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Research Article

The study of the physicochemical properties of nata de soya with the addition of bilimbi fruit (*Averrhoa bilimbi* L.) juice

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Abstract
This study aims to determine the effect of bilimbi fruit juice addition on the physicochemical properties of nata de soya from tofu liquid waste and the best treatment based on the sensory analysis. The research design was completely randomized (CRD) with five treatments and five replications. The data obtained were analyzed using ANOVA and DNMRT. The treatment was the bilimbi fruit juice addition: A = 4%, B = 6%, C = 8%, D = 10%, and E = 12%. The control treatment was prepared without the addition of bilimbi fruit juice (0%). The results showed that the concentration of bilimbi fruit juice in nata de soya had a significantly different effect on yield, thickness, moisture, ash, protein, crude fiber, pH, and antioxidant activity. Based on sensory analysis, treatment A obtained the highest average of 5.35, with physicochemical properties: yield (53.97%), thickness (28.67 mm), moisture content (75.60%), ash content (1.73%), protein content (20.73%), crude fiber content (3.14%), pH value (4.53), and antioxidant activity (42.17%). This research is expected to contribute to utilizing environmentally friendly natural ingredients in diversifying healthy foods.

Keywords
bilimbi fruit, natural organic acid, nata de soya, fermentation, tofu liquid waste

Abbreviations
CRD – completely randomized design; SD – standard deviation; ANOVA – analysis of variance; DNMRT – Duncan's New Multiple Range Test; Crude Fbr – crude fiber; pH – the negative log of the hydrogen ion concentration; Trt – treatment;

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Introduction

Agricultural industrial waste is also included in post-harvest waste that accumulates and can cause environmental problems. This waste comes from factories or agricultural processing industries. However, some of this waste can be utilized for human benefit with specific processes (Fitria et al. 2023). Liquid tofu waste is agricultural industrial waste. This liquid tofu waste is often disposed of and can endanger the surrounding environment (Cahyani et al. 2021). One solution is to utilize it in making nata because it has good nutritional value.

Nata is an organic food product that looks like jelly, is white to clear in color, and has a chewy texture. Nata is a fermented product of *Acetobacter xylinum* (Putri et al. 2021). *Acetobacter xylinum* bacteria can form nata because they grow on a substrate (medium) containing water, protein, fat, carbohydrates, and several minerals (Sari et al. 2021). Tofu liquid waste contains 40-60% protein, 25-50% carbohydrates, and 10% fat (Nostia et al. 2023). Based on its nutritional content, tofu liquid waste has the potential to be a medium for making nata. Nata, made from tofu liquid waste, is known as nata de soya.

Acetobacter xilynum bacteria also requires an acidic environment to grow on the fermentation medium for making nata, and the acid used is usually in the form of vinegar. However, vinegar is a synthetic product. Therefore, bilimbi fruit can be an alternative natural ingredient in creating an acidic environment when making nata.

Bilimbi (*Averrhoa bilimbi* L.) plant is a small tree from the Maluku Islands. It is cultivated and grows freely in Indonesia, the Philippines, Sri Lanka, Myanmar, and Malaysia. This plant is usually planted in yards to harvest its round and oval fruit with sides, 4-6.5 cm long, yellowish green, juicy when ripe, and tastes sour. Bilimbi fruit can be observed in Pic. 1.

Bilimbi fruit contains citric acid, oxalic acid, and ascorbic acid, which causes its taste to be very sour, so it is less popular with the public. The lack of variation in the use of bilimbi fruit contains citric acid, oxalic acid, and ascorbic acid, which causes its taste to be very sour, so it is less popular with the public. The lack of variation in the use of starfruit causes the low economic value of this fruit. However, the organic acids in bilimbi fruit can produce nata in an optimal acidic environment.

Picture 1. Bilimbi fruit

Acetobacter xylinum also needs nitrogen to increase the activity of producing nata. Nitrogen sources often used in making nata come from Zwavelzure ammonia (ZA) and urea. However, using ZA or urea to manufacture nata does not meet food standards because they are more specifically for plant fertilizers, not food ingredients. For this reason, an alternative is needed to replace the role of ZA in making nata, one of which is mung bean sprouts. Mung bean sprouts contain 4.4 g of protein per 100 g, so they can potentially replace ZA. Mung bean sprouts are more environmentally friendly because they are made from organic material, do not cause harmful residues, are easy to obtain, and have been proven to produce quality nata de soya (Prawira et al. 2022).

