

Characteristics of Soyghurt Added with Tuntung Pandang Bananas with Variations in Fermentation Time

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ABSTRACT: Soyghurt is one of the beverage products from soy milk, which is produced through a fermentation process by lactic acid bacteria (LAB). The bacteria commonly used are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. This study aimed to analyse the quality of the physical and chemical properties of banana yoghurt with various fermentation times. The method used in this research involves making soy yoghurt products through four stages of fermentation: 6 hours, 12 hours, 18 hours, and 24 hours. The quality analysis performed was physical analysis (viscosity test and pH test), chemical analysis (ash content test, acid content test, and protein test), and organoleptic properties (hedonic test and hedonic quality test). Then, an analysis of the ANOVA test was conducted to determine the average of more than two groups of data by comparing the variances and describing the total data. Based on the results of the study, it can be interpreted that the analysis of the quality of banana soyghurt with various physical and chemical showed results, namely the viscosity between 51.00cp - 55.05cp, pH test 5.27 - 4.18, ash content 0.37% - 0.49%, test for acid content 0.50% - 0.72%, and test for protein 2.18%, and the organoleptic test for hedonic panelists is somewhat like texture, somewhat like the taste, liked the aroma and somewhat liked the color, for hedonic quality slightly thick texture, sour flavour, distinctive pungent soyghurt aroma, and yellowish white color.

Keywords: Banana, fermentation, soyghurt

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INTRODUCTION

Soy milk is a good source of protein. However, the use of soy milk is still limited because of its unpleasant taste (flavoured). The limitations of soy milk can be reduced through the fermentation process of soy milk into yoghurt, better known as fermented soyghurt, which is one of the efforts made and has been proven to increase the nutritional value and improve the acceptability of soy milk (Rosida et al., 2020).

Soyghurt is a beverage product made from soy milk, produced through lactic acid bacteria (LAB) fermentation. The bacteria commonly used are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. This fermented milk is popular among the public because it tastes delicious and offers numerous health benefits. Besides that, soy yoghurt has several benefits resulting from the

fermentation process of lactic acid bacteria, including balancing the digestive system, lowering cholesterol levels, preventing cancer, and treating fungal and bacterial infections. The soyghurt added carrot juice has a significant effect on increasing antioxidant activity (Susiloningsih et al., 2016).

One fruit that is widely available and popular among most people is the banana. Therefore, bananas are added to make soyghurt. One type of banana that is commonly cultivated in the Tanah Laut area is the "Tuntung Pandang" banana or "Tundang" banana. Tundang bananas are typical of Tanah Laut bananas, which are almost spread throughout Tanah Laut Regency (South Kalimantan, Indonesia) (Inspirasi Tala, 2022). Bananas are used for human nutrition and are a potential source of prebiotics, which can be

used as an ingredient in functional foods. (Powthong et al., 2020). A combination of bananas and soy milk produces a balanced and nutritional food.

The addition of sugar, skim milk, starter, and CMC in making soyghurt is one factor influencing soyghurt fermentation. Another factor that also influences the success of fermentation is fermentation time. The length of fermentation will affect the number of probiotic bacteria present and the characteristics of the product that will be produced. Making soyghurt requires a long fermentation time to produce acid from soy milk. As fermentation takes longer, it will cause changes in the number of lactic acid bacteria, a decrease in pH, and changes in characteristics such as texture, color, aroma, and taste of the soyghurt produced. (Gabriela et al., 2021; Rosida et al., 2020; Susiloningsih et al., 2016).

Currently, there are no studies regarding the production of soyghurt, which is added to the Tuntung Pandang banana, which is a typical banana from Tanah Laut with different fermentation times. In this research, Tundang banana soyghurt was fermented at various times, namely 6, 12, 18, and 24 hours. Next, the soyghurt analysis is analyzed based on physical properties (viscosity and pH tests), chemical properties (acid content test, ash content test, and protein test), and organoleptic properties.

