UNIZIK JOURNAL OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING

Journal homepage: https://journals.unizik.edu.ng/ujabe/

UJABE

April (2026), 1(2): 1-12

ISSN: 3141-2912

EFFECT OF SODIUM CHLORIDE CONCENTRATION ON THE SHORT-TERM PRESERVATION OF COW, GOAT, AND SOY MILK

Officha, Chinwe Oluokwukwe, *Ogbuagu, Nneka Juliana, Nwanna, Emmanuel Chukwudi.

[1] *Department of Agricultural and Bioresources Engineering, Nnamdi Azikiwe University, Awka*

**Corresponding Author's E-mail:* nj.ogbuagu@unizik.edu.ng

Received: 14th February 2026; **Accepted:** 15th February 2026; **Available Online:** 30th April 2026

ABSTRACT

The effect of sodium chloride (NaCl) concentration on the preservation of Cow, Goat, and Soy milk during short-term storage was investigated. Fresh milk samples were pasteurized at 72 ºC and NaCl at concentrations of 0.004, 0.008, 0.012, and 0.016 g/ml were added at three replicates, then stored for five days under controlled conditions. Parameters evaluated included boiling point elevation, pH, viscosity, and electrical conductivity. Boiling point elevation increased progressively with NaCl concentration, reaching maximum values of approximately 19°C in Cow milk, 17.4°C in Goat milk, and 14.4°C in Soy milk at the highest concentration by Day 5, indicating enhanced thermal stability. pH trend was dependent on the milk type that is dairy and plant milk. Cow and Goat milk exhibited increasing pH during storage, whereas Soy milk showed acidification. Statistical analysis showed that NaCl had no significant effect on pH ($p > 0.05$), suggesting that storage time and intrinsic milk composition were dominant factors. Viscosity increased in all milk types over time, but higher NaCl concentrations significantly moderated viscosity development in Soy and Goat milk ($p < 0.05$), whereas Cow milk viscosity was less affected. Electrical conductivity increased remarkably with NaCl concentration ($p < 0.001$), reflecting enhanced ionic content, with Soy milk exhibiting the highest values. These results demonstrate that sodium chloride modifies thermal stability, flow behavior, and ionic characteristics of both dairy and plant-based milk systems. The study highlights NaCl's effectiveness as a preservative while emphasizing the need for optimized concentrations to maintain quality and minimize adverse effects on the properties studied.

Keywords: Sodium Chloride, Concentrations, Storage, Diary Milk, Plant Milk

1.0 INTRODUCTION

Milk and milk-based beverages are nutritionally important liquid foods widely consumed for their protein, mineral, and bioactive content. In Nigeria and many developing economies, Cow milk, Goat milk, and Soy milk represent major animal-based and plant-based liquid food systems. However, their high-water activity and rich nutrient composition make them highly susceptible to microbial spoilage and physicochemical instability during storage (Tapia *et al*., 2020). Colligative properties, such as boiling point elevation, freezing point depression, and osmotic effects, play a critical role in the processing, preservation, and quality control of liquid foods. In dairy systems, these properties are influenced by dissolved solutes, including lactose, salts, organic acids, and added preservatives. Furthermore, the unique compositional attributes of Cow and Goat milk influence their colligative properties, which, in turn, affect their functional applications in dairy processing (Magan *et al*., 2021). Soy milk, a dairy alternative, is recognized for its protein content and low glycemic index, and therefore presents unique colligative properties that dictate its stability and processing behavior (Otolowo *et al*., 2022). Variations in colligative behavior affect thermal processing efficiency, shelf stability, and product authenticity. Likewise, studies on physicochemical characteristics such as pH, viscosity, and electrical conductivity greatly affect properties of diary milk (Huppertz and Fox, 2006; Zhao and Corredig, 2016; Pindešová *et al.*, 2022; Costa *et al.*, 2021).

Preservatives are commonly employed to extend the shelf life of milk and milk alternatives (Wang et al., 2024). Sodium chloride (NaCl), otherwise known as common salt, is widely used due to its antimicrobial and antioxidant properties. However, its addition alters the total solute concentration of milk systems, thereby modifying colligative (Neri *et al.*, 2020) and physicochemical characteristics such as pH, viscosity, and electrical conductivity. Differences in protein structure, fat content, and mineral composition between Cow milk, Goat milk, and Soy milk further influence their responses to preservative addition. Despite the importance of these interactions, limited studies have comparatively evaluated the effect of preservatives on the colligative and physicochemical behavior of animal and plant-based milk systems under identical storage conditions. Therefore, this study aimed to evaluate the effect of NaCl preservative on the boiling point elevation and some physicochemical properties of Cow milk, Goat milk, and Soy milk during short-term storage.

2.0 METHODOLOGY

2.1 Materials and Equipment

The materials used for this study include: Cow and Goat milk, freshly harvested from white Fulani cow and West African Dwarf (WAD) goat, and Soy milk from soy beans. The equipment used in this study includes a laboratory tabletop oven used in drying samples; a Petri Dish Canister for storage, an automatic pipette for accurate sample dilution, UV/Visible Spectrophotometers for measurement of NaCl concentrations, a Pycnometer for measuring the density of liquid, a viscometer for measurement of the viscosity of the solution and an analytical balance for mass measurement of solutes.

