Structure

1.1 Flavoured Milk
1.2 Sterilization Milk
1.3 Toned Milk
1.4 Double toned milk
1.5 Recombined milk
1.6 Reconstituted milk
1.7 Standardized milk
1.8 Irradiated milk
1.9 Humanization of milk

Learning Objectives

After studying this unit, the student will be able to

• Understand about preparation of Liquid Milks.
• Know about the PFA standards of Liquid Milks.
• Know about method of manufacturing Flow diagram of Liquid Milks.
• Know about calculation of Toned Milk.
1.1 Flavoured Milk

Milk to which some flavours one added are termed as flavoured milks. When the milk is used, the product should contain milk fat percentage at least equal to the minimum legal requirements for market milk. But when the fat level is lower it should be called as drink.

1.1.1 Purpose

(i) To make more palatable to those who do not relish it as such.
(ii) To increase the sale of milk
(iii) To put skim milk to profitable use.

1.1.2 Types

The main types are
(i) Chocolate milk/drinks
(ii) Fruit flavoured milk/drinks
(iii) Sterilized flavoured milk/drinks

1.1.3 Methods of manufacture of chocolate/fruit flavoured milks drinks.

(a) Flow diagram of manufacture

```
Receiving milk
  ↓
Standardization
  ↓
Pre-heating (60°C)
  ↓
Homogenization 2500 psi
  ↓
Mixing cocoa, sugar and stabilizer
  ↓
OR
  ↓
Mixing flavour/essence, colour and sugar
  ↓
Pasteurization (71°C/30 min)
  ↓
Cooling (5°C)
  ↓
Bottling and storage (5°C)
```

(b) Details of manufacture

i. Chocolate milk drinks. The following formula may be used.

   (i) Cocoa powder           1 to 1.5%
   (ii) Sugar (Sucrose)       5 to 7.0%
   (iii) Stabilizer           0.2%
   (Sodium Alginate)

   **Fat level in milk/drink**: Minimum legal standard is 2% fat. The milk on receipt is standardized preheated to 35-40°C and filtered, alternatively after standardization. It is preheated to 60°C, homogenized at 2500 psi and then clarified. To the warm milk the desired amounts of cocoa mix, sugar and stabilizer are slowly added and stirred so as to dissolve them properly. (The cocoa powder may also be added in the form of syrup, and the stabilizer in the form of solution). The mixture is then pasteurized at 71°C/30 minutes, cooled rapidly to 5°C bottled and kept under refrigeration (5°C) until used. The bottles should be in variably inverted up and down a few times before consumption.

   **Note**: Standardized milk is homogenized to prevent or delay in rising of cream flug. It may be homogenized after addition of cocoa and sugar, but this has the effect of increasing sedimentation. Stabilizer is usually added to delay or prevent settling of cocoa particles, it also aids in the prevention cream separation.

ii. Fruit Flavoured milk / drink: Permitted fruit flavoured essences, together with permitted (matching) colour and sugar are used. The method of preparation is similar to that used for chocolate milk/drinks. The common flavours used are strawberry, orange, lemon, pineapple, banana, vanilla etc. However in order to obtain good results the following precautions should be taken.

   (i) No acid (citric or tartaric) should be added to the fruit syrups, as this may result in curdling. The pH of the milk syrup mix should be about 5, which keeps the mix safe from curdling.

   (ii) Excessive sweet syrups should be avoided. The optimum sugar content of the syrup may be between 45-55 percent.

   (iii) Add 1 part of fruit syrup to 5 parts of milk. (Fruits which give particularly good results are strawberry, orange, lemon, pineapple, blackberry, rasberry, and black currant etc.).

   (iv) Care should be taken to see that, there should be pleasant blend of sweet, fruity and milky flavours (together with an appealing colour).
1.1.4 Method of manufacture of sterilized flavoured milk/drink

These have the combined advantages of both sterilized and flavours milk/drinks. The method of preparation can be as below.

(a) Flow diagram of manufacture

(b) Details of manufacture: The method of preparation consists of all steps as indicated under 1.1. In addition, in between classification and fillings are essence, permitted (matching) adding colour and sugar (syrup) which are mixed into the milk.

1.1.5 Vitaminized/irradiated milk

(a) Vitaminized milk is milk, to which vitamins are added. Irradiated milk is milk, in which the vitamin D content has been increased by exposure to Ultra-Violet rays. Mineralized milk is milk, to which minerals have been added.

(b) It is well known that, lack of vitamins in the diet causes specific deficiency disease, which in turn can be cured by the intake of those particular vitamins. Addition of vitamins (and minerals) to milk is called fortification, and such milk is called fortified milk. The vitamins (and minerals) may be added singly or, more commonly as multi-vitamin preparations.

(c) Some common vitamin deficiency disease have been listed in table 1.1.
Sterilized milk must (i) Keep without deterioration, i.e. remain stable and have good commercial value for a sufficient period to satisfy commercial requirements, (ii) Be free of micro-organisms which are harmful to consumer health, i.e. pathogenic, toxin genic germs and toxins, (ii) be free of any microorganism liable to proliferate i.e. should not show sign of bacterial growth (which leads, interalia, to absence of deterioration).

1.2.1 Advantages and Disadvantages

Advantages

(i) Remarkable keeping quality, does not need refrigerated storage
(ii) No cream layer/plug formation.
(iii) Forms a soft digestible curd, and hence useful for feeding of infants and invalids
(iv) Distinctive ‘rich’ (due to homogenization)
(v) Economical to use
(vi) less liable to develop oxide taints.

Disadvantages

(i) Increased cost of production
(ii) More loss in nutritive value than pasteurization (50 percent of the vitamin C and 33% of vitamin B originally present are destroyed and there is slight reduction in the biological value of the milk proteins).
(iii) Gerber test may be conducted by normal procedure but it may not show accurate results.

1.2.2 Methods of manufacture

(a) Flow diagram of manufacture

Flow diagram 1.2

- Receiving of milk
- Pre-heating (35-40°C)
- Filtration/clarification
- Standardization
- Pre-heating (60°C)
- Homogenization (2500 psi) (60°C)
- Clarification (60°C)
- Filling and capping (in cleaned and sanitized bottles)
- Sterilizing (108 -111°C / 25-30 min.)
- Cooling and Storage (room temperature)

(b) Details of manufacture: The raw milk on receipt should be strictly examined by the prescribed physico-chemical and bacteriological test and only high-quality milk should be used for production of sterilized milk. Care should be taken to accept milk supplies which have no developed acidity and which contain the least number of spore-forming bacteria. The intake milk should be promptly cooled to 5°C for bulk storage in order to check any bacterial growth.

Next it should be pre-heated to 35-40°C for efficient filtration / clarification, so as to remove visible dirt etc. and to increase its aesthetic quality. The milk should again be cooled to 5°C so as to preserve its quality. It should then be standardized to the prescribed percentages of fat and solid-not-fat state for both cow and buffalo milks. It must be stored at 5°C until efficient homogenization to prevent any subsequent formation of creamlayer. Usually single stage homogenization is carried out at 2500 psi pressure.
The homogenized milk must be clarified so as to remove the sediment formed during the homogenization process. The hot milk from the homogenizer should be filled into the hot cleaned and sanitized bottles coming from the bottle washing machine and then sealed bottles coming from the bottle washing machine and then sealed with special caps, (of the crown seal type). The filled and capped bottle should then be placed in metal crates for sterilization by the Batch process, or feed into conveyor for the continuous process. Usually the milk is sterilized at 108°C-111°C (225-230°F) for 25-30 minutes. The sterilized milk bottles should be gradually cooled in room temperature. Any sudden cooling may lead to bottle breakage. Finally the milk-in-bottles should be stored in a cool place.

(c) Sterilizers: These may be 1. Batch 2. Continuous

1. Batch: These may either be rotary or non-rotary in type. The batch (tank) sterilizers are rectangular, horizontal, boiler shaped retorts shape with a steam inlet and condensate outlet, fitted with clamp-down covers, into which steam is adjusted for the required temperature and time for sterilization.

Advantages

(i) Simplicity and flexibility of operation
(ii) Less initial capital and recurring expenditure.

Disadvantages

(i) Usually produces - type
(ii) Sterilization maybe faulty
(iii) Cooling has to be gradual to avoid breakage
(iv) Economic advantages of large scale processing are not obtained.

In the batch rotary type the filled bottles are put into holders which are rotated at 6-7 RPM.

2. Continuous: In this type the filled and sealed milk bottles are automatically placed by means of slat conveyor into the pockets of carrier cages. They then pass into water at or near boiling temperature, from there they enter sterilizing zone, which consist of steam chamber at 108-111°C (225-230°F). Here, the bottles remain for a pre-determined time, viz, 25-30 minutes for milk sterilization.

(d) Cooling: After heat treatment in the batch/tank sterilizers, the milk bottles may be cooled in air for water. If cooling is too rapid, it may lead to caramelization. In the continuous system after leaving the sterilizing zone, the bottles enter a column of hot water where the cooling process begins. This
followed by their passage through another tank of water (at lower temperature than the previous one) for further cooling, and lastly through a shallow tank of cold water for final cooling. The bottles are then automatically discharged and conveyed to a point where they are placed in which they are transferred to the storage room.

(e) Ultra high temperature (UHT) methods of sterilization: In these processes, the milk is heated to 135-150°C for a few seconds generally in a plate or tubular heat-exchanger. The milk which is then almost sterile has to be filled into containers for distribution, the filling has to be done aseptically. In many cases pre-sterilization as above is followed by in bottle sterilization.

1.2.3 Distribution

Once in a week. This is why, sterilized milk has great scope in warm countries as household refrigerators are not in common use.

1.2.4 Tests

(i) Tubirdity test. (This is official test).

(ii) Bacterial count.

1.2.5 Faults

The most common is browning. Because of this fault, plain sterilized milk is not so popular. Flavoured (and simultaneously coloured) sterilized milk is more popular.

1.3 Toned milk

1.3.1 Definition

Toned milk (also called single toned milk) refers to milk which is obtained by the addition of water and skim milk powder to whole milk. In practice, whole buffalo milk is admixed with reconstituted spray dried skim milk for its production. It should contain 3% fat and 8.5% SNF.

1.3.2 History

Tone milk is the brain child of D.N. Khurody (India) who is also credited with coining its name. It was first produced in 1946 in the Central Dairy of the Aarey Milk Colony and marketed in Bombay city. Soon in other cities, notably Calcutta Madras and Delhi started producing and marketing Toned Milk which has become a permanent feature ever marketing the market milk industry in India. In the words of Mr Khurody.
By merely adding water to whole buffalo milk, both the fat and Solids-not-Fat content are reduced. But by adding skim milk powder to the mixture, solid-not-fat is ‘toned up or increased the original level. As the product was neither whole milk nor standardized a new name Toned milk was given to it’.

1.3.3 Merits

(i) Increase the supply milk. The buffalo milk initially used is increased by 100-150 percent

(ii) Reduces the price of milk so as to reach lower income groups of the population.

1.3.4 Method of manufacture

(i) Flow diagram of manufacture

![Flow diagram](image)

(ii) Calculation

**Problem: Given**: 1,000 kg of whole buffalo milk testing 7.5% fat and 9.8% SNF testing 0.5% and 96.5% SNF Toned milk to contain 3.0% fat and 8.5% SNF.

**Solution**: Let the amount of water required be W kg and SMP be S kg.

Amount to Toned milk = (1000 + W + S) kg.

The following equations can be framed.
(1000 x 7.5 /1000) + ( S x 005/100)  
= (1000 + W + S ) x 3/100 .. (I) (Fat equation)  
(1000 x 9.8 / 1000) +  (S x 96.5 / 1000)  
= (1000 + W + S ) 8.5/100 ..(II) (SNF equation).  

Solving the above equation  
Water required is = 1382.1 kg  
SMP required is   = 141.5 kg  Answer).  

