

## Ice Cream Nutrition and Its Health Impacts

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### Abstract

Ice cream is a sweetened frozen dairy product preferred as snacks or dessert made of milk and milk products that is often added with fruits along with other essential ingredients like flavors colors. The objective of this review is to assess nutritional and health impacts of ice cream to identify the nutritional advantage and also its impacts on health. Ice cream is classified based on their ingredients and flavor used. Ice composes high sugars (20.7mg/100g) and fat (16mg/100gm) and other compositions like minerals, vitamins. Ice cream is a nutritious product which is very conducive for microbial growth specially, pathogenic organisms that cause a food borne out break. Some studies suggest that ice cream can be used as probiotic carrier but due to its high fat and sugar contents it may be unhealthy food for many individual. But, some studies have been conducted to find sugar substitute with little success because of organoleptic sensory impairment. By combining the two ideas (probiotics incorporation and reduction of fat and sugar) the ice cream consumption and its marketing have a chance to be grown fast.

**Keywords:** Ice cream; Probiotics; Emulsifier; Junk food; Flavor

### Introduction

Ice cream is a sweetened frozen dairy product preferred as snacks or dessert made of milk and milk products, that is often added with fruits (raw and/or dried form), along with other essential ingredients like flavors, colors. It is typically sweetened with sugar or sugar alternatives. Flavorings and colorings are added in combination to stabilizers and emulsifiers<sup>[1]</sup>. By other definition “ice cream is a liquid mixture that turns into a paste after simultaneously shaking and cooling” although the definition of ice cream varies from country to country due to differing regulations and traditions of composition (Fiol.et al, 2016).

Ice cream is a nutritionally enriched congealed dairy product consumed by all age groups particularly children, during summer<sup>[2]</sup>. In the ice cream mix that will become ice cream are so many elements of different nature as sugars, fats, dairy, stabilizer, water, among others. And they all have to be correctly blended and emulsified together so there is nothing left behind that may reduce the quality of the final product. Making this possible considering the characteristics and behaviors of each ingredient and the relationships between them is what is known as the balancing exercise. We can make it stable and spreadable at negative temperature from  $-11$  to  $-18$  °C (standard ice cream serving temperatures)<sup>[3]</sup>.

In ice cream making, the first step is to blend a series of liquid and solid ingredients in different orders and temperatures, obtaining a liquid mixture also called “mix”. After the process-

ing and pasteurization process, this mixture is poured into an ice cream machine in which, it incorporates a quantity of air between 30% and 40% (overrun) that is held or set by cooling at negative temperatures and the result is a semi-solid spreadable and moist past mixture (Fiol et al.,2016).

This liquid mixture turned into ice cream will present specific characteristics of taste, structure and texture, determined by quality of ingredients used, mix balance and manufacturing process, the standard parameters for a dairy base ice cream is 64% water, 18% sugars, 10% non-fat milk solids and 8% milk solid fats, all these parameters, is expected to have a stable structure maintaining its characteristics in negative temperature with smooth texture (without appearance of ice crystals), and stable (maintain his characteristics at serving temperature)<sup>[3]</sup>.

According to other authors a standard ice cream is about 5% fat and 15% sugar solution by volume. The composi-

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tion for a standard ice cream is; Fat 7–15%, and sugars 12–16% (Clark, 2012). Also the range in composition may be fat, 8 – 20%, sugar, 13 – 20% stabilizer – emulsifier, 0 – 0.7%; and total solids, 36 – 43% and an average ice cream contains 3–4 times more fat and about 12–16% more protein than milk does<sup>[4]</sup>. This high fat comes from addition of oil (emulsifiers) and the fat already present in milk used for ice production. It was identified by some studies that the cholesterol contents of ice cream are about 45mg/100<sup>[5]</sup>. It can be estimated that from one pieces of ice cream a high amount of cholesterol is consumed. It is obvious that consumption of foods consist of low cholesterol level has no effects on individual health but in products like ice cream it seems a very huge amount that may leads to different diseases such as cardio vascular disease and hyper tension.

In general, as it is seen from some studies the fat and sugar contents of ice cream is very high and its consumption may leads to adverse health effects such as diabetes, cardio vascular disease and others. Many research have been done on ice cream contents and its nutritional and probiotic advantages but there is little researches conducted on it health impacts which is a series problem in such types of foods with high fat and sugar contents in the same products. Therefore, the aim of this paper is to review some research ideas conducted on ice cream in relation to its nutrition and its health impacts and gives recommendation on the existing gap.