2.2 Sample Preparation

Fresh Cow milk and Goat milk were obtained from local dairy sources, while Soy milk was produced using standard aqueous extraction and filtration procedures. All samples were pasteurized at least 72 ^{o}C for 15 seconds before preservation treatment.

2.3 Preservative Treatment

Sodium chloride (NaCl) was added to each milk sample at concentrations of 0.004, 0.008, 0.012, and 0.016 g/ml. Untreated samples served as controls. The choice of the concentration level was based on research in which such a range was selected because its effects are measurable and milk remains realistic and stable (Huppertz and Fox, 2006; Zhao and Corredig, 2015; Pindešová *et al.*,2015). The treated samples were stored for five days under controlled laboratory conditions of 25 ^{o}C and 60% relative humidity.

2.4 Sample Property Tests

The colligative property tested was boiling point elevation, while the physicochemical properties tested included pH, viscosity, and electrical conductivity. The method for their determination are discussed as follows;

2.4.1 Boiling Point Elevation

The boiling-point elevations (BPE) of the milk samples were determined by following procedures developed by Gabas *et al.* (2008) with some minor adjustments. Solutions of varying salt concentrations were created by dissolving different amounts of each solute/salt (0.2, 0.4, 0.6, and 0.8 g) in 50 ml aliquots of each milk sample to produce known molar concentrations. Each solution was heated on a thermostatically controlled hot plate. A precise thermometer was inserted into the solution to record its temperature continuously. First, the boiling point of the raw milk (without any added salt) was recorded as a control. Then, the boiling points for each solution containing each salt concentration were determined when vigorous boiling commenced. The boiling-point elevation (ΔTb) for each solution was determined using Equation (1) and is expressed as the difference between the boiling-point of each solution and that of the raw milk.

$$\Delta T_b = T_{boiling,} solution - T_{boiling,} raw\ milk \quad \text{.................................} \ 1$$

2.4.2 pH Determination

The pH of each sample was measured using a Hanna multi-parameter instrument calibrated using standard buffer solutions at pH values of 4.0, 7.0, and 10.0. Before and after measuring the pH of each sample, the probe was thoroughly cleaned with distilled water. Three replicate pH measurements were made for each sample at room temperature, and the mean pH value was calculated and recorded.

2.4.3 Relative viscosity

Viscosity was measured using the capillary flow method employing a micro Ostwald viscometer (515 30 model; ±0.001 mPa·s. The flow times for a fixed distance for both de-ionized water and the sample were recorded. By assuming that the viscosity and density of water at 25°C are 1.005 cP and 1.000 g/cm^3, respectively, the relative viscosity of the sample was calculated using Equation (2).

$$Relative\ viscosity\ (\mu_1) = \mu_2 \frac{\rho_1 t_1}{\rho_2 t_2} \quad \text{.................................} \ 2$$

Where;

ρ_1 = density of milk,

ρ_2 = density of water,

t_1 = flow time of milk

t_2 = flow time of water

2.4.4 Electrical Conductivity

Electrical conductivity measurements were made using the same multi-parameter instrument. Electrical conductivity was calibrated using standard solutions of 1413 µS/cm and 12.9 mS/cm. For each sample, three replicate conductivity measurements were made, and the average value was recorded.

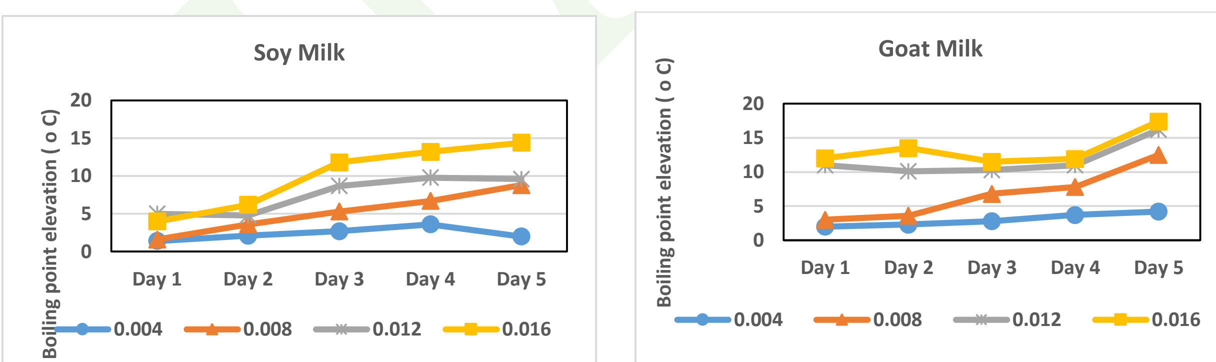
2.5 Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using Microsoft Excel (Microsoft Office LTSC Professional Plus 2024) to evaluate for significant differences between treatments and storage days under study.

