

Toward camel milk–specific benchmarks: Assessment impact of freezing duration and temperature analytics on the compositional parameters and somatic cell count (SCC) of raw camel milk samples

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ABSTRACT. The quality of camel milk is affected by prolonged storage, while somatic cell count (SCC) is an important indicator used to assess udder health. This study aimed to evaluate the effects of freezing periods (0, 7, 14 and 21 days) and experimental temperatures (37 °C and 50 °C) on the composition and SCC of camel milk. A total of 51 milk samples were collected from two local camel breeds, the Al-Majahim ($n = 31$) and the Al Maghateer ($n = 20$), reared under semi-arid conditions in Saudi Arabia. The results showed that the basic milk composition was not significantly affected by experimental temperatures (37 °C vs. 50 °C) or freezing time. Fresh camel milk analysed at 50 °C had SCC and log transformed SCC (LSCC) values that were at least 50% higher than in frozen samples. SCC decreased significantly ($P < 0.01$) at both 37 °C and 50 °C with increasing freezing duration (7, 14, and 21 days). Correlation analysis showed a significant positive association between SCC and LSCC for all freezing periods ($P < 0.001$). Principal component analysis (PCA) indicated that experimental temperatures explained 6.3% of the variation, while freezing duration accounted for 81.8%. These findings demonstrate that the SCC in camel milk is strongly influenced by freezing period and support the development of specific criteria for the handling and analysis of camel milk rather than relying on standards established for bovine animals.

Introduction

Camels play an important role in the economies of many developing countries and are a vital source of food in harsh environmental conditions. The Kingdom of Saudi Arabia is a major consumer of camel-derived products, including

meat and milk, due to its diverse camel breeds and the fourth-largest camel population in the Arab world. The Kingdom also aims to become a leading global producer of high-quality camel milk. In Saudi Arabia, milk is among the most important camel-derived products and is widely consumed by the local population. The camel population

is estimated at approximately 2.2 mln head (SGAS, 2023), with daily milk production ranging from 4 to 15 kg per animal (Aljumaah et al., 2020). Moreover, demand for camel milk has recently been growing due to its nutritional and therapeutic properties (Ait El Alia et al., 2025).

Consumers require milk to be produced under conditions that ensure high biological value, safety and overall quality. This expectation drives legislation, research and technology transfer aimed at meeting market demands. They are also closely associated with the competitiveness and profitability of the dairy sector and are essential for market access and the sustainability of dairy production (Henrichs et al., 2014). Milk from all mammalian species is a heterogeneous secretion containing numerous components with diverse chemical and functional properties (Park and Nam, 2015). Its characteristics are related to physicochemical parameters used in the development appropriate hygiene and sanitation standards in dairy farming (Murphy et al., 2016). Milk quality depends on interactions between herd health status, mammary gland condition, milking practices, and milk storage conditions (Fusco et al., 2020).

Mastitis is a common disease in dairy herds and causes substantial economic losses due to changes in mammary gland secretion. It also reduces the productive lifespan of dairy animals and affects the major components of milk (Karamatić et al., 2026). Somatic cell count (SCC) is one of the main parameters for assessing milk quality and udder health, as it is directly associated with milk composition, industrial performance, and food safety (Karamatić et al., 2026). High SCC and total bacterial count (TBC) values in milk are linked to increased enzymatic activity, which may adversely affect milk composition, quality, and technological properties (Carmo et al., 2023). Therefore, accurate determination of SCC is important for the development of appropriate treatments and disease resistance indicators, and may represent an important component of camel breeding and selection programmes aimed at improving animal welfare (Hisira et al., 2023). Somatic cells can be measured using several methods, including microscopic counting, Coulter counting, or Fossomatic™ analysis. Standards for the use of these methods are well established for cow milk; however, appropriate norms for SCC determination in sheep, goat, and camel milk still need to be developed (Hisira et al., 2025).

Cooling and freezing of raw milk facilitate sample collection and transport logistics and reduce economic losses associated with the activity of mesophilic bacteria. The use of fresh milk or milk with added preservatives is generally recommended

(Martin et al., 2023). It should be noted that samples collected for culture as part of mastitis control programmes are frequently frozen. In addition, freezing is necessary during equipment failure or when sampling is conducted in remote locations. As camel herds are maintained in dispersed and remote desert areas, camel milk often requires freezing before analysis. Moreover, camel milk differs from cow milk in terms of solubility, fat content and other compositional characteristics. Therefore, the influence of storage time, storage temperature, and experimental temperature on SCC estimation should be evaluated to support reliable testing of camel milk. These differences indicate the need for camel-specific evaluation criteria to ensure accurate interpretation of SCC in camel milk rather than relying on standards established for bovine products.

