ICE CREAM

Lakshman J. Gnanaprakasam
Consultant,
Small & Medium Food Processing Industries

"I scream, you scream,
we all scream for ice cream
May be that's all we want"

As this well-known party ballad indicates, ice cream is a favourite of everyone, young or old. It is a food relished by people all over the world. It is served at small children's parties as well at formal dinners, at parks, beaches, restaurants. teashops and practically everywhere. In spite of it being so common, how many of us eat good ice cream? Ice cream is a food packed with nutrition and rich in calories. If consumed properly it is a health food, but abuse in the consumption can result in ill effects. It is said that, you supplement your food with ice cream and you gain weight or you substitute your food with ice cream and lose weight. (Arbuckle)

CLASSIFICATION OF ICE CREAM

There have been numerous classifications derived for ice cream. These classifications were based on composition, ingredients, form and consistency of the finished product. However, it has become universal to classify all frozen desserts (ice cream, sherbets, ices, etc) together.

In general, the term ice cream may be defined as a frozen food made from a mixture of dairy products to give the desired percentage of milk fat, milk-solids-non-fat (MSNF), together with sugar, colouring, flavouring, stabilizer with or without eggs, fruits, nuts, etc. and made smooth by whipping or stirring while freezing. (Arbuckle)

The Sri Lanka Standards Institution in its Standards Publication SLS 223:1989 defines ice cream *as a frozen, sweetened product made from a heat-treated mix consisting of edible fat and milk solids, with or without other ingredients and permitted additives. The product is intended for storage, sale and consumption in the frozen state.*

According to the SLS 223:1989 ice cream is categorized into three main types. They are-

Simple Ice Cream

A sweetened product made from consisting of edible fat, milk solids, colour, flavour, emulsifier and stabilizer.

Complex Ice Cream

A simple ice cream with any one or more of the optional ingredients listed below.

(Optional Ingredients - Fruits, fruit products, nuts, jellies and ingredients intended to impart flavour such as cocoa, chocolate, coffee, biscuits, etc)

Novelty Cream

Single-serve packs of either simple or complex ice cream with an outer edible coating such as chocolate, nuts, biscuits, etc.

ICE CREAM INGREDIENTS

Basically, the ice cream mix consists of edible fat, milk-solids-non-fat (MSNF) stabilizer/emulsifier and water. These constituents are obtained from a variety of raw materials, usually each supplying more than one of the required constituent. In addition, there are other supplementary ingredients like fruits, nuts, jellies, etc. which may or may not supply the necessary constituents. The functions and properties of these constituents and some of their usual sources are described below.

Properties of Ingredients

Fat:

The source of fat can be milk, butter, dairy cream, vegetable fat, eggs, etc. These ingredients could be used singly or in combination. Originally, ice cream consisted of fat derived entirely from dairy products, but now it is usual to add fat from other sources such as vegetable fat. Fat in the correct proportion gives the cream good flavour, richness and a good body. It also enhances the eating properties. Too low a content of fat will result in an ice cream with harsh and lack of creaminess. Excess fat imparts heavy and greasy taste. If fat content is above 14%, incorporation of air becomes difficult.

Milk Solids-Non-Fat (MSNF)

Milk Solids-Non-Fat consists of proteins, lactose and mineral salts. The source can be whole milk, skim milk, full cream milk powder, skim milk powder, condensed milk, etc. or a combination of them. A high solid content favours entrapment of air. Milk produces body and texture of ice cream and enhances the flavour of dairy fat. Casein in the milk assists in emulsifying the ice cream mix. When the quantity of milk is too low, the ice cream will have a flat flavour and improper homogenization results. High percentage of MSNF may give a sandy texture due to the formation of lactose crystals.

Sugar

The prime purpose of adding sugar is as a sweetener and flavour enhancer. It is required by law that any sweetener used, except in the case of special diet ice creams, should be carbohydrate sweeteners. Although it is the usual practice to use sucrose (cane sugar) due to its high sweetness and easy availability, any of the following sugars, either singly or in combinations, could be used.

Monosaccharides (e.g. Dextrose, laevulose)

Disaccharides (e.g. Sucrose, maltose, lactose)

Polysaccharides (e.g. Corn syrup (glucose syrup), Corn flour)

Apart from its function as sweetener, sugar increases the solid content of the mix and gives proper freezing, melting and whipping properties. Excess sugar will increase the viscosity, depress the freezing point, shrink ice cream on hardening and give a grainy texture due to the formation of large crystals. Sometimes it is the practice to blend sucrose with an invert sugar to prevent crystallization.

Water

Water forms the major constituent of the ice cream mix, and is obtained from all the ingredients used in the mix, the main source being milk or the water used to reconstitute milk powder. The ice crystals formed during freezing should be uniform in size, evenly distributed and minute in size. These conditions are important in obtaining a smooth ice cream. Large crystals end up in a gritty textured ice cream. Proper beating and fast freezing are the requirements to achieve evenly distributed, minute crystals.

