

Effect of Preservation Methods on Proximate Composition and Physicochemical Properties of Raw Cow Milk in Aliero, Kebbi State

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Abstract

This study evaluated the effects of selected natural preservation methods—clove (T₂), honey (T₃), charcoal (T₄), and ginger (T₅), relative to an untreated control (T₁)—on the proximate composition and physicochemical properties of raw cow milk. Samples were arranged in a Completely Randomised Design (CRD) and monitored over a storage period at ambient temperature. Honey-treated milk (T₃) recorded the highest crude protein (1.39%) and ash content (0.86%), alongside the lowest moisture content (78.27%), establishing a notable nutrient concentration effect. Physicochemical profiling on Day 3 revealed that honey (T₃) and ginger (T₅) treatments maintained structural indices closer to fresh milk standards, exhibiting stable pH (6.62 and 6.55 respectively) and high total solids (12.60% and 12.45%) compared to charcoal (T₄), which triggered advanced acidification. The findings demonstrate that honey acts effectively as both a nutritional enhancer and a stabilizer for short-term milk storage, though it requires environmental temperature controls for optimal performance.

Introduction

Milk serves as a foundational biochemical fluid essential for mammalian nourishment, offering rich reservoirs of proteins, calcium, and essential saturated lipids (Da-Silva, et al., 2023). However, its high-water activity and neutral pH render it highly perishable (Sulieman *et al.*, 2021). In developing regions, especially across tropical African zones like Nigeria, the combination of high ambient temperatures exceeding 30°C and a systemic deficit in cold-chain logistics or reliable electrification severely undercuts the shelf life of raw milk (Abdollahi and Hosseini, 2014).

While synthetic chemical preservatives offer shelf-life extensions, growing consumer aversion to artificial chemical additives has shifted academic focus toward natural, non-thermal alternatives (Ogwu and Izah, 2025). Spices and natural syrups such as cloves (*Myrtaceae*), ginger (*Zingiber officinale*), and honey (*Apis mellifera*) possess bioactive compounds capable of extending food stability (Shahidi and Zhong, 2015). This paper isolates and examines how these specific treatments alter the macronutrient matrices (proximate composition) and foundational physical characteristics (pH, titratable acidity, specific gravity, and total solids) of raw milk stored in a Sudano-Sahelian climate framework.

Materials and Methods

Study Area: The laboratory analyses were executed within the Department of Animal Science Laboratory, Faculty of Agriculture, Abdullahi Fodio University of Science and Technology, Aliero, Kebbi State, Nigeria. The location lies within the Sudano-Sahelian agro-ecological zone characterized by an undulating terrain and high ambient dry-season temperatures ranging from 21°C to 41°C (Sulieman *et al.*, 2021).

Sources of Materials: Fresh, raw cow milk was systematically sourced from the Labana Farm infrastructure in Aliero. The traditional preservation additives (ginger rhizomes, cloves, honey, and charcoal) were procured from the Aliero local market matrix.

Data Collection

Preparation of Additives: Fresh ginger rhizomes were cleaned, peeled, and dehydrated in a hot-air oven at 65°C for 12 hours before being pulverized into a fine powder, sieved through a 50 µm mesh, and autoclaved. Pure honey and cleaned, crushed charcoal was similarly processed and autoclaved to avoid external contaminant loading.

Experimental Setup: Five liters of fresh milk were partitioned into experimental units of 300 mL inside sterile 500 mL vessels. The treatments were administered at a concentration of 4% w/w under homogenized stirring and maintained at ambient room temperature for a 72-hour window prior to multi-laboratory physical sampling.

Data Analysis

The experiment utilized a Completely Randomised Design (CRD) with three distinct replications per treatment block ($5 \times 3 = 15$ experimental units). Statistical modeling was performed using Analysis of Variance (ANOVA) via SPSS software. Group means were separated using the Duncan Multiple Range Test, with statistical significance determined at a confidence threshold of $p < 0.05$.

