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Formulation of Functional Yogurt from Corn-Mung Bean Extract Blend Using Commercial Biokul Starter Culture

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Abstract. Yoghurt, a fermented dairy product containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, is widely recognized for its health benefits. This study investigates the potential of plant-based alternatives by incorporating corn (*Zea mays*) and mung bean (*Vigna radiata*) extracts into yoghurt formulations. This study aimed to evaluate the colour quality, hedonic acceptance, and pH of yoghurt formulated with a blend of corn extract and mung bean extract. The research method consists of the preparation of materials and the process of making yoghurt. Results demonstrated significant colour variation between single-extract (corn) and blended-extract yoghurts. Hedonic testing revealed significantly higher consumer preference for the blended formulation compared to corn-only yoghurt. pH analysis showed no significant difference between the final pH values of both products. The study concludes that the optimal product formulation is the sweet corn-mung bean blended yoghurt, based on superior organoleptic acceptance while maintaining equivalent acidity levels.

Keywords : yogurt, corn extract, mung bean extract

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Introduction

Milk constitutes a highly nutritious food material that can be processed into various derivative products, including functional foods. This commodity contains numerous bioactive compounds that provide significant health benefits. Fermentation represents a key milk processing technique. Fermented dairy products serve as functional foods due to their high content of bioactive compounds, with prominent examples being yogurt (probiotic cultures), kefir (symbiotic microbial communities), and cheese (bioactive peptides)[1]. Probiotics consist of live microorganisms that confer health benefits when consumed, while prebiotics refer to indigestible dietary components that selectively stimulate the growth of beneficial gut microbiota [2]. For example, consuming probiotic powder with *L. plantarum* Dad-13 for 33 days increased height, weight, and BMI in adolescents and showed increased SCFA concentrations, which have potential health benefits [3]. One prominent example of a widely consumed dairy-based functional food is yogurt. Yogurt is produced through milk fermentation using lactic acid bacteria (LAB), particularly *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*, which generate probiotic content and impart characteristic acidic flavor notes. [4].

Yogurt, with its millennia-old consumption history, embodies both cultural heritage and nutritional excellence worldwide. Contemporary research has driven renewed interest in its documented physiological benefits, including: (1) gastrointestinal health promotion, (2) immune system modulation, and (3) intestinal microbiome regulation. The manufacturing process harmonizes empirical science with ancestral knowledge, where critical parameters - thermal regulation, bioprocessing time, and starter culture specificity - collectively govern product attributes and textural properties. [5]. Furthermore, yogurt demonstrates effective stimulation of gastric and small intestinal functions, attributable to *Lactobacillus bulgaricus*, which reduces toxic substances in the digestive system. In addition to its high nutritional value, yogurt also reduces lactose content by 25%, making it safer for lactose-intolerant individuals, lowers blood cholesterol levels, maintains gastric health, and prevents digestive tract cancers [2].

Recent innovations in yogurt production have expanded to include plant-based milk alternatives as raw materials. These vegetable-derived extracts offer a cost-effective substitute for animal milk while providing beneficial dietary fiber that supports digestive health. [6]. This study utilized plant-based extracts from corn (*Zea mays*) and mung beans (*Vigna radiata*) as economical alternatives to bovine milk. These botanical sources offer comparable nutritional profiles to dairy, with corn serving as a significant source of carbohydrates and proteins, particularly for populations where it constitutes a staple food. Although corn contains relatively high protein content (8-11%), its nutritional value is limited by deficiencies in essential amino acids, notably lysine and tryptophan. [7]. One strategy to address this amino acid deficiency involves nutritional complementation through mung bean (*Vigna radiata*) incorporation. Mung beans possess a well-balanced nutrient profile, being rich in protein (22.9 g/100 g), iron (7.5 mg/100 g), and dietary fiber while maintaining low-fat content. With an energy value of 323 kcal per 100 g, mung beans serve as an excellent protein source to compensate for corn's lysine and tryptophan limitations [8]. [9] Nutritional analysis reveals that mung beans (*Vigna radiata*) possess well-balanced compositions of all essential amino acids along with complete non-essential amino acid profiles, establishing them as an excellent plant-derived protein resource with high biological value. Amelia [10] further noted that the sweet corn and mung bean yogurt represents a promising functional food innovation, containing both health-beneficial amino acids and probiotic compounds derived from lactic acid bacteria (LAB) cultures. This product is anticipated to serve as an affordable alternative solution for providing functional food options to communities.

