Quality of synbiotic yogurt drink based on beneng taro flour and honey pineapple juice

YOYOK BUDI PRAMONO[1,*], DINADI RISKA TIARSONO[1], ANNISA ROFIFAH[1], EVA MARUTININGSIH[1], SITI SUSANTI[1], ANANG MOHAMAD LEGOWO[1] AND BAMBANG DWILOKA[1]

[1]Department of Food Technology, Diponegoro University, Semarang, Indonesia.

* Corresponding author: yoyokbudipramono@lecturer.undip.ac.id

Data of the article

First received : 25 September 2023 | Last revision received : 10 November 2023
Accepted : 19 December 2023| Published online :28 December 2023
DOI : 10.17170/kobra-202307218417

Keywords

synbiotic yogurt; beneng taro flour; total LAB; dietary fiber; hedonic.

Yogurt is one of the beverage products that people are interested in comes from fermented milk from bacteria generally Lactobacillus bulgaricus and Streptococcus thermophillus. Synbiotic yogurt is an innovative yogurt product derived from bacteria combined, with breast milk, probiotics, and prebiotics. The bacteria used in fermentation as probiotic bacteria are Lactobacillus acidophilus. Prebiotics are types of carbohydrates that cannot be digested by the digestive system, one of which is found in taro flour. This research aims to determine the effect of adding different concentrations of taro beneng flour on total soluble solids, viscosity, total LAB, reduced sugar content, fiber content, and hedonic level of synbiotic yogurt products combination of beneng taro flour and honey pineapple juice. This study was conducted with the addition of 0.3% bacterial starter, beneng taro flour concentration (2%, 4%, 6%), and the addition of 4% honey pineapple juice. Microbial tests (total LAB), physicochemical tests (total dissolved solids, viscosity, fiber content, and reduction sugar content), and hedonic tests (aroma, color, taste, texture, overall). The results of statistical studies of synbiotic yogurt beneng taro flour and honey pineapple juice showed that the difference in the concentration of adding beneng taro flour had a significant effect on total dissolved solids, viscosity, fiber content, but in total LAB and reduced sugar content had no real effect. The conclusion of the best treatment research was obtained from yogurt with the addition of taro flour as much as 6% based on the Simple Additive Weighting method with three parameters that are priorities for determining the best quality of synbiotic yogurt, dietary fiber content, total LAB, and hedonic overalls.

1. Introduction

Yogurt is a nutritious dairy product with numerous health benefits. As a fermented dairy product, yogurt is made by involving lactic acid bacteria (LAB), resulting in a viscous liquid with a refreshing sour taste. Yogurt is one of the sources of probiotics, which are live bacteria that can survive in the intestine and in certain quantities can provide health benefits to their host (Fazilah et al., 2018). Some of the benefits of probiotic bacteria for the health of their host include improving food absorption, aiding in vitamin production, maintaining health, inhibiting the growth of pathogenic bacteria, reducing cholesterol levels, and preventing carcinogenesis. Lactobacillus acidophilus is one of the probiotic bacteria that is commonly used in yogurt production.

The benefits of probiotics can be enhanced by adding prebiotics. Prebiotics are a type of indigestible carbohydrate that can be fermented by probiotics (LAB) as a source of nutrition to enhance their activity in maintaining the health of their host (Rezende et al., 2021). Consuming yogurt with added prebiotics can help support colon health and improve the absorption of calcium and minerals. In addition to boosting probiotic activity, prebiotics in the form of fiber also have the potential to enhance the chemical quality of yogurt in terms of its fiber content (Gahruie et al., 2015). The combination of probiotics and prebiotics in yogurt production results in synbiotic yogurt. They work synergistically, with prebiotics acting as growth stimulants for probiotic bacteria, allowing their population to increase optimally. This, in turn, can reduce the number of pathogenic bacteria in the human gut and improve other health effects.

Prebiotic sources can be obtained from various food plants, including indigenous tubers (Riyanto and Nafisah, 2022). Talas Beneng (Xanthosoma undipes K. Koch) is an indigenous biodiversity in the Pandeglang region of Banten, known for its larger size compared to other taro varieties and yellow-fleshed corms. Taro flour is an excellent candidate for development as a prebiotic source due to its high dietary fiber content ranging from 8-9% (Putri et al., 2021) and an inulin content of 12% (Eris et al., 2022). Inulin is a water-soluble fiber composed of fructose units that serve as nutrition for the growth of probiotic bacteria (Moghadam et al., 2019). Inulin acts as a prebiotic because it cannot be digested by digestive enzymes but it is fermented by beneficial bacteria like Lactobacillus and Bifidobacteria. Fortifying dairy products with dietary fiber can have a synbiotic effect, increasing dietary fiber content, improving various functional properties such as texture, and serving as a sugar-reduction ingredient (Chen et al., 2018). Yogurt is a dairy product lacking in fiber content, so fortifying it with fiber is necessary to meet the daily fiber requirements of 38 g per day for men and 28 g per day for women (Ozcan and Kurtuldu, 2014).

The addition of fruit juice to synbiotic yogurt is related to consumer acceptance of sensory aspects, including texture, color, taste, and aroma. In this study, honey pineapple juice (Ananas comosus (L.) Merr) will be added to enhance the quality and diversify the synbiotic yogurt product. Honey pineapple is chosen for its stronger sweet taste compared to regular pineapple, with a sugar reduction of 8.66% (Putri et al., 2020). Additionally, compared to other fruits, honey pineapple is selected because it is a local fruit widely preferred by the Indonesian population and readily available.

