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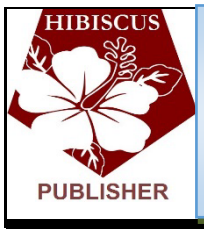

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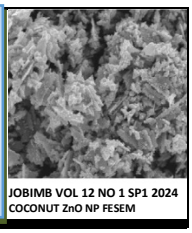

Properties of Malaysian Coconut-Breed (MATAG, MAWA, and Pandan) Yogurts: A Preliminary Analysis of Chemical, Microbiological, and Sensorial Characteristics

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ABSTRACT

The conversion of coconut milk (CM) into yogurt may enhance its nutritional qualities and acceptance as a sustainable alternative to dairy. Three types of CM (Pandan, MATAG, and MAWA) were analyzed for protein and fat content using the Kjeldahl and Gerber method, respectively. Commercial plant-based starter culture was utilized to produce yogurts, with Pandan CM showing the highest lactic acid bacteria count (>10^9 CFU/mL). Consequently, sensory analysis with 50 untrained panelists revealed no significant differences between Pandan CM yogurt and dairy yogurt in terms of texture, flavor, sourness, creaminess, and overall acceptability. The study suggests that coconut yogurt is a microbiologically and commercially viable option, suitable for consumers preferring plant-based products and sustainability practices.

INTRODUCTION

As the human population approached eight billion by 2020, the burden on food production to feed everyone increased significantly. Plant-based milk options, such as soy, almond, oat, and coconut milk, have recently gained popularity as alternatives to traditional dairy milk. These options are more sustainable, requiring fewer resources and less deforestation to produce, and some, like coconut milk (CM), can be harvested for extended periods before replanting is needed.

Cocos nucifera (coconut) is a widely distributed fruit tree in Malaysia. It consists of three primary coconut types (tall, dwarf, and hybrid). The most popular cultivars are Aromatic Dwarf or Pandan (PDN), Malayan Yellow Dwarf Tagnanan Tall (MATAG), and Malayan Yellow Dwarf West African Tall (MAWA) [1]. Because of its abundance of beneficial medium-chain fatty acids, such as lauric acid, and the lack of milk allergens, CM serves as an outstanding dairy substitute in yogurt production while being more sustainable [1]. However, given the distinct nutritional profiles of dairy and various CM variants, the resulting yogurts may exhibit differences, particularly in terms of microbial growth and sensory characteristics [2]. Therefore, this study seeks to compare the performance of three coconut varieties (PDN, MAWA, and MATAG) in producing coconut yogurt, evaluating sensory attributes and consumer acceptance in comparison to dairy yogurt.

MATERIALS AND METHOD

Raw Materials Preparation

CM from MATAG-. MAWA-, and Pandan (PDN)-coconut were obtained from the Ladang Sungai Bernam Estate, Selangor, Malaysia, managed by United Plantation. The coconut milk was obtained by grating and extracting the coconut meat using the ratio 1:1 of water to grating coconut flesh. Starter culture (Belle+Bella, non-dairy yogurt starter) contained *S. thermophilus*, *L. bulgaricus*, and *L. acidophilus* was obtained

from an online Shopee app, and sugar, tapioca starch, commercial yogurt, and 'Cap Kapal ABC' product brand of Lee Hin Enterprise Sdn. Bhd. was obtained from local markets in Selangor, Malaysia.

Chemical Composition of CM

Following the Association of Official Analytical Chemists, AOAC (2016), the chemical makeup of CM from three distinct coconut cultivars was ascertained. Using the Kjeldahl method, the protein content was determined. A Gerber method was used to measure the fat content of CM.

Production of Coconut Yogurt

A yogurt-like product sample was created in a 1000-ml beaker with 600 g of pasteurized CM from three different varieties of coconuts with 1.0% (w/w) tapioca starch added [3]. A 5% (w/w) sugar supplement was added to each sample. By following the instructions stated on the back of the starter's packaging, the starting culture was added at 0.5% (w/w) after the mixtures of CM, tapioca starch, and sugar were cooled to 44 °C after being heated to 90 °C for three minutes [4]. The mixtures were then incubated at 44 °C for 9 to 10 hours to get an optimized pH for yogurt. The resulting products were kept for two days at 4 °C after fermentation.