(iii) Details of manufacture : The calculated amount of potable water is received in the pasteurizing vat/tank equipped with an agitator. The water is heated while the agitator is kept in motion to 38-43°c. Then a proportionate amount of spray dried skim milk is slowly added at the point of agitation and the mixture is thoroughly agitated till it is dissolved completely. A calculated amount of whole buffalo milk is added and the mixture again is agitated thoroughly till a homogeneous mixture is obtained. The mixture is then pumped through a filter, pasteurized at 63° for 30 minutes, rapidly cooled to 5°c packaged and kept at 5°C or below until distribution.

1.4 Double toned milk  

1.4.1 Definition  
Same as Toned milk, except that under the PFA rules (1976) Double Toned milk should contain a minimum of 1.5 percent fat and 9.0 cent Solids -Not-Fat throughout India.  

1.4.2 History  
1.4.3 Merits  
1.4.4 Method of Manufacture \{ Same as for ‘Toned milk’ but to conform to ‘Double toned milk’ standars. \}  

1.5 Recombined milk  

1.5.1 Definition  
This refer to the product obtained when butter oil (also called dry/ anhydrous drous milk fat) skim milk powder and water are combined in the appropriate proportions to yield fluid milk. The milk fat may also be obtained from other sources, such as unsalted butter or plastic cream.  

Under the PFA rules (1976) recombined milk should contain a minimum of 3.0 percent fat and 8.5 percent Solids-Not-Fat throughout the country.
1.5.2 Merits

(i) Helps in making up the shortage of fresh milk supplies in developing countries.

(ii) Helps prevent price rise of liquid milk in cities.

1.5.3 Method of manufacture

(i) Flow diagram of manufacture

```
Receiving water in pasteurizing vat
↓
Pre heating (39-49°C)
↓
Addition of skim milk powder and mixing (38-43°C)
Addition of butter oil and mixing (42-49°C)
↓
Filtration
↓
Pasteurization (63°C/30 min)
↓
Homogenization (2500 psi/63°C)
↓
Cooling (5°C)
↓
Packaging and storage (5°C)
```

Flow diagram 1.4

(ii) Details of manufacture: A calculated amount of potable water is received in the pasteurizing vat/tank equipped with an agitator. The water is heated while the agitator is kept in motion, to a temperature of 38-43°C. A proportionate amount of spray dried skim is slowly added at the point of agitation. When the water reaches a temperature of 43-49°C, proportionate amount of butter oil is added. These constituents are thoroughly agitated till a homogenous mixture is obtained. The mixture is then pumped and later pasteurized at 63°C to 30 minutes. It is then homogenized at the pasteurization temperature at 2500 psi single stage to ensure emulsification of the milk fat. The product is quickly cooled to 5°C, package and stored at 5°C below until distribution.

1.6 Reconstituted / Rehydrated milk

1.6.1 Definition

This refers to milk prepared by dispersing whole milk powder (this also called dried whole milk) in water approximately in the proportion of 1 part
powder to 7-8 parts water. (Usually spray-dried powder is used, since it is more soluble and produces less sediment).

1.6.2 Merits

(i) Help in making up the shortage of fresh water supplies in developing countries

(ii) Used by Armed forces in other countries as it can be prepared instantly.

1.6.3 Method of manufacture

(i) Flow diagram of manufacture

Receiving water in pasteurizing vat

Pre heating to 38-43°C

Addition of whole milk powder and mixing

Filtration

Pasteurization (63°C/30 min)

Cooling (5°C)

Packaging and storage (5°C)

Flow diagram 1.5

(ii) Details of manufacture: The calculated amount of potable water is received in the pasteurizing vat/tank preheated to with an to 38-43°C. Then calculated amount of spray dried whole milk is slowly added at the point of agitation, and the mixture is thoroughly agitated till it dissolves completely. Special powder mixer equipment may be used for this purpose. The mixture is then pumped through a filter, pasteurized at 63°C for 30 minutes and promptly cooled to 5°C or below until distribution.

1.7 Standardized milk

1.7.1 Definition

This is milk whose fat and/or solids-not-fat content have been adjusted to a certain pre-determined level. The standardization can be done by partially skimming the fat in the milk a cream separator, or by admixture with fresh or reconstituted skim milk in proper proportions.
Under the PFA rules (1976) the standardized milk for liquid consumption should contain a minimum of 4.5 percent fat and 8.5 percent Solids-Not-Fat throughout the country.

**Note:** Standardized milk maybe marketed as such or used for making certain products. In the latter case, the fat and Solids-Not-Fat contents may be varied according to the product requirement.

### 1.7.2 Merits

(i) Ensures milk particularly with uniform and constant composition and nutritive value to the consumer

(ii) The surplus fat can be converted into butter and ghee

(iii) Possible to supply cheaper milk

(iv) More easily digestible (because of reduced fat content)

**Note:** The initial reaction of the consumer may be that standardized milk is ‘thinner’ than whole milk.

### 1.8 Vitaminized/Irradiated milk

(a) Vitaminized milk is milk, to which one or more vitamins are added. Irradiated milk is milk in which the vitamin D content has been increased by exposure to Ultra-Violet rays. (Mineralized milk is milk to which minerals have been added).

(b) It is well known that, lack of vitamin in the diet causes specific deficiency disease, which in turn can be cured by the intake of those particular vitamins. Addition of vitamin (and minerals) to milk is called fortification, and such milk is called fortified milk. The vitamins (and minerals) may be added singly or more commonly as multi-vitamin preparations.

(c) **Some common vitamin deficiency disease have been listed in Table**

<table>
<thead>
<tr>
<th>Name of Vitamin</th>
<th>Results of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Poor growth in young; lowered resistance to infections.</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>night blindness</td>
</tr>
<tr>
<td>Vitamin B₁ (Thiamin)</td>
<td>Rickets in children and Osteomalacia in adults</td>
</tr>
<tr>
<td>Vitamin B₂ (Riboflavin)</td>
<td>Beri-beri</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Sore mouth and tongue in children</td>
</tr>
<tr>
<td></td>
<td>Scurvy (swollen gums)</td>
</tr>
</tbody>
</table>

Table 1.2 A few vitamin deficiency diseases
(d) Commercial vitamin D milks can be prepared by any of the following methods.

(i) **Metabolized** : By feeding irradiated yeast to milk, where by the vitamin D content of milk can be increased.

(ii) **Irradiated** : By exposure of a thin rapidly flowing film of milk to an intensive source of ultra-violet radiation, such as a carbon arc lamp or a quartz mercury vapor lamp, the milk develops an increased vitamin D potency (as result of conversion of milk cholesterol to vitamin D) by rays of wavelength vitamin D concentrate.

### 1.9 Humanized Milk

When whole cow or buffalo milk is so modified in its chemical composition that it resembles human milk, it is called Humanized milk.

### Short Answer Type Questions

1. Define Flavoured Milk.
2. What are the advantages of Sterilized Milk?
3. What is Toned and Double toned Milk?
4. What is Reconstituted Milk?
5. Define "Humanised" Milk.

### Long Answer Type Questions

1. Briefly write about “Chocolate” flavoured Milk.
2. Explain the method of manufacturing process of sterilized milk.
3. Write the method of manufacture of “Recombined Milk”.
5. Explain the method of manufacture of toned milk.
structure

2.0 Introduction

2.1 Cream

2.2 Butter

2.3 Ghee

Learning Objectives

After studying this unit, student will be able to

• Understand about Fat rich milk products.

• Know about various types of cream.

• Know about composition, classification and uses of Butter.

• Learn about Ghee and preparation of Ghee from Cream.

2.0 Introduction

Cream has been known from time immemorial as the fatty layer that rises to the top of the milk when it stands undistributed for some time. The production of cream in India in 1966 was estimated to be about 1.9 percent of the total manufacture of dairy products, which is at present in increased to __%
2.1. Cream

Cream may be defined as

(i) That portion of milk which is rich in milk fat or

(ii) That portion of milk which contains a large portion of milk fat or.

(iii) When milk fat is concentrated into a fraction of the original milk that portion is known as cream.

According to the PFA rules (1976), cream, excluding sterilized cream is the product of cow or buffalo milk or combination thereof which contains not less than 25 percent milk fat.

2.1.1 Classification

Cream is not a definite specific substance. It contains all the milk constituents but in varying proportions. The milk fat in cream may vary from 18 to 85 percent, the solids-fat-fat constituents occur in lower proportions than in milk.

Cream may be classified broadly as (a) Market cream which is used for direct consumption, and (b) Manufacturing cream which is used for the manufacture of dairy products.

The various types of cream are

(i) Table
   (i) Light cream
   (iii) Coffee cream
   (iv) Whipping cream
   (v) Heavy cream
   (vi) Plastic cream

    " Containing 20-25 percent milk fat.

    " Containing 65-85 percent milk fat.

2.1.2 Methods

Cream is obtained from milk by either gravity or centrifugal methods.

1. Gravity methods: When milk is allowed to stand for some time, undisturbed there is a tendency for the fat to rise. The velocity, or rate at which the fat globules rises, is given by the following equation which is known as Stocke’s Law

\[ V = \frac{2G (d_s-d_f)r^2}{9n} \]
2.1.3 Factors influencing fat percentage of cream

The important factors influencing the fat percentage of cream by centrifugal separation are

(a) Position of the cream screw (or skim milk screw)
(b) Fat percentage in milk
(c) Speed of the bowl
(d) Rate of inflow of milk
(e) Temperature of milk
(f) Amount of water or skim milk added to flush the bowl.

(a) Position of the cream screw (or skim milk screw): (Cream screw IN and skim milk screw OUT, higher fat percentage cream and vice versa). The cream screw/outlet consist of a small, threaded, hollow screw pierced by a circular orifice through which the cream emerges. This screw can be driven IN or OUT thus bringing it nearer to, or away from the center of rotation similarly the skim milk screw/outlet is for removal of skim milk.

Once the cream screw under normal conditions, a definite ratio os skim milk and cream, which is usually 9:10 (or 85:15) by volume. Basically any change in the separation procedures which alters the relative quantities of skim milk.
milk and cream will influence the fat test of the cream. By altering the position of the cream screw (or skim milk screw) the ratio of skim milk to cream changes. Thus when the cream screw is moved IN towards the axis of rotation, a higher fat percentage in cream is obtained and vice versa this is because the force tending to discharge cream through the orifice is decreased (‘R’ in the formula $F = KWRN^2$ is decreased.) while that tending to discharge skim milk remains unaltered. A similar proportion of cream is therefore discharged, which, contains the same quantity of fat, shows a higher fat percentage. Screwing OUT the cream produces thinner cream. Similarly the skim milk screw OUT results in richer cream and vice versa.

(b) Fat percentage in milk: (The higher the fat percentage in milk, the higher the per cent fat in cream, and vice versa). Since practically all the fat in milk is contained in the cream, the cream from the separation of high-fat milk has a higher fat content than that from low-fat milk, a greater fat content in cream, the amount of which remains unaltered in two cases, will obviously show higher fat percentage in it, and vice versa.

(c) Speed of bowl: (The higher the speed of the bowl, the higher the fat percentage in cream and vice versa). The higher the speed of the bowl, the greater will be the centrifugal force, and the more rapidly will the skim milk leave the bowl. An increase in bowl speed, therefore increases the capacity of skim milk discharge. This means less cream is discharged and, consequently with the same fat content, a higher fat percentage in cream will be obtained.

(d) Rate of milk inflow: (The higher the rate of milk inflow the lower the fat percentage in cream, and vice-versa). When the rate of inflow increases, the discharge from the cream outlet increase, as the skim milk discharge remains constant (with constant centrifugal force) more cream containing the same amount of fat results in a lower test, and vice versa.

(e) Temperature of milk: (The lower the temperature of milk during separation, the higher the fat percentage of the cream, and vice versa). Lowering of temperature viscosity of both cream and skim milk, but that of cream increases (proportionately) more than skim milk. Hence of quantity of cream discharged is reduced (due to clogging of the bowl) thereby resulting in a higher fat test.

