A Study on the Utilization of Local Purple Sweet Potato (*Ipomea Batatas L*) in Making Ice Cream which Potentialize as an Antioxidant

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Abstract: The purpose of this study was to determine: overrun, water content, anthocyanin, and antioxidant content and to know the best formulations. The design used was completely randomized design (CRD) unidirectional pattern consisting of 5 treatments with four replications, while the treatment factor was the difference in the ratio of sweet potato dough to water, as follows: P1: 50%: 50%; P2`: 60%: 40%; P3: (70%: 30%); P4: (80%: 20%); P5: 90%: 10%. Observation variables: water content, overrun, anthocyanin, and antioxidant activity. The results showed that the treatment had a significant effect (P <0.05) on average water content, overrun, and anthocyanin activity. The treatment did not have a significant effect (P> 0.05) on the average antioxidant activity.

Keywords: antioxidants; ice cream; overrun; purple sweet potato; water content

1 Introduction

1.1 Background

One of the innovations in serving sweet potato diversification is by developing into ice cream products. Sweet potato is a food that has nutritional advantages, one of which is purple sweet potato, the local variety which has anthocyanin content and has the potential as an antioxidant (Hendarto & Siregar, 2010). Ice cream is a freezing product made from a combination of milk, sugar, other additives such as flavorings, stabilizers, emulsifiers, and coloring ingredients. The popularity of ice cream is increasing in tropical or hot countries, as in Indonesia. The filling material in the manufacture of ice cream is solids derived from fat and non-fat solids (Affandi & Handajani, 2011).

As a source of food, purple sweet potato contains carbohydrates, vitamin C, niacin, riboflavin, thiamin, and minerals which will enrich the nutritional content of ice cream, it also contains natural color pigments such as anthocyanin and beta-carotene, so that ice cream has high nutritional value. The purple sweet potato anthocyanin level was 9000 µg (32,967 SI), higher than orange sweet potato of 2900 µg (9,657 SI), anthocyanin in sweet potatoes was ± 519 mg / 100 g wet weight. Anthocyanin in purple sweet potato has been researched more stable than anthocyanin from other fruits and vegetables (Suda et al., 2003 in Hendarto & Siregar, 2010).

Beside non-fat additives, water is the main constituent of the ice cream ingredients other than sugar, fat (milk) and cream (Chan, 2009). Therefore the amount of the composition of water in ice cream determines the final result of the ice cream produced. The water in the ice cream serves as a dispersant to dissolve the ice cream mixture. The amount of water used directly affects the formation of fat globules and ice crystals (Hakim, Purwadi, & Padaga, 2018).

This study observed the effect of variations in the ratio of water and purple sweet potato (Ipomea batatas L.) in making ice cream on physical properties (overrun and texture) chemistry (fat content), and organoleptic (color, taste, aroma, and softness).

1.2 Statement of the Problem

The statement of the problem in this study was whether the ratio of water and purple sweet potato (Ipomea batatas L.) to ice cream making had an effect on physical properties (overrun and texture), organoleptic (color, taste, aroma, and softness) and anthocyanin and antioxidant content.

1.3 Objectives and Benefits of Research

The objectives of this study are as follows:

1. To find out the benefits of the influence of differences in the ratio of water and purple sweet potato

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(*Ipomeabatatas L.*) to the manufacture of ice cream on physical properties (overrun and moisture content), anthocyanins and antioxidants.
2. To find out the best ratio.

This research is expected to be able to provide information to the readers and the public about the study of the use of purple sweet potato (*Ipomeabatatas L.*) to the manufacture of ice cream.

1.4 Hypothesis

H0: There is no effect on the ratio of water and purple sweet potato *(Ipomea batatas L.)* to the manufacture of ice cream on physical properties (*overrun* and moisture content), anthocyanin and antioxidant content.

H1: There is an influence of the ratio of purple water and sweet potato (*Ipomea batatas L.*) to the manufacture of ice cream on physical properties (*overrun* and moisture content), anthocyanin and antioxidant content.

