

# Methods of Reducing Fat Content in Ice Cream and their Influences on Flavor of Ice Cream

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**Abstract.** The increasing awareness of the health's importance leads to the increasing demand for healthy food. To meet the demand of the market, ice cream industries need to find applicable ways to make their ice cream healthier. Lowering the fat and sugar contents for ice cream are two main areas researchers can work on to achieve it. Researchers have already done great jobs in these aspects. Some sugar substitutes can even be used in daily cooking. However, the methods of fat reduction are not as known as the sugar ones. So this report will focus on the several methods that factories can use to reduce the fat content in the ice cream. The way that these methods reduce the fat content and what difference in flavor these methods will bring to the ice cream will be mainly discussed in this report. Due to the importance of the flavor of fat for ice cream flavor, this report also analyzes how these methods make a difference in the flavor of ice cream. It shows that all of these methods will not bring negative effects of the flavor of the ice cream under certain conditions. This report provides examples for further research of fat reduction methods for ice cream. The methods mentioned here more or less influence the flavor of the ice cream, and these methods are too general. Further research is needed in how to reduce the influence of flavor or finding a better way to achieve the fat reduction for a certain taste of ice cream.

**Keywords:** Ice cream; fat reducing; flavor; overrun; fat replacers.

## 1. Introduction

In recent years, consumers pay more attention to health concerns [1]. People are more likely to choose the food that is healthier. Which means customers are more likely to choose the food that is marked reduced fat, low sugar, or fat-free. Food industries are also facing challenges to produce this kind of food [2]. It is easy to recognize that there are more items that are marked “0 sugar,” “fat-free,” and something like that appears in the market. It shows that many food industries have already developed their own ways to follow this trend. However, there are still many people working on this aspect. Since fat and sugar is essential for most of the food. They need to find out the best fit way. Especially for the industries that produce “junk” foods. High fat and high sugar are why they are called “junk.”

Ice cream is one of favorite “junk” foods for people today. It seems the ice cream is falling behind time, due to its high sugar and high fat which are treated unhealthy today. However, according to the most recent analysis of the United States ice cream market, the market scale of ice cream is still increasing. It relies on the special flavors of ice cream. Its flavor attracts people to keep consuming it, while its compound threatens our health. Thus, to make a change to this situation, there are a great number of scientists who put their efforts into making the ice cream healthier.

Among all substances in ice cream, fat and sugar are two most important components that scientists work to make the ice cream healthier. Since that is not only where the flavors come from, but also the threats of health come from. However, taking in too much fat will increase the risk of CVD [3], consuming too much sugar will negatively influence our immune system [4]. Thus finding methods for reducing these contents is essential for a healthier ice cream. Besides this, it is also important to be aware that making a food or drink healthier is not only about lowering the ratio of the specific substance, but also needs to maintain similar flavors for the product. Thus knowing how certain compounds work in flavor of the product is needed if the industry wants to lower it in the product. This article is focused on the ways to reduce the ratio of fat in ice cream. Fat will not only release



Hydrophobic aroma but also influence the texture of ice cream. In other words, fat is essential for the flavor of ice cream.

Thus, finding methods to lower the fat ratio and keep the original flavor from fat at the same time is one of the most important things to do to make the ice cream healthier. This article will focus on several methods that can achieve this purpose.

## **2. Increase Overrun to Make Ice Cream Healthier**

### **2.1. Overrun for Ice Cream**

Ice cream is a mixture of crystallized fat, ice crystals, air cells, and sugar solution. Thus, increasing the content of air can help decrease the content of sugar and fat. Air cells are essential for an ice cream. In a normal ice cream, air cells take 30% to 50% of its volume. It can influence the texture, stability, and physical properties of the ice cream. To estimate the air content in ice cream, the overrun of ice cream will be used in this report. The percentage of overrun will be calculated by equation (1).

$$\text{Overrun}(\%) = \left[ \frac{\text{weight of ice cream after add air} - \text{weight of ice cream}}{\text{weight of ice cream}} \right] * 100\% \quad (1)$$

### **2.2. Utilization of Carbonation and Ultrasound (US) Treatment to Increase the Overrun**

Carbonation is to fill the air cells in ice cream with CO<sub>2</sub>. To achieve this, industries can add dry ice to the ice cream. Dry ice will produce nano air cells of CO<sub>2</sub> [5]. Part of dry ice will form carbolic acid with other material of ice cream. While stirring ice cream, some carbolic acid will be decomposed into nano-bubbles of CO<sub>2</sub>. However, these nano air cells are unstable, they will disappear quickly [6]. Thus the use of emission of low power ultrasound is needed. It will produce even vibration to the whole ice cream and may make stable air bubbles of ice cream [6]. It will also help control the crystallization process of the ice cream [5]. Both carbonation and US treatment can help increase the overrun of the ice cream. Combining these two methods will produce an ice cream with over 3 times higher overrun than the one without any of these methods [6]. It was also found that the lifting of carbolic acid does not influence the flavor of ice cream [6]. Thus utilizing carbonation and low power ultrasound work very well in increasing ice cream's overrun.