(f) Amount of water or skim milk added of flush the bowl: (The greater the quantity of water or skim milk added to flush the bowl, the lower that fat percentage in cream and vice versa). The addition or more water or skim milk will cause an increase in the amount of cream produced, which with the same fat content, will show of lower fat test.
2.2 Butter

Butter leads amongst the milk products manufactured in developed dairying countries of the world today. The world’s recorded annual butter production in 1969 (vide F.A.O Production Year Book 1970) has been estimated to have been 5,584 thousand tonnes, and India’s contribution in the same was 448 thousands tonnes, i.e. percent of the world’s total. The production of creamery butter in India in 1986 was estimated to have been about 6.3 percent of the total milk production and 11.3 percent of the milk used for the manufacture of dairy products.

Butter serves as the balance wheel of the dairy industry, surplus milk is converted into butter, while during times of scarcity, the milk intended for butter making is used for more essential products.

2.2.1 Definition

Butter may be defined as a fat concentrate which is obtained by churning cream, gathering the fat into the compact mass and then working it. According to the PFA Rules (1976), table (creamery) butter is the products obtained from cow or buffalo milk or a combination thereof, or from curd obtained from cow or buffalo milk or a combination thereof, with or without the addition of common salt and annatto or carotene as colouring matter. It should be free from other animal fats, wax and mineral oils, vegetable oils and fats.

Fig. 2.2 Butter slices

No preservative except common salt and no colouring matter except annatto or carotene may be added. It must contain not less than 80 percent by weight of milk fat, not more than 1.5 percent by weight of curd and not more than 3 percent by weight of common salt. Diacetyl may be added as flavouring
agent but, if so used, the total diacetyl content must not exceed 4 ppm. Calcium hydroxide, sodium bicarbonate, sodium carbonate, sodium poly phosphates may be added, but must not exceed the weight of butter whole by more than 0.2 percent.

2.2.2 Classification

Many kinds of butter are found in the market. These differ with the type of cream from which they are made and with variation in the manufacturing process. Unless specifically mentioned, the different kinds of butter may or may not have been salted. A brief description of several kinds of butter follows.

(a) Pasteurized cream butter: Made usually from pasteurizing sweet cream. Such butter usually has a milder flavour than the one made from similar cream not pasteurized.

(b) Ripened cream butter: Made from cream in which a pleasant delicate aroma has been developed before churning by ripening (i.e. inoculating the cream with a butter culture and holding it at a desired temperature). Properly made, ripened to as ‘real butter flavour delicate flavour which sometimes referred to as ‘real butter flavour’.

(c) Unripened cream butter: Made from unripened cream. The flavour of such butter is usually mild.

(d) Salted butter: Butter to which salt has been added.

(e) Unsalted butter: Contains no added salt.

(f) Sweet cream butter: In the case, the acidity of the churned flavour cream does not exceed 0.20 percent.

(g) Sour cream butter: Made from cream which has more than 0.20 percent acidity.

(h) Fresh butter: Such butter has not undergone cold storage (Usually fresh butter is not kept for more than 3 weeks).

(j) Cold storage butter: Here it has been stored at a temperature of about 18°C (0°F) for some time. (Generally cold storage butter is from one to six months old when offered for retail trade).

(k) Dairy butter (USA): Made on a farm. It is usually manufactured from unpasteurized sour cream which has not been standardized for acidity. This butter has a sour flavour due to high acid content of the cream.
2.2.3 Composition

According to the PFA rules (1976) table creamery butter should contain not less than 80 percent fat, and more than 1.5 percent curd and not more than 3.0 percent common salt. The typical composition of Indian butter has been given in table 2.1

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter fat</td>
<td>80.2</td>
</tr>
<tr>
<td>Moisture</td>
<td>16.3</td>
</tr>
<tr>
<td>Salt</td>
<td>2.5</td>
</tr>
<tr>
<td>Curd</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 2.1 Composition of Indian Butter

Note: The standards for composition of butter are prescribed either as 80 percent fat or 16 percent moisture.

2.2.4 Uses of Butter

(i) Direct consumption with bread

(ii) In the preparation of sauces

(iii) As a cooking medium

(iv) In the baking and confectionery industries

(v) In the manufacturing of ice cream, butter oil and ghee (India).

2.2.5 Desi Butter

Milk --> Curd --> added with cold water --> beaten by mattris --> added with wash water --> butter,

2.2.6 Creamery Butter

Milk --> Separator --> Cream --> Standardized --> Salted

Butter moisture test  Blending  Dry  Brine  Salting  Salting
2.2.7 Butter

Moisture test --> blending --> dry salting --> brine salting

--> Bulking --> Bulk storage --> Retail processing --> Patting and Extruding --> small packages.

2.2.8 Recombination process

Butter oil --> added with 16 percent reconstituted milk --> heated to 162.5°F --> homogenized (10.5kg/cm²) --> cooled to 3°C --> added with 2 percent salt --> mixed well --> cooled to 10°C --> chilled to 4°C --> extruded --> standardized --> bulk package --> storage --> retail package.

2.2.9 Types of Butter

1. Pasteurized cream butter- obtained from pasteurised sweet cream.

2. Ripened cream butter - obtained by churning ripened cream, i.e., inoculating the cream with a butter culture.

3. Unripened cream butter made from unripened cream

4. Salted butter - butter to which salt has been added.

5. Unsalted butter - butter containing no salt

Fig. 2.3 Various types of butter
6. Sweet cream butter - acidity of churned cream will be within the limit of 0.20 percent.

7. Dairy butter - made from unpasteurized sour cream

8. Creamery butter - Made in a creamery or dairy factory and uniform in quality.

9. Fresh butter - Made freshly and not kept in cold storage.

2.2.10 Uses of Butter

1. Direct consumption with bread
2. As cooking medium
3. In the baking and confectionery industries
4. In the manufacture of ice cream, butter oil and ghee.
5. In the preparation of sauce.

2.3 Ghee

2.3.1 Definition

Ghee may be defined as clarified butter fat prepared chiefly from cow or buffalo milk. According to the PFA rules (1976), ghee is the pure clarified fat derived solely from milk or from desi (cooking) butter or from cream.

2.3.2 Desi Method of ghee preparation

The preparation of makkhan is already been described. Both makkhan and ghee are essentially prepared on cottage industry scale following the procedures at household. A lot of makkhan, fresh or accumulated over a few days, is usually taken in suitable open mud-pot or metallic vessel, and heated and stirred on a low fire to drive out the moisture. When practically all the moisture has been removed, a stage judged by experience, further heating air and the vessel are removed from the fire. On cooling when the residue has settled down, the clear fat is decanted into suitable containers. (Alternatively, the makkhan is converted into Kacha ghee, which has a somewhat longer keeping quality than makkhan).

Ghee making : The Indigenous way

```
Fermentation       Churning       Clarification
Milk              Curd              Butter              Ghee
                  |                 |  \                  |
                  |                 |   \                |
                  |                 |     \              |
                  |                 |       \            |
                  |                 |         \         |
                  |                 |           \      |
                  |                 |             \    |
                  |                 |               \  |
Butter milk
```
2.3.3 Preparation of ghee from cream (Direct cream method)

In this direct-cream heating method, the cream usually obtained by normal separation of milk is heated in the same ghee boiler described for the creamery-butter method. The procedure for heating and moisture removal, final temperature of clarification, cooling and sedimentation, granulation and pack-aging also remain the same.

![Ghee](image)

**Fig. 2.4 Ghee**

2.3.3.1 Merits

Overall economy in labour compared to the creamery butter method, since one stage, viz. Cream to butter, is eliminated.

2.3.3.2 Demerits

i. Lower percentage of fat recovery in ghee due to greater fat loss in ghee residue the amount of which is higher in this method than by the butter methods;

ii. Slightly greasy texture in ghee

2.3.4 Pre-stratification

(a) **Introduction**: Clarification of butter into ghee by country or creamery methods has certain obvious demerits. In country methods, there is much greater possibility of obtaining a finished product characterized by an over-heated and smoky flavour. In the creamery methods, as also in the country method, the high acidity of the raw material (especially true of makkhan) at high clarifying temperatures, makes the products greasy and also reduces its shelf life. Research work has led to the evolution of a modified technique capable of yielding a higher grade product at lower cost of clarification.
(b) Principle: When butter is left undistributed at a temperature of 80-85°C for 15 to 30 minutes, it stratifies, i.e. separates into 3 distinct layers viz a top layer of floating denatured particles of curd, a middle layer of fat, and a bottom layer of buttermilk. This separation into layers is called pre-stratification. The bottom layer of buttermilk contains 60-70% of Solids-Not-Fat and also over 80% of the moisture originally present in the butter. The buttermilk is mechanically removed without disturbing the top and middle layer. Later the temperature of the remaining two upper layers (of denatured curd and fat) is raised to the usual clarifying temperature of 100-120°C.

2.3.5 Merits

(i) Economy in consumption as compared to direct clarification method

(ii) Production of ghree with lower acidity and longer shelf-life (acid get separated along with buttermilk).

2.3.6 Agmark grading

(a) Need for grading: The quality as well as purity of ghee can be judged only by detailed physical and chemical analysis. Contrary to general belief, it is not possible for an average customer to judge the purity of a sample of market ghee by its appearance, taste or smell, at the time of purchase. Under existing trade practices a limited effort to grade for marketing takes place at different stages of its assembly by thumb-rule methods. Grading, i.e., classification according to quality assures the customer of quality and purity of the ghee and its need, therefore is obvious.

(b) The Agmark ghee grading scheme: Literally Agmark is an insignia-AG for ‘Agriculture and Mark for marketing’ with a view to developing
the orderly marketing of agriculture produce on all-India basis, the Indian legislature and passed the agriculture produce (Grading and Marketing) Act, 1937. This Act which is permissive in nature. Provides for the grading of ghee on a voluntary basis.

The Agmark ghee grading scheme was initiated by the Agriculture Marketing Department as early as 1938. Under the scheme, recognized ghee dealers (individuals, groups of individuals cooperative organizations and similar bodies) can market ghee in standard containers bearing the seal of authority of Agmark and designating the quality of the product.

(c) objective: The Agmark (ghee) grading scheme was introduced mainly to achieve the following objectives.

(i) To assure the customer a produce of pre-tested quality and purity.
(ii) To enable manufactures of a high-grade product to obtain better returns and
(iii) To develop an orderly marketing of the commodities by eliminating mal practices when transferring them from the producer to the consumer.

Short Answer Type Questions

1. Define Cream.
2. What is Plastic Cream?
3. Define “Stokes Law”.
4. What is the composition of Indian Butter?
5. What is pasteurized cream butter?
6. Define “Ghee”.
7. What is AGMARK?
8. What are the Objectives of AGMARK?

Long Answer Type Questions

1. Explain the factors influencing fat percentage of cream.
2. Explain about the “Desi method” of Ghee preparation.
4. Explain the method of manufacturing of process of ‘Cream’.
Structure

3.1 Definition
3.2 Classification of ice creams
3.3 Figuring of ice cream
3.4 Method of manufacture of ice cream
3.5 Role of ingredients in ice cream
3.6 Overrun in ice cream

Learning Objectives

After studying this unit, student will be able to

- Understand about classification of Ice cream.
- Know about figuring and manufacturing of ice cream.
- Learn about role of ingredients and overrun in ice cream.

3.1 Definition

Ice cream is frozen dessert which is made by freezing a pasteurized mix with agitation which incorporates air and ensures uniformity of consistency. It contains, sweetening materials, water, stabilizer and other optional ingredients like eggs or egg products with the exception of air and flavouring material.
3.1.1 Composition

The composition of ice cream is usually expressed as percentage of its constituents, i.e. percentage of milk fat, milk Solids-Not-Fat, sugar, egg yolk solids stabilizers and total solids. The average composition of good ice cream is shown in Table 3.1

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Per cent values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
</tr>
<tr>
<td>Fat</td>
<td>8-20</td>
</tr>
<tr>
<td>Milk solids-not fat</td>
<td>8-15</td>
</tr>
<tr>
<td>Sugar (Sucrose)</td>
<td>13-20</td>
</tr>
<tr>
<td>Stabilizer / Emulsifier</td>
<td>0-0.7</td>
</tr>
<tr>
<td>Total solids</td>
<td>36-43</td>
</tr>
</tbody>
</table>

Table 3.1 Approximate composition of Ice-Cream

3.1.2 Legal and BIS Standards

As per the Prevention of Food Adulteration Act (1954), ‘ice cream is a frozen product obtained from cow or buffalo milk or a combination thereof with or without the addition of cane sugar, eggs, fruits, juices, preserved fruits, nuts, chocolate, edible flavours and permitted food colours. It may contain permitted stabilizers and emulsifiers not exceeding 0.5 percent by weight. The mixture must be suitably heated before freezing. The product should contain not less than 10.0 percent milk fat, 3.5 percent protein and 36 percent total solids. However, when any of the aforesaid preparation may be proportionately reduced, but may not be less than 8.0 percent by weight. Starch may be added to a maximum extent of 5 percent with a declaration to that effect on the label.

