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Development of Plant-Based Yogurt Analogue from Coconut Milk

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Abstract

Plant-based "yogurt" products are ideal alternatives to milk for ethical and health concerns. A coconut milk-based "yogurt" was developed in this study, and its physicochemical properties, microbial stability, and sensory attributes were analysed. Changes of coconut milk into "yogurt" involved major changes, such as a reduction of pH from 6.45 to 4.66 and an increase of acidity from 0.17% to 0.68, which suggests a successful fermentation. Moisture content was reduced from 83.79% to 70.20%; this improved the texture and consistency of the "yogurt"; total solids increased from 16.21% to 29.80%; these results contribute to a rich flavour profile. As a result, 100% coconut milk "yogurt" and vanilla-flavoured variants were identified as the most preferred by panellists through sensory evaluation. Over four-week shelf-life testing on proof batches revealed no microbial contamination, indicating the absence of yeast, mold, and coliform bacteria. Acidity of increased steadily with storage, necessitating fermentation optimization to strike an appropriate flavour stability and consumer acceptability. Comparative analysis with existing literature proved that coconut milk "yogurt" is nutritious and sensory beneficial but also revealed limitations like its low protein content and difficulty in maintaining consistent flavour over time. Optimization of fermentation processes, further study into alternative plant-based protein and functional additive formulations, as well as adoption of sustainable packaging solutions, are some of the recommendations mentioned. This study provides significant insights into the feasibility of coconut milk "yogurt" as a plant-based dairy alternative, which caters to consumer needs for healthy, low lactose, and more environmentally friendly dairy products.

Keywords: Coconut milk "yogurt", fermentation, sensory evaluation

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Introduction

The growing global appetite for plant-based products reflects shifting dietary choices influenced by health, environmental, and ethical concerns. Lactose intolerance, milk allergies, and awareness of the environmental and ethical alternatives. Among these, coconut milk has emerged as a popular choice due to its rich nutritional profile, formulated with medium-chain triglycerides, lauric acid, and key nutrients essential for health. Its versatility makes it a promising base for plant-based "yogurt", offering a lactose-free option with potential probiotic benefits similar to conventional dairy yogurt.

Despite its advantages, coconut milk presents unique challenges in "yogurt" production, such as achieving desirable texture, taste, and probiotic viability due to its low protein content. Existing research has explored stabilizers and fermentation techniques, but gap remains in understanding nutrient bioavailability, digestibility, and consumer acceptance compared to dairy yogurt. Additionally, while coconut milk's health benefits, such as improved metabolism and cardiovascular health, are well documented, their retention and efficacy post-fermentation are understudied. Addressing these gaps is critical for optimizing coconut milk "yogurt" as a viable, competitive dairy alternative.

This study aims to develop a high-quality coconut milk "yogurt" analogue by investigating its digestibility, sensory appeal, and textural properties. Key objectives include comparing nutrient bioavailability and digestibility between coconut milk and dairy milk yogurt, evaluating consumer perceptions of sensory attributes, and assessing the impact of thickening agents on texture and mouthfeel. By bridging these research gaps, the study will provide insights into the food industry, supporting the development of sustainable, nutritious, and consumer-friendly plant-based products. The findings will contribute to the broader movement toward environmentally responsible and health-conscious food systems.

Materials and Methods

Coconut milk was extracted from freshly harvested 8–12-month-old mature coconuts obtained from local trees in Pelwatte, Buttala, Sri Lanka. Additionally, probiotics (ABY 10 – containing *Lactobacillus acidophilus*, *L. lactis*, and *Pediococcus acidilactici*) and White Classic 1-01 thermophilic culture were provided by Pelwatte Dairy Industries. For flavouring, sugar and vanilla flavour were used, while potassium sorbate served as a preservative. Thickening agents, including corn starch, gelatine, and maltodextrin, were also supplied by Pelwatte Dairy Industries.

Market survey

A market survey was conducted among students (population: 430) following the biotechnology degree program at Horizon Campus, Malabe, to assess "yogurt" preferences. A representative sample size of 204 was selected using appropriate statistical formulae (n = $\frac{\boldsymbol{N\cdot p\cdot(1-p)}}{(N-1).+P\,.\left(\frac{E}{Z}\right)^2\,(1-P)}$) (Taherdoost, 2017). Data were collected via Google Forms and analysed using descriptive statistics (SPSS software) to identify consumption patterns and preferences.

