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## EFFECT OF VISCOSITY AGAINST OVERRUN ICE CREAM USING CORNSTARCH, MOCAF AND CANNA FLOUR AS CARBOHYDRATE - BASED FAT REPLACER

Lidya Mandari<sup>1</sup>, Laksmi Hartayanie<sup>2</sup> and Victoria Kristina Ananingsih<sup>2</sup>

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### ABSTRACT

Ice cream is a dairy product that contains high fat. The fat existence in the ice cream contributes on the ice cream body and texture. Decrease of fat content in the ice cream product can make the ice cream melt quickly. The usage of stabilizers and carbohydrate-based fat replacer can improve the body and texture of low - fat ice cream. Cornstarch, mocaf and canna flour is several materials that can be used in the ice cream products as carbohydrate - based fat replacer. The usage of each fat replacer will cause a different viscosity. The purpose of this research was to find out the characteristics of ice cream dough viscosity against the overrun. The formulation ratio in this research: whipped cream against the flour (cornstarch, mocaf and canna flour) was 75% : 25%. The results showed that on mocaf flour ice cream, the value of overrun was the closest to the control ice cream rather than cornstarch ice cream and canna flour to the control ice cream. The value of control ice cream overrun was 76.25% and for the flour mocaf ice cream was 61.21%. The dough viscosity can reach a value of 66.25 d.Pa.s, and this can increase the overrun value of carbohydrate-based fat replacer ice cream.

**Key words:** Ice cream, fat replacer, cornstarch, mocaf, canna flour.

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## 1. INTRODUCTION

Ice cream is one of dairy products which created by freezing and mixing the raw materials together. Ice cream has 3-4% milk fat, 12-14% solids not fat, 29-31% total solids, 0.4% stabilizers and 13-16% sweeteners (Naresh and Shailaja, 2006). The high fat content of ice cream comes from whipped cream and milk. Whipped cream is used to help the development process and the cream, texture and shape formation of a product (Bennion and Hughes, 1975). In an ice cream product, the fat content can affect the dough viscosity and the air trapping. Arbuckle (1996) said, the viscosity is an important characteristic of a nice cream dough, which is to get a proper foaming and to restrain the air. Therefore, carbohydrate-based fat replacer was used in this research to find out the viscosity characteristics and the overrun of low-fat vegetarian ice cream. Fat replacer significantly contains less fat and calories. In general, carbohydrate-based fat replacer aims to reduce fat and calories because fat has energy value of 9 kcal / g. Carbohydrate or protein-based fat replacer has less energy i.e. 4 kcal / g.

Carbohydrate-based fat replacer which used in this research was using cornstarch, moca and canna flours. The reason in choosing these flours were because of their high carbohydrate content, and also the usage of these materials is one of alternative way to increasing the diversity of food in Indonesia.

The usage of this carbohydrate-based fat replacer can improve the quality of low-fat vegetarian ice cream. The raw material of the flours is easily found in Indonesia because it is a local raw material. Besides it is easy to grown, this flours is also easy to processed and ended up with easy to obtained. The price of this flour is very cheap and mostly in good quality, so that people can buy and process them easily.

The starch from different sources also have different natures and characteristics due to the different type of content and molecular structures. Starch molecule consists of two fractions i.e. amylose and amylopectin. Amylose is a long-chain molecules that affect the gel characteristics during the heating and cooling.

The purpose of this research was to find out the effect of viscosity against the ice cream overrun using cornstarch, moca and canna flours as the alternate carbohydrate-based fat replacer.

## 2. MATERIALS DAN METHODS

### 2.1. The Research Time and Place

This research was conducted in two phase i.e. introduction research and main research. Both research was done at Food Engineering Laboratory and Food Science Laboratory of Food Technology Study Program, Faculty of Agricultural Technology Soegijapranata Catholic University.

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**2.2. Material**

**2.2.1. Materials**

The materials used in this research were soybean, canna flour, cornstarch, mocaf, whipping cream, fructose, baking soda and distilled water.

**2.2.2. Tools**

The tools used to make ice cream were Ice Cream Maker, mixer, blender, freezer, measuring cup and a tool to do viscosity test i.e. viscometer (RION Viscotester VT - 04) (d.pas).

**2.3. Methods**

**2.3.1. The Making of Soybean Essence**

The making of soybean essence process can be seen in Figure 1.

