University "St. Kliment Ohridski" - Bitola, Republic of North Macedonia
Faculty of Technology and Technical Sciences - Veles

Book of proceedings of the 1st International Scientific Conference - Food Science, Nutrition, Innovative Technologies and Sustainability

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INFLUENCE OF THE TECHNOLOGICAL PROCESS AND WHEY PROPERTIES ON THE QUALITY OF ALBUMIN CHEESES

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Abstract
In recent years, a noticeable increase in consumer interest in products low in fat and calories has been observed. Albumin cheeses, produced from whey as a by-product of the dairy industry, occupy an important place in a balanced diet due to their high content of whey-derived albumin proteins and low fat levels. These cheeses are recognized as products of high nutritional value and potential relevance in nutritional science or food technology. The aim of this literature review is to present the most relevant segments of the technological process and the composition of albumin cheeses, both of which significantly influence all aspects of their quality. Data from relevant scientific literature indicate that the chemical composition of albumin cheeses varies considerably, mainly due to differences in the type of whey used and the diversity of production technologies. Standardizing the quality of albumin cheeses would support broader recognition of their potential as nutritious food products within a balanced diet.

Keywords: albumin cheese, urda, whey, sustainable production

1. Introduction

Whey is a by-product of the casein cheese production process (Murata et al., 2023) and serves as the primary raw material for the production of albumin cheese. The production of albumin cheeses is one of the oldest and most widespread methods of whey valorization (Bleoussi et al., 2020). Utilizing whey for albumin cheese production represents an economical approach to managing whey as a waste material, while also promoting sustainable production and environmental protection (Bintsis & Papademas, 2023).

Albumin cheeses are obtained through thermal coagulation of whey proteins, and due to their distinct composition and properties, they are classified as a separate group of dairy products (Pintado et al., 2001; Sulejmani & Amedi, 2025). Today, albumin cheeses are produced either artisanally using traditional methods or through standardized industrial processes (Bintsis & Papademas, 2023).

2. Types of Albumin Cheeses

Traditional cheeses are produced locally or regionally and hold an important place in rural, regional, and food culture. They reflect the history, geography, climate, and agriculture of a country (Pappa et al., 2020).

The traditional Italian albumin cheese Ricotta is most commonly made from sweet sheep whey but can also be produced from cow, goat, or buffalo whey. The whey is mixed with 5–10%

milk, 0.1% salt and citric acid at 0.11 kg/L are added, and the mixture is heated to 80–85°C (Pintado et al., 2001; Niro et al., 2013).

Ricotta salata is produced similarly to Ricotta, using sweet sheep whey (Casti et al., 2016), whereas Ricotta fresca is traditionally made in Sardinia from whey left after sheep cheese production and can be found under the names ricotta fresca ovina or ricotta gentile. To improve the texture and increase yield, the production of Ricotta fresca can be modified by using a whey and milk mixture or cream (Pala et al., 2016).

Myzithra and Manouri are traditional whey cheeses produced in Greece (Kaminarides, 2015; Bintsis et al., 2024). Myzithra is made from sweet or acid sheep or goat whey. When produced solely from sweet whey, partial acidification during heating is necessary (Kalantzopoulos, 1999). According to Kaminarides (2015), Myzithra is produced from sheep, goat, or a mixture of sheep and goat whey obtained from the production of hard and semi-hard cheeses. It can also be modified by adding whey protein concentrate prepared from sheep and goat whey, standardized with appropriate amounts of sheep milk, cream, or water.

Manouri is a traditional whey cheese produced in northwestern Greece (Bintsis et al., 2024). Historically, it was made from whey obtained from Bacos, a semi-hard cheese produced from goat or mixed goat and sheep milk. Today, Manouri is also made from whey derived exclusively from sheep milk cheeses. The overall production technology of Manouri closely resembles that of Myzithra, but the final moisture content (50 to 60%) is lower (Litopoulou-Tzanetaki & Tzanetaki, 2014).

