International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2024; SP-9(1): 549-553

www.veterinarypaper.com
Received: 25-10-2023
Accepted: 30-11-2023

Nishida Naduvil Peediekal
PG Scholar Department of Dairy Microbiology, Verghese Kurien Institute of Dairy and Food Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Mohamed Sanjeed Malayanakath
PG Scholar, MSTM Arts and Science College, Perinthalmanna, Kerala, India

Archana Chandran
Assistant Professor, Department of Dairy Microbiology, College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Archana Suresh
Teaching Assistant, Department of Dairy Microbiology, College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Rejeesh Raveendran Nair
Assistant Professor, Department of Dairy Microbiology, College of Dairy Science and Technology, Trivandrum, Kerala Veterinary and Animal Sciences University, Kerala, India

Smitha James Lukose
Assistant Professor, Department of Dairy Chemistry, Verghese Kurien Institute of Dairy and Food Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Beena Athrayil Kalathil
Professor, Department of Dairy Microbiology, Verghese Kurien Institute of Dairy and Food Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Corresponding Author:
Archana Chandran
Assistant Professor, Department of Dairy Microbiology, College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Kerala, India

Optimisation of brine concentration in feta type cheese made using malabari goat milk

Nishida Naduvil Peediekal, Mohamed Sanjeed Malayanakath, Archana Chandran, Archana Suresh, Rejeesh Raveendran Nair, Smitha James Lukose and Beena Athrayil Kalathil

Abstract
Optimisation of brine concentration is a critical step in the manufacture of feta type cheese. The objective of this research paper was to study the effect of brining salt concentration on the salt content, microbial quality, and sensory analysis of Feta-type cheese made from Malabari goat milk. Three different brines with salt concentrations of 10%, 13%, and 16% were used to brine the cheese. The analysis of salt content revealed that the salt concentration in the cheese brined with 10% salt remained stable during ripening. In contrast, the cheese brined with 13% and 16% salt concentrations showed a decline in salt content over time. Microbial quality analysis demonstrated a correlation between salt concentration and microbial reduction. The results revealed that the cheese brined with 10% salt concentration scored the highest in sensory acceptability. These results offer valuable insights to optimize brining processes to achieve desired quality in Feta-type cheese.

Keywords: Feta type cheese, brine concentration, sensory evaluation, aging period, salt content

1. Introduction
Feta cheese is a pickled variety of cheese that originated in Greece and is now produced worldwide. It is a soft type of cheese made from sheep's milk or a mixture of sheep's and goat's milk by rennet coagulation and salting of cheese curd [1]. High salt content and prolonged storage in brine are distinguishing characteristics of pickled cheeses. As a result, salt plays a crucial role in determining the physical, microbial, and sensory attributes of these cheeses.
The addition of NaCl can solubilize approximately 23-25% of the colloidal calcium in buffaloes and cows' milk, whereas only 10% is solubilized in goat's milk. This suggests that there are species-specific variations in the exchangeability of colloidal calcium. Also, adequate salt levels in cheese play a direct role in enhancing its flavor and texture by restraining proteolytic activity [2]. In traditional feta cheese manufacture, cheese blocks are dry salted after initial whey drainage and held at 16 to 18 °C for several days [3]. But overnight brining followed by gravity drainage of brine was found to be more useful for large-scale production as it has a milder flavor, faster salt absorption rate, higher moisture retention and yield of cheese [4]. Microbial stabilization of brine is essential in reducing the risk associated with the proliferation of unwanted bacteria in cheese [5]. Hence optimization of brine concentration in cheese by evaluating the microbial and sensory quality is essential for the standardization of feta-type cheese production from the milk of Malabari goat, an indigenous breed of Kerala.

2. Materials and Methods
2.1 Materials for feta ty pe cheese making
Goat milk (Breed: Malabari, an indigenous breed of Kerala, India) procured from Goat Farm, Kerala Veterinary and Animal Sciences University, Wayanad was used as cheese milk. The freeze-dried starter culture blends of strains of *Lactococcus lactis* subsp *lactis* and *Lactococcus lactis* subsp *cremoris* procured from National collection of dairy cultures (Dairy Microbiology Division), ICAR-National Dairy Research Institute- Karnal, Haryana was used as cheese starter culture. The rennet was obtained from Chris. Hansen India pvt.Ltd (Chy- Max R).

