Physicochemical Characteristics and Antioxidant Activity of Soymilk Ice Cream with The Addition of Jamun Fruit (*Syzygium cumini*) and Stevia (*Stevia rebaudiana*)

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Abstract. This study aims to determine the physicochemical properties, antioxidant activity, and organoleptic acceptability of soymilk ice cream fortified with jamun fruit and stevia. The methods used included the production of jamun and stevia extracts, production of soymilk, production of eleven variants of fortified jamun and stevia ice cream, namely V1 as a control without stevia and jamun; V2 as a sugar control substituted with 1% stevia without the addition of jamun fruit; V3, V4, and V5 with added jamun fruit paste (15%, 20%, and 25%) in V2; V6,V7, V8 added 5% stevia in jamun fruit paste (15%, 20%, and 25%) in V2; and V9, V10, and V11 added 10% stevia in jamun fruit paste (15%, 20%, and 25%) in V2. The products resulted were tested for organoleptic, physicochemical (total solids, overrun, melting time, protein, and phytochemical), and antioxidant activity. The results showed that V10 (addition of 10% stevia and 20% jamun fruit) was the best composition for every aspect. The V10 results meet SNI standards, namely with a solids total of 33.07; overrun 30%, melting time 20 minutes, protein content 3.09, and antioxidant activity 73.95%.

Keywords: Antioxidant Activity, Ice Cream, Jamun, Physicochemical, Stevia.

Introduction

Ice cream is a dairy product with high nutritional value. Ice cream is made through freezing process of milk mixed with stabilizers, sugars, emulsifiers, and other ingredients that have been pasteurized and homogenized [1]. Ice cream often consumed by tropical countries such as Indonesia. According to Indonesia's central statistical agency in 2022, ice cream has been consumed 0.176 small bowl/ person/week or equivalent to 0.5 Liters/person/year [2], [3]. Ice cream can be produced by using vegetable sources such as soymilk as a substitute for cow's milk.

Soymilk is a potential alternative source of cow's milk because it has a lower fat content namely 1.96 grams and protein content that almost like cow's milk namely 3.55 grams, so it can be digested more than 92% [1], [4], [5]. Soymilk can be processed into ice cream. This processing can improve the taste and functional properties of soymilk,

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but the functional properties can still be improved by replacing the usual sweetener source with stevia and the antioxidant activity with jamun fruit.

Stevia (*Stevia rebaudiana*) is a natural sugar that has a sweetness thas is 250-300 times higher that sucrose or cane sugar [6]. Stevia has a sweet taste cause by glycoside compounds which are diterpene derivatives [7]. This compound is safe for diabetic's sufferers because it can't be metabolized in the body and can prevent the growth of bacteria and fungi in the teeth [8].

Jamun's fruit (*Syzygium cumini*) is a fruit which has high levels of anthocyanin which indicate by its purple and black [9], [10], [11]. This fruit widely found in the Java Islands, Indonesia [12], [13]. This fruit has been used as medicine to treat diabetes, gastric complaints, and dysentery [14]. However, it's seasonal nature causes jamun's fruit to become rare, even though it has potential to be developed [15], [16]. Antioxidant's compound in jamun's fruit and stevia can increased nutritional's value if soymilk ice cream.

Salamah [3] and Pratiwi [17] has conducted research on ice cream with fortified jamun fruit and found the best antioxidant activity was the addition of 20% jamun fruit. In addition, Pon [18] has conducted research on the use of stevia as a natural sweetener in ice cream. However, research using stevia and jamun's fruit in soy ice cream has never been carried out before. The ice cream fortified by jamun fruit and stevia may offer additional values and health benefit. Therefore, this research aims at characterizing ice cream product fortified by natural antioxidant from jamun fruit and natural sweetener from stevia. The physicochemical properties, antioxidant activity, and organoleptic acceptability of soymilk ice cream fortified with jamun fruit and stevia was discussed and analyzed.