**Objective**

**General objective**

- The objective of this paper is to review nutritional and health impacts of ice cream

**Specific objectives**

- To review nutritional contents of ice cream and identify the difference
- To know whether consumption of ice cream has impacts on human health

**Ingredients of Ice Cream**

Ice cream is a frozen dairy product made by freezing the ice cream mix with agitation. It is composed of a mixture of food ingredients like milk products, sweetening materials, stabilizers, colors, flavors, and egg products. Ice cream mix is the unfrozen mixture of the ingredients, consisting of all the ingredients of ice cream with the exception of air and flavoring materials. The composition of ice cream is usually expressed as a percentage of its constituents, for example, the percentage of milk fat, milk solids not fat, sugar, egg solids, stabilizers (which are the compounds added in very small quantities to strongly influence the formation and growth of ice crystal in the ice cream so as to render the product with desired body and texture), and the total solids<sup>[5]</sup>. Ice cream is made of different ingredients that are very important to keep its characteristics similar which are sensorial quality by consumers. Sugars and milk (milk) fats are the main ingredients of ice cream whereas others like emulsifiers, flavors, stabilizers, and colors are added depending on the type the ice cream intended to be produced.

**Table 1:** Ingredients of ice cream with their brief explanation

| Ingredients types | Brief explanations   |
|-------------------|--|
| Emulsifiers       | -To produce ice cream with a smoother body and texture, to impart dryness.<br>-Emulsifiers extensively used are monoglycerides or diglycerides, sorbates, and polysorbates etc. Excessive amount produce slow melting characteristics and body and texture defects in the product  |
| Flavors           | -The most important characteristics of ice cream.<br>-The kind of flavoring influences the quality (slight off-flavor in it can obscure the delicate flavor).<br>-Preference of the consumers determines the type of flavor to be added.<br>- Can be Natural and synthetic flavor.   |
| Colors            | -Most are of chemical origin that can be available in liquid or powder form.<br>-Manufacturers prefer to purchase dry colors since these are more economical and can be dissolved in boiling water as needed.  |
| Stabilizers       | -prevent the formation of objectionable large ice crystals<br>-prevent ice crystal formation in storage, give uniformity of product<br>-Stabilizers are added at the rate of 0.2–0.3% of the mix.<br>-Examples are sodium alginate, sodium carboxymethyl cellulose (CMC), guar gum, locust bean gum, carrageenan, gelatin, and pectin. |

Source: Deosarkar et al., 2016<sup>[5]</sup>.

**Types of Ice Cream**

Ice-cream is a frozen mixture of a combination of components, such as milk, sweeteners, stabilizers, emulsifiers and flavoring agents<sup>[6]</sup>. This category includes several related products, such as plain ice-cream, reduced fat, low fat, nonfat, fruit, and nut ice-creams, puddings, variegated, mousse, sherbet, frozen yoghurt, besides other frozen products (Marshall & Arbuckle, 1996).

Classification of ice cream is based on their ingredients or type of flavors used. For instance, in vanilla ice cream, mango ice cream, straw berry ice cream, chocolate ice cream the flavor used are vanilla, mango, straw berry, and chocolate respectively. The classification of the various frozen products commonly considered under the general term “Ice Cream” is difficult to accomplish with any exactitude, because of frequent innovations and lack of uniformity in commercial practice, and because of the many variations possible in the combinations of ingredients used. Classifications have been proposed by various authors: after a review of various references on the subject, and a consideration of commercial practices, suggested a classification dividing the products into ten different classes (Table 2).

**Table 2:** Types of ice cream with short explanation

| No | Types             |   |
|----|-------------------|---|
| 1  | Plain Ice Cream   | -made from various dairy products to obtain a composition which ranges widely. -The range in composition (8% to 16.0% fat, with some as high as 22%, 6% to 12.0% serum solids; 12.0% to 17.0% sugar).<br>-Eggs are quite commonly used<br>-frozen with the addition of a single flavor such as vanilla, chocolate, maple, mint, butterscotch, coffee, etc   |
| 2  | Nut Ice Cream     | -frozen from the same mixes as plain ice cream with the addition of various nuts-walnuts, almonds, filberts, pistachio (love nuts), chestnuts, etc.<br>- Frequently these nuts are used in conjunction with the flavors mentioned under plain ice cream. Pistachio nuts are frequently used in connection with mint flavor.   |
| 3  | Fruit Ice Cream:  | - made from the same mixes as plain ice cream with the addition of fruits at the time of freezing.<br>-Frequently the fruit flavor is fortified by true or imitation extracts, and usually color is added.  |
| 4  | Bisque Ice Cream: | -made from mixes as under plain ice cream with the addition of such substances as macarons, "grape nuts," sponge cake and marshmallows, and usually with the addition of other flavoring material   |
| 5  | Mousse:           | -made by whipping cream as in making "whipped cream." After the cream has been properly whipped, the sugar and whatever flavoring extract are used.<br>-set into the hardening room or in a freezing mixture of ice and salt.<br>-It will be noted that in this product the whipping of the cream and the mixing in of the flavoring is done without any freezing, the freezing being done entirely after the mixture is complete.  |
| 6  | Frozen Custards   | -This class of ice cream properly contains liberal amounts of whole eggs or egg yolk, the egg yolk content being the distinguishing characteristic.<br>- Parfait, French Ice Cream and New York Ice Cream, in present usage, are synonymous to Frozen Custard.<br>-U. S. standard for frozen custard the suggested requirement is an egg yolk solids content of 1.4 percent by weight   |
| 7  | Puddings:         | -There is a decided lack of uniformity in commercial practice in the making of puddings.<br>-differ from fruit ice cream only in that a mixture of fruits is used, and usually the total addition of fruits is more generous. To justify the name of pudding the product should, in addition, contain egg yolks in amounts similar to Frozen Custards.  |
| 8  | Milk or Milk Ice  | -contain about 4 per cent fat, 12 to 14 per cent serum solids, and are similar to ice cream with respect to sugar and stabilizer content, and overrun   |
| 9  | Ices:             | -made from fruit juices diluted with water and sweetened by the addition of sugar. -Usually color, fruit flavoring and a stabilizer are also added.<br>-Citric acid or other edible acids are added to give the product the desired tartness.   |
| 10 | Sherbets          | -made from the same ingredients as ices with the exception that milk, cream or ice cream mix is used in place of part or all of the water.<br>-In order to prevent the curdling of the casein in the milk products used in sherbets, acid fruit juices and citric acid are not added until the rest of the mixture has been frozen almost to the proper consistency in the freezer. A sherbet made with the use of sour milk (starter) is known as Lacto. A sherbet made with the addition of egg yolks is known as a Souffle |

