



## Characteristic Ice Cream using Stevia (*Stevia rebaudiana*) Leaf Powder as Natural Sweetener

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### Abstract

Sweetener is one of important factors which affect consumer acceptance as it affects the ice cream texture. Research on an alternative and healthier sweetener to substitute sugar in ice cream production has begun to emerge as consumers' awareness on healthy food has been increasing. One of the promising alternatives was the utilization of Stevia leaf powder as it is known to have no calorie content. In this research, the best proportion of stevia leaf powder to substitute sugar in ice cream production was determined based on its physicochemical properties (viscosity, overrun, melting rate, sugar and total calories) and antioxidant activity. The research was done through laboratory experiment with a Completely Randomized Design consisted of four sugar and stevia leaf powder combinations and four replications. The treatments were P0 (20% sugar + 0% stevia leaf powder); P1 (17.5% sugar + 0.3% stevia leaf powder); P2 (16.25% sugar + 0.45% stevia leaf powder); and P3 (15% sugar + 0.6% stevia leaf powder). The obtained data was analyzed by ANOVA and further tested by Duncan's Multiple Range Test upon significant effect. The results showed that the utilization of stevia leaf powder as sugar substitution gave highly significant effects ( $P < 0.01$ ) on ice cream viscosity, overrun, melting rate, sugar content, total calories and antioxidant activity. It can be concluded that the combination of 15% sugar and 0.6% stevia leaf powder (P3) produced the best ice cream characteristics with the viscosity of 1336.25 cP, overrun of 30.01%, melting rate of 37.24 minutes/50 g, sugar content of 34.63%, total calorie of 4.99 kcal and antioxidant activity of 81.92%.



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### Keywords

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## Introduction

Ice cream is one of the many other dairy products are favourable by consumers because of its sweet taste, while also has a high nutritional value which can be easily assimilated in the body. One of the important factors in determining the consumers' acceptance in ice cream product is the used sweetener, as it also ice cream texture aside of its sweet taste. The utilization of alternative sweetener to substitute sugar in ice cream production is become more popular as consumers' awareness of healthy food has been increasing. However, the utilization of alternative sweetener should consider common problems occurred in ice cream production, such its viscosity, overrun, melting time and also consumers' preferences on healthy product. Therefore, the utilization of alternative sweetener should be able to improve ice cream quality while also provides additional benefit for consumers' health. Stevia leaf powder is a natural sweetener which has a potential to substitute sugar in ice cream production.

*Stevia* leaf powder (*Stevia rebaudiana*) contains 5-10% stevioside and is 10-15 times sweeter than sucrose. These stevia leaf powder characteristics thus provide a sweet taste, while also safer for diabetic consumers, consumers with dental caries and obesity.<sup>1</sup> Moreover, stevia leaf powder also known to contains phenol compound as much as 2.5% (on dry basis) which showed  $IC_{50}$  inhibition at 50% of DPPH radical at 11.04  $\mu\text{g}$ .<sup>2</sup> This showed that the utilization of stevia leaf powder as sugar substitution on ice cream production could also give an antioxidant property to the ice cream by the availability of phenol compound from the leaf powder. Phenol, as an antioxidant, would complement the lack of electrons in free radical, inhibiting the chain reaction of free radical formation from continuous oxidation process in the body when consumed. The purpose of this research is to determine the best stevia leaf powder proportion to substitute sugar in ice cream production based on the ice cream viscosity, overrun, melting rate, sugar content, total calorie and antioxidant activity.

## Materials and Methods

### Materials

The materials used in this research were raw milk, skim milk, non-dairy creamer, sugar, stevia leaf powder, and emulsifier for ice cream production,

while the raw milk was obtained from KUD Mitra Bhakti Makmur Batu.

### Methods

The research was done through laboratory experiment. The observed parameters were physicochemical properties and antioxidant activity of the ice cream. The ice cream physicochemical properties include ice cream viscosity which was measured by using Brook Field Viscometer,<sup>3</sup> overrun which was measured by following method described by Failisnur,<sup>4</sup> melting rate which was measured by following method described by Roland *et al.*,<sup>5</sup> sugar content which was measured by using refractometer<sup>3</sup> and total calorie which was measured by using bomb calorimeter.<sup>3</sup> The ice cream antioxidant activity was measured by using DPPH method as mentioned by Garcia *et al.*,<sup>6</sup>