Previous research has explored the addition of talas beneng flour in yogurt production, but only at a 1% level, without measuring the nutritional content or total LAB (Kusumasari and Pamela, 2019). The novelty of this research is to increase the nutritional content, especially dietary fiber, optimize total LAB, and improve the organoleptic quality of synbiotic yogurt by adding talas beneng flour and honey pineapple juice. Therefore, this study aims to determine the optimal percentage of talas beneng flour addition to enhancing the nutritional value in terms of dietary fiber and total LAB and the addition of honey pineapple juice to diversify a yogurt product preferred by consumers.

Materials and Methods

Preparation of Beneng Taro Flour

The production of beneng taro flour refers to the method of Elisabeth (2015) with modifications. The specific beneng taro used is 12-month-old tubers obtained from a beneng taro producer in Pandeglang, Banten. The process begins by peeling the beneng taro with a knife, washing it with running water, slicing it to a thickness of approximately 1 cm, and soaking it in a 10% NaCl solution for 1 hour to reduce its oxalate content. Afterward, the beneng taro is dried at 60°C for 6 hours in a cabinet dryer (Maksindo, Indonesia). The dried beneng taro is then ground using a grinder (Maksindo, Indonesia) and sifted through a 100-mesh sieve to obtain uniformly sized beneng taro flour.

Preparation of Honey Pineapple Juice

The production of pineapple juice was carried out according to Akhter et al. (2019). The pineapples used are Honey Pineapples from Pemalang, with the criteria of being sufficiently ripe, having a yellow-orange color, and suitable for processing, purchased from fruit vendors at Pasar Jati Banyumanik in Semarang. The process begins with peeling the pineapples using a knife, washing them with running water, and then reducing their size by cutting them into pieces. Subsequently, a pretreatment is performed, which involves blanching at 80°C for 15 minutes, aiming to deactivate the bromelain enzyme that can produce a bitter aftertaste in the product. Afterward, the pineapple pieces are crushed using a blender (Philips, Netherlands) and strained through a straining cloth to obtain honey pineapple juice.

Synbiotic Yogurt Production

The production of synbiotic yogurt was carried out according to the method of Sofyan et al. (2022) with modifications. The process began with commercial pasteurized, Greenfields brand, to which beneng taro flour was added according to the following treatments: P0: no addition of beneng taro flour, P1: addition of 2% beneng taro flour by volume of milk (w/v), P2: addition of 4% beneng taro flour by volume of milk (w/v), and P3: addition of 6% beneng taro flour by volume of milk (w/v). The milk was transferred to sterilized glass bottles for inoculation at 40°C for 4 hours using a commercial yogurt starter, Yogourmet brand, containing L. bulgaricus, L. acidophilus, and S. thermophillus bacteria at a concentration of 0.3% (w/v) of the total yogurt volume. Afterward, 4% honey pineapple juice was added, and incubation was carried out for an additional 1 hour. The finished synbiotic yogurt was then stored at 5°C to inhibit the fermentation process.

2.4 Parameter Analysis

2.4.1 Total Soluble Solids

The total soluble solids (TSS) of yogurt were measured using a digital refractometer (Atago, Japan). The sample was pipetted approximately 1 ml and dripped on the lens until the entire lens surface was evenly covered by the sample. Then the start button was pressed and the TPT value in ˚Brix will appear on the screen automatically. A digital refractometer was used to measure the total soluble solids due to its convenience and speed of measurement.

2.4.2 Viscosity

The viscosity of yogurt was measured using a rotational viscometer, specifically the Brookfield viscometer (Brookfield, USA), as yogurt is a non-Newtonian fluid with viscosity that changes in response to shear stress. Viscosity was measured using spindle number 2 at a spindle speed of 30 rpm (Chen et al., 2018). A 300 ml sample was poured into a beaker. The spindle is attached to the viscometer and lowered into the beaker until it is immersed in the spindle limit line. The reading of the number is done after 7-8 turns of the needle. The measurement results were multiplied by the description factor (10) to obtain the viscosity value in centi Poise (cP) units.

2.4.3 Reduced Sugar Content

The analysis of reducing sugars was determined using the Nelson Somogyi spectrophotometric method as described by Ismail et al. (2020). The Nelson Somogyi Spectrophotometric method is chosen due to its high precision level, making it applicable to sugars with very low concentrations. Initially, 1 ml of the sample solution was diluted and then 1 ml of the Nelson reagent was added. All tubes were heated in a water bath for 20 minutes. After cooling, 1 ml of the Arsenomolybdate reagent was added and shaken until dissolved, followed by the addition of 7 ml of distilled water and further agitation until homogenous. Optical Density (OD) was measured for each solution at a wavelength of 540 nm.

2.4.4 Dietary Fiber Content

The dietary fiber content was determined using the enzymatic gravimetric method following the standard procedure specified by the Association of Official Analytical Chemists (AOAC 985.29, 2011). Measurement of dietary fiber involves simulating the digestive process in the human intestines. The process began by removing its fat content, followed by the hydrolysis of starch and protein using protease and aminoglycoside enzymes. Molecules that remain undigested were separated through filtration as residue. This fiber residue was then dried and weighed. Subsequently, the residue's protein and ash content were analyzed. The dietary fiber content was obtained by subtracting the protein and ash content from the residue.

2.4.5 Total LAB

The measurement of total Lactic Acid Bacteria (LAB) was conducted following the method by Fawzi et al. (2022) using the Total Plate Count (TPC) method, and colony enumeration was performed using the pour plate technique to ensure an even distribution of cells throughout the agar medium. The process begins with sterile dry Petri dishes (Herma, China), Man Rogosa and Sharpe (MRS) agar medium (Merck, Germany), and a dilution solution consisting of 0.85% NaCl that was sterilized using autoclaving (Hirayama, Japan) at 121°C for 15 minutes. The sample was serially diluted seven times, with 1 ml of the diluted sample being added to a reaction tube (Onemed, Indonesia) containing 9 mL of dilution solution. Colony enumeration was carried out by transferring 1 ml from the three most recent dilutions to a Petri dish, followed by the addition of MRS agar medium. After solidification of the medium, the Petri dishes were incubated at 37°C for 48 hours. The colony growth on each dish was quantified as TPC (Total Plate Count) within 1 ml by multiplying the average colony count by the dilution factor and the colony-forming unit (CFU/ml).