Yogurt production can utilize commercial starter cultures such as "Biokul" as the fermentation agent. [5] Biokul can be used as a starter culture for yogurt production. The yogurt manufacturing process involves fermentation mediated by Biokul's starter bacteria, specifically *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. These bacterial strains metabolize lactose present in milk into lactic acid, imparting the characteristic tangy flavor to yogurt. Precise control of fermentation temperature and duration is critical for achieving optimal product quality and desired sensory characteristics. Therefore, this study aims to determine the quality parameters of yogurt produced from sweet corn extract supplemented with mung

bean extract using commercial plain yogurt starter culture (Biokul brand).

Experimental

The yogurt production utilized standard laboratory equipment (blender, stove, cooking pots) with the following formulation: Sweet corn: 1000 g, Mung beans: 250 g, Water: 200 L, Skim milk powder: 50 g, Granulated sugar: 90 g, Powdered agar: 7 g, Commercial plain yogurt (Biokul brand): 80 g

Plant Extract Preparation. Preparation of Sweet Corn Extract: Following Rahayu and Adnriani's method [11], fresh sweet corn was thoroughly cleaned and destalked; Blended with mineral water (1:3 w/v ratio); Filtered through muslin cloth to obtain clear extract.

Preparation of Mung Bean Extract. The production of mung bean extract follows the method of Maryani [6], beginning with the sorting of mung beans to select high-quality seeds. Subsequently, the beans are washed and soaked for 6 hours to remove impurities and facilitate hull removal. The soaked mung beans are then ground with water at a 1:3 ratio (beans to water) to produce a thick, protein-rich extract. The mixture is then filtered to separate the liquid extract from the residue. Finally, the mung bean extract undergoes pasteurization through heating to eliminate pathogenic microorganisms without altering its flavor or nutritional composition.

Preparation of Yogurt. The yogurt production followed Amelia's method [10] with modifications. Two formulations were prepared: Label 814 (corn extract-based yogurt) and Label 609 (a 1:1 blend of corn and mung bean extracts). For both formulations, the procedure consisted of four key steps. First, extract preparation involved heating either corn extract (Label 814) or the corn-mung bean blend (Label 609), followed by cooling to room temperature. Next, ingredient mixing was performed by adding sugar, skim milk, powdered agar, and plain yogurt starter culture (Biokul brand) to the cooled extracts. The mixture was then reheated and cooled again to ensure homogeneity. Finally, fermentation was carried out by incubating the inoculated mixture in a sealed container for 20 hours to promote lactic acid bacteria (LAB)

growth and acidification, which facilitated proper texture and flavor development in the final yogurt product.

Hedonic Test. The hedonic test in this study was conducted to evaluate panelists' preferences for the yogurt based on color, taste, aroma, and texture parameters. A total of 15 panelists from Politeknik Negeri Sriwijaya were randomly selected to assess the yogurt samples and rate their preference using a 4-point scale, where: 1 = Dislike very much; 2 = Dislike; 3 = Like; 4 = Like very much [12]. The test aimed to determine consumer acceptability and sensory quality of the yogurt formulations.

pH Test. The pH of yogurt is tested using pH paper. The pH paper is smeared on the yogurt sample, and then the results are compared with the score on the pH paper.

Data Analysis. The research results were analyzed descriptively for both hedonic test and pH measurements, comparing pure corn milk yogurt with the blended corn-mung bean milk yogurt. The sensory evaluation data (color, aroma, taste, and texture) obtained from the 4-point hedonic scale were presented as mean preference scores with standard deviations. Similarly, pH values from triplicate measurements were reported to assess acidity differences between the two yogurt formulations.

Result and Discussion

Color Appearance Evaluation. Color serves as a critical determinant of food quality and consumer acceptance. Even with optimal flavor and texture, unappealing coloration may render products visually unappealing or non-standard [13]. Our findings demonstrate distinct color characteristics between samples: corn milk yogurt (814) exhibited an intense yellow hue (Figure 1.A). At the same time, the corn-mung bean blend (609) showed a pale yellowish-green coloration (Figure 1.B). The vibrant yellow in sample 814 originates from carotenoid pigments present in corn. As Luján et al. [14] established, carotenoids (including β -carotene and lutein) impart characteristic red, yellow, and orange pigmentation in corn (Figure 1.A). The mung bean caused the color to be pale yellowish-green, in sample 609 contributes chlorophyll pigments that generate greenish tones [15]. Increasing the mung bean extract proportion resulted in progressive darkening and greyish discoloration of the final product. This observation aligns with previous research [16] on