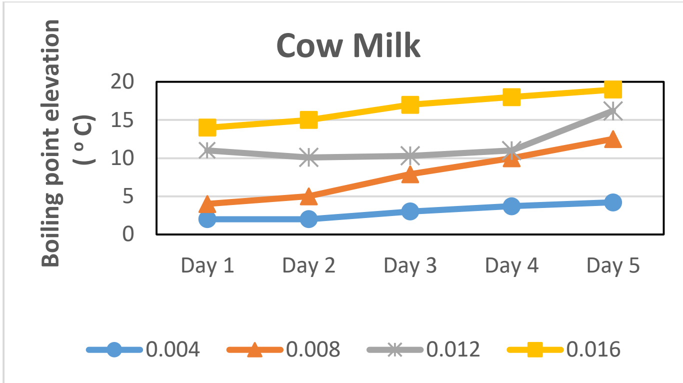
3.0 RESULTS AND DISCUSSION

3.1 Effect of NaCl Concentration on Boiling Point Elevation for Short-Time Storage

The boiling point elevation increased with increasing NaCl concentration and storage time in all milk samples (Fig. 1). Cow milk exhibited the highest boiling point elevation, reaching approximately 19°C above baseline at 0.016 g/mL by Day 5, followed by Goat milk (17.4°C). Soy milk showed a comparatively lower elevation, attributed to differences in protein and mineral composition between animal and plant milk. The increase in boiling point confirms the colligative effect of NaCl concentration, which indicates an increase in solute particle concentration that lowers vapor pressure, thus requiring higher thermal energy for phase transition (Huppertz and Fox, 2006; Pindešová et al., 2022). Pindešová et al. (2022) also observed that higher salt content is strongly linked to freezing point depression in Cow milk, i.e., more NaCl results in a lower freezing temperature. Thus, by the colligative principle, the same ion increase that decreases the freezing point will elevate the boiling point by a small amount at similar concentrations. Furthermore, the ANOVA (Table 1) also confirms a significant effect of NaCl concentration on the storage, $p < 0.001$ for Cow milk and Goat milk, and $p < 0.01$ for Soy milk. This is due to matrix differences among the milk samples. Cow milk and Goat milk are both complex emulsions with casein micelles and similar ions; however, Goat milk differs in protein and fat profile but shows quantitatively similar colligative responses to NaCl with Cow milk (Kousar *et al*., 2025). On the other hand, Soy milk is an aqueous plant protein suspension with different protein and mineral compositions from Cow and Goat milk.



(a) (b)



(c)

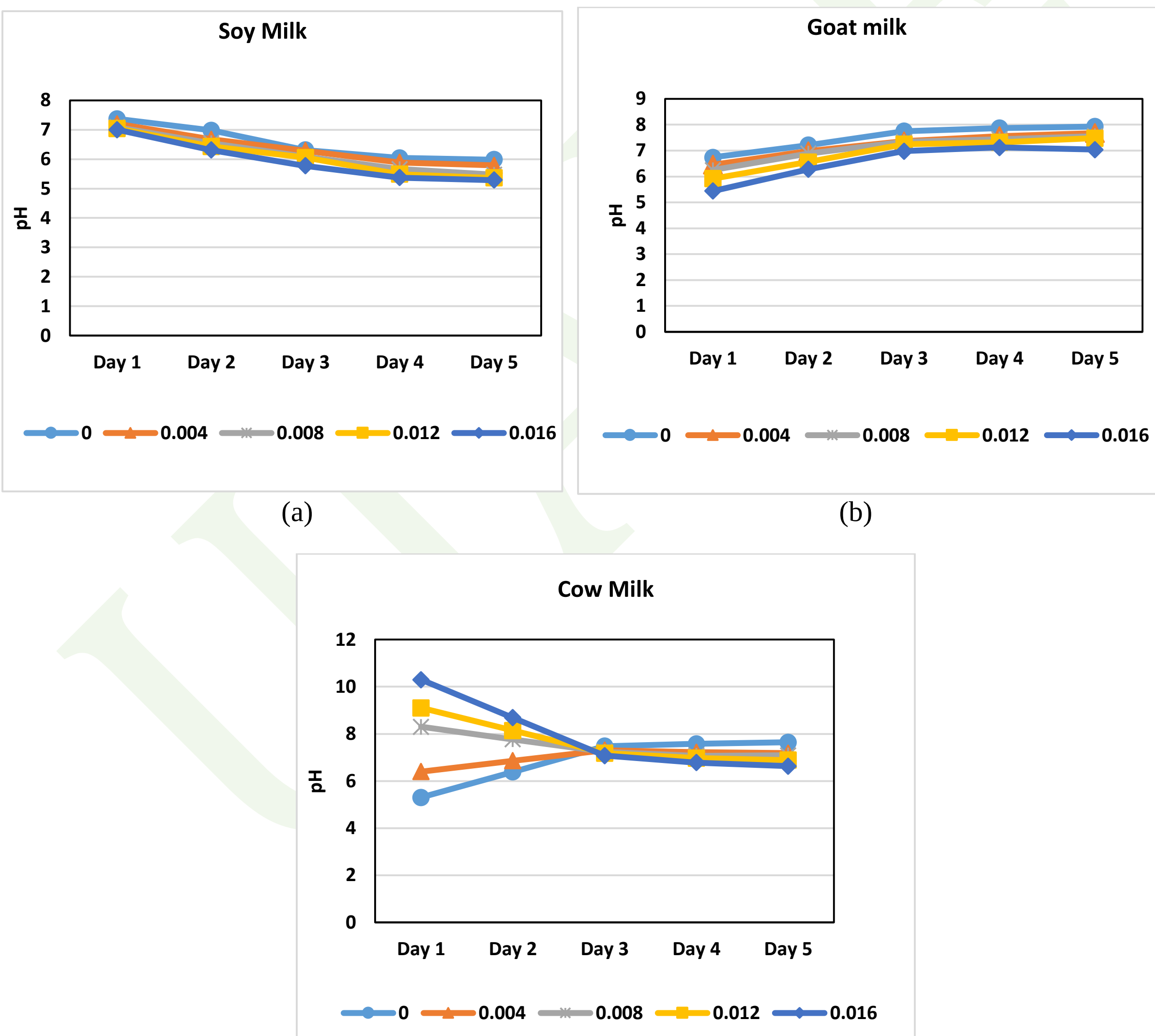
Figure 1: Boiling point Elevation at levels of NaCl concentration over time. (a) Soy Milk, b) Goat milk, c) Cow Milk