2.4.6 Hedonic Test

The hedonic test was determined by referring to the method of Nurhartadi et al. (2017). The hedonic test was performed to determine the acceptance of the panelists regarding the aroma, color, taste, texture, and overall quality of the synbiotic yogurt. The samples were evaluated by 25 semi-trained panelists with the criteria of panelists being Food Technology students of Diponegoro University. The tested samples are served approximately 15 ml and labeled with a 3-digit random number. The panelists provided ratings for their liking level for each attribute using a scoring system, namely score 1 = dislike, score 2 = somewhat like, score 3 = quite like, and score 4 = like. The use of a scoring range from 1 to 4, with values representing dislike, somewhat like, quite like, and like, was employed to avoid a neutral or middle score that could potentially introduce bias into the data.

2.5 Statistical Analysis

This study used a completely randomized design. Data analysis of total LAB, total soluble solids, and viscosity were analyzed using One-way ANOVA, followed by Duncan's multiple range test to compare mean differences at $P<0.05$. The results of the hedonic test were analyzed using the Kruskal Wallis, followed by Mann-Whitney with a significance level of 5% ($P<0.05$). Statistical analyzes were performed using SPSS 26.0 Version. Reduced sugar and dietary fiber content were analyzed descriptively. Determination of the best treatment using the Simple Additive Weighting (SAW) method.

Results and Discussion

The physicochemical quality of syinbiotic yoghurt with variations in the concentration of adding beneng taro flour is illustrated in Table 1.

3.1 Total Soluble Solids

Based on the results of the analysis of variance, it showed that the addition of beneng taro flour had a significant difference ($P<0.05$) in the total soluble solids of synbiotic yogurt. The total soluble solids of yogurt ranged from 7.72 to 10.06 °Brix. The highest total soluble solids value (10.06 °Brix) was obtained with a 6% addition of beneng taro flour, while the lowest value (7.72 °Brix) was obtained in the control treatment (see Table 1). These values show that the more concentration of beneng taro flour was added, the higher total soluble solids were contained.

The total soluble solids in yogurt include total sugars, lactic acid, and organic acids. These components result from the fermentation process carried out by the starter culture, which involves breaking down proteins into simpler components that are soluble in water, as well as the breakdown of carbohydrates and fats (Ahsan et al., 2020). The high carbohydrate content (80%) in beneng taro is suspected to affect the total soluble solids content of yogurt. One factor that can increase the total soluble solids in yogurt is the presence of additional compounds in the form of carbohydrate macromolecules, which will be broken down by lactic acid bacteria (LAB) into reducing sugars and lactic acid during the fermentation process (Greis et al., 2022). An increase in the carbohydrate nutritional content in yogurt will enhance the total soluble solids content in yogurt.

The dietary fiber inulin present in talas beneng flour is also suspected to have an impact on increasing the total soluble solids in yogurt. Inulin is water-soluble,

ISSN-Internet 2197-411x OLCL 862804632

Table 1. Physicochemical Quality of Synbiotic Yogurt

Beneng Taro Flour	Total Soluble Solids (°Brix)	Viscosity (centi Poise)	Reduced Sugar Content (%)	Dietary Fiber Content (%)
0%	7.72 ± 0.57[a]	191±8.94[a]	1.28	3.67
2%	9.00 ± 0.35[b]	633±30.74[C]	1.20	3.56
4%	9.02 ± 0.30[b]	524±9.61[b]	1.34	4.51
6%	10.06±0.78[C]	773±43.39[s]	1.30	4.29

Data is showed as the average value ± standard deviation. Values with different lowercase superscripts show a noticeable difference (P<0.05).

and its solubility can enhance the total soluble solids in yogurt. Inulin dissolves in water and during the fermentation process, it can be broken down by Lactobacillus bacteria to be used as a source of energy in their metabolism (Permana et al., 2020). This is in line with the results of Vasconcelos et al. (2021) that the addition of yacon flour, which contains inulin, resulted in yogurt with higher total soluble solids compared to the control yogurt.

3.2 Viscosity

Based on the result of the analysis of variance, it showed that the addition of beneng taro flour had a significant difference (P<0.05) in the viscosity of synbiotic yogurt. The viscosity of yogurt ranged from 191 centi Poise to 773 centi Poise. The highest viscosity value (773 centi Poise) was obtained with a 6% addition of talas beneng flour, and the lowest value (191 centi Poise) was obtained in the treatment without the addition of beneng taro flour (see Table 1). Yogurt with the addition of beneng taro flour exhibited higher viscosity compared to the control treatment. Viscosity changes because the solubility of casein decreases due to an increasingly acidic pH, leading to the formation of hydrophobic casein micelles that contribute to the structure and consistency of yogurt.

Beneng taro flour increases the viscosity of synbiotic yogurt because it contains 80% carbohydrates (Rostianti et al., 2018). According to Dhawi et al. (2020), the carbohydrate content can increase viscosity because it can bind water and form a gel. Beneng taro flour contains 75.62% of the total starch. The addition of taro starch can increase yogurt's viscosity because starch, composed of amylose and amylopectin as solid components, has a high water absorption capacity, resulting in high-viscosity yogurt (Khubber et al., 2021).

Starch binds water and acts as a thickening agent. The more addition of starch, the higher the viscosity because of the increased water-binding capacity (Sofyan et al., 2022).

Inulin present in beneng taro flour is also suspected to be a factor in the increased viscosity of synbiotic yogurt. This result aligns with the findings of Handayani et al. (2016), indicating that yogurt with modified yam flour (containing 7.5% inulin) at 2%, 4%, and 6% levels exhibited higher viscosity in each treatment. The higher viscosity of yogurt is attributed to inulin's ability to bind extracellular polysaccharides and proteins, resulting in the firmness of the yogurt's texture.