Brine solutions were prepared in different concentrations (10%, 13%, 16%) by dissolving sodium chloride (Annapurna iodized salt) in potable water followed by sterilization by autoclaving.

2.2 Preparation of cheese

The goat milk was standardised by adding the necessary amount of cream to achieve a casein to fat ratio of 0.87. Subsequently, it was pasteurized at 72 ºC for 15 seconds using the High Temperature Short Time (HTST) method. The milk was cooled to a temperature of 32 ºC in a cheese vat and starter culture consisting of a 1:1 mixture of *Lactococcus lactis subsp lactis* and *Lactococcus lactis subsp cremoris* was added at the rate of 1.5 percent. A ripening period of 15 minutes at 37 ºC was allowed before adding the optimized amount of rennet (0.002%). Just prior to adding the rennet, 0.02% $CaCl_2$ was added. The mixture was left undisturbed for 30 minutes for the rennet to take effect. After 30 minutes, the curd was cut using cheese knives and stirred after an additional 15 minutes. Approximately one-third of the whey was removed, and the curd and whey were then transferred to rectangular stainless steel cheese molds with perforations. The curd was allowed to mat together and press under its own weight for 1 hour. Finally, the cheese was placed in various brine concentrations(10%,13%,16%) and refrigerated at 5-7 ºC for 24 hours. After brining the cheese blocks were packed by vacuum packaging(Polyester-Polyethylene pouch and machine make) and kept at 10 ºC for aging for 30 days. The flow diagram for the manufacture is as shown in the Figure 1.

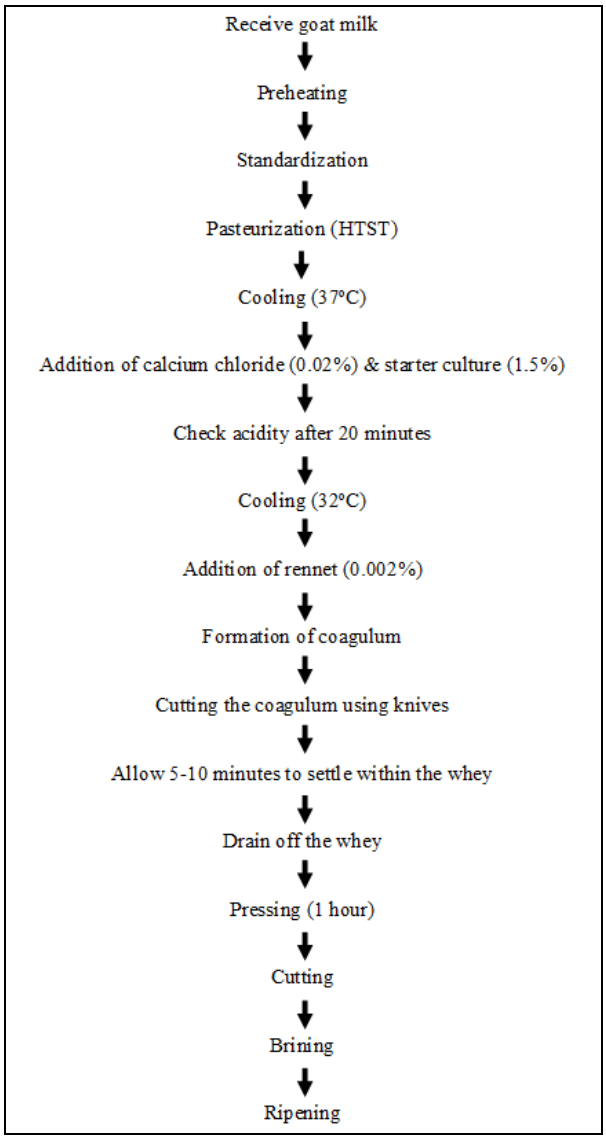

Fig 1: Flow chart depicting the production process of feta-type cheese

2.1 Microbial analysis of cheese during ageing

Total bacterial count of cheese samples were estimated on the 0^{th} day, 15^{th} day and 30^{th} day of ripening [6]. Standard plate count agar (Himedia MO91-500G) was used for total plate count. 25 g of cheese dissolved in 225ml saline. The diluted samples were plated and incubated at 37 °C for 48 h. At the end of incubation, plates showing between 30 and 300 colonies were selected and counts were taken with the help of a colony counter. The number of colony forming units (cfu) per gram of sample was calculated by multiplying the mean colony count in duplicate plates with the dilution factor and expressed as log cfu /g.