Table 1: ANOVA for Boiling Point Elevation

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Soy Milk						
Between Groups	157.3575	3	52.4525	5.934883	0.006394	3.238872
Within Groups	141.408	16	8.838			
Total	298.7655	19				
Goat Milk						
Between Groups	331.22	3	110.4067	15.9013	4.66E-05	3.238872
Within Groups	111.092	16	6.94325			
Total	442.312	19				
Cow Milk						
Between Groups	500.6255	3	166.8752	27.794	1.39E-06	3.238872
Within Groups	96.064	16	6.004			
Total	596.6895	19				

3.2 Effect of NaCl Concentration on pH for Short-Time Storage

The effect of sodium chloride (NaCl) concentration on the pH of Soy, Goat, and Cow milk during short-term storage is presented in Fig 2. For Soy milk, pH values decreased progressively during storage at all NaCl concentrations such that as the percentage decrease of 18.86% recorded at the control increases gradually with increase in concentration of 24.42% at 0.016 g/ml. Also, samples with higher NaCl concentrations (0.012–0.016 g/ml) consistently recorded slightly lower pH values compared to the control. This decline can be attributed to the presence of fermentable carbohydrates and limited buffering capacity, and can be confirmed by the similar result obtained for Soy cheese stored at 5-10% NaCl (Zhu *et al*., 2021). The changes are also attributed to protein interactions and not directly by the intrinsic pH of the Soy milk (Matsuno *et al*., 2024). These properties as an aftermath of the interaction, favor acid production during storage, thereby overshadowing any minor stabilizing effect of NaCl. In Goat milk, pH values increased with storage time across all NaCl concentrations, and samples containing higher NaCl concentrations generally maintained lower pH values. This is in line with Stocco et al. (2019), who stated that pH is more strongly tied to goat milk fat than to NaCl level alone. Because of this reason, Goat milk proteins and buffering salts likely contributed to resistance against acidification. For Cow milk, NaCl concentration exerted a pronounced influence on initial pH values, with higher salt concentrations resulting in markedly higher pH on Day 1. Over the storage period, pH values gradually declined and converged across treatments. Small decreases in pH have been recorded for Cow milk (Bovine milk) by other researchers (Zhao and Corredig, 2015; Huppertz, and Fox, 2006). This result trend suggests strong protein and salt-mineral interactions, particularly involving casein micelles and calcium phosphate complexes, and the subsequent convergence of pH across treatments implies that microbial and enzymatic activities progressively counterbalanced the initial alkalizing effect of NaCl. Contrast, between Goat milk and Cow milk behavior can be attributed to Zhu et al. (2025) report that found Goat milk is more prone to protein aggregation and oxidation when compared to Cow milk. Analysis of variance (Table 2) showed no significant effect ($p > 0.05$) of sodium chloride concentration on the pH of Soy, Goat, and Cow milk during short-term storage. Observed pH variations were primarily attributed to storage time and intrinsic milk characteristics rather than preservative concentration.



(c)

Figure 2: pH at different levels of NaCl concentration over time. (a) Soy Milk, (b) Goat milk, (c) Cow Milk

Table 2: ANOVA for pH

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Soy Milk						
Between Groups	1.098784	2	0.274696	0.643295	0.637928	2.866081
Within Groups	8.54028	20	0.427014			
Total	9.639064	24				
Goat Milk						
Between Groups	2.392976	4	0.598244	1.7235	0.184336	2.866081
Within Groups	6.9422	20	0.34711			
Total	9.335176	24				
Cow Milk						
Between Groups	3.781816	4	0.945454	0.975662	0.442838	2.866081
Within Groups	19.38076	20	0.969038			
Total	23.16258	24				