3.2 Classification of Ice Creams

It is made from a basic mix to which only one flavour, such as vanilla, maple, chocolate, or caramel has been added in plain ice cream (should contain a minimum of 10% fat, twenty percent total milk solids and minimum weight of 0.45 kg/litre and a minimum of 0.5% stabilizers), the total amounts of the colour and flavouring ingredients is less than five percent of volume of the unfrozen ice-cream.
(a) Bisque

Ice cream containing appropriate flavourings and particles of either grape nuts, macaroons, ginger snaps, sponge cake, or other bakery products.

(b) Chocolate

Ice cream flavoured with cocoa or chocolate.

(c) Fruit

Ice cream containing fruit, with or without additional fruit flavourings or colour. The fruit such as straw berry, apricot, pineapple, etc. It may be fresh, frozen canned or preserved.

(d) Nut

Ice cream containing nut meats such as almonds, pistachio, walnuts etc. With or without additional flavour or colour.

(e) Puddings

Ice cream containing a generous amount of mixed fruits, nut, meals, and raisin, with or without liquor, spices, or eggs.

(f) Frozen custard

Ice cream cooked to a custard before freezing. It contains a generous amount of eggs, with or without additional flavouring and colour.

(g) Mousse

Whipped cream plus sugar, colour and flavourings and frozen further flavourings and frozen without further agitation. Sometimes condensed milk is added to give a better consistency.

(h) Ice Milk

A product containing 2-7 percent fat and 12-15 percent SNF, sweetened flavoured and frozen like ice cream.

(i) Ices

Made with fruits, sugar and stabilizer with or without additional fruit, acid colour, flavouring or water and frozen to the consistency of ice-cream. Usually contains 28-30 percent sugar, 20-25 percent overrun and no dairy products.
Fig. 3.1 Bisque Icecream
Fig. 3.2 Chocolate Icecream
Fig. 3.3 Fruit Icecream
Fig. 3.4 Nut Icecream
Fig. 3.5 Fruit Salad
Fig. 3.6 Rainbow Icecream
(j) Sherbet

It is similar to ice except that it contains milk products like whole, skim, condensed or powdered milk or ice-cream mix in place of all or part of the water.

(k) Confectionery

Ice cream with appropriate flavourings plus particles of candy, such as peppermint stick, butter crunch, chocolate chip.

(l) Variegated ice cream

Plain vanilla ice-cream combined with a syrup such as chocolate, butter scotch etc., so as to produce a marbled effect in the hardened ice-cream.

(m) Fanciful ice-cream

The flavour of these products is usually due to mixture of several flavourings ingredients.

(n) Novelties

Any novelty ice cream is any specially shaped and is usually a low priced package, e.g. candy or chocolate coated ice-cream bars, with or without sticks, ice cream sandwich.

(o) Rainbow ice cream

A product made by carefully mixing six or more difficult coloured ice-creams as they are drawn from the freezers.

(p) Gelatin Cube Ice Cream

Ice cream in which coloured, fruits flavoured gelating cut into small cubes, is used in place of fruits to give a colour and a flavour and a characteristic chewiness.

(q) Frappe

An ice made form a mixture of fruit juices and frozen to a slushy consistency to be served as a drink.

(r) Souffle

A sherbet containing egg-yolk or whole eggs.

(s) Granite

Water ice cream with very little agitation.
(t) **Frozen Yoghurt**  
Made from Yoghurt, butter milk, or cultured sour milk with fruits and sugar and frozen like sherbet.

(u) **Fruit salad**  
Mixed fruits in large pieces in combination with a mixture of whipped cream and frozen to be served as salad.

(v) **Fancy Molded Ice-Cream**  
Includes ice creams, ice and sherbets molded in fancy shapes and composed either of one colour and flavour or ice cream or a combination of colour and flavours, or specially decorated. This group includes brick ice cream, sliced brick, cakes, cake roll, ice cream waffles and tarts, spumoni and aufait.

(w) **Soft or Softy Ice-cream**  
This is frozen product which is served directly to the consumer as its is drawn from the freezers at 7 to 8°c. The overrun is usually less (30-50 percent) than that for ice cream. The sugar content is two to three percent less than that of ice cream in India, it is commonly known as ‘softy’

### 3.3 Figuring the mix

A knowledge of calculation of ice cream mix helps in properly balancing a mix, in establishing and maintaining uniform quality and in producing ice cream that conforms to legal standards. Ice creams mix may be divide into two groups, namely simple and complex. Simple mixes requires the least calculation and are made of ingredients each of which supplies one constituent. Complex mixes are more difficult to calculate. They includes mixes where at least one constituent is obtained from two or more products. (Complex mixes requires the use of the Pearson’s Square, the Serum point of Algebra method). Before a mix can be calculated it is necessary to

(i) Decide upon the composition of the mix to be made

(ii) Decide on the amount of mix to be made in batch at one time. (What ever the amount, it may be calculated on the basis of 100 kg, if so desired).

(iii) Choose from the available ingredients those that will give the desired quality characteristics and composition at the lowest cost.

(iv) Be familiar with the composition (i.e. the analysis) of ingredients to be used.
Since ice cream contains a higher percentage of fat than fluid milk, one of the mix ingredients must be high in fat. Cream plastic cream, or butter is usually used for this purpose. Ice cream also contains more Solids-Not-Fat than milk, and scores high in these solids such as condensed skim milk, condensed whole milk or (preferably skim) milk powder is needed. Fluid milk is usually used as the basic ingredient in ice cream mix. Calculation of the mix involves finding the required weights of these ingredients along with the necessary sugar and stabilizers.

The calculations are simplified by first finding the weights of the ingredients needed to make 100 kg, of the desired mix. With the algebraic method, symbols such as X, Y, Z are used to represent the weights of dairy ingredients for a 100 kg, batch of mix. These symbols are then used in writing the three equations that express the weights of fat, serum solids (solids-not-fat) and the total weight of dairy ingredients for 100 kg of mix. The method is applicable to all types of mix problems. A typical and its solution is follows.

Problems: Prepare an ice cream mix containing fat 10 percent, Serum solids, 11 percent sugar 14.5 percent and stabilizers 0.3 percent. Given whole milk testing 6.8 percent fat and 9.6 percent serum solids, cream testing 40 percent fat and 5.4 percent serum solids, skim milk powder testing 0.85 percent fat and 97 percent serum solids sugars and stabilizers (cen per cent by matter).

Whole milk required = X kg.
Cream required = Y kg.
and skim milk powder required = Z kg.

Hence
\[ X \times \left(\frac{6.8}{100}\right) + Y \times \left(\frac{40}{100}\right) + Z \times \left(\frac{0.5}{100}\right) = 10 \] (Fat equation)
\[ Y \times \left(\frac{9.6}{100}\right) + Y \times \left(\frac{54}{100}\right) + Z \times \left(\frac{97.0}{100}\right) = 11 \] (S.S. Equation)
\[ X + Y + Z + 14.5 + 0.3 = 100 \] (Weight equation)

Solving the above.

\[ X = 67.9 \]
\[ Y = 13.4 \]
\[ Z = 3.9 \]
3.4 Method of manufacture of Ice cream

The basic steps involved in the manufacture of ice-cream are depicted in Flow diagram 3.1.

Selection of ingredients
-
Calculation of mix / Figuring of mix
-
Preparation of mix
-
Pasteurization of mix 68° C / 30 min
-
Homogenization of mix
-
Cooling and ageing of mix
-
Freezing of mix
-
Packaging of ice cream
-
Hardening and storage of ice cream

Flow diagram 3.1 For preparation of Ice-Cream

3.5 Role of Ingredients in ice cream

The basic ingredients are milk fat, MSNF, sweetener solids (sugar), stabilizers, emulsifiers, flavouring, colour and water.

3.5.1 Milk Fat

1. Milk fat is an ingredient of major importance in ice-cream
2. The fat improves body
3. Smoothens the texture
4. Constitutes a characteristic richness and mellowness to ice-cream
5. It is good carrier and synergist for added flavour compounds.
6. It promotes desirable texture qualities
7. It has a high caloric value
8. An excellent commercial product can be made with 12 percent butter fat content.
3.5.2 Milk Solids Not Fat (MSNF)

1. MSNF have a water-binding capacity which is of great importance as ice-cream contains 60 percent water.
2. It enhances palatability
3. It increase food value and is also economical
4. It increase viscosity and resistance to melting
5. Improve body and texture
6. Results in higher overrun.

3.5.3 Sugar

1. Sweetener for ice cream may be cane sugar (sucrose)
2. Sugar may be used in dry or liquid form
3. Sugar increases the acceptance of the product
4. Makes the product sweeter
5. Enhances the pleasing creamy flavour and desired delicate fruit flavour
6. Sugar in the range of 14 to 16 percent is most desirable
7. Cheapest source of total solids in the mix.

3.5.4 Stabilizers

1. Used to prevent the formation of objectionable large ice crystals in ice cream.
2. Have a high water-building capacity.
3. Effective in improving the texture and giving body to the finished product.
4. Increases viscosity
5. Prevent coarsening of texture under temperature fluctuations in retail cabinet.
6. Gives uniformity of product
7. Improves handling properties.

3.5.5 Emulsifiers

1. Improve uniform whipping quality of the mix
2. Helps to produce drier ice cream with smoother body and texture

3. Produce uniform distribution of air cells in the internal structure of ice cream.

3.5.6 Flavour or Colour

1. Flavour is the most important characteristic of ice cream

2. Have influence on delicacy and palatability.

3. Flavour increases the acceptability

4. Colour makes the product attractive and increases its aesthetic appeal.

3.5.7 Outline of making commercial ice cream

Add less viscous fluids to more viscous --> add sugar and gelatin --> mix the ingredients thoroughly --> pasteurize by heating to 68°C for 30 min --> homogenies the mix (2 stage) --> immediately cool to 4°C --> allow to age (4 to 24 hours) --> frozen (either in batch or continuous freezers) --> packing --> hardening and storage (-20 to -30°C).

3.5.8 Home Made Ice Cream

The common ingredients used for home made ice-cream are milk, sugar, custard powder or corn flour, or ice-cream powder, and desirable flavouring material.

The ingredients are well mixed and heated to boil and then cooled. The cooled mix is poured in the container of a hand-operated freezer. The freezing is done by putting a freezing mixture consisting of salt and chipped ice in proportion of 1 : 4, around the container. The handle of the freezer is rotated at speed of 100 to 150 revolutions per minute. The temperature of the salt solution is about 210°F. The handle should be rotated continuously until the cream is frozen, the ice cream is then allowed to harden in the freezer.

3.5.9 Flow Diagram of ice-cream preparation

```
Selection of ingredients
↓
Calculation for the ingredients of mixes
↓
Preparation of the mix
↓
Pasteurization of the mix (68°C for 30 min or 155°F for 30 minute in batch method or 80°C / 175°F for not less than 25 sec= HTST method)
```
Homogenizing the mixing (63-77°C, 1st stage 2500 psi, 2nd stage 500 psi)

Cooling the mix (0-5°C/32-40°F)

Aging the mix (5°C/40°F for 3-4 hour)

Freezing the mix (-4 to -3°C/24-26°F for 7 minutes in batch freezer or -6 to -5°C/21-22°F for 24 sec in continuous freezer)

Packaging of ice cream

Hardening and storage of ice cream (-23 to -29°C/-10 to -12°F)

3.6 Over Run in Ice Cream

Overrun is usually the volume of ice cream obtained in excess of the volume of mix. It usually expressed as ‘percent overrun’. The increased volume is composed mainly of air incorporated mainly for air incorporated during the freezing process. The amount of air which should be in cooperated depends upon the composition of the mix and the way it is processed and is regulated so as to give that prevent overrun which will give proper body, texture and palatability to the ice cream. Too much air will produce a snowy fluffy ice cream while too less air on the other hand will lead to soggy, heavy ice cream.