The limited availability of research data indicates that the effects of freezing duration on camel milk composition and SCC remain insufficiently investigated. The objective of this study was to investigate the effect of freezing duration and experimental temperature (37 °C and 50 °C) on milk constituents and SCC in raw camel milk using the Fossomatic™ system. Milk from two camel genotypes raised under semi-arid conditions in the Riyadh region of Saudi Arabia was analysed to provide data relevant to the evaluation of camel milk under local production conditions.

Material and methods

Ethical statement

All procedures were performed in accordance with the guidelines of the King Saud University Research Ethics Committee and Saudi Arabian regulations governing the use and care of animals in research (Approval No. KSU-SE-23-16).

Animal management

This study involved a total of 51 dromedary camels representing two ecotypes, Al-Majahim ($n = 31$) and Al-Maghateer ($n = 20$) as presented in Figure 1. Al Majahim camels are characterised by predominantly black coat and dense hair covering. They differ phenotypically from other breeds, have a relatively large body size, are mainly selected for high meat and milk yields, and are generally not used for riding purposes. Al-Maghateer camels are characterised by a light coat colour ranging from white and yellow to pale brown. They are medium-sized animals that produce large quantities of milk and are also used for meat production.

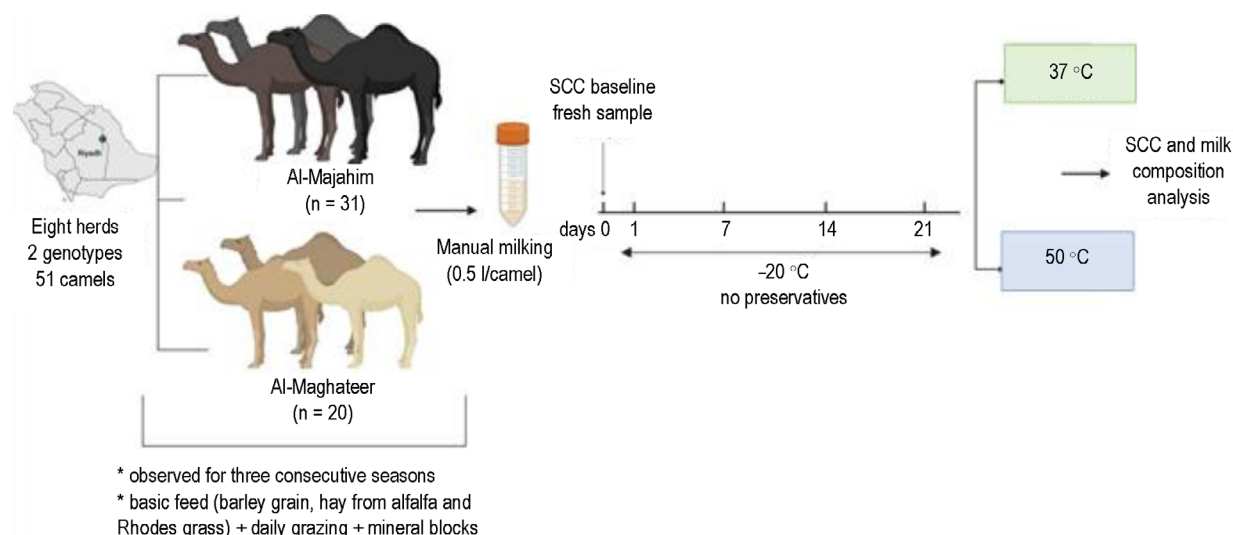


Figure 1. Geographic distribution of the camel population and analytical characterization of raw camel milk. SCC – somatic cell count

Historically, Al-Maghateer camels were a highly valued livestock among Bedouin communities in central and northern Arabia and have remained culturally and economically important to this day.

All camels included in the study were clinically healthy lactating animals selected from eight herds located in the vicinity of Riyadh, Saudi Arabia, and monitored over three consecutive seasons. The animals were raised under traditional farming conditions.

The basic feed ration on the sampled farms consisted of conventional feed, including barley grain, alfalfa hay and Rhodes grass. In addition, the camels were allowed to graze daily for approximately 2–3 h drinking water and mineral blocks were available *ad libitum* throughout the study.