2 Methods

2.1 Tools and Materials

The equipment needed are blender, pot, mixer, stove, pH meter, beaker 100 mL, analytical scale, oven, desiccator, ice cream container, stopwatch, evaporating dish, test tube, test tube's container, volumetric flask 100 mL, volumetric flask 50 mL, volumetric flask 10 mL, dan spectrophotometer UV-Vis

The ingredients used in this research were soybeans which purchased from traditional market in Cimahi, milk powder, cornstarch, SP koepoe koepoe's brand, stevia powder which bought in Tokopedia E-commerce, jamun's fruit, and some pro-analyst grade chemical such as hydrochloric acid (HCl), Sodium hydroxide (NaOH), methanol, 2,2-diphenyl-1-picrylhydrazyl (DPPH), copper sulfate hydrate ($CuSO_4.5H_2O$), Potassium sodium tartrate, ascorbate acid, magnesium powder, casein, buffer pH 1 and buffer pH 4.5.

2.2 Soymilk Preparation

Soymilk is made by sorting dan separating soybeans from impurities. Then, soybeans washed and soaked in hot water for 8 hours. After that, soybeans are peeled and boiled for 5 minutes. Soybeans are mixed with water in ratio of 1:3 then grounded with blender. Soybeans are filtered through a cloth and the juice is pasteurized at 80℃ for 15 seconds [19].

2.3 Jamun's Pulp Preparation

Jamun fruits are selected based on the level of ripeness then washed with running water and the seeds removed. The flesh of jamun fruits is grounded by blender then divided into three with a mass of 250 grams each. After that, the jamun's pulp added with 0%, 5%, and 10% stevia powder then homogenized.

2.4 Soymilk Ice Cream Fortified by Jamun's Pulp and Natural Sweetener Stevia Preparation

Soymilk ice cream preparation is using the method of Salamah, 2022 [3] and several modifications were made. 300 mL soymilk are heated with 3 grams stevia powder then added 10.5 grams milk powder. After reaching 85℃, 10 grams cornstarch is added as thickener. Then, ice cream mixture is stored in freezer for 24 hours at 12℃. After that, ice cream mixture is added 7.5 grams SP and homogenized by mixer for 15 minutes. Jamun's fruits are added with 0%, 15%, 20%, and 25% variation and with stevia 0%, 5%, dan 10%. Ice creams are packaged in the freezer at 12℃.

2.5 Total Solid Content

Total solids content was tested by following Indonesian National Standards 3713:2018 [20]. Total solids analysis was carried out by drying evaporating dish in the oven at 105℃ for 1 hour. Then, the evaporating dish is weighted and recorded the mass. After that, 10 g sample added into the evaporating dish then dried in the oven at 105℃ for 3 hours. Then, the sample are placed in desiccator for 30 minutes and weighed the mass. Total solids content calculated using equation 1.

$$\text{Total Solids Content} = \frac{\text{mass of sample after drying}}{\text{mass of sample before drying}} \times 100 \quad (1)$$

2.6 Protein Content

Protein contents were tested by using biuret method. 10,000 ppm of casein solution was made from weighing 1 gram casein powder and dissolved with 100 mL distilled water in volumetric flask. After that, the solution diluted to 1000, 2000, 3000, 4000, and 5000 ppm. 2 mL of each standard solution was pipetted then stored in test tube. 8 mL biuret

reagent were added to each test tube and incubated at 37°C for 10 minutes. After that, the solution is measured for absorption at the maximum wavelength and processed into calibration curve where x is the concentration and y in the absorbance.

Ice cream samples were weighted at 0.5 grams then stored in 50 mL volumetric flask then added distilled water until the limit mark. 5 mL of solution was pipetted and added in 10 mL volumetric flask then added distilled water until the limit mark. Sample solution pipetted 2 mL to test tube then added 8 mL biuret reagent. Then each solution was incubated at 37°C for 10 minutes. The sample solutions were measured at the maximum wavelength and the data were processed by using calibration curve [3].

