JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Physical Characteristics and Antioxidant Activity of Ice Cream Blend of Coconut Milk and Red Dragon Fruit Peel Extract

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Received: December 16, 2024
Revised: February 15, 2025
Accepted: April 25, 2025
Published: April 30, 2025

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DOI: 10.29303/jppipa.v11i4.10889

Abstract: Coconut milk, which is rich in fat and protein, is used as a substitute for milk fat in making ice cream. Red dragon fruit skin contains antioxidants such as anthocyanins, flavonoids, and polyphenols, serving as a natural colorant and increasing the nutritional value of ice cream. This study aims to analyze the overrun, melting power, color and antioxidant activity of ice mixture of coconut milk and red dragon fruit peel extract. The research method used was a Completely Randomized Design (CRD) with four mixed proportion treatments: 100% coconut milk, 75% coconut milk and 25% red dragon fruit skin extract, 50% coconut milk and 50% red dragon fruit skin extract, 25% coconut milk and 75% red dragon fruit skin extract. Repetition was done three times in each treatment. Data analysis used analysis of variance (ANOVA), then BNT test if there were significant differences. The results showed that the overrun of ice cream ranged from 36.1% - 51.2%; melting power of ice cream 18.3 - 24.3 minutes; ice cream color with color grade of ice cream brightness value (L) 65.7-91.3; a value (red/green) -0.36 - 40.6s and b value (yellow/blue) -0.4 - 0.96. The antioxidant activity of the ice cream varied between 37.1 - 541.6 ppm. In conclusion, mixed ice cream of red dragon fruit peel extract and coconut milk has the potential to be developed as a nutritious processed food product, because it has antioxidant activity with good physical characteristics. This study also provides contextual scientific material that can be integrated into science learning about antioxidants and food technology.

Keywords: Antioxidants; Ice cream; Melting power; Overrun; Physical characteristics

Introduction

Ice cream is one of the frozen foods that is very popular with many people, both as a snack and dessert. The process of making ice cream generally involves various ingredients, such as milk fat, sugar, and stabilizers, which aim to produce a soft texture, delicious taste, and good resistance to the melting process (Jumiati et al., 2015). The main ingredient that is often used in making ice cream is milk fat, which functions to provide flavor and creamy texture to ice cream products (Marshall et al., 1996). However, along with the increasing demand for plant-based food products, many producers have begun to develop ice cream using alternative non-animal ingredients, one of which is coconut milk.

Coconut milk (Cocos nucifera L.) is one of the processed coconut products that are widely used in the food industry, including as raw material for ice cream. Coconut milk contains high vegetable fat, so it can replace milk fat in making ice cream, give a soft texture, and reduce the formation of ice crystals (Cahya & Susanto, 2014; Beegum et al., 2022). In addition, coconut milk also contains proteins and carbohydrates that

How to Cite:
Koapaha, T., Langi, T. M., & Umboh, R. J. J. (2025). Physical Characteristics and Antioxidant Activity of Ice Cream Blend of Coconut Milk and Red Dragon Fruit Peel Extract. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 306–312. https://doi.org/10.29303/jppipa.v11i4.10889

contribute to the nutritional quality of the ice cream produced (Masykuri et al., 2012). The high fat content of coconut milk can replace animal milk and has the potential to be used in ice cream products that are friendly to lactose intolerants, namely those who do not consume dairy products and their processed products. Coconut milk is one of the products produced from the meat of old coconuts aged 11-12 months. Pure coconut milk naturally contains about 54% water, 35% fat, and 11% lean solids (carbohydrates ± 6%, protein ± 4%, and other solids) categorized as an oil-in-water emulsion. Coconut milk also contains a number of vitamins and minerals (Damanik et al., 2020). Coconut milk has a higher fat content than cow's milk or other animals, this makes coconut milk one of the best alternatives as a substitute for milk fat in making ice cream (Santana et al., 2011).

In the manufacture of ice cream, fat content plays an important role to improve texture, reduce crystallization and provide a creamy texture. High quality ice cream will not melt quickly when served at room temperature and is soft and non-crystallized (Marshall et al., 1996). Coconut milk is one of the products produced from the meat of old coconuts aged 11-12 months. Pure coconut milk naturally contains about 54% water, 35% fat, and 11% nonfat solids (carbohydrates ± 6%, protein ± 4%, and other solids) categorized as an oil-in-water emulsion. Coconut milk also contains a number of vitamins and minerals (Damanik et al., 2020). Coconut milk has a higher fat content than cow's milk or other animals, this makes coconut milk one of the best alternatives as a substitute for milk fat in making ice cream. In making ice cream, fat content plays an important role to improve texture, reduce crystallization and provide a creamy texture. High quality ice cream will not melt quickly when served at room temperature and has a soft and non-crystallized texture (Marshall et al., 1996).