Based on the description of alternative organic materials above, this study aims to determine the effect of bilimbi fruit juice addition on the physicochemical properties of nata de soya from tofu liquid waste and the best treatment based on the sensory analysis.

Materials and Methods

Materials. The main ingredients used in this study were tofu liquid waste, mung bean sprouts, and bilimbi fruit. Tofu liquid waste was obtained at Dapoer Tahu Lubuk Buaya, Padang City, West Sumatra Province, Republic of Indonesia, and mung bean sprouts were purchased at Pasar Raya, Padang City, West Sumatra Province, Republic of Indonesia. Bilimbi fruit was obtained from direct harvest in our garden in West Padang, Padang City, West Sumatra, Republic of Indonesia. The first harvest time for bilimbi fruit was 15 months after planting.

Chemicals: Sulfuric acid, hydrochloric acid, sodium hydroxide, selenium reagent mixture, and boric acid were obtained from Merck (Germany). DPPH was purchased from Sigma-Aldrich (Singapore).

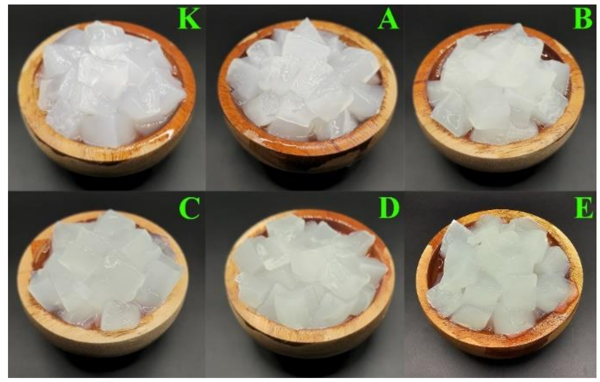
Methods. Nata starter preparation. A starter is a population of microbes in the amount and physiological condition ready to be inoculated into the fermentation medium that will become the nata product. Making a starter using pineapple juice began with cutting one young pineapple. The fruit was washed thoroughly, and the juice was taken using a juicer (Philips HR1832) for five min. The pineapple juice was then mixed with sugar and water in a ratio of 2:1:1 (v/v). Then, the mixture was stirred until homogeneous and put into a tightly closed bottle. The mixture was left for 14 days (pH value on day 0 = 4.48 and day 14 = 3.19) at 25°C in an incubator (Memmert IN30) until a white layer formed, which would be used as a starter (Syam et al. 2023).

Mung bean sprout juice preparation. Mung bean sprouts were washed thoroughly with running water and crushed by adding 50 mL of water using a juicer (Philips HR1832) for three min. Mung bean sprout juice was obtained.

Bilimbi fruit juice preparation. Bilimbi fruits were washed with running water and crushed using a juicer for three min. Bilimbi fruit juice was obtained.

Nata de soya preparation. Fresh tofu liquid waste was filtered with food-grade polyester nylon filter cloth, and 500 mL was taken for each treatment. The solution was heated at 100°C for 15 min while stirring. 50 g of sugar and 75 mL of mung bean sprout juice were added to the solution. Sugar was added as a carbon source for metabolism and nata formation. After that, bilimbi fruit juice was added according to the treatment. When boiling, the media was poured into a sterilized container. The media was cooled. Nata starter was added as much as 50 mL into the container. Then, it was covered with sterile cloth and fermented at 25 °C for 2 weeks in an incubator. The nata that had been formed was then harvested, and its physicochemical and organoleptic properties were observed. The treatment of bilimbi fruit juice addition used was as follows: A = 4%, B = 6%, C = 8%, D = 10%, and E = 12%. The control treatment (K) was prepared with the addition of 2% acetic acid and without the addition of bilimbi fruit juice (0%).

The products of nata de soya can be seen in Pic. 2.



