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Article

Effect of The Addition of Unripe Berlin Banana Flour on The Organoleptic Characteristics of Synbiotic Yogurt

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Abstract: Synbiotic yogurt is a fermented milk product that combines probiotic bacteria with ingredients containing prebiotic components. Unripe banana flour (UBF) contains resistant starch (RS), which contributes to the development of prebiotics in synbiotic yogurt products. The research aimed to know the effect of the addition of UBF on the organoleptic characteristics of synbiotic yogurt. The research was carried out with an unripe Berlin banana. Four treatment groups included 2% inulin (P0), 1% UBF (P1), 2% UBF (P2), and 3% UBF (P3). The organoleptic characteristics include hedonic and hedonic quality tests using 48 semi-trained panelists. The data was statistically analyzed using the Kruskall-Wallis test followed by the Mann-Whitney test. The results of the hedonic test indicate that texture, aroma, and color significantly differed between groups ($P<0.05$), while taste did not significantly differ between groups ($P>0.05$). The hedonic quality test indicated that there were significant differences between groups in terms of texture, aroma, and color ($P<0.05$). However, there was no significant difference in taste between the groups ($P>0.05$). In conclusion, formula 2% UBF (P1) is the most preferable formula based on the organoleptic test.

Keywords: organoleptic; synbiotics yogurt; unripe banana flour

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1. Introduction

Yogurt is formed by the fermentation of lactose to lactic acid by the starter bacteria [1]. Synbiotic yogurt is one of the functional foods with health benefits. Synbiotic yogurt is a fermented dairy product that combines probiotic bacteria with ingredients containing prebiotic components [2]. Synbiotic Yoghurt can significantly reduce pathogenic bacteria in faeces [3].

A probiotic is a live microorganism when administered in adequate amounts, improves the health of the host [4]. Most known probiotic species belong to the lactic acid bacteria (LAB) group [5]. The most common strains as probiotics and possessing beneficial health effects are *Enterococcus faecium, Bifidobacterium, Bacillus, Saccharomyces boulardii (S. boulardii), Lactobacillus strains,* and *Pediococcus* [6]. Probiotics have beneficial effects, including anticholesterolemic, anti-ulcer, anti-diabetic, anticlerosis [7], anti-inflammatory, anti-obesity, anti-angiogenesis, anti-cancer, relief of lactose intolerance symptoms, improvement of gastrointestinal diseases, inhibition of pathogenic bacteria, synthesis of essential micronutrients and improvement of the bioavailability of nutrients in the diet [8,9].

Prebiotics are substrates selectively used by host microbes to provide health benefits. The criteria for a prebiotic substrate include resistance to gastric acid, resistance to

degradation by digestive enzymes, resistance to absorption by the gut, ability to ferment by the gut microbiome, and ability to stimulate the growth of the gut microbiome to promote health [10]. There are many types of prebiotics. The majority of them are a subset of carbohydrate groups and are mostly oligosaccharide carbohydrates (OSCs). Fructan is one type of prebiotic consist of inulin and fructo-oligosaccharide or oligofructose. Some studies implicated that fructans can stimulate lactic acid bacteria selectively [11]. Prebiotics play an important role in human health and naturally exist in different dietary food products, including asparagus, sugar beet, garlic, chicory, onion, Jerusalem artichoke, wheat, honey, banana, barley, tomato, rye, soybean, human's and cow's milk, peas, beans, etc [12]. Prebiotics effects for health maintenance and protection against disorders. Prebiotics not only have protective effects on the gastrointestinal system but also on other parts of the body, such as the central nervous system, immune system, and cardiovascular system [13].

Synbiotic yogurt is growing rapidly in Indonesia, with research focusing on the addition of fruits such as bananas. Bananas are a rich source of fiber, starch, and any minerals such as magnesium, potassium, manganese, and phosphorus, as well as vitamin B6 for consumers [14]. Additionally, bananas contain bioactive compounds such as carotenoids, phenolics, and phytosterols [15,16]. In vitro and in vivo models have demonstrated the potential health benefits of bananas and the importance of phenolic compounds against of phenolic compounds against various physiological disorders [17].

