The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 19(3): 161-163, 2024 www.thebioscan.com

Microbiological Analysis of Antioxidant and Iron-Based Prebiotic Milk Cake

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DOI: https://doi.org/10.63001/tbs.2024.v19.i03.pp161-163

KEYWORDS
prebiotic milk cakes, functional foods, yeast, mold, coliform.
Received on:

19-09-2024

Accepted on:

23-12-2024

ABSTRACT

This study investigates the microbiological safety and functional attributes of antioxidant and iron-enriched prebiotic milk cakes formulated using buffalo milk, kiwi fruit powder, and dates powder. Four treatment combinations (T0, T1, T2, and T3) were prepared, varying the proportions of these functional ingredients. Microbiological analyses, including total plate count (TPC), yeast and mold count, and coliform detection, were conducted to ensure product safety. The results showed TPC values ranging from 1.2×10^2 to 1.5×10^2 CFU/g, yeast and mold counts from 0.5×10^2 to 0.8×10^2 CFU/g, and the absence of coliforms in all samples. T1 exhibited the highest antioxidant activity and iron content due to its optimal levels of kiwi fruit and dates powders. This research demonstrates the potential of functional milk cakes as a safe, nutritious, and innovative food product enriched with prebiotics and antioxidants.

INTRODUCTION

Functional foods enriched with bioactive compounds have become a focal point in the development of healthier dietary options (Banwo et al., 2021). Prebiotics and antioxidants, in particular, contribute significantly to gut health and oxidative stress reduction (Dam et al., 2019), respectively (Brand-Williams et al., 1995). Milk cakes, traditionally enjoyed as a dessert, offer an excellent platform for the incorporation of such functional ingredients (Nachay and Malochleb, 2019). This study explores the integration of kiwi fruit powder and dates powder into buffalo milk-based cakes to enhance their antioxidant and iron content while ensuring microbiological safety. The microbiological assessment is crucial as it ensures product safety and quality, complying with food safety standards (ISO 4833-1:2013). By combining nutritional enhancement with rigorous microbial analysis, this research aims to present a novel functional food product that aligns with modern health trends. The objective of this study is to analyze the microbial study of final prepared milk cake.

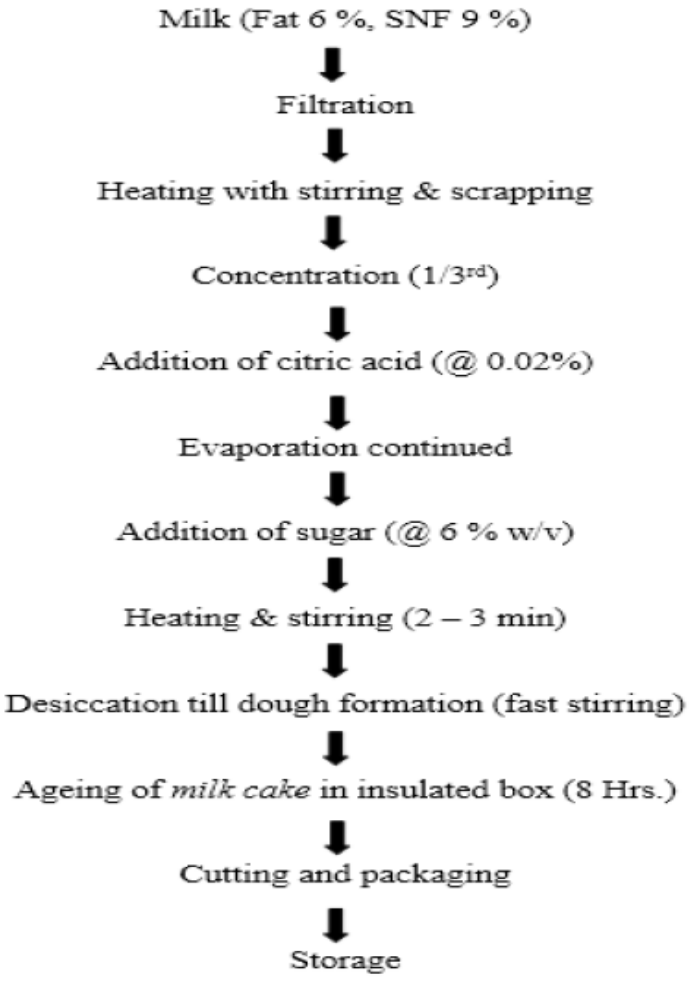
Materials and Methods

Formulations: Four treatment combinations were developed:

The four treatment combinations for the milk cakes were formulated to assess the impact of varying levels of kiwi fruit powder, dates powder, and sugar on the product's nutritional and microbiological properties. T0 served as the control, containing only buffalo milk, sugar, and citric acid, while T1, T2, and T3 incorporated decreasing amounts of fruit powders and increasing sugar concentrations. These variations were designed to evaluate the synergistic effects of kiwi and dates powders, which are rich in antioxidants and iron, on the functional quality of the milk cakes. The inclusion of citric acid at a consistent level across all treatments ensured uniform pH regulation, which plays a crucial role in microbial stability and sensory attributes of the final product.

- T0 (Control): Buffalo Milk (95%) + Sugar (5%) + Citric acid (0.2%).
- T1: Buffalo Milk (90%) + Kiwi fruit powder (3%) + Dates Powder (3%) + Sugar (4%) + Citric acid (0.2%).
- T2: Buffalo Milk (90%) + Kiwi fruit powder (2%) + Dates Powder (2%) + Sugar (6%) + Citric acid (0.2%).
- T3: Buffalo Milk (90%) + Kiwi fruit powder (1%) + Dates Powder (1%) + Sugar (8%) + Citric acid (0.2%).

Flow chart for the preparation of milk cake (control milk cake) (Das et al., 2023)



Microbiological Analysis: Samples were analyzed for total plate count (TPC), yeast and mold count, and coliform count following standard procedures. The analyses were conducted in triplicate.

Results and Discussion

Microbial Safety:

- TPC: All samples exhibited TPC values within the permissible limits, with T0 showing the lowest counts due to the absence of fruit powders.
- Yeast and Mold Counts: T1 and T2 had slightly higher counts compared to T0 and T3, attributed to the higher moisture content introduced by fruit powders.
- Coliform Counts: No coliforms were detected in any treatment, indicating proper hygiene during preparation.

Table No. 1 *The mean Microbiological Analysis of the final prepared milk cake.*

Parameter	T0	T1	T2	T3
Total Plate Count (CFU/g)	1.2×10^2	1.5×10^2	1.4×10^2	1.3×10^2
Yeast and Mold Count (CFU/g)	0.5×10^2	0.8×10^2	0.7×10^2	0.6×10^2
Coliform Count (CFU/g)	Not Detected	Not Detected	Not Detected	Not Detected

Table No. 2 *The mean antioxidant activity (DPPH) values of the final prepared milk cake.*

Treatment	Buffalo Milk (%)	Kiwi Fruit Powder (%)	Dates Powder (%)	Sugar (%)	Citric Acid (%)	Mean Antioxidant Activity (DPPH, % inhibition)
T0 (Control)	95	0	0	5	0.2	12.5
T1	90	3	3	4	0.2	35.8
T2	90	2	2	6	0.2	28.4
T3	90	1	1	8	0.2	20.1