Picture 2. Nata de soya products with the addition of bilimbi fruit juice (K = control, A = 4%, B = 6%, C = 8%, D = 10%, and E = 12%)

Determination of yield. Determination of yield was carried out using the following formula:

$$Yield\ (\%) = \frac{b}{a} x\ 100$$

b is the net weight of nata (g), a is the weight of the fermentation media (g) (Budaraga et al. 2023).

Determination of thickness A micrometer (Mitutoyo 25/0.001mm) was used to measure the nata thickness. The thickness of nata was determined from the average measurement of the six positions (Fitria et al. 2023).

Determination of moisture content. Determination of moisture content is a way to measure the amount of water contained in nata. Weight was measured by evaporating water in the nata dried in an oven (Memmert UN110) at 105°C until a constant weight was obtained. The formula for calculating moisture content (wet basis) was as follows:

$$Moisture\ (\%) = \frac{b-(c-a)}{b} x\ 100$$

a is the weight of the empty cup (g), b is the weight of the initial sample (g), c is the weight of the final sample + cup (g) (Zambrano et al. 2019).

Determination of ash content. The cup was dried in the furnace for 15 min, then cooled and weighed (a). The nata was weighed at 5 g (b), then dried. Then, the sample was placed in an ashing furnace (Carbolite AAF 1100). Ashing was carried out in two stages. The initial temperature was 400 ℃ and continued until the temperature was 550 ℃. After cooling in a desiccator, the sample was weighed until it was constant (c). Ash content was determined using the following formula:

$$Ash\ (\%) = \frac{c-a}{b-a} x\ 100$$

a is the weight of cup (g), b is the weight of cup + initial sample (g), and c is the weight of cup + final sample (g) (Liu 2019).

Determination of protein content. The protein content test used was the Micro Kjeldahl Method. The stages carried out in protein analysis consist of three stages, namely destruction, distillation, and titration. A sample of 0.1 g was put into a tube, then 0.2 g of selenium mix and 10 mL of concentrated sulfuric acid were added. The tube was put into the destruction apparatus for 60 min at 400℃. The destruction process was carried out until the solution was transparent green. The destruction solution was dissolved with demineralized water in a 10 mL measuring flask, then put into the distillation apparatus, and 10 mL of 40% sodium hydroxide was added. The distillate was collected in a 125 mL Erlenmeyer flask containing 50 ml of boric acid solution and two drops of Tashiro indicator. Titration was carried out using 0.1 N hydrochloric acid until the color of the solution in the Erlenmeyer flask turned pink. The titrant volume obtained was then read and recorded. Protein content was calculated using the following formula:

$$N\ (\%) = \frac{(V1 - V0)\ x\ N\ x\ 14{,}007}{m}\ x\ 100$$

$$Protein\ (\%) = N\ (\%)\ x\ Kp$$

V0 is the blank HCl volume (g), V1 is the sample HCl volume (g), N is HCl Normality (N), m is the sample weight (g), and Kp is the protein conversion factor (6.25) (Aguirre 2023).

Determination of crude fiber. The type of fiber in nata is crude fiber, which results from the breakdown of sugar in the fermentation medium by the activity of *Acetobacter xylinum*. The principle of crude fiber testing is to hydrolyze components in the sample that are not resistant to strong acids and bases. This reaction causes carbohydrates, proteins, and other substances to be hydrolyzed and dissolved, and then the sample is filtered and washed with hot water containing acid and alcohol. Furthermore, the sample is burned, and the results obtained are weighed. The formula determines the crude fiber content:

$$Crude\ fiber\ (\%) = \frac{b-(c-a)}{c-a} x\ 100$$

b is the weight of filter paper + dried sample (g), a is the weight of the filter paper (g), c is the weight of the sample (g) (Ahmad et al. 2023).

Determination of pH. Ten g of sample was put into a measuring flask and added with demineralized water. The solution was homogenized and poured into a beaker. The pH was measured using a pH meter (Hanna Instrument HI 2211) calibrated using pH buffer solutions (Fitria et al. 2023).

Determination of antioxidant activity. Determination of free radical scavenging activity was carried out using the DPPH (1,1-diphenyl-2-picryl hydrazyl) method. The absorbance of the DPPH standard and samples was measured at a wavelength of 517 nm using a UV-VIS spectrophotometer (Thermoscientific Genesys 150). This formula determines antioxidant activity:

$$Antioxidant\ activity\ (\%) = \frac{a-b}{a} x\ 100$$

a is the control absorbance (A), b is the sample absorbance (A) (Baliyan et al. 2022).

