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Assessment of Stabilizer Potential of Porang Flour and Maize Starch on Antioxidant Activity and Physicochemical Characteristics Ice Cream

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ABSTRACT

Ice cream is a semi-frozen food made from milk or milk products, sweeteners, stabilizers, emulsifiers, and added flavors. Many ice cream product developments have been carried out to improve the quality of ice cream. One of them is the addition of stabilizers that maintain emulsions and enhance the softness of ice cream products. They can prevent the formation of large ice crystals in ice cream, provide uniformity of product texture, and provide resistance so that it does not melt easily. The purpose of this study was to analyze ice cream's antioxidant activity and physicochemical quality using different types and amounts of stabilizers (porang flour and cornstarch). This research method uses a completely randomized design (CRD) consisting of 5 levels of treatment with 3 replicates each. The treatment used in this study is the use of porang flour and cornstarch stabilizer at different concentrations, including; A1: 100% cornstarch; A2: Combination of 25% porang flour and 75% cornstarch; A3: Combination of 50% porang flour and 50% cornstarch; A4: Combination of 75% porang flour and 25% cornstarch; A5: 100% porang flour. The results showed that the treatment of the use of stabilizer combination of porang flour and cornstarch had a very significant effect ($P<0.01$) on ice cream testing parameters, including antioxidant activity and viscosity. Using a stabilizer combination of porang flour and cornstarch has no effect ($P>0.05$) on ice cream testing parameters, such as taste, texture, liking, melting power, and *overrun*. Treatment (A4) combines 75% porang flour and 25% cornstarch as stabilizers in ice cream.

Keywords: Ice cream, stabilizer, antioxidant activity, physicochemical quality

INTRODUCTION

Ice cream is a semi-frozen food created by freezing milk or dairy products, sweeteners, stabilizers, emulsifiers, and flavor additives [1]. It is produced through several process stages: mixing, pasteurization, homogenization, *aging*, freezing, agitation, packaging, and hardening. The

development of ice cream products has been extensively pursued to enhance consumer appeal [2], [3]. The key principle of making ice cream is to trap air within the mixture, allowing for volume expansion, which results in ice cream that is fluffy, not overly dense, and has a soft texture.

A stabilizer is an additive used in small quantities during food processing to maintain emulsions and enhance the creaminess of ice cream products [4], [5], [6], [7]. Additionally, its application in ice cream production can prevent the formation of large ice crystals, ensure consistent product texture, provide melting resistance, and improve overall product characteristics. Ice cream made with a stabilizer becomes smoother and softer [8]. Ice cream with a stabilizer also becomes smoother and softer [9].

Commonly used stabilizers that soften the texture of ice cream and other *frozen desserts* include *Carboxy Methyl Cellulose* (CMC), gelatin, sodium alginate, carrageenan, gum arabic, and pectin [2]. Stabilizers consist of carbohydrate or protein compounds that help stabilize the dough components and influence the physicochemical properties of ice cream [10], [11], [12]. Alternative natural ingredients with stabilizing compounds include cornstarch and porang flour, providing varying amounts of carbohydrates and proteins.

Porang (*Amorphophallus oncophyllus*) tuber flour contains 15-65% glucomannan and 10.24% starch. Glucomannan, a water-soluble dietary fiber, is a strong hydrocolloid and low in calories, which offers high potential for use as a stabilizer in various industries. Furthermore, porang flour contains terpenoids, flavonoids, and tannins, which may serve as antioxidants [13].

Cornstarch is a flour made from processed corn kernels. It contains 72-73% starch or carbohydrates. Additionally, cornstarch is recognized as a functional food. It includes antioxidants such as dietary fiber, iron, and beta-carotene (provitamin A).

The use of porang tuber flour and cornstarch as stabilizers in this study influenced the physicochemical and functional properties of the ice cream. This description highlights the need for further research on the optimal percentages of porang flour and cornstarch to produce healthy, high-quality ice cream.