3.3 Reduced Sugar Content

The results of the study indicated that the reduced sugar content in synbiotic yogurt with the addition of beneng taro flour and honey pineapple tended to increase with the addition of beneng taro flour. The highest reduced sugar content (1.34%) was obtained in the treatment with 4% beneng taro flour addition, and the lowest result (1.20%) was obtained with 2% taro yam flour addition (see Table 1). The reduced sugar content is related to the total LAB (Lactic Acid Bacteria) because the reduced sugar content reflects the amount of simple sugars that have been broken down by LAB for metabolic processes. The reduced sugar content in synbiotic yogurt comes from the ingredients used, which include milk containing lactose, honey pineapple juice containing galactose, fructose, glucose, and beneng taro flour.

Beneng taro flour influences the reduced sugar value, where the greater the addition of taro yam flour, the higher the reduced sugar content obtained. It is suspected that LAB may not be optimal in breaking down the reduced sugar present in yogurt with the addition of beneng taro flour, resulting in a relatively high remaining total reduced sugar content. A similar condition was also observed in the research by Sampurno et al. (2020), where the addition of jackfruit and cempedak pulp did not have a significant impact on reducing the sugar content in goat milk yogurt due to an excessive amount of nutrients added, causing LAB not to break down the sugars optimally, resulting in high residual reduced sugar content.

3.4 Dietary Fiber Content

The highest dietary fiber content (4.51%) was obtained in synbiotic yogurt with 4% beneng taro flour addition, while the lowest dietary fiber content (3.56%) was found in synbiotic yogurt with 2% beneng taro flour addition (see Table 1). These results indicated that the variation in dietary fiber content was influenced by the composition and proportion of ingredients used in the production of synbiotic yogurt. Beneng taro flour contains dietary fiber ranging from 8-9% and inulin at 12%, which can function as a prebiotic (Putri et al., 2021; Eris et al., 2022). Similar findings were previously reported by Atwaa et al. (2020), demonstrating a positive effect on the chemical properties of yogurt with the addition of mango peel fiber, where dietary fiber increased with the amount of added flour.

Dairy products fortified with dietary fiber can provide a synbiotic effect and increase dietary fiber content (Chen et al., 2018). The control yogurt contains dietary fiber solely from the addition of honey pineapple juice, which contains dietary fiber at 1.46% (Anggaratih and Rahmawati, 2022). The type and formulation of various dietary fibers added can influence the quality and acceptance of the yogurt produced.

3.5 Total LAB

The addition of beneng taro flour to synbiotic yogurt did not have a significant effect on the total LAB (Lactic Acid Bacteria) (P>0.05). The highest total LAB (2.6 x 109 CFU/ml) was obtained in the treatment without the addition of beneng taro flour, and the lowest result (6.5 x 108 CFU/ml) was obtained in the treatment with 2% beneng taro flour addition (see Figure 1). The total LAB obtained represents the synergy of LAB present in the starter culture, including S. thermophilus, L. bulgaricus, and L. acidophilus, which undergoes cell multiplication. The lower total LAB in synbiotic yogurt with the addition of beneng taro flour is likely due to the inability of one of the starter bacteria to break down the substrate from the beneng taro flour.

That is in line with Cahyanti et al. (2021) statement that L. bulgaricus is a culture that cannot ferment certain types of substrates, including inulin. Supported by Eris et al.'s (2022) statement that beneng taro flour contains 12% inulin.

LAB obtains its source of nutrients from the ingredients used. The reduction in the concentration of milk, which is replaced by the addition of taro yam flour, is suspected to result in lower total LAB in synbiotic yogurt with beneng taro flour because of the reduced availability of lactose. The breakdown of lactose into glucose and galactose, subsequently converted into lactic acid, is the main source of energy during LAB cell multiplication in yogurt (Herper et al., 2022). Furthermore, the lower total LAB in yogurt with added beneng taro flour compared to the control treatment is suspected to be due to excess nutrients that cannot be utilized by LAB. According to Riyanto and Nafisah (2022), the potential prebiotic carbohydrates in beneng taro flour are oligosaccharides, including inulin. The addition of beneng taro flour allows for increased nutrition for LAB, especially carbohydrates. That is consistent with the findings of Cahyanti et al. (2021), where the addition of jackfruit and cempedak pulp had no impact on the population of LAB due to an optimal limitation for LAB to use sugar as an energy source during fermentation. This limitation results in not all nutrient sugars being fermented into lactic acid. Although the addition of beneng taro flour did not significantly increase the number of LAB in yogurt, it still met the Indonesian National Standard (SNI) for Yogurt 2981:2009, with a total LAB count exceeding 107 CFU/ml.