The benefits of secondary metabolites present in bananas are due to their various biological activities. These activities include regulating enzyme expression, antioxidants, chemoprevention, and anti-inflammatory effects [18]. Berlin banana is a type of banana commonly found in Jember Regency. Berlin banana flour has a higher protein content of 4% compared to 3.76% for Kepok banana flour and 3.82% for Gedah banana flour [19]. Unripe banana flour supports the growth of probiotic bacteria [20]. Unripe bananas contain resistant starch (RS), which has the potential to act as a prebiotic due to its ability to resist digestion and pass through the colon. This positively stimulates gut microbiota fermentation [21]. Resistant starch (RS) is a form of dietary fiber found naturally in many starchy foods. Resistant starch is classified into 5 subtypes: RS1 (physically inaccessible to digestion), RS2 (native starch granules), RS3 (physically modified starch), RS4 (chemically modified starch), and RS5 (amylose–lipid complexes) [22]. Research suggests that unripe banana peel and banana pulp flour have adequate levels of insoluble and soluble fiber. The consumption of pulp flour significantly stimulated a lower glycaemic response in animals [23]. Analysis showed that a resistant starch (RS) content of 40.01% per 100 g Unripe Berlin banana flour, while ripe Berlin banana flour contained 39.76% [24]. In addition to RS content, unripe berlin banana flour also contains flavonoids as much as 241 mg/100 g flour. Pre-clinical tests in vivo showed that the intervention of unripe berlin banana flour in dyslipidemic rats can significantly reduce total and LDL cholesterol levels at a dose of 0.114 g/body weight [25]. The objective of this study was to investigate the impact of incorporating unripe Berlin banana flour on the sensory properties of synbiotic yogurt.

2. Materials and Methods

The research was conducted from June to August 2023. This research was conducted at the Dietetics Laboratory, Nutrition Education Laboratory, Nutrition Study Programme, Jember State Polytechnic. Bananas in the research used unripe berlin banana (Musa acuminata). Unripe banana flour is carried out by modifying the method from Agustin et al. in 2019. The process begins with the selection of unripe bananas that have green peel with state 1 maturation. Process of making unripe banana flour on picture 1 [25].

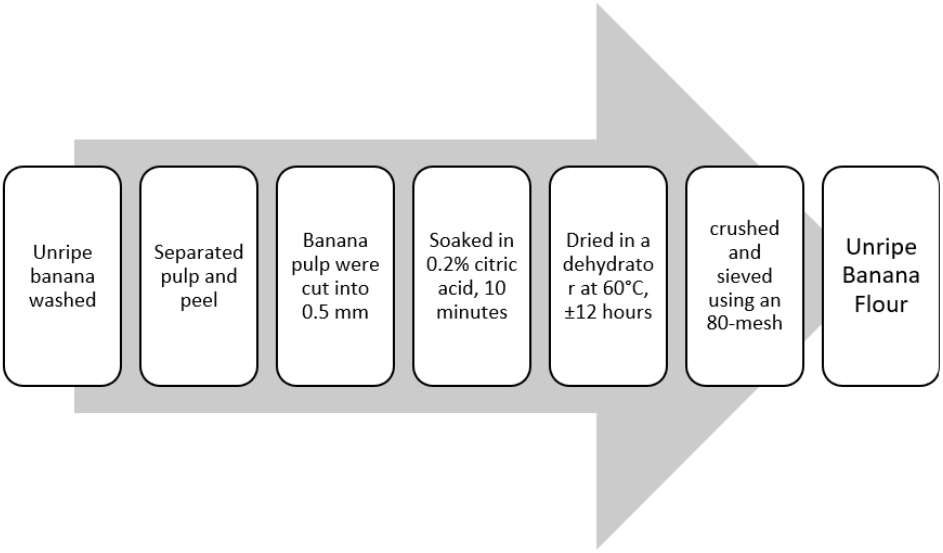
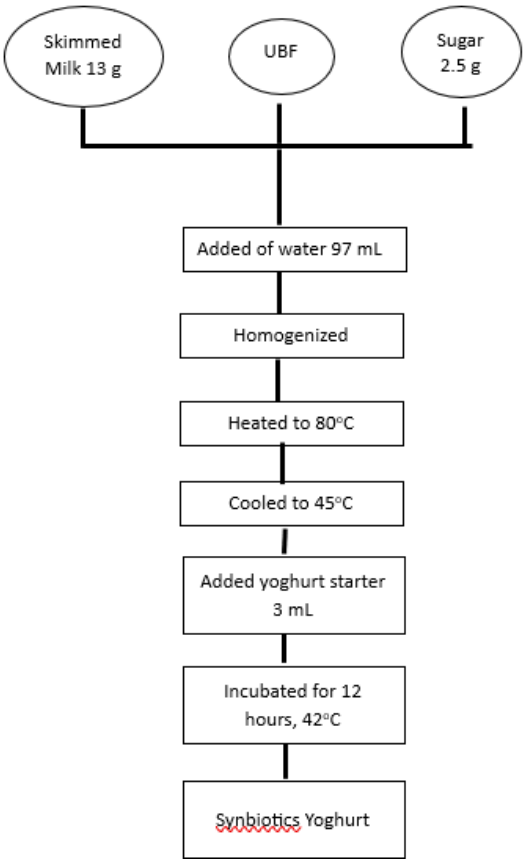


Figure 1. Process of making unripe banana flour (UBF)

The yogurt starter is made by dissolving skimmed milk powder in 1 L of warm sterile water (temperature 45oC). 3 g of dry yogurt starter was added to the warm sterile milk solution, then the solution was then incubated in closed container for 24 hours. Production of unripe banana flour synbiotic yogurt, which is carried out according to the treatment. Then, the stages of making synbiotic yoghurt on picture 2.