2.2 Estimation of salt content and syneresis

Salt was measured by titration with silver nitrate solution [7]. 5 g of cheese sample was added into 250 ml conical flask. 10ml of boiling distilled water was added. The contents were mixed and cooled to 50 °C to 55 °C (titration temperature). 2ml of potassium chromate solution and 0.25 g of calcium carbonate was added into it. Titration was done at 55 °C to 55 °C with

standard silver nitrate solution, until the brownish color persist for half a minute. Blank test was carried out with all the reagents in the same quantity except the cheese sample. Whey Syneresis was analyzed by measuring the volume of separated whey drained from the curd during ripening [8]. The volume of whey collected in the vacuum packs on 0th, 15th and 30th day was recorded.

2.4 Sensory evaluation of cheese: Sensory evaluation of cheese using 9-point hedonic scale involves assessing the overall sensory characteristics of the cheese based on a scale of nine points, ranging from dislike extremely to like extremely (1 to 9). Before evaluation, the cheese samples were removed from the refrigerator and left at room temperature for some time. Each panel member was provided with approximately 20g of cheese for evaluation. Additionally, water and Biscuit were provided to the panelists to rinse their mouths between samples, ensuring a fresh palate for each evaluation. Graders were requested to rank the samples in order according to their overall quality or general acceptability. The cheeses were graded after 0,15,30 days of ripening by 6 graders (from the permanent staff of CDST Pookode). They graded the cheeses for Flavor (scale 1 to 9), Body and texture (scale 1 to 9), Finish (scale 1to 9), Colour (scale 1 to 9) and Overall acceptability (scale 1 to 9). Sensory evaluation aimed to assess how the sensory characteristics of the brined Feta type cheeses developed during the ripening period and how these changes influenced the overall quality and acceptability of cheese.

2.5 Statistical analyses

For all standardized values of responses, a two-way analysis of variance (ANOVA) was conducted using IBM SPSS Statistics (version 24) to examine statistical significance of model terms. The group mean was computed and significance of means were tested at 5% level of significance.

3. Results and Discussion

3.1 Impact of Brine Concentration on Product Attributes and Microbial Behavior

The brining step in cheese-making is essential for flavor development and microbial control. Recent studies have focused on optimizing brine concentration and its effects on cheese quality. Researchers have demonstrated that specific brine concentrations significantly influenced salt diffusion, resulting in variations in texture, flavor, and microbial dynamics in cheese [9]. Exploring different brining techniques, such as dry salting or controlled brining with varying salt concentrations, could further enhance the flavor and quality of the cheese. Studies reported brining of cheese for 8 weeks decreases the moisture content of cheese and increases the salt content as it is ripened [10]. Increasing the salt concentration in the brine resulted in a noticeable reduction in microbial growth within the cheese samples [11]. The salt in the brine can draw out moisture from the cheese, creating an environment that is less conducive to microbial growth. The removal of moisture reduces the water activity (aw) within the cheese, making It less favorable for microorganisms to thrive [12]. The average value of microbial count and salt content in cheese samples during ripening are given in Table 1.

Table 1: Microbial count in cheese during ripening period.

Time of ripening (Days)	Microbial count ($x10^{-8}$ cfu/g)		
	10%	13%	16%
0th day	10.24±0.05	8.62±0.275	8.40±0.37
15th day	9.19±0.105	10.12±0.05	8.73±0.265
30th day	8.8±0.2	9.95±0.05	8.89±0.175

A two-way ANOVA with three time intervals and brine concentrations (10%, 13% and 16%) as independent variables was conducted to compare the microbial quality of the cheese samples. The results of the two-way ANOVA indicate that there were no significant differences in the microbial count as affected by ripening period (p<0.01) is given in Table 2. However, there was significant difference between the microbial count of cheese samples as influenced by the brine strength (p>0.01). In addition, the interaction effect of the ripening period and brine solution on the microbial load was also found to be significant (p>0.01).