ISSN-Internet 2197-411x OLCL 862804632

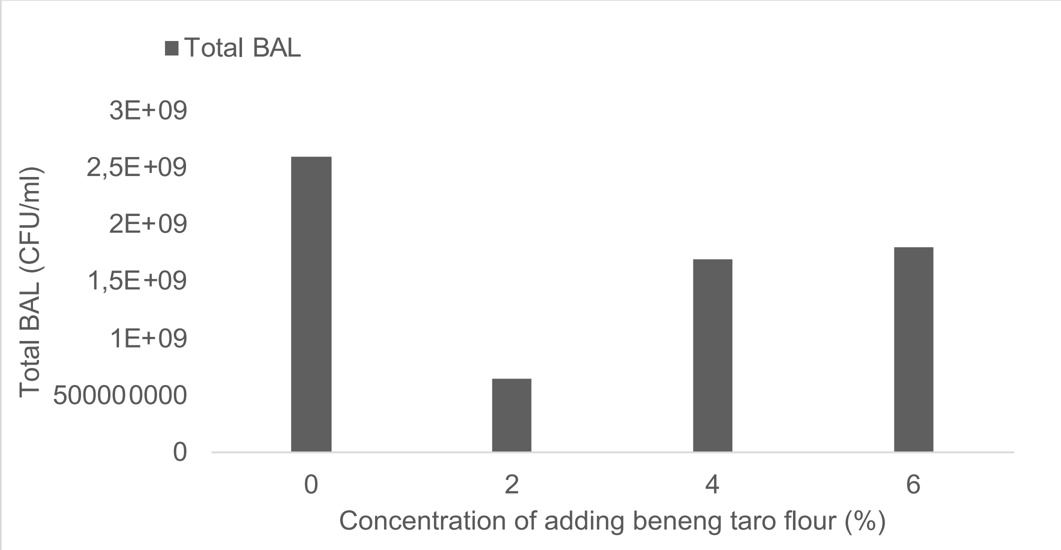

Figure 1. Total LAB Synbiotic Yogurt Beneng Taro Flour

Table 2. Synbiotic yogurt hedonic test results

Beneng Taro Flour	Aroma	Color	Taste	Texture	Overall
0%	3.00±1.15^{ab}	3.00±1.08^{a}	2.12±1.01	1.52±0.71^{a}	2.24±1.05^{a}
2%	3.40±0.91^{a}	3.60±0.71^{b}	2.68±1.03	3.24±0.83^{b}	3.12±0.83^{b}
4%	3.20±0.87^{a}	3.00±0.91^{a}	2.28±0.94	2.80±0.71^{C}	2.64±0.81^{ab}
6%	2.68±0.95^{b}	2.72±1.02^{a}	1.96±0.84	3.20±0.76^{BC}	2.40±0.91^{AC}

Data is showed as the average value ± standard deviation. Values with different lowercase superscripts show a significant difference (P<0.05).

3.6 Hedonic test

The test results of panelists' preference for the aroma, color, taste, texture and overalls of synbiotic yogurt with variations in the concentration of adding beneng taro flour are shown in Table 2.

Based on the results of the Kruskal-Wallis test for the hedonic parameters, it showed that the addition of beneng taro flour had a significant difference in terms of aroma, color, texture, and overall attributes (see Table 2). However, there is no significant difference in the taste attribute of synbiotic yogurt with beneng taro flour and honey pineapple juice. Adding more concentrate of beneng taro flour reduces the panelists' acceptance of all hedonic attributes except for the texture.

Generally, panelists do not prefer yogurt with a strong sour aroma (Thun et al., 2022). The more beneng flour is added, the stronger the aroma is produced because more lactic acid is formed by lactic acid bacteria due to the increasing breakdown of nutritional components. For the color attribute, panelists prefer products with a brighter color (Emam and El-Nashar, 2022). The addition of taro yam flour causes the visual color of synbiotic yogurt to become darker. The darker color of synbiotic yogurt is due to the cream-brown color of beneng taro flour produced by enzymatic reactions during flour production (Sofyan et al., 2022).

For the taste attribute, panelists prefer yogurt with a balanced combination of acidity and sweetness (Atwaa et al., 2022). The addition of beneng taro flour tends to decrease the panelists' preference for the taste of synbiotic yogurt. The addition of beneng taro flour is suspected to increase the nutritional content, especially carbohydrates, which are utilized by lactic acid bacteria (BAL), leading to increased activity and the production of more acidic compounds. The strong acidic taste is also due to the absence of sweeteners in the yogurt production, causing panelists to judge it from somewhat like to quite like for the taste of yogurt (Nurhatadi et al., 2017).

The more beneng taro flour was added, the higher the preference for the texture of synbiotic yogurt because its texture becomes thicker. Panelists prefer a thick-semi-solid texture and do not like a watery texture (Selvamuthukumaran and Farhath, 2014). Beneng taro flour contains carbohydrates as its main component and also contains inulin and starch that bind water, so the addition of beneng taro flour can increase the thickness of the yogurt.

The highest overall acceptability rating (quite like) was obtained for synbiotic yogurt with a 2% beneng taro flour addition. This synbiotic yogurt received a quite like rating for aroma, color, and texture attributes, and a somewhat like rating for taste. Synbiotic yogurt with the addition of beneng taro flour in higher amounts received the lowest acceptability ratings from the panelists in terms of aroma, color, taste, and texture. As reported by Dhawi et al. (2020), the addition of higher amounts of fenugreek seed and moringa oleifera flour to frozen yogurt decreases its sensory acceptance.

This research indicates that consumers tend to dislike yogurt with higher concentrations of beneng taro flour. Consumers only accept yogurt with up to 2% addition of beneng taro flour. Although increasing the amount of beneng taro flour can improve the texture of yogurt, it did not enhance the yogurt's taste, which became more sour. These findings are consistent with the research conducted by Kusumasari and Pamela (2019), which showed that adding beneng taro flour to yogurt, makes its taste more acidic than the control yogurt. Among all sensory attributes, consumers generally consider taste as the primary factor in determining their preference for all food products, including synbiotic yogurt. Therefore, to continue using beneng taro flour to enrich its fiber content in yogurt production, further diversification is needed to address the taste of beneng taro flour yogurt. Alternatively, further research can be conducted to create synbiotic beneng taro flour yogurt without the use of sweetening ingredients by modifying the production method, particularly with regard to the temperature and incubation time used.

3.7 Determination of best treatment

The best treatment in this research was determined using the Simple Additive Weighting (SAW) method. The SAW method is a method with the basic concept of finding the weighted sum of performance levels in each alternative and in all attributes. In this method, it is necessary to normalize the decision matrix (X) to a scale that can be compared with all available alternative levels. There are two types of attributes in the SAW method: benefit attributes and cost attributes, and the difference is based on the criteria selection when making decisions. Benefit attributes indicate that the value of an indicator is better when it is larger, while cost attributes indicate that the value of an indicator is better when it is smaller.

