

PREPARATION AND STANDARDIZATION OF ICE CREAM MIX

1. Preparation of Ice Cream Mix

Preparation of ice cream mix involves various essential steps like

- Selection of ingredients
- Formulation of ice cream mix
- Blending of mix
- Pasteurization of mix
- Homogenization of mix
- Cooling of mix
- Ageing of mix

2. Selection of Ingredients

Good quality materials are essential if the resultant product need to be satisfactory in all aspects. The raw ingredients necessary to provide the components of ice cream must contain sufficient fat and milk solids in proportions that can be combined to make a mix of the desired composition.

Selection of ingredients depends on their

Availability, Perishability, Convenience in handling, Effect on flavour, body and texture of ice cream, Cost, Equipments available etc.

Ice cream ingredients may be grouped into dairy and non-dairy products.

a) Dairy Ingredients

Dairy products that supply fat and MSNF – Sweet cream, Sweet milk, fresh butter, unsweetened, condensed and evaporated milks , full-cream milk powder, separated milk powder.

Dairy products that supply MSNF alone – Skim milk, skim milk powder, condensed skim milk, sweet-cream buttermilk.

b) Non-Dairy Ingredients

Sweetening agents – Cane sugar, beet sugar, corn sugar, corn syrup, invert sugar, saccharin

Stabilizers– Gelatin, sodium alginate, guar gum, etc.

Emulsifiers– Mono or di-glycerides of fat forming fatty acids

Flavours– Vanilla, chocolate, strawberry, pineapple, lemon, banana, mango, orange, etc.

Colours– Yellow, green, pink, etc.

Egg solids – Yolk solids

Fruits & nuts – Apple, banana, mango, pine apple, grape, almond, pistachio, cashew nut, walnut and groundnut.

3. Formulations of Mix

Consideration of various factors is highly essential to obtain a proper mix. The fundamental requirement of mix formulation is to obtain a well balanced mix which also satisfies the legal standards. A well balanced mix should always ensure:- A correct total solids to water ratio – if too high, sandiness and rough texture and if too low, glassy or icy texture with weak body. Usually total solids of 36.0 to 40.0% will result in organoleptically acceptable ice cream.

There is inverse relation between fat and SNF in ice cream mix for e.g. super premium ice cream (high fat) will have lower SNF than good average (moderate fat) ice cream. A correct fat to sugar ratio – to prevent fatty mouth feel in case of high fat ice cream the sugar content has to be raised accordingly. For instances 16% fat ice cream should ideally have 17% sugar as against 15% sugar for economy (10% fat) ice cream. As a thumb rule, the MSNF should be about 15.6% (slow turn over) to 18.5% (rapid turn over) of the TS of the mix, depending on the turnover of the ice cream. The maximum MSNF that can be kept to prevent sandiness in ice cream is as follows.

For slow turn over the formula is

$$\text{Max MSNF \%} = \frac{100 - (\text{Sum of \% of all other solids in mix other than milk solids})}{6.4}$$

For rapid turnover formula is

$$\text{Max MSNF \%} = \frac{100 - (\text{Sum of \% of all other solids in mix other than milk solids})}{5.4}$$

Proper formulation of the mix is mandatory for the preparation of mix. The following methods can be used to calculate the mixes:

- i. Pearson square method
- ii. Serum point method
- iii. Formula tables / graphics method
- iv. Algebraic method
- v. Computer developed formulations

Standardization of Ice Cream Mix

In order to attain the desired composition of ice cream mix, the calculated quantities of ingredients (dairy and non-dairy) is arrived at through standardization. This is accomplished using either (a) Algebraic method, (b) Serum Point method.

In algebraic method the following three equations are used

Quantity equation

$$\mathbf{W+C+P=100-NDP} \text{ -----1}$$

Fat equation

$$\mathbf{W \times F1 + C \times F2 + P \times F3 = \text{Desired fat \%} \times 100} \text{ -----2}$$

SNF Equation

$$\mathbf{W \times SNF1 + C \times SNF2 + P \times SNF3 = \text{Desired SNF \%} \times 100} \text{ -----3}$$

Where, W= whole milk, C= cream, P= skim milk powder, NDP = Non-dairy product (sugar, stabilizer, emulsifier), F1, F2 and F3= fat % of W, C and P respectively; SNF1, SNF2 and SNF3= SNF % of W, C and P respectively.