2 Methods

2.1 Time and Place of Research

This research was conducted at the end of December 2018 at the Food Engineering Laboratory, Chemistry and Biochemistry Laboratory of the Faculty of Agricultural Technology, Semarang University.

2.2 Materials and Tools

2.2.1 Materials

The raw materials for ice cream were local purple sweet potato varieties to harvesting age 4 months obtained from market Satrio Wibowo Semarang. Full cream milk powder brand Dancow with a fat content of up to 11%, refined sugar brand gulaku and whipping cream brand Pondan were obtained from supermarket Superindo Semarang. The material for the analysis was aqua dest, H2SO4 pa, 0.1 N HCl obtained from a Chemical Store in Semarang City.

2.2.2 Tools

The tools were digital scales Tanita KD-160, an analytical balance Ohaus PAJ 1003, blender Miyako, refrigerator Brands Sharp, Ice Cream Maker brands Suwei YB-0002A, gas stove brands Rinnai, mixer brands Miyako, spoons, pots, mixer, washbasin, freezer brands Sharp, LLOYD Texture Analyzer, glass beaker brands pyrex, measuring cup brands pyrex, funnel brands pyrex.

2.3. Stage of Research

This research was divided into two stages, the first was making molten of purple sweet potato, and the next stage was making ice cream. The procedure was as follows:

2.3.1. The process of making purple sweet potato

1) Fresh purple sweet potatoes were stripped, washed, cut, and weighed 250 g for each treatment.
2) The clean purple sweet potato was steamed for ± 15 minutes.
3) The mature purple sweet potato was then crushed by blending until smooth and homogeneous and allowed to cool.

The flow chart of the purple sweet potatoes was shown in Figure 1.

2.3.2. Making Ice Cream

1) Preparing the necessary materials and tools, then all of the ingredients were weighed.
2) The ingredients that have been prepared (full cream milk powder, granulated sugar, whipping cream, gelatin were mixed and stirred using a mixer. After that, purple sweet potato and water were added according to the prescribed treatment ratio into a mixture that mixes equally.
3) Then the evenly distributed dough was homogenized with a mixer for 10 minutes.
4) Homogenized ice cream dough was put into the refrigerator for Aging 3-4 hours.
5) The Aging ice cream mixture was frozen for 30 minutes with the Ice Cream Maker tool at --2,8^{O}C.
6) The next step was packing and hardening in the freezer at a temperature of 0 to -5^{O}C for 24 hours.
7) Then the ice cream was analyzed chemically, physically, and organoleptically.