Red dragon fruit peels, while underutilized and often considered waste, contain many benefits, especially as an excellent source of antioxidants. Red dragon fruit skin is rich in anthocyanins, flavonoids, and vitamin C, which can act as a natural colorant in food and provide health benefits to the body (Waladi et al., 2015). This red dragon fruit skin has the potential as a natural colorant and attractant and a source of antioxidants that can improve the nutritional quality of ice cream (Wahdaningsih et al., 2015; Simanjuntak et al., 2022).

This study aims to analyze the physical characteristics, and antioxidant activity of ice cream made from a mixture of coconut milk and red dragon fruit peel extract, and explore the potential of red dragon fruit peel as a natural colorant and source of antioxidants in ice cream products based on coconut milk vegetable ingredients.

Given the increasing emphasis on contextual and problem-based learning in science education, research on food innovation like this can support science curriculum on nutrition, emulsification, and antioxidant mechanisms

Method

Materials and Tools

The materials used in this research are old coconut meat (11-12 months), red dragon fruit skin, sucrose, cornstarch and whippy cream. The tools used in this research are analytical scales, mixer, blender, freezer, pot, stainless steel container, spoon knife, measuring cup, beaker glass, ice cream cup, Petri dish, porcelain cup, desiccator, spatula, drop pipette, gloves, container for sensory test, camera and stationery.

Research Methods

The research design used is a completely randomized design (CRD) with the treatment of a mixture of coconut milk and red dragon fruit peel extract consisting of 4 levels, namely A = 100% coconut milk; B = 75% coconut milk: 25% red dragon fruit skin extract; C = 50% coconut milk and 50% red dragon fruit skin extract; D = 25% coconut milk and 25% red dragon fruit skin extract. Each treatment was repeated 3x. This research methods used can also be used as a model for laboratory practicum in higher education, science or food technology.

Research Procedure
Making Coconut Milk

Coconut milk is made using old coconut fruit (11-12 months), grated with a coconut grater to obtain grated coconut meat. Weighed 1 kg of grated coconut meat, put in a pan and added 1 kg of hot water, mixed, let stand until cool. Then extracted using a filter cloth and squeezed by hand. The result of the squeeze is coconut milk which is still mixed with other ingredients. Next, filtering is done with a sieve and accommodated in a pan to be ready for use in ice cream making experiments according to treatment. the stages of making coconut milk adopt the research results of Muthoharoh et al. (2017).

Preparation of Red Dragon Fruit Peel Extract

Red dragon fruit is split, remove the pulp separated from the skin. Red dragon fruit skin is then separated from the outer skin and take the inner skin. Furthermore, the inner skin which is reddish pink in color is reduced in size and extracted by blending, the

ratio of red dragon fruit skin and water (2: 1). The results of the crushed dragon fruit skin and water are then separated (extracted) by inputting in a filter cloth and extracted by squeezing. The results in the form of red dragon fruit skin extract liquid will then be used in making ice cream according to the treatment experiment. The manufacture of red dragon fruit peel extract adopted and modified the research method from Waladi et al. (2015).

Making of Ice Cream

Coconut milk according to treatment (100%, 75%, 50%, 25%), sugar, whippy cream, cornstarch were mixed. Then red dragon fruit peel extract was mixed according to the treatment (0%, 25%, 50%, 75%) and heated to 80 °C for 1 minute while stirring (homogenization). Remove and transfer to a container, cooled to room temperature. Mixing with a mixer for 5 minutes and stored in the freezer for the first 4 hours. Mixing activities for ice cream products are carried out 3 times in the same way. The stages of making ice cream adopted and modified the research method from Perdani et al. (2017).

Measurement of Overrun and Melting Power

Measurement of ice cream overrun is done when the ice cream before and after mixing according to the number of observations with the procedure: calculating the volume of ice cream in the container used before mixing and the volume of ice cream after mixing in the same container, while the melting power of ice cream is done after the 3rd mixing is completed and stored in a frezzer.

Color Measurement (Color grap application)

Prepare an application on a mobile phone with the colorgrap feature. Looking for the right position to conduct experiments with good lighting.

