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THE EFFECT OF THE USE OF ARROWUT STARCH AND SATURATED LEAF EXTRACT ON THE PHYSICOCHEMICAL AND ORGANOLEPTIC PROPERTIES OF ICE CREAM

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Abstract

sweet taste , soft texture, and refreshing cold sensation. This study aims to examine the effect of variations in the concentration of arrowroot starch and katuk leaf extract on the physicochemical and organoleptic properties of ice cream. The study used a quantitative experimental method with a one-factor Completely Randomized Design (CRD), consisting of four treatments: P1 (22.5 % : 2.5%), P2 (20%: 5%), P3 (17.5%: 7.5%), and P4 (15%: 10%), each repeated three times. Ice cream making includes preparation of ingredients, boiling, mixing thickener, cooling, stirring, and freezing. Observed variables include melting speed, overrun, protein content , fat, total solids, polyphenols, as well as organoleptic tests of color, aroma, taste, and texture. Data analysis was carried out using ANSIRA, significant difference test (LSD/LSD/Duncan), Kruskal-Wallis test for organoleptic, and effectiveness test to determine the best treatment. The results showed that variations in the concentration of arrowroot starch and katuk leaf extract had a significant effect ($p < 0.05$) on the melting speed, polyphenol, protein, fat, and total solids levels, but did not have a significant effect ($p > 0.05$) on the overrun and texture values. Organoleptic tests showed that all treatments were in the neutral category. The best treatment was P4 (15% arrowroot starch: 10% katuk leaf extract) with the highest yield value (NH) of 0.86, melting speed of 1.30 g/minute, protein 4.53%, fat 2.08%, total solids 33.89%, polyphenols 2.27%, and color 3.30, aroma 3.76, taste 3.40, and texture 3.58 (neutral).
This study shows that the combination of arrowroot starch and katuk leaf extract can produce functional ice cream with high nutritional value and sensory quality acceptable to consumers.

Keywords : katuk leaves, ice cream, organoleptic, arrowroot starch, physicochemical properties

INTRODUCTION

Ice cream is a frozen food product popular among various groups due to its sweet taste , soft texture, and refreshing cooling sensation. Ice cream is generally made from milk , cream, sugar, stabilizers, and emulsifiers through a cooling and churning process. Along with advances in food technology, ice cream product development focuses not only on sensory characteristics but also on increasing nutritional value and utilizing healthier natural ingredients (Hadijah, 2023). Therefore, the use of local ingredients as alternative food additives is becoming increasingly important to study. One local ingredient that has the potential to be utilized is arrowroot starch (*Maranta arundinacea* L.). Arrowroot is a source of starch with high levels and good digestibility. Faridah et al. (2014) reported that arrowroot starch contains 98.10% starch with a relatively balanced composition of amylose and amylopectin, making it potentially used as a natural thickener and stabilizer. In addition to being able to form a stable gel, arrowroot starch can also improve the texture of ice cream and stabilize ice crystals during the freezing process (Pangesti et al., 2019; Hadijah, 2023). The use of arrowroot starch is expected to replace conventional thickeners such as cornstarch. Apart from arrowroot starch, katuk leaves (*Sauropus androgynus* (L.) Merr.) Katuk leaves have potential as a functional fortification ingredient. Katuk leaves are known to contain various bioactive compounds, such as flavonoids, polyphenols, tannins, and steroids, as well as vitamins, minerals, and fiber that are beneficial for health (Hikmawanti et al., 2020; Nurdianti & Lilis, 2017; Sari et al., 2023). The phytosterol and papaverine content in katuk leaves also plays a role in stimulating the hormones prolactin and oxytocin (Ibrahim & Pratiwi, 2021). The use of katuk leaf extract in ice cream is expected to increase nutritional value while providing a natural green color without the addition of synthetic dyes.

However, the addition of katuk leaf extract has the potential to affect the sensory characteristics of ice cream. Zaen et al. (2024) reported that the addition of katuk leaves significantly affected the color, aroma, taste, and texture of ice cream. At certain concentrations, katuk leaf extract can increase antioxidant activity and panelist acceptance levels, but at high concentrations it can cause a bitter taste which reduces consumer preference (Nurani et al., 2014; Afrilla et al., 2023). In general, good ice cream must meet the composition standards of the International Commission of Ice Cream (ICM), which include the balance of fat, non-fat dry matter (BKTL), sugar, stabilizer, and emulsifier (Padaga et al., 2005; Wahyuni, 2008). In this study, arrowroot starch was used as a substitute for cornstarch as a source of BKTL because it has a similar function in increasing viscosity and improving the texture of ice cream (Sugiyono et al., 2009). The addition of katuk leaf extract was carried out as an effort to fortify nutrition while still considering the adjustment of sugar content so that organoleptic characteristics remain acceptable. Based on the description, this study aims to examine the effect of using arrowroot starch and katuk leaf extract on the physicochemical and organoleptic properties of ice cream. The results of this study are expected to contribute to the development of functional ice cream products based on local ingredients that have high nutritional value and good sensory quality.