Picture 2. Synbiotic yoghurt

In this study, four treatment groups were synbiotic yogurt with 2% inulin (P0), synbiotic yogurt with 1% unripe banana flour (P1), synbiotic yogurt with 2% unripe banana flour (P2), and synbiotic yogurt with 3% unripe banana flour (P3). The organoleptic test includes hedonic and hedonic quality tests conducted on all treatment groups. The organoleptic test involved 48 semi-trained panelists. The organoleptic tests (texture, aroma, taste, and color). The hedonic test about taste, texture, aroma, and color of the product, with rating scales (1: very dislike, 2: dislike, 3: neutral, 4: like, 5: very like). The hedonic quality test included rating scales for taste (1: very sour, 2: sour, 3: moderately sour, 4: slightly sour, 5: not sour), texture (1: very thin, 2: thin, 3: slightly thick, 4: thick, 5: very thick), aroma (1: very milky aroma, 2: milky aroma, 3: moderately milky and banana aroma, 4: banana aroma, 5: very banana aroma), and color (1: milk white, 2: off-white, 3: light brownish, 4: light brown, 5: brown). The data consisted of mean value and the analysis was performed using Kruskall-Wallis and further tests using Mann-Whitney with a 95% confidence level.

3. Results and Discussion

Synbiotic yogurt with unripe banana flour was prepared with the addition of 1% (P1), 2% (P2), and 3% (P3). Synbiotic yogurt on P0 groups used inulin 2%. Inulin is the one of commercial prebiotics. An organoleptic test was conducted on synbiotic yogurt including hedonic and hedonic quality tests related to taste, texture, aroma, and color. The results of the sensory properties can be shown in Table 1.

Table 1. Sensory Properties on Synbiotic Yogurt.

Characteristics	Groups (Mean ± SD)				*P*
	P0	P1	P2	P3	
Hedonic test					
Taste	2.62 ± 0.81^{a}	2.58 ± 0.99^{a}	2.66 ± 1.10^{a}	2.54 ± 1.13^{a}	0.900
Texture	3.72 ± 0.78^{a}	3.58 ± 0.76^{ab}	3.44 ± 0.86^{b}	2.98 ± 1.00^{c}	0.000
Aroma	3.82 ± 0.69^{a}	3.44 ± 0.86^{b}	3.56 ± 0.84^{a}	3.16 ± 0.93^{bc}	0.002
Color	4.26 ± 0.56^{a}	3.62 ± 0.78^{b}	3.22 ± 0.79^{c}	2.48 ± 0.71^{d}	0.000
Hedonic Quality					
Taste	2.48 ± 1.05^{a}	2.10 ± 0.75^{a}	2.31 ± 1.06^{a}	2.19 ± 1.16^{a}	0.264
Texture	2.63 ± 0.82^{a}	3.38 ± 0.70^{bc}	3.54 ± 0.71^{c}	4.54 ± 0.65^{d}	0.000
Aroma	2.17 ± 0.93^{a}	2.75 ± 0.79^{b}	3.08 ± 0.82^{c}	3.65 ± 0.86^{d}	0.000
Color	1.10 ± 0.31^{a}	1.94 ± 0.43^{b}	2.67 ± 0.56^{c}	3.50 ± 0.58^{d}	0.000

Notes: The superscripts within the same row indicate significant differences ($P<0.05$).

The hedonic test for taste reported that non-significant difference between the groups ($P > 0.05$) (Table 1). Panelists rated all treatments as neutral. The taste score for product P2 was the highest compared to P0, P1, and P3. The hedonic quality test related to taste described no significant differences between the groups ($P > 0.05$). The overall mean for all groups is in the range of 2.19-2.48 (moderately sour). In this study, the addition of unripe banana flour did not affect the taste of the yogurt in terms of both hedonic ratings and hedonic quality. This taste is in line with the quality requirements for yogurt taste, such as the SNI 2981-2009 standard, which states that yogurt should have a sour taste [26].