Sensory analysis. The sensory analysis was conducted on nata products. This test includes a preference test for taste, aroma, texture, and color parameters conducted by 25 trained panellists. This test was conducted to determine the preference level for the products. The test used a hedonic scale ranging from strongly disliked to strongly liked (numerical scale 1-7). The results of the panellist test were then tabulated by entering the panellist assessment figures for the four parameters above (Ehoche et al. 2021).

Statistical analysis. The research design was completely randomized, with five treatments and five replications. Data are presented as Means ± SD. Data were processed and analyzed using IBM SPSS version 29.0.1 software through one-way analysis of variance (ANOVA) followed by Duncan's New

Multiple Range Test (DNMRT) to separate significantly different means at $p<0.05$.

Results and Discussion

Physical properties of nata de soya. The physical properties of the addition of bilimbi fruit juice on nata de soya from tofu liquid waste can be seen in Table 1. The analysis of variance shows that the addition of bilimbi fruit juice has a significantly different effect on the yield and the thickness of nata de soya.

The highest yield of nata de soya is in treatment A at 53.97%, while the lowest yield is in treatment E at 18.85%. The yield range for nata de soya is 18.85-53.97%. The higher the concentration of bilimbi fruit in nata de soya, the lower the yield value. The higher the concentration of bilimbi fruit added, the lower the yield obtained because the crude fiber in the form of cellulose formed is also less. The increasingly acidic conditions of the fermentation media cause the formation of nata to become less.

Tofu liquid waste is better used as a nitrogen source for bacterial cellulose production than ZA. This is because tofu liquid waste contains more complex nutrients besides nitrogen to increase bacterial activity, whereas ZA only provides nitrogen, and the highest yield value is 13.25% (Yanti et al. 2020). Meanwhile, the yield in this study is relatively high using mung bean sprouts as a nitrogen source, namely 53.97%.

The yield produced is directly proportional to the thickness of the nata de soya. The thicker the nata de soya cellulose layer, the greater the yield. The high concentration of bilimbi fruit juice provides an acidic environment that is less than optimal in the fermented liquid media so that the growth of *Acetobacter xylinum* becomes inhibited to form cellulose or fiber in nata, thereby reducing the thickness. The less cellulose is formed, the less viscosity the nata will produce. Thickness is also related to the fiber content in nata, where the higher the crude fiber content, the higher the resulting thickness. The highest thickness occurred in treatment A, with a thickness of 28.7 mm.

Compared to the control treatment (K), nata produced with the addition of bilimbi fruit juice obtained a lower yield and thickness. This is because the pH value of 2% acetic acid used as a control is more optimal for the nata formation than the pH of bilimbi fruit juice.

Chemical properties of nata de soya. The chemical properties of the addition of bilimbi fruit juice on nata de soya can be seen in Table 2. The analysis of variance shows that the addition of bilimbi fruit juice has a significantly different effect on the moisture, ash, protein, pH, and antioxidant activity of nata de soya.

Table 2 shows the values of moisture, ash, crude fiber, pH, and antioxidant activity of nata de soya. Moisture content is one of the most essential characteristics of foods. The highest moisture content of nata de soya is in treatment E at 96.53%, while the lowest is in treatment A at 75.60%. The range of moisture content of nata de soya is 75.60-96.53%. The moisture content increases in line with the concentration of bilimbi fruit in nata de soya, so the moisture content is also higher.

The moisture content of nata de soya increases as the concentration of bilimbi fruit juice increases by 12%, giving the highest moisture content value. This is because a fermentation medium that is too acidic (low or less than optimal pH) can weaken the cellulose bonds.

The moisture content in nata products is influenced by the raw materials used. In addition, the water content is affected by the thickness of the nata. The thinner the nata, the higher the moisture content. High moisture content nata has a looser cellulose structure, allowing water to penetrate it easily. This also lowers the nata fiber content (Alayda et al. 2024).