Source: (sommer, 1951)

### Flow chart of ice cream

Liquid and dry ingredients  
 Pre-heating (45-50°C)  
 Blending (65-75°C)  
 Ice cream mix  
 Homogenization (2500 – 500psi)  
 Pasteurization (80°C, 5min)  
 Cooling (4±1°C)  
 Aging ((4±10c, 12hrs)  
 Freezing  
 Packing  
 Handling (-23°C)  
 Storage (-20°C)



**Figure1:** The simplest Process flow Diagram of ice cream

Source: Patil and Banerjee (2017)[1]

### Nutritional Composition of Ice Cream

Ice cream is frequently considered as a 'fun food,' which is undeserving consideration, and even was considered as a 'junk' food. In reality, ice cream is a relatively well-balanced, wholesome, easily digestible, and delicious food. Because, ice cream is a nutritious

element of the diet that is frequently used as a meal component. Ice cream contains about four times as much carbohydrates as milk. In developing a formulation of satisfactory composition, some of the factors that need to be considered are personal preference of company management or customer demands for flavor, body and texture, and color characteristics of the finished product, that is, natural or fortified flavor with artificial flavoring; chewy to heavy, higher overrun; or more cooling body and texture characteristics. Composition standards are also influenced by demands of customers, volume of operation, quality of ingredients, and ingredient costs<sup>[5]</sup>. Even though ice cream is considered as a nutritious food, it is high in fat and sugar which may be its limitation for consumption. The type of oil used in developing ice cream may be a risk for ice cream consumers especially in developing countries (Table 3).

**Table 3:** Composition of plain ice cream

| Constituent            | Average content | Ice milk | Ice cream cones | Water ice |
|------------------------|-----------------|----------|-----------------|-----------|
| Water (%)              | 61.7            | 66.7     | 8.9             | 66.9      |
| Energy(Cal)            | 222.0           | 152.0    | 377.0           | 78.0      |
| Protein (%)            | 4.1             | 4.8      | 10.0            | 0.4       |
| Fat (%)                | 16.0            | 5.1      | 2.4             | Trace     |
| Total carbohydrate (%) | 20.7            | 22.1     | 77.9            | 32.6      |
| Wt/100cal(g)           | 50.8            | 65.6     | 26.5            | 128.4     |

Source: Arbuckle (2005)<sup>[31]</sup> as cited by Deosarkar (2016)<sup>[5]</sup>

Ice cream contains three- to four fold fat content than milk and about 15% more protein than milk. It also contains other food products such as fruits, nuts, eggs, dry fruits, and sugar, which boost its nutritive value. The controlled use ice cream finds a place in the diet of persons who need to reduce or who do not wish to gain weight. Like milk, ice cream is not a good source of iron and some of the trace elements<sup>[5]</sup>. The nutritive value of commercial ice cream and related products is depicted in Table 4.

### Proteins in Ice Cream

The milk proteins contained in ice cream are of excellent biological value, because they contain all the essential amino acids. Milk proteins are important sources of essential amino acids like tryptophan and lysine. Proteins in the diet supply the amino acids required for the growth of infants and children and for the maintenance of tissues in adults. Not only are milk proteins known to be complete, but also the assimilation of ingested milk proteins is 5–6% more complete than other proteins in general. The values for protein are calculated from determinations of the nitrogen content in the food. Early analysis of proteins showed that they have close to 16% nitrogen. The glycosylated proteins make the ice cream more compact and smooth and tend to prevent a weak body and coarse texture. However, excessive amounts result in a salty or cooked flavor and soggy or sandy body and texture defect<sup>[5]</sup>. But, when feeding the children this type of foods the frequency and amount of it should be limited to avoid later problem that may affects their health.