### Samples Preparation

The ice cream formulation is presented in Table 1. The ice cream was prepared by firstly pasteurizing the fresh milk at 65 °C for 15 minutes, then adding the skim milk (5.5%), non-dairy creamer (5.5%), emulsifier (2.5%), sugar and stevia leaf powder according to the following treatments: P<sub>0</sub> (20% sugar + 0% stevia leaf powder); P<sub>1</sub> (17.5% sugar + 0.3% stevia leaf powder); P<sub>2</sub> (16.25% sugar + 0.45% stevia leaf powder); and P<sub>3</sub> (15% sugar + 0.6% stevia leaf powder). The mixture was then homogenized with a mixer for 15 minutes. The next step was aging the homogenized mixture in the refrigerator at 4 °C for 4 hours, followed by freezing on an ice cream maker. The produced ice cream is then kept in the freezer for 24 hours.

### Statistical Analysis

The analysis was carried out according to Completely Randomized Design. The obtained data was analyzed by analysis of variance (ANOVA) and further tested using Duncan's Multiple Range Test for each significant results. The final results obtained were expressed as mean values  $\pm$  Standard deviation

## Result and Discussions

Physicochemical Properties of *Stevia* Leaf Powder  
The physicochemical properties of *stevia* leaf powder used in this research was determined to further elucidate its effect for sugar substitution on ice

cream production. The observed physicochemical properties of *stevia* leaf powder are presented in Table 2.

Research by Campos *et al.*, showed that dried *stevia* leaves contained 12.11% protein, 3.23% fat and 9.52% crude fiber.<sup>7</sup> The differences of physicochemical properties of *stevia* leaf powder in this research and research by Campos *et al.*, could be caused by the conditions of location, soils, climates and plant growth conditions.<sup>7</sup>

Physicochemical Properties and Antioxidant Activity of Ice Cream Formulated with *Stevia* Leaf Powder  
The results of statistical analysis showed that the treatments of sugar substitution using *stevia* leaf powder gave highly significant effect ( $P < 0.01$ ) to viscosity, overrun, melting power and antioxidant activity ice cream. The mean value of viscosity, overrun, melting rate and antioxidant activity ice cream with substitution of *stevia* leaf powder were present in Table 3.

#### Description

<sup>a,b,c</sup>Different superscript on the same column gave highly significant effect ( $P < 0.01$ )

#### Description sample

(BDS: *stevia* leaf powder)

P<sub>0</sub> = 20% sugar (control), P<sub>1</sub> = 17.5% sugar + 0.3%

BDS, P<sub>2</sub> = 16.25% sugar + 0.45% BDS, P<sub>3</sub> = 15% sugar + 0.6% BDS

#### Viscosity

Ice cream viscosity with *stevia* leaf powder formulation is presented in Table 3. The substitution sugar with *stevia* leaf powder showed a highly significant effect ( $P < 0.01$ ) to the ice cream viscosity. It was observed that different *stevia* leaf powder and sugar proportions resulted in different ice cream viscosity, where ice cream viscosity was increased following higher *stevia* leaf powder proportion.

The obtained result was allegedly due to the fiber content of *stevia* leaf powder. The fiber content in *stevia* leaf powder could increase the total solid content of the produced ice cream, resulted in more viscosity in the ice cream.<sup>8</sup> However, sugar content in the ice cream could also binds water, resulted in an increased ice cream viscosity. Gianti and Evanuarini<sup>9</sup> proposed that sugar addition into the food will increase its viscosity, yet in this research it can be seen that the sugar substitution with *stevia* leaf powder did not reduce ice cream viscosity, even though the sugar content was reduced.

#### Overrun

Ice cream overrun is the condition where ice cream volume was increased due to the trapped air in the ice cream dough during agitation and freezing

Table 1: Ice cream formulation

Ingredients	Composition (%)			
	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Raw milk	6	6	6	7
Skim milk	6.5	8.7	9.8	0.9
Non-dairy creamer	5	5	5	5
Sugar	5	5	5	5
Stevia leaf powder	5	5	5	5
Emulsifier	5	5	5	5
	2	1	1	1
	0	7.5	6.25	5
	0	0	0	0
	2	3	45	6
	5	2	2	2
		5	5	5

**Table 2: Physicochemical compositions of stevia leaf powder**

Component	Composition (%)
Moisture	8.55
Protein	15.98
Fat	4.85
Crude fiber	11.80
Flavonoid	21.32
Phenol	6.05

process. The ice cream formulated with stevia leaf powder overrun is presented in Table 3. The result of statistical analysis showed that the substitution of sugar with stevia leaf powder showed a highly significant effect ( $P < 0.01$ ) to the ice cream overrun. This is suspected by the different stevia leaf powder proportion used to produce the ice cream, which affect the air trapping during agitation and freezing proces in ice cream maker. This can be seen by decreasing the overrun value following the increase of the stevia leaf powder proportion.