Desired fat and SNF may be 10.0 and 12.0 per cent respectively.

Equating the above three equations we can arrive at the individual quantities of each ingredient of ice cream mix

Blending of Mix

The ingredients to be blended are taken in a vat, where it can be heated to facilitate dissolving, blending and pasteurizing. Mixing process varies from a small batch operation type to a large scale automatic continuous type depending upon the amount of mix to be processed.

The order in which ingredients are to be added is as follows:-

- Liquid ingredients are mixed together and heated to 49°C prior to the addition of all dry ingredients.
- Sodium alginate is mixed with a portion of sugar and slowly added to the liquid maintained at 71.1°C at a moving agitator point.
- When gelatin is used, it should be dissolved in nine times water by weight with equal volumes of sugar before the liquid temperature reaches 49°C.

If butter, plastic cream, frozen cream or other frozen products are used, they should be cut into small pieces and allowed for complete melting before pasteurization.

Homogenization of Mix

Homogenization of ice cream mix is a most essential step to make a permanent and uniform suspension of the fat by reducing the size of the fat droplets to a very small diameter, preferably not more than 2 µm.

Advantages of homogenization

Proper homogenization of the mix will never allow the fat to form the cream layer

- More uniform ice cream
- Smoother texture
- Improved whipping ability
- Shorter ageing period
- Less opportunity for churning to occur in freezer
- Less stabilizer is required

Homogenization of mix is usually done at temperature ranging from **63 to 77°C**. A pressure of **2000 to 2500 psi** (135 to 170 kg/cm²) **with one valve** or **2500 to 3000 psi (170 to 200 kg/cm²) on the first and 500 psi (35 kg/cm²) on the second stage** will usually give good results for an average mix.

Freezing of Ice cream mix:

Ice cream is a very complex food. The mix has usually more than 60% water. The water dissolves the sugars, both natural lactose and the added sugars, and also dissolves a portion of the salts from the milk solids. Hence there is a colloidal system with proteins suspended in water and an emulsion system with fat – in – water. Freezing the mix is one of the most important steps in making ice cream, since it decides the quality, palatability, and yield of the finished product.

The Freezing Process

The freezing process may be divided into two parts

- 1) The mix, with the proper amount of colour and flavouring agents generally added to the freezer, is quickly frozen while being agitated to incorporate air in such a way as to produce and control formation of the small ice crystals that are necessary to give smoothness in body and texture, palatability and satisfactory overrun in the finished ice cream.
- 2) When ice cream is partially frozen to the proper consistency, it is drawn from the freezer into packages and quickly transferred to cold storage rooms, where the freezing and hardening process is completed without agitation.

The various factors that influence freezing time are

1. Mechanical
2. Character of mix

1. Mechanical

- a) Type and make of freezer
- b) Condition of freezer wall and blades
- c) Speed of dasher
- d) Temperature of refrigerant
- e) Velocity of refrigerant passing around freezing chamber
- f) Overrun desired
- g) Temperature at which ice cream is drawn
- h) Rate at which freezer is unloaded.

Character of mix

- a) Composition of mix
- b) Freezing point of mix
- c) Acidity content of ingredients
- d) Kind of ingredients, particularly those carrying fat
- e) Methods by which the mix is processed
- f) Kind and amount of flavoring materials added

Actual freezing process –

Changes during freezing process

- a) Lowering the temperature of the mix from ageing temperature to the freezing point
- b) Freezing a portion of water in the mix
- c) Incorporating air into the mix
- d) Cooling ice cream from the temperature at which it is drawn from the freezer to hardening room temperature.

The **first phase of freezing process accounts for the freezing of 33 to 67 per cent of the water and the second phase (hardening process) accounts for freezing another 23-57 per cent** depending on the drawing temperature.

Within one or two minute the temperature of the mix which is put into the freezer drops very rapidly while the sensible heat is being removed and before any ice crystals are formed. Meanwhile, the rapid agitation reduces the viscosity by partially destroying the gel structure and by breaking up the fat-globule clusters and also hastens incorporation of air into the mix.

When the freezing point is reached, the liquid water changes to ice crystals which appear in the mix. These ice crystals are practically pure water in a solid form, and thus the sugar as well as the other solutes becomes more concentrated in the remaining liquid water. Increasing the concentration of the solutes slightly depresses the freezing point and when the freezing point is continuously lowered, more ice crystals are formed increasing the concentration of sugar and other solutes in the remaining liquid water until the concentration is so great that further freezing will not occur. Thus all the water does not freeze even after long periods in the hardening room.