Milking procedures and sampling

The camels were milked manually daily by an experienced milker. Prior to milking, the udder and teats were cleaned using disposable fleece cloths and gently stimulated by hand. Apart from the use of gloves during milking, post-milking teat dipping was not applied. During the first three milking seasons, milk samples were collected under aseptic conditions and transported in sterile containers with appropriate precautions taken to minimise contamination. Approximately 0.5 l of milk (pooled sample) was collected from each camel and then subdivided into 20 aliquots of 20–25 ml each. SCC in fresh samples was determined within the first 12 h after sampling, and these samples were considered controls for comparison purposes.

The samples were then frozen at -20°C in a commercial freezer for storage periods of 0, 1, 7, 14 and 21 days without the addition of preservatives, and continuous freezer temperature

monitoring. Duplicate aliquots were used for each storage period.

Milk composition analysis

Milk samples were thawed at room temperature for 45 min, then placed in a water bath at 37°C or 50°C for 20 min and subsequently analysed using MilkScan™ 6 RM (Foss Electric-Allé 1-DK-3400 Hilleroed, Denmark) to determine milk composition (fat, protein, lactose and total solid) after different freezing times (0, 1, 7, 14, and 21 days).

SCC determination

Thawing procedure. Samples were thawed at room temperature for 45 min, then placed in a water bath at 37°C or 50°C for 20 min, after which SCC was determined using a Fossomatic™ apparatus (FOSS-Nils Foss Allé 1-DK-3400 Hilleroed-Denmark). The instrument was cleaned and calibrated prior to each analysis using a reference sample. Samples were classified as healthy ($< 400,000$ somatic cells) or infected ($> 400,000$ somatic cells), as the initial SCC may affect the number of cells remaining after freezing.

Statistical analysis

Data were statistically analysed using analysis of variance within the General Linear Models (GLM) procedure for repeated measurements in SAS software (SAS, 9.4) to evaluate the effect of freezing duration and experimental temperature on milk components and SCC. When significant effects were detected, Duncan's multiple range test was applied to determine differences between means. The following linear model based on a randomised complete blocks design (RCBD) was used:

$$Y_{ijkl} = \mu + A_i + F_j + T_k + FT_{ij} + e_{ijkl};$$

$$i = 1, 2, 3; j = 1, 2, 3, 4; k = 1, 2; l = 1, 2, \dots, 100$$

where: Y_{ijkl} – number of somatic cells, μ – general mean, A_i – animal effect, F_j – freezing effect, T_k – experimental temperature effect, e_{ijklm} – random error. It was assumed that μ is constant and $e_{ijkl} \sim \text{NIID}(0, \sigma^2 e)$.

Data were transformed using the natural logarithm to approximate normal distribution and reduce differences between animals resulting from variation in somatic cell count (SCC). The following model was applied:

$\text{LSCC} = \ln(\text{SCC}) - \ln(\text{initial SCC})$, where: LSCC – log-transformed somatic cell count, initial SCC – mean value obtained for fresh sample (day 0) SCC represents the mean value obtained for fresh sample (day 0).

Correlation between SCC during different storage periods were calculated using Pearson's correlation coefficient. Linear and quadratic regression models were estimated using the following equations:

$$\text{LSCC} = \beta_0 + \beta_1 (\text{days})$$

$$\text{LSCC} = \beta_0 + \beta_1 (\text{DAdays}) + \beta_2 (\text{days})^2.$$

Factor analysis and principal component analysis (PCA) were performed using OriginPro 2025 software.

Results

The mean values of milk components (fat, protein, lactose, and total solids) at different freezing periods (0, 1, 7, 14, and 21 days) and experimental temperatures (37 °C and 50 °C) are presented in Table 1. Milk samples stored frozen and subsequently analysed at 37 °C and 50 °C showed only minor compositional changes during storage (Table 1). Fat content ranged from 2.79 to 3.24%, with a slight increase on the first day followed by a gradual decrease by day 21 of storage. Protein, lactose, and total solids remained relatively stable, ranging from 2.77 to 2.81%, 3.95 to 4.09%, and 10.08 to 10.72%, respectively, suggesting that freezing period had no measurable effect on these components. Statistical analysis did not reveal any significant main effects of freezing duration (0, 1, 7, 14, and 21 days) or experimental temperature (37 °C and 50 °C), or freezing duration $\times$ temperature interaction on fat, protein, lactose, or total solids (Table 2).