3.3 Effect of NaCl Concentration on Viscosity for Short-Time Storage

Viscosity increased progressively with storage time in Soy, Goat, and Cow milk across all sodium chloride (NaCl) concentrations as shown in Fig. 3. In all cases, the control samples (0% NaCl) consistently exhibited the highest viscosity values, while samples treated with NaCl showed lower viscosity throughout the storage period. Increasing NaCl concentration resulted in a reduction in viscosity development in all milk types. Higher salt levels (0.012–0.016g/ml) consistently produced the lowest viscosity values, indicating a suppressive effect of sodium chloride on structural thickening during storage. Among the milk types, Soy milk exhibited the greatest relative increase in viscosity over time, reflecting strong network formation during storage. Even though there is no literature linked directly with the behaviour of Soy milk at levels of application of NaCl, but Urbanski *et al*., (1982) studied the effect of NaCl on Soybean beverages and obtained similar result and in this research. However, Goat and Cow milk showed more moderate increases in viscosity. This is because animal milk proteins responded similarly to NaCl addition, suggesting comparable salt-protein interaction in the Goat and Cow milk. ElSalam *et al*. (1987) recorded a nonlinear increase in viscosity at 1% NaCl, but above this level (2-3%), viscosity decreased over time, indicating a strong dependence on protein content. Generally, storage time was the dominant factor influencing viscosity, whereas NaCl concentration acted as a moderating agent, limiting viscosity buildup during short-term storage. Analysis of variance (Table 3) showed that NaCl concentration had a significant effect on the viscosity of Soy milk ($F = 3.836$; $p = 0.018$) and Goat milk ($F = 3.757$; $p = 0.019$) during short-term storage, with higher concentrations reducing viscosity development. In contrast, Cow milk viscosity was not significantly affected by NaCl ($F = 1.870$; $p = 0.155$), indicating that storage time and intrinsic milk properties dominated viscosity changes during the short-term storage.