Samples that become objects to be tested are taken pictures and see the numbers listed on the brightness level (L) b value and a value on the color grap tool, observed and recorded.

Result and Discussion

Value of Ice Cream Overrun

The average overrun value of ice cream mixed with coconut milk and red dragon fruit peel extract ranged from 36.1 to 51.2%. The highest overrun value was in ice cream with a mixture of 75% coconut milk and 25% dragon fruit skin extract. The results of the analysis of the overrun value of ice cream obtained that the treatment of a mixture of coconut milk and red dragon fruit peel extract affects the overrun value of ice cream. For more details can be seen in Table 1.

Table 1. Average Overrun of Ice Cream Blended with Red Dragon Fruit Peel Extract and Coconut Milk

Coconut milk (% and dragon fruit peel extract)	Average (%)
A: 100% (control)	$51.2^{a} \pm 0.7$
B: 75% and 25%	$47.7^{ab} \pm 1.3$
C: 50% and 50%	$40.7^{bc} \pm 1.1$
D: 25% and 75%	$36.1^{d} \pm 2.2$

*BNT 5%: 2.7

According to Table 1, this is in accordance with the opinion of Praptiningsih et al. (2013) which states, the more air trapped in the dough causes the overrun value to increase. Milk fat in ice cream helps form a stable emulsion structure between water and fat, which allows air containment in the mixture. When the fat content is higher, more space is available for air to mix in, thus increasing the overrun. In other words, increasing the fat content in the ice cream mixture can increase the overrun volume, which results in a lighter and creamier ice cream (Goff et al., 2013). Based on the research of Koapaha et al. (2024), coconut milk contains fat, coconut milk levels in containing total fat content of 13.47%, protein 0.78%, carbohydrates 11.31%, and crude fiber 0.05%. The test results of fat and protein content of ice cream mixture of coconut milk with red dragon fruit peel extract in the treatment of 25% coconut milk and 75% dragon fruit peel extract with fat content of 7.015% and protein of 1.065%. Fat content of ice cream mixture of 25 percent coconut milk and 75% extra red dragon fruit skin meets SNI.

Power of Ice Cream Melting

The average melting time of the ice cream blend of coconut milk and dragon fruit peel extract ranged from 18.3 to 24.3 minutes. For more details can be seen in Table 2.

Table 2. Ice Cream Melting Power Observation

Coconut milk (% and dragon fruit peel extract)	Average (%)
A: 100%	$18.3^{a} \pm 0.058$
B: 75% and 25%	$20.2^{ab} \pm 0.056$
C: 50% and 50%	$21.4^{bc} \pm 0.092$
D: 25% and 75%	$24.3^{d} \pm 0.030$

*BNT 5%: 0.5333

According to Table 2, the results of ANOVA analysis of ice cream melting power show that the treatment of coconut milk mixture with red dragon fruit peel extract has a significant effect on the melting power of ice cream. The percentage of dragon fruit peel extract will increase the value of ice cream melting time. Melting power is the ability of ice cream to maintain its shape

before melting at room temperature (certain) Melting power is influenced by the composition of constituent materials, fat content, stabilizers, emulsifiers and manufacturing techniques. The lowest melting power of ice cream was obtained in the treatment of coconut milk mixture without a mixture of dragon fruit peel extract (control) and the highest melting power was obtained in a mixture of 25% coconut milk and 75% dragon fruit peel extract.

The large percentage of red dragon fruit peel extract in making ice cream with coconut milk mixture, causes the ice cream melting time to be longer, and vice versa. This is inversely proportional to the overrun of ice cream. The higher the overrun value of ice cream, the faster the melting time will be, and vice versa, the lower the overrun value of ice cream, the longer the melting time. Waladi et al. (2015), namely the manufacture of ice cream by using red dragon fruit peel extract, the overrun of ice cream will decrease which will cause the melting power of ice cream to be longer because the melting time of ice cream is influenced by the amount of air trapped in the ice cream mixture and the fat content in it. The standard melting power of good ice cream is about 15-25 minutes (SNI 1995). The melting time of red dragon fruit skin extract ice cream and coconut milk produced has met the SNI, which ranges from 18.3-24.3 minutes.

This is in line with the research of Simanjuntak et al. (2022) which states the higher the percentage value of red dragon fruit peel, the higher the antioxidant activity.