Based on previous research, the addition of lime extract and inoculum concentration to the characteristics of nata de soya from liquid waste from the tofu industry gave an average moisture content value of 96.7% and 96.84% (Aini and Nur 2019; Putri et al. 2021). Compared to these data, the moisture content of nata in this study is relatively lower.

Table 1. Physical characteristics of nata de soya

Treatments	Parameters	
	Yield, %	Thickness, mm
K	55.31 ± 0.73^{a}	29.74 ± 0.23^{a}
A	53.97 ± 1.52^{a}	28.67 ± 0.18^{b}
B	45.56 ± 0.81^{ab}	16.65 ± 0.14^{c}
C	41.24 ± 1.68^{b}	10.96 ± 0.48^{d}
D	33.83 ± 1.05^{c}	10.70 ± 0.31^{d}
E	18.85 ± 0.79^{d}	10.10 ± 0.12^{e}

*Numbers in the same column followed by different superscript letters indicate significantly differences in the DNMRT ($p<0.05$)

The increase in ash content in each treatment is influenced by the ash and mineral content in bilimbi fruit juice. The bilimbi fruit juice used in the research has an ash content of 0.35%. This percentage causes an increase in the ash content of nata de soya, along with the higher bilimbi fruit concentration.

Bilimbi fruit contains minerals, including iron, magnesium, manganese, and potassium. However, increased ash content is not always caused by beneficial minerals (Salihat et al. 2023). Ash content can be an indicator of the purity and cleanliness level of a food product. Food ingredients comprise 96% organic material and water; the rest is inorganic in ash containing minerals (Ali et al. 2022). Based on Table 2, it can be concluded that the nata de soya produced does not contain too much ash.

Increasing the concentration of bilimbi fruit juice when making nata affects the product's protein content. The highest protein content occurs in treatment A, with a value of 20.73%. All protein contents decrease compared to the control protein content (22.64%), where treatment E has the lowest protein value (12.11%).

The decrease in protein content in nata occurs due to protein denaturation caused by the organic acid content in bilimbi fruit. Protein denaturation is caused by several factors, including acid (Acharya and Chaudhuri 2021). Therefore, the more bilimbi fruit juice is used, the lower the protein content in nata de soya.

The analysis of variance shows that the addition of bilimbi fruit juice has a significantly different effect on the crude fiber content of nata de soya. The highest crude fiber content of nata de soya is found in treatment A, which was 3.14%, while the lowest crude fiber content is found in treatment E, which was 1.05%. The range of crude fiber content of nata de soya is 1.05-3.14%.

Based on previous research, adding lemon juice affected the quality of nata de coco products, which resulted in a crude fiber content of 1.23% (Wahyuni 2019). In another study, nata de coco pina contained 0.93% crude fiber (Tallei et al. 2022). Compared with these data, the nata fiber content in this study is relatively higher. The test results for crude fiber content show that the higher the concentration of bilimbi fruit juice, the lower the crude fiber content of nata de soya.

The higher the concentration of bilimbi fruit added, the lower the nata de soya fiber content value. The condition of the fermentation media that is too acidic or less than optimal results in the growth and development of *Acetobacter xylinum* bacteria being inhibited and results in the cellulose being formed is not optimal, meaning that the fibers formed being lower (Souisa et al. 2019).

Measuring the pH value determines the acidity level of the nata de soya. From the variance analysis results, the addition of bilimbi fruit juice in nata de soya has significantly different effects on the pH value. The higher the addition of bilimbi fruit juice, the lower the pH value of nata de soya. The pH value in treatment A was 4.53. This value continues to decrease as more bilimbi fruit juice is added. The lowest pH value of nata de soya was obtained in treatment E, 3.52.