Skuta is a traditional albumin cheese produced in Croatia (Zandona et al., 2020). Brač Skuta is made by thermal coagulation of sheep whey at 95–97°C. After coagulation of the whey proteins, the curds are collected from the surface with a perforated spoon, washed with cold water, and transferred into cylindrical perforated molds (Rako et al., 2016). In the production of Paška Skuta, the coagulated aggregates are placed in cheesecloths which are tightened and left to drain for 4–6 hours (Antunac et al., 2011). Acidification of Skuta can occur naturally by storing the whey for 1–3 days or by adding 10% acid whey or citric acid (Antunac et al., 2011).

The albumin cheese Urda is traditionally produced in North Macedonia (Talevski, 2012) from sweet sheep, goat, or cow whey obtained during the production of kashkaval, beaten cheese, or white brined cheese (Pintado et al., 2001; Chadikovski et al., 2022). Urda is characterized by a white to white-gray color. It has a fine granular texture with a soft consistency, suitable for spreading, with a pleasant and distinctive fresh cheese aroma and flavor (Bojanic Rasovic et al., 2017; Pappa et al., 2020). Urda is classified among soft cheeses and is most often used as fresh cheese (Paskaš et al., 2019). It is mainly consumed fresh and unsalted, as a table cheese, combined with sugar or honey, or used in the preparation of certain dishes such as cheese pies (Bojanic Rasovic et al., 2017). Fresh whey cheese produced in the Polog region of North Macedonia has a long tradition as a popular dairy product in Southeastern Europe (Sulejmani & Amedi, 2025).

3. Technology of Albumin Cheese Production

Understanding the quality and production technology of Urda is important regarding its nutritional and biological value, standardization, preservation of traditional technology, and protection of geographical origin (Bojanic Rasovic et al., 2017).

The production process of Urda involves heating the whey to a temperature of 85 to 90°C and holding it for 30 minutes, during which whey proteins denature, coagulate, and form aggregates on the surface (Bilyk et al., 2017). The aggregates separated from the surface are transferred into cloth strainers and drained for 6–7 hours at 19–21°C. The drained Urda is salted with 1–2% salt (Paskaš et al., 2019), packed in plastic containers, and stored refrigerated for 3 to 4 days (Bojanic Rasovic et al., 2017).

In Skuta production, the separated aggregates are transferred into perforated cylindrical molds or cheesecloths (Antunac et al., 2011). For Ricotta production, 10% milk is added to the

whey, acidified with citric acid, and heated by injecting low-pressure steam. After the aggregates form, they are transferred to perforated molds, drained for 10 minutes, salted, and pressed (Paskaš et al., 2019).

Sheep and goat whey with a normal pH of approximately 6.5 coagulate upon heat treatment at 78 to 80°C without exogenous acidification (Salvatore et al., 2014), whereas cow and buffalo whey require acidification (Mucchetti et al., 2017) by adding acid whey (Bojanic Rasovic et al., 2017) or synthetic acidulants (e.g., citric acid, lactic acid, magnesium sulfate) (Paskaš et al., 2019). Traditional albumin cheese production includes storing sweet whey for a certain period to reduce active acidity (pH) to a range of 5.7 to 6.0 (Antunac et al., 2011; Bozanic et al., 2014).

Adding milk, cream, or other dairy raw materials before or after whey coagulation contributes to increasing the nutritional value of albumin cheeses, the protein content, and the amount of essential amino acids in the proteins (Paskaš et al., 2019).

Salting of albumin cheeses may occur after production (Paskaš et al., 2019) or during the thermal treatment of whey (Antunac et al., 2011). Adding salt during albumin cheese production enhances interactions among negatively charged proteins, improving aggregation (Mucchetti & Neviani, 2006). Salt content contributes to cheese flavor, control of microbial growth, enzymatic activity, nutritional value, and acts as a natural preservative.

Due to their neutral pH, high water content, high water activity (aw), low salt content, and absence of preservatives, albumin cheeses are characterized by a short shelf life (Zandona et al., 2020). According to Pires et al. (2021), albumin cheeses are preferably consumed within 10 days of production.