The data from each parameter that has been obtained is compiled in the form of a matrix and then calculated using the SAW method. The calculation steps are as follows:

a. Determine the research alternatives, which are A1, A2, A3 and A4 with the following descriptions:

A1 = Addition of 0% Beneng taro flour
A2 = Addition of 2% Beneng taro flour
A3 = Addition of 4% Beneng taro flour
A4 = Addition of 6% Beneng taro flour

b. Determine the criteria indicators that serve as research parameters, namely indicators C1 to C10 and determine the weight of each indicator with a total weight of 100%, with the following descriptions:

C1 (Dietary Fiber Content) = 30%
C2 (Total LAB) = 15%
C3 (Reduced Sugar Content) = 10%
C4 (TSS) = 5%
C5 (Viscosity) = 5%
C6 (Hedonic Aroma) = 5%
C7 (Hedonic Color) = 10%

ISSN-Internet 2197-411x OLCL 862804632

C8 (Hedonic Taste) = 10%
C9 (Hedonic Texture) = 5%
C10 (Hedonic Overall) = 15%

The difference in the weight of each parameter is determined based on the priority of the purpose of making synbiotic yogurt products, beneng taro flour and honey pineapple juice, namely yogurt products that have high fiber content, the amount of LAB that conforms to SNI standards and yogurt that can be accepted by consumers so that the highest indicator weights are obtained from C1 (dietary fiber content), C2 (total LAB) and followed by C10 (hedonic overall).

c. Compile the values and criteria of alternatives into a table and determine the attributes of each indicator (table 3)

d. Calculate the normalized matrix values (Rij) using Microsoft Excel and obtain the following results:

$$R = \begin{bmatrix} 0.81 & 1 & 0.94 & 0.77 & 0.25 & 0.88 & 0.88 & 0.83 & 0.79 & 0.47 & 0.72 \\ 0.79 & 0.25 & 1 & 0.89 & 0.82 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0.65 & 0.90 & 0.90 & 0.68 & 0.94 & 0.83 & 0.83 & 0.85 & 0.86 & 0.85 \\ 0.95 & 0.69 & 0.92 & 1 & 1 & 0.79 & 0.76 & 0.76 & 0.73 & 0.99 & 0.77 \end{bmatrix}$$

e. Determine the ranking of alternatives by multiplying the normalization results by the weight value of each indicator and then summing the results of the multiplication of each criterion, resulting in table 4.

From the calculation of the results, the highest alternative value in 95.2, which corresponds to A3. Therefore, the addition of 4% beneng taro flour is the best treatment in the production of synbiotic yogurt combined with beneng taro flour and honey pineapple juice.

Conclusion

Increasing the amount of beneng taro flour added in the production of synbiotic yogurt will increase the total dissolved solids, viscosity, fiber content, reduced sugar content, and panelist' preference for texture but it will decrease the total LAB and panelists' preference for aroma, color, taste, and overall yogurt. The best treatment result is obtained from yogurt with the addition of 4% beneng taro flour based on the Simple Additive Weighting method, with three parameters being the top priority in determining the best quality of synbiotic yogurt, namely fiber content, total LAB, and overall hedonic.

Table 3. Alternative and Criteria Values

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	3.67	26	1.28	7.72	191	3	3	2.12	1.52	2.24
A2	3.56	6.5	1.2	9	633	3.4	3.6	2.68	3.24	3.12
A3	4.51	17	1.34	9.02	524	3.2	3	2.28	2.8	2.64
A4	4.29	18	1.3	10.06	773	2.68	2.72	1.96	3.2	2.4
	Benefits	Benefits	Cost	Benefits	Benefits	Benefits	Benefits	Benefits	Benefits	Benefits

Table 4. Final Results

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total Alternative Value	Rank
A1	24.41	15	9.38	3.84	1.24	4.41	8.33	7.91	2.35	10.77	87.63	4
A2	23.68	3.75	10	4.47	4.09	5	10	10	5	15	91	3
A3	30	9.81	8.96	4.48	3.39	4.71	8.33	8.51	4.32	12.69	95.2	1
A4	28.54	10.4	9.23	5	5	3.94	7.56	7.31	4.94	11.54	93.44	2

Conflict of Interest

The authors declare no conflict of interest. Besides, the funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Acknowledgements

We would like to thank PT. Indofood Sukses Makmur Tbk. has funded this research through the Indofood Research Nugraha 2023 program.

References

Ahsan, S., Khaliq, A., Chughtai, M. F. J., Nadeem, M., Din, A. A., Hlebová, M., Rebezov, M., Khayrullin, M., Mikolaychik, I., Morozova, L., & Shariati, M. A. (2020). Functional exploration of bioactive moieties of fermented and non-fermented soy milk with reference to nutritional attributes. Journal of Microbiology, Biotechnology and Food Sciences, 10(1), 145-149. doi: 10.15414/jmbfs.2020.10.1.145-149

Akther, S., Basak, M., Badsha, M. R., & Sultana, A. (2019). Quality attributes of mixed fruits leather prepared from mango, pineapple and papaya pulp. Bangladesh Journal of Veterinary and Animal Sciences, 7(2), 47-53. doi: 10.60015/bjvas/v07i2a7

Anggaratih, R., & Rahmawati, R. (2022). Benefits of pineapple powder fortified biscuit and bread products. Journal Nutrition and Culinary, 3(2), 1-7. doi: 10.35706/giziku.v3i2.8339

Association of Official Analytical Chemists International. (2011). Official methods of analysis of AOAC International. MD, USA: AOAC International. Retrived from https://www.aoac.org/scientific-solutions/standards-and-official-methods/

