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A Study on the Utilization of Purple Sweet Potato (*Ipomea batatas* L) for Ice Cream as Additional Antioxidants

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Abstract

The purposes of this study were to determine overrun, water content, anthocyanin and antioxidant content, and to find out the best formulations. The design used was completely randomized design with a unidirectional pattern consisting of 5 treatments with 4 replications, while the treatment factor was ratio of sweet potato mash and water, as follows: P1= 50:50; P2`= 60:40; P3 = 70:30; P4= 80:20; P5=90:10. The observed variables were the content of water, overrun, anthocyanin and antioxidant activity. The results showed that the treatment had a significant effect ($p<0.05$) on the average water content, overrun and anthocyanin activity. The treatment did not have a significant effect ($p>0.05$) on the average antioxidant activity. In conclusion, the ratio of purple sweet potato mash might change water content, overrun and anthocyanin, but less changed antioxidant activity with the best ratio of water and purple sweet potato mash was 80:20.

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Introduction

One of the innovations in serving sweet potato diversification is by producing ice cream. Sweet potatoes are nutritional food especially purple sweet potato, a local variety which has anthocyanin content and as an antioxidant (Hardoko, 2010). Ice cream is a frozen product as a combination of milk, sugar, and other additives such as flavorings, stabilizers, emulsifiers and coloring ingredients. The popularity of ice cream is increasing in tropical countries as in Indonesia. The components in the production of ice cream are solids from both fat and non-fat (Rachmawanti and Handajani, 2011; Mulyani *et al*., 2017).

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. Besides, it contains natural color pigments such as anthocyanin and beta-carotene, ice cream has high nutritional value. The anthocyanin content of purple sweet potato was 9000 μg(32,967SI), higher than orange sweet potato of 2900 μg (9,657 SI), and anthocyanin in sweet potatoes was ±519 mg/100 g. The study showed that anthocyanin purple sweet potato was more stable than anthocyanin of other fruits and vegetables (Suda *et al*., 2003). The anthocyanin content in purple sweet potato provides an attractive purple appearance for consumption (Siswati *et al*., 2019; Lanusu *et al*., 2017).

Besides non-fat additives, water is the main constituent of ice cream other than sugar, fat (milk) and cream (Chan, 2009), therefore the amount of the 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 affects directly to the formation of fat globules and ice crystals (Hakim *et al*., 2015).

This study was conducted to observe the effect of variations in the ratio of water and purple sweet potato (*Ipomea batatas* L.) for ice cream on physical properties (overrun and texture), chemistry (fat content), and organoleptic (color, taste, aroma, and softness) anthocyanin content and antioxidant activity.

Materials and Methods

The raw materials for ice cream was *Ayamurasaki* variety of local purple sweet potato harvested at the age of 4 months obtained from local market, Semarang. Commercial full cream milk powder with the fat content of up to 11%, refined sugar, and Pondan® whipping cream were purchased in modern supermarket in Semarang. The materials for the analysis were aquadest-purified water, H_2SO_4, 0.1 N HCl. Digital scales such as Tanita KD-160, Ohaus PAJ 1003 analytical balance, Miyako blender, Sharp refrigerator, Suwei YB-0002A Ice Cream Maker, Rinnai gas stove, Miyako mixer, Sharp freezer, LLOYD Texture Analyzer, and measuring cup were used.

Manufacture of Purple Sweet Potato Mash

Fresh purple sweet potatoes were stripped and washed then cut and weighed in 250 g for each treatment. The cleaned purple sweet potato was steamed for ± 15 minutes. The cooked purple sweet potato then was crushed by blending until smooth and homogeneous and allowed to cool.