### Carbohydrates in Ice Cream

Carbohydrates provide a significant amount of energy in all human diets. Sugars of several kinds may be used in the manufacture of ice cream. These include starch, dextrin, cellulose, pectin, gums, and related substances. The commonly used sugar is sucrose. It may come from either cane or beet, as these are identical in composition. Lactose constitutes over one-third of the solid matter in milk and 20% of the carbohydrates in ice cream. It enhances the utilization of calcium and phosphorus in the human body. Additionally, ingestion of higher amounts of lactose is conducive to the growth of lactose-fermenting *Lactobacillus acidophilus*, which produces acidic condition in the intestine, thereby creating unfavorable conditions for the growth of putrefactive bacteria. A sandy body and texture defect is caused by a high concentration of lactose<sup>[5]</sup>. In ice cream, the amount of sugar used very high to have an ice cream with expected sensory quality. High content of sugars in food is being considered as unhealthy foods. Because of this, some research ideas are coming to search for a product that can substitute sugar in ice cream. Although trials are started for this purpose, there is little success since the physical and sensorial properties of ice cream made with sugar substitute products are low when compared with the existing ice cream.

### Fat in Ice Cream

In ice cream there is a high amount of fat which comes from milk, emulsifier, and egg yolk (in some type). Fat is of major importance in ice cream. It contributes a rich flavor and is a good carrier for added flavor compounds and promotes a desirable texture quality which is a very important parameter in ice cream. It is essential to use the correct percentage of milk fat to balance the mix properly as also to satisfy legal standards<sup>[5]</sup>. But, the correct proportion which fits the standards are not seem to be produced since the ice cream producing industries use high amount of fats to obtain an ice cream with a good texture quality. High fat content limits consumption, will increase the cost, and increase calorific value. Generally, the fat content of a good average ice cream is considered to be 12 %<sup>[5]</sup>. But, some studies conducted on ice cream shows that the fat contents of ice cream about 16% which is out of the standard for ice cream.

Milk fats have both saponifiable matter and non-saponifiable matter. The saponifiable fraction includes the glycerides, phospholipids, and other esters, such as those of cholesterol and minor acid components. Milk fat contains at least 60% fatty acids which contributes significantly to the nutritive value of ice creams and serves as a carrier of fat-soluble vitamins A, D, E, and K, and contains a significant amount of essential fatty acids, for example, linoleic and arachidonic acids<sup>[5]</sup>. Unsaturated fatty acids and cholesterol in ice cream, ice cream cones, and ice milk is given in Table 4.



**Table 4:** Nutritive value of commercial ice cream and related products

| Type of ice cream     | Wt.(g) | Fat  | pro-<br>tein | carbo-<br>hydrate | Total<br>solids | Cal-<br>ories |
|-----------------------|--------|------|--------------|-------------------|-----------------|---------------|
| Vanilla ice cream     | 100    | 12   | 4            | 20.7              | 38.3            | 204           |
| Mango ice cream       | 100    | 10   | 3.5          | 21.2              | 36.3            | 188           |
| Straw berry ice cream | 100    | 8    | 3.6          | 21.2              | 40.8            | 194           |
| Chocolate ice cream   | 100    | 13.1 | 3.6          | 25.8              | 42.1            | 221           |
| Ice milk              | 100    | 4    | 4.1          | 20.5              | 33.5            | 144           |
| Diabetic ice cream    | 100    | 9    | 4.3          | 20.6              | 28.6            | 152           |
| Ice lolly             | 60     | -    | -            | 27.6              | 14.5            | 54            |
| Frozen yoghurt        | 100    | 3.5  | 4            | 21.7              | 31.1            | 133           |

### Minerals in Ice Cream

A variety of inorganic elements are essential for growth and performance. Those needed in substantial amounts, such as calcium, phosphorus, magnesium, sodium, potassium, and sulfur, are termed as major minerals or macronutrients. Those needed in small amounts, such as iodine, manganese, zinc, fluorine, and selenium, are termed as trace elements. The inorganic nutrients are interrelated and should be in particular proportions in the diet. Calcium and phosphorus are of vital concern, since they are very closely related. Milk and products like ice cream are the richest sources of calcium, phosphorus, and other minerals essential in adequate nutrition. It has been proved by research workers that additional amounts of lactose in the diet favor the assimilation of calcium. As ice cream is a rich source of lactose, it favors the assimilation of greater quantities of the calcium content of diet, which is needed by growing children and some adults. The calcium contents of milk and ice cream are 0.118 and 0.132 g/100 g, respectively; the corresponding phosphorus contents are 0.093 and 0.105 g/100 g, respectively<sup>[5]</sup> (Deosarkar et al., 2016). Also many research indicated that the mineral bioavailability of milk product is very high (99%). The Bioavailability of minerals in foods of plant source are very low (70%) except pulse source which may be up to 90%. This may encourage one to include dairy products in his/her daily food (Table 5).