Table 2. Chemical characteristics of nata de soya

Trt	Parameters					
	Moisture, %	Ash, %	Protein, %	Crude fiber,%	pH	Antioxidant activity,%
K	72.43 ± 0.34[a]	1.51 ± 0.08[a]	22.64 ± 0.28[a]	3.30 ± 0.48[a]	4.97 ± 0.04[a]	34.85 ± 0.42[a]
A	75.60 ± 0.10[ab]	1.73 ± 0.05[b]	20.73 ± 0.10[b]	3.14 ± 0.27[b]	4.53 ± 0.07[b]	42.17 ± 0.14[b]
B	81.01 ± 0.33[b]	1.90 ± 0.07[c]	19.19 ± 0.25[bc]	3.12 ± 0.36[bc]	4.23 ± 0.06[bc]	48.78 ± 0.43[c]
C	85.91 ± 0.16[c]	1.96 ± 0.04[cd]	17.89 ± 0.23[c]	2.10 ± 0.27[cd]	3.74 ± 0.09[cd]	57.91 ± 0.07[d]
D	91.10 ± 0.28[d]	2.25 ± 0.08[d]	15.76 ± 0.18[d]	2.05 ± 0.39[d]	3.69 ± 0.07[d]	62.32 ± 0.17[de]
E	96.53 ± 0.26[e]	2.58 ± 0.05[e]	12.11 ± 0.46[e]	1.05 ± 0.11[e]	3.52 ± 0.12[d]	70.79 ± 0.55[e]

*Numbers in the same column followed by different superscript letters indicate significantly differences in the DNMRT ($p<0.05$)

The optimal pH value for nata de soya products is between 4.0-4.5 at room temperature (Kurniawan et al. 2023). Based on this range, treatments A and E meet the criteria. This statement is also supported by the nata yield values produced in Table 1. Treatments A and B obtained the highest nata yields compared to the other three treatments.

The pH value decreased with increasing bilimbi fruit juice in each treatment. The organic acid content is responsible for the acidity level of bilimbi fruit. The pH value of the bilimbi fruit used in this research was 2.01. The low pH value of bilimbi fruit juice is one of the causes of the decrease in the pH value of the nata de soya product produced.

The addition of bilimbi fruit juice in the process of making nata de soya has a significantly different effect on antioxidant activity. The data in Table 2 shows that the more bilimbi fruit juice added, the higher the antioxidant activity of nata de soya. The antioxidant activity value ranged between 42.17-70.79%. This increase in antioxidant activity is directly proportional to the addition of bilimbi fruit juice.

Bilimbi fruit is a fruit that has high antioxidant activity thanks to its high content of vitamins A, C, and β-carotene. Bilimbi fruit has an antioxidant activity value of 91.89% (Wati et al. 2022). In comparison, the antioxidant activity of other fruits with organic acids, such as lime (32.59%) (Rahmiati et al. 2023) and pineapple (46.7%) (Syahputra and Amna, 2024). Based on these data, the antioxidant activity contained in bilimbi fruit is higher. Antioxidant agents can contribute one or more electrons to ward off free radicals (Budaraga and Salihat 2020; Gaglio et al. 2021; Pereira et al. 2020). Antioxidant agents capture free radicals, so they do not have the chance to stick to and damage DNA (Budaraga et al. 2023; Salihat and Putra 2021).

Increasing antioxidant activity also has a relationship with decreasing pH values. The high antioxidant activity of nata de soya can impact the body positively. However, the product's antioxidant activity and pH must be considered so as not to cause health problems because a product's acidity level that is too high is not suitable for the stomach. In addition, nata de soya, which is too sour, affects the panellists' assessment of taste and aroma parameters.

Compared to the control treatment (K), the treatment with the addition of bilimbi fruit juice (A-E) has higher antioxidants. This is because bilimbi fruit has a higher antioxidant content (89.76%) than the 2% acetic acid used in the control treatment.

Sensory analysis. The sensory analysis determines the quality and consumer acceptance of the nata product. The sensory analysis can determine the level of panelists' preference for nata de soya produced by observing the aroma, color, taste, and texture produced by 25 trained panelists. The sensory analysis of nata de soya can be seen in Table 3 and Fig. 1.

Table 3 shows the panellist's overall nata de soya product assessment. Treatment A has the highest average. Apart from control, the preferred aroma of nata de soya in treatment A was because its sour smell of nata de soya is no longer smelled when harvested.