Stabilizers and Emulsifiers

The purpose of using stabilizers is to maintain the stability of air-water-fat emulsion of the ice cream mix. Hence, the stabilizer used should have aerophilic, hydrophilic and lipophilic properties, so that the interfacial tension between the three phases could be kept minimum. Casein found in milk has stabilizing properties, but the quantity is insufficient. Therefore, it is necessary to add small amounts of proprietary stabilizers, which are freely available in the market. The stabilizer used could be protein, vegetable gum or chemically modified compounds or a blend of them. Some examples of stabilizers are gelatin, agar-agar, gum tragacanth, carboxymethyl cellulose (CMC), etc.

Stabilizers give uniformity and smoothness of texture and body. Insufficient stabilizers will result in poor stability and a rough texture. Excess stabilizer will give a leathery texture and impart an off flavour.

Emulsifiers improve the quality of the mix by producing a smooth body and a drier ice cream. Two types of emulsifiers are available, viz. (a) mono and di-glycerides and (b) Polyoxyethylene derivatives of hexahydric alcohols, glycol and glycol esters.

Now there are proprietary preparations, having both emulsifying and stabilizing properties available in the market for use in ice cream industry.

Flavouring and Colouring

Natural or synthetic flavouring and colouring could be used but the type and quantity used should conform to SLS 223:1989 and the Food Act No. 26 of 1980 and regulations framed there under. In the case of chocolate ice cream, the cocoa added to the mixture gives the desired colour and flavour.

Fruits, Nuts, Jellies, etc

Fruits, nuts, jellies, etc. added to ice cream gives a highly acceptable product. Fruits can be fresh, dried, candied or otherwise preserved. They can be cut into small pieces, pureed or be a combination of fruit puree and fruit pieces. The quantity of fruit added depends on the type of fruit and the flavour. An average of 10 to 25 percent fruit is found to produce good results. The quantity of fruit however should not be less than 3 percent.

Nuts added should be clean, sound and free from any rancid flavours. Special attention should be given to mould growth in nuts, which could produce afla-toxins. The commonly used nuts in Sri Lanka are cashew nuts and peanuts. The nuts should be suitably pre-treated before adding to the mix.

Formulation of Ice Cream Mix

The proper selection and composing of the ingredients to form the ice cream mix is a vital factor in the

manufacture of ice cream. The quantity of each constituent in relation to the other is limited and any deviation will adversely affect the quality of the ice cream. The SLS 223:1989 specifies the *minimum* percentages of fat, MSNF and sugar as 8, 8 and 10 percent respectively. The usual range of composition of ice cream mix is as follows.

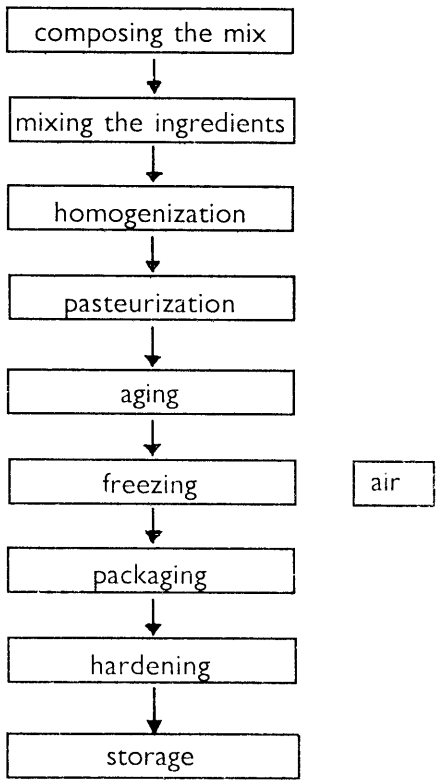
Fat	– 8 to 14%
MSNF	– 8 to 12%
Sugar	– 12 to 16%
Stabilizer/Emulsifier	– 0.3 to 0.5%
Water	– 60 to 65%

The actual ratio of the three constituents will have to be determined mathematically. In computing the ice cream mix formula, first the fat and sugar percentages have to be decided. The Percentage of MSNF is then calculated using the following formula:

Where *n* is the sum of all solids other than MSNF. i.e. the sum of the percentages of fat, sugar, emulsifier/ stabilizer, etc.

Manufacturing Process

The flow diagram for the manufacture of ice cream is given below.



Composing the Mix

The first step in the manufacture of ice cream is the selection of ingredients and composing the mix. Quality assured ingredients should be selected and accurately measured according to the formula described above.

Mixing the Ingredients

The liquid ingredients such as milk, water, etc are first added into the mixing vat or vessel and mixed well. The dry ingredients are then mixed and the vat heated. When the vat temperature reaches about 50°C, frozen ingredients such as butter, frozen cream, etc. are mixed. Flavours and colouring are generally not mixed at this stage. They are kept aside for mixing at a later stage.