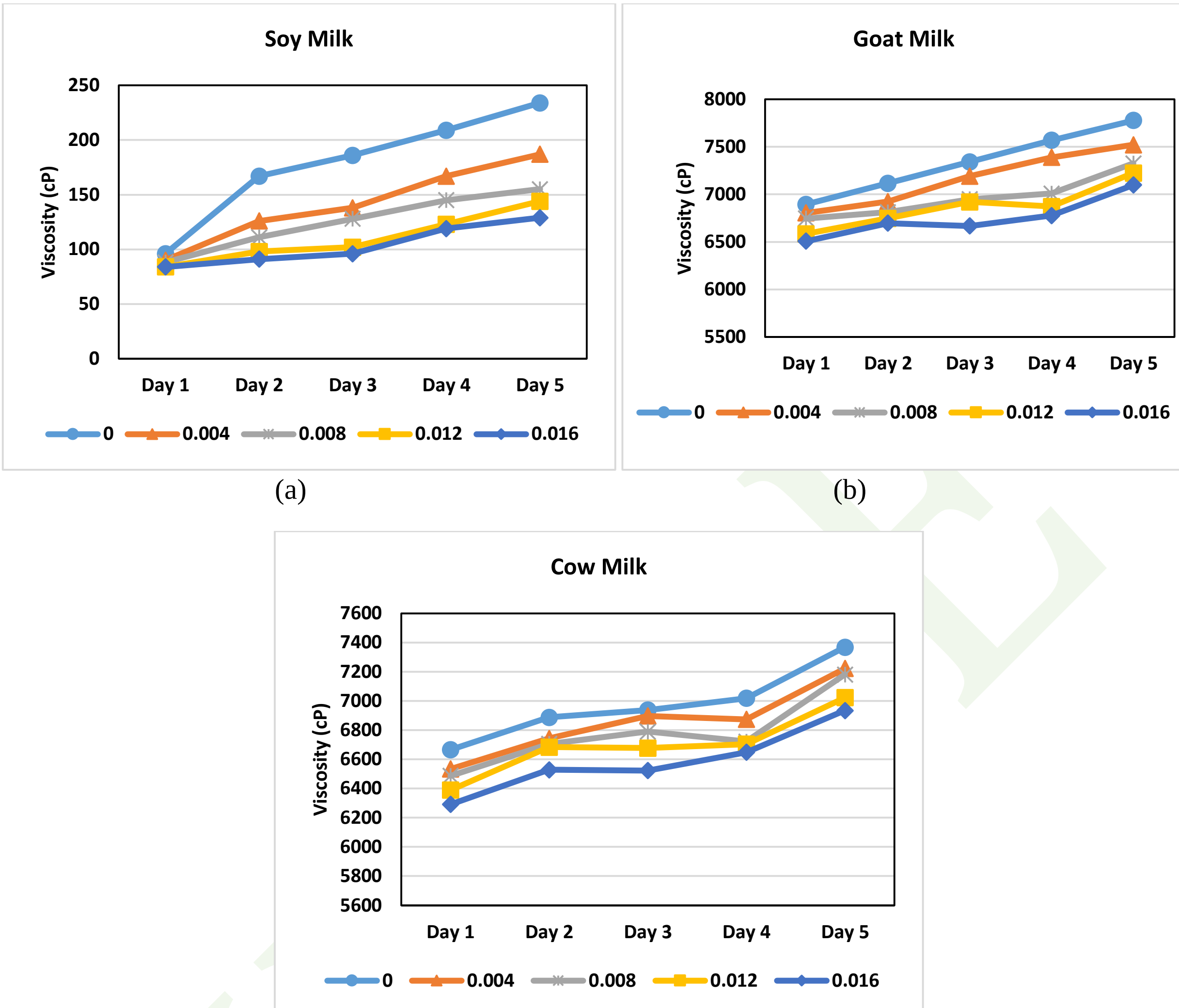


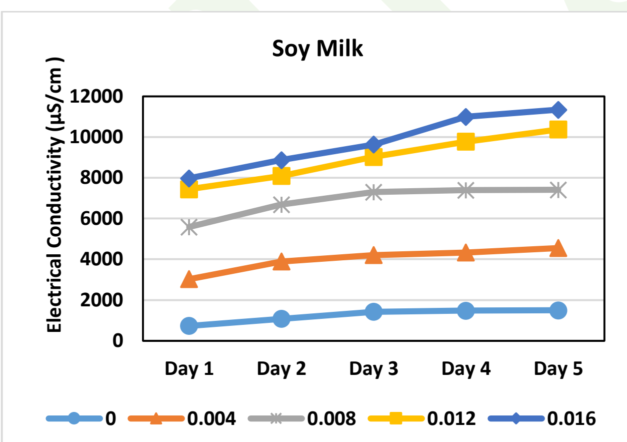
Figure 3: Viscosity at different levels of NaCl concentration over time. (a) Soy Milk, (b) Goat milk, (c) Cow Milk

Table 3: ANOVA for Viscosity

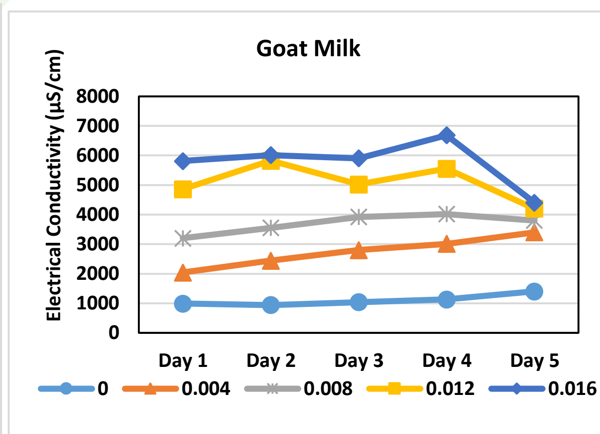
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Soy Milk						
Between Groups	17795.44	4	4448.86	3.836018	0.01798	2.866081
Within Groups	23195.2	20	1159.76			
Total	40990.64	24				
Goat Milk						
Between Groups	1109795	4	277448.7	3.757358	0.019475	2.866081
Within Groups	1476829	20	73841.44			
Total	2586624	24				
Cow Milk						
Between Groups	444848	4	111212	1.869574	0.155283	2.866081
Within Groups	1189704	20	59485.2			
Total	1634552	24				

3.4 Effect of NaCl Concentration on Electrical Conductivity for Short-Time Storage

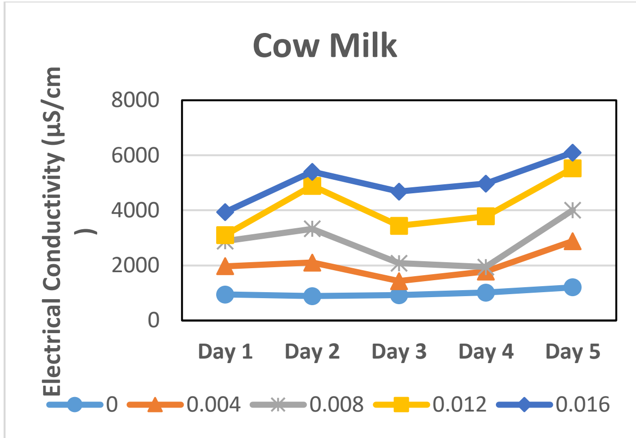
Results of the electrical conductivity (EC) of the milks are presented in Fig. 4. It shows that the electrical conductivity (EC) of Soy, Goat, and Cow milk increased with storage time and sodium chloride (NaCl) concentration across all treatments. This correlates with electrical conductivity of aqueous NaCl solutions (Anyigor *et al*., 2025; Amaro-Estrada *et al*., 2025). In all three milk types, the control samples (0% NaCl) had the lowest EC values throughout the five-day storage period, while samples with higher NaCl concentrations exhibited progressively higher conductivity. Soy milk showed the largest EC values, particularly at 0.012–0.016 NaCl, reaching over 11,000 µS/cm by Day 5, reflecting strong ion accumulation in the presence of salt. Goat milk EC increased steadily with both storage time and NaCl concentration, though high-concentration samples showed slight fluctuations mid to late storage, likely due to protein–ion interactions. Cow milk exhibited a similar trend, with EC rising with NaCl concentration and time, but intermediate concentrations displayed more variability due to interactions between ions and casein micelles. Milk EC is mainly determined by soluble salts, especially Na^+ and Cl^- ions; fat and lactose contribute little to conductivity (Mabrook and Petty, 2023; Căpriţă et al., 2003; Căpriţă and Căpriţă, 2010). When the concentration of NaCl increases, the ionic strength also increase thus EC rises (Mabrook and Petty, 2003; Nascimento, 2020; Mohamed *et al*., 2012; Căpriţă and Căpriţă, 2010). In overall, the results indicate that NaCl concentration is the primary determinant of EC, with storage time acting as a secondary factor. Higher NaCl concentrations significantly increased the ionic strength of all milk types, highlighting the role of sodium chloride in enhancing electrical conductivity during short-term storage. Analysis of variance (Table 4) showed that sodium chloride concentration had a highly significant effect on the electrical conductivity of Soy milk ($F = 69.41$; $p < 0.001$), Goat milk ($F = 57.43$; $p < 0.001$), and Cow milk ($F = 23.60$; $p < 0.001$) during short-term storage. Higher NaCl concentrations consistently produced the greatest increases in EC across all milk types.