Table 2: Results of two-way ANOVA on salt content of cheese samples

Source	Sum of Squares	*Df*	F-Value	P-Value
Day	.203	2	1.226	p>0.001
Salt	2.710	2	16.370	p<0.001
Day × Salt	4.963	4	14.992	p<0.001

A two-way ANOVA with three time intervals and brine concentrations (10%, 13% and 16%) as independent variables was conducted to compare the salt content of the cheese samples. The results of the two-way ANOVA indicate that there were no significant differences in the salt content as affected by ripening period (p<0.01) is given in the Table 3. However, there was significant difference between the salt content of cheese samples as influenced by the brine strength (p>0.01). In addition, the interaction effect of the ripening period and brine solution was also significant (p>0.01).

Table 3: Salt content in cheese samples during ripening period.

Time of ripening (Days)	Salt concentration		
	10%	13%	16%
0th day	4.89±0.017	6.49±0.020	7.31±0.020
15th day	3.81±0.012	4.02±0.030	4.31±0.029
30th day	3.32±0.017	3.17±0.016	3.98±0.024

3.2 Impact of Brine Concentration on whey syneresis

Relationship between brine concentration and whey syneresis over time is given in the Figure 2. The protein matrix of cheese expands or contracts based on variations in salt concentration [13]. The osmotic phenomena in cheese and its implications on cheese production and quality has been evaluated [14]. When the cheese is placed in brine, the brine has a higher concentration of salt (NaCl) compared to the cheese. As a result, water from the cheese will move out through the cheese matrix to the brine, while the smaller NaCl molecules will move from the brine into the cheese. In this study cheeses were subjected to a 24-hour brining process, followed by vacuum-packing and ripening under controlled conditions results the 10% brine cheese exhibited higher whey syneresis than the 16% brine cheese, while the salt content of the 16% & 13% brine cheeses experienced a substantial decrease during ripening. The role of salt in cheese

preservation by inhibiting spoilage and preventing the growth of pathogens have been reported previously [2]. The observed difference in whey syneresis between the 10%,13% and 16% brine cheeses can be attributed to the brine concentration's impact on cheese matrix and protein interactions. Higher brine concentration (16%) likely led to a firmer protein network, which restricted whey expulsion during ripening. Conversely, the lower brine concentration (10%) may have resulted in a more open cheese structure, facilitating whey release and leading to higher whey syneresis. The decrease in salt content in the 16% brine cheese during ripening raises concerns about potential salt leaching. Vacuum-packing may have accelerated this process by creating a pressure differential between the cheese's interior and exterior, driving the migration of salt ions. In contrast, the 10% brine cheese might have experienced minimal salt leaching due to its more open structure and potentially lower salt concentration, resulting in a more stable salt content during ripening.

The overall trend of increased whey syneresis over time is consistent for all brine concentrations, the rate of syneresis appears to be influenced by the initial brine concentration. Cheese with a higher salt content can show less syneresis during storage in vacuum packs [15]. The higher salt concentration in cheese helps to create a stronger protein network, which contributes to reducing whey syneresis. When this cheese is vacuum-packed, it further enhances the ability to retain moisture and minimize whey separation.