MATERIALS AND METHODS

The tools used in this study include measuring cups, analytical scales, pans, gas stoves, stirrers, tablespoons, ice cream cups, thermometers, stopwatches, test tubes, tube racks, *spectrophotometers, micropipettes*, *and freezers. The* materials utilized in the research consist of whole milk, whipped cream, vegetable cream, sugar, egg yolks, water, porang flour, cornstarch, labels, tissues, DPPH powder (*Diphenyl Picryl Hydrazyl),* and methanol.

The composition table of ice cream ingredients with porang flour stabilizer and cornstarch is presented in Table 1.

Making Ice Cream with the Addition of Porang Flour as a Stabilizer

Making ice cream begins with weighing all the necessary ingredients: whole cream milk, whipped cream, vegetable cream, sugar, egg yolks, water, and a percentage of porang flour and cornstarch (according to treatment). The ice cream ingredients are mixed and stirred over low heat on the stove until well blended. The ice cream dough ingredients are pasteurized at a low temperature for a long time (LTLT) at 70 °C for 15 minutes, and then cooled to a temperature of

27 °C. The ice cream mixture is then chilled for 4 to 5 hours at -10 °C (half-frozen). Next, it is homogenized for 15 minutes to create the ice cream dough specific to each treatment. After that, the dough is packaged and frozen in a freezer at approximately -10 °C for 24 hours. Finally, organoleptic testing (taste, texture, and liking), antioxidant activity, overrun, and viscosity assessments are conducted on the ice cream.

Table 1. Ingredients Composition of Ice Cream in Different Treatments

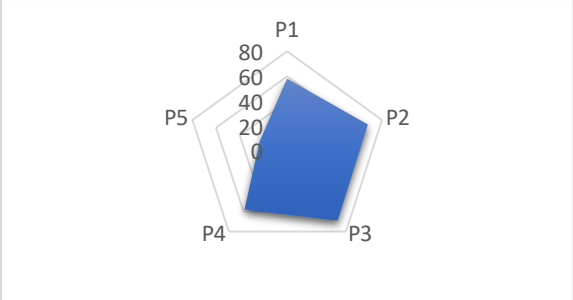
Material	A1	A2	A3	A4	A5
Full cream milk	10	10	10	10	10
Whippy cream	8.5	8.5	8.5	8.5	8.5
Plant-based cream	12	12	12	12	12
Sugar	8	8	8	8	8
Egg yolk	15	15	1.5	1.5	1.5
Water	60	60	60	60	60
Total	100	100	100	100	100
Maizena*	0.5	0.375	0.25	0.125	
Porang*		0.125	0.25	0.375	0.5

Source: Modified ice cream formulation from the Biotechnology Laboratory of Dairy Processing
Description: *added from the total dough ingredients used

RESULTS AND DISCUSSIONS

Antioxidant activity

Analysis of the variance of antioxidant activity in ice cream showed that the antioxidant activity was significantly affected (P<0.05) by the treatment using a stabilizer combination of porang flour and cornstarch (Figure 1). The average antioxidant activity of ice cream ranged from 23.60 to 69.00. Antioxidants are compounds that are stable enough to donate electrons to free radicals, stopping the chain reactions. They can prevent or inhibit cell damage caused by free radical activity.



Picture 1. Antioxidant activity of ice cream

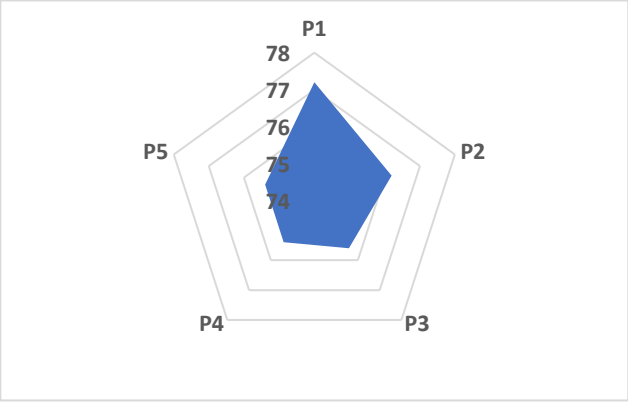
Notes: Superscripts[a,b,] and[c] in the same column indicate significant differences (P<0.05).