4. Chemical Composition of Albumin Cheese

The quality and nutritional value of cheese are defined by its composition. The chemical composition of whey cheeses varies significantly (Table 1), primarily due to differences in the source and type of whey (sheep, goat, cow) (Paskaš et al., 2019), the method of acidification (vinegar, acid whey) during processing, the addition of salt during or after the process (Bozanic et al., 2014), as well as the addition of milk and cream (Kaminarides et al., 2013).

Table 1. Chemical Composition of Albumin Cheeses

Albumin Cheese	Type of Whey	pH	Fat	Proteins	Dry matter	Moisture	Salt	Reference
Urda	Cow whey from kashkaval	/	/	18.25 %	30.00 %	/	/	Sulejmani &Amedi, 2025
Urda	Cow whey from beaten cheese	/	/	32.37 %	37.00 %	/	/	Sulejmani &Amedi,20 25
Urda	Cow whey from white brined cheese	5.53	4.98 %	8.25 %	19.42 %	/	/	Chadikovski et al., 2022
Urda	Bovine whey from kashkaval	/	5.61 %	10.66 %	20.41 %	/	/	Paskaš et al., 2019
Urda	Sheep whey from kashkaval	6.39	16.30 %	16.80 %	/	60.10 %	1.50 %	Pappa et al., 2020
Urda	Sheep whey (55 kg) + sheep milk (12 kg)	6.39	28.8%	14.57 %	/	56.97%	0.6 %	Pappa et al., 2016
Urda	Goat whey (65 kg) + goat milk (22 kg)	6.41	29.7%	12.63 %	/	54.13%	0.51 %	Pappa et al., 2016
Ricotta	Cow whey (80%) + cow milk (20%)	6.45	8.13 %	12.39 %	/	73.36 %	/	Aamir et al., 2023

Ricotta	Ovine whey from Pecorino Sardo cheese + protein concentration (1.56%)	6.69	20.50 g/100g	6.70 g/100g	/	69.52 g/100g	/	Salvatore et al., 2014
Ricotta	Bovine whey from kashkaval + 10 % bovine milk	/	6.36 %	16.88%	/	69.82%	2.18 %	Paskaš et al., 2019
Homogenised Ricotta	Buffalo whey from Mozzarella + fresh cream from buffalo whey (1.5%)	6.9	22.50 %	5.63 %	34.49 %	65.51 %	/	Tripaldi et al., 2020
Skuta	Cow whey from fresh soft cheese Škripavac	/	13,37 %	9,70 %	/	70,60 %	0,66 %	Zandona et al., 2020
Bračka Skuta	Sheep whey	6,55	24,93 g/100g	9,70 g/100g	38,03 g/100g	61,97 g/100g	/	Rako et al., 2016
Mizithra	Ovine whey from Kefalotyri cheese	/	15.70 %	11.25 %	31.96 %	68.04 %	/	Kaminarides et al., 2013
Mizithra	Ovine whey from Kefalotyri Cheese (85 %)+ ovine milk (15 %)	/	17.25 %	11.70 %	35.02 %	64.98 %	/	Kaminarides et al., 2013
Mizithra	Ovine whey from Kefalotyri Cheese (79 %) + ovine milk (15 %) + ovine cream (6 %)	/	34.25 %	9.06 %	47.24 %	52.76 %	/	Kaminarides et al., 2013

Whey, as the primary raw material for the production of urda cheese, directly influences the composition of albumin cheese (Pappa et al., 2016). The chemical composition of whey is directly affected by the type of milk (sheep, goat, cow), the animals' feeding regime, and the stage of lactation (Casper et al., 1998; Kalevska et al., 2018). Sheep whey is characterized by a higher content of total solids, lipids, and proteins compared to cow whey (Pintado et al., 2001). The composition and ratio of proteins and fatty acids in whey depend on the lactation period, likely due to changes in pasture quality (Nudda et al., 2005). Furthermore, the treatment of milk prior to cheese production affects whey composition. Whey obtained from ultrafiltered milk or milk heated at high temperatures contains proportionally fewer proteins (Eugster et al., 2000; Božanić et al., 2014; Chadikovski et al., 2023).