MATERIALS AND METHODS

Materials

The ingredients used in this research were soybeans, water, sugar, CMC, skim milk, tuntung pandang bananas, and starter. Materials used in testing distilled water, NaOH, borate, HCL, bromocresol green (BCG), potassium sulfate, super sulfate, pH indicator, and soyghurt.

The Making of Soy Milk

The tools and materials for making soy milk should be clean and ready. This includes 1 kg of soybeans, a basin, a pan, gauze, a blender, a stove, a thermometer, and a spoon. The soybeans should be thoroughly cleaned, with any dirt or impurities removed. The soybeans should be boiled for approximately 15 minutes. The cooked soybeans should be soaked for about 12 hours and then rewashed to remove the epidermis. The soybeans should be blended with a water ratio of

1:8, meaning 8 litres of water should be added to 1 kg of soybeans. The mixture should be filtered through gauze. The filtered mixture should be boiled for approximately 30 minutes, stirring at a temperature of 85–90°C. This process ensures that the soy milk is safe and ready to use (Meirida et al., 2016).

Making Tuntung Pandang Banana Soyghurt

Prepared tools and materials for making soy milk into soyghurt, such as small pans, measuring cups, small plates, small jars, stoves, thermometers, spoons, soy milk, CMC, skim milk, sugar, Tundang bananas, and starter. Weighed 100 ml of soy milk and obtained 98 grams. Added 20% granulated sugar, 20% skim milk, and 5% banana beans by weight of soy milk. CMC stabilizer was added to the sample at a concentration of 0.06% of the weight of soy milk. The next step is to heat the soy milk on the stove at 85–90°C for 15 minutes, stirring continuously, and then cool it to a temperature of 43–45°C. Starter inoculation (Culture of *Lactobacillus bulgaris* and *Streptococcus thermophilus*) is as much as 10%, stirred evenly. The results were put into a small jar, tightly closed, and incubated for 6, 12, 18, and 24 hours, and then the soygurt was analyzed (Meirida et al., 2016).

Physical Properties

Viscosity

The first stage involves preparing all the necessary tools and materials. After that, weigh the mass of the marble using an analytical balance, then measure the diameter of the marble using a calliper, and place the sample into a 30 mL measuring cup. Drop the marble into the sample bottle and count the number of times it falls to a certain depth. The viscosity value is calculated using the following formula:

$$\text{Viscosity} = \pi = \frac{2rb^2(Pb - Pf) g}{9 \cdot V}$$

With g = gravitational acceleration = 980 cm/s²; r = radius of the ball (m); Pb = Density of Marbles (g/ml); Pf = Liquid Density (g/ml); V = Ball Speed (m/s)

pH Test

Test the pH of soyghurt. The first step is to turn on the pH meter and then rinse with distilled water. After that, insert the electrode in a pH 7

buffer solution, then press 'call' until the pH 7 reading is stable. After that, dip the pH meter into the sample. The reading on the pH meter is obtained a few moments after the pH meter is immersed. Look at the stability of the measurement. If the measurement is stable, record the pH meter reading shown on the pH meter screen.

Chemical Analysis

Ash Content

The ash content was measured by weighing an empty porcelain cup and a 10-gram sample, then heating them in a furnace for 5 hours at 550°C until the sample had completely turned to ash. After that, it was cooled in a desiccator and weighed. Then, the ash content is calculated.

Acid Content

The first stage of the acid content test is making a 0.1 N NaOH solution. Weigh 0.4 g of NaOH, then put it in a beaker by adding a little distilled water to dissolve it. Transfer the NaOH into a 100 mL volumetric flask, close the flask, and then homogenise. Then, 50 mL is placed into the burette, and the remaining 50 mL is used for the subsequent titration. The next stage is to test the acid content of the soy yoghurt, by placing 10 ml of the sample into an Erlenmeyer flask and adding three drops of 1% phenolphthalein (PP) indicator. Then, titrate using 0.1 N NaOH until a constant pink color appears. Acid content is calculated using the following formula:

$$\text{Acid content (\%)} = \frac{V_1 \times N \times B}{V_2 \times 100} \times 100\%$$