LITERATURE REVIEW

Garut tubers (Maranta arundinacea L.)

Arrowroot is a local tuber with low protein and fat content, but high dietary fiber (9.78 %), making it potentially beneficial for preventing degenerative diseases, including heart disease (Faridah et al., 2008). This tuber is often used to help prevent ulcers, maintain weight, and assist breastfeeding mothers in producing breast milk (Melyandra et al., 2024). Arrowroot flour can increase its economic value and has the potential to replace some of the wheat flour, which is still largely imported (Alifah, 2021; Djaafar & Rahayu, 2006). Arrowroot starch is easily digested, making it suitable for infants, convalescent patients, and the elderly (Ariesta et al., 2004). Research results show that arrowroot starch has a yield of 15.69 % with an amylose content of 24.64% and an amylopectin content of 73.46% (Faridah et al., 2014).

Katuk Leaf (Sauropus androgynus (L.) Merr.)

Katuk is a vegetable that is rich in active substances such as flavonoids, steroids, polyphenols, vitamins and dietary fiber (Pathmavati, 2004; Zaen et al., 2024). Polyphenol compounds have an antioxidant role that can prevent degenerative diseases and cardiovascular disorders (Keerthi et al., 2014). Katuk leaf flour is produced from leaves that are washed, dried at 45°C, ground, and sifted so that they are more stable and uniform than fresh leaves (Nabila, 2022; Nahak & Sahu, 2010). Previous research shows that the addition of katuk leaf flour to ice cream increases antioxidant activity and optimal organoleptic properties at concentrations of 2.5 – 10% (Zaen et al., 2024; Afrilla & Faridah, 2023).

Ice cream

Ice cream is a semi-solid frozen food made from milk , fat, sugar, and other additives (SNI 3713:2018). The texture of ice cream is influenced by the fat content, emulsifiers, and stabilizers that maintain the distribution of water and air within the product (Ismunandar, 2004; Didinkaem, 2006). The use of natural additives such as arrowroot starch and katuk leaf flour can improve the physical quality, taste, and bioactive content of ice cream, without causing side effects from synthetic dyes or flavors (Cahyadi, 2009; Lailatul, 2023).

Ingredients for Making Ice Cream

Ice cream based on arrowroot and katuk leaves uses UHT milk as a source of protein and calcium, whipping cream for fat and soft texture, granulated sugar as a sweetener and freezing point lowering agent, and CMC and emulsifiers to maintain product stability and consistency. The addition of vanilla flavoring enhances the aroma, while cornstarch improves the texture (Apriantini, 2020; Arbuckle, 2013; Anggrahini et al., 2017; Fatsecret Platform API, 2024–2025).

Physicochemical and Organoleptic Tests

The tests conducted included polyphenol , protein, fat, total solids, overrun, melting power, and organoleptic assessment. Polyphenols were measured to assess antioxidant activity (Galanakis, 2018), protein and fat affect nutrition and texture (Probosari, 2019; Ratu Ayu, 2008), total solids determine the stability of foam and ice crystals (Violisa et al., 2012), overrun indicates the volume of trapped air (Yuliani, 2020), and resistance/melting power

determines the ability of ice cream to maintain its shape (Tuhumury et al., 2016). Organoleptic assessments were carried out by panelists using a Likert scale for color, aroma, texture, and taste (Mehran, 2015). Effectiveness testing is used to determine the best treatment by combining chemical and sensory results (Fadhilah, 2019).

RESEARCH METHODS

This research was conducted at the Food Processing Laboratory of the Food Technology Study Program, Faculty of Food Technology and Fisheries, Dr. Soetomo University, Surabaya, from November 2025 to January 2026. The main materials used included arrowroot starch obtained through online purchases and katuk leaf powder made from fresh katuk leaves harvested in Balun Village, Turi District, Lamongan Regency. Other supporting materials, such as UHT milk , whipping cream, CMC, granulated sugar, SP, cornstarch, and vanilla flavoring, were obtained from local shops in Surabaya. For chemical analysis, various reagent solutions and organic solvents were used, while the tools used included basic laboratory equipment and special instruments such as a spectrophotometer, Kjeldahl apparatus, Soxhlet apparatus, and ovens and chillers.