2.7 Overrun test

Overrun test was carried by calculating the difference between ice cream volume and ice cream dough volume [17]. 10 grams dough sample was stored in 50 mL measuring cup then volume is recorded. After that, the dough sample were mixed using mixer for 15 minutes then weighed 10 grams in 50 mL measuring cup after that the volume recorded. The overrun was calculated by using equation 2.

$$\%\text{overrun} = \frac{\text{ice cream volume} - \text{dough ice cream volume}}{\text{dough ice cream volume}} \times 100 \quad (2)$$

2.8 Melting time

Melting time is carried out by weighing ±15 grams of sample then stored in a plate at room temperature 25°C. Melting time measured by using stopwatch [21].

2.9 Organoleptic test

Organoleptic test was tested on 20 panelist using preference test for color, taste, smell, texture, and overall attribute. The rating scale used in this test were 1 very not like, 2 for not like, 3 somewhat like, 4 like, and 5 for very like [17].

2.10 Antioxidant activity

Ice cream samples were melted then filtered using filter paper. Filtered ice cream then pipetted 1 mL to volumetric flask then added methanol until limit mark. Sample solution then pipetted 4 mL to dark vial the added 20 ppm DPPH. Mixtures were incubated for 30 minutes then measured at 517 nm [3]. Activity antioxidant can be calculated by equation 3.

$$\%AA = \frac{\text{Abs DPPH kontrol} - \text{Abs DPPH sisa}}{\text{Abs DPPH kontrol}} \times 100 \quad (3)$$

Explanation: % AA = percentage of activity antioxidant; Abs DPPH control = DPPH absorbance; and Abs DPPH leftover = DPPH absorbance after adding sample

3 Results and Discussion

3.1 Result of Soymilk Ice Cream Fortified by Jamun and Stevia Production

Ice cream without jamun and stevia had white color. Replacement of sugar by stevia gave green color to ice cream. Adding jamun fruit without additional stevia giving purple color. Adding more stevia in jamun pulp made ice cream has brown-grayish color. The appearance of ice cream fortified by jamun, and stevia can be seen on Fig. 1.

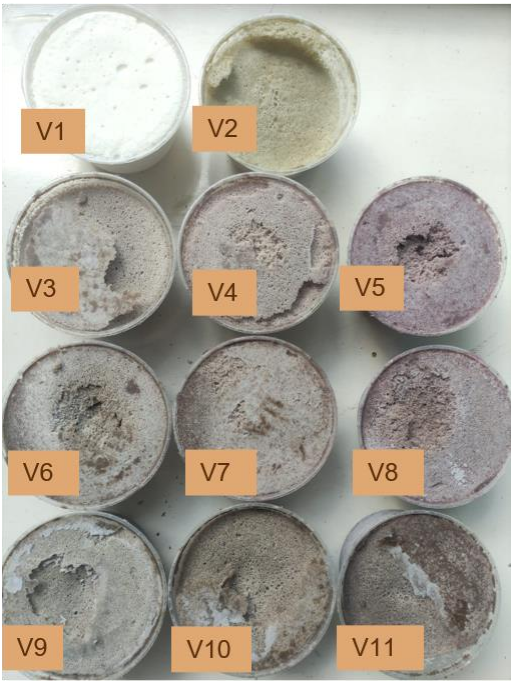


Fig. 1. Soymilk ice cream fortified by jamun and stevia.

According to Fig. 1, addition jamun fruit giving purple color caused by anthocyanin compounds [14]. This result was compatible with research conducted by Salamah [3] and Pratiwi [17] which showed purplish color on their ice cream when added jamun's fruit. Addition of stevia giving green color because of chlorophyll in the stevia leaves [22], [23]. The result of mixing purple color from jamun's fruit and green color from stevia gave the ice cream grayish brown color.