The descriptive results presented in Table 3 indicate that SCC and log-transformed somatic cell count (LSCC) in fresh camel milk analysed at 37 °C were 44% higher compared to samples frozen for 14 days. Similarly, at 50 °C, SCC and LSCC decreased rapidly following freezing, with the greatest

Table 1. Milk components (fat, protein, lactose, and total solid) for different analytical temperatures and freezing times, %

Freezing time, day	Analytical temperature, 37 °C				
	fat	protein	lactose	total solids	SEM
0	3.17	2.81	4.07	10.72	0.45
1	3.24	2.77	3.95	10.64	0.54
7	3.10	2.78	4.08	10.64	1.02
14	3.07	2.81	4.09	12.52	0.95
21	2.79	2.81	4.29	10.08	0.85
Analytical temperature 50 °C					
0	3.17	2.81	4.07	10.72	0.46
1	3.21	2.82	4.09	10.79	0.56
7	3.12	2.75	3.98	10.62	1.11
14	3.08	2.82	4.09	10.67	0.96
21	3.01	2.84	4.10	10.70	0.84

SEM – standard error of means

Table 2. Analysis of variance of freezing treatments, analytical temperatures, and the interactions for milk components, %

Source of variation	df	P-value			
		fat	protein	lactose	total solids
Time	4	0.08	0.57	0.61	0.36
Temperature	1	0.71	0.91	0.99	0.61
Time $\times$ temperature	4	0.09	0.61	0.81	0.29

df – degree of freedom; $P < 0.05$ means that the data is significantly different

Table 3. Somatic cell count (SCC) and log-transformed somatic cell count (LSCC) (means and standard errors = SE) for different analytical temperature and freezing times, %

Freezing time, day	Analytical temperature			
	37 °C		50 °C	
	mean	SEM	mean	SEM
SCC ($\times 10^3$ cells/ml)				
0	864	251	1541	301
1	481	149	780	197
7	566	190	621	165
14	493	166	506	162
21	574	192	601	183
LSCC				
0	2.46	0.12	2.92	0.52
1	2.19	0.12	2.35	0.15
7	2.16	0.13	2.21	0.15
14	2.14	0.13	2.15	0.13
21	2.20	0.13	2.21	0.14

SCC – Somatic cell count; LSCC – logarithm somatic cell count; SEM – standard error of means

reduction observed on day 14 (67%) and values remaining more than 60% lower on day 21. At the beginning of the storage period, SCC measured at 56 °C was significantly higher than at 37 °C. Following freezing, values obtained at both experimental temperatures became more similar, and differences between days 14 and 21 were minimal (approximately 3–5%).

The mean SCC in all post-freezing sampling points (days 1–21) was 528.5 at 37 °C (−38.8% compared to day 0) and 627.0 at 50 °C (−59.3% compared to day 0), indicating a greater overall decrease at 50 °C.

Figure 2 illustrates changes in SCC with increasing freezing duration at different experimental temperatures (37 °C and 50 °C) compared with fresh milk. All curves showed a sharp decrease in SCC after the initial freezing period followed by a gradual stabilisation during subsequent storage.

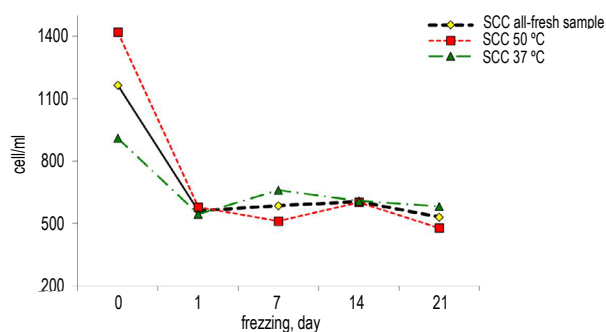


Figure 2. The difference between the Somatic cell count (SCC) during different the freezing duration compared to the thawing analysis at 37 and 50 °C

SCC All – analysis of all samples collected as Fresh sample; SCC 50 °C – analysis of samples at 50 °C; SCC 38 °C – analysis of samples at 38 °C; d – analysis of samples frozen during the period (0, 1, 7, 14 and 21 days)

As freezing duration increased, SCC values obtained at both experimental temperatures converged towards lower levels, with the greatest decrease observed at 50 °C. Overall, the data indicate that freezing duration influences SCC values, with the greatest variation occurring at the early stages of frozen storage, particularly at 50 °C.