The flow chart of ice cream manufacturing process was shown in Figure 2

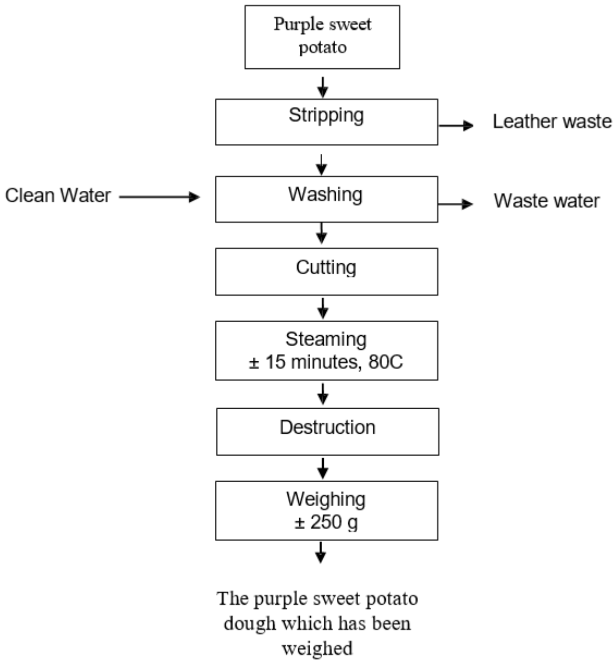

Figure 1. The flow chart of process for making purple sweet potato dough

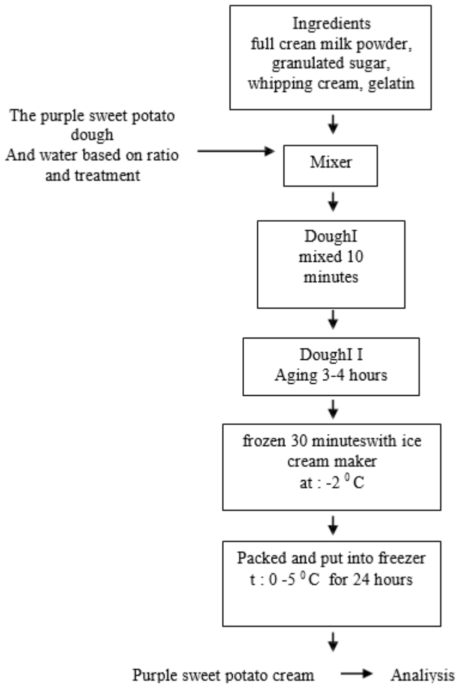

Figure 2. the flow chart for making ice cream

2.4 Trial Design

The design of this study was a completely randomized design (CRD) of one factor, which was the ratio of water and purple sweet potato dough, which consists of 5 treatments with 4 replications. The composition of ingredients in Ice Cream Mix is based on Sudarmanto (2014). The ratio factor of purple sweet potato (the ratio expressed in grams is shown in Table. 1 as follows:

P1 : The ratio of Purple Sweet Potato dough : Water (5: 5)
P2 : The ratio of Purple Sweet Potato dough : Water (6: 4)
P3` : The ratio of Purple Sweet Potato dough : Water (7: 3)
P4 : The ratio of Purple Sweet Potato dough : Water (8: 2)
P5 : The ratio of Purple Sweet Potato dough : Water (9: 1)

Table 1: Formulation of Ice Cream Dough

	Treatment				
	A1	A2	A3	A4	A5
Whipping Cream (g)	200	200	200	200	200
Granule sugar (g)	150	150	150	150	150
Full Cream milk powder(g)	200	200	200	200	200
Liquid milk (g)	100	100	100	100	100
Gelatin (g)	2	2	2	2	2
Purple sweet potato dough (g)	224	269	309	344	348
water (g)	124	79	39	4	0

Source: Primary Data (2018); Sudarmanto, (2014)

2.5. Observation Variables

2.5.1. Overrun (Malaka, 2011)

Volume development (overrun) is an increase of the ice cream volume because of the foaming air into the mixture during the process of foaming and freezing with the formula:

$$\%\ \text{Overrun} = \frac{\text{Volume of ice cream} - \text{volume of mixture of ingredients}}{\text{mixed volume of material})}$$

2.5.2. Texture Analysis with the LLOYD Instrument Testing Machine (Sudarmanto, 2014b)

a) Turning on the LLOYD engine is less than 30 minutes for warming up so that the pressure movement is following the break detector and cycle.
b) The computer is turned on, entered the LLOYD program, press number 1 then enter.
c) The cursor is placed dci installation, enter.
d) The cursor is placed at the default, written B: / (no.3) enter e)
e) Cursors are placed on Machine control, enter:
   1. Pressed A and B on the LLOYD engine display unit with the remote control text.
   2. After the relationship between the LLOYD machine and the computer has occurred, the LLOYD Instrument Standart program will appear on the screen
f) The cursor is placed on the detector
   1. choose "On" if the sample is easily broken / easily changes suddenly
   2. choose "Off" by pressing the control sign N on the keyboard
   3. The cursor is placed in the return autoresponder, if the sample is more than 1 with the same size then after the test is complete, the pressure or puller will return to its original location.
g) The cursor is placed in auto zero, so that the leadder extension shows the number 0.0 at the time of Go (testing).
h) The cursor is placed in the cycle, until it appears:
   1. Court: how many times is pressed, Example for number 1 means when the suppression is used for violence, cut and drawn.
   2. Upper cycle limit is a range of depth suppression from the sample surface when the mode is compression.
   3. Low cycle limit is the difference between the second depth of emphasis (upper lower).
i) The cursor is placed in mode, select compression or emphasis.
j) The cursor is placed on the extensometer, select internal, it means that the computer will automatically record the distance traveled by the press or puller.
k) The cursor is placed in x axis, write .... mm / minute (description of y axis and x axis is used for graph display)
l) The cursor is placed in a test speed, filled in ..... mm / min, minimum mm / min and a maximum of 20 mm / min.
m) The cursor is placed in the Width (sample width) .... mm n)
n) The cursor is placed in Depth (sample thickness) .... mm
o) The cursor is placed in gaughe lenght (sample length) .... mm p)
p) Press F9 to go to the graphic screen
q) Press F7 to Go (Testing) after finished, press the letter S to save data.