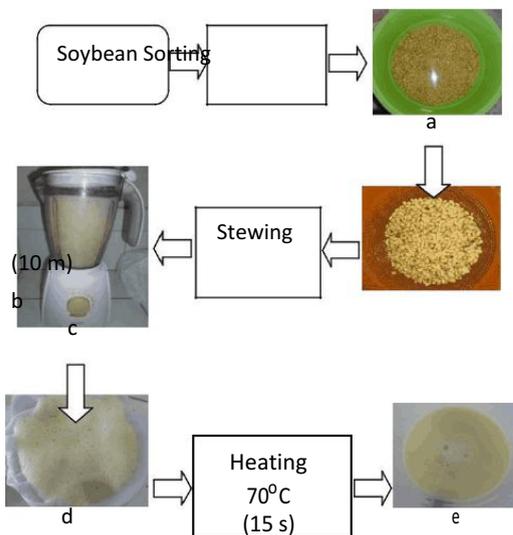


Figure 1 : Flowchart Process of Soybean Essence(Gulo, 2006 modified)

Description:

- a. The soybean being soaked with ratio of clean water:soybean (1:3) for 12 hours and 5 grams of baking soda added.
- b. The soybean being washed and drained
- c. The soybean being grinded by the ratio soybean:water (1:4)
- d. The soybean being filtered
- e. Soybean essence

**2.3.2. Making the Ice Cream at Different Fat Replacer Concentrations**

The process of making the ice cream can be seen in figure 2.

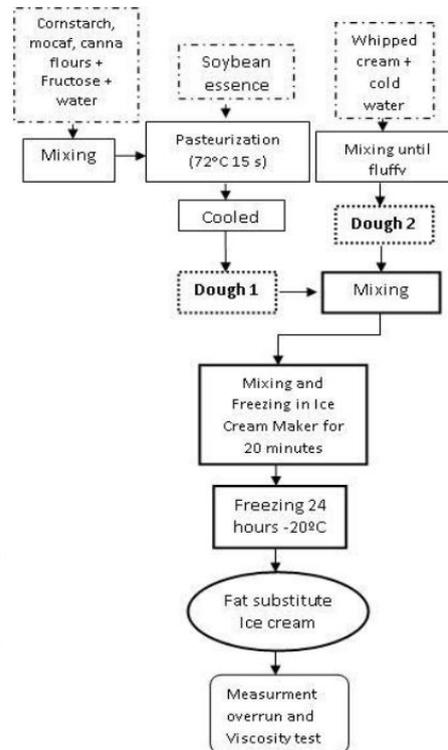


Figure 2: The process of making ice

cream

**Table 1.** Ice cream formulations of Carbohydrate-Based Fat replacer

Materials	P0	P1	P2	P3
Soybean essence (ml)	200	200	200	200
Fructose	60	60	60	60
Whipped cream (%)	100	75	75	75
Cold water(ml)	200	150	150	150
water (ml)	-	200	200	200
Cornstarch (%)	-	25	-	-
Mocaf (%)	-	-	25	-
Canna Flour (%)	-	-	-	25

(Source : Astawan & Astawan, 1988 modified)

Description:

P0: The addition of whipped cream without adding fat replacer(control)

P1: Comparison of cornstarch and whipped cream addition (25: 75)

P2: Comparison of mocaf and whipped cream addition (25: 75)

P3: Comparison of canna flour and whipped cream addition (25: 75)

### 2.3.3. Ice cream Overrun level analysis

(Potter & Hotchkiss, 1996)

Overrun measurements aims to find out the increasing of ice cream volume that occurred after the freezing and mixing process. The principle of overrun measurement is the difference between the ice cream volume and the dough volume at the same time or the difference of the ice cream mass and the

cought at the same volume. ice cream Overrun measurement % can be calculated with the following formula:

*overrun* =

$$\frac{\text{volume of after mixing} - \text{volume of early dough}}{\text{volume of early dough}} \times 100\%$$

### 2.3.4. Ice cream viscosity measurements

(Prindiville *et al*, 2000).

Ice cream viscosity measurements were performed by using a Viscotester at the room temperature. Viscosity measurements were done on ice cream that has not been and had been frozen at temperature of  $\pm 4^{\circ}\text{C}$ . The Viscosity Measurement of each ice cream has been done for three times replications.

### 2.3.5. Data Analysis

The data obtained from this research were processed using SPSS for Windows version 14.0 using One Way ANOVA methods and Duncan's regiontest.

## 3. RESEARCH RESULTS

The physical characteristics of viscosity and ice cream overrun at various concentration of fat replacer can be seen in Table 2.

**Table 2.** Ice Cream Physical Characteristics in Various Fat Replacer Concentration

Sample	Characteristic		
	Overrun (%)	Viscosity1 (d.Pa.s)	Viscosity2 (d.Pa.s)
P0	<b>76,25</b> ± <b>6,66<sup>c</sup></b>	53,33 ± 3,02 <sup>a</sup>	29,16 ± 3,41 <sup>a</sup>
P1	44,01 ± 7,67 <sup>a</sup>	63,33 ± 3,02 <sup>bc</sup>	34,16 ± 4,67 <sup>bc</sup>
P2	61,21 ± <b>66,25</b> ± <b>38,75</b> ±		

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	6,59 <sup>b</sup>	3,79 <sup>c</sup>	4,08 <sup>c</sup>
P3	40,83 ± 7,54 <sup>a</sup>	61,25 ± 4,40 <sup>b</sup>	32,50 ± 3,16 <sup>ab</sup>

Description:

- P0: ice cream with the addition of 0% carbohydrate-based fat replacer and 100% whipped cream
- P1: ice cream with the addition of 25% cornstarch and 75% whipped cream
- P2: ice cream with the addition of 25% mocaf and 75% mocaf whipped cream
- P3: ice cream with the addition of 25% canna flour and 75% whipped cream
- Viscosity 1: viscosity before freezing.
- Viscosity 2: viscosity after freezing.
- Values with different superscript within a column indicates a significant differences between treatments at the 95% confidence level ( $p < 0.05$ ) based on the one way ANOVA with Duncan's multiple range test using of different tests.