Table 4 presents the effects of freezing duration and experimental temperature on SCC and LSCC. The duration of freezing had a highly significant effect on SCC ($F = 5.8$, $P < 0.01$) and LSCC ($F = 10.9$, $P < 0.01$), indicating that prolonged freezing significantly affected estimated SCC and LSCC values.

Table 4. Analysis of variance of freezing treatments, analytical temperatures, and the interactions for somatic cell count (SCC), log transformed somatic cell count (LSCC)

Source of variation	df	SCC	LSCC
		<i>P</i> -value	<i>P</i> -value
Time	4	5.8**	10.9**
Temperature	1	4.1*	5.1*
Time × temperature	4	1.5 ns	2.1 ns

df – degree of freedom; P -value = $P < 0.05$; ** $P < 0.01$ or * $P < 0.05$ means that the data is significantly different; ns – means that data not significantly different ($P > 0.05$)

Similarly, experimental temperature exerted a significant effect on SCC ($F = 4.1$, $P < 0.05$) and LSCC ($F = 5.1$, $P < 0.05$). In contrast, the interaction between freezing duration and experimental temperature was not significant for either SCC ($F = 1.5$, ns) or LSCC ($F = 2.1$, ns), indicating that the effect of freezing time was consistent for both experimental temperatures.

Correlation coefficients for SCC and LSCC showed statistically significant positive correlations ($P < 0.001$) between freezing duration (0, 1, 7, 14, and 21 days) and experimental temperatures (37 °C and 50 °C; Figure 3). These findings indicate that SCC response remained relatively stable and con-

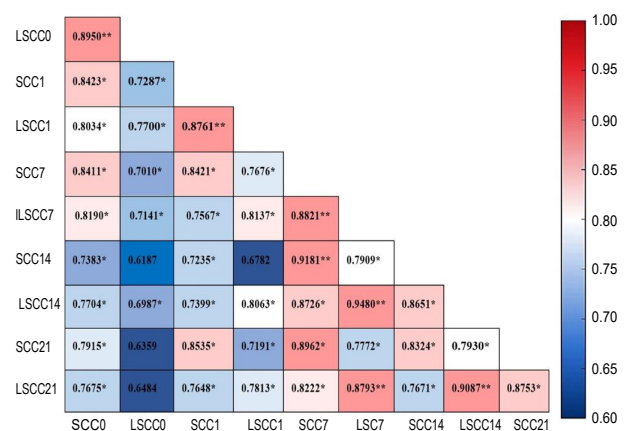


Figure 3. Correlation coefficients of SCC and LSCC at freezing duration (0, 1, 7, 14, and 21 days) by temperature analysis (37 °C and 50 °C)

SCC – somatic cell count; LSCC – log-transformed somatic cell count

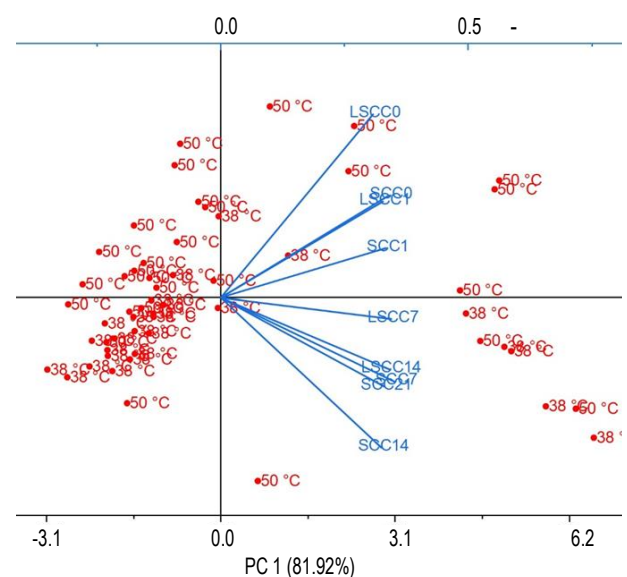


Figure 4. Principal component analysis (PCA) for SCC and LSCC in a 37 °C and 50 °C degree temperature analysis with different freezing periods (0, 1, 7, 14 and 21 days)

SCC – somatic cell count, LSCC – log-transformed somatic cell count. PC1 – first factor and ctor of the freezing period, PC2 – second factor of the temperature sample for analysis

sistent at both temperatures (37 °C and 50 °C) analysed. A slight reduction in correlation observed at the longest freezing periods (SCC14 and SCC21) may reflect the initial effects of prolonged storage on milk properties; however, the overall correlation pattern remained largely preserved.