(a)



(b)



(c)

Fig. 4: Electrical Conductivity at different levels of NaCl concentration over time. (a) Soy Milk, (b) Goat milk, (c) Cow Milk

Table 4: ANOVA for Electrical Conductivity

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Soy Milk						
Between Groups	2.5E+08	4	62573336	69.40809	1.94E-11	2.866081
Within Groups	18030560	20	901528			
Total	2.68E+08	24				
Goat Milk						
Between Groups	69292744	4	17323186	57.43229	1.11E-10	2.866081
Within Groups	6032560	20	301628			
Total	75325304	24				
Cow Milk						
Between Groups	51950984	4	12987746	23.60095	2.47E-07	2.866081
Within Groups	11006120	20	550306			
Total	62957104	24				

4.0 CONCLUSION

Sodium chloride (NaCl) significantly influenced the boiling point elevation and physicochemical properties of Cow, Goat, and Soy milk during short-term storage. Boiling point elevation increased with NaCl concentration, enhancing thermal stability, while pH changes were milk-type dependent, with Soy milk showing slight acidification and Cow and Goat milk exhibiting gradual alkalization. NaCl had no significant effect on pH. Viscosity increased over time, but higher NaCl concentrations moderated viscosity development in Soy and Goat milk, whereas Cow milk viscosity was less affected. Electrical conductivity rose markedly with increasing NaCl, reflecting enhanced ionic content, particularly in Soy milk. These findings demonstrate that NaCl is effective as a preservative, but its concentration must be optimized to maintain desirable milk quality and physicochemical characteristics.

REFERENCES

Amaro-Estrada, J., Salvatierra, J., Crisafulli, D., and Torres-Verdín, C. (2025). Experimental and molecular modeling of the structure and electrical conductivity of bulk ionic aqueous solutions: Sodium, potassium, and lithium chloride. *Journal of Molecular Liquids*. https://doi.org/10.1016/j.molliq.2025.127687.

Anyigor, S., Anyigor, N., Ezeagwu, O., Ugwuanyi, P., & Nwuzor, O. (2025). Efficacies of Dissolved Substances on the Electrical Conductivity of Liquids. *Nigerian Journal of Physics*. https://doi.org/10.62292/njp.v34i1.2025.380.

Căpriţă, R., Căpriţă, A., and Benscik, I. (2003). The Electric Conductivity as a Parameter for Milk Quality Appreciation. *Acta Veterinaria Scandinavica*, 44, 1. https://doi.org/10.1186/1751-0147-44-s1-p87.

Căpriţă, A., and Căpriţă, R. (2010). Effect of Mineral Composition on the Electrical Conductance of Milk. *Journal of Agroalimentary Processes and Technologies*

Costa, R., Freire, R., De Araújo, G., Queiroga, R., Paiva, G., Ribeiro, N., Oliveira, R., Domínguez, R., and Lorenzo, J. (2021). Effect of Increased Salt Water Intake on the Production and Composition of Dairy Goat Milk. *Animals: An Open Access Journal from MDPI*, 11.

El-Salam, M., El-Shibiny, S., Mahfouz, M., and El-Dein, H. (1987). Effect of pH and sodium chloride on the viscosity of skim milk retentates. *Lait*, 67, 111-119. https://doi.org/10.1051/lait:198717. https://doi.org/10.3390/ani11092642.

Gabas, A. L., Sobral, P. J. D. A., Cardona-Alzate, C. A., Telis, V. R. N., and Telis-Romero, J. (2008). Influence of fluid concentration on the elevation of boiling point of blackberry juice. *International Journal of Food Properties*, *11*(4), 865-875.

Huppertz, T., and Fox, P. (2006). Effect of NaCl on some physico-chemical properties of concentrated bovine milk. *International Dairy Journal*, 16, 1142-1148. https://doi.org/10.1016/j.idairyj.2005.09.011.

Hassan, N., El-Deeb, A., and E.F, S. (2021). Improving the quality properties and extension the shelf life of soy cheese. *International Journal of Food Science, Nutrition Health and Family Studies*. https://doi.org/10.21608/ijfsnh.2021.213447.

