The Effect of Brine Concentration and Storage Period on Physio-Chemical and Microbial Quality of White Soft Cheese

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Abstract

This study investigated the effect of different brine concentrations (4%, 8%, 12%, and 16% NaCl w/v) and storage durations (1, 7, 14, 21, and 28 days) on the physio-chemical and microbiological quality of white soft cheese. Results showed that moisture content significantly decreased with increasing brine concentration and time, dropping from 64.5% (Day 1, 4% brine) to 52.0% (Day 28, 16% brine). Fat content remained relatively stable (~18%), with minor increases in higher brines due to moisture loss. Protein content slightly decreased from 15.5% to 14.2% in 4% brine and remained more stable at higher salt levels. Salt content rose proportionally with brine level, reaching a maximum of 4.6% at Day 28 in 16% brine. pH decreased from 4.8 to 4.2 over the storage period in 16% brine, while titratable acidity increased from 0.61% to 1.01%, indicating enhanced acid development. Cheese hardness increased with salinity and storage, rising from 1.9 N (Day 1) to 7.8 N (Day 28, 16% brine), reflecting moisture reduction and salt-induced protein tightening. Microbial analysis showed that total plate counts rose in 4% brine (from 4.2×10^3 to 8.5×10^3 CFU/g), while in 16% brine, microbial counts remained low (5.2×10^3 CFU/g by Day 28). Coliforms and yeasts/molds were not detected after Day 14 in brines ≥8%. The results show that both brine concentration and storage period have significant impacts on cheese quality. Higher salt concentrations significantly inhibited microbial growth, but they also lowered pH, increased salinity and hardness over storage, and accelerated up moisture loss.

Overall, brine concentrations of 8–12% NaCl provided optimal preservation, balancing microbial safety with acceptable chemical and textural properties without excessive hardness or saltiness. Depending on these results, cheese compositions can be modified to increase shelf life, and traditional brine cheese preservation techniques can be improved.

Keywords: Cheese, Brine, Storage, Physio-chemical, Quality

Introduction

White soft cheese is a fresh, high-moisture and a popular dairy product in the Mediterranean and the Middle East. It's usually kept in brine solutions to improve its flavor and extend its shelf life [1, 2, 3].

White soft cheeses are traditionally preserved by brine storage; the addition of salt during the brining process enhances the cheese's flavor and texture while also extending its shelf life [4, 5, 6].

By reducing water activity and preventing microbial growth, brine serves as a preservative. This preservation method affects a number of important quality attributes, such as moisture content, microbial safety, pH stability, and texture characteristics. It also plays a role in cheese ripening, affecting both physicochemical and microbiological stability [7].

In addition to its preservative and microbial growth-inhibiting properties, sodium chloride in brine also influences water activity, protein interactions, and texture development [8]. It also affects enzymatic and microbial activities, which influences the safety and maturation of cheese [7, 8], as well as reducing microbial activity and enhancing flavor. Nevertheless, over time, extended exposure to salt may affect microbial dynamics, texture, and moisture retention [8].

Two important factors that affect preservation effectiveness and quality standard maintenance are brine concentration and storage duration [9]. Determining the ideal brine content and storage time is crucial for maintaining cheese's quality and safety over the duration of its shelf life while preventing excessive salt intake [10]. Higher amounts of salt have been linked to harder textures because of improved protein interactions and syneresis, according to previous studies [7, 11]. Low salt content may cause deterioration to occur quickly, whereas excessive salting (high salt content) or prolonged storage can lead to sensory degradation and negatively affect palatability [12].

This study aims to determine the optimal brine concentrations and storage times for preserving the quality and safety of white soft cheese by investigating the impact of varying NaCl concentrations on the cheese's chemical, textural, and microbiological properties.

Materials and Methods

Cheese Production

White soft cheese made by pasteurizing cow milk, which contains fat □ 3.5%. After cooling milk to 35–37 °C, the rennet was added, and curds were allowed to form over 45 minutes. Curd was cut and drained, then pressed and cut into 100 g cubes [13].

Brine Preparation and Storage

Four brine solutions (4%, 8%, 12%, and 16% NaCl w/v) were prepared using distilled water. Cheese cubes were immersed in sterilized brine and stored at 4°C in sterile containers for 28 days. Samples were taken on days 1, 7, 14, 21, and 28 [14].

Analytical Procedures

Moisture Content:
The moisture content was determined using the oven-drying method at 105°C for 4 hours [15].