Arkan, N. D., Setyawardani, T., & Rahardjo, A. H. D. (2022). Physicochemical and functional properties of yoghurt made of cow milk, colostrum, and milk-colostrum combination. Food Research, 6(1), 188-195. doi: 10.26656/fr.2017.6(1).120

Atwaa, E. H., Eman, T., Sayed-Ahmed, A., & Hassan, M. A. A. (2020). Physicochemical, microbiological and sensory properties of low-fat probiotic yoghurt fortified with mango pulp fiber waste as source of dietary fiber. Journal of Food and Dairy Sciences, 11(9), 271-276. doi: 10.21608/jfds.2020.118368

Atwaa, E. S. H., Shahein, M. R., El-Sattar, E. S. A., Hijazy, H. H. A., Albrakati, A., & Elmahallawy, E. K. (2022). Bioactivity, physicochemical and sensory properties of probiotic yogurt made from whole milk powder reconstituted in aqueous fennel extract. Fermentation, 8(2), 52. doi: 10.3390/fermentation8020052

Cahyanti, A. N., Sampurno, A., Nofiyanto-dan, E., & Iswoyo, I. (2021). Starter Growth by Utilizing Jackfruit and Cempedak as Sugar Additives in Goat's Milk Yogurt. In National Seminar on Animal Science Agribusiness Technology (pp. 482-489). Purwokerto-Indonesia.

Chen, X., Singh, M., Bhargava, K., & Ramanathan, R. (2018). Yogurt fortification with chickpea (Cicer arietinum) flour: physicochemical and sensory effects. Journal of the American Oil Chemists' Society, 95(8), 1041-1048. doi: 10.1002/aocs.12102

Dhawi, F., El-Beltagi, H. S., Aly, E., & Hamed, A. M. (2020). Antioxidant, anti-bacterial activities and mineral content of buffalo yoghurt fortified with fenugreek and moringa oleifera seed flours. Foods, 9(9), 1157. doi: 10.3390/foods9091157

Elisabeth, D. A. A. (2015). Added value improvement of taro and sweet potato commodities by doing snack processing activity. Procedia Food Science, 3, 262-273. doi: 10.1016/j.profoo.2015.01.02

Emam, A. O., & El-Nashar, H. A. S. (2022). Technological and nutritional aspects of incorporating jamun (Syzygium cumini (L.) skeels) fruit extract into yoghurt. Journal of Food Research, 11(1), 28-37. doi: 10.5539/jfr.v11n1p28

Eris, F. R., Riziani, D., Pamela, V. Y., Febriansah, M. R., Kusumasari, S., & Sari, A. K. (2022). A review of the potential of beneng taro as material for inulin making and its application to yogurt. Advances in Biological Sciences Research - Proceedings of the 2nd International Conference for Smart Agriculture, Food, and

Environment (ICSAFE 2021). doi: 10.2991/978-94-6463-090-9_5

Standardisasi Nasional Indonesia (SNI). (2009). Syarat Mutu Yogurt SNI (JKT 2981-2009). Jakarta, Indonesia: Standardisasi Nasional Indonesia. Retrieved from https://www.bsn.go.id/

Fawzi, N. Y., Abdelghani, D. Y., Abdel-azim, M. A., Shokier, C. G., Youssef, M. W., El-Rab, M. K. G., Gad, A. I., & Abou-Taleb, K. A. (2022). The ability of probiotic lactic acid bacteria to ferment Egyptian broken rice milk and produce rice-based yogurt. Annals of Agricultural Sciences, 67(1), 107-118. doi: 10.1016/j.aoas.2022.06.004

Fazilah, N. F., Ariff, A. B., Khayat, M. E., Rios-Solis, L., & Halim., M. (2018). Influence of probiotics, prebiotics, synbiotics and bioactive phytochemicals on the formulation of functional yogurt. Journal of Functional Foods, 48, 387-399. doi: 10.1016/j.jff.2018.07.039

Gahruie, H. H., Eskandari, M. H., Mesbahi, G., & Hanifpour, M. A. (2015). Scientific and technical aspects of yogurt fortification: A review. Food Science and Human Wellness, 4(1), 1-8. doi: 10.1016/j.fshw.2015.03.002

Galanakis, C. M., Rizou, M., Aldawoud, T. M. S., Ucak, I., & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. Trends in Food Scinence & Techonology, 110, 193-200. doi: 10.1016/j.tifs.2021.02.002

Greis, M., Sainio, T., Katina, K., Nolden, A. A., Kinchla, A. J., Seppä, L., & Partanen R. (2022). Physicochemical properties and mouthfeel in commercial plant-based yogurts. Foods, 11(7), 941. doi: 10.3390/foods11070941

Handayani, M. N., Cakrawati, D., & Handayani, S. (2016). Effect of Modified Yam (Dioscorea Esculenta) Flour on Some Physicochemical and Sensory Properties of Synbiotic yogurt. IOP Conference Series Materials Science and Engineering, 128, 1-10, doi: 10.1088/1757-899X/128/1/012035

Harper, A. R., Dobson, R. C. J., Morris, V. K., & Moggré, G.-J. (2022). Fermentation of plant-based dairy alternatives by lactic acid bacteria. Microbial Biotechnology, 15(5), 1404-1421. doi: 10.1111/1751-7915.14008

Ismail, S. A., El-Sayed, H. S., & Fayed, B. (2020). Production of prebiotic chitooligosaccharide and its nano/microencapsulation for the production of functional yogurt. Carbohydrate Polymers, 234, 1-11. doi: 10.1016/j.carbpol.2020.115941

Kariyawasam, K. M. G. M. M., Lee, N. K., & Paik, H. D. (2021). Synbiotic yoghurt supplemented with novel probiotic Lactobacillus brevis KU200019 and fructooligosaccharides. Food Bioscience, 39, 100835. doi: 10.1016/j.fbio.2020.100835