**Table 5:** Selected fatty acids and cholesterol in ice cream and related products

| Item            | Fatty Acids (per 100 g edible portions) |                     |          |             |                      |
|-----------------|---|---------------------|----------|-------------|----------------------|
|                 | Total(g)                                | Unsaturat-<br>ed(g) | oleic(g) | Linoleic(g) | Choles-<br>terol(mg) |
| Ice cream       | 12.5                                    | 7.0                 | 4.0      | Trace       | 45.0                 |
| Ice cream cones | 2.5                                     | 1.0                 | 1.0      | Trace       | 0.0                  |
| Ice Milk        | 5.1                                     | 3.3                 | 2.0      | Trace       | 21.6                 |

Source: Deosarkar (2016)[5], the Encyclopedia of Food and Health

### Vitamins in Ice Cream

Vitamins are organic substances, which are required in small amounts by the body for its metabolism and cannot be synthesized in sufficient quantities by the body. Like milk, ice cream is a rich source of many of the essential vitamins without which normal growth and health cannot be maintained<sup>[5]</sup> (Deosarkar et al., 2016). The following are illustration of some fat and water

soluble vitamins. They were taken from the above authors' work. Fat-soluble vitamins in ice cream

**Vitamin A:** Ice cream is an excellent source of this anti-infective vitamin (492 IU 100 g). It is the principal milk fat vitamin. It is essential for growth and normal functioning of the retina.

**Vitamin D:** Ice cream contains little quantities of this ant-rachitic vitamin (4 IU 100 g. Vitamin D-enriched ice creams can be prepared from fortified milk.

**Vitamin E:** Ice cream is a fair source of anti-sterility vitamin, containing about 3 mg/kg. It acts as an antioxidant for polyunsaturated fatty acids and prevents a large number of degenerative disorders.

### Water-soluble vitamins

**Vitamin B1 (thiamine):** Ice cream contains an average of 0.48 mg/ kg of this vitamin, with a range of 0.38–0.65mg/kg which is essential for proper metabolism and health.

**Vitamin B2 (riboflavin):** Ice cream is a fairly good source of riboflavin, containing an average of 2.3 mg/ kg with a range of 2.0–2.6 mg /kg.

**Vitamin B6 (pyridoxine):** It is an important coenzyme in the metabolism of amino acids. Ice cream contains an average of 0.0047 mg/ kg of this vitamin, with arrange of 0.0026–0.0078 mg kg.

**Vitamin B12 (cyanocobalamin):** It is one of the anemia preventing vitamins and is unique among vitamins, as it is not found in any plants. This vitamin has the most complex structure of all vitamins. Ice cream contains an average of 0.0047 mg kg of this vitamin, with a range of 0.0026–0.0078 mg/ kg.

**Vitamin C (ascorbic acid):** Fruit ice creams are excellent sources of this vitamin. On an average, ice cream contains 3 mg/ kg of this vitamin, with a range of 0–11 mg /kg

### Importance of ice cream for health

In addition to nutritional importance ice cream can be used as a functional food. The increased awareness of the consumer regarding health and nutrition related issues as well as the role of several food regulatory bodies to promote the production and consumption of minimally processed, healthier and more nutritious food products, appear to be steering a transformation within the food industry<sup>[7]</sup>.

The interest of the food industry in the development of new products is constantly increasing and becoming more challenging, due to consumers' awareness about healthier foods<sup>[8]</sup>. Dairy products, such as ice creams and yogurts, are considered nutritious foods and present a great potential to incorporate bio-actives<sup>[9]</sup>. Many research support that ice cream is a good source of different essential nutrients. In related to health, ice cream is used as probiotics carrier and also for other disease prevention.

### Ice cream as probiotic carrier

Ice cream is a product with peculiar textural and organoleptic features and is highly appreciated by a very broad spectrum of consumers. Ice cream's structure and colloidal design, together with its low-temperature storage, renders it a very promising carrier for the stabilization and in-vivo delivery of bioactive compounds and beneficial microorganisms. According to the FAO/WHO (2002)<sup>[10]</sup>, the term probiotic refer to live microorganisms that when orally administered in adequate amounts (106 to 107 CFU/g) confer health benefits to the host. To date, many applications related to the design and development of functional ice cream have been documented, including products containing probiotics, prebiotics, symbiotic, dietary fibers, natural antioxidants such as polyphenols, essential and polyunsaturated fatty acids, and low glycemic index blends and blends fortified with mineral or trace elements (Christos, 2014).