Huppertz, T., and Patrick F. Fox, (2006). Effect of NaCl on some physico-chemical properties of concentrated bovine milk, International Dairy Journal, Volume 16, Issue 10, Pages 1142-1148. https://doi.org/10.1016/j.idairyj.2005.09.011.

Kousar, S., Arshad, M., Zahoor, T., Faisal, M., Abdi, G., and Aadil, R. (2025). Anti-Inflammatory effect of Goat milk against Acetic Acid-Induced ulcerative colitis in Rat model. *Food Science and Nutrition*, 13. https://doi.org/10.1002/fsn3.70641.

Mabrook, M., and Petty, M. (2003). Effect of composition on the electrical conductance of milk. *Journal of Food Engineering*, 60, 321-325. https://doi.org/10.1016/s0260-8774(03)00054-2.

Magan, J. B., O′ Callaghan, T. F., Kelly, A. L., and McCarthy, N. A. (2021). Compositional and functional properties of milk and dairy products derived from Cows fed pasture or concentrate-based diets. *Comprehensive reviews in food science and food safety, 20*(3), 2769-2800.

Matsuno, M., Murakami, K., Morita, K., and Shimoyamada, M. (2024). Effects of pH and salt concentration on freeze–thaw fractionation of soymilk protein. *Journal of the Science of Food and Agriculture*, 104. https://doi.org/10.1002/jsfa.13322.

Mohamed T., Tammam, A., and Abd-El-Rahim, A. (2012). Electrical Conductivity of Raw Milk and Kareish Cheese. *Journal of Food and Dairy Sciences*. *3*(5), 315-323. doi: 10.21608/jfds.2012.75395.

Nascimento, W. (2020). Mathematical models for correlating electrical parameters and milk adulterants, 2, 27-33. https://doi.org/10.34019/2674-9688.2020.v2.29753.

Neri, L., Faieta, M., Di Mattia, C., Sacchetti, G., Mastrocola, D., and Pittia, P. (2020). Antioxidant activity in frozen plant foods: Effect of cryoprotectants, freezing process and frozen storage. *Foods, 9*(12), 1886.

Otolowo, D. T., Omosebi, O. M., Araoye, K. T., Ernest, T. E., and Osundahunsi, O. F. (2022). Effects of the substitution of Cow's milk with soymilk on the micronutrients, microbial, and sensory qualities of yoghurt. *Food Production, Processing and Nutrition*, *4*(1), 15.

Pindešová, I., Fehér, A., Prus, P., Zajác, P., and Prčík, M. (2022). Farm Level Milk Adulteration: Changes in the Physicochemical Properties of Raw Cow's Milk after the Addition of Water and NaCl. *Agriculture*. https://doi.org/10.3390/agriculture12020136.

Stocco, G., Pazzola, M., Dettori, M., Paschino, P., Summer, A., Cipolat-Gotet, C., and Vacca, G. (2019). Effects of indirect indicators of udder health on nutrient recovery and cheese yield traits in Goat milk. *Journal of dairy science*. https://doi.org/10.3168/jds.2019-16369.

Tapia, M. S., Alzamora, S. M., and Chirife, J. (2020). Effects of water activity (aw) on microbial stability as a hurdle in food preservation. *Water activity in foods: Fundamentals and applications*, 323-355.

Urbanski, G., Wei, L., Nelson, A., and Steinberg, M. (1982). Effect of Solutes on Rheology of Soy Four and Its Components. *Journal of Food Science*, 47, 792-795. https://doi.org/10.1111/j.1365-2621.1982.tb12716.x.

Wang, Q., Yang, Y., Li, Z., Jin, H., Shu, D., Jin, Y., Jin, G., and Sheng, L. (2024). Research advances on the effects of thermal and non-thermal processing techniques on the physicochemical properties and microbiological control of liquid eggs. *Food Control, 155*, 110106.

Zhao Z. and Corredig M. (2016). Influence of sodium chloride on the colloidal and rennet coagulation properties of concentrated casein micelle suspensions, *J. Dairy Sci*, Vol. 99, Pages 6036-6045. http://dx.doi.org/10.3168/jds.2015-10622.

Zhao Z., and Corredig M. (2015). Changes in the physico-chemical properties of casein micelles in the presence of sodium chloride in untreated and concentrated milk protein. *Dairy Science and Technology*, EDP sciences/Springer, 2015, 95 (1), pp.87-99. 10.1007/s13594-014-0200-7. hal-01264548

Zhu, L., Fan, Z., Li, W., and Shan, Y. (2025). Goat Milk Exhibits a Higher Degree of Protein Oxidation and Aggregation than Cow Milk During Cold Storage. *Foods*, 14. https://doi.org/10.3390/foods14050852.

To cite this article:
Officha, Chinwe Oluokwukwe, Ogbuagu, Nneka Juliana and Nwanna, Emmanuel Chukwudi, 2026. Effect of Sodium Chloride Concentration on the Short-Term Preservation of Cow, Goat, and Soy Milk. 1(2): 1-12. https://journals.unizik.edu.ng/ujabe/