The research result in Table 2 shows that the control ice cream has a higher overrun value than the ice cream with flour addition. Based on one-way ANOVA test of significance using Duncan's multiple range tests, the ice cream overrun percentage significantly different from the control ice cream overrun value with the addition of cornstarch, mocaf and canna.

The real difference is shown by the control ice cream overrun percentage which higher i.e.  $76.25 \pm 6.66$  compared with ice cream which being added with cornstarch, mocaf and

canna i.e.  $44.01 \pm 7.67$ ,  $61.21 \pm 6.59$  and  $40.83 \pm 7.54$ . Viscosity values before and after control ice cream freezing is significantly different from ice cream which being added with cornstarch, mocaf and canna because it has a lower value i.e.  $53.33 \pm 3.02$  and  $29.16 \pm 3.41$ .

#### 4. DISCUSSION

Overrun is the increasing of dough volume which generated from air trapping at the time of the mixing process during the freezing period (Muse and Hartel, 2004). Arbuckle (1996) said that the viscosity or flow resistance is an important characteristic of ice cream dough to get a proper foaming and for air detention. In this research, ice cream viscosity measurements had been done before and after freezing at temperature of  $4 \pm 1^\circ\text{C}$ . Viscosity measurements after freezing were done to find out the effect of the freezing process.

Table 2 shows that the overrun value of the control ice cream is higher than the ice cream with flour addition. While the viscosity of the ice cream control is lower than the ice cream with flour addition. Muse and Hartel (2004) said that the fat content in the ice cream will be more destabilized due to mixing action so that it forming a fat globule which coat and restrain air molecule, and then linked together to form fatty tissue which will trap the air. Therefore the overrun value of the control ice cream is higher because it

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contains more whipping cream. Whipping cream and milk are known as fat source within the ice cream products so that the overrun value of the control ice cream is higher because it can trap air during the mixing.

Table 2 also shows that the control ice cream has a lower viscosity value than the ice cream with flour addition. Viscosity values before ice cream freezing has a higher value than the viscosity values after freezing. According to Setianawati et al., (2002) the decreament of viscosity due to the deformation of the ice cream shape due to temperature changes (heat shock) from the freezing process to thawing process.

Overrun value of the ice cream with cornstarch, mocaf and canna flours (44.01%, 61.21% and 40.83%) addition is still below the control (76.25%) indicate that carbohydrate-based fat replacer have not been able to trap the air during the mixing. According Adapa et al., (2000), on the thick ice cream dough, the bonds between the molecules will become more tight so that it would be difficult to trap the air during the mixing process because the matrix has been become solid. Added by Akesowan (2008) that the more thick gel network can affect air entry during the freezing process, so that the overrun values is lower.

Mocaf, cornstarch and canna flours as the ice cream fat replacer has a high ability to form a water trap gel during the gelatinize process, but have a low ability to form an air trapper matrix.

Table 2 results shows that the control ice cream, cornstarch, mocaf and canna flours ice cream has viscosity values after freezing i.e. d Pa.s 29.16, 34.16 d.Pa.s, 38.75 d.Pa. s and 32.50 d Pa.s. Ice cream which treated with various types of flour as a carbohydrates-based fat replacer have a more viscous characteristics than the control ice cream. This was occur because the flours contain more starch so that it included in fat mimetic group of fat replacer because of its ability to absorb large amounts of water that can mimic some of the fat on the sensory natures of ice cream (Akoh, 1998).

Mocaf flour ice cream has a higher viscosity and overrun values compared to the cornstarch and canna flour ice cream. This relates to the relationship between overrun and viscosity. Viscosity determines the ice cream overrun. The greater viscosity value then the greater percentage of overrun untill a certain extent, and vice versa. This is occurs because at a certain viscosity the ice cream dough capable to trap the air.

If the ice cream dough is too liquid, it has less ability to trap the air. For the thick ice cream dough, there is only a few space for

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the air bubble during the mixing because the composer molecule structure is too close resulting a lower overrun cough value. This is occurs because the air bubble which trapped in the ice cream has become the barrier for the fluid to flow.

## 5. CONCLUSIONS

- Substitution of cornstarch, mocaf and canna flours as carbohydrate-based fat replacer can change the characteristics of viscosity and ice cream overrun. □
- The higher overrun value, the higher viscosity untill a certain extent. □
- Ice cream with formulation which contains of 75% whipped cream and 25% mocaf flour has a higher overrun percentage ( $61.21 \pm 6.59$ ) and also the viscosity value before and after deep cooling ( $66.25 \pm 3.79$  and  $38.75 \pm 4.08$ ) compared with cornstarch and canna flours ice cream. □

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