In recent studies, it is supporting that ice cream is very suitable to be used as probiotic carrier because of its storage suitability (low temperature) and also a source of a known probiotic, lacto bacillus. But, the sugar and fat contents of ice cream is very high and not suitable for many individuals. In order to mitigate this problem some study has proven that ice cream composition like sugar and fat can be kept at low level. Because, it can be said that combination of this two ideas (lower fat and sugar content and probiotic incorporation) can improve the ice cream importance.

### Digestibility and Palatability of Ice Cream

Ice cream is considered as an ideal food for people suffering from stomach or throat ailments when other foods cannot be taken. There are several reasons to support this viewpoint. Its sweet, pleasant flavor, smooth texture, and characteristic coolness make it a highly palatable food. Its high palatability stimulates the flow of digestive juices, which enhances digestion. Moreover, homogenization employed in its manufacture facilitates digestion as it happens with homogenized milk, as the digestive juices readily act upon the fat globules broken into small globules. Many experiments show that homogenized milk is more digestible than milk not so treated. The same holds true for the fat in ice cream mix when it is forced through the homogenizer, as is now the practice in commercial ice cream plants<sup>[5]</sup>. Dairy products are preferred for children since their digestion system are not well developed to digest complex foods.

### Health Impacts of Ice Cream

#### Microbial

Ice cream, a milk based product, can be considered a good medium for microbial growth due to its nutrient content, almost neutral pH (pH 6–7) and long storage duration (Kanbakan and Ayar,2016). Several steps in the production of ice cream can cause microbiological hazards. However, pasteurization, freezing and hardening steps can eliminate most of these hazards. Pasteurization of milk can destroy most of the pathogens posed risk to public health. However, the potential microbiological hazards can still be found in the final products after pasteurization through the addition of contaminated ingredients.

Although ice cream is stored at low (-18°C) storage temperature, contamination can occur at different stages. Because having adequate information on microbial quality of ice

cream is a very important before consumption of the product. Due to its composition, it can harbor many potent pathogens. Most ice creams become contaminated with microbes during production, transit, and preservation. Such contaminated food product can be responsible for food borne infections in children, elderly people and immune-suppressed patients<sup>[11]</sup>. In our country, ice cream industries distribute the ice cream to their out lets by using vehicle equipped with fridge system. But, contamination may occur from ingredients used, during loading and unloading. Once the ice cream becomes contaminated, freezing temperature later could not make the product safer<sup>[12]</sup>. There are psychrophilic microorganisms that can survive in a low storage temperature. Because, it is unbelievable to say ice cream is safe due to low temperature storage.

Ice cream is a type of dairy products which is very perishable product and needs a very careful handling and aseptic method processing to prevent health problem caused by contaminated ice cream with pathogenic microorganisms. According to the study of Jadhav (2014)<sup>[12]</sup>, Salmonella species (1- 8 cfu/g) and Shigella 32 species (1- 5 cfu/g) were isolated from some ice cream samples. It was observed that about 0% samples showed presence of Salmonella species while 53% samples showed presence of Shigella species. It can be understood from this review that contamination can be occur in ice cream products although low temperature is applied to processing and storage stages (Table 6).

**Table 6:** Ratio relationship between total viable bacterial count and E. coli and Staphylococcal density per/ml portion of ice cream samples of different brands

| Brand   | No. of sample analyzed | Average total viable count/ml | Average E. coli count/ml | Ratio of E. coli count : TVC | Average staphylococcal count/ml | Ratio of staphylococcal count : TVC |
|---------|------------------------|-------------------------------|--------------------------|------------------------------|---------------------------------|-------------------------------------|
| Igloo   | 3                      | 11850                         | 9255                     | 1 : 1.2804                   | 2595                            | 1: 4.5664                           |
| Polar   | 3                      | 13855                         | 1136                     | 1 : 12.1963                  | 0.0                             | 1: α                                |
| Kwality | 3                      | 8530                          | 794                      | 1 : 10.7430                  | 0.0                             | 1: α                                |

Source: Hasan Kamru et al., 2015<sup>[12]</sup>

Much attention is still needed to apply in aspects of microbiological quality control for attaining desired safety margins and giving assurance that the ice cream product received by the consumer will be pure, healthful and of the quality claimed. To do so useful and effective legislation must have to be enacted and enforced, the chief aim of which is to ensure that the production, handling, processing, distribution and storage of ice cream could be maintained under strict hygienic control to protect consumers against health hazard and under quality standards<sup>[13]</sup>.

Spore bearing microorganisms may pose risks through consumption of milk products (e.g ice cream). Furthermore, the presence of pathogens in ice cream samples is mostly due to tools and equipment, water, workers, environment, packaging materials and contaminations during the transportation and distribution of ice cream<sup>[13]</sup>. Salmonella is still the most important agent causing acute food borne diseases and Consumption of ice

cream contaminated with enteropathogenic bacteria such as *Salmonella* has been the cause of several disease outbreaks<sup>[14]</sup>. From this review paper it is understandable that ice cream is conducive for microbial growth and susceptible to contamination.