(i) How to obtain and control overrun

The following factors need to be considered in determining the amount of overrun in ice cream.

• Legal regulations forced in the market area.
• Total solids content of the ice cream mix
• Type of ice cream to be made (fruit/ nut/ ice cream etc.)
• Selling price of ice cream
• Type of packages.

(ii) The overrun attainable at the freezer depends upon the following points

• Type of ingredients used in the mix
• Sharpness of scrapper blades
• Speed of dasher
• Volume of refrigerant passing over freezing chamber
• Temperature of refrigerant.

The use of proper overrun tester will ensure uniform overrun. The control of overrun is very important and should be maintained as nearly constant as possible from batch to batch.

(iii) The percent overrun

The percent overrun in different types of ice cream given in table 3.1

<table>
<thead>
<tr>
<th>Type of Ice Cream</th>
<th>Percent overrun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream package</td>
<td>70-90</td>
</tr>
<tr>
<td>Ice cream bulk</td>
<td>90-100</td>
</tr>
<tr>
<td>Soft-serve ice cream</td>
<td>30-50</td>
</tr>
</tbody>
</table>

*Table 3.1 Percent overrun*

(iv) Failure to obtain the desired overrun

Due to the following factors one fails to obtain overrun in ice cream

• Longer time to obtain overrun
• Too high drawing temperature
• Very soft ice cream
• Tendency to form ice cream with coarse texture because of large ice crystal formation.

(v) Method of calculating percent overrun

The following are two methods, by which the present overrun can be calculated.

1. By Volume

\[
\% \text{ Overrun} = \frac{\text{Volume of ice cream} - \text{Volume of mix}}{\text{Volume of mix}} \times 100
\]

**Example:**

10 litres of ice cream mix are frozen to make 19 litres ice cream. What is the overrun in the ice cream.
Volume of ice cream mix = 10 litres
Volume of ice cream = 19 litres

\[
\% \text{ Overrun} = \frac{\text{Volume of ice-cream} - \text{Volume of mix}}{\text{Volume of mix}} \times 100 = \frac{19-10}{10} \times 100 = 90\%
\]

2. By Weight

Weight of unit

\[
\frac{\text{Volume of mix} - \text{Volume of ice cream}}{\text{Weight of unit volume of ice cream}} \times 100
\]

Example:

Weight of 100 ml ice cream mix = 110 gm
Weight of 100 ml of frozen ice cream = 55 gm

Wt. of unit of mix - Wt. of same unit of ice cream?

Wt. of unit volume of mix - Wt. of same unit volume of ice cream

Therefore, \[
\% \text{ Overrun} = \frac{\text{Wt. of unit volume of mix} - \text{Wt. of same unit volume of ice cream}}{\text{Wt. of same unit of ice cream}} \times 100 = 90\%
\]

Short Answer Type Questions

1. Define Ice cream.
2. What is overrun in ice cream?
3. What is softy ice cream?
4. What is composition of Ice Cream?

Long Answer Type Questions

1. Mention the method of manufacture of Ice-cream.
2. Explain the role of ingredients in Ice cream.
3. Explain in detail about the classification of Ice cream.
UNIT 4

Fermented Milk Products

Structure

4.1 Starter Cultures - Importance of types
4.2 Classification of fermented milks
4.3 Dahi - Srikhand
4.4 Yoghurt
4.5 Classification of cheese varieties
4.6 Cheddar cheese
4.7 Cottage cheese
4.8 Processed cheese

Learning Objectives

After studying this unit, student will be able to

• Understand about classification of fermented milks.
• Know about Dahi, Srikhand and Yoghurt.
• Know about classification of cheese varieties.
• Learn about Cheddar, Cottage and Processed cheese and their importance.
4.1 Starter Cultures - Importance of types

Dairy cultures or starters are harmless, active bacteria grown in milk which are to give clean and whole some souring and to impact certain characteristics and predictable qualities to the various milk products. Skim milk has been generally found to be best propagating medium.

Fermented products like dahi, yoghurt, shrikhand, cultured butter milk, kefir, kumiss, sour cream and varieties of cheese are prepared almost invariably by employing the starter culture. (Jaman or Khatta). The main function of the starter culture is to initiate fermentative activity in the preparation of cheese and fermented products. Therefore, the term tarter as applied to the dairy industry refers to the judiciously selected microorganisms, generally lactic acid bacteria, which are added to milk initiate and carry out the necessary fermentative changes in the production of cheese and fermented milk products.

4.1.1 Micro-organisms

Lactic acid streptococci are considered to be synonymous with starter cultures, but this is too restrictive a view. There are several distinct types of starters for milk fermentation which have marked morphology and utility differences. A number of them do not belong to the lactic acid streptococcus groups. This fact is illustrated in Table 4.1.

Starter commonly belong to the genus streptococcus. They may or may not contain associative organisms of the genus luconostoc. The starter species most commonly used in the industry are S.Lactic, S.Cremoris, S.Diacety lac tic.

<table>
<thead>
<tr>
<th>S.no</th>
<th>Cultures</th>
<th>Major known functions</th>
<th>Product use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>S.Lactic and S.Cremoris</td>
<td>Acid</td>
<td>Cultured butter - milk, dahi, sour cream, cottage cheese and other types of cheese.</td>
</tr>
<tr>
<td>2.</td>
<td>S.thermophilus</td>
<td>Acid</td>
<td>Yoghurt, Emmental, Cheddar and Italian cheese.</td>
</tr>
<tr>
<td>3.</td>
<td>Luconostoc species</td>
<td>Flavour</td>
<td>Dahi, cultured butter - milk, sour cream cottage cheese, ripened cream butter.</td>
</tr>
<tr>
<td>4.</td>
<td>S. diacety lactic</td>
<td>Acid and flavour</td>
<td>Dahi, cultured butter milk, sour cream, cheese, ripened cream butter.</td>
</tr>
</tbody>
</table>
Table 4.1 Various types of cultures

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>S. durans</td>
<td>Acid and flavour</td>
<td>Soft Italian cheese</td>
</tr>
<tr>
<td>6</td>
<td>S. faecalis &amp; S. faecalis</td>
<td>Acid and flavour</td>
<td>Cheddar and some Swiss cheese</td>
</tr>
<tr>
<td>7</td>
<td>L. bulgaricus</td>
<td>Acid and flavour</td>
<td>Yoghurt, Kefir, Kumiss</td>
</tr>
<tr>
<td>8</td>
<td>L. helveticus</td>
<td>Acid and flavour</td>
<td>Swiss, Emmental Italian cheese</td>
</tr>
<tr>
<td>9</td>
<td>L. acidophilus</td>
<td>Acid</td>
<td>Acidophilus milk</td>
</tr>
<tr>
<td>10</td>
<td>Propioni bacterium shermanii</td>
<td>Flavour and eyes formation</td>
<td>Emmental and Swiss cheese</td>
</tr>
</tbody>
</table>

L. citrovorm, and L. dextranicum. A starter may be comprised of a single lactic strain or a mixture of lactic streptococci with or without Luconostoc spp. Currently, a high percentage of cheese, better milk and sour cream is being made from multiple types of mixed strain culture. A multiple culture should be composed of strains which are mutually compatible with each other, and such blends should contain strains which can be maintained in the proper ratio of lactic to flavour producers.

The lactic acid bacteria are generally divided into two different groups, homofermentative and heterofermentative. The former group represented by the lactic acid bacteria of milk such as S. lactis and L. bulgaricus produces only lactic acid during the fermentation of sugars. The heterofermentative lactic acid bacteria, on the other hand, form an appreciable amount of CO₂, ethyl alcohol, acetic acid and glycerol together with large quantities of lactic acid, such as S. diacetylactis.

4.1.2 Types of Starters

In general, three different types of starter cultures are used in dairy industry for the manufacture of a variety of fermented products.

i. Single Strain Starters: A single strain starter is a pure culture of lactic acid bacteria such as Lactococcus lactis subsp. Lactic or L. lactis subsp. Cermoris, etc. This type of culture, if found satisfactory in vigor and flavour, it can give a steady acid production, and thereby, a predictable quality of fermented milk product. However, there is a serious disadvantage with this type of starter as during its application, if it gets attacked by a phage or fails due to any other reason, the quality of the resultant product can be adversely affected.
ii. Mixed Strain Starters: These consist of two or more strains or species and this, may be more variable in behavior. The mixed strain starters are generally combinations of L.lactis subsp.lactis and L.latis subsp. Cermoris and the gas and aroma producing mesophillic lactic acid bacteria (L.lactis subsp. Diacetilactic and Leuconostoc spp.). Mixed starters are considered safe because if one strain is attacked by a phage, the others usually continue to work because of high phage specificity. A wider tolerance to other factors like temperature and pH, changes, etc, may be an additional advantage.

iii. Multiple Strain Starters: Multiple strain starters are mixture of known compatible, non-phage related, carefully selected strains which give generally consistent products when used commercially for production of fermented milk products. Although, their overall phage relationships may be known, the number of individual phage relationships among the strains in these cultures to relatively unknown. A multiple strain starter culture consists of known number of single strains so that the starter can be used for an extended period of time.

**Thermophilic lactic acid bacteria (LAB)**

Thermophilic LAB (37-45°C) are also used in dairy industry for the manufacture of some formented products like yoghurt, acidophilus milk and high temperature scalded cheese such as Swiss cheese. The examples of thermophillic LAB are S. thermophilus and the Lactobacillus species. These starters produce lactic acid at faster rate at high temperature and the rate of acid production is further enhanced if symbiotic relationships exist between different species. The such typical example is of yoghurt culture namely, S.thermophilus and L.delbrueckii bulgaricus. Similarly, the combined activity of mesophillic and thermophillic LAB and yeasts leads to lactic acid/alcohol fermentation milk during the manufacture of Kefir and Kumiss.

4.2 Classification of fermented milks

A variety of traditional as well as modern fermented milks are now in vogue in different parts of the world (Table 4.2). Originally, these were prepared from sheep and buffalo milk and to a lesser extent from that of goat, cow and mare milk and the fermentations were carried out in cloth or skin bags or wooden or earthen pots.
<table>
<thead>
<tr>
<th>Name</th>
<th>Country of origin</th>
<th>Milk types conditions</th>
<th>Micrrollora</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dahi</td>
<td>India, persia</td>
<td>Cow’s or buffalo’s milk</td>
<td>L. lactis subs. lactis, S. salivarius subsp. Thermophilus, L. delbrueckii subsp. Bulgaricus, lactose fermenting yeasts, mixed culture (not defined).</td>
</tr>
<tr>
<td>Srikhand (chakka)</td>
<td>India</td>
<td>Cow’s or buffalo’s milk</td>
<td>S. salivarius subsp. Thermophilus, L. delbrueckii subsp. Bulgaricus.</td>
</tr>
<tr>
<td>Lassi</td>
<td>India</td>
<td>Cow’s or buffalo’s milk</td>
<td>S. salivarius subsp. Thermophilus, L. delbrueckii subsp. bulgaricus.</td>
</tr>
<tr>
<td>Cultured butter milk</td>
<td>Scandinavia and European</td>
<td>Cow’s or buffalo’s milk</td>
<td>L. lactis subsp. lactis, L. lactic subsp. diacetilactis, leuconos toc dextranicum subsp. citrovorum.</td>
</tr>
<tr>
<td>Acidophilus milk</td>
<td>Australia</td>
<td>Cow’s milk</td>
<td>L. acidophilus</td>
</tr>
<tr>
<td>Yoghurt (bio-yoghurt)</td>
<td>Middle Asia, Balkans</td>
<td>Cow’s milk, goat’s or mixed milk</td>
<td>S. salivarius subsp. Thermophilus, L. delbrueckii subsp. bulgaricus, micrococccus and other lactic acid cocci, yeasts, molds.</td>
</tr>
<tr>
<td>Kefir</td>
<td>Caucasus</td>
<td>Sheep’s, cow’s, goat mixed milk, fermentation in skin bag or in wooden barrels.</td>
<td>L. lactis subsp. lactis, leuconostoc spp. L. delbrueckii subsp. causiucucu, saccharomyces kefir, t orula kefir, micrococi, spore forming bacilli.</td>
</tr>
</tbody>
</table>
Fig. 4.1 Dahi