Thus, V_1 = NaOH Titration Volume (ml); V_2 = Soyghurt Sample Weight (ml); N = NaOH (0.1 N); B = Molecular weight of lactic acid (90)

Protein

Crude Protein (CP) testing is carried out by weighing 1 gram of the sample, then placing it in a clean and dry Erlenmeyer flask. Next, 7 grams of potassium sulfate and 0.8 grams of super sulfate are added, followed by 12 mL of concentrated H₂SO₄. The mixture is then heated in an acid chamber at a temperature of 500°C. Then, cool until the colour is transparent green. After cooling, add 25 mL of distilled water, 50 mL of NaOH, and 30 mL of borate. Then distilled to produce 15 ml. The resulting distillate was placed

in a flask, and two drops of BCG were added. It was then titrated with HCl until the colour changed to yellow. Blanks are also done in the same way. Acid content is calculated using the following formula:

$$N(\%) = \frac{\text{ml HCl (Sample - Blank)} \times N \text{ HCl} \times 14,007 \times 100\%}{\text{Mass Sample} \times 100}$$

$$\%CP = \%N \times \text{Conversion factor of Protein} \times \text{distillation factor}$$

Organoleptic Properties (SNI 01-2346-2006, 2006)

The organoleptic test carried out is a score sheet test, which consists of hedonic tests evaluating the quality of texture, taste, aroma, and colour. In the hedonic test, nine hedonic scales are used to indicate liking, namely 9: really like very much, 8: like very much, 7: like, 6: somewhat like, 5: neutral, 4: somewhat dislike, 3: dislike, 2: very much don't like, 1: don't like.

Meanwhile, the hedonic quality test uses 5 hedonic quality scales. On a scale of texture, 5: very thick, 4: thick, 3: slightly thick, 2: thin and 1: very thin. Taste scale 5: very sour, 4: sour, 3: somewhat sour, 2: not sour and 1: no sour taste. Aroma scale 5: typical of soyghurt is very strong, 4: typical of soyghurt is strong, 3: typical of strong milk, 2: typical of milk is not strong and 1: no smell. Color scale 5: white, 4: yellowish white, 3: slightly yellow, 2: yellow and 1: very yellow.

Data Collection Techniques

The test results obtained were then analysed using the SPSS application, a method for distinguishing the means of more than two groups of data by comparing variances and breaking down the total diversity of the data into components that measure various sources of diversity. This research uses the ANOVA test to see the differences in each sample (Riadi et al., 2020).

RESULTS AND DISCUSSION

Physical Properties

The soyghurt analysis is analyzed based on physical properties (viscosity and pH tests) and chemical properties (acid content test, ash content test, and protein test). The results obtained from the physical properties of banana soyghurt are presented in Table 1.

Table 1. Physical properties of banana soyghurt

No.	Treatment	Viscosity (cp)	pH
1	Fermentation 6 hours	51.00±0.00 ^a	5.27±0.00 ^c
2	Fermentation 12 hours	54.29±0.67 ^b	4.86±0.01 ^b
3	Fermentation 18 hours	54.37±0.00 ^b	4.87±0.00 ^b
4	Fermentation 24 hours	55.05±0.18 ^b	4.18±0.00 ^a
5	SNI-2981-2009	-	4-5

Values in the same column followed by the same letter show no significant difference at a significance level of 5 %.

Viscosity is a measurement that indicates the resistance of a liquid to flow, which is a measure of the friction within the liquid. The greater the viscosity of a fluid, the more difficult it is for the fluid to flow, and also indicates how difficult it is for an object to move through the fluid. Based on the research results, the long fermentation treatment in making Tuntung Pandang banana soyghurt yielded significantly different results in terms of viscosity values. Based on the test results, the average values were obtained, namely, the 6-hour fermentation viscosity value was 51.00 cP, the 12-hour fermentation viscosity value was 54.29 cP, the 18-hour fermentation viscosity value was 54.37 cP, and the 24-hour fermentation viscosity value was 55.05 cP. The viscosity parameter is not listed in SNI 01-2981-2009 as a measurement quality standard because it is based solely on the visual measurement of yoghurt's appearance. SNI 01-2981-2009 states that yoghurt

of good quality has the appearance of a thick to dense liquid and a homogeneous consistency.