The distribution of experimental groups according to freezing duration and sample analysis temperature was also evaluated using PCA (Figure 4). PC1 explained 81.82% of the total variance and reflected the predominant effect of freezing duration. In contrast, principal component 2 (PC2) explained 6.27% of the total variance and was associated with the effect of temperature during sample analysis. Collectively, these findings confirm that extending the freezing period beyond 7 days significantly affects SCC and LSCC values in raw camel milk.

Discussion

The quality of the milk is mainly related to the organoleptic characteristics and visual presentation of dairy products, whereas for producers it is associated with increased milk yield from healthy animals, and consequently, higher economic returns from milk production (Koc et al., 2025). Somatic cells in milk consist predominantly of leukocytes involved in the immunological defence of the mammary gland against pathogenic microorganisms. SCC in camel milk is an important indicator of udder health, as it enables assessment of the hygienic and physiological status of the mammary gland (Nagy et al., 2013). Elevated SCC values indicate inflammatory processes in the udder and may reflect the condition of the mammary gland (Kaskous et al., 2022). In addition, SCC is routinely used for the detection of subclinical and clinical mastitis and for monitoring the progression and regulation of inflammatory and infectious processes in the udder (Sermyagin et al., 2021).

Sanchez et al. (2005) investigated the effects of temperature, storage time and their interaction on SCC and main components of goat milk, and concluded that the increase in SCC observed after storage at 4 °C may be partly due to bacterial proliferation, while SCC variation was less than 10%. Gonzalo et al. (2004) similarly reported that sheep milk samples should be analysed within three days of collection and not after freezing.

In the present study, freezing duration and sample analysis temperature did not significantly affect milk composition, whereas freezing had a highly significant effect on both SCC and LSCC in raw camel milk. These findings are consistent with observa-

tions reported for bovine milk, where SCC declined in samples frozen for 1, 2, 3, 4, 7, 14, and 28 days compared to fresh samples (Barkema et al., 1997). In addition, Kaskous (2019) reported that camel milk samples stored at room temperature for 24 h or at 4 °C for 48 h did not show any significant changes in milk composition or SCC. The effects of preservation methods, storage temperature, heating and storage duration on the accuracy of SCC determination using the Fossomatic analyser has previously been documented (Barkema et al., 1997). Vrskova et al. (2021) observed a reduction in SCC values after freezing milk from individual sheep half-udders. However, the impact of freezing time on SCC was not consistent between samples, indicating variability in response to frozen storage. Currently, no data are available regarding the effects of freezing camel milk samples on SCC determination, indicating the need for further research in this area.

The observed decrease in the number of somatic cells in milk after freezing is primarily attributed to cell lysis induced by freezing, which compromises somatic cell structure. Freezing can disrupt both cellular and nuclear membranes, resulting in partial or complete cell damage (Hanuš et al., 2002). Previous studies have shown that ice crystal formation damages cytoplasmic and nuclear membranes, leaving mainly cellular debris that cannot be reliably enumerated by automated cytometric systems (Sanchez et al., 2005). Since freezing may affect both the plasma membrane and the nuclear envelope, the affinity and binding efficiency of markers used for SCC determination may be reduced, leading to systematic underestimation of cell counts (Hanuš et al., 2002). After cell rupture, endogenous enzymes such as proteases may further degrade cellular components, reducing the proportion of intact and detectable somatic cells (Martinez et al., 2003). Although the study focused mainly on the effects of freezing on SCC values rather than on enzymatic degradation itself, the findings indicate that freezing significantly reduces SCC in samples without preservatives (Sanchez et al., 2005). These observations are consistent with earlier reports describing reduced pooled SCC values in frozen or thawed milk, particularly in samples treated with azidol or free from preservatives (Martinez et al., 2003). Biddle et al. (2004) also reported that repeated freezing and thawing cycles exerted a lethal effect on *Mycoplasma*, which might contribute to diagnostic inaccuracies.