Fig. 4.2 Srikhand

Fig. 4.3 Lassi

Fig. 4.4 Yogurt

Fig. 4.5 Kefir

Fig. 4.6 Leban
Table 4.3 Types of fermented milks

<table>
<thead>
<tr>
<th>Type</th>
<th>Region</th>
<th>Description</th>
<th>Microorganisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumiss</td>
<td>Asiatic steppes</td>
<td>Mare’s camel’s or asse’s milk fermentation in skin bag.</td>
<td>L. delbrueckii subsp. bulgaricus, L. acidophilus, torula kumiss, sac charomyces lactis, micrococi, spore forming bacilli lactis, micrococi, spore forming bacilli.</td>
</tr>
<tr>
<td>Leban, Labneh</td>
<td>Lebanon and Arab</td>
<td>Goat’s or sheep’s milk, fermentation in skin bag/earthenware.</td>
<td>L. lactis subsp. lactis, S. salivarius subsp. thermophilus, L. delbrueckii subsp. bulgaricus, lactose fermenting yeasts.</td>
</tr>
</tbody>
</table>

4.3 Dahi - Srikhand

Indian curd known as Dahi, is well known fermented milk product consumed by large sections of the populations throughout the country, either as part of the daily diet to as refreshing beverage. In 1966, The production of dahi was estimated to be about 7.8 percent of the total milk production in India and 14.0 percent of the milk used for the manufacture of dairy products.

Since conversion of milk into dahi is an important intermediary step in the manufacture of indigenous butter and ghee, it can be said that over 40 percent of the total milk production in India to day is converted into dahi.

An extensive all-India survey project on dahi was carried out nearly three decades ago (32-34). It revealed that there are broadly speaking two types of dahi prevalent in the country for direct consumption, viz a sweet/mildy sour variety with a pleasant flavour, and sour variety with a sharp, acid flavour. The microorganism responsible for these two types were also identified, and are maintained in selected centres as freeze-dried cultures for sale to the industry and public alike.

4.3.1 Definition

According to the PFA rules (1976), dahi or curd is the product obtained from pasteurized or boiled milk by souring, natural or otherwise, by harmless lactic or other bacterial culture. Dahi may contain additional cane sugar. It should have the same percentage of fat and solids-not-fat as the milk from which it is prepared of fat and solids-not-fat as the milk from dahi, it is prepared.
dahi of curd other than skimmed milk dahi is sold or offered for sale without any indication of the class of milk, the standards prescribed for dahi prepared from buffalo milk shall apply.

The Indian standard specifications for designation of fermented milk products based on the types of culture used are given in Table 4.3.1 and requirements.

**Table 4.3.1 Designation of fermented milk products**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Culture used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet dahi</td>
<td>Str. lactis&lt;br&gt;Str. diacetilactis&lt;br&gt;Str. cremoris</td>
</tr>
<tr>
<td></td>
<td>Single or in combination with or with out Leuconostoc species.</td>
</tr>
<tr>
<td>Sour dahi</td>
<td>Same as above, along with lact. bulgaricus or Str. thermophilus or both</td>
</tr>
</tbody>
</table>

**Table 4.3.1 Requirements for fermented milk products**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity, lactis (% wt) (max)</td>
<td>Sweet dahi</td>
</tr>
<tr>
<td>Yeast and mould count per g. (max)</td>
<td>100</td>
</tr>
<tr>
<td>Coliform count per g. (max)</td>
<td>10</td>
</tr>
<tr>
<td>Phosphatase test</td>
<td>-ve</td>
</tr>
</tbody>
</table>

**4.3.2 Classification**

Broadly speaking, dahi may be classified in two types

(a) Sweet dahi

(b) Sour dahi
4.3.3 Food and nutritive value

It has been established that, fermented milk products including dahi increase food and nutritive value as compared to the original milk. The following points are cited in their favour.

(i) Dahi is more palatable and those who usually do not like drinking milk would consume it readily.

(ii) Dahi is more easily digested and assimilated than milk.

(iii) Dahi seems to exert a possible therapeutic value in the stomach and during intestinal disorders, due possibly to its content of antibiotics.

4.3.4 Composition

An average composition of (whole) milk dahi is given in Table (4.3.4).

Table 4.3.4 Composition of (whole) milk dahi (percentage)

<table>
<thead>
<tr>
<th>Water</th>
<th>Fat</th>
<th>Protein</th>
<th>Lactose</th>
<th>Ash</th>
<th>Lactic Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-88</td>
<td>5-8</td>
<td>3.2-3.4</td>
<td>4.6-5.2</td>
<td>0.70-0.72</td>
<td>0.5-0.11</td>
</tr>
</tbody>
</table>

4.3.5 Srikand

Srikhand which is a popular dairy product in Maharastra, is a semi-soft, sweetish-sour, whole milk powder prepared from lactic fermented curd. The curd (dahi) is a partially strained through a cloth (the basic ingredient for srikhand). This chakka is mixed with the required amount of sugar etc., to yield srikhand. The srikhand is further desiccated over an open pan to make the srikhand wadi sweet. (All three product are quite popular in the western region of the country).

4.3.6 Composition

The composition of chakka will depend on the initial composition of milk and the degree of fermentation (i.e. acidity developed) and the extent of whey removed. These three factors together with the amount of sugar added, influence the composition of srikhand. The composition of srikhand wadi depends upon the extent to which srikhand is desiccated. The average composition of chakka (laboratory - made samples from buffalo milk) srikhand and wadi are given in table 4.3.6 (54-56)
Table 4.3.6 Composition of chakka and srikhand wadi * (percentage)

<table>
<thead>
<tr>
<th>Product</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture</td>
</tr>
<tr>
<td>Chakka</td>
<td>63.2</td>
</tr>
<tr>
<td>-do-</td>
<td>59.6</td>
</tr>
<tr>
<td>Srikhand wadi</td>
<td>6.5</td>
</tr>
</tbody>
</table>

- Laboratory - made samples from buffalo milk

4.3.7 Method of preparation

The standardized method of preparation may be described as follows. Fresh, sweet, buffalo milk boiled for then cooled to 28-30°C. It is then inoculated @ 1 percent with lactic culture (Str.lactis) which is mixed well and incubated at 28-30°C for 15-16 hours (overnight). When the curd has set firmly (acidity 0.7-0.8 percent lactic), it is broken and placed in a muslin cloth bag and hung on a peg for the removal of whey for 8-10 hours. During this period, the position of the curd may be altered, or the curd gently squeezed, to facilitate whey drainage. The settled mass thus obtained is called Chakka, which is the srikhand base. This chakka is then admixed with sugar (crystal or ground) and well kneaded for uniform mixing. Colour and flavour may also be added. The product now obtained is known as srikhand. When the srikhand is further desiccated to hard mass by heating on an open pan over a direct fire, srikhand wadi is obtained (84) (58).

4.3.8 Uses

(i) Chakka is used for preparation of srikhand

(ii) Srikhand is used either for direct consumption of for the preparation of the srikhand wadi sweet

(iii) Srikhand wadi is used for direct consumption.
4.4 Yogurt

Yogurt is a product similar to dahi and is gaining popularity in India. It is made from milk containing three percent fat and ten percent SNF. Skim milk powder is used to increase the SNF content of milk. Milk is homogenized and then pasteurized. For sweet yogurt, sugar at a rate of eight percent is added to the milk prior to homogenization and pasteurization. The milk is cooled at 42°C inoculated with a starter culture comprising of S. Thermophilus and L. Bulgaricus and allowed at set to 42°C for three to four hours. Fruits, nuts, etc. can also be added to yogurt, if desired. Yogurt prepared from buffalo milk using tapioca as a stabilizer possesses a better flavor, texture and acidity in comparison to the product made by using other stabilizers like gum acacia. Supplementation of yogurt culture with Bifidobacterium bifidum and Lactobacillus streptococci thermo phillus, acidophilus, singly or in combination improves the nutritive and therapeutic values of yogurt.

4.4.1 Composition

The average composition of yogurt is shown in Table 4.4.1

<table>
<thead>
<tr>
<th>Total Solids</th>
<th>13.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>3.9</td>
</tr>
<tr>
<td>Fat</td>
<td>3.4</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>4.9</td>
</tr>
<tr>
<td>Ash</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Table 4.1.4 Average composition of Yogurt (percent)

4.4.2 Manufacture of Yogurt

Yogurt is a product made from milk standardized to three percent fat and ten percent SNF. The milk is then pre-heated at 65°C and is homogenized using 2500 psi pressure at the first stage milk is then at the second stage. The milk is heated at 90°C for ten minutes and cooled to the incubation temperature of 42-43°C. The milk is then inoculated at three percent level of S. Thermophilus and L. Bulgaricus in equal proportion (1:1). The contents are mixed thoroughly and then filled in glass bottles, covered with lids or aluminum foil caps, and incubated at 42°C. After incubation for three to three and half hours when the coagulum is formed, the product is chilled and stored at about 5°C till consumption.

There are several types of yogurt which includes set, stirred, condensed, concentrated, soft, hard, frozen or dried. The set yogurt is packed immediately
after inoculation with a bulk starter and is incubated in the packages. The stirred yoghurt is inoculated and incubated in a tank. After incubation the product is chilled before packaging. In the fruit yoghurt, the proportion of fruit added is usually about 15 percent. A generalized scheme for the manufacture of yoghurt is given in Flow 4.1.

Flow diagram 4.1 A general scheme for manufacture of yoghurt

4.4.3 Shelf-Life of Yoghurt

The storage life of yoghurt refers to maintaining its characteristics unaltered for a sufficient period of time, until the product consumed. There are various factors which influence the keeping quality of yoghurt, like temperature of storage, atmospheric oxygen and low contributing humidity of air. Other factors contributing to the shelf-life of yoghurt are packaging materials types of manufacturing process and treatment of yoghurt after incubation. Plain and sweetened yoghurt packed both in plastic cups stored at 5°C to 10°C have a
shelf life of 13 and 15 days respectively. The shelf-life of yoghurt can be extended to 16 days by adding 0.03 percent sorbic acid.

4.5 Classification of Cheese varieties

The present word ‘Cheese’ is derived through the Old English words ‘cese’ and ‘chiese’ from the Latin ‘caseus’. The equivalent words in is German ‘Kase’ in French ‘Fromage’, in Spanish ‘Queso’ and in Italian ‘Fromaggio’. The great range of cheese varieties due to size, shape packing or coating as well as place of manufactures types of milk, etc, makes classification of cheese extremely complicated. It is reported that there are probably about 20 distinct classes/types/varieties of cheese in the world today, although they are given over 2,000 different names. Cheese can be classified according to the following factors.

(i) Geographical consideration: Country valley, town, city, region or institution where it is first produced and marketed.

(ii) Types of milk: Cow, Buffalo, Goat, Sheep etc.

(iii) Method of Manufacture: Temperature of cooking, level of acidity development, size of cutting, duration of cooking, time and pressure employed for pressing curd, etc. These affect moisture retention in cheese, which in turn affects the compositional quality of cheese, body and texture and also rate of ripening.

(iv) Organoleptic quality: Flavour, body, texture, colour, appearance etc.

(v) Physical and rheological properties: Very hard, hard, semi-hard, and soft hardness, cohesiveness, gumminess, springiness and chewiness.

(vi) Chemical analysis: Moisture, fat, protein, casein, lactose, ash, acidity, soluble protein, non-protein nitrogen (NPN), non-casein nitrogen (NCN) free fatty acids (FFA), total volatile fatty acids (TVFA) etc.

