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THE EFFECT OF CASHEW NUT PUREE ON THE PHYSICOCHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF SOY MILK ICE CREAM FOR LACTOSE INTOLERANCE SUFFERERS

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Abstract

Soy milk ice cream is an alternative food product for those with *lactose intolerance* who cannot consume cow's milk. The addition of cashew nut puree increases the fat content and improves the texture of the ice cream, making it smoother and creamier. This study aims to determine the effect of variations in cashew nut puree concentration on the physicochemical and organoleptic properties of soy milk ice cream. This study used a laboratory experimental method with a completely randomized design (CRD) with one factor consisting of four treatment levels, namely the addition of cashew nut puree of 0%, 10%, 20%, and 30%, each with three replications . The parameters observed included physicochemical properties consisting of protein, fat, overrun, melting speed, total solids, and organoleptic tests (color, aroma, taste, and texture). The results showed that the addition of cashew nut puree had a significant effect ($p < 0.05$) on the physicochemical and organoleptic properties of soy milk ice cream. The treatment with the addition of 30% cashew nut puree showed the highest values in protein, fat, and total solids levels, and produced a slower melting speed and a higher level of sensory acceptance compared to other treatments. Although the highest overrun value was obtained in the treatment with the addition of 20% cashew nut puree, increasing the concentration of cashew nut puree to 30% generally resulted in an increase in the physicochemical quality and organoleptic characteristics of non-dairy soy milk ice cream.

Keywords: soy milk ice cream, cashew nut puree

INTRODUCTION

The development of the food industry is driving the emergence of practical, nutritious product innovations that align with the functional food trend. Consumers now demand products that are not only delicious but also healthy, making product innovation a key focus. Ice cream, with its popularity and versatility in both local and imported ingredients, offers significant potential for new product development. Soy milk-based ice cream is an alternative for people with *lactose intolerance* , a condition where the body is unable to digest lactose, resulting in digestive problems (Nasytoh, 2022). Soy milk contains protein and fat, which can provide health benefits and produce a smooth ice cream texture (Jhunaedy et al., 2025). The protein in soy milk plays a role in emulsion formation and aeration, although its fat content is lower than cow's milk, so the final texture of the ice cream tends to be less *creamy* (Ahsan et al., 2015). Various methods, such as the addition of plant-based ingredients or stabilizers, are used to improve the texture and stability of ice cream. Previous research supports this: Masithah (2015) reported that adding 20% avocado to soy ice cream resulted in the best organoleptic properties, while Achyadi (2020) showed that adding coconut milk and beetroot improved the texture and flavor of soy milk ice cream. Cashew nuts (*Anacardium occidentale L.*) have the potential to improve the quality of soy milk ice cream due to their high fat content (~48.3%) and protein (~21.3%) which can strengthen the emulsion and provide a *creamy sensation* (Rico, 2015). Therefore, this study aims to determine the effect of variations in cashew nut puree concentration on the physicochemical properties and organoleptic characteristics of soy milk ice cream.

LITERATURE REVIEW

Ice cream

Ice cream is a dairy product with a semi-solid to frozen texture and a sweet flavor, popular with all ages. Fat and protein play important roles in the structure and texture of ice cream. As a lactose-free alternative, soy milk

can be used because its protein and fat content is similar to cow's milk and it is cholesterol-free. The use of soy milk increases the protein content and physical quality of ice cream without adding fat, making it a safe and nutritious functional ingredient (Mita & Herawati, 2024).

Ice Cream Quality Requirements

Commercial ice cream must meet SNI 3713:2018 standards, including ingredient composition, physical characteristics, and other quality tests. Previous research has shown that ingredient variations affect ice cream quality: Achyadi et al. (2020) reported a 2:1 soy extract:beetroot ratio with 22% coconut milk produced the best organoleptic properties, while Masithah et al. (2015) found that adding 20% avocado to soy ice cream improved color, flavor, and nutritional content.