The research method applied is quantitative experimental with the aim of studying the causal relationship between variables. All experiments are conducted in a laboratory to ensure a controlled environment and accurate data. The experimental design used a one-factor Completely Randomized Design (CRD) with four different treatments of the proportion of arrowroot starch flour and katuk leaf powder, each repeated three times. The research procedure is divided into two stages, namely making katuk leaf flour and making arrowroot starch ice cream with the addition of katuk leaf extract. Making katuk leaf flour includes selecting the leaves, separating them from the stems, washing them, drying them with a food dehydrator, grinding them into a fine powder, and sieving them using an 80 mesh sieve.

Ice cream making is done through several stages, namely weighing the ingredients according to the formulation, boiling milk and sugar, heating the katuk leaf solution, mixing the thickening agent, initial cooling, stirring with the addition of whipping cream, SP, CMC, vanilla flavor, and katuk leaf solution, then final freezing and serving. The variables observed include polyphenol content , total solids, fat, protein, overrun, melting speed, and organoleptic assessment using panelists with a preference scale from very dislike to very like. Data analysis was performed using parametric statistics through ANSIRA with the help of SPSS version 24. If there was a significant difference in the Coefficient of Diversity (KK) <5%, the Least Significant Difference (LSD) test was performed, for KK 5–10% using BNJ, and for KK >10% using Duncan's test. Nonparametric data, especially organoleptic tests, were analyzed using a hedonic scale and the Kruskal-Wallis test. Effectiveness tests are used to assess product success based on chemical parameters and consumer preferences, with an index calculation formula that is adjusted to the desired value direction of the product.

RESULTS AND DISCUSSION

1. Chemical Test

Overnight Test

The results of the overrun test of arrowroot starch ice cream and katuk leaf extract with each different treatment did not affect the overrun of the ice cream.

Table 1. Average ice cream overrun results

Arrowroot starch flour: katuk leaf flour	Average (%)
P1 (22.5 % : 2.5%)	0.29 ± 0.276 [a]
P2 (20 % : 5%)	1.19 ± 0.162 [a]
P3 (17.5 % : 7.5%)	2.45 ± 0.474 [a]
P4 (15 % : 10%)	0.92 ± 0.423 [a]

Based on Table 1, the use of arrowroot starch and katuk leaf flour did not significantly affect the ice cream overrun value (significance > 0.05) . The highest overrun value occurred in treatment P3 (17.5 % arrowroot starch, 7.5% katuk leaves) at 2.45%, while the lowest was in P1 (22.5% arrowroot starch, 2.5% katuk leaves) at 0.29%. Descriptively, overrun tended to decrease as the concentration of arrowroot starch increased, possibly because the dough viscosity increased so that air was difficult to trap, in accordance with Pangesti et al. (2019).

Melting Speed Test

The results of the melting speed test of arrowroot starch ice cream and katuk leaf extract with each different treatment had an effect on the melting speed of the ice cream .

Table 2. Average results of ice cream melting speed

Arrowroot starch flour: katuk leaf flour	Average (gr/min)
P1 (22.5 % : 2.5%)	0.86 ± 0.989 [a]
P2 (20 % : 5%)	1.03 ± 0.130 [b]
P3 (17.5 % : 7.5%)	1.21 ± 0.080 [c]
P4 (15 % : 10%)	1.30 ± 0.065 [d]

Based on Table 2, the addition of arrowroot starch and katuk leaf extract significantly affected the melting speed of ice cream ($p < 0.05$) . The highest melting speed occurred in P4 (15% arrowroot starch: 10% katuk leaves) at 1.30 g/minute, while the lowest was in P1 (22.5% arrowroot starch: 2.5% katuk leaves) at 0.86 g/minute. This difference is thought to be related to the ability of arrowroot starch to form a more stable dough structure, thereby slowing melting, in line with Anita and Agustino (2010) that arrowroot starch is hydrophilic due to its amylose and amylopectin content.

Polyphenol Level Test

Presenting a test of the polyphenol content of arrowroot starch ice cream and katuk leaf extract with each different treatment having an effect on the polyphenol content of ice cream.