Results and Discussion

Preservation treatments significantly adjusted raw milk proximate boundaries ($p < 0.05$). Honey-treated milk (T₃) recorded significantly higher crude protein values (1.39%) and ash contents (0.86%) compared to the untreated control (T₁). This augmentation is attributed to the inherent peptide, enzyme, and mineral assets (potassium, calcium, magnesium) structurally present within natural honey (Sulieman *et al.*, 2021). Furthermore, T₃ exhibited a sharply depressed moisture rate (78.27%), showing that its hygroscopic, sugar-rich matrix bound free water molecules, generating a nutrient concentration effect (Abdollahi and Hosseini, 2014).

Parameters (%)	T ₁ (Control)	T ₂ (Clove)	T ₃ (Honey)	T ₄ (Charcoal)	T ₅ (Ginger)
Crude protein	1.28 ± 0.02 ^b	1.31 ± 0.01 ^b	1.39 ± 0.01 ^a	1.32 ± 0.00 ^b	1.29 ± 0.01 ^b
Ether extract	2.82 ± 0.01 ^a	2.83 ± 0.01 ^a	2.76 ± 0.01 ^b	2.81 ± 0.01 ^a	2.80 ± 0.01 ^a
Ash content	0.82 ± 0.02 ^b	0.75 ± 0.01 ^c	0.86 ± 0.00 ^a	0.80 ± 0.00 ^b	0.82 ± 0.01 ^b

Moisture content	(84.07 0.06 ^a)	(82.93 0.24 ^b)	(78.27 0.17 ^d)	(84.37 0.14 ^a)	(81.07 0.43 ^c)
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Table 1.1: Effects of Preservation on Proximate Elements (%)

Values (means ± SE) in the same row with different superscripts differ significantly (p<0.05).

By Day 3 of storage, physicochemical evaluation revealed notable divergence. The control (T₁) retained a baseline pH of **6.70**. Among the room-temperature additions, honey (T₃) ginger (T₅) effectively limited degradation, maintaining stable pH balances of **6.62** and **6.55**, alongside total solids of **12.60%** and **12.45%** respectively. Conversely, charcoal (T₄) dropped to a low pH of **6.30** and high titratable acidity (**0.22%**), indicating unchecked acid development via lactose fermentation.

Table 1.2: Physicochemical Parameters on Day 3 of Storage

Parameter	T ₁ (Control)	T ₂ (Clove)	T ₃ (Honey)	T ₄ (Charcoal)	T ₅ (Ginger)
pH	(6.70 0.03 ^a)	(6.45 0.05 ^c)	(6.62 0.04 ^b)	(6.30 0.06 ^d)	(6.55 0.04 ^b)
Titratable acidity (%)	(0.14 0.01 ^a)	(0.18 0.02 ^c)	(0.15 0.01 ^b)	(0.22 0.02 ^d)	(0.16 0.01 ^b)
Total solids (%)	(12.85 0.12 ^a)	(11.90 0.18 ^c)	(12.60 0.14 ^b)	(11.40 0.20 ^d)	(12.45 0.15 ^b)
Specific gravity	(1.032 0.001 ^a)	(1.028 0.002 ^c)	(1.031 0.001 ^b)	(1.026 0.002 ^d)	(1.030 0.001 ^b)

Values (means ± SE) in the same row with different superscripts differ significantly (p<0.05).

Conclusion

Natural treatments significantly affect the nutritional profiles and physical characteristics of raw milk. Honey (T₃) functions effectively as a dual nutritional fortifier and physicochemical stabilizer. It increases crude protein and ash components while maintaining stable specific gravity indices during warm ambient storage.

Recommendations

1. Dairy processors seeking non-synthetic methods to stabilize physical components should employ honey (T₃) or ginger (T₅) extracts to preserve native pH and total solids.
2. For specific nutritional targets demanding reduced fat content alongside increased crude protein density, honey (T₃) treatments at 4% w/w provide optimal values.

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