Salt Content:
Determined by Mohr titration [16].

pH Measurement:
Prepared by blending 10 g of cheese in 90 mL distilled water, then measured with a calibrated pH meter [17].

Fat Content:
Analyzed by the Gerber method according to [15].

Microbial Analysis:

Sample Preparation:
Eleven grams from each sample were blended with 99 mL of sterile 0.1% normal saline. Serial dilutions were prepared up to 10^{-6} [18].

Standard Plate Count (SPC):
The SPC was determined using Nutrient Agar media and the pour plate technique

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with plate count agar. Plates were incubated at 37 °C for 24-48 hours [19, 20].

Coliforms:
Counts were done using MacConkey agar, incubated at 37 °C/24 hours [20].

Yeasts and Molds:
Samples were spread on Potato Dextrose Agar and incubated at 25°C for 2-5 days [20].

Texture Profile Analysis (TPA)
Texture Profile Analysis (TPA) was conducted to determine the hardness of the cheese samples using a CT3 4500 texture analyzer (Brookfield Engineering Lab). The procedure followed the method described by [21]. A 25 mm probe (cylinder), 5 kg load, 10 mm penetration, 5 g trigger force, and 3 mm/s speed were applied.

Statistical Analysis
Data were subjected to analysis of variance (ANOVA) using XLSTAT software (version 16.8). Mean comparisons were performed using the Least Significant Difference (LSD) test at a significance level of $p < 0.01$.

Results and Discussion

Table 1: Chemical Composition of White Soft Cheese Samples stored in different brines for 28 days

Storage (Day)	Brine Concentration (%) NaCl	Moisture (%)	Salt (%)	Fat (%)	Protein (%)
1	**4.0**	64.5	1.2	18	15.5
7		63.4	1.6	17.8	15.3
14		60.1	2.0	17.7	14.9
21		58.9	2.3	17.5	14.6
28		57.2	2.5	17.3	14.2
1	**8.0**	64	1.2	18	15.5
7		61.2	1.8	18.2	15.6
14		59	2.3	18.3	15.4
21		57.1	2.7	18.2	15.2
28		55.8	3.1	18.1	14.9
1	**12.0**	63.5	1.3	18	15.5
7		60.4	2.2	18.4	15.8
14		58.2	2.8	18.6	15.7
21		56	3.3	18.7	15.6
28		54.3	3.8	18.8	15.5
1	**16.0**	63	1.3	18	15.5
7		59.6	2.8	18.5	16
14		56.8	3.5	18.6	15.9
21		54.2	4.1	18.9	15.8
28		52	4.6	19	15.7
LSD (P≤0.01)		**1.40**	**0.71**	**0.64**	**0.55**

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Brine concentration significantly influenced moisture content. As shown in the above table, moisture content decreased over time in all samples, with sharper reductions observed at higher salt concentrations. Higher brine concentrations accelerated moisture loss due to osmotic dehydration, a process where water is drawn out of the cheese matrix by the hypertonic salt solution. This moisture decline is primarily attributed to the osmotic effect of brine on the cheese structure [22]. Higher brine concentrations significantly reduced moisture content, lower moisture content contributes to firmer texture and longer shelf life [23]. This agrees with previous findings by [23], where salt draws water from the curd matrix, firming the cheese.

Fat content in white soft cheese is generally steady, with slight changes due to brine effects on moisture [24].

By decreasing moisture, a higher percentage of brine causes an apparent increase in fat, although lipolysis may affect flavor, but it does not substantially change the percentage of total fat [25].

White soft cheese's protein content might vary while being stored due to moisture loss, which causes a noticeable rise in the amount of protein. However, proteolysis breaks down proteins into peptides and amino acids, reducing protein content. While brine concentration goes up, microbial and enzymatic activity drop, which causes proteolysis to slow down [26].

Salt absorption increased with brine concentration and storage period. The rapid salt uptake at higher concentrations improves preservation but risks over-salting [27]. Salt absorption was directly proportional to brine strength. Excessive salt (>4%) may affect sensory acceptability, although necessary for microbial control [28].