Microbiological Analysis

For microbiological analysis, three coconut yogurt samples from different coconut milk types were tested to determine the best variety for optimal lactic acid bacteria (LAB) content. LAB count was assessed using MRS agar, while Plate Count Agar (PCA) determined total bacterial colonies. Samples were diluted tenfold, spread on MRS and PCA agar plates, and incubated at 37°C for 24-48 hours. LAB and total viable bacteria were quantified as Colony Forming Units (CFU) per milliliter of yogurt-like product.

Sensory Evaluation

Sensory evaluation was performed on 50 untrained panelists of both genders, ranging from 19 to 60, using a 9-point hedonic scale for different attributes such as texture, flavor, sourness, creaminess, and overall acceptance. The sensorial test was carried out at the sensory booth at Food 3, Faculty of Food Science and Technology, UPM. The samples were served on clear small glasses and were named with random three-digit numbers. The panelists were invited to taste the samples and score the samples using the 9-point hedonic scale for each attribute from 1 (dislike extremely) to 9 (like extremely).

Statistical Analysis

All data were analyzed using the Minitab application. The One-Way Analysis of Variance (ANOVA) and Paired T-test were used to analyze the significant differences among the samples. Statistical significance was reported as $p<0.05$.

RESULT AND DISCUSSION

Chemical Composition of CM

Food composition profoundly affects various aspects of food products. Table 1 illustrates differences in fat and protein content of coconut milk compared to previous studies. MATAG exhibits the lowest fat content at 6.80 ± 0.87, while MAWA boasts the highest at 13.97 ± 0.97. The fat percentage varies between 10% and 37.4% depending on the coconut milk type. MATAG and PDN CM share similar fat content but significantly differ from MAWA. In a previous study, MAWA demonstrated the highest oil content among coconut varieties, suggesting its potential as a fat replacer in reduced-fat meatballs [5].

The protein content of coconut milk (CM) typically falls below that of dairy milk, which serves as a comprehensive protein source containing all nine essential amino acids vital for bodily functions [6]. However, MATAG CM exhibits slightly higher protein content than dairy milk. Previous studies have consistently shown lower protein levels in coconut products compared to dairy alternatives [7]. Research indicates considerable variability in CM composition, ranging from 75.40% to 81.97% moisture, 1.03% to 4.3% ash, 62.70% to 78.39% fat, and 6.33% to 32.16% protein [8]. Table 1 highlights notably lower fat (6.80%-13.97%) and protein (0.97%-3.65%) levels in milk samples compared to prior research findings.

Table 1. Chemical composition of three different types of CM - MATAG, MAWA, and Pandan CM (PDN).

Parameters (%)	MATAG	MAWA	PDN
Fat	6.80 ± 0.87^{b}	13.97 ± 0.97^{a}	7.60 ± 1.10^{b}
Protein	3.65 ± 0.69^{a}	0.97 ± 0.37^{b}	1.14 ± 0.02^{b}

Data are mean values of triplicate determinations ± standard deviation. Superscript letters indicate significance among different coconut species.

Microbiological Analysis

Fig. 1 displays the number of lactic acid bacteria, or LAB, that appear or are present in these three samples: Sample A as MATAG coconut yogurt, Sample B as MAWA coconut yogurt, and Sample C as PDN coconut yogurt. The MRS (de Man, Rogosa, and Sharpe) agar is a selective medium used in this microbiological analysis to isolate and cultivate lactic acid bacteria, especially species belonging to the genera *Lactobacillus*, and *Streptococcus*. Sample C, which is PDN coconut yogurt, had the highest lactic acid bacteria count (1.40×10^{9} CFU/ml) at the dilution of 10^{6} followed by sample B (4.20×10^{8} CFU/ml). The higher LAB count in PDN coconut yogurt is attributed to the elevated sugar content in PDN CM. This higher sugar content contributes to greater nutrient availability, fostering the growth of LAB [9]. Based on a previous study from Wasim et al. (2023), lactic acid bacteria (LAB) viable cell count grew dramatically during fermentation and cold storage period (1 to 14 days) to reach 6.4 × 10^8 CFU/ml in fermented coconut milk [10]. To determine the viability of LAB, which is necessary for the manufacturing of yogurt and other fermented dairy products, the MRS test is frequently employed [11]. The higher viable microbial count in the MRS test suggests that LAB in the sample is healthier and more active.