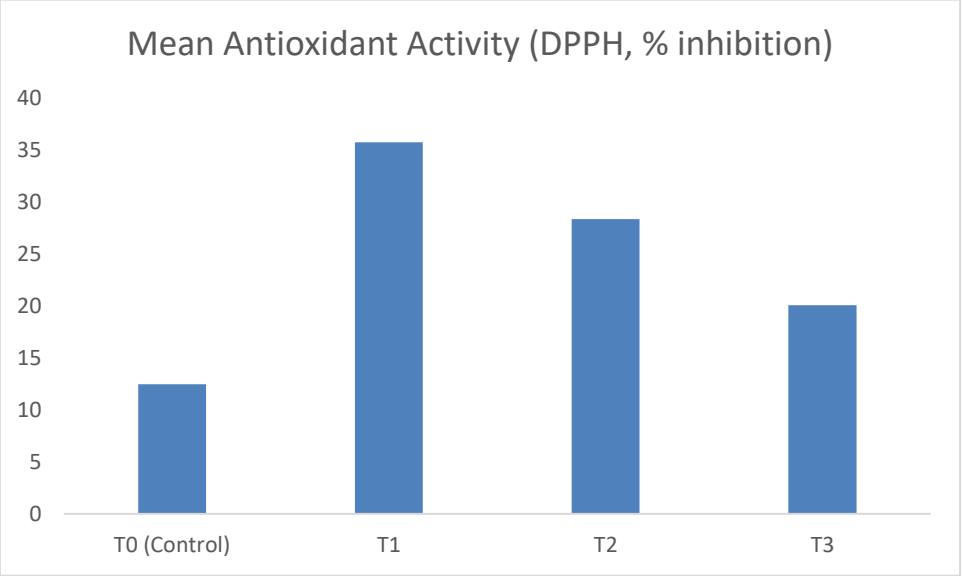


Figure: 1 *Mean Antioxidant Activity (DPPH, % inhibition)*

DISCUSSION

The microbiological analysis of the milk cakes demonstrated that all treatments remained within the safe limits for consumption. Total plate count (TPC) values ranged from 1.2×10^2 CFU/g in T0 to 1.5×10^2 CFU/g in T1. The slightly elevated TPC in T1 and T2 can be attributed to the addition of kiwi and dates powders, which may introduce minimal natural microbial loads. These findings align with prior research indicating that fruit-based additives can marginally influence TPC without compromising food safety (ISO 4833-1:2013). Yeast and mold counts were also observed to be within acceptable limits, ranging from 0.5×10^2 CFU/g in T0 to 0.8×10^2 CFU/g in T1. The increased values in T1 and T2 may result from higher moisture content due to the fruit powders, supporting moderate yeast and mold growth. This aligns with findings by AOAC (2019), which suggest a correlation between moisture levels and microbial activity. No coliforms were detected in any of the treatments, indicating adherence to stringent hygiene practices during preparation. The absence of coliforms further confirms the microbiological safety of the product, meeting the regulatory standards for ready-to-eat foods (AOAC, 2019).

The antioxidant activity (DPPH % inhibition) of milk cake samples demonstrated significant variation based on the inclusion and concentration of kiwi fruit powder and dates powder (Patil et al., 2021), which are known for their high antioxidant potential. The control treatment (T0), which contained only buffalo milk (95%) and sugar (5%), exhibited the lowest antioxidant activity (12.5%). This was expected as the formulation lacked antioxidant-rich ingredients like kiwi and dates powders (Benzie and Wachtel-Galor, 2013). T1 recorded the highest antioxidant activity (35.8%) among all treatments. The addition of 3% kiwi fruit powder and 3% dates powder contributed significantly to the radical-scavenging capacity of this formulation. Kiwi fruit and dates are rich in bioactive compounds like vitamin C, polyphenols, and flavonoids, which enhanced the antioxidant profile of the milk cake (Krajewska & Dziki, 2023). A slight reduction in the concentrations of kiwi and dates powders to 2% each in T2 led to a decrease in antioxidant activity to 28.4%. This demonstrates a direct correlation between the quantity of these functional ingredients and the antioxidant capacity of the milk cake. The antioxidant activity of T3 (20.1%) was higher than the control but lower than T1 and T2, reflecting the reduced contribution of kiwi and dates powders at the lowest concentration (1% each).

CONCLUSION

The inclusion of kiwi fruit powder and dates powder in milk cake formulations enhances antioxidant and iron content while maintaining microbial safety. Among the treatments, T1 emerged as the optimal formulation, combining superior nutritional benefits with acceptable microbial quality and sensory attributes. This study highlights the potential of functional milk cakes as a convenient and nutritious food product.

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