Color

The color of the ice cream produced is the appearance of bright pink with increasing proportions of dragon fruit peel extract in ice cream dough in the treatment of 25% coconut milk and 75% red dragon fruit peel extract. This is due to the anthocyanin content in the red dragon fruit peel contained in the red dragon fruit peel extract which is a large proportion in the treatment.

Color is an appearance factor that can be seen directly by consumers. Attractive colors will increase product acceptance. Color analysis is done objectively with a color reader tool so that the L, a and b values are obtained which are color parameters. The L value indicates the level of brightness with a value range of 0-100. The higher the L value, the brighter the product color. The a value determines the degree of green to red with a value range of 0-100, while the b value determines the degree of yellow to blue. Potato ice cream with the addition of red dragon fruit peel extract. Ice cream with a mixture of dragon fruit peel extract and coconut milk. Based on the results of the analysis of variance, it shows that the addition of red dragon fruit peel extract has a significant effect on the color of the ice cream mixture of red dragon fruit peel extract and coconut milk produced. The average value of the results of measuring the color of ice cream mixed with red dragon fruit peel extract and coconut milk can be seen in Table 3.

According to Table 3, the average value of the color measurement results of ice cream ice cream mixture of dragon fruit peel extract and coconut milk Extract Fruit peel L value a Value b Description of dragon red color (%) 0 91.3 -0.36 -0.4 white 25 87.7 9.5 2.4 white red 50 73.8 29.5 0.2 Light pink red 75 65.7 40.6 0.96 pink red The higher the L value, the brighter the brightness of the ice cream produced will be and vice versa if the lower the L value, the brightness of the ice cream will decrease.

Table 3. Average Color Value of Ice Cream Ice Cream Mixture of Dragon Fruit Peel Extract and Coconut Milk Coconut

Red dragon fruit peel extract (%)	Value L	Value a	Value b	Color description
0	91.3	-0.36	-0.4	White
25	87.7	9.5	2.4	White red
50	73.8	29.5	0.2	Light pink red
75	65.7	40.6	0.96	Pink red

Information: L; light, a; red/green, b; yellow/blue

Bioactive compounds are compounds that occur naturally in the body of animals and plants that are beneficial to human life including as a source of antioxidants, antibacterial, anticancer, and anti-inflammatory (Firdayani et al., 2015). Anthocyanins are natural coloring agents that produce red, orange, purple or blue colors and are widely found in flowers and fruits (Hidayat et al., 2006). Red dragon fruit skin contains antioxidants in the form of anthocyanin pigments which are classified as flavonoid antioxidants (Simanjuntak et al., 2014). Increasing citric acid concentration was associated with color brightness and anthocyanin stability. The best results showed the addition of 2% citric acid with a pH value of 2.75, anthocyanin content of 6.38 mg/50g, antioxidant activity of 80.71% and color values of L* 49, a* 59 and b* 14 (Nizori et al., 2020). The ratio of red dragon fruit skin extract concentrations of 32% produced the best characteristics, moisture content 88.02%, color intensity l* 40.83, a* 58.86, dan b* 33.36, total anthocyanin 0.98 mg/L, antioxidant capacity 9.95 mg GAEAC/100g, color liked and carmine, aroma, texture, taste, overall acceptance is liked (Syoufiani et al., 2023).

Based on Table 3, it can be concluded that the greater the percentage of red dragon fruit peel extract will reduce the brightness value of ice cream (L) and will change the color to pink red with the increasing percentage of red dragon fruit peel extract in the tool used. It is suspected that the anthocyanin content contained in red dragon fruit peel will affect the decrease in the brightness of ice cream (L value).

Based on Table 3 shows that the more the proportion of red dragon fruit peel extract causes the b value to decrease. The b value in the range -0.4 -2.4 indicates pink color. The highest b value was obtained at a proportion of 25% which amounted to 2.4 and the lowest b value was obtained at a proportion of 0% red dragon fruit peel extract. The proportion of red dragon fruit peel extract is significantly different from the b value at 0% dragon fruit peel extract, but 25%, 50% and 75% dragon fruit peel extract are almost the same 4.5.

Antioxidant Activity

Measurement of antioxidant activity based on DPPH method is obtained from absorbance value and then transferred to percent inhibition. Then calculated inhibitor concentration 50 (IC50) which the results are presented in Table 4.