Ingredients for Making Ice Cream

Soybeans are a complete source of vegetable protein with bioactive compounds such as isoflavones and phenolics, which play a role in functional food products (Zhu et al., 2023). Processing can produce active peptides with antioxidant and anti-inflammatory effects (Tan et al., 2023). High-quality water influences the taste, aroma, and stability of ice cream (Bhagwat, 2019; BSN, 2009). Cashews are rich in healthy fats and proteins that support a *creamy texture* (Pardamean et al., 2022). Sugar acts as a sweetener and lowers the freezing point of ice cream, typically by 8–15% (Nur Habieb et al., 2024; Prasetyo et al., 2023). CMC is used as a thickener and stabilizer (Gupta et al., 2024), while emulsifiers/SP improve the softness, homogeneity, and stability of ice cream (Roy et al., 2021).

Ice Cream Making Process

The production stages include mixing the ingredients, heating to 80°C for 15 minutes, cooling, stirring until half frozen, and freezing at -18°C for 24 hours (Atallah & Barakat, 2017). 2.5 Chemical Properties Total solids determine the amount of protein, fat, carbohydrate, and mineral components after water evaporation (Rizkalla et al., 2024; SNI 01-2891-1992). Fat affects texture, flavor, and emulsion stability, measured by the Soxhlet method (Shrestha & Maskey, 2018). Protein plays a role in the viscosity, structure, and stability of ice cream, analyzed by the Kjeldahl method (Ghaderi et al., 2021).

Physical Properties

Overrun indicates the amount of air in ice cream; SNI standards: 35–80% depending on production scale (Choirunnisa et al., 2022). Melting speed is influenced by fat, protein, total solids, and stabilizer content; ideally 15–30 minutes at room temperature (Pramudya, 2022).

Organoleptic Test

Organoleptic testing assesses color, aroma, taste, texture, and overall impression with trained panelists, serving as a reference for consumer preferences (Ghaderi et al., 2021).

RESEARCH METHODS

This research was conducted for one month, namely from November to December 2025, at the Food Processing Laboratory, Food Technology Study Program, Faculty of Food Technology and Fisheries, Dr. Soetomo University, Surabaya. The equipment used included a blender, digital scales and analytical balances, measuring cups, pans, gas stoves, mixers, shakers, cloth filters, freezers, and tools for testing total solids, fat, and protein such as ovens and desiccators. The main research materials consisted of soybeans and cashews obtained from the Sidoarjo Larangan Market. Granulated sugar, CMC, SP, and mineral water were obtained from local shops. Aquadest, n-hexane, concentrated sulfuric acid, 40% NaOH, H_3BO_3, methyl red-bromcresol green indicator, and 0.1 N HCl. The research method used laboratory experiments. The experiment used a Completely Randomized Design (CRD) with one factor, namely the concentration of cashew nut puree in soy milk ice cream, with four treatment levels (0%, 10%, 20%, and 30%) repeated three times. The variables measured included total solids, fat content, protein content, overrun, melting speed, and organoleptic tests of color, aroma, taste, texture, and overall impression. Data analysis used ANOVA with further tests of LSD, LSD, or Duncan for parametric data, and Kruskal-Wallis and Mann-Whitney tests for non-parametric data, according to the level of significance and coefficient of variation (Akbar et al., 2022). The ice cream formulation involved mixing soy milk, granulated sugar, CMC, SP, water, and cashew nut puree according to the treatment. Cashew nut puree was prepared by selecting, washing, boiling, cooling, and blending using a blender (modified by Adenike et al., 2021). Soy milk

was prepared by washing, soaking, peeling, grinding, and filtering to obtain a homogeneous soybean extract (modified by Mawarni et al., 2018). The ice cream production process followed the procedure of Fauzia et al. (2022) with the modification of adding cashew nut puree. All ingredients were mixed until homogeneous, heated at 70–75°C for 15 minutes, cooled at ±5°C for 12 hours, SP was added, whipped until smooth, then frozen at -18°C for ±24 hours and stored until testing.

RESULTS AND DISCUSSION

1. Chemical Test

Protein Level Test

The protein content test aims to assess the effect of adding cashew nut puree on the protein content of soy milk ice cream, which is important for structure, emulsion stability, and texture. The protein content of soy milk and cashew nuts can enhance the nutritional value of the product.