The increase in viscosity is due to microbial activity that ferments the protein in soy milk in an acidic atmosphere, causing the protein in soy milk to become semi-solid. *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are both types of lactic acid bacteria. They produce primary metabolites in the form of lactic acid (Gezginc et al., 2016). Research by Adiputra et al. (2022) found that the addition of starter concentration and length of fermentation time in making cow's milk-based yoghurt can increase the viscosity of yoghurt. Additionally, the inclusion of other ingredients, such as kolang-kaling, and the duration of fermentation time in yoghurt production can also enhance the viscosity of the yoghurt. (Salami et al., 2022).

pH expresses the acidity or alkalinity level of a substance, solution, or object. Normal pH has a pH value of 7, while a pH value of more than 7 indicates that the substance has alkaline properties, while a pH value of less than 7 indicates a degree of acidity. (Angelia, 2017). Based on the test results, it was found that the long fermentation treatment in making Tuntung Pan banana soyghurt yielded significantly different results in terms of pH value. The pH values of each sample are as follows: 6 hours of fermentation has a pH value of 5.28, 12 hours of fermentation has a pH value of 4.76, 18 hours of fermentation has a pH value of 4.56, and 24 hours of fermentation has a pH value of 4.18.

Chemical Properties

The chemical properties of banana soyghurt were presented in Table 2. Ash content is the residue from burning organic materials in the form of inorganic substances.

Table 2. Chemical properties of banana soyghurt

No.	Treatment	Ash Content (%)	Acid Content (%)	Protein (%)
1	Fermentation 6 hours	0.49±0.02 ^b	0.50±0.01 ^a	2.18±0.00 ^a
2	Fermentation 12 hours	0.47±0.01 ^b	0.58±0.03 ^b	2.18±0.00 ^a
3	Fermentation 18 hours	0.47±0.00 ^b	0.67±0.00 ^c	2.18±0.00 ^a
4	Fermentation 24 hours	0.37±0.02 ^a	0.72±0.01 ^c	2.18±0.00 ^a
5	(SNI 2981 - 2009, n.d.)	Max. 1.0%	0.5-2.0%	Min. 2.7%

Values in the same column followed by the same letter show no significant difference at a significance level of 5 %.

The determination of ash content is used to assess the mineral content, where a higher ash content indicates a lower product quality. In comparison, a lower ash content indicates a better quality. Based on the test results, it was found that the long fermentation treatment in making Tuntung Pandang banana soyghurt yielded significantly different results in terms of ash content compared to the control. The average ash content in soyghurt products was 0.49% for 6 hours of fermentation, 0.47% for 12 hours of fermentation, 0.47% for 18 hours, and 0.37% for 24 hours. Based on SNI-2981-2009, the ash content in Tuntung Pandang banana soyghurt is a maximum of 1.0%. Therefore, overall, each sample tested complies with SNI.

Acid content is determined by measuring the levels of acidic compounds using a standard alkaline solution (NaOH). The determination of acid content is based on the colour change in the sample and is often referred to as the final point of the titration. Based on the test results, it was found that the long fermentation treatment in making Tuntung Pangan banana soyghurt yielded significantly different results in terms of acid levels compared to the control. In each sample treated with various fermentation lengths, the average acid content was determined, with values of 0.50% for 6-hour fermentation, 0.58% for 12-hour fermentation, 0.67% for 18-hour fermentation, and 0.50% for 24-hour fermentation. Value 0.72%. Based on SNI-2981-2009, the acid content value in Tuntung Pangan banana soyghurt is a maximum of 0.5% to 2.0%. Therefore, each sample tested follows SNI.