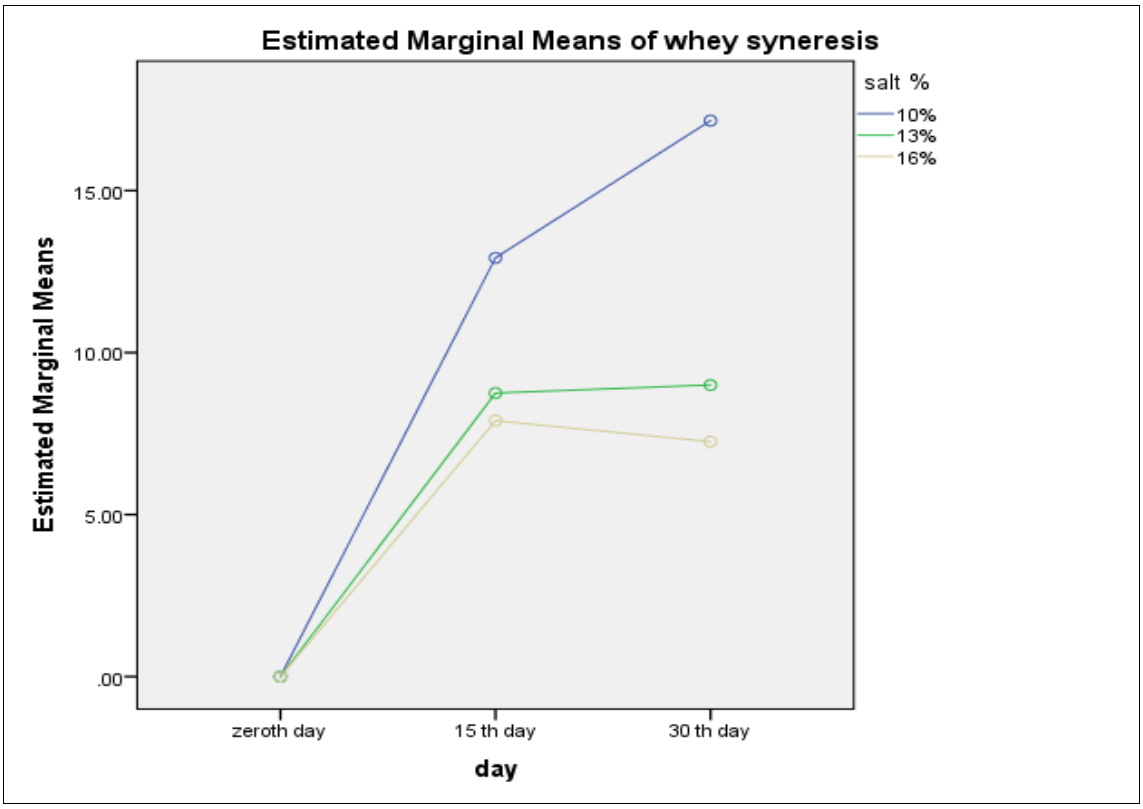

Fig 2: Relationship between brine concentration and whey syneresis over time.

3.3 Sensory evaluation

The sensory evaluation of cheese samples were done by 6 graders of different age groups with in the 20-45 age range (Institutional faculty) and graded the samples on 0th,15th and 30 day of ripening. Based on the mean sensory scores of differently brined cheeses is given in the Table 4. The 10% brined cheese demonstrated superior qualities in flavor, body and texture, finish, color, and overall acceptability compared to other different brining levels tested in the evaluation on 0^{th}, 15^{th} and 30^{th} day.

In this study the 10% brined feta type cheese demonstrated superior qualities in flavor, body and texture, finish, color, and overall acceptability compared to other variations tested in the evaluation. Also the brine concentration influenced the microbial quality, whey syneresis and salt content during cheese ripening. The 10% brine cheese demonstrated higher whey syneresis, while the 16% brine cheese experienced a substantial decrease in salt content. These observations can be attributed to the brine concentration's impact on cheese matrix and protein interactions, as well as salt leaching during ripening and vacuum-packing.

Table 4: The mean sensory scores of the experimental cheese

Sensory attributes	Age of cheese, (days)	Brine concentration (%)		
		10%	13%	16%
Flavour	0	8±0.63	6.4±1.84	6.6±2.57
	15	7.6±0.8	7.2±1.16	6±0.89
	30	8.4±0.48	8.4±0.8	7±0.63
Body and texture	0	8.2±0.74	7.6±0.8	8±0.63
	15	8±0.89	7.8±0.74	7.2±0.97
	30	8.8±0.4	8±0.63	8±0.89
Finish	0	8.2±0.75	7.6±0.8	7.6±0.8
	15	8.2±0.4	7.8±1.16	7±0.63
	30	8.8±0.4	8.6±0.48	8.4±0.48
Colour	0	8.2±0.75	8±0.63	7.8±0.74
	15	8.2±0.4	7.8±1.16	7.2±0.74
	30	8.8±0.4	8.6±0.48	8.2±0.72
Overall acceptability	0	8.2±0.75	6.3±1.74	6.2±2.22
	15	7.8±0.74	7.4±1.01	6.2±0.74
	30	8.8±0.4	7.8±0.4	6.6±0.48

Conclusion

This research underscores the critical importance of brine concentration in the production of Feta-type cheese from Malabari goat milk. The study elucidates that different brine

salt concentrations significantly influence salt content, microbial quality, and sensory attributes of the cheese. A salt concentration of 10% emerges as the optimal choice, maintaining stable salt levels during ripening while ensuring superior microbial quality and sensory acceptability. Further research may explore additional parameters to refine cheese manufacturing processes and expand product quality optimization.

