores for appearance assessed by panelists were awarded to (Y) Fresh cheese (5.0±0.10) and (B) sample gained the lowest score of 3.3±0.13 on the first day of storage, with significant differences for this characteristic between the three treatments. The sensory evaluation results regarding color, aroma, texture, and flavor, as shown in Figure 3, have significant differences. Despite variations in the physico-chemical parameters, the results indicate that samples K and Y exhibited high sensitivity qualities, with values ranging from 34.9 to 34.8 points. All cheese samples showed statistically significant differences ($P<0.05$) regarding specific qualities. The consistency of all cheeses was smooth and soft while the taste and aroma were characteristic for the particular cheese type. The results indicate that cheese and yogurt produced under both commercial and traditional conditions can serve as good raw materials for high-quality fresh cheese production. Correlations between physico-chemical compounds and sensory properties were determined by bivariate correlation (Table 2). Therefore, a statistical relationship was found between the sensory characteristics. In particular, a positive correlation was found between "flavor" and "aroma" of Fresh cheese and a negative correlation was found between "color" and "fat content" ($P<0.01$). A medium positive correlation was observed between the fat content and the protein content in fresh cheese (0.817). Additionally, there was a medium positive correlation between the ratio of titratable acidity to protein content in cheese (0.836). Conversely, a medium negative correlation was found between pH and color (-0.822), as well as between titratable acidity and aroma in fresh cheese (-0.858). Furthermore, a high negative correlation was evident

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between fat and color (-0.999), between cheese fat and texture (-0.986), and between cheese fat and appearance (-0.973). These results are consistent with the results of Bittante *et al*. (2024)

Conclusion

The investigation into the chemical composition of fresh cheeses revealed notable variations in their characteristics, highlighting the complexity of these dairy products. The process of milk acidification was identified as a critical determinant of quality, especially in yogurt cheese, where it significantly influenced both texture and nutritional composition. This transformation underscores the importance of processing methods in shaping the final attributes of dairy products. Fresh cheese produced from hard cheese whey exhibited significantly higher concentrations of dry matter, pH, protein, and fat compared to its counterparts. These elevated levels contribute to a denser, creamier texture, which is often preferred by consumers seeking a rich and indulgent cheese experience.

However, the inherent variability in the composition of whey cheese presents substantial challenges in producing cheese with consistent quality. Each of the three types of fresh cheese analyzed displayed distinct sensory profiles, which included variations in flavor, aroma, and mouthfeel. Notably, fresh cheese derived from Kashkavall cheese and yogurt received higher acceptability ratings from consumers, attributed to their unique flavor characteristics and pleasing textures. As research continues to refine and standardize the nutritional and sensory attributes of fresh cheeses, there is a burgeoning recognition of their potential as nutrient-dense food products. This acknowledgment could position fresh cheeses as integral components of a balanced diet, thereby enhancing their status within the culinary market as high-quality, health-oriented options.

Conflict of interest

The author hereby declares the absence of any conflicts of interest that may compromise the impartiality and integrity of this research.

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