Protein is a vital food substance that plays a crucial role in the body, serving as fuel, a building block, and a regulator. Amino acids are simple structural units of proteins and peptides consisting of several amino acids joined by

peptide bonds. (Natsir, 2018). Protein analysis of the fermentation time for the Tuntung Pangan banana soyghurt sample showed that it was not significantly different from the samples analysed for protein content, and the percentage obtained was also the same, namely 2.18% of all samples. Based on SNI-2981-2009, the protein content in yoghurt is at least 2.7%. Therefore, overall, each sample tested does not comply with SNI due to the small number of microbes used. *Streptococcus thermophilus* and *Lactobacillus bulgaricus* were added.

Organoleptic Properties

Based on the organoleptic test and the hedonic quality test carried out on Tuntung Pandang banana soyghurt, the average values obtained are presented in Tables 3 and 4. Then, an ANOVA test was conducted using the SPSS application to assess the differences in each treatment applied to the sample.

Texture

Based on Table 3, the results of the hedonic organoleptic test indicate that the highest scale result obtained in the 12-hour fermentation treatment was 6.27 (somewhat like). At the same time, the lowest value was recorded in the 24-hour fermentation treatment at 5.97 (somewhat like). Based on the ANOVA test, it was concluded that the treatment of various fermentation times in making Tuntung Pandang banana soyghurt, as assessed by the hedonic test on texture parameters, was similar to the product produced. Based on the panellists' assessment, the texture created in soyghurt has slightly favourable criteria for each different fermentation time treatment. Fermentation time had no significant effect on the level of panellist preference for the texture parameter. Soyghurt that has a viscosity of 51.00 - 55.05 cp produces a texture that panellist's favour.

Hedonic Test

Table 3. Hedonic test of banana soyghurt

No.	Treatment	Texture	Taste	Aroma	Color
1	Fermentation 6 hours	6.00±1.01 ^a	6.97±1.21 ^b	5.67±1.32 ^a	6.00±1.33 ^a
2	Fermentation 12 hours	6.27±0.86 ^a	6.53±0.73 ^{ab}	5.53±1.07 ^a	5.87±1.22 ^a
3	Fermentation 18 hours	6.30±0.75 ^a	6.17±1.02 ^a	5.57±1.59 ^a	5.83±1.26 ^a
4	Fermentation 24 hours	5.97±0.91 ^a	6.37±0.80 ^a	5.60±1.52 ^a	6.23±1.19 ^a

Values in the same column followed by the same letter show no significant difference at a significance level of 5 %.

Taste

Based on Table 3, the highest scale result obtained in the 6-hour fermentation treatment was 6.97 (liked), and the lowest value received in the 18-hour fermentation treatment was 6.17 (somewhat liked). Based on the ANOVA test, it was concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as evaluated by the hedonic test on taste parameters, was significantly different from the product produced. This is under research by (Dhahana et al., 2021), where the longer fermentation causes an increase in total acid and a decrease in pH, which results in a sour-tasting product. It means that, on average, all researchers chose to like and somewhat like the Tuntung Pandang banana soyghurt product.

Aroma

Based on Table 3, the results are obtained. The highest scale obtained in the 12-hour fermentation treatment was 5.53 (rather like it), and the lowest score obtained in the 6-hour fermentation treatment was 5.67 (somewhat like it). The ANOVA test concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as determined by the hedonic test on aroma parameters, was not significantly different from the product produced. This finding aligns with research by Dhahana et al. (2021), which suggests that a shorter fermentation time is used to produce a lactic acid aroma that is not too strong and can be accepted by the panellists.

Color

Based on Table 3, the most significant scale results obtained in the 24-hour fermentation treatment were 6.23 (rather like it), and the lowest score obtained in the 18-hour fermentation treatment was 5.83 (somewhat like it). The ANOVA test concluded that the treatment of various fermentation times in making Tuntung

banana soyghurt for the hedonic test on color parameters was not significantly different from the product produced. This follows research by Dhahana et al. (2021) that the color produced in soyghurt drinks treated with varying times of fermentation is uniform. So, it is interpreted that, on average, all panellists chose the colour rather than the Tuntung Pandang banana soyghurt product.