Table 4. Regression Equation of Antioxidant Activity of Ice Cream Mixture of Dragon Fruit Peel Extract and Coconut Milk

Treatment	Linear Equation	Correlation Coefficient	IC_{50} (Ppm)
A	y = 0.102x - 5.7576	R^2 = 0.981	546.7
B	y = 0.046x + 41.782	R^2 = 0.9328	178.6
C	y = 0.91x + 16.185	R^2 = 0.8326	39.4
D	y = 0.064x + 47.476	R^2 = 0.8564	37.1

Table 4 showed IC 50 ice cream mixture of coconut milk and red dragon fruit peel extract obtained IC 50 values of 37.1 to 546.7 (ppm). This data shows that the treatment of a mixture of coconut milk and red dragon fruit peel extract has a significant effect on the antioxidant activity of the ice cream produced. The magnitude of the percentage of red dragon fruit peel extract affects the increase in IC50 in this case the smaller IC50 value means the stronger the antioxidant activity value.

IC50 (Inhibition Concentration) is the concentration of sample solution needed to inhibit 50% of DPPH free radicals (Maryam, 2015). The lower the IC50 value, the more effective the antioxidant in counteracting free radicals or has strong antioxidant activity (Maryam, 2015).

Sardin et al. (2023) stated the higher the percentage value of red dragon fruit peel, the higher the antioxidant activity. The treatment of adding red dragon fruit skin has a very significant effect on increasing the organoleptic values of color, aroma, and taste. The highest level of panelist liking was obtained in treatment G4 (cucumber 500 g: red dragon fruit skin 20 g) with a value for color 4.69 (very like), aroma 3.44 (like), and taste 3.43 (like) while the lowest treatment was obtained in treatment G0 (cucumber 500 g: red dragon fruit skin 20 g). As well as viscosity analysis of 1.43 cP, pH 5.35, and antioxidant activity analysis of 380.87%.

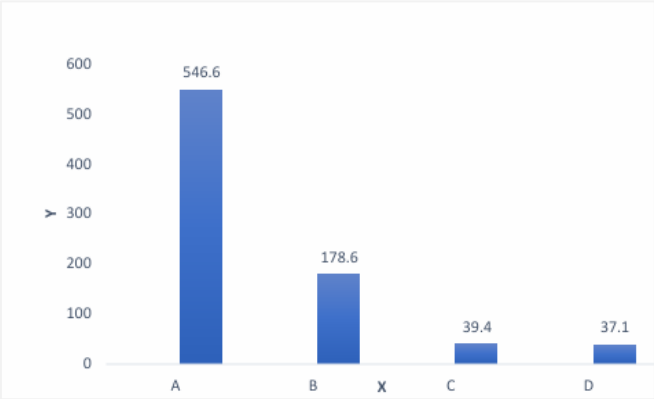

Figure 1. Histogram of IC50 values

These findings could serve as a foundation for developing student worksheets (LKPD) or laboratory modules focused on antioxidant activity, emulsion science, and the role of plant-based ingredients in processed foods.

Conclusion

The average value of overrun ice cream mixture of red dragon fruit peel extract and coconut milk ranges from 36, 1% - 51.2% Overrun ice cream mixture of red dragon fruit peel extract and coconut milk has met household scale standards, ice cream Proportion; A (100% coconut milk) optimum overrun results, while the melting time of ice cream ranges from 18, 3 - 24.3 minutes proportion; 25% coconut milk and 75% red dragon fruit peel extract is the fastest melting power results. The color of ice cream with color grade of ice cream brightness value (L) 65.7 to 91.3, a value (red/green) -0.36 to 40.6s and b value (yellow/blue) -0.4 to 0.96. The antioxidant activity of ice cream blends of red dragon fruit peel extract and coconut milk ranged from 37.1 - 541.6 ppm. 75% red dragon fruit peel extract and 25% coconut milk was the strongest antioxidant activity treatment with IC50 value of 37.1 ppm. Ice cream mixed with red dragon fruit peel extract and coconut milk as a product of natural science innovation has the potential to be developed as a nutritious processed food product, has antioxidant activity with good physical characteristics.

Acknowledgments
The authors would like to thank the Rector of Sam Ratulangi University, the Institute for Research and Community Service, the Dean of the Faculty of Agriculture, Sam Ratulangi University (UNSRAT), who gave us the opportunity to conduct this research.

Author Contributions
T.K.: Developing ideas, analyzing, writing, reviewing, responding to reviewers' comments; T.M.L., R.J.U.: analyzing data, overseeing data collection, reviewing scripts, and writing.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

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