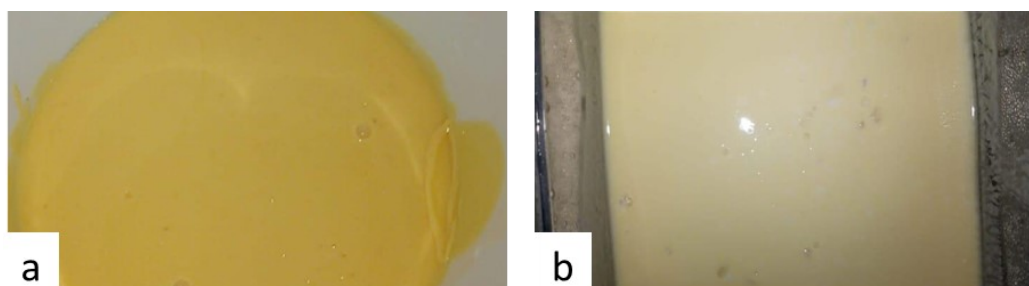


Figure 1. (A) pure corn milk yogurt (Sample 814); (B) corn-mung bean blended yogurt (Sample 609)

plant-based milk combinations, where higher mung bean content relative to sweet corn produced darker beverage coloration, subsequently reducing color acceptability scores. The phenomenon confirms that raw material composition directly influences final product color intensity through pigment interactions.

Color Hedonic Evaluation. Yogurt color is a critical factor influencing product quality perception and consumer acceptance [17]. The hedonic scores for color preference showed minimal differences between pure corn milk yogurt (sample 814) and the corn-mung bean blended yogurt (sample 609). This similarity can be attributed to both samples exhibiting moderate yellow coloration that closely resembles conventional yogurt. The comparable color profiles between the two formulations likely resulted from the balanced 1:1 blending ratio of the ingredients. As supported by previous research [18], the relatively similar color preference scores between the corn-based yogurt and the corn-mung bean combination may be explained by the well-proportioned formulation. As shown in Figure 2, panelists demonstrated a higher preference for the corn-mung bean blended yogurt. This preference appears to be influenced by the product's less intense yellow coloration compared to the pure corn variant, suggesting that consumers favor yogurt colors that approximate traditional dairy-based products.

Texture Hedonic Evaluation. The corn-mung bean blended yogurt (Sample 609) achieved the highest texture preference score of 10. As illustrated in Figure 3, panelists generally preferred Sample 609, as evidenced by lower "dislike" scores and higher "like" scores compared to other samples. The blended yogurt exhibited a notably denser texture than the pure corn milk yogurt (Sample 814), indicating consumer preference for a thicker yogurt consistency. Adawiyah et al [19] state that sensory panels

typically favor yogurts with fine textures rather than grainy ones, since smooth textures are commonly associated with better palatability and a more pleasant sensory experience. This texture enhancement can be attributed to the starch content from mung bean extract, which significantly increased the product's viscosity. Louisa Sine [13] demonstrated in their study on organoleptic testing of mung bean-corn milk that starch undergoes proper gelatinization with adequate heat treatment. The addition of mung bean to dairy analogs improves stability and viscosity due to its higher starch content. Furthermore, product stability correlates with total soluble solids content. Sweet corn contains higher sugar levels but lower starch content compared to mung beans, resulting in reduced viscosity. This explains the texture differences between the two formulations, where the mung bean-enriched sample (609) showed superior thickness and corresponding higher consumer acceptance.

Aroma Hedonic Evaluation

The blended corn-mung bean yogurt (Sample 609) received the highest scores in the "like very much" category. However, overall preference was greater for pure corn yogurt (Sample 814), as evidenced by comparative scores between samples: Higher "dislike" scores for Sample 609 (7) versus Sample

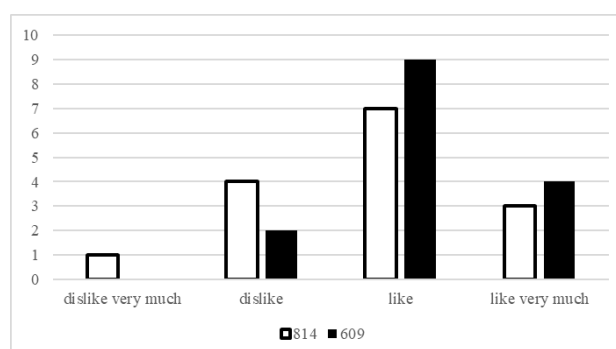


Figure 2. Hedonic evaluation of yogurt color attribute; (a) pure corn milk yogurt (Sample 814) and (b) corn-mung bean blended yogurt (Sample 609)