Table 3. Average results of ice cream polyphenol content

Arrowroot starch flour: katuk leaf flour	Average (%)
P1 (22.5 % : 2.5%)	1.246 ± 0.072 [a]
P2 (20 % : 5%)	1.396 ± 0.041 [ab]
P3 (17.5 % : 7.5%)	1.493 ± 0.061 [b]
P4 (15 % : 10%)	2.270 ± 0.125 [c]

The analysis of variance showed a significant effect ($p < 0.05$) . The higher the amount of arrowroot starch, the polyphenol content of ice cream tended to decrease, while the higher the katuk leaf extract, the polyphenol content increased. The highest polyphenol content was found in P4 (2.270%) and the lowest in P1 (1.246%), possibly due to the content of bioactive compounds in katuk leaves, especially polyphenols, which can stimulate cell metabolic activity, including the secretion of the hormone oxytocin (Definingsih Yuliastuti et al., 2022).

Fat Content

Presenting a test of the fat content of ice cream made from arrowroot starch and katuk leaf extract, with each different treatment having an effect on the fat content of ice cream.

Table 4. Average ice cream fat content results

Arrowroot starch flour: katuk leaf flour	Average (%)
P1 (22.5 % : 2.5%)	1.683 ± 0.195 [a]
P2 (20 % : 5%)	1,810 ± 0,200 [a]
P3 (17.5 % : 7.5%)	1.833 ± 0.075 [a]
P4 (15 % : 10%)	2.086 ± 0.110 [b]

The results of the analysis of variance showed a significant effect ($p < 0.05$) . The higher the amount of arrowroot starch, the fat content of ice cream tended to decrease, while the higher the katuk leaf extract, the fat content increased. The highest fat content was found in P4 (2.086%) and the lowest in P1 (1.683%), but all treatments were still below the SNI standard (≥5%), possibly because arrowroot starch has a low fat content (≈0.68 %) so that its contribution to ice cream fat is minimal (Faridah et al., 2014).

Protein Content

Presenting a test of the protein content of arrowroot starch ice cream and katuk leaf extract with each different treatment having an effect on the protein content of the ice cream.

Table 5. Average results of ice cream protein content

Arrowroot starch flour: katuk leaf flour	Average (%)
P1 (22.5 % : 2.5%)	2.766 ± 0.049 [a]
P2 (20 % : 5%)	3,560 ± 0.185 [b]
P3 (17.5 % : 7.5%)	4,300 ± 0.175 [c]
P4 (15 % : 10%)	4.536 ± 0.120 [c]

The results of the analysis of variance showed a significant effect ($p < 0.05$) . The higher the amount of arrowroot starch flour, the protein content of ice cream tended to decrease, while the higher the katuk leaf extract, the protein content increased. The highest protein content was found in P4 (4.536%) and the lowest in P1 (2.766%), in line with Satyaningtyas et al. (2014) that the high protein content in katuk leaves (±24.8 %) significantly increased the protein content of the product.

Total Solids Test

Presenting a test of the protein content of arrowroot starch ice cream and katuk leaf extract with each different treatment having an effect on the protein content of the ice cream.

Table 6. Average total solids of ice cream

Arrowroot starch flour: katuk leaf flour	Average (%)
P1 (22.5 % : 2.5%)	28,133 ± 1,657 [a]
P2 (20 % : 5%)	30.323 ± 0.543 [a]
P3 (17.5 % : 7.5%)	33.226 ± 0.151 [b]
P4 (15 % : 10%)	33,890 ± 0.130 [b]

The results of the analysis of variance showed a significant effect ($p < 0.05$) . The higher the amount of arrowroot starch flour, the total solids content of ice cream tended to decrease, while the higher the katuk leaf extract, the total solids content increased. The highest total solids content was found in P4 (33.890%) and the lowest in P1 (28.133%), in accordance with Zaen et al. (2017) that katuk leaf flour has the property of binding water so that the total solids content increases.

2. Organoleptic Test

Presenting the results of organoleptic tests on arrowroot starch ice cream and katuk leaf extract with each different treatment having an effect on the level of liking for the ice cream.