(vii) Microbiological properties: Bacteria ripened, mould ripened, fresh or unripened.

There are about 2,000 names of cheese. It is very difficult to classify the different types of cheese. There are probably only about 18 distinct types or kinds of natural cheese. These are: Brick, Camembert, Cheddar, Cottage, Cream, Edam, Gouda, Herve, Limburger, Neufchatel, Parmesan, Provolone, Romano, Roquefort, Sapsago, Swiss, Trappist and whey cheeses.
Such a grouping though manufacture is imperfect and incomplete. The cheese can also classified on the basis of their rheology (the science of deformation) and

**Ripened by bacteria, with eyes**: Swiss.

Semi Soft Moisture > 40-47%

(a) **Ripened principally by bacteria**: Brick

(b) **Ripened by bacteria and surface micro organism**: Limburger

Proteolysis with very strong smell.

(c) **Ripened**: Principally by blue mould:

**External**: Camembert

**Internal**: Gorgonzola, blue, Roquefort

**Soft**: Moisture > 47%

(a) **Ripened**: Neufchatel (as made in France).

(b) **Unripened**: Cottage.

### 4.5.1 Composition

The proximate percentage composition of some varieties of cheese is presented in Table 4.5.1

**Table 4.5.1 Approximate percentage composition of some varieties of cheese**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Moisture</th>
<th>Fat</th>
<th>Protein</th>
<th>Ash (salt-free)</th>
<th>Salt</th>
<th>Calcium</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheddar</td>
<td>37.5</td>
<td>32.0</td>
<td>25</td>
<td>2.0</td>
<td>1.5</td>
<td>0.86</td>
<td>0.60</td>
</tr>
<tr>
<td>Swiss</td>
<td>39.0</td>
<td>28.0</td>
<td>27</td>
<td>2.0</td>
<td>1.5</td>
<td>0.90</td>
<td>0.75</td>
</tr>
<tr>
<td>Roquefort</td>
<td>39.5</td>
<td>32.0</td>
<td>22</td>
<td>2.0</td>
<td>4.0</td>
<td>0.65</td>
<td>0.45</td>
</tr>
<tr>
<td>Brick</td>
<td>41.0</td>
<td>31.0</td>
<td>22</td>
<td>1.2</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Limburger</td>
<td>45.5</td>
<td>28.0</td>
<td>22</td>
<td>2.0</td>
<td>2.1</td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td>Cottage (Uncreamed)</td>
<td>79.5</td>
<td>0.3</td>
<td>15</td>
<td>0.8</td>
<td>1.0</td>
<td>0.10</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Flow of material and according to the manner of ripening as shown below. From the point of view of cheese, it may be considered as the study of how hard and how elastic cheese may be and the reasons for these particular properties.

1. Very hard (grating) - Moisture < 35% on matured cheese.
   (a) Ripened by bacteria - Parmesan, Romano, Italian varieties.

2. Hard - Moisture - < 40%
   (a) Ripened by bacteria, without eyes - Cheddar.

### 4.6 Cheddar Cheese

Cheddar cheese originated in the country of Somerset in South-Western England. The name ‘Cheddar’ is taken from the town cheddar located in that country. This type of cheese is made extensively in English-Speaking countries like Canada, United States, New Zealand, Australia and South Africa. In India it is the only variety which is being manufactured at commercial scale. Cheddar cheese to please the consumers must have the following qualities.

(i) It must be attractively packaged.

(ii) It must have a sound rind, free from surface defects.

(iii) The flavour of short cured cheese should be mild and free from off-flavours.

(iv) Aged cheese should have a clean desirable, pronounced cheese flavour.

(v) The body should be smooth, firm and waxy, the texture free from gas and yeast, holes and reasonably free from mechanical openings.

(vi) It should have a good slicing properly. It must not be crumbly or corky.

(vii) The colour should be pleasing and uniform throughout.

![Fig. 4.7 Cheese](image1)

![Fig. 4.8 Cheddar Cheese grated](image2)
4.6.1 Method of Manufactures

The flow diagram in Fig 4.6.1 Shows the method of manufacture.

- Receiving milk
- Pre-heating
- Filtration / Clarification
- Standardization
- Pasteurization
- Adding starter culture
- Adding colour
- Adding Rennet
- Setting
- Cutting
- Cooking
- Patting
- Draining
- Cheddaring
- Milling
- Salting
- Hooping
- Pressing
- Dressing
- Drying
- Paraffining
- Ripening
4.6.2 Preparation of equipment

The proper washing and sanitization of cheese vats, utensils, pipelines and other accessories is essential for the production of high quality cheese. A standard procedure is to pre-rinse all the equipments and with cold water immediately after use, then to brush it thoroughly with warm water (50°C), which contains a good detergent with lukewarm 82°C water for five minutes. Chlorine or steam may be used in place of hot water for sanitization. A 15 ppm alkaline chlorine solution in stainless steel trough provides good stoppage for tools and utensils and automatically sanitizes the hands of workers when the tools are removed.

4.6.3 Selection of Milk

The quality of milk used in cheese making is of prime significance. It is well established that only high grade milk can yield good quality cheese. The efficient grading of milk consists of:

(i) Examination of milk for odour and taste
(ii) Inspecting the appearance of milk which should be free from extraneous material
(iii) Examining milk for sediments
(iv) Performing MBR, Resazurin and renneting test
(v) Estimation of titratable acidity and
(vi) Testing milk for bacteriophage, antibiotics and inhibitory substances.

The quality of milk, thus received is weighed and further processed for the manufacture of cheese.

4.6.4 Filtration/Clarification

Milk is filtered through a muslin cloth and also clarified in order to remove any visible dirt and foreign materials in the milk. The milk is preheated at 35-40°C for efficient clarification. If the milk is properly clarified, the process in addition to removing the extraneous matter also removes a considerable number of body cells such as white blood cells, epithelial cells, and if present, red blood cells. A large number of bacteria are also removed from the milk, but not sufficient to have any marked influence on the quality of the cheese manufactured.

4.6.5 Standardization

In cheese making, standardization refers to adjustment of casein fat ratio in milk. The objectives of standardization are
(i) To obtain good quality cheese
(ii) To meet the legal requirements
(iii) To minimize use the batch-to-batch variations
(iv) To regulate the fat in the dry matter of cheese and
(v) To produce the maximum amount of cheese per kg of fat in cheese milk. The correct determining the amount of milk available, ensures.
(vi) Correctly testing the milk of fat
(vii) Correctly testing the milk for casein
(viii) Calculating the amount of skim milk to be added or the amount of cream to be removed in order to establish the desired fat casein ratio, and
(ix) Testing every vat of standardized milk for fat. It requires a considerable skill and correct calculations.

4.6.6 Cheese Colour

Principle of cheese colour is obtained from the seeds of the Annatto tree (Bixa Orellana) which grows in the tropics. This seed is white inside but is covered with a thin coat that is highly coloured. The colours obtained are Bixin, which is yellow and Orellana, which is red. The commercial product consist of an alkaline solution containing the colouring property. It is important that, the cheese colour is protected against freezing and also against high heat.

4.7 Cottage Cheese

4.7.1 Definition

This is a soft unripened cheese usually made from skim milk. It has mildly acid flavour. It consists of small particles of flakes of curd which have a mealconsistency (when made from rennet curd). Creamed cottage cheese has cream mixed into it so that the finished product contains not less than 4 percent fat. Both varieties are usually salted.

4.7.2 Types of curd

These are
(a) Acid curd, in which the milk is coagulated by lactic acid developed by the action of a lactic starter.

(b) Rennet curd, in which milk is coagulated by the action of rennet in the presence of lactic acid, developed in turn by the action of lactic starter. The character of cottage cheese resulting from these two types of curd is shown in table 4.7.2

**Table 4.7.2 Character of cottage cheese in relation to type of curd**

<table>
<thead>
<tr>
<th>Type of curd</th>
<th>Character of cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td>1. Small particles / grains</td>
</tr>
<tr>
<td></td>
<td>2. Extremely acid flavour (mildly acid if thoroughly washed)</td>
</tr>
<tr>
<td></td>
<td>3. Lower yield</td>
</tr>
<tr>
<td>Rennet</td>
<td>1. Large particles / flakes</td>
</tr>
<tr>
<td></td>
<td>2. Mildly acid flavour</td>
</tr>
<tr>
<td></td>
<td>3. Higher yield</td>
</tr>
<tr>
<td></td>
<td>4. Meaty body</td>
</tr>
</tbody>
</table>

Rennet curd may be formed either by short setting or long setting methods, the particulars of which are given in Table 4.7.2

**Table 4.7.2 Particulars of rennet curd formation**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Long setting</th>
<th>Short setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting temperature</td>
<td>220°C (72°F)</td>
<td>29-32°C (85-90°F)</td>
</tr>
<tr>
<td>Setting time</td>
<td>15-16 hrs</td>
<td>4-6 hrs</td>
</tr>
<tr>
<td>Amount of starter added to milk</td>
<td>0.3-1 percent</td>
<td>4-5 percent (up to 10 percent)</td>
</tr>
</tbody>
</table>

4.7.3 Method of manufacture

1. Receiving (pasteurized) skim milk
2. Adding calcium chloride
3. Adding starter
4. Adding rennet
4.7.3 Flow diagram of manufacture

4.7.4 Details of manufacture

1. Receiving skim milk: The skim milk should be fresh, sweet, low in fat and bacterial content and clean in flavour. It should be pasteurized immediately after separation, preferably by the holder method (since higher heating temperatures result in a softer curd, which is easily broken while cutting and handling).

2. Adding calcium chloride: Calcium chloride is generally added to the skim milk at the rate of 1 ml. Saturated solution per 100 litres of milk. The object is to restore the concentration of calcium ions (which is lowered due to pasteurization) to the original level, for formation of the firm curd desired. It is added after the pasteurized milk has been cooled to the setting temperature.

3. Adding starter: A high-quality lactic starter prepared from skim milk is added as indicated in Table 4.7.2 and thoroughly mixed into it.

4. Adding rennet: Rennet is added at 2-2.5 ml. per 1000 litres of milk. Before adding, it is diluted with 40 times its volume of (potable) water for uniform distribution.

5. Setting: The temperature and time of setting have already been indicated in 4.7.2.

6. Cutting: The most desirable acidity of whey at cutting is approximately 0.5 percent (pH 4.6 - 4.7). The whey whey should come from
the interior of the curd and should be clear and free from curd particles. The method of cutting and the size of curd cubes are the same as for cheddar cheese.

7. **Cooking**: This begins soon after cutting and continues for an hour or two until the temperature reaches 46°C (115°F), or until the curd becomes firm enough to remove the whey. The temperature is increased slowly at first and the final temperature is reached in one-and-a-half to two hours. Stirring during cooking is kept at a minimum and is very gently done in the early stages.

8. **Drainage of whey**: Whey is removed when the curd cubes no longer have a ‘soft centre’ and when a handful of them squeezed gently show slight elasticity. The whey is removed from the curd approximately two hours after cutting. By this time the size of the curd cubes is approximately two-thirds of their original volume. The whey is drained in the same way as in cheddar cheese.

9. **Washing and draining**: The curd is washed after all the whey has been removed. This treatment makes the curd firmer and hard to the touch, it also removes acid-whey from around it and helps produce the desired mildness in flavour. The wash water is applied in at least two treatments. In the first, the temperature is about 21°C (70°F) and the quantity not less than twice the volume of curd in the vat, after soaking the cubes for 15 minutes, the wash water is removed. The second (or third, if necessary) lot of wash water is at 16°C (60°F) or below, in the same quantity as above.

   After it has been washed, the curd is drained. Draining should be thorough. It is best done by placing the curd cubes in a draining rack with perforations at the bottom, which can be heeled into refrigerated rooms.

10. **Salting**: This is done when free moisture has been drained from the curd. Salt can be added to the curd in the vat, or it can be dissolved in the cream for creamed cottage cheese. Coarse salt is preferable. Salt is added at 1 percent of curd (or 15 percent of milk).