Duncan's further test results revealed that the antioxidant activity of ice cream exhibited a very significant difference (P<0.01) due to using a stabilizer combination of porang flour and cornstarch. This indicates that antioxidant activity can continue to increase as the use of cornstarch rises. Cornstarch and porang flour are two sources of natural antioxidants. Cornstarch is derived from corn. Some studies mention that corn kernels, used as the raw material for

making cornstarch, contain phenolic compounds such as ferulic acid, flavonoids, and anthocyanidins, which have the potential to act as antioxidants [14].

Overrun

Analysis of the variance of ice cream overrun showed that it was not affected (P>0.05) by using a stabilizer combination of porang flour and cornstarch. The average value of ice cream overrun ranged from 75.40 to 77.20. The higher the overrun, the faster the ice cream melts; conversely, the lower the overrun, the longer it melts.



Picture 2. Overrun Value of Ice Cream with the Treatment of the Use of Stabilizer Combination of Porang Flour and Maizena Flour

Ice cream overrun is influenced by the sugar (sucrose) content added to the ice cream mixture. Sucrose influences the total solids of ice cream and affects the amount of air trapped in the ice cream dough, causing the overrun to decrease. A good overrun ranges from 60-100%. Ice cream with 80% overrun has a 12-14% fat content [15].

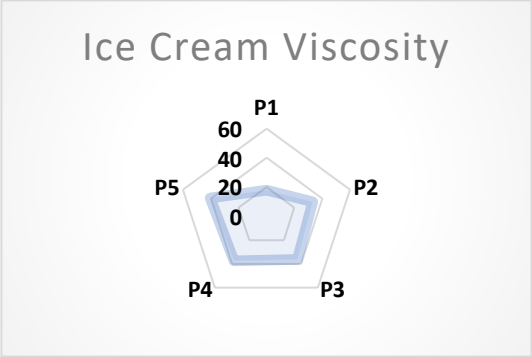
Adding porang tuber flour to jackfruit ice cream, the average value of jackfruit ice cream overrun is known to have increased in the 0% to 0.4% treatment [16]. The increase in the overrun of jackfruit ice cream is influenced by stabilizers that can capture air when mixing ice cream. The stabilizers in ice cream dough can increase the ability to expand in the right composition to create ice cream froth stability, causing high overrun [17]. The increase in ice cream overrun value can also be caused by agitation.

Viscosity

Analysis of the variance of ice cream viscosity showed that viscosity was significantly affected (P<0.01) by the treatment involving a stabilizer combination of porang flour and cornstarch. The average value of ice cream viscosity ranged from 18.00 to 40.40 (cP). The concentration of porang flour and cornstarch can affect a product's viscosity and cohesiveness attributes [18].

The results of Duncan's further test showed that the viscosity of ice cream showed a very significant difference (P<0.01) by the treatment of the use of a stabilizer combination of porang flour and cornstarch. The gelatinization ability of starch causes changes in the product's texture, which becomes softer due to increased viscosity. Excessive addition of starch will cause the

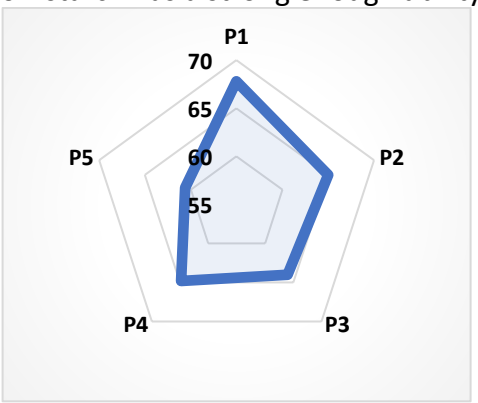
texture to become chewy due to the lower amount of water absorbed by the starch, so the gel formed becomes very soft. The starch content of porang flour is 10.24% [19]. The starch content of cornstarch is 76.89% [20]. The functional characteristics of starch are influenced by the amylose and amylopectin content. Corn starch contains 72% amylopectin and 28% amylose [10]. Research also shows that cornstarch can increase viscosity and reduce water mobility in frozen cream products [21].