Table 1. Variance of soymilk ice cream

Variance	Detail
V1	Ice cream as recipe [3]
V2	Ice cream with stevia
V3	Addition of 15% jamun pulp
V4	Addition of 20% jamun pulp
V5	Addition 25% of jamun pulp
V6	Addition 5% stevia in 15% jamun pulp
V7	Addition 5% stevia in 20% jamun pulp
V8	Addition 5% stevia in 25% jamun pulp
V9	Addition 10% stevia in 15% jamun pulp
V10	Addition 10% stevia in 20% jamun pulp
V11	Addition 10% stevia in 25% jamun pulp

3.2 Total Solid Content

According to Indonesia National Standard (SNI) 3713:2018 on ice cream [20], the total solid requirement for ice cream is a minimum of 31. Total solid content is important because it's giving texture and body for ice cream [18]. The result of total solid content is shown in Fig. 2.

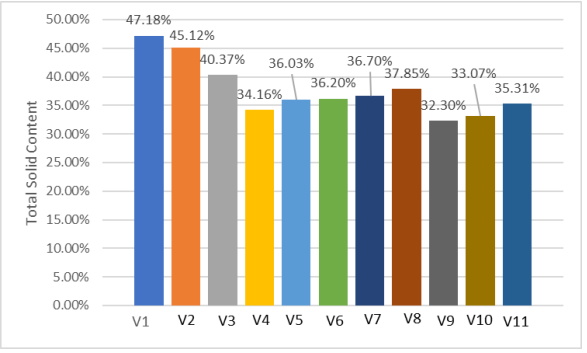


Fig. 2. Total solid content graph of soymilk ice cream fortified by jamun and stevia.

Application of stevia as sugar substitute reduced total solid content in ice cream which showed in Fig. 2 (V1 and V2 sample). This is caused by lots of free water in stevia ice cream which caused the formation of ice crystals greater [18]. According to Pon, et al. [18], application of stevia decreased the interaction intermolecular of water so unbounded water content in stevia ice cream is more than regular ice cream. Furthermore, the addition of jamun's fruit increased total solid content in the soymilk ice cream. This result is the same as Salamah's research which showed increased of total solid content in soymilk ice cream fortified by jamun [3].

3.3 Protein Content

Protein content was carried out by using biuret method using casein as standard protein solution. The linear regression equation of standard solution is y= 4.10^{-5}x - 0,0026 with correlation coefficient (r) of 0.9995. Sample measurements were carried out at absorbance 542 nm. The results are shown in Fig. 3.

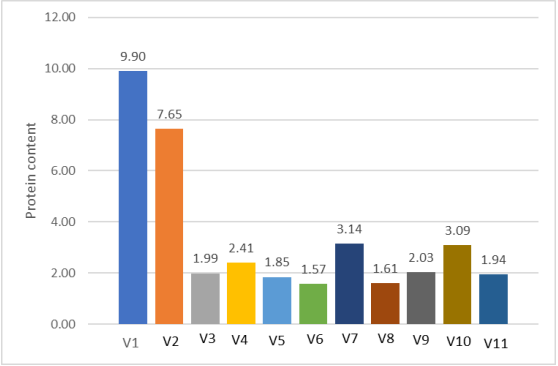


Fig. 3. Protein content of soymilk ice cream fortified by jamun and stevi.

According to Fig. 3, substitution of sugar by stevia decreased protein content (V1 and V2). This is happened because the characteristic of protein which easily damaged by temperature [24]. Stevia gave more sweetness if extracted by high temperature [25]. The addition of jamun's fruit decreased protein content because decrease in pH which showed by Table 2.

Table 2. pH test results on samples

Sample	pH
V1	6.09
V2	6.72
V3	5.09
V4	4.92
V5	4.87
V6	4.77
V7	4.69
V8	4.54
V9	4.88
V10	4.68
V11	4.62

Soymilk protein would form aggregation under pH 5.8 [26], especially glycinin protein. The presence of calcium in soymilk would make protein not dissolved in solution. According to Table 1, addition of stevia increased pH in sample. This result is the same

as Kusumaningsih, et al. [27], who stated that stevia extract has high pH. Addition of stevia could increase pH because alkaloid compound that are alkaline in nature [28].