The control treatment showed the largest ice cream overrun as it did not use any stevia leaf powder for sugar substitution, while the smallest overrun was showed in treatment  $P_3$ , which used 15% sugar and 0.6% stevia leaf powder. This indicates that the increase of stevia leaf powder proportion will

resulted in lower ice cream overrun. The ice cream viscosity was increased following the increased stevia leaf powder proportion, in which caused a greater surface tension and narrow air cavities that reduce the trapped air capacity, thus limit the ice cream volume development. On the contrary, if the ice cream viscosity is low, it will cause a smaller surface tension, in which air cavities become wider and more air will be trapped, resulted in better ice cream volume development. The ice cream overrun value is inversely proportional to the ice cream viscosity, where higher ice cream viscosity will inhibit the ice cream volume development and minimize the overrun.<sup>10</sup>

Granular stevia leaf powder in the ice cream mixture will narrow the space in the ice cream mixture which caused less trapped air during agitation. The ice cream overrun in this study ranged from 30.01 to 35.13%. This shows that the ice cream has low qualities when compared with the standard ice cream overrun, which on the average ranging from 50-60%.<sup>11</sup>

#### Melting Rate

The ice cream melting rate is the time for the ice cream to melt completely at room temperature. The ice cream melting rate with stevia leaf powder formulation is presented in Table 3. The result of statistical analysis showed that the treatments of sugar substitution with stevia leaf powder showed

**Tabel 3: The mean value of viscosity, overrun, melting rate and antioxidant activity ice cream with substitution of stevia leaf powder**

Treatments	Parameters					
	Viscosity (cP)	Overrun (%)	Melting rate (min/50g)	Sugar content (%brix)	Total calories (kcal)	Antioxidant activity (%)
$P_0$	1131.2 5a ± 37.50	35.1 3c ± 0.57	29.5 7a ± 0.42	39.5 0c ± 0.58	5.4 0d ± 0.02	31.03 a ± 1.33
$P_1$	1138.7 5a ± 31.72	31.2 5b ± 0.26	34.3 6b ± 0.64	36.3 8b ± 0.25	5.2 0c ± 0.05	80.25 b ± 0.43
$P_2$	1242.5 0b ± 35.24	30.4 4ab ± 0.21	36.13 c ± 0.61	35.1 3a ± 0.63	5.0 7b ± 0.08	81.46 b ± 0.86
$P_3$	1336.2 5c ± 33.76	30.0 1a ± 0.60	37.2 4c ± 0.65	34.6 3a ± 0.63	4.9 9a ± 0.05	81.92 b ± 0.35

a highly significant effect ( $P < 0.01$ ) to the ice cream melting rate. This is suspected of difference proportion stevia leaf powder is used to produces different values melting rate on each treatments. Fat content in stevia leaf powder can increase fat content on ice cream and affect the rate speed of melting ice cream. This is shown by the longer time ice cream melting with increasing proportion of stevia leaf powder is used. Muse and Hartel<sup>11</sup> suggested that fat content in ice cream can affect the speed of melting ice cream. Type and amount of sweetener affects the melting rate of ice cream. The higher amount of air cells that diminish of heat transfer across the ice cream, thus slowing the melt down.<sup>26</sup>

The control treatment had the fastest melting rate because did not contain stevia leaf powder. While the longest melting time obtained from the treatment by using 15% sugar and 0.6% stevia leaf powder. The use of stevia leaf powder will affect the strength of ice cream body. More stevia leaf powder form a thicker and sturdier ice cream structure, therefore slow the melting process.<sup>12</sup> states that the fast melting time of ice cream is indicated by the weak and less sturdy body of ice cream. The use of stabilizers can also slow the melting process of ice cream when served. The high overrun value of control treatment causes more cavities of air formed. Ice cream quickly melts at room temperature if more air cavities on ice cream.<sup>11</sup> states that the value of overrun affects the density of ice cream. The high overrun produces a lot of air cavities forming ice cream with too soft texture and fast melting rate. The ice cream produced in this study had good quality based on its average value of melting speed of over 25 minutes. The melting rate of good quality ice cream ranges from 20 to 30 minutes.<sup>13</sup>

### **Sugar Content**

The sugar content of the ice cream with stevia leaf powder formulation is presented in Table 3. The results of statistical analysis showed that the utilization of stevia leaf powder in ice cream with different proportions provide a highly significant effect ( $P < 0.01$ ) to the total sugar of the produced ice cream.