Picture 3. Average Value of Viscosity of Ice Cream with the Treatment of Stabilizer Use of Combination of Porang Flour and Maizena Flour

Melting Power

This melting speed is one of the parameters that determines the quality of ice cream [22]. Analysis of the variance of ice cream melting power showed that melting power was not affected (P>0.05) by the treatment of the use of a stabilizer combination of porang flour and cornstarch (Figure 4). Ice cream's average melting power value ranged from 60.60 to 67.80 (minutes). The addition of porang flour and cornstarch has a strong enough ability to bind free water.



Picture 4. Average Melting Power Value of Ice Cream with the Treatment of Stabilizer Use of Porang Flour Combination and Maizena Flour

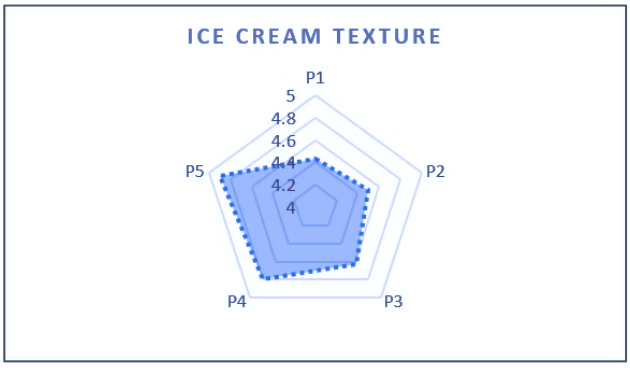
Porang flour has chemical properties as a thickener, gelling agent, and water binder so that it can slow down the melting time of ice cream. This is the opinion of Angraeni et al. [23], who state that in porang flour, there are hydrocolloids, namely glucomannan, which can absorb water. Ice cream that melts quickly is less preferred because the ice cream will melt immediately at room temperature [24]. Still, if the ice cream has a slow melting speed, it is also disliked by consumers

because the shape of the ice cream is fixed or unchanged at room temperature, giving the impression that too many solids are used. Ice crystals are smaller and have a softer texture due to increased viscosity [21].

Texture

Analysis of the variance of ice cream texture showed that the texture of ice cream was not affected (P>0.05) by the treatment of the use of a stabilizer combination of porang flour and cornstarch. The average panelist assessment of ice cream texture ranged from 4.43 to 4.90 (soft) (Figure 5). The texture of ice cream is influenced by the ingredients mixed, processing, and storage. The texture of ice cream depends on the size, shape, and particle size of the solids that make up the ice cream. The ideal texture for ice cream is very smooth, and the particle size of the solids is so tiny that it is not detected in the mouth [25].

Adding a stabilizer, such as cornstarch or flour, binds free water in the mixture so that ice crystals do not form [14]. Total solids also affect the texture of ice cream. A gritty texture (coarseness) can indicate that large crystals are non-uniform or that the air cells are too large [5].



Picture 5. Average Texture Value of Ice Cream with Stabilizer Treatment of Porang Flour and Maizena Flour Combination

In addition, porang flour includes glucomannan plants that can bind a certain amount of water. Porang tubers are glucomannan-style plants where glucomannan can help bind a certain amount of free water and control ice crystal growth to obtain a relatively soft ice cream texture [23]. The desired texture of ice cream is soft [16].