Making Ice Cream

The Ice cream was processed according to Sudarmanto (2014); Annishia and Dhanarindra (2017) with modification. The full cream milk powder, granulated sugar, whipping cream, and gelatin were mixed and stirred using mixer and added the mash purple sweet potato and water corresponding to the treatment ratio. The dough was homogenized with a mixer for about 10 minutes. The homogenized ice cream dough was placed into refrigerator about 3-4 hours. The aged ice cream dough was then freezed for 30 minutes with a ice cream maker at temperature of –2,8˚C. The next step was packaging and hardening in freezer at 0 to –5˚C for 24 hours. The ice cream was then analyzed.

The Formula of Treatments

The design in this researh is completely randomized design one factor, which was consisted of 5 treatments with 4 replications. The source of the composition of ingredients on *Ice Cream Mix* is based on Sudarmanto (2014). The factor ratio on purple sweet potato mash (the ratio was presented in grams) as follows: 50:50; 60:40; 70:30; 80:20; 90:10 that was represented as P1, P2, P3, P4, and P5.

Parameter of Observation

Volume development (overrun) was analyzed based on the previous researcher (Malacca, 2011), determination of antioxidant was analyzed using DPPH (1.1 Diphenyl-2-pycrylhydrazyl) as substrate (Amarowicz *et al.,* 2000). Total anthocyanin was observed using method of Chen and Breen (1998).

Analysis Data

The data were analysed using ANOVA (Analysis of Variance) and SPSS software version 20.0. If there were differences due to the treatment, Duncan's Multiple Range Test at the level of 5% were carried out (Steel and Torrie, 1995).

Results and Discussion

Water content

The water in the ice cream mixture affected thickness, overrun and softness of the final product. The water in ice cream mixture may bind with amylose and amylopectin of purple sweet (that was consist of 20% amylose and 80% amylopectin) which called as the gelatinization mechanism (Swinkles, 1985). The effect of the treatment on the water content is shown in Table 1 that was indicated the water content value has decreased along the increase of the amount of purple sweet potato mash. Consecutively, each water content value was 75.21% (P1); 73.63% (P2); 71.38% (P3); 66.55% (P4) and 64.80% (P5). According to Clarke (2015), the water content in ice cream generally ranges from 62 to 64%, while the results of the study indicate the water content range of 64.08–75.21%. In this case, the difference could be caused by the differences in the main constituents of ice cream; it is mainly because of the purple sweet potato mixture has a water content of 70.46%.

The more the purple sweet potato added, the lower water content as water absorption in the starch granule. In this process, the amylose molecule released into the water phase covering the granule, so that the structure of the starch granules becomes more open and has more water in the granule, therefore it causes the granule swells and its volume has increase (Imaningsih, 2012).

Overrun of Ice Cream

Overrun shows the increase in the volume of the ice cream mixture because the air trapped in the ice cream mixture due to the aging process. Overrun affects texture and density, which greatly determines the quality of ice cream. The presence of air in the ice cream forms air cavities released immediately together with the melting ice cream and thus produces more air cavities causing the ice cream melt quickly at room temperature (Padaga and Sawitri, 2005). The effect of treatment on the value of overrun in ice cream is presented in Table 3.

Table 1. Water content (%), overrun (%), anthocyanin content (mg/100 g), and antioxidant of purple sweet potato ice cream

Treat ments	Water content	Overrun	Anthocyanin content	Antioxidant
P1	75.12±0.41^{a}	24.18±1.19^{a}	17.50±0.53^{a}	14.21±8.70^{a}
P2	73.63±0.72^{b}	24.87±0.83^{a}	36.39±4.13^{b}	20.01±14.16^{a}
P3	71.38±0.67^{c}	28.04±0.73^{b}	40.49±1.02^{c}	23.79±13.69^{a}
P4	66.55±0.67^{d}	33.25±0.52^{c}	40.64±1.64^{c}	26.44±10.34^{a}
P5	64.80±0.86^{e}	34.92±0.45^{d}	40.27±1.46^{bc}	31.65±14.41^{a}

Note : Data shown as mean±SD. Superscript showed a significant difference ($p<0.05$). P1, P2, P3, P4, P5 represented 50:50; 60:40; 70:30; 80: 20; 90:10 grams ratio on purple sweet potato mash and ice cream mix, respectively

As can be seen, the overrun value ranges from 24.18 to 34.92%. It was revealed that the treatment had a significant effect ($p<0.05$) on the overrun, and it was identified that P1 and P2 were not statistically significantly different, but significantly different for P3, P4 and P5. Meanwhile, P3, P4 and P5 were statistically significantly different from other.