The results of this study are consistent with the findings of Sukasih et al in 2021, who reported that there was no significant difference in the taste of yogurt [27]. Taste is a complex phenomenon in itself and its interaction with other sensory properties adds to the complexity of human perception. The sour taste of yogurt is a complex and dynamic biochemical process influenced by the lactic acid bacteria (LAB) used as starter, such as

Lactococcus lactis, *Lactobacillus species*, *Streptococcus thermophilus*, *Bifidobacterium* species, and *Leuconostoc* species. Flavor-related compounds in yogurt are mainly derived from microorganism-mediated lipolysis, glycolysis, and proteolysis [28]. The acidity of yogurt is influenced by the fermentation of glucose to lactic acid by LAB. The higher the glucose content, the more acidic the resulting taste [29]. Unripe banana flour contains resistant starch, which is a prebiotic compound [25,30].

The average hedonic score for texture showed significant differences between the groups ($P < 0.05$) (Table 1). The texture on P3 was significantly different from P0, P1, and P2. In P0 and P1, panelists rated texture as favorable, whereas in P2 and P3 it was rated as neutral. This is due to the addition of the highest amount of unripe banana flour in P3 compared to the other groups. The more unripe banana flour is added, the lower the average hedonic score. This is in line with a study by Abdalla & Ahmed in 2019, who found that the addition of green banana flour had a significant effect on yogurt texture preference scores [31].

The texture showed significant differences between the groups ($P < 0.05$). The texture of yogurt with unripe banana flour ranged from slightly thick (P1, P2) to thick (P3). This met the requirements of SNI 2981-2009. The standard states that yogurt has a semi-solid to solid appearance [26]. The addition of banana flour can increase the thickness of the yogurt. The pectin content of banana flour increases the viscosity of yogurt [32]. Pectin is a hydrocolloid that can bind water strongly, with this strong water-binding ability it will reduce syneresis in yogurt [33].

The hedonic test for yogurt aroma showed a significant difference between the groups ($P < 0.05$) (Table 1). This result is different from Jenie et al. in 2013 research that banana flour substitution did not affect the aroma preference of yogurt [34]. Aroma in P2 is significantly different from P1 and P3, but not significantly different from P0. Panelists gave favorable ratings to the aroma in P2 and P0. Banana flour supplementation can improve the fatty acid (long chain) and volatile profiles, thereby increasing aroma acceptability [35].

Based on hedonic quality analysis of yogurt for aroma also reported significant differences between groups ($P < 0.05$). The aroma attributes produced on P1, P2, and P3 have resulted from moderate milky and banana aroma (P1, P2) and banana aroma (P3). This is in line with the requirements of SNI 2981-2009 for the normal/typical aroma of yogurt [26]. The aroma of yogurt is caused by the large amount of fermented lactic acid bacteria. *Streptococcus thermophillus* bacteria grow faster and produce acid and *Lactobacillus bulgaricus* produces glycine and histidine which stimulate Streptococcus *Thermophillus* to produce acid. On the other hand, *Streptococcus thermophillus* produces formic acid which stimulates the growth of *Lactobacillus bulgaricus*, producing a distinctive aroma [28, 36].

The color hedonic analysis reported that the addition of the concentration of unripe banana flour significantly influenced the acceptance of synbiotic yogurt ($P < 0.05$) (Table 1). The panelists' preference decreased as the concentration of unripe banana flour increased. Panelists rated P0 and P1 as liked, P2 as neutral, and P3 as disliked in terms of color. The color based on hedonic quality test showed significant differences between the groups ($P < 0.05$). The addition of unripe banana flour results in different colors. P1 groups were milky white, P2 groups were pale white, and P3 groups were light brownish. The addition of unripe banana flour changed the color of the yogurt. This is due to the higher amount of UBF in P3 compared to P1 and P2. Unripe banana flour was yellowish in color with a slight greenish tinge [37]. This color may be due to the ripeness of the fruit and the high starch content [31]. The brownish color of banana flour is due to an increase in the activity enzyme polyphenol oxidase (PPO), which causes enzymatic browning [38]. PPO

activity is further increased when the flesh is exposed to oxygen during peeling and drying. The result is the formation of brown by-products that give the flour an unpleasant brownish color [39].

4. Conclusions

The addition of unripe banana flour to synbiotic yogurt based on hedonic and hedonic quality tests can be concluded to have an impact on the texture, aroma, and color of synbiotic yogurt. The higher concentration of unripe berlin banana flour showed the thicker yogurt texture, banana fruit aroma, and brown color of synbiotic yogurt. Formula P1 is the most preferable formula based on the hedonic test. Formula P1 has a moderately sour taste, slightly thick, moderate milky and banana aroma, and a milky white color.

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