2.5.3. Determination of antioxidant activity with free radical capture methods with DPPH (1.1 Diphenyl-2-pycrylhydrazyl = C18H12N506; BM = 394.32 (Amarowicz, Naczk, & Shahidi, 2000).

2.5.3.1 Making 200 ppm BHT solution

0.002 g is added to the 10 ml volumetric flask, then added to methanol until the tera line.

2.5.3.2 Making DPPH 0.1 mM solution

0.001 g DPPH is put in a 10 ml volumetric flask, then added with methanol to the tera line.

2.5.3.3 Testing of Antioxidant Activities (Amarowicz et al., 2000).

Each extract concentration was taken 0.5 ml and added 1 ml DPPH 0.1 mM. It was conducted the addition of 4 ml methanol to be vortexed until homogeneous, then incubated for 30 minutes. Furthermore, it was carried out at λ 517 nm. For controls, the treatment was the same, but without the addition of samples. Manufacturing of blanks was done by replacing the sample with methanol. The result was expressed in percent DPPH radical capture.

$$\%\ \text{radical capture} = \frac{\text{absorbance control - absorbance of sample}}{\text{absorbance of control}} \times 100\%$$

2.5.4. Determination of Total Anthocyanin Levels of Different pH Methods (Cheng and Breen, 1998)

Anthocyanin analysis uses the pH difference method. The purple rice extract samples were 0.1 ml each mixed with 6.4 ml of buffer solution pH 1 and pH 4.5. then the absorbance measurements were carried out at λ 510 nm and λ 700 nm. The results of absorbance measurements are included in the equation:

$$\text{Anthocyanin content: } \frac{A \times MW \times DF}{\varepsilon x}$$

Information
A : Absorbance
{(A 510 - A 700) pH 1 - (A 510 -A 700) pH 4.5}
E : molar extraction coefficient (cyanidin-3-glycoside: 29,600 L / mol cm) L: cuvette width
M : molecular weight (cyanidin-3-glycoside: 445 g / mol) DF: Dilution Factor (Dilution Factor)

2.5.4.1. Making pH 1 buffer solution

1.49 g of KCl was dissolved in 100 ml of distilled water and 1.7 ml of concentrated HCl was mixed into 100 ml of distilled water. Then mix 25 ml of KCl solution with 67 ml of HCl solution. Furthermore, pH is measured by a pH meter until it reaches pH 1 by adding HCl solution.

- Making 0.2 M KCl solution
  - KCl molecular weight: 74,557
  - Molarity: 0.2 mol / 1000 ml
  - The amount of KCl needed to make a concentration of 0.2
    M 0.2 = G / 74.557
    G = 14,9114 g / L

2.5.4.2. Making pH 4.5 buffer solution

1.64 g of sodium acetate was dissolved in 100 ml of distilled water. Then add the HCl solution carefully until it reaches pH 4.5.