Table 2: Acidity and pH of White Soft Cheese Samples stored in different brines for 28 days

Storage Day	Brine Concentration (%) NaCl	Acidity%	pH
1	**4.0**	0.61	4.8
7		0.65	4.7
14		0.68	4.6
21		0.71	4.5
28		0.75	4.5
1	**8.0**	0.62	4.8
7		0.67	4.7
14		0.74	4.6
21		0.81	4.5
28		0.85	4.4
1	**12.0**	0.62	4.7
7		0.68	4.6
14		0.76	4.5

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21		0.84	4.4
28		0.91	4.3
1	**16.0**	0.63	4.7
7		0.70	4.6
14		0.79	4.4
21		0.90	4.3
28		1.01	4.2
LSD (P≤0.01)		**0.09**	**0.08**

A gradual pH decrease occurred due to metabolic activity and salt stress. This decline contributes to microbial inhibition but may alter cheese flavor [29].

Brine concentration affected the acidification process. Lower pH and higher titratable acidity were observed with higher salt levels, indicating an interaction between salt and microbial fermentation [26]. pH values dropped steadily with time, more so in higher salt treatments.

The acidic environment is due to residual microbial metabolism, but salt suppresses activity, thereby moderating pH changes. [26] notes similar buffering effects of brine on cheese fermentation.

Table 3: Hardness of White Soft Cheese Samples stored in different brines for 28 days

Storage Day	Brine Concentration (%) NaCl	Hardness (N)
1	**4.0**	1.9
7		2.3
14		3.1
21		4.6
28		5.2
1	**8.0**	1.9
7		2.4
14		3.4
21		4.9
28		6.1
1	**12.0**	1.9
7		2.6
14		3.7
21		5.4
28		6.9
1	**16.0**	1.9
7		2.9
14		4.8
21		6.4
28		7.8
LSD (P≤0.01)		**0.90**

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Higher salt concentrations reduced moisture and increased hardness. Hardness increased with increasing salt, as salt impacts protein interactions [30]. This result is close to the result found by [27].

Table 4: Microbial Tests of White Soft Cheese Samples stored in different brines for 28 days

Storage Day	Brine Concentration (%) NaCl	Total Plate Count (log CFU/g)	Coliforms (log CFU/g)	Yeast and mold
1	**4.0**	$4.2 * 10^3$	TFTC	ND
7		$4.8* 10^3$	TFTC	ND
14		$5.9* 10^3$	ND	ND
21		$7.0* 10^3$	ND	ND
28		$8.5* 10^3$	ND	ND
1	**8.0**	$4.3* 10^3$	TFTC	ND
7		$5.1* 10^3$	TFTC	ND
14		$6.0* 10^3$	ND	ND
21		$6.5* 10^3$	ND	ND
28		$6.9* 10^3$	ND	ND
1	**12.0**	$4.2* 10^3$	TFTC	ND
7		$4.5* 10^3$	ND	ND
14		$4.9* 10^3$	ND	ND
21		$5.4* 10^3$	ND	ND
28		$5.8* 10^3$	ND	ND
1	**16.0**	$4.2* 10^3$	TFTC	ND
7		$4.3* 10^3$	ND	ND
14		$4.6* 10^3$	ND	ND
21		$5.0* 10^3$	ND	ND
28		$5.2* 10^3$	ND	ND
LSD (P≤0.01)		**1.26**	**-**	**-**

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TFTC: too few to count
ND: not detected

Microbial growth increased over time in lower brines but was suppressed in higher concentrations. Increased salt levels effectively reduced microbial counts. At 12–16% brine, coliforms and yeasts/molds were nearly eliminated, improving cheese safety [31]. Also, microbial growth remained minimal, highlighting the preservative role of salt. Similar trends were observed by [31].

The data indicate that brine concentration and storage duration exert substantial influence on cheese quality. Moisture and fat losses were most pronounced at 16% brine, which also yielded the best microbial control. 12% brine offered a balance between safety and sensory quality. pH remained relatively stable but decreased slightly, further supporting microbial inhibition.

These findings support previous studies by [27, 28], confirming that salt concentration above 10% is effective for microbial safety in soft cheeses. However, care must be taken to avoid over-salting and textural degradation.

Conclusion

This study confirms that both brine concentration and storage duration exert significant influences on the physicochemical levels of 8–12% NaCl were found to provide an optimal balance, ensuring microbial safety while maintaining desirable textural properties and minimizing undesirable compositional changes. These findings highlight the importance of appropriate brining strategies in enhancing cheese quality and shelf-life. and microbiological characteristics of white soft cheese. Brine

Further investigations should incorporate consumer sensory assessments to validate product acceptability and explore alternative brining systems, particularly reduced-sodium or non-sodium formulations, to address growing public health concerns related to salt intake.

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