Table 1. Average Results of Soy Milk Ice Cream Protein Content Test

Soy Milk Concentrate : Cashew Nut Puree	Average (%)
P1 (100%)	2.71 ± 0.21 [a]
P2 (90% : 10%)	3.14 ± 0.06 [ab]
P3 (80% : 20%)	3.67 ± 0.21 [b]
P4 (70% : 30%)	5.62 ± 0.28 [c]

The results of the protein content test showed that the addition of cashew nut puree increased the protein content of soy milk ice cream as the concentration increased. The highest protein content was obtained at 5.62 ± 0.28%, while the lowest was in P1 at 2.71 ± 0.21%. Treatments P2 and P3 produced 3.14 ± 0.06% and 3.67 ± 0.21%, respectively. Treatment P4 was significantly different from the other treatments. Treatment P3 was significantly different from P1, but not significantly different from P2, while P1 and P2 showed no significant difference. This increase was due to the high protein content of cashew nuts (18–21%) and the increase in total solids in the dough, thus enriching the protein content of the final product. These results are in line with previous studies that show that nut fortification can increase the protein content and nutritional value of plant-based products (Ilfada et al., 2024; Kurnianingsih et al., 2021). Adding up to 30% cashew nut puree has the potential to produce plant-based ice cream with higher protein, which is safe for people with lactose intolerance. The protein content of soy milk ice cream in all treatments ranged from 2.71 to 5.62% and met the minimum protein requirements for ice cream according to SNI 3713:2018, which is ≥ 2.7% **.** The increase in protein content with increasing cashew nut puree concentration indicates the ingredient's contribution to increasing the nutritional value of the product.

Fat Content Test

The fat content test aimed to assess the effect of adding cashew nut puree on the fat content of soy milk ice cream. Fat is essential for flavor, texture, and product stability, and the high fat content of cashew nuts is expected to increase the fat content of ice cream.

Table 2. Average Results of Fat Content Test of Soy Milk Ice Cream

Soy Milk Concentrate : Cashew Nut Puree	Average (%)
P1 (100%)	3.34 ± 0.41 [a]
P2 (90% : 10%)	3.99 ± 0.14 [b]
P3 (80% : 20%)	5.12 ± 0.12 [c]
P4 (70% : 30%)	6.12 ± 0.1 [d]

Table 2 shows that the addition of cashew nut puree increased the fat content of soy milk ice cream. The highest fat content was found in P4 (70% soy milk: 30% cashew nut puree) at 6.12 ± 0.10%, while the lowest was in P1 (100% soy milk) at 3.34 ± 0.41%. Treatment P4 was significantly different from the other treatments, while P3 was significantly different from P2 and P1. Treatment P2 was also significantly different from P1. This increase is consistent with the high fat content in cashew nuts (44–48%), which plays a role in the soft texture, savory taste,

and emulsion stability of ice cream. Fat helps stabilize air during freezing, slows the melting rate, and enhances the creamy sensation. This study supports previous findings that fortification with high-fat plant ingredients can improve the physical and sensory quality of ice cream (Presilia et al., 2025; Mulyani et al., 2018; Eliska, 2025). The fat content of soy milk ice cream ranges from 3.34–6.12%. Treatments with the addition of 20% and 30% cashew nut puree have met the minimum fat content requirements for ice cream according to SNI 3713:2018, which is ≥5%. Meanwhile, the fat content in treatments without additional additions or with low puree concentrations is still below this limit, which is related to the low natural fat content of soy milk as the base ingredient. Thus, the addition of up to 30% cashew nut puree can produce plant-based soy milk ice cream with a higher fat content and better quality, while remaining safe for people with lactose intolerance.

Total Dissolved Solids Test

A total dissolved solids test was conducted to assess the effect of adding cashew nut puree on the amount of solids in soy milk ice cream. Total dissolved solids are important because they affect the texture, viscosity, melting point, and sensory quality of ice cream. Higher solids levels tend to result in a smoother, more stable texture and better sensory quality.