Homogenization

The mix is pre heated to 65°C to 70°C and passed though a homogenizer. The homogenizing pressure will depend on the type of mix, viscosity, etc. For two-stage homogenizing, the usual pressures employed are 140 to 200 bar pressure for first stage and 50 bars for the second stage.

Pasteurization

The homogenized mix should then be pasteurized. For small-scale manufacturing, batch pasteurizer is used. The pasteurizing temperature is 68°C with a holding time of 30 minutes. Batch pasteurizing should be carried out with gentle agitation to prevent localized heating and development of off flavours. In large-scale plants, pasteurizing may be done using a plate heat exchanger at 85°C for 15 seconds.

Aging

For proper stabilizing, the fat to crystallize and the viscosity to improve the mix should be aged for 4 to 24 hours at a temperature 2 to 5°C with gentle agitation. The time for aging depends largely on the type of stabilizer and the formulation of the mix. With modern stabilizers available in the market aging for more than 4 hours is not necessary. At the end of aging period, flavouring and colouring agents are added.

Freezing

The ice cream is next fed into the ice cream freezer. This is a vital operation in the manufacture of ice cream. During this process, two important events take

place.The water in the mix is frozen to a large number of very minute crystals, at the same time incorporating air into the mix. The freezing of water should take place quite rapidly to minimize the size of the frozen ice crystals. Air incorporation should be such that the air is evenly and uniformly distributed in the form of fine bubbles. Proper incorporation of air contributes to the achievement of a good over-run. *Over-run is the increase in volume while freezing, obtained by the incorporation of air.* Over-run is discussed more in detail below.The mix, which enters the ice cream freezer at the aging temperature of 2°C to 5°C, leaves the freezer at a temperature of - 4°C to - 7°C.

Packaging, Hardening and Storage

Ice cream from the freezer is drawn into large containers as bulk or multi-service packages or into single serve packages for individual use.

In the early days the ice cream industry used recyclable multi-serve containers made out of aluminium, mild steel or stainless steel. Single serve packs were then made of cardboard or paper tubs coated with paraffin, to make them impervious to moisture. The tubs were usually accompanied with a wooden spatula.

The modern trend is to pack bulk ice cream in disposable poly-packs or plastic containers. Single serve ice cream is packed in thermo-formed plastic tubs closed with either heat-sealed polythene lined aluminium foil or close fitting plastic closures.The tubs are accompanied with injection moulded plastic spatulas. It is important that all plastics used for packaging and serving be of food grade. When ice cream is made in dispensing or extrusion machines, they are usually served in wafer cones.

Whatever form the packaging may be, they should conform to specifications and regulations laid out in *Standards for Ice Cream -- SLS 223:1989, Code of Practice for Labelling of Packaged Food – SLS 467:1979 and Packaging Regulations framed under Food Act No. 26 of 1980.*

The manufacture of ice cream is not complete at this stage.The ice cream after packaging should be allowed to harden at a much lower temperature. For this purpose, the packaged ice cream is stored in hardening room or chambers at a temperature of -18°C to -20°C. If the hardened ice cream is to be kept for a longer period, they should be stored at a temperature of -25°C. In very large-scale industries, hardening is carried out by passing the ice cream through hardening tunnels at a temperature of -18°C to -20°C and thereafter stored in cool rooms at -25°C. Ice cream manufactured in dispensing or extrusion machines have the hardening operation included in the process.

The shelf life of ice cream will depend on a number of factors, including the type of ice cream, type of packaging, ingredients used, storage facilities, manufacturing process, etc. Generally, the storage period could be up to 9 months.

Over-run

Obtaining a good ice cream largely depends on achieving the proper over-run. If the air incorporated is insufficient, the ice cream becomes very heavy and thick. Excess air will make the ice cream too fluffy and unfit for consumption. Hence, it is important to incorporate a controlled amount of air into the mix. Generally, for simple ice creams, an over-run of 80 -100% could be expected.

Over-run may be defined as, "The volume of ice cream obtained in excess of the volume of the mix, and is expressed as a percentage" Mathematically, over-run can be expressed as

$$\text{Over run} = \frac{\text{Volume of ice cream - volume of mix}}{\text{volume of mix}} \times 100\%$$

There are many factors that favour over-run, each having its own importance.The choice of ingredients and the composition of the mix is the primary factor. Ingredients which favour over-run have already been discussed under "Properties of Ingredients". Further, the composition of the mix should be such that the total solid content should not be less than 35% and the quantities of the basic constituents are in the correct ratio. Another feature that is important in achieving the desired over-run is the proper design and operation of the ice cream freezer. Sharpness of the freezer blades, speed of dasher, flow rate of refrigerant, temperature of freezing and rapid cooling contribute much towards achieving a high over-run

(cont. next issue Vol. 27 No. 1)