Raw materials procurement

High-quality raw materials were carefully selected for "yogurt" production. Mature coconuts (8-12 months old) were sourced from local trees in Pelwatte, Buttala, Sri Lanka to ensure freshness and sustainability. The selected probiotic culture (ABY 10) contained *L. lactis*, and *Pediococcus acidilactici* strains, while the thermophilic culture (white classic 1-01) included *L. bulgaricus* and *S. thermophilus* for optimal fermentation.

Various thickening agents (gelatine, corn starch, maltodextrin) and additional ingredients (sugar, sorbate (preservative), vanilla flavour) were procured for formulation and all these other raw materials were supplied by Pelwatte Dairy Industries

Coconut milk extraction and "yogurt" preparation

The production process began with careful coconut preparation: dehusking, washing, and grating the coconut meat. Coconut milk was derived through the infusion of hot water (80 °C) into grated coconut a 1:2 ratio, blending thoroughly, and straining through a mesh filter. The extracted milk was cooled to 44 °C before processing. For "yogurt" formulation, precise quantities of ingredients were measured per batch (100 g and 2000 g scales), including coconut milk (84.75 g/ 1675 g), sugar (9 g/180 g), water (3.57 g/ 71.4 g), corn starch (2 g/ 40 g), gelatine (0.6 g/ 12 g), sorbate (0.05 g / 1 g), and vanilla flavour (0.02 g/ 0.4 g).

Processing and Fermentation

The prepared mixture [coconut milk (84.75 g/ 1675 g), sugar (9 g/180 g), water (3.57 g/ 71.4 g), corn starch (2 g/ 40 g), gelatine (0.6 g/ 12 g), sorbate (0.05 g / 1 g), and vanilla flavour (0.02 g/ 0.4 g)] underwent several critical processing steps: initial blending with a hand blender, heating to 55 °C, homogenization at 2000 rpm for 10 min, and pasteurized by maintaining a temperature of 85 °C for 15 s. Upon reaching 44 °C during the cooling process, sorbate was added as a preservative before inoculation with the prepared thermophilic and probiotic cultures. The inoculated mixture was poured into sterile containers and incubated at 45 °C until the pH reached 4.5-4.8, followed by immediate refrigeration.

Quality control and analysis

The study incorporated a comprehensive physicochemical analysis to evaluate product quality. Key parameters measured included pH (digital pH meter, model & specifications), moisture content (oven-drying method), acidity (titration with N/10 NaOH), and total solids (calculated from moisture content), total soluble solids (digital refractometer). Data from both market research and laboratory analysis were subjected to statistical evaluation to analyse product characteristics and consumer preferences; both descriptive statistics (mean and standard deviation) and inferential methods (t-test and ANOVA) were employed. Strict quality control measures were implemented throughout the production to ensure consistency in texture, flavour, and nutritional profile of the final coconut milk "yogurt" product.

Results

Market survey

The market survey indicated a substantial consumer preference for coconut milk "yogurt" products, with 74.5% of respondents favouring a shelf life of around 15 days without preservatives, highlighting the demand for fresh, natural products. Taste was identified as a critical factor influencing purchasing decisions, with high importance ratings. Additionally, brand loyalty was observed, with Highland being the most preferred brand; however, 88.7% expressed openness to trying new brands, suggesting strong market potential for innovative coconut "yogurt" formulations.

Sensory evaluation

Three sensory evaluations provided insights into consumer preferences. The third sensory evaluation compared two variants: Variant 155 (coconut flavour coconut set "yogurt") and Variant 150 (100% coconut milk set "yogurt"). Both scored similarly in colour (around 6), with Variant 155 slightly higher in smell (6 vs. 5.85). Taste ratings favoured Variant 155, reflecting a consumer preference for coconut flavour. Overall, sensory attributes such as flavour, aroma, and texture showed no significant differences in preference, but the coconut-flavoured variant received slightly higher scores, indicating its potential appeal.

Physico-chemical testing

The transformation from coconut milk to "yogurt" involved notable physico-chemical changes**.**

pH and Acidity

The pH decreased from 6.45 (coconut milk) to 4.66 (final "yogurt"), indicating increased acidity due to fermentation. Acidity increased from 0.17% to 0.68% during processing, essential for flavour development and safety.