Table 3. Average Results of the Total Dissolved Solids Test for Soy Milk Ice Cream

Soy Milk Concentrate : Cashew Nut Puree	Average (%)
P1 (100%)	22.5 ± 2.1 [a]
P2 (90% : 10%)	24.04 ± 1.65 [b]
P3 (80% : 20%)	25.63 ± 0.53 [c]
P4 (70% : 30%)	27.05 ± 0.17 [d]

The results of the total dissolved solids test showed that the addition of cashew nut puree increased the total solids of soy milk ice cream as the concentration increased. The highest total solids content was found in treatment P4, at 27.05 ± 0.17% **,** while the lowest was at P1 at 22.50 ± 2.10% **.** Treatments P2 and P3 each produce 24.04 ± 1.65% And 25.63 ± 0.53% **,** with significant differences between treatments. The increase in total solids is related to the contribution of solid components of cashew nuts, especially fat, protein, and carbohydrates, which increase the solid fraction in the ice cream mixture. The total solids value of all treatments was above the minimum limit of SNI 3713:2018.

Melting Speed Test

Melting speed test results showed that the addition of cashew nut puree affected the resistance of soy milk ice cream to melting at room temperature. The higher the concentration of cashew nut puree, the longer the melting time, caused by the increased levels of fat, protein, and total solids, which strengthen the ice cream matrix structure. This makes the ice cream more stable and maintains a soft texture for longer, thus improving the physical quality of the product and making it more popular with consumers, including those with lactose intolerance.

Table 4. Average Results of Melting Speed Test of Soy Milk Ice Cream

Soy Milk Concentrate : Cashew Nut Puree	Average (%)
P1 (100%)	18.33 ± 1.15 [a]
P2 (90% : 10%)	20.67 ± 1.53 [b]
P3 (80% : 20%)	25.67 ± 0.58 [c]
P4 (70% : 30%)	28 ± 0 [d]

The melting speed test results showed that the addition of cashew nut puree significantly affected the melting resistance of soy milk ice cream at room temperature. Ice cream with the highest concentration of cashew nut puree (P4, 30%) had the longest melting time (28.00 ± 0.00), while ice cream without added puree (P1) had the shortest melting time (18.33 ± 1.15). Treatment P4 was significantly different from the other treatments, followed by P3, P2, and P1. The increase in melting resistance with increasing cashew nut puree was due to the increase in fat, protein, and total solids content, which strengthened the ice cream matrix structure, so that water and air were better retained during melting. This is in line with the findings of Violalita et al. (2025) and Susanti et al. (2021) who stated that high fat and solids content formed a stable structure and slowed the melting rate. Thus, the addition

of cashew nut puree up to 30% increased the physical stability of plant-based ice cream and remained suitable for people with lactose intolerance. The melting speed of ice cream is one of the characteristics of ice cream quality based on SNI 3713:2018.

Overrun Test

The overrun test aims to assess the effect of adding cashew nut puree on the ability of soy milk ice cream to expand during freezing and churning. Overrun reflects the amount of trapped air, which affects the volume, softness, and texture of the ice cream.

Table 5. Average Results of Soy Milk Ice Cream Overrun Test

Soy Milk Concentrate : Cashew Nut Puree	Average (%)
P1 (100%)	22.92 ± 5.08 [a]
P2 (90% : 10%)	26.6 ± 1.61 [ab]
P3 (80% : 20%)	31.4 ± 1.44 [c]
P4 (70% : 30%)	28.05 ± 2.22 [bc]

The results of the overrun test showed that the addition of cashew nut puree affected the ability of soy milk ice cream to expand during freezing and churning. The highest overrun value was recorded in treatment P3, at 31.40 ± 1.44% **,** while the lowest was at P1 at 22.92 ± 5.08% **.** Treatment P3 was significantly different from P1 and P2, while P4 was not significantly different from P2 or P3. The increase in overrun up to P3 was due to the role of fat and protein in cashew nut puree in stabilizing air bubbles, while the decrease in overrun in P4 was related to the increase in dough viscosity which inhibited air entry. The ice cream overrun value for all treatments is still below the ice cream overrun range according to SNI 3713:2018.