Diet plays an important role in preventing diseases and ensuring health. Hence, the consumption of functional foods (i.e., beneficial compounds or foods containing microorganisms) which provide health benefits with a reduction of coronary heart disease, obesity risk, and diabetes has increased during the last decade<sup>[15]</sup>. Probiotic microorganisms are usually used as culture concentrates in dried or deep freeze forms to be added to food for industrial or home uses<sup>[16]</sup>.

Dairy products with incorporated probiotic bacteria are gaining popularity and the probiotics comprise approximately 65% of the world functional food market<sup>[17]</sup>. The species of bacteria most commonly used in dairy products for probiotic effect are *Lactobacillus* and *Bifidobacterium*<sup>[18]</sup>. Standards requiring a minimum of 10<sup>6</sup> to 10<sup>7</sup> CFU/g of *Lactobacillus acidophilus* and/or *Bifidobacterium* in fermented dairy products have been introduced by several food organizations worldwide<sup>[19]</sup>. The production of dairy products with added lactobacilli and *Bifidobacterium* cultures is still expanding in the food market, as several studies have proved the beneficial effects on the consumer deriving from the ingestion of bacteria named probiotics<sup>[20,21]</sup>.

The sensorial analysis was carried out on an ice cream formulation with intermediate sugar and fat content, in order to average the influence of the two components. The triangle method highlighted a significant ( $P < 0.01$ ) difference between the ice cream with LGG cells and a control ice cream produced without micro-organisms. Most ice cream is, however, flavored and this could probably hide the 'probiotic' off flavor<sup>[22]</sup>. The metabolic activities of selected strains belonging to the *Lactobacillus* genus allow the body to enhance the digestion of lactose, decrease the cholesterol level in the blood serum, prevent intestinal disorders and stimulate the immune function<sup>[23]</sup>.

Administration of probiotics to the human host has been reported to be associated with immune system modulation, reduction of symptoms related with irritable bowel syndrome (IBS), diarrhea treatment, serum cholesterol reduction, anti-inflammatory action, and the prevention of cancer and mutagenesis<sup>[24]</sup>. Because, it may be useful to do further study to promote application probiotics to ice cream to keep the health of consumers without changing the expected quality from ice cream.

### **Sugar and Fat Contents of Ice Cream**

Ice cream is a highly complex food matrix, containing proteins, fat, sugars, air, minerals, etc. and countless interfaces between the different constituents<sup>[25]</sup>. Recently, growing concern about health and life qualities has encouraged people to exercise, eat healthy food and decrease the consumption of food rich in sugar, salt and fat<sup>[26]</sup>. As sugar consumption increased, the number of diseases related to excessive sugar consumption such as diabetes and cardiovascular diseases heightened. Ice cream is a highly complex food matrix, containing fat, sugars and countless interfaces between the different constituents (Frost et al. 2005). Both sugar and fats are found in ice cream in a high amount that may cause health problems and the concern should be given for this since it may be dangerous for public health.

Due to increasing consumer demands for low calorie

foods, products made with alternative sweeteners have become more popular recently. Changing attitudes in sucrose consumption have heightened because of its causing effect to diabetes and obesity. Many studies have been confirmed that both sugars and fats are a main cause for obesity and therefore tangible information needs to be addressed concerning ice cream consumption and its safety. Although there were many studies about ice cream in the literature, there are few studies on using different sugars in ice cream production (Ozdemir et al, 2008). Thus it is important to generate information by collecting different researches and reviews conducted on ice cream to find the gap and work on it or to recommend for further researches.

According to Deosarkar (2016)<sup>[5]</sup>, it was seen that the carbohydrate (sugar) contents of an ice cream is said to be between 20.7 and 22.1 per 100g of an ice cream which is a very high contents for consumption. According to the U.S. Department of Agriculture, one-half cup of vanilla ice cream provides 137 kilocalories of energy, about twice the amount in one-half cup of whole milk. Ice cream is a good choice when you need energy or if you are pursuing a program to gain weight<sup>[27]</sup>. This may be dangerous for health and leads to obesity and diabetic disease. Because, it is advisable to find other ingredient of ice cream that can replace sugars for healthy consumption. Concerning these replacements some researches were conducted but the results shows that other ingredients affects the physical and sensorial properties of ice cream. Because, further research is needed to search for ingredients that can replace sugars without affecting the physical and sensorial properties of the ice cream.

According to Joanne (2018)<sup>[27]</sup>, when the mixture freezes, it develops the rich, creamy consistency of ice cream, a food that can affect your health in both positive and negative ways. Ice cream is rich in carbohydrate, with about 15 grams in a one-half-cup serving. A serving also contains about 7 grams of fat and 2 grams of protein, making it an energy-dense food. At present, there is an increasing concern about the effect of diet on health and quality of life and Stake holders are interested in low fat products that are less associated with the risk of chronic diseases like obesity and coronary heart diseases. The Food and Drug Administration has approved the use of labeling name of reduced-fat, low-fat and non-fat ice creams for such products containing less than 10% milk fat. It is known that oil is one of the ingredients of ice cream in addition to fat in milk (major ingredient).