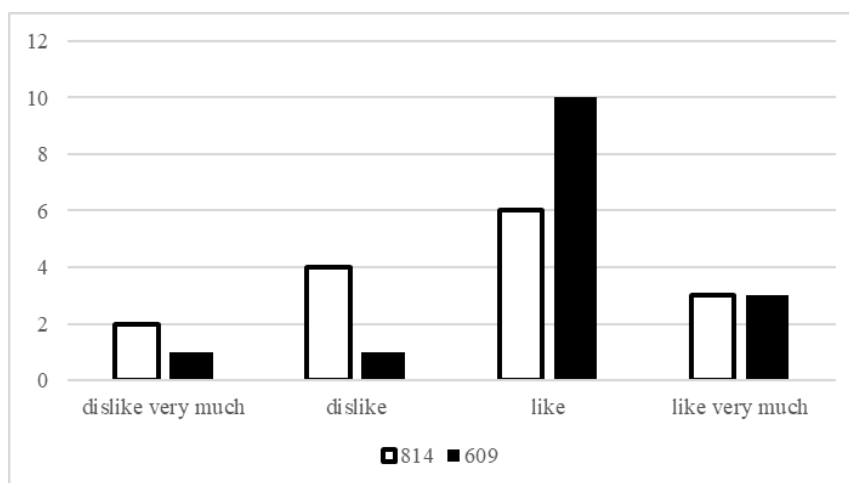


Figure 3. Hedonic evaluation results of yogurt texture preference: (a) pure corn milk yogurt (Sample 814) and (b) corn-mung bean blended yogurt (Sample 609)

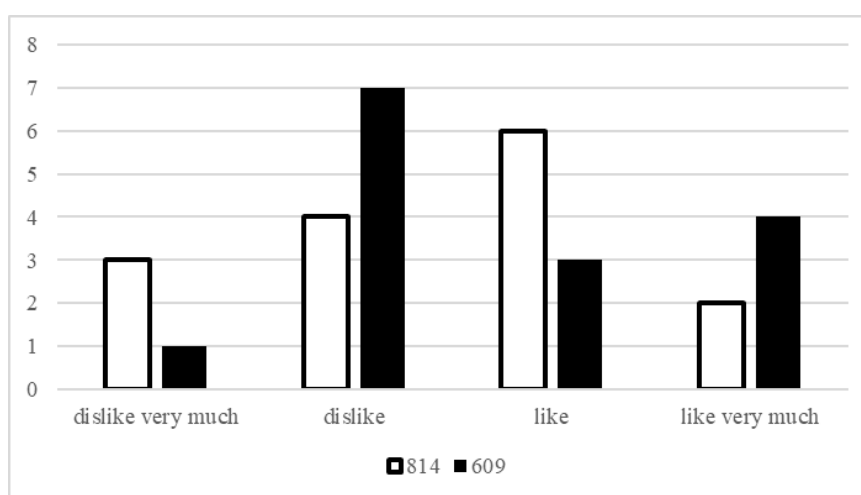


Figure 4. Hedonic evaluation results of yogurt aroma preference: (a) pure corn milk yogurt (Sample 814) and (b) corn-mung bean blended yogurt (Sample 609)

814 (4); Lower "like" scores for Sample 609 (3) compared to Sample 814 (6). This preference pattern indicates panelists favored the characteristic corn aroma over the slight beany off-flavor of mung bean. Notably, the blended yogurt achieved higher "like very much" scores due to effective mitigation of this off-flavor. As demonstrated by Setyani et al [18], proper processing can minimize undesirable beany notes in mung bean products. Sriantha [20] further explains that volatile compounds (e.g., acetaldehyde) in corn may function as natural flavor modifiers, effectively neutralizing beany aromas. The panelists' responses to the plant-based yogurt varied, with a predominant perception of acidic aroma notes. This characteristic sour aroma profile results from the fermentation process mediated by the starter culture, which significantly influences metabolic activities, particularly in the formation of distinct aromatic compounds [21].