Hedonic Quality Test

Texture

Based on Table 4, the highest scale result obtained in the 24-hour fermentation treatment was 3.97 (thick), and the lowest value received in the 6-hour fermentation treatment was 2.53 (slightly thick). Based on the ANOVA test, it was concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as evaluated by the hedonic test on texture parameters, was significantly different from the resulting product. The texture of soyghurt is influenced by the resulting viscosity. The longer the fermentation, the higher the viscosity, so the thickness of the soyghurt also increases. On average, some panellists chose "thick" and "slightly thick" for the Tuntung Pandang banana soyghurt product.

Taste

Based on Table 4, the highest scale result obtained in the 24-hour fermentation treatment was 4.30 (sour), and the lowest value received in the 6-hour fermentation treatment was 3.33 (slightly acidic). Based on the ANOVA test, it was concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as evaluated by the hedonic test on taste parameters, was significantly different from the product produced.

Table 4. Hedonic quality test of banana soyghurt

No.	Treatment	Texture	Taste	Aroma	Color
1	Fermentation 6 hours	2.53±0.97 ^a	3.33±0.47 ^a	3.80±0.66 ^a	3.93±0.64 ^b
2	Fermentation 12 hours	2.70±0.83 ^{ab}	3.60±0.49 ^{ab}	3.77±0.67 ^a	3.77±0.62 ^{ab}
3	Fermentation 18 hours	3.07±0.86 ^b	3.63±0.49 ^b	3.83±0.64 ^a	3.60±0.62 ^{ab}
4	Fermentation 24 hours	3.97±0.76 ^c	4.30±0.65 ^c	3.97±0.80 ^a	3.43±0.62 ^a

Values in the same column followed by the same letter show no significant difference at a significance level of 5 %.

This is under research by Dhahana et al. (2021). The sour taste becomes more pronounced as the fermentation time increases. This is because prolonged fermentation causes an increase in total acid and a decrease in pH, resulting in a sour-tasting product. So, on average, all researchers chose a sour and slightly sour taste in the Tuntung Pandang banana soyghurt product.

Aroma

Based on Table 4, the highest scale result obtained in the 24-hour fermentation treatment was 3.97 (typical of pungent soyghurt), and the lowest value received in the 12-hour fermentation treatment was 3.77 (typical of pungent soyghurt). The ANOVA test concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as assessed by the hedonic test on aroma parameters, was similar to the product produced. This is based on research by Dhahana et al. (2021), which shows that a longer fermentation time results in an aroma that the panellists prefer. Due to the long fermentation time, the resulting product has a distinctive and robust aroma that the panellists dislike. On average, all researchers identified the characteristic pungent aroma of soyghurt in the Tuntung Pandang banana soyghurt product.

Color

Based on Table 4, the highest scale result obtained in the 6-hour fermentation treatment was 3.93 (yellowish white), and the lowest value received in the 24-hour fermentation treatment was 3.43 (slightly yellow). The ANOVA test concluded that the treatment of various fermentation times in making Tuntung banana soyghurt, as determined by the hedonic test on colour parameters, significantly differed from the product produced. This follows the research of Dhahana et al. (2021). The colour produced in soy yoghurt drinks treated with different fermentation times is uniform: yellowish-white. So, it means that, on average, all panellists chose yellowish-white and slightly yellow for the Tuntung Pandang banana soyghurt product.

CONCLUSION

Based on the research results, it can be concluded that the analysis of the quality of Tuntung Pandang banana soyghurt with various physical, chemical, and organoleptic fermentation

times showed results, namely the viscosity test between 51.00cp - 55.05cp, pH test 5.27 - 4.18, ash content test 0.37% - 0.49%, acid content test 0.50% - 0.72%, protein test 2.18% and organoleptic test for hedonic panelists in terms of texture somewhat like, taste like, aroma somewhat like and color like, For hedonic quality, slightly thick texture, sour taste, distinctive pungent soyghurt aroma, and yellowish white color

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