Protein content in ice cream is regulated in SNI 3713:2018 about ice cream [20] is minimum 2.7%. According to Fig. 3, only V7 and V10 meet the standard, namely 3.14% and 3.09%. This result happened because on pH 4.90 - 5.10 have highest formation rate of aggregation [26], so V3-V6 and V9 have low protein content because many aggregations formed.

3.4 Overrun

Overrun is a test to determine amount of air trapped in the foam. Overrun could be obtained through increased beating to make bubble in ice cream dough. The higher overrun will provide a softer ice cream texture [29], [30]. Fig. 4 shows overrun graph from samples.

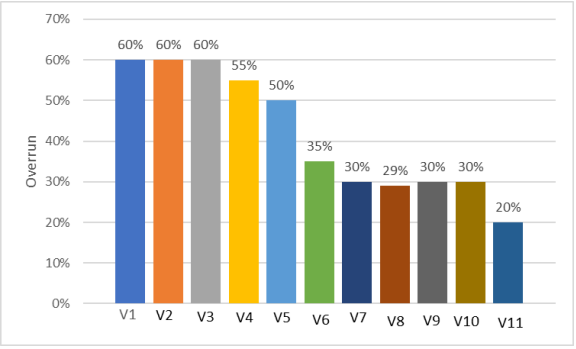


Fig. 4. Overrun content of soymilk ice cream fortified by jamun and stevia

According to Fig. 4, addition jamun's fruit and stevia decreased overrun from soymilk ice cream. Reduction of overrun was also experienced by research on jamun's fruit ice cream which conducted by Salamah [3] and Pratiwi [17]. This is caused by the addition of jamun fruit which causes the ice cream mixture to become thicker and can prevent air from entering mixture. Meanwhile, according to Pon et al. [18], increased stevia would make overrun increased too. The difference can be caused by inconsistencies in beating process caused by limited equipment and the formation of emulsion that is not optimal caused by not perfectly homogenous ice cream [18], [31].

According to Oktafiyani [31], overrun occurred because there is increase in volume caused by entry of air into ice cream. Bubbles can be maintained due to the presence of fat in the emulsion system. Overrun is also related to formation of foam which is related to decrease in surface tension of system consisting of air and water caused by molecular adsorption [32]. Ice cream overrun ranges from 30-50% for home industry and 60-100% for factory production.

3.5 Melting time

Melting time refers to the time for ice cream to melt perfectly [31]. The melting time's result were showed in Fig. 5.

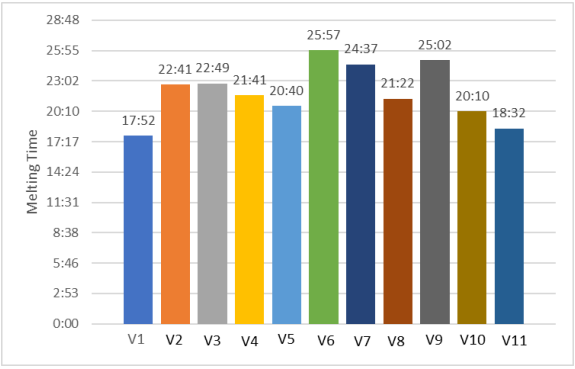


Fig. 5. Melting time of soymilk ice cream fortified by jamun and stevia.

According to Fig. 5, the addition of jamun fruit decreased melting time. It happened because the total solid content increased in the sample so the freezing point in the ice cream decreased [31]. Addition of stevia increased melting time because the total solid content decreased. Sample with best melting time is V6 (5% stevia in 10% jamun fruit) with 25 minutes and 57 seconds to melt.

3.6 Organoleptic

The organoleptic test values given by panelist are relative. The attributes tested on panelist were color, aroma, texture, flavor, and overall. The organoleptic result was shown in Fig. 6.