4. Acknowledgment and/or disclaimers, if any

The Authors acknowledge Kerala Veterinary and Animal Sciences University for granting necessary permissions and funding the research work under the PG Research Grant for M.Tech. Scholar.

5. References

1. El-Salam MA, Alichanidis E, Zerfiridis G. Domiati and Feta type cheeses. Cheese: Chemistry, Physics and Microbiology: Volume 2 Major Cheese Groups; c1993. p. 301-335. https://doi.org/10.1007/978-1-4615-2648-3_11.
2. Guinee T. Salting and the role of salt in cheese. International Journal of Dairy Technology. 2004;57(2-3):99-109. DOI: 10.1533/9781845693046.3.332
3. Moschopoulou E, Kandarakis I, Anifantakis E. Characteristics of lamb and kid artisanal liquid rennet used for traditional Feta cheese manufacture. Small Ruminant Research. 2007;72(2-3):237-241. DOI: 10.1016/j.smallrumres.2006.10.018
4. Eugster-Meier E, Fröhlich-Wyder MT, Jakob E, Wechsler D, Morales MBL, *et al*. Semi-hard Cheeses. Global Cheesemaking Technology: Cheese Quality and Characteristics; c2017. p. 247-300. DOI:10.1002/9781119046165.ch3
5. Mestani M, Ramadani X, Gjergji TM, Dizdarevic T, Mehmeti I. Influence of brine concentration and ripening temperature on quality of sharri cheese; c2017. DOI: 10.3923/ijds.2017.310.317
6. McSweeney P, Fox P, Lucey J, Jordan K, Cogan T. Contribution of the indigenous microflora to the maturation of Cheddar cheese. International Dairy Journal. 1993;3(7):613-634. https://doi.org/10.1016/0958-6946(93)90104-8
7. Johnson ME, Olson N. A comparison of available methods for determining salt levels in cheese. Journal of Dairy Science. 1985;68(4):1020-1024. https://doi.org/10.3168/jds.S0022-0302(85)80924-3
8. Pearse M, Mackinlay A. Biochemical aspects of syneresis: A review. Journal of Dairy Science. 1989;72(6):1401-1407. https://doi.org/10.3168/jds.S0022-0302(89)79247-X
9. Madadlou A, Mousavi ME, Farmani J. The influence of brine concentration on chemical composition and texture of Iranian white cheese. Journal of Food Engineering. 2007;81(2):330-335. DOI: 10.1016/j.jfoodeng.2006.11.010
10. Kaya S. Effect of salt on hardness and whiteness of Gaziantep cheese during short-term brining. Journal of Food Engineering. 2002;52(2):155-159. https://doi.org/10.1016/S0260-8774(01)00098-X
11. Guinee T, O'Kennedy B. Reducing salt in cheese and dairy spreads. Reducing salt in foods: Elsevier; c2007. p. 316-357. https://doi.org/10.1111/j.1471-0307.2004.00145.x
12. Bae I, Park JH, Choi HY, Jung HK. Emerging innovations to reduce the salt content in cheese; effects of salt on flavor, texture, and shelf life of cheese; and current salt usage: A review. Korean journal for food science of animal resources. 2017;37(6):793. DOI: 10.5851/kosfa.2017.37.6.793
13. Vieira ADP, Von Keyserlingk M, Weary D. Effects of pair versus single housing on performance and behavior of dairy calves before and after weaning from milk. Journal of Dairy Science. 2010;93(7):3079-3085. DOI: 10.3168/jds.2009-2516
14. Guinee T, O'brien B. The quality of milk for cheese manufacture. Technology of cheesemaking; c2010. p. 1-67. DOI: 10.1002/9781444323740.ch1
15. Pastorino A, Hansen C, McMahon DJ. Effect of salt on structure-function relationships of cheese. Journal of Dairy Science. 2003;86(1):60-69. DOI: https://doi.org/10.3168/jds.S0022-0302(03)73584-X