Texture Test

Texture testing showed that the addition of cashew nut puree affected the texture characteristics of soy milk ice cream. Cashew nut puree increased the viscosity, softness, and elasticity of the ice cream, resulting in a smoother and more stable texture compared to ice cream without cashew nut puree. This improvement in texture was due to the increased fat, protein, and total solids content of the cashew nuts, which strengthened the ice cream matrix structure and increased consumer acceptance of plant-based products

Table 6. Average Results of Soy Milk Ice Cream Texture Test

Perlakuan	Hardness (g)	Fracturability (g)	Adhesiveness (g·sec)	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
P1	265,31 ± 23,05 [a]	197,94 ± 2,06 [b]	−53,17 ± 1,84 [a]	0,982 ± 0,018 [a]	0,075 ± 0,002 [a]	19,54 ± 2,42 [a]	19,20 ± 2,40 [a]	0,016 ± 0,002 [a]
P2	90,14 ± 7,20 [c]	35,11 ± 4,59 [c]	−31,21 ± 2,33 [b]	0,997 ± 0,000 [b]	0,317 ± 0,017 [b]	25,49 ± 3,01 [b]	25,42 ± 2,99 [b]	0,020 ± 0,003 [b]
P3	160,61 ± 56,33 [b]	64,00 ± 20,50 [c]	−26,13 ± 2,94 [c]	0,998 ± 0,001 [b]	0,358 ± 0,052 [b]	22,67 ± 2,36 [c]	22,11 ± 2,89 [b]	0,015 ± 0,001 [a]
P4	225,15 ± 3,99 [a]	439,90 ± 53,06 [a]	−27,86 ± 0,72 [c]	0,991 ± 0,014 [ab]	0,184 ± 0,003 [c]	31,56 ± 3,13 [c]	28,69 ± 2,72 [c]	0,018 ± 0,001 [ab]

The results of the soy milk ice cream texture test showed that the addition of cashew nut puree affected various texture parameters, including hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness, and resilience. The highest hardness was found in ice cream without cashew nut puree (P1), while the addition of cashew nut puree decreased the hardness in P2 and increased again in P3 and P4 due to increased viscosity and total solids. The hardness in P1 and P4 was not significantly different, but significantly different from P2 and P3. Fracturability increased at high puree concentration (P4), indicating a more brittle structure. Treatment P4 showed a significant difference compared to the other treatments, while P2 and P3 were not significantly different. Adhesiveness tended to decrease with the addition of puree, while springiness and cohesiveness were highest in P3, indicating a more elastic and compact structure. The adhesiveness value in P1 was significantly different from the other treatments, while P3 and P4 were not significantly different. Springiness and cohesiveness in P2 and P3 were not significantly different, but significantly different from P1. Gumminess and chewiness increased with puree concentration, the highest in P4, indicating a chewier texture. Gumminess and chewiness values in P3 and P4 were not significantly different from P1 and P2. These texture changes were influenced by the fat, protein, and total solids content of cashew nuts that strengthen the ice cream matrix. Overall, treatment P3 (80% soy milk : 20% cashew nut puree) produced the best texture balance, with optimal hardness, cohesiveness, and springiness, thus potentially providing a higher level of consumer acceptance. Resilience values between

treatments showed no significant difference, so the product's ability to return to its original shape was relatively stable. Ice cream texture is part of the product quality characteristics, although instrumental texture parameters are not specifically regulated in SNI 3713:2018.

2. Organoleptic Test

Organoleptic testing was conducted to assess panelists' acceptance of soy milk ice cream with cashew nut puree based on color, aroma, flavor, texture, and overall preference. This testing is crucial because a product's success is determined not only by its physicochemical properties but also by consumer preference.