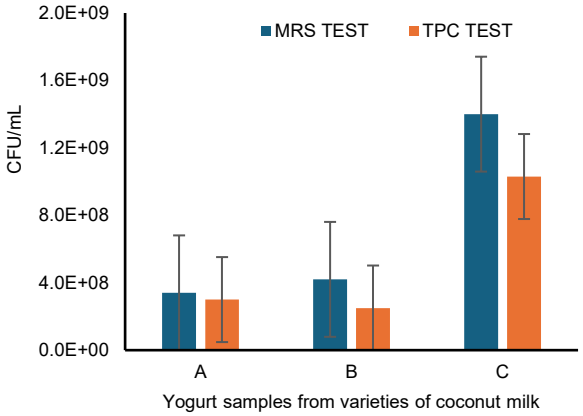

Fig. 1. Lactic Acid Bacteria and Total Plate Count of Coconut Yogurt from 3 different varieties of Coconut Milk. Only sample C exhibited significantly higher microbial contents compared to sample A and B . MRS - De Man–Rogosa–Sharpe; TPC – Total Plate Count.

The microbiological composition of the yogurt samples that were examined is displayed in **Fig. 1**. The Plate Count Agar (PCA) or Total Plate Count (TPC) test also was conducted in this study to estimate the total number of viable microorganisms (bacteria, yeast, molds) present in samples. The result of the total microbial count shows that Sample C (PDN) has the highest microbial load (1.03×10^9) compared to Sample A (MATAG) and B (MAWA). Nevertheless, all the yogurt samples were found to exceed the acceptable standard specified by Codex Alimentarius. The study's overall viable count of the coconut yogurt exceeded the permitted level of less than 1×10^6 CFU/ml [12].

Sensory Analysis

Based on the results from the microbiological analysis using the MRS test and PCA test, the yogurt-like product made with Pandan CM has a higher colony count score. **Table 2** displays the average sensory scores for the acceptability and organoleptic evaluation of the various yogurt samples. Statistical analysis found that the sensory qualities observed in the yogurt samples did not show any significant difference ($p<0.05$) for overall attributes and acceptability.

Table 2. Sensory analysis of the yogurts.

Parameters	Dairy Yogurt	PDN CM Yogurt
Texture	6.26 ± 1.93^a	5.78 ± 1.74^a
Flavor	5.20 ± 1.80^a	5.58 ± 2.12^a
Sourness	5.34 ± 2.01^a	5.64 ± 2.00^a
Creaminess	6.02 ± 1.58^a	5.84 ± 1.82^a
Overall acceptability	5.64 ± 1.95^a	5.90 ± 2.02^a

*Data are mean values ± standard deviation. Superscript letters indicate the significance between Dairy yogurt and PDN coconut yogurt. Mean within a row with different letters has no significant difference at ($P<0.05$).

Products made with dairy milk demonstrated higher liking scores for texture (6.26) and creaminess (6.02) attributes compared to PDN CM yogurt (**Fig. 2**). This is often the case for plant-based milk substitutes [13]. Since dairy yogurt is more viscous and looks like spoon-able yogurt, people tend to like it more than PDN CM yogurt, which has a slightly watery texture. However, for flavor (5.58), sourness (5.64), and overall acceptability (5.90) attributes, PDN CM yogurt obtained the highest scores compared to its dairy counterpart.

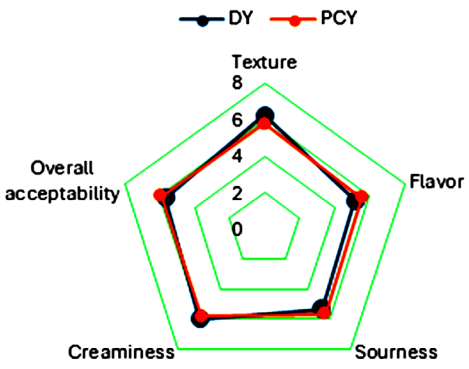

Fig. 2. Sensory evaluation using two different yogurts, dairy (DY) and Pandan coconut yogurts (PCY).

CONCLUSION

The study underscores the significance of utilizing high-quality coconut varieties in producing coconut yogurt to enhance consumer acceptance. Pandan (PDN) coconut yogurt demonstrated microbiological quality compared to other CM. The sensory evaluation indicated positive acceptance of yogurt-like products made from PDN coconut milk, suggesting potential market success.

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