Variations in the composition of albumin cheeses, beyond the whey type, are also directly influenced by processing practices (Paskaš et al., 2019). Coagulation of milk with citric acid reduces moisture content, firmness, and yield, whereas the addition of calcium chloride improves firmness and consumer acceptance (Ortiz Araque et al., 2018). The addition of milk and cream to whey during albumin cheese production results in cheese with higher fat content (Kaminarides et al., 2013; Pappa et al., 2016). Conversely, adding skimmed milk to whey produces cheese with lower fat content, firmer texture, and higher levels of ash, calcium, magnesium, and potassium compared to the control (Kaminarides et al., 2015).

An analysis of 17 samples of Istrian and 11 samples of Pag skuta revealed significant compositional variations. Water content in Istrian skuta ranged from 37.07% to 65.58%, fat from 19.00% to 43.00%, protein from 7.70% to 14.92%, and pH from 6.05 to 6.81. In Pag skuta, moisture ranged from 53.26% to 73.43%, fat from 11.00% to 32.00%, protein from 8.30% to 14.49%, and pH from 5.31 to 6.43 (Antunac et al., 2011). Bojanic Rasovic et al. (2017) analyzed 14 urda samples from as many production batches within the same facility, observing differences

in chemical composition. Fat content ranged from 15.84% to 35.65%, protein from 9.55% to 17.53%, moisture from 47.75% to 63.86%, and salt from 2.17% to 3.08%. Paskaš et al. (2019), analyzing 15 urda samples produced from cow whey obtained during kashkaval production acidified with citric acid, reported fat levels between 4.5% and 7.0%, protein from 8.94% to 12.71%, moisture from 76.81% to 82.21%, and salt from 1.86% to 2.04%.

5. Nutritional Value of Albumin Cheeses

Due to their high nutritional value, stemming from whey proteins (Kalevska et al., 2018), albumin cheeses can not only be classified as functional foods but are also considered nutraceuticals because of their anticancer, anti-inflammatory, immunomodulatory, and antimicrobial activities (Rako et al., 2018).

Urda produced from buffalo/cow whey is a rich source of amino acids, including 0.80 g/100 g leucine, 0.45 g/100 g lysine, 0.68 g/100 g threonine, 0.31 g/100 g phenylalanine, and glutamic and aspartic acids as dominant amino acids present at 1.65 g/100 g and 0.80 g/100 g, respectively (Paskaš et al., 2019). The bioavailability of amino acids, especially leucine, after consuming whey cheese is 32 times higher compared to casein cheese consumption, indicating its potential for more efficient stimulation of muscle protein synthesis (Lorieau et al., 2019).

Nutritionists recommend the consumption of cheeses with high protein content and low fat and salt levels (Tratnik, 2003). Cheeses low in fat and salt do not increase the risk of cardiovascular diseases (Jachimowicz-Rogowska & Winiarska-Mieczan, 2023; Rozenberg et al., 2016). Due to their low caloric value and high digestibility of whey proteins, albumin cheeses can play an important role in the diet of children and elderly individuals (Rako et al., 2016; Paskaš et al., 2019). Finding ways to incorporate protein-rich, low-calorie, and low-fat and cholesterol food products into the diet to increase muscle mass may be a challenge in the future (Alemán-Mateo et al., 2012).

6. Conclusion

The production of albumin cheese is the oldest method of whey valorization. Due to the abundance of bioavailable whey proteins, low fat, and salt content, these cheeses can be classified as products with functional characteristics. Variations in the composition of whey and the production process influence the composition of albumin cheeses, and consequently, their nutritional value. Standardizing the quality of albumin cheeses would contribute to their greater recognition and acceptance in diets as products with high nutritional and biological value.

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