The lower sugar percentage in the ice cream with stevia leaf powder substitution is regarding that the used sugar was mainly sucrose, wherein sucrose the

total dissolved solids was basically the total sugar content in a material.<sup>14</sup> The existing sweetening agent in stevia leaf powder are glycosides consisted in stevioside, rebaudioside and dulcoside, all of which are bound to carbohydrates such as rhamnosa, fructose and glucose, xylose, arabinose.<sup>15</sup> Sucrose content in sugar is very high, up to 99.8%,<sup>16</sup> while sugar levels in the stevia leaf powder was around 74.6 g/100 g stevia leaf powder, in which 1 tsp sugar sweetness level equivalent to 1/8 stevia leaf powder, so that 1 gram of sugar is equivalent to 0.125 grams of stevia leaf powder.<sup>17</sup>

### **Total Calories**

The total calories in ice cream with stevia leaf powder formulation is presented in Table 3. The results of statistical analysis showed that the use of stevia leaf powder in ice cream with different proportions showed a highly significant effect ( $P < 0.01$ ) to the ice cream total solids. The mean value was propotional to the total calorie value of the mean total sugars. The total value of calorie ice cream depends on the percentage of added carbohydrates such as lactose or sweeteners, protein percentage and percentage of added fats.<sup>18</sup> The lower the percentage of sugar was used, but it was suspected because stevia leaf powder was added having fat absorption range 4.5 ml/g so that the number of calories produced became. Value of high calorie ice cream that can be caused by the addition of sugar.<sup>19</sup> Widodo *et al.*,<sup>20</sup> stated that the replacement of sugar with stevia leaf powder as a sweetener by it self could reduce the caloric value of the product. According to Wulandari *et al.*,<sup>16</sup> the number of calorie content in sucrose is 3.94 kcal/gram while the number of calories in the stevia leaf powder according to Savita *et al.*,<sup>21</sup> is 2.7 kcal/ gram. The total calorie in ice cream could affect the composition of ice cream mixture or overrun of the ice cream.<sup>18</sup>

### **Antioxidant Activity**

The ice cream antioxidant activity with stevia leaf powder formulation is presented in Table 3. The content of antioxidant compounds such as flavonoids and phenols contained in stevia leaf powder can increase the content of antioxidant compounds on ice cream and affect the antioxidant activity ice cream. This was indicated by increased the antioxidant activity ice cream with the increased proportion of stevia leaf powder. Hastuti and Rustanti<sup>22</sup> stated

that phenol and flavonoids are compounds in food ingredients that can act as antioxidants.

The value of antioxidant activity ice cream with the use of stevia leaf powder had the ability to counteract free radicals above 50%. The ability to counteract free radicals on ice cream is related to the content of flavonoid and phenol in stevia leaf powder (Table 2) and antioxidant compounds that may be contained in fresh milk and skim milk that was used in the formulation, such as vitamins A, C, E and carotenoids. Dhianawaty and Ruslin<sup>23</sup> stated that the formation of phenoxide ions in phenol compounds as an effort to complete the electron deficiency in free radicals so as to form non-radical compounds. The mechanism of flavonoids as antioxidants by stabilizing singlet oxygen and inhibiting the action of lipoksigenase enzyme.<sup>24</sup>

The antioxidant activity of the control sample was 31.03%. Milk contains vitamin A, C, E and carotenoids as a source of antioxidants. The antioxidant nature of the milk produced from the antioxidant compounds in milk is casein, protein whey, peptide and amino acids, vitamin C, Vitamin A and carotenoids.<sup>25</sup>

### Conclusions

The best sugar and stevia leaf powder proportion to substitute sugar as ice cream sweetener is 15% sugar and 0.6% stevia leaf powder based on the psychochemical properties and antioxidant activity of the produced ice cream. The characteristic of ice cream produce from the best formulation was 1336.25 cP in viscosity, 30.01% overrun, 37.24 minutes/50 g melting rate, 34.63% sugar content, 4.99 kcal total calories and 81.92% antioxidant activity.

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### Conflict of Interest

We declare no potential conflict of interest.

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