Storage of bovine milk at 3–5 °C for up to 2 days did not significantly affect SCC; however, prolonged storage exceeding that period was considered unsuitable (Gargouri et al., 2013). In bo-

vine milk, freezing, cooling, and prolonged storage significantly affect SCC, with a reported decrease of approximately 14% during the first week of storage (Martinez et al., 2003). Similarly, Şahin et al. (2019) recorded a comparable reduction in SCC in bovine milk ranging from 28 to 36%. As expected, storage at room temperature results in even greater deterioration of milk quality. Gonzalo et al. (2004), concluded that bovine milk samples should be analysed within the first three days after collection and should not be frozen before analysis (O'Connell et al., 2016). Storage periods also has a significant effect on SCC, as Sanchez et al. (2005) demonstrated that goat milk samples could be refrigerated for up to 25 days without significant changes in SCC or milk composition, whereas frozen samples showed SCC reductions ranging from 28 to 34%. Martinez et al. (2003), reported that sheep milk samples could be refrigerated for up to 25 days without significant changes in SCC or other milk components and subsequently frozen without significant effects on these parameters. The same study also showed that analysis of sheep milk samples at 50 °C resulted in a significant reduction in detectable SCC values. The number of somatic cells was higher during refrigerated storage than after freezing and decreased significantly following thawing. The authors recommended freezing samples for up to 60 days and then analysing them at 40 °C, as this procedure produced results comparable to those obtained under refrigerated storage conditions (Martinez et al., 2003).

Analysis of samples at 60 °C may facilitate the removal of dissolved gases and induce disruption of cell walls, thereby increasing penetration of the bromide stain into the cell nucleus. Gonzalo et al. (2004) evaluated repeatability using the coefficient of variation, standard deviation, and linear regression analysis.

Sierra et al. (2006) observed that when the Fossomatic™ system was used to evaluate initial goat milk fractions, SCC values were higher at 60 °C than at 40 °C in both fresh samples and samples stored overnight, with differences of approximately 50 000 cells/ml depending on sample age. Although samples stored for one day had higher mean SCC values than fresh samples, the difference was not statistically significant. Incubation at 60 °C resulted in higher SCC values in samples analysed on the day of collection compared with samples analysed the following day (Sierra et al., 2006). This effect may be associated with increased heat-induced cell lysis in fresh samples, leading to greater availability of nuclear material for fluorescent dye (Gonzalo et al., 2004).

The authors concluded that, in general, fresh samples are suitable for analysis using the Fossomatic™ apparatus. The effects of prolonged storage on SCC measurements appear to be inconsistent, although storage at −80 °C is considered preferable to storage at −20 °C, as SCC survival and resistance to lysis are higher at lower temperatures (Wang et al., 2024). Moreover, commercially applied slow freezing and thawing procedures have been shown to cause more extensive cellular damage (Omar et al., 2018). However, since the Fossomatic™ system quantifies nucleic acids and not intact cells, the effect of cell damage on assay results is minimal (Barkema et al., 1997).

Finally, greater attention should be given to milk quality management on camel milk farms, not only for economic reasons but also to ensure that consumers receive a safe and highly nutritious product of reproducible quality. Increased SCC should be carefully monitored, as it negatively affects both milk production and its quality. Reduced milk yield associated with elevated SCC is primarily related to tissue damage caused by mastitis. Regarding quality, increased SCC is associated with undesirable changes in milk composition and reduced levels of desirable components. Maintaining low SCC values is therefore important for the production of high-quality cheese and for extending the shelf life of dairy products. Available evidence indicates that only a limited number of studies have investigated the effects of freezing on SCC determination in camel milk. Therefore, standardised freezing protocols for camel milk require further evaluation to ensure reliable SCC measurements.

Conclusions

The present findings demonstrate that prolonged freezing of camel milk (e.g., 7, 14, and 21 days) may adversely affect milk quality by inducing cellular lysis and reducing somatic cell count (SCC) values. In contrast, short-term freezing periods (less than 7 days) are unlikely to cause significant alterations in milk composition. A freezing duration not exceeding 3 days, combined with a sample analysis temperature of up to 37 °C, appears to provide suitable conditions for milk quality assessment while preserving the characteristic physicochemical properties of camel milk. Freezing period also affected the viability of micro-organisms and somatic cells. Therefore, the use of fresh milk samples is generally recommended for SCC determination. These observations indicate the need for further studies aimed at optimising freezing protocols for camel milk to

ensure reliable SCC measurements and preserve microbiological quality during bacteriological analyses performed after storage.

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Conflict of interest

The Authors declare that there is no conflict of interest.

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