Overall hedonic evaluation. The blended corn-mung bean yogurt (Sample 609) was chosen as the best sample due to its high preference score in most parameters, both in terms of "like" and "very much like" scores, compared to pure corn yogurt with code 814. This finding is consistent with research on the effect of combining sweet corn and green beans on the physicochemical and organoleptic characteristics of plant-based beverages, which showed that the highest overall hedonic score was achieved with a 1:1 ratio of corn to green beans. The resulting yogurt has a sour taste, which is a result of the degradation of simple sugars (lactose) by lactic acid bacteria (LAB) through the Embden-Meyerhof-Parnas (EMP) pathway. This metabolic process produces lactic acid as the end product, which contributes to the decrease in pH through progressive acidification [16] [21].

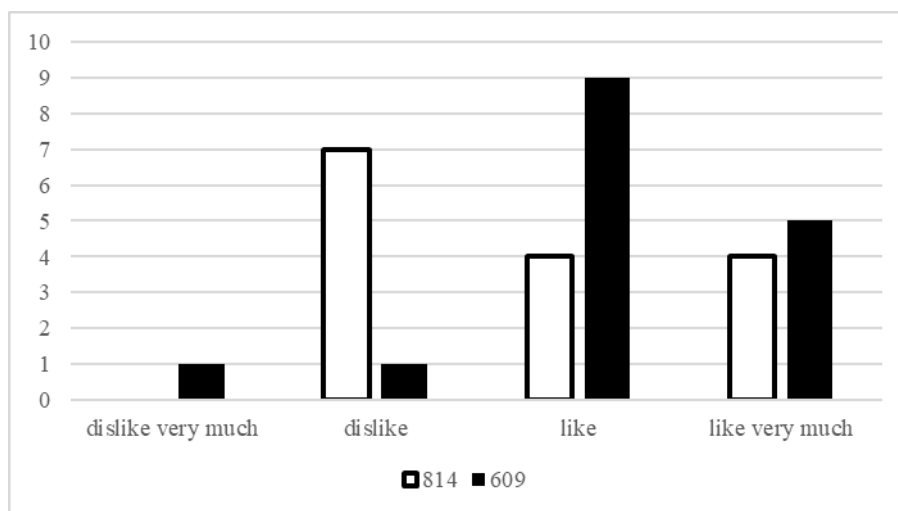


Figure 5. Overall hedonic evaluation results of yogurt samples: (a) pure corn milk yogurt (Sample 814) and (b) corn-mung bean blended yogurt (Sample 609)

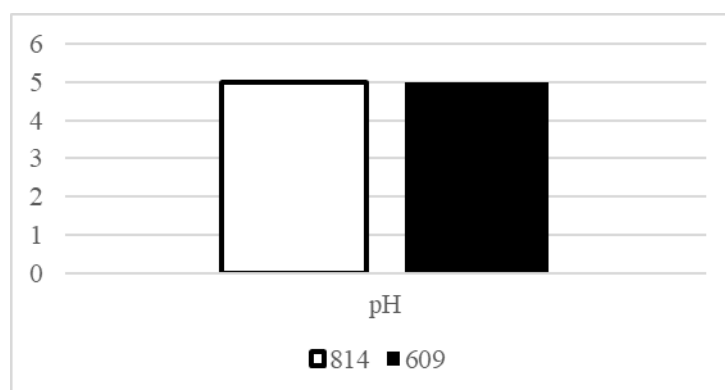


Figure 6. pH of yogurt product; (a) pure corn milk yogurt (Sample 814) and (b) corn-mung bean blended yogurt (Sample 609)

pH evaluation. Fermentation of yogurt by lactic acid bacteria such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus* converts lactose into lactic acid, lowering the pH and making the yogurt more acidic. A similar process occurs in sweet corn and green bean yogurt, resulting in a pH of around 5. There was no significant difference in the final pH between the two samples. pH testing after fermentation is crucial to determine the acidity level and safety for consumption. If the yogurt is too acidic, it can have negative impacts on stomach health. During fermentation, LAB converts carbohydrates into lactic acid, which accumulates in the fermentation liquid. The more acid secreted, the higher the acidity level. This

accumulation of lactic acid ultimately leads to a decrease in pH. A low pH indicates high acidity, while a high pH means the yogurt is less acidic. Lactic acid bacteria produce lactic acid from carbohydrate fermentation, affecting the yogurt's acidity [21] [22] [23].

Conclusion

Based on the conducted research, it can be concluded that mung bean extract affects yogurt product quality by altering its color and achieving higher hedonic test scores compared to pure corn milk yogurt. No significant difference was observed in the final pH between the products. Therefore, the best yogurt product is the combination of corn and mung bean extracts."

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Author Contributions

All authors participated in scientific discussions that informed this article.

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