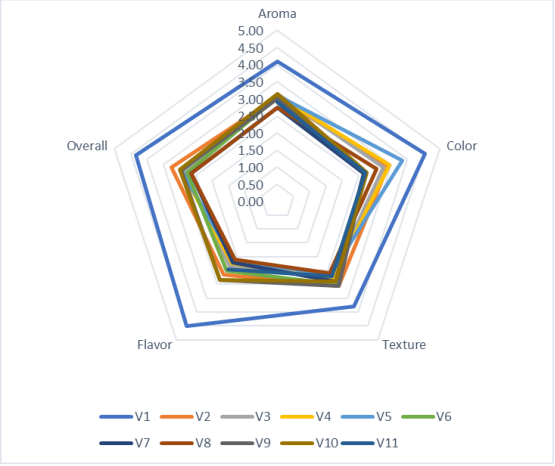


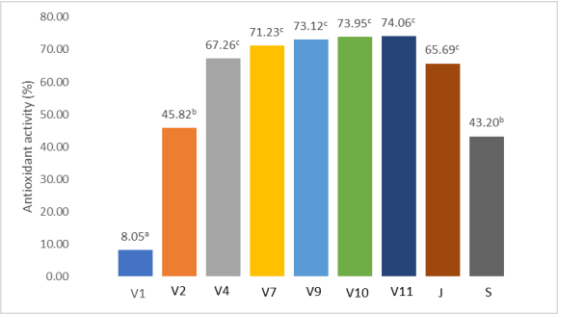
Fig. 6. Organoleptic test of soymilk ice cream fortified by jamun and stevia.

The results of assessment from 20 panelists showed that V1 was preferred by panelist because original taste and appearance more attractive for them. The addition of stevia as substitute sugar was less liked by panelist because aftertaste given by it. This aftertaste caused by steviol glycoside gave bitter taste to the tongue [33].

Fortifican sample most liked by color was V6 cause by purplish color with 3.85 score. The purplish color caused by anthocyanin in jamun fruit more dominant in this sample [14]. Addition of more stevia gave grayish brown color, so it was less liked by panelist. The most liked fortifican sample was V10 (10% stevia ini 20% jamun fruit). The attribute liked in this sample was aroma, flavor, and overall. This is due the right combination of sweet in stevia and sour flavor from jamun in this sample.

3.7 Antioxidant Activity

Antioxidant activity was interaction of antioxidants with DPPH to neutralize free radicals in DPPH [17]. The antioxidant activity results were shown in Fig. 7.



*Numbers followed by the same superscript letter indicate treatments that are not significantly different

Fig. 7. Antioxidant activity of soymilk ice cream fortified by jamun and *stevia.*

According to Fig. 7, addition of stevia and jamun pulp increased antioxidant activity. Addition stevia as sugar substitute increased antioxidant activity significantly. This is caused by stevia which contained antioxidant compound that can neutralized DPPH radicals [22], [23].

Addition jamun pulp increased antioxidant activity in soymilk ice cream. Jamun fruit contained many anthocyanin compounds as a source of antioxidant [14]. Ice cream without jamun and stevia (V1) also had antioxidant activity of 8.05%. The source of antioxidants from V1 is soymilk. However, the antioxidant group in soymilk a weak antioxidant group [34]. This is caused by the small amount of total antioxidant compounds; i.e. total flavonoid compounds are 0,304 mg QE (*Quercetin equivalent*)/mL and total phenolic compound is 1,128 mg GAE (*Galic Acid Equivalent)/*mL. The best antioxidant activity in these samples were V10 with 73.95.

4 Conclusion

Addition of stevia and jamun fruit affected physicochemical properties of soymilk ice cream. Addition of stevia caused a decreased in total solids content, overrun, and protein, but increased in melting time. Addition of jamun pulp caused decreased in protein, overrun, and melting time, but increased in total solids content. The most liked fortifican sample is V10 (addition of 10% stevia in 20% jamun pulp). Addition of stevia and jamun increased antioxidant activity as the concentration increased with the best activity value at V10. Thus, the best sample result according to physicochemical, organoleptic, and antioxidant activity is V10 (addition of 10% stevia in 20% jamun pulp).

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