### **2.3. The Influence of Overrun in Ice Cream**

The overrun does influence the ice cream in texture. Ice cream with higher overrun will be softer. It is because the ice cream with higher overrun will have smaller air cell size and smaller ice crystals. These will make the ice cream softer. In the carbonation and US treatment this report mentioned before. These two methods will provide nano-bubbles of air. then may make the ice cream even softer. The overrun will also influence melting speed. Besides this, the overrun has little effect on the melting speed of ice cream. Adhikari's experiment shows that the ice cream with higher overrun has slower melting speed [6]. However Singo's report shows an opposite result with Adhikari's [7]. While there is also another report that shows that overrun has little effect on melting speed [8]. This kind of difference may be caused by their way of controlling overrun. Adhikari's experiment uses carbonation and US treatment to increase the overrun value, while the other two reports use roselle extracts to increase it. This means the differences between CO<sub>2</sub> and roselle extracts may cause the differences in melting speed. More research is needed to be done in this aspect.

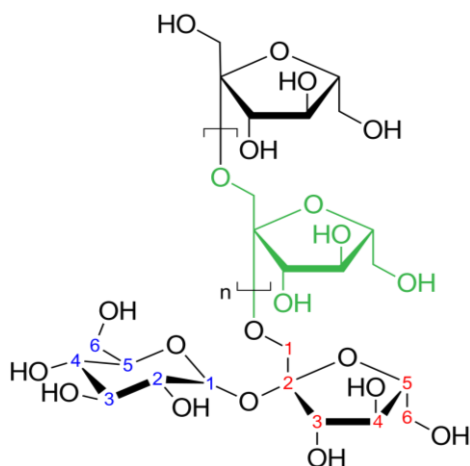
## **3. Fat Replacers**

The most direct and effective way to lower the fat content is lower the amount of it that is added into the ice cream. But it will greatly influence the flavor and texture of the ice cream. Thus, fat replacers are needed to make a healthier ice cream. It works similarly to the sugar substitute, it is supposed to have a similar texture or flavor with fat but healthier than it.

### 3.1. Inulin

Inulins are a group of naturally occurring polysaccharides produced by many types of plants. Because of the  $\beta$  (2,1) linkages, inulin is not digested by enzymes in the human alimentary system. Thus, adding inulin to the ice cream will reduce the calorie value. It will also work as dietary fiber and has prebiotic effects (Figure 1).

Inulin may become a fat replacer mainly because of its ability to stabilize the structure of aqueous phase. This ability will help it have a similar mouthfeel to fat in ice cream. Among inulins, long chain inulin works better in fat replacement. It is because long chain inulin has lower solubility than short chain ones, thus long chain inulin can form small crystals which are undetectable by human's mouth. These crystals will make the product smoother.



**Figure 1.** Structural formula of inulin (fructan). Additional features (carbon numbers and repeated fructosyl units) are highlighted with colors [9]

Add Inulin can help reduce the amount of fat content that is needed to maintain the normal flavor and texture of ice cream. A report shows that addition of 3% weight content inulin can help reduce 25% overall fat content [9]. What's more, it can work to replace not matter butyric fat content but also vegetable fat. Which means it can also work with the product that uses non-dairy cream. Also, due to the special structure of the inulin this change does not change a lot about the physicochemical or sensory properties of ice cream [9].

Though inulin works very well as a fat replacer, it does not mean insulin can replace all the fat in ice cream. Research shows that the flavor and overall acceptability of the ice cream will drop greatly after the content of inulin increases beyond 4% [10]. Thus, to balance the flavor and health, the inulin weight content should be around 4%.

### 3.2. Cold-pressed Chia Seed Oil By-product

The content of Cold-pressed chia seed oil by-product is mainly about insoluble dietary fiber. They have the ability to increase the viscosity of the solution. Thus it can work well as a fat replacer [11]. Akcicek and Karasu already developed a way to utilize it as fat replacers for salad source [12]. Research shows that cold-pressed chia seed oil by-products can be one of the candidates for fat replacement because it does not have a significant impact on the taste of ice cream [11]. What's more, it is the waste of cold-pressed chia seed oil industries, thus it will help lower the cost of ice cream [11]. However, due to the containment of carbohydrate, the priority of cold-pressed chia seed oil as a fat replacer is lower than the inulin.

## 4. Conclusion

To Making the ice cream healthier by lowering the fat content, two methods are mentioned in this paper. They are the increase of the overrun of ice cream and the usage of fat replacers. Carbonation

and ultrasound treatment works well in increasing the overrun for ice cream. The increasing of overrun makes the ice cream healthier by lower fat density in it. The overrun's increasing can also help increase the texture of ice cream. There also some another way to increase the overrun of ice cream. Further researches need to be done to find the best way for ice cream's overrun increasing. Good fat replacers for ice cream are components that works similar with fat in it but healthier than fat. Inulin and Cold-pressed chia seed oil by-product are both works well as fat replacers for ice cream. Use them to replace part of fat in ice cream can make it healthier and reduce the fat content in it without huge change in the flavor of it. However, this report do not put much effort in analyzing the possible negative impact these fat replacers will bring to ice cream taste. To deal with it, future researches can focus more on the how the concentration of different fat replacers influence the flavor of the ice cream to determine the limitation in concentration for different kinds of ice cream. In addition, fat substitutes for different flavors of ice cream can also be personalized to find their specific fat substitutes.

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