- Making Sodium Acetate (NaCH3COO)
  - Molecular weight : 82,041 g
    NaCH3COO – Molarity : 1 mol / L = 0.1 mol / 100 m
  - The amount of NaCH3COO was
    0.1 = G / 82,041 so that G = 8,2041 g in 100 m

2.6. Data Analysis

The data were analysed using analysis of variance ANOVA (Analysis of Variance) using SPSS version 20.0 software. If there are differences due to the treatment, Duncan's Multiple Range Test (DMRT) test will be carried out at the level of 5% using the following testing criteria:
F count <F table H0 accepted H1 rejected
F count ≥ F table H1 is accepted H0 is rejected. (Steel and Torrie, 1995 in Santoso, 2017)

3 Result and Discussion

3.1 Water content

The water on the ice cream mixture effects the thickness (texture), overrun, and softness of the final product. Water in ice cream dough will bind with sweet purple amylose and amylopectin (20% amylose and 80% amylopectin) which is called the gelatinization mechanism (Swinkles, 1985). The effect of treatment on water content, shown in table 2.

Table 2: Average Ice Cream Water Level due to treatment

Treatment	Water Content (%)
P1	75.21^{a}
P2	73.63^{b}
P3	71.38^{c}
P4	66.55^{d}
P5	64.80^{e}

Looking at table 2, the value of the water content decreases as the amount of purple sweet potato added to the ice cream dough increases. Consecutively the water content value of P1 is 75.21%; P2 is 73.63%; P3 of 71.38%; P4 is 66.55%, and P5 is 64.80%. According to Clarke (2015), the water content in ice cream generally ranges 62.0% - 64% while the results of the study obtained a range of water content of 64.08% - 75.21%, in this case, the difference could be caused by differences in the main ingredients of ice cream constituents mainly because of purple sweet potato mixture which has a water content of 70.46%.

The more the purple sweet potato is added, the lower the water content. The water in the ice cream dough will bind with purple sweet amylose and amylopectin in the gelatinization mechanism, which causes absorbed water to enter the starch granule (gelatinization process). In this process, the amylose molecule is released into the water phase that envelops the granule so that the structure of the starch granules becomes more open and more water enters the granule, causing the granule swells and its volume increases, according to Imanningsih (2012).

3.2. Overrun Ice Cream

Overrun shows the increase in the volume of the ice cream mixture because the air trapped in the ice cream mixture is due to the aging process. Overrun affects texture and density, which greatly determine the quality of ice cream. The presence of air in the ice cream will form air cavities which will immediately be released together with melting ice cream. The more air cavity causes the ice cream to quickly melt at room temperature (Prasetyo, Padaga, & Sawitri, 2013). The effect of treatment on the value of overrun ice cream is shown in table 3.

Table 3: Average Value of Overrun Ice Cream due to treatment

Treatment	Overrun (%)
P1	24.18^{a}
P2	24.87^{a}
P3	28.04^{b}
P4	33.25^{c}
P5	34.92^{d}

Description: a number followed by a different lowercase superscript in the same column shows a significant difference (P <0.05)

Looking at table 3 above, it can be seen that the overrun value ranges from 24.18% - 34.92% with details P1 of 24.18%, P2 of 24.87%, P3 of 28.04%, P4 of 33.25% and P5 of 34. 92%. After a variety analysis, it is known that the treatment has a significant effect (P <0.05) on the average overrun, and after further testing (DMRT), it is known, P1 and P2 are not significantly different, but significantly different from P3, P4 and P5. P3, P4 and P5 are significantly different from each other.

The difference is caused by differences in water ratio and purple sweet potato dough, in this study P1 to P5 the water ratio decreases compared to the purple sweet potato, the water in the ice cream mixture will bind with purple sweet amylose and amylopectin gelatinization mechanism that causes water enter to the starch granule (gelatinization process) in this process the amylose molecule is released into the water phase that envelops the granule, so that the structure of the starch granules becomes more open and more water enters the granule, causing the granule swell and the volume increases, this is in accordance with the opinion of Imanningsih (2012). When compared to the results of research by Prasetyo, Padaga, & Sawitri (2013) which stated that overrun ice cream for industrial-scale ranged from 70% - 80% while for household-scale ranged from 30% - 50%, then this study is still included in the category of home industry scale. Furthermore, it was also explained that ice cream with a low overrun caused the texture of the ice cream to be too hard, and if the overrun was too high, it caused the texture of the ice cream to be too soft and melt faster.