Ice cream is a high-fat food, since it must contain greater than 10 percent milk fat to be designated ice cream, with some products having as much as 16 percent. Milk fat is largely cholesterol, a saturated fat. When your blood cholesterol level is too high, it can build up as plaque, a fatty deposit in your arteries that interferes with blood flow and raises your risk of heart disease and stroke. Ice cream is also high in sugar, which makes up the majority of its carbohydrate content. Fat content is a vital parameter for texture and quality of ice cream and reduced fat ice cream has a body and texture associated with customer dissatisfaction. For improving the sensory qualities of ice cream, the dairy manufacturers use some fat replacers for the improving quality of reduced fat ice creams. Variety of dietary fiber have been tried to use as fat replacers in reduced fat ice creams. The fat can be partially replaced with low energy generating nutrients such as proteins (whey proteins) or carbohydrates (modified



starch).

According to Deosarkar et al., (2016)<sup>[5]</sup>, the average amount of sugar and fat are 20.7 and 16.0 respectively. But, according to some authors a standard ice cream is about 5%fat and 15% sugar solution by volume. From this it can be seen that there is a gap between a standards ice cream being produced in Spain. Also Clarks (2012)<sup>[28]</sup> addressed that compositions for a standard ice cream is fat 7–15%, Lactose 5–7%, other sugars 12–16%. From these review papers, everyone can understand that existing composition of ice cream is not safe for health.

Milk naturally contains lactose (milk sugar), which is not very sweet. Ice cream makers need to add a lot more sugar than you probably realize usually, sucrose or glucose. Cold tends to numb the taste buds, making them less sensitive. So, more sugar needs to be added to produce the desired effect at the low temperatures at which ice cream is usually served<sup>[29]</sup>. Preservation at -16°C, as usually occurs for retail-manufactured product in ice cream shops, does not impair the survival of micro-organisms<sup>[29]</sup>.

A big reason why ice cream tastes so good is because of its high fat content. Unless it is labeled as light, low-fat, or non-fat ice cream must contain at least 10% fat and this fat must come from milk. Before milk is homogenized, a thick layer of cream rises to the top. This cream has a high fat concentration—up to 50%—and supplies most of the fat in ice cream. Premium ice creams may have up to 20%fat, which gives it a velvety, rich texture. Reduced-fat ice cream does not taste as good as the real thing, and tends to lack the creamy texture<sup>[29]</sup>.

All groups of the population, particularly children, are consuming far too much sugar<sup>[30]</sup>. This increases the risk of excess calorie consumption and weight gain<sup>[31]</sup>. Many researchers are in agreement that consumption of too much sugar may contribute to health problems such as weight gain, cavities and increased levels of blood triglycerides, another unhealthy type of fat. To lower your risk for high cholesterol and sugar-related problems, consume ice cream in moderation or choose a low-fat, low-sugar ice cream substitutes<sup>[27]</sup>. Food selection is now becoming a critical work to keep health of individuals. Because, consumption junk foods like ice cream needs to have limitation. Ice cream is mostly considered as children's food since it preferred by them because of its delicious taste. But, parents can limit the frequency and amount consumed by their children to care of their health at well status through their life<sup>[34]</sup>.

## Conclusion and Recommendation

Ice cream is a sweetened frozen dairy product preferred as snacks or dessert made of milk and milk products, that is often added with fruits, along with other ingredients like flavors, colors. Classification of ice cream is based on their ingredients or type of flavors used. Ice cream is a nutritious food containing high amount of protein, fats, carbohydrate, minerals and also important minerals. In addition to nutrition advantages, ice cream can be used as probiotic carrier and also as a source of probiotic (lactic acid bacteria). Also Ice cream is considered as an ideal food for people suffering from stomach or throat ailments when other foods cannot be taken. Although ice cream is stored at low (-18°C) storage temperature, contamination can occur at different stages and results in public health impacts. Ice cream is high

in sugar (20.7/100g) and fat (16.0) which is very high and leads to health problem in public.

In general, it can concluded from this review that ice cream is a nutritionally important but it can cause a health problem because of its high fat and sugar content and also a high microbial growth due to its high nutritional and water contents. Although few researches have been started for substitution of sugar with other similar ingredients with a low calories further research needs to be conducted to mitigate the problems. The incorporation of probiotic in ice cream is being a promising because of its storage suitability, therefore, the strains probiotics microorganisms survive in low storage needs to be identified. All the results of this study is from the research done in different country, but it is better to conduct study on ice cream nutrition, microbial and its health impact in our country (Ethiopia).

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