Table 7. Average Results of Organoleptic Test of Soy Milk Ice Cream

Soy Milk Concentrate : Cashew Nut Puree	Parameter				Average (%)	Category
	Color	Flavor	Aroma	Texture		
P1 (100%)	3.11 ± 1.36 ^{a}	2.97 ± 1.52 ^{a}	3.44 ± 1.46 ^{a}	3.5 ± 1.52 ^{a}	3.26	Neutral
P2 (90% : 10%)	3.42 ± 1.54 ^{ab}	3.51 ± 1.54 ^{ab}	3.62 ± 1.39 ^{ab}	3.59 ± 1.57 ^{ab}	3.54	Neutral
P3 (80% : 20%)	3.93 ± 1.33 ^{b}	3.99 ± 1.58 ^{b}	4.1 ± 1.43 ^{b}	4.31 ± 1.39 ^{b}	4.08	Like
P4 (70% : 30%)	4.89 ± 1.49 ^{c}	5.37 ± 1.33 ^{c}	4.9 ± 1.22 ^{c}	4.99 ± 1.34 ^{c}	5.04	Like

Color

The results of the organoleptic test showed that panelists' preference for the color of soy milk ice cream increased with increasing concentration of cashew nut puree. Treatment P1 (100% soy milk) obtained an average value of 3.11 (neutral category), P2 increased to 3.42, P3 was 3.93 (like category), and P4 reached the highest value of 4.89 (like category). This increase is thought to be because the natural color of cashew nut puree provides a brighter and more attractive appearance, thus improving consumers' visual perception. Color is the first attribute that influences the acceptance of food products. Treatment P4 showed a significant difference compared to P1 and P2, while P3 showed a significant difference to P1 but was not significantly different from P2. This indicates that increasing the concentration of cashew nut puree has a significant effect on increasing the preference for ice cream color.

Taste

The taste preference showed a significant increase with the addition of cashew nut puree. Treatment P1 obtained a value of 2.97 (neutral), P2 increased to 3.51, P3 was 3.99 (like), and P4 was the highest at 5.37 (like). This increase was due to the natural fat and distinctive taste of cashew nuts which were able to cover the unpleasant taste of soy milk, thus improving the complexity of the taste and sensory profile of vegetable ice cream. Treatment P4 was significantly different compared to other treatments, while P3 was significantly different from P2. This shows that increasing the concentration of cashew nut puree was able to significantly increase taste preference.

Aroma

Aroma scores followed a similar pattern, increasing from P1 (3.44, neutral) to P4 (4.90, likeable). The mild, savory cashew aroma masked the less-preferred soy milk aroma, enhancing the flavor perception and providing a more pleasant overall impression for panelists. Treatment P4 was significantly different from P1 and P2, while P3 showed a significant difference from P1 but not from P2. This indicates that the addition of cashew nut puree increased the liking of the ice cream aroma.

Texture

Panelists' preference for texture increased with increasing concentration of cashew nut puree. P1 obtained a score of 3.50 (neutral), P2 increased to 3.59, P3 was 4.31 (like), and P4 was the highest at 4.99 (like). This improvement in texture is thought to be due to the fat and total solids from cashew nuts which improve the softness, compactness, and mouthfeel of the ice cream. The softer and more stable texture of the ice cream increases comfort when consumed. Treatment P4 showed a significant difference compared to P1 and P2, while P3 was significantly different from P1 but not significantly different from P2. This indicates that increasing the concentration of cashew nut puree has a significant effect on improving the quality of ice cream texture.

CONCLUSION

The results showed that the addition of cashew nut puree significantly affected the physicochemical and organoleptic properties of soy milk ice cream. Increasing the concentration of cashew nut puree from 0% to 30% increased the levels of protein, fat, and total solids, which resulted in a slower melting speed and a softer texture .

The protein and fat content of cashew nuts also suppressed the unpleasant aroma and taste of soy milk, thereby increasing panelists' preference for color, taste, aroma, and texture. Treatment with the addition of 30% cashew nut puree showed the highest values in protein, fat, and total solids content, and produced a slower melting speed and higher sensory acceptance level compared to other treatments. Although the highest overrun value was obtained in the treatment with the addition of 20% cashew nut puree, increasing the concentration of cashew nut puree to 30% generally provided an improvement in the physicochemical quality and organoleptic characteristics of non-dairy soy milk ice cream.

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