Table 7. The average results of the hedonic ice cream test

Treatment	Parameter					
	Color	Flavor	Aroma	Texture	Average	Category
P1	3.63± 0.84a	3.44± 0.849a	3.41± 0.763b	3.31± 0.979a	3.45	Neutral
P2	3.26± 0.801b	3.18± 0.967a	3.14± 0.842c	3.39± 0.932a	3.24	Neutral
P3	3.38± 0.743b	3.00± 0.899b	3.43± 0.862b	3.60± 0.909a	3.35	Neutral
P4	3.30± 0.741b	3.40± 0.946a	3.76± 0.916a	3.58± 0.96a	3.51	Neutral

Color

Based on Table 7, the use of arrowroot starch and katuk leaf extract significantly affected the color of ice cream (Kruskal–Wallis test, $p < 0.05$) . The most preferred color was found in treatment P1 with 22.5 % arrowroot starch and 2.5% katuk leaves (value 3.63, neutral category), while the lowest color was found in P2 (20% : 5%, value 3.26, neutral category). Despite the differences in values, all treatments were still in the neutral category.

Aroma

Table 7 shows that the ice cream aroma was also significantly influenced by variations in arrowroot starch and katuk leaf extract ($p < 0.05$) . The most preferred aroma was obtained at P4 (15 % : 10%, value 3.76, neutral), while the lowest aroma was at P2 (20% : 5%, value 3.14, neutral). The increase in katuk leaf concentration is thought to provide a distinctive aroma character, thus influencing panelist preferences.

Flavor

The results of Table 7 show a significant effect on ice cream flavor ($p < 0.05$) . The most preferred flavor was found in P1 (22.5 % : 2.5%, value 3.44, neutral), while the lowest flavor was found in P3 (17.5%: 7.5%, value 3.00, neutral). The decrease in preference for P3 is likely due to the increase in the distinctive flavor of katuk leaves with higher concentrations.

Texture

In contrast to the previous parameters, Table 7 shows that variations in arrowroot starch and katuk leaves did not significantly affect the texture of ice cream ($p > 0.05$) . The highest texture value was found in P3 (17.5 % : 7.5%, value 3.60) and the lowest in P1 (22.5%: 2.5%, value 3.31), but all treatments were still in the neutral category. This indicates that the texture of the ice cream was relatively the same and accepted by the panelists.

3. Determination of Best Treatment (effectiveness test)

Effectiveness testing is used to determine the best and most preferred treatment. Based on the results of the effectiveness test on all research parameters including chemical tests and organoleptic tests, as presented in Appendix 15, it is known that the best treatment is indicated by the highest yield value (NH).

Table 8. Effectiveness Test Results

Parameter	Yield Value (NH) of Treatment			
	P1	P2	P3	P4
Overrun	0.00	0.04	0.10	0.03
Melting speed	0.00	0.04	0.08	0.10
Protein	0.00	0.06	0.11	0.13
Fat	0.00	0.04	0.04	0.11
Total solids	0.00	0.04	0.10	0.11
Polyphenols	0.00	0.02	0.04	0.16
Color	0.20	0.00	0.06	0.01
Aroma	0.03	0.00	0.03	0.06
Flavor	0.08	0.03	0.00	0.07
Texture	0.00	0.02	0.08	0.08
Total	0.31	0.29	0.64	0.86*

Based on the determination of the effectiveness test on all research parameters contained in Appendix 15, it shows that ice cream with treatment code P4 is the best treatment with a yield value (NH) of 0.86% with parameter criteria, namely an overrun content of 0.92%, a melting speed of 1.30 g/minute, a protein content of 4.53%, a fat content of 2.08%, a total solid content of 33.89%, a polyphenol content of 2.27%, a color of 3.30 (neutral), an aroma of 3.76 (neutral), a taste of 3.40 (neutral), and a texture of 3.58 (neutral).

CONCLUSION

The results showed that variations in the concentration of arrowroot starch and katuk leaf extract had a significant effect ($p < 0.05$) on the melting speed, polyphenol, protein, fat, and total solids levels of ice cream, but did not have a significant effect ($p > 0.05$) on the overrun value and texture. Increasing katuk leaf extract tended to increase the levels of polyphenol, protein, fat, and total solids, while increasing arrowroot starch tended to decrease the levels of polyphenol and protein, but helped slow down the melting speed of ice cream. The results of the organoleptic test showed that variations in treatment significantly affected color, aroma, and taste, but did not affect texture, with all treatments in the neutral category so they were still accepted by the panelists. Based on the effectiveness test, treatment P4 (15% arrowroot starch: 10% katuk leaf extract) was the best treatment with the

highest yield value (NH) of 0.86, indicated by the characteristics of overrun of 0.92%, melting speed of 1.30 g/minute, protein content of 4.53%, fat content of 2.08%, total solids of 33.89%, polyphenol content of 2.27%, and organoleptic values of color 3.30, aroma 3.76, taste 3.40, and texture 3.58 (all neutral).

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