Overrun calculation

Overrun is usually **defined as the volume of ice cream obtained in excess of the volume of the mix**. It is usually expressed as **percentage of overrun**. This **increased volume is composed mainly of air incorporated during the freezing process**. The amount of air that should be incorporated depends upon the composition of the mix and the way it is processed, and is regulated so as to give the percentage of over run or yield that will give proper body, texture and palatability necessary to good quality ice cream.

Calculating Overrun

Overrun can be calculated by weighing a container and making a note of it so it can be subtracted later. Note how much the container weighs filled with liquid mix and subtract the container weight. Fill the same container level with frozen product and note its weight

$$\text{Overrun \%} = \frac{(\text{Weight of ice cream} - \text{Weight of same volume of ice cream})}{\text{Weight of same volume of ice cream}} \times 100$$

Too much air will produce a snowy, fluffy, unpalatable ice cream; too little air, a soggy, heavy product.

Five factors that are usually considered when determining the amount of overrun are

1. Legal regulations enforced in the market area
2. TS content of the ice cream. High TS permit use of a higher overrun.
3. Bulky flavour ice creams require a lower overrun than plain ice cream in order to obtain an equally desirable body and texture.
4. Selling price of ice cream
5. Type of package – bulk packages which are solid for ‘dipping’ usually contain 90- 100per cent overrun, while packages of the carry home type usually are more satisfactory if they contain 70-80 per cent.

The ability to obtain overrun at the freezer depends partly on the **concentration and type of ingredients in the mix** and on the **freezing process** itself. **Sharpness of scrapper blades, speed of dasher, volume of refrigerant passing over freezing chamber and temperature of refrigerant** are important in determining the overrun.

The factors that **depress overrun** includes

- Fat content

- MSNF content
- Corn syrup solids content
- Increased amount of stabilizer
- Fruits,cocoa and chocolate
- Excessive calcium salts
- Poor homogenization
- Amount of mix in batch freezer
- Insufficient refrigeration
- Mix too warm
- Dull freezer blades
- Freezing the mix to high stiffness.

The Factors specific for continuous freezer to **depress overrun** includes

- Slow freezer speed
- Slow pump speed
- Pumps worn or need adjusting
- Pump spring bent
- Fruit feeder operation

The factor listed as **enhancing overrun** includes

- Sodium caseinate
- Whey solids
- Egg yolks
- Emulsifiers
- Certain stabilizers
- Certain salts
- Pasteurization of mix at higher temperature

Those factors specific for continuous freezers to **enhance overrun** includes

- Air leaks in mix intake line
- Erratic springs in air intake valve

- Height of flavour tank
- Volume of mix in the flavour tank
- Distance of flavour tank from freezers
- Air pump.

To secure uniform overrun and yield, the following points should receive attention:

1. Uniformity in refrigerant temperature and rate of flow of refrigerant.
2. The use of overrun testers, Drawrite or Willman controls.
3. Uniform make, etc., of freezers.
4. Not too many freezers per worker.
5. Hopper systems for filling containers if both freezers are used.
6. The use of a system of checking the weight of packages or containers as they enter the hardening room.

Changes in Overrun During Discharge From Batch Freezer

The usual sequence of changes is **an increase in overrun during the discharge of about first half of the batch**, followed by a **decrease in overrun during discharge of the last portion of the batch**.

The initial increase in overrun is due to the greater opportunity afforded for whipping and expansion as part of the batch is removed. The later decrease in overrun is due to the dasher no longer effectively whipping the mix (the quantity of the mix is reduced) **and gradual warming up of the mix** (since refrigerant is shut off at the start of whipping).

Control of Overrun

The control of overrun is very important and should be maintained as nearly constant as possible from batch to batch and from day to day. A variation of 10% overrun represents sizable differences in profit to the manufacturer. The correct overrun percentage depends upon the kind and composition of product

and freezing equipment. The overrun of different products may normally be as shown in table.

Products	Overrun %
Ice cream, packed	70-80
Ice cream, bulk	90-100
Sherbet	30-40
Ice	25-30
Soft Ice cream	30-50
Ice milk	50-80
Milk shake	10-15
Super premium ice cream	0-20

Also the control of overrun can be maintained by below two types

1. Manually by using pumps and overrun System
2. By using automated overrun control