The color of the resulting nata de soya has changed from its original color, which was cloudy white, to

Table 3. Recapitulation of nata de soya sensory analysis

Treatments	Parameters					Information
	Aroma	Color	Taste	Texture	Average	
K	5.54 ± 0.27	4.72 ± 0.34	5.19 ± 0.11	5.29 ± 0.14	5.18 ± 0.34	lightly liked
A	5.18 ± 0.19	5.26 ± 0.09	5.30 ± 0.07	5.68 ± 0.21	5.35 ± 0.22	lightly liked
B	4.58 ± 0.37	5.16 ± 0.11	5.17 ± 0.13	5.22 ± 0.18	5.03 ± 0.30	lightly liked
C	4.50 ± 0.29	5.12 ± 0.38	4.85 ± 0.06	5.21 ± 0.40	4.92 ± 0.32	lightly liked
D	4.35 ± 0.15	4.58 ± 0.15	4.76 ± 0.14	5.18 ± 0.27	4.71 ± 0.35	lightly liked
E	4.10 ± 0.22	4.60 ± 0.36	4.46 ± 0.07	4.45 ± 0.51	4.40 ± 0.21	indifferent

*The evaluation was identified using a 7-point hedonic scale (1 - strongly disliked, 2 - moderately disliked, 3 - slightly disliked, 4 - indifferent, 5 - lightly liked, 6 - moderately liked and 7 - strongly liked).

creamy white or somewhat white because of the addition of bilimbi fruit juice. Color is an important sensory parameter in food because it influences overall acceptability. The old saying that the eye accepts the food before the mouth is true (Palamthodi et al. 2021).

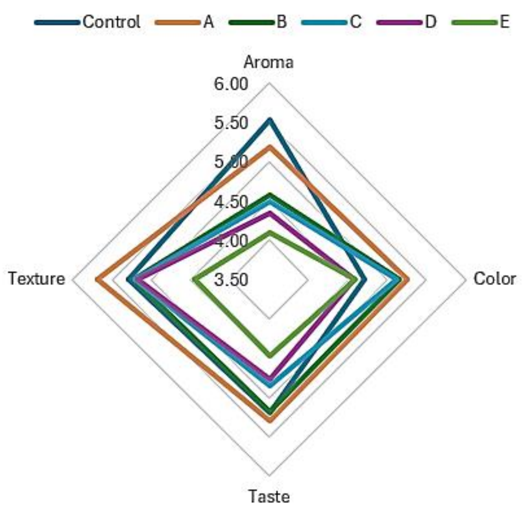


Figure 1. Radar chart of nata de soya sensory analysis

The preferred taste of nata de soya in treatment A is sweet because the sample has been given a sweet taste and has a suitable thickness and elasticity. The texture of nata, which obtains the highest rating, can be influenced by the formation of cellulose with the availability of sufficient nutrients so that the resulting texture is dense and promising. The texture is closely related to cellulose because cellulose influences the formation of nata, resulting in a good and supple texture that is influenced by the density of the cellulose network (Ardyansa et al. 2022).

Treatment A has a higher average acceptance than the control treatment (A). Nata, produced from treatment A, has a distinctive aroma of bilimbi fruit that is not too strong, mint cream or pale green color, a fresh taste typical of bilimbi fruit that is not too strong and has a chewier texture. The nature of these organoleptic parameters was not obtained from the control treatment.

Apart from the effect of bilimbi fruit juice addition, constraints in controlling pH during the fermentation process can affect the physico-chemical properties of the resulting nata de soya. In addition, the pH of the bilimbi fruit juice used also impacts all parameters tested.

Conclusions

The addition of bilimbi fruit juice to the production of nata de soya affected the parameters tested, increasing moisture content, ash content, and antioxidant activity. Meanwhile, the protein content, crude fiber content, and pH value of nata de soya decreased along with the increase in bilimbi fruit juice. The best nata de soya based on organoleptic test results was treatment A (addition of 4% bilimbi fruit juice). Based on the tested parameters, nata products treated with the addition of bilimbi fruit juice were more effective than the control product.

Due to the problem limitations of this article, many other aspects can still be learned from this nata de soya product. The combination of bilimbi fruit with other sources of organic acids, the duration of fermentation of nata de soya, and the use of natural additives are other aspects that can be explored in the future. Based on the availability of raw materials, bilimbi fruit can be further utilized in food products that require environmentally friendly sources of organic acids, both as a source of nutrients in fermentation and as a protein coagulant.

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