Khubber, S., Chaturvedi, K., Thakur, N., Sharma, N., & Yadav, S. K. (2021). Low-methoxyl pectin stabilizes low-fat set yogurt and improves their physicochemical properties, rheology, microstructure and sensory liking. Food Hydrocolloids, 111, 106240. doi: 10.1016/j.foodhyd.2020.106240

Kusumasari, S., & Pamela, V. Y. (2019). Sensory evaluation of synbiotic yoghurt with Banten taro flour as prebiotic. IOP Conference Series: Earth and Environmental Science, 383(1), 012044. doi: 10.1088/1755-1315/383/1/012044

Lase, Y. Y., Haryadi, & Fatmi, Y. (2019). Analysis of effective storage time to deteremine the quality of milk usingsimple additive weighting method. Journal of Physics: Conference Series, 1361(1), 1-7. doi: 10.1088/1742-6596/1361/1/012077

Moghadam, B. E., Keivaninahr, F., Fouladi, M., Mokarram, R. R., & Nazemi, A. (2019). Inulin addition to yogurt: prebiotic activity, health effects and sensory properties. International Journal of Dairy Technology, 72(2), 183-198. doi: 10.1111/1471-0307.12579

Nurdyanto, R. D., Sawitri, M. E., & Manab, A. (2022). The effect of stevia (Stevia rebaudiana) sweetener addition on physical quality of synbiotic yoghurt containing extract of evaporated red dragon fruit peels (Hylocereus polyrhizus). Asian Journal of Advances in Agricultural Research, 18(4), 1-8. doi:10.9734/afsj/2022/v21i330419

Nurhartadi, E., Utami, R., Nursiwi, A., Sari, A. M., Widowati, E., Sanjaya, A. P., & Esnadewi, E. A. (2017). Effect of Incubation Time and Sucrose Addition on the Characteristics of Cheese Whey Yoghurt. IOP Conference Series: Materials Science and Engineering, 193, 012008. doi: 10.1088/1757-899X/193/1/012008

Ozcan, T., & Kurtuldu, O. (2014). Influence of dietary fiber addition on the properties of probiotic yogurt. International Journal of Chemical Engineering and Applications, 5(5), 397-401. doi: 10.7763/IJCEA.2014.V5.417

Permana, I. D. G. M., Gunam, I. B. W., & Putra, I. D. G. A. T. (2020). Improving the digestibility value of the feed of banana stems by fermentation using effective microorganism 4 (EM4) and organic liquid supplement (OLS). Bioscience Research, 17(2), 988-993.

Putri, M. A. R., Purwijantiningsih, E. and Pranata, F. S. (2020). Quality of synbiotic yogurt ice cream with a combination of yam (Pachyrhizus erosus (L.) Urb) and honey pineapple (Ananas cosmosus (L.) Merr). Journal Food Technology, 14(2), 1-14. doi: 10.33005/jtp.v14i2.2446

Putri, N. A., Riyanto, R. A., Budijanto, S. and Raharja, S. (2021). Preliminary study on improving the quality of beneng taro flour (Xanthosoma undipes K. Koch) as Banten's superior product potential. Journal of Tropical AgriFood, 3(2), 63-72. doi: 10.35941/jtaf.3.2.2021.6360.63-72

Rezende, E. S. V., Lima, G. C., & Naves, M. M. V. (2021). Dietary fibers as beneficial microbiota modulators: a proposed classification by prebiotic categories. Nutrition, 89, 111217. doi: 10.1016/j.nut.2021.111217

Riyanto, R. A., & Nafisah, A. (2022). Short review of oligosaccharides application from local Indonesian tubers as prebiotic. Journal of Food and Agricultural Product, 2(1), 15-22. doi: 10.32585/jfap.v2i1.2242

Rostianti, T., Hakiki, D., Ariska, A. And Sumantri, S. (2018). Characterization of physicochemical properties of beneng taro flour as local food biodiversity of Pandeglang Regency. Gorontalo Agriculture Technology Journal, 1(2), 1-7. doi:10.32662/GATJ.V1I2.417

Sampurno, A., Cahyanti, A. N., & Nofiyanto, E. (2020). Characteristics of goat's milk yoghurt based on jackfruit and cempedak. Journal of Engineering and Technology Development, 16(2), 121-128. doi : http://dx.doi.org/10.26623/jprt.v16i2.2990

Sarker, P., Begum, R., Hasan, M. R., & Akter, S. (2022). Physicochemical, microbiological and sensory properties of carrot juice fortified set-style yogurt. Food Research, 6(5), 215-222. doi: 10.26656/fr.2017.6(5).526

Selvamuthukumaran, M., & Farhath, K. (2014). Evaluation of shelf stability of antioxidant rich seabuckthorn fruit yogurt. International Food Research Journal, 21(2), 759 - 765.

Sofyan, A., Ikhsani, A. Y., Purwani, E., Hasanah, L. E. N., & Febriyadin, F. (2022). The effect of suweg (Amorphophallus paeoniifolius) flour and incubation temperature on characteristics of yogurt with the addition of Bifidobacterium bifidum as probiotic. Materials Today Proceedings, 63(1). doi: 10.1016/j.matpr.2022.04.538

Thun, Y. J., Yan, S. W., Tan, C. P., & Effendi, C. (2022). Sensory characteristic of sugar reduced yoghurt drink based on check-all-that-apply. Food Chemistry Advances, 1, 1-7. doi: 10.1016/j.focha.2022.100110

Vasconcelos, C. M., Minim, V. P. R., & Chaves, J. B. P. (2012). Low-calorie yogurt added with yacon flour: development and physicochemical evaluation. Revista Chilena de Nutricion, 39(3), 65-71.

ISSN-Internet 2197-411x OLCL 862804632