Moisture and Total Solids

Moisture content decreased from 83.79% to 70.20%, with total solids increasing from 16.21% to 29.80%, reflecting the concentration of solids during fermentation.

Total Soluble Solids, Fat Content, Protein, Ash and Carbohydrates

The total soluble solids increased significantly, reflecting fermentation activity. The fat content remained relatively stable at approximately 9%. Protein and ash contents showed minor variations, with carbohydrate content increasing as fermentation progressed, contributing to flavour and texture development.

Shelf-life testing

Over a 4-week storage period, the following changes were observed. pH declined from 4.66 in the first week to approximately 3.90 in the fourth week, indicating ongoing fermentation and acid production. Moisture showed a decreasing trend from about 83.79% initially to roughly 70.20% by the end of four weeks, likely due to evaporation and structural changes. Acidity increased progressively from 0.17% to 0.68%, confirming continued fermentation activity. Microbial Stability test revealed that the yeast, mold, and coliform levels remained undetectable throughout the testing period, ensuring microbiological safety.

Other Parameters

Changes in total solids and soluble solids paralleled acidity trends, with minor fluctuations indicating product stability and controlled fermentation processes during storage.

ANOVA Testing

Multivariate ANOVA analyses confirmed the significance of the observed changes over time. Wilks' Lambda and Hotelling's Trace tests yielded p-values of 0.000, indicating highly significant effects of the 'Week' factor on parameters such as pH, acidity, moisture, and total solids. The model validated that fermentation and storage period exert statistically significant influences on the physico-chemical properties, confirming the dynamic nature of the product during shelf life.

Table 1: *ANOVA test*

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	1.000	85936.539 [b]	3.000	6.000	.000
	Wilks' Lambda	.000	85936.539 [b]	3.000	6.000	.000
	Hotelling's Trace	42968.270	85936.539 [b]	3.000	6.000	.000
	Roy's Largest Root	42968.270	85936.539 [b]	3.000	6.000	.000
Week	Pillai's Trace	1.169	1.702	9.000	24.000	.143
	Wilks' Lambda	.009	9.705	9.000	14.753	.000
	Hotelling's Trace	90.482	46.916	9.000	14.000	.000
	Roy's Largest Root	90.271	240.724 [c]	3.000	8.000	.000

a. Design: intercept+ week
b. Exact static
c. The static is an upper bound on F that yields a lower bound on the significance level.

Discussion

This study successfully demonstrated the feasibility of transforming coconut milk into a "yogurt" product with desirable physicochemical, microbial, and sensory qualities. The fermentation process induced a significant decrease in pH from 6.45 to 4.66, indicating effective fermentation by probiotic bacteria, which contributed to the development of the characteristic tangy flavour of "yogurt". Acidity increased progressively during storage, reaching levels that both enhance flavour and ensure microbial safety, aligning with previous findings that regulated acidification can improve product preservation. The morphological and compositional changes—including decreased moisture content, increased total solids, and sugar conversion—highlight the role of fermentation and stabilizers in enhancing texture and consumer appeal.

Microbiological safety was maintained throughout the shelf life, with no detection of yeast, mold, or coliform bacteria, confirming the effectiveness of hygiene practices and fermentation conditions. However, the study did not examine the viability or activity of probiotic strains during storage, which is critical for probiotic health benefits. Flavour dynamics indicated a natural souring over time, which could impact consumer acceptance; thus, future research should focus on optimizing bacterial strains and fermentation parameters to maintain flavour stability and reduce undesirable sourness.

Limitations of the study include a small sample size for sensory evaluation and the controlled laboratory conditions that may not fully replicate real-world storage environments. Future studies should explore larger, more diverse consumer panels and assess product performance under variable storage conditions to better predict market viability.

Conclusion

This research provides an important step toward developing a nutritionally appealing, microbiologically safe, and sensory acceptable coconut milk "yogurt" as a plant-based dairy alternative, contributing to sustainable and health-conscious food options. While the process effectively converts coconut milk into a yogurt-like product, challenges remain in optimizing fermentation to control acidity and flavour stability, enhancing nutritional content—particularly protein—and ensuring probiotic viability during shelf life. Addressing these issues through further research will enhance product quality, consumer acceptance, and health benefits. Overall, this study offers valuable insights for industry stakeholders and researchers committed to innovating in the growing plant-based "yogurt" market and promoting sustainable food solutions for diverse populations.

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