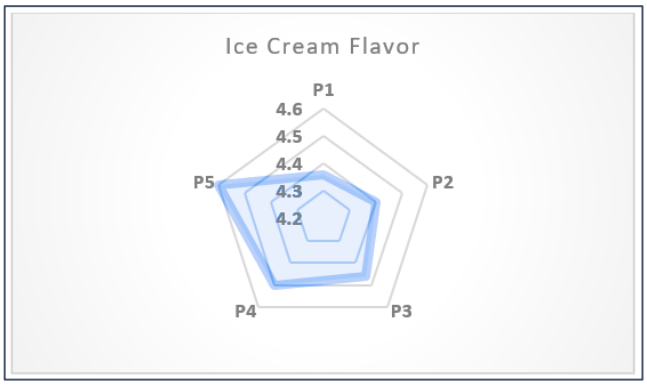
Taste

Analysis of the variance of ice cream flavor showed that ice cream flavor was not affected (P>0.05) by the treatment of the use of a stabilizer combination of porang flour and cornstarch. The average panelist rating of ice cream flavor ranged from 4.36 to 4.60 (sweet). The sweetness of ice cream is influenced by the sugar content (sucrose) added to the dough (Figure 6). In addition, sweetness also comes from other ingredients such as milk and whipped cream. The sweetener commonly used is granulated sugar (sucrose), which provides sweetness, improves taste, and minimizes the formation of ice cream crystals [25].

The factor that can affect the sweetness of ice cream is the addition of sucrose to the dough. Sucrose is one type of sweetener in ice cream making. The general term that is often used

is sugar. Every kind of sucrose used will give different results because it has a different texture and level of sweetness. However, the amount of sugar added to the dough was not different in this study. The addition of sweeteners determines the degree of sweetness in ice cream. This is because sweeteners lower the freezing point and control the frozen water in the ice cream and the softness of the final product [26]. Sucrose improves the product's body and texture [27], [28], [29].

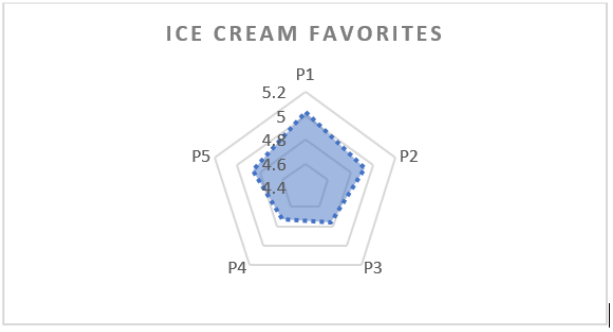
The addition of stabilizer does not affect the taste of the ice cream. Porang tuber flour has a neutral flavor and can be added to various food ingredients [30].



Picture 6. Average Ice Cream Taste Value with the Treatment of the Use of Stabilizer Combination of Porang Flour and Maizena Flour

Favorite

Analysis of the variance of panelists' liking for ice cream showed that liking was not affected (P>0.05) by the treatment of the use of a stabilizer combination of porang flour and cornstarch (Figure 7). The average panelist rating of liking ice cream ranged from 4.86 to 5.03 (like). Panelists' liking for ice cream was assessed based on taste and texture.



Picture 7. Average Panelist's Favorite Value of Ice Cream with the Treatment of the Use of Stabilizer Combination of Porang Flour and Maizena Flour

Adding stabilizers in the form of porang flour and cornstarch or a combination of both did not affect the overall liking of the panelists. This is because the concentration of stabilizer added in all treatments is still in an amount that is not excessive. Adding flour ingredients can give a floury taste to food at high concentrations. Food containing flour, either in the form of paste or gel, can

contribute to providing a *starchy* flavor [17]. This is supported by research Wahyuni and Widjanarko [17], which shows that adding cornstarch is the primary contributor to the starchy flavor in egg-based tofu formulations. In addition, adding a stabilizer in excessive amounts can cause the texture of ice cream, which was initially soft, to turn a little *chewy*, making it less preferred by panelists.

CONCLUSIONS

Using a stabilizer combination of porang flour and cornstarch significantly affects ($P<0.01$) the ice cream testing parameters, namely antioxidant activity and viscosity. In contrast, the stabilizer combination of porang flour and cornstarch has no effect ($P>0.05$) on the ice cream testing parameters: taste, texture, liking, melting power, and *overrun*. Increasing the amount of cornstarch in combination with stabilizers can enhance the values of antioxidant activity, liking, melting power, and *overrun in* ice cream. Expanding the use of porang flour with stabilizers can improve the taste, texture, and viscosity values in ice cream. Using a combination of 75% porang flour and 25% cornstarch in the ice cream formulation produced the best ice cream in terms of physicochemical characteristics.

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