The decrease of the water content might inversely proportional affected to the overrun, and the more the amount of purple sweet potato mash, the higher the overrun. At this point, the water in the ice cream mixture bound with amylose and amylopectin of purple sweet potato in gelatinization mechanism that causes the water absorbed in the starch granule (gelatinization process). Based on Imaningsih (2012), in this process, the amylose molecule is released into the water phase covering the granule, so that the structure of the starch granules becomes more open and has more water in the granule, therefore it causes the granule swells and its volume increases. Comparing to the results of the research conducted by Padaga and Sawitri (2005), overrun ice cream for industrial scale ranged from 70 to 80%, while the one for household scale ranged from 30 to 50% and therefore this study was still comparable based on home industry scale. Furthermore, it also explained that ice cream with a low overrun, with the overrun value near to Aulia *et al.* (2017), it produced super hard ice cream texture, and otherwise if the overrun was too high, the texture of the ice cream could be too soft and melted rapidly. Overrun ice cream was also determined by the fat content and emulsifier. The introduce of air and well shaking may produce a good product, which has small air cells. Furthermore, shaking the ice cream may contribute air penetration into the tiny fat globules resulting in the expansion in volume. The addition of gelatine contributed to the lower overrun value. The addition of gelatine is important to provide distinctive texture properties and is resistant to sudden changes in temperature (Haryatie, 2011).

Anthocyanin Content

Table 1 presents the anthocyanin content in purple sweet potato ice cream that showed a significant effect of water ratio and the treatment of purple sweet potato mash. 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 was in P1 treatment of 17.50. The trend of the effect treatment on anthocyanin content increased along with the increase of purple sweet potato mash. The anthocyanin content of purple sweet potato per 100 grams was 21.43 mg, and after ice cream processing, the anthocyanin content turned into the range of value from 17.50 to 40.63. it assumed because of the steamed process of purple sweet potatoes. Factors affecting anthocyanin stability may come from oxygen, pH, temperature, light, metal ions, enzymes and ascorbic acid (Markakis, 2012).

Antioxidant Activity

The purple sweet potato contains anthocyanin and peonidine glycosides. According to Pokorny *et al.* (2001), Ginting (2001) stated that phenol compounds content of sweet potato ranged between 14–51 mg, however Rumbaoa *et al.* (2009) obtained a wider range of 50.1–362.8. In purple sweet potato, the anthocyanin content and phenol compounds are quite high. Commonly, high antioxidant may be achieved along with the high anthocyanin content, however in this study found that the use more purple sweet potato mash contained less antioxidant, showed not significant difference in the antioxidant contents. This may be explained due to narrow intervals of applied sweet potato mash. The antioxidant content produced in this study ranged between 14.21–31.65.

The antioxidant of purple sweet potato per 100 grams of material was about 61.24%. After ice cream processing, the antioxidant value ranged between14.21–31.65%. It has lower antioxidant compared to the sweet potatoes that may due to several factors such as oxygen, pH, temperature, light, metal ions, enzymes and ascorbic acid (Markakis, 2012). This results near to pineapple ice cream by Chauliyah and Murbawani (2015) with the antioxidant activity about 13-46%.

Conclusion

The different ratio of water and purple sweet potato mash (*Ipomea batatas* L.) in producing ice cream apparently influenced overrun, water content, and anthocyanin content, but not for antioxidant activity. The treatment 80:20 ratio produced best water content and overrun that had correlation with high anthocyanin and antioxidant activities.

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