Overrun ice cream is also determined by the fat content and raw material of the emulsifier. The entry of air and good shaking will produce a product that has small air cells. This is important to prevent ice cream from being too dense and too cold in the mouth. At the time of shaking, the air will enter into the very small fat globules, so that the volume expands.

3.3. Anthocyanin Activity

Anthocyanin acts as a natural food coloring agent and has physiological functions, namely selenium and iodine as anti-cancer substances and as an antioxidant and protector of heart disease. The results showed that the anthocyanin content of purple sweet potato ice cream is shown in Table 4. The results of the variance analysis showed a significant effect due to the difference in water ratio with the prevalence of purple sweet potato. The range of anthocyanin content in this study was 17.50 to 40.63. The greatest anthocyanin content was achieved in P4 treatment of 40.63, while the lowest in treatment P1 was 17.50. The trend of the effect of treatment on anthocyanin content increases with the increasing of purple sweet potato dough. The detail can be seen in Table 4.

Table 4: Average Ice Cream Anthocyanin Content due to treatment

Treatment	Anthocyanin Content
P1	17,50^{a}
P2	36,39^{b}
P3	40,49^{c}
P4	40,64^{c}
P5	40,27^{b}

Description: a number followed by a different lowercase superscript in the same column shows a significant difference ($P < 0.05$)

Factors affecting anthocyanin stability are oxygen, pH temperature, light, metal ions, enzymes, and ascorbic acid (Markakis, 2012). Anthocyanin has the characteristic of a potential antioxidant so that it can prevent degenerative diseases. The anthocyanin content of purple sweet potato per 100 grams of material is 21.43 mg after being processed into ice cream. The anthocyanin content ranges from 17.50 to 40.63.

3.4. Antioxidant Activity

Anthocyanin has physiological functions, namely selenium and iodine as anti-cancer substances and antioxidants

Table 5: Average Antioxidant Content of Ice Cream due to treatment

Treatment	Antioxidant Content
P1	14,21^{a}
P2	20,01^{a}
P3	23,79^{a}
P4	26,44^{a}
P5	31,65^{a}

Description: a number followed by the same lowercase superscript in the column the same shows no significant difference ($P > 0.05$)

Purple sweet potato contains anthocyanin and *peonidine glycosides,* which have stronger antioxidant activity. According to Pakorny et al., (2001) in Hendarto & Siregar (2010). Walter McCollum (1979) in Ginting (2011) stated that the content of the sweet potato phenol compounds ranged from 14 - 51 mg, but Rumbaoa (2009) in Ginting (2011) obtained a wider range of 50.1 - 362.8. In purple sweet potato, the anthocyanin content and phenol compounds are quite high and can function as antioxidants.

Based on the antioxidant content is directly proportional to the anthocyanin content, but in this study it was found that the more purple sweet potato dough contained less antioxidant, but it did not produce a significant difference in the content of antioxidants, this is thought to be due to a narrow interval of sweet potato. The antioxidant content produced in this study ranged from 14.21 - 31.65.

The antioxidant content of purple sweet potato per 100 grams of material is 61.24%. After being processed into ice cream, the antioxidant value ranges from 14.21 - 31.65. This is lower compared to the sweet potatoes. This is directly proportional to the decrease in anthocyanin content which has decreased due to processing into ice cream. This is in accordance with the statement of Markakys (2012) which states that several factors that influence anthocyanin stability are oxygen, pH, temperature, light, metal ions, enzymes and ascorbic acid.

4. Conclusion

1. The difference in the ratio of water and purple sweet potato dough (Ipomeabatatas L.) in the manufacture of ice cream influences the actual physical properties (overrun and moisture content), and anthocyanin activity, but it does not significantly affect antioxidant activity.
2. The best ratio in making ice cream is the Purple Sweet Potato Dough Ratio: Water (8: 2), with water content and overrun which is still in standard conditions and high anthocyanin and antioxidant activities.

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