11. **Creaming**: This is done immediately after draining, if the product is to be packaged at once. Holding the curd overnight in a cold room before it is creamed makes it more firm when creaming. The amount for 20 percent cream required to give 4 percent fat in the finished product is then homogenized before mixing so as to form thick glossy coats over the curd particles.

12. **Packaging and storage**: Cottage cheese, creamed or uncreamed, may be packed in axed/polythene-coated paper cups or in polythene bags. It should be stored at 5-10°C.
4.7.5 Yield

The yield of cottage cheese before creaming depends essentially upon:

1. The composition of milk
2. Manufacturing losses, and
3. The moisture content of the cheese. While the approximate yield of uncreamed cottage cheese is 15 percent of milk, that of creamed cottage cheese (with 20 percent fat in cream and 4 percent fat in the finished product) is 18.3 percent.

4.7.6 Keeping quality

The keeping quality of cottage cheese, whether uncreamed or creamed, is short even under refrigerated storage (5-10°C). Uncreamed cottage cheese may be preserved for 90 days or longer by freezing or by brine storage. However, it will deteriorate in quality because freezing often leads to graininess and curd-shattering, particularly with rennet cheese.

4.8 Processed Cheese

4.8.1 Definition

Processed cheese is a dairy product obtained from the mixing and heating of several lots of a natural cheeses with suitable emulsifying agents, into homogeneous plastic mass, and following this with air cooling. It may contain the spices. Cheese is processed for uniformity safety, longer, keeping quality and easier merchandising.

According to the PFA rules (1976), Processed cheese refers to the product obtained by heating cheese with permitted emulsifiers and/or stabilizers, namely citric acid, sodium citrate, sodium salts of orthophosphoric acid and polyphosphoric acid with or without viz. Vinegar, lactic acid, acetic and citric acid and phosphoric acid. Processed cheese may contain not more than 4.0 percent of anhydrous permitted emulsifiers and/or stabilizers provided that the content of anhydrous inorganic the finished product, should not be more than
47.0 percent moisture, milk fat content should not be less than 40.0 percent of the dry matter. Processed cheese may contain 0.1 percent or calcium salts (calculated as sorbic acid) or 0.1 percent of nisin, either singly or in combination.

Processed cheese food is cheese blended with legally limited amounts of dairy products such as milk, skim milk casein, cream or whey and certain optional ingredients. Processed cheese food may also contain condiments, flavour made with cheese as a base but with the addition of optional ingredients, similar to those used in cheese foods, for properties. For processed cheese foods and spreads, higher heating temperature such as 71 to 85°C are normally required than in processed cheese.

This high temperature destroys spoilage and putrefactive organisms and thereby improves the shelf stability of the products. Processed cheese spreads are homogenized to give good shinks and smooth consistency in the finished product. The specifications for processed cheese foods and spreads, are given in Table 4.8.

Table 4.8 Specification for processed cheese, processed cheese foods and processed cheese spreads.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Processed cheese</th>
<th>Processed cheese foods</th>
<th>Processed cheese spreads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture(%) (Maximum)</td>
<td>47.0</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>Fat in dry matter(%) (Minimum)</td>
<td>40.0</td>
<td>23</td>
<td>20</td>
</tr>
</tbody>
</table>

4.8.2 Desirable Qualities of Processed Cheese

Good processed cheese has a smooth, compact body and is devoid of fermentative gas holes, and has uniform colour. Air cells are normal in processed cheese. These are generally very small and concentrated on one side of the packaged product. Good processed cheese can be sliced without crumbling or sticking and it melts uniformly mild to sharp depending upon the natural cheese, or the combination of different types of cheese used. It never bitter, oxidized, rancid, or unclean.

4.8.3 Method of Manufacture

The flow diagram (Fig 4.8.3) depicts the method of manufacture of processed cheese.
4.8.4 Selection of Natural Cheese

The natural cheese is selected on the basis of its age, texture, taste, odour, acidity and composition. The manufacture usually prefers to control the ripening of the cheese is processed so that the quantity and quality of the same should meet the requirements.

4.8.3 Flow diagram for preparation of processed cheese

4.8.5 Analysis

After receiving the cheese blocks, representative samples are drawn from each block and then analysed for acidity, fat, moisture, salt, pH, etc.

4.8.6 Preparation of Blend

Blending is an important step, where cheese of different age-groups is mixed together for processing. Proper blending requires judgement, experience and technical skill, it produces the desired rheological properties in the
finished product. It is desirable to use 75 percent of one to three months old, 50 percent four to five months old and 25 percent of six to eight months old cheese. Highly acidic cheese can be incorporated up to five percent, whereas gassy cheese should not be more than two percent.

**Short Answer Type Questions**

1. Mention any four fermented milk products.
2. Define “Dahi”.
3. Write the composition of Yoghurt.
4. Define the “Srikhand.”
5. What is “Cottage Cheese”?
6. Mention the types of starter cultures.

**Long Answer Type Questions**

1. Explain the preparation method of “Dahi”.
2. How do you prepare “Srikhand”?
4. How do you prepare Cheddar cheese?
5. Briefly write about the processed cheese.
5.1 Classification of concentrated milk

5.2 Preparation of condensed milk

5.3 Preparation of evaporated milk

5.4 Dried milk - Definition - types and standards

5.5 Drum dried powder

5.6 Spray dried milk powder

Learning Objectives

After studying this unit, student will be able to

• Understand about classification of concentrated milk.
• Know about preparation of condensed and evaporated milk.
• Learn about Dried milk and different types of milk powder.

5.1 Classification of concentrated milk

i. Condensed milk / unsweetened (evaporated) milk

It is the product obtained from cow or buffalo milk or a combination thereof for fro standardized milk by partial removal of water. It may contain added calcium chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding
0.3 percent by weight of the finished product. Such addition need not be declared on the label and not less than 26.0 percent milk solids. The product shall be suitably sterilized.

If the product is subjected to Ultra High Temperature (UHT) treatment heating it to temperature of not less than 140°C for a minimum period of 3 seconds followed by aseptic packaging it shall be designated as UHT.

**ii. Condensed milk sweetened**

It is the product obtained from the buffalo milk or cow milk or a combination thereof or from standardized milk by partial removal of water. It may contain added refined lactose, calcium chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly-phosphoric acid (as linear phosphate) not exceeding 0.3 percent by weight of the finished product. Such addition shall not be less than 9.0 percent. Condensed milk sweetened shall contain not less than 40 percent cane sugar. The total acidity expressed as Lactic Acid shall not be more than 0.3 percent.

**iii. Condensed skimmed milk/unsweetened/evaporated skimmed milk**

It is the product obtained from cow or buffalo skimmed milk or a combination thereof by the partial removal of water. It may contain added calcium chloride citric acid and sodium citrate, sodium salts of ortho-phosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding 0.3 percent weight of the finished product. Such addition need not be declared on the label. Condensed skimmed milk (unsweetened) shall contain not less than 20 % total milk solids. The fat content shall not exceed 0.5% by weight. The product shall be suitably sterilized.

If the product is subjected to Ultra High Temperature (UHT) treatment, heating it at a temperature of not less than 140°C for minimum period of 3 seconds followed by aseptic packaging it shall be designated as UHT and label a specified under clause (ddd) of sub rule (B) rule 42.

**iv. Condensed skimmed milk sweetened**

It is the product obtained from cow or buffalo milk or combination thereof by partial removal of water and addition of cane sugar. It may contain added refined lactose, calcium chloride, citric acid and sodium citrate, sodium salts of ortho phosphoric and poly-phosphoric acid (as linear phosphate) not exceeding 0.3 % by weight of the finished product. Such addition need not be declared on the label. Condensed skimmed milk (sweetened) shall contain not less than 26.0 % of total milk solids and less than 40.0 % cane sugar. The fat
content shall not exceed 0.5 percent by weight. The total acidity expressed as Lactic Acid shall not be more than 0.35 %.

v. Partly skimmed sweetened condensed milk

It is the product obtained from partly cow or buffalo milk or a combination thereof by the partial removal of water and with addition of cane sugar. It may contain added refined lactose, calcium chloride, citric acid and sodium citrate, sodium salts of ortho phosphoric acid and poly - phosphoric acid (as linear phosphate) not exceeding 0.3 % by weight of the finished product. Partly skimmed sweetened condensed milk shall contain not less than 28.0 % of total milk solids and not less than 40.0 % cane sugar. The fat content shall not be less than 3.0 % and more 9.0 % by weight. The total acidity expressed as Lactic Acid shall not be more than 0.35 %.

5.2 Preparation of condensed milk

Different steps involved in the manufacture of sweetened condensed milk are given in the Flow diagram 5.1.

Receiving milk

Filtration clarification

Standardization

Pre-heating fore warming

Addition of sugar

Condensing

Cooling

Crystallization

Packaging

Storage

Fig 5.1 Flow diagram for preparation of sweetened condensed milk
5.3 Preparation of evaporated milk

Unsweetened concentrated milk is known as evaporated milk and manufactured practically in the same manner as is followed for the sweetened condensed milk. In this product no sugar is added as preservative. To achieve preservation the product is sterilized by heat after concentration and sold in the hermetically sealed container in which it has been sterilized.

1. Receiving milk/filtration/clarification/standardisation: The raw milk used in the preparation of evaporated milk is treated in a similar manner to that which applies in case of sweetened condensed milk as discussed earlier. It is important that the raw milk should be of very good quality in order to ensure that it is free from any heat resisting microorganisms. Only fresh milk can be
used since, if the acidity of evaporated milk is above normal it will clot or curdle during sterilization and will thus be rendered un-saleable.

**ii. Preheating/Forewarming of Milk:** To improve the heat stability of concentrated product and for imparting optimum viscosity to the finished product the fluid milk is preheated before it is condensed. Milk may be preheated either at 95-100°C for few minutes (5-10) or at 140-145°C with not holding time.

**iii. Concentration:** Preheated milk is concentrated in an evaporator. Multiple effect evaporators are used for handling large amount of milk to have continuous operation.

**iv. Homogenization:** After concentration the milk is homogenized. Fat separation in evaporated milk during storage is a major defect. This defect can be reduced or eliminated by homogenization of condensed milk. Homogenization refers to a process of forcing milk under pressure through equipment called homogenizer. This is an essential part of production of evaporated milk. The homogenizer reduces the mean size of the fat globules in the milk so that they are uniformly distributed in milk and do not rise to the top to form the creamy layer during storage. In raw milk, the diameters of the fat particles (globules) vary from 1 to 20 micron while a diameter of about 2 micron or less is required to keep the fat distributed uniformly. In this process milk is forced through a small orifice at a high pressure by means of a positive displacement pump.

**v. Cooling:** After homogenization concentrated milk is cooled at 5°C and held in storage tank. Stabilizing salts may be added to concentrated milk in tank as indicated by pilot sterilization test.

**vi. Pilot Sterilization:** The purpose is to determine the amount and type of chemical stabilizers to be added to any given batch of condensed milk for most satisfactory heat stability. Heat coagulation of milk is influenced by many factors such as initial quality of raw milk, forewarming, concentration and sterilization. In raw milk it has been suggested that salt balance of milk i.e. ratio of calcium + Magnesium to citrate + Phosphate is important for the stability of milk towards heat. Depending upon the type of milk and the processing condition used 100 to 300 gm of stabilizing salts per 100 kg of evaporated milk may be needed to improve the heat stability. Calculated amount of salt is added to the evaporated milk in the form of a solution using just enough water to dissolve it.

**vii. Sterilization:** The object is to destroy all bacteria their spores and enzymes thereby preserve the product for a longer time. In addition sterilization process is also used to increase the viscosity and improve body and texture to give a creamy consistency to the product.
Batch Sterilization: This method is suitable for small scale operation and is also useful for cans of various sizes. In this system the cans leaving the filling machine are placed in racks. The racks are then loaded into a steam-tight boiler. The racks are moved by a revolving mechanism, which keeps them in motion throughout the process, the speed of rotation varies between 6-12 revolutions per minute.

Continuous Sterilization: This is used for large scale continuous operation. This system consists of many compartments, which are maintained at different temperature/pressures. The filled cans entering the apparatus roll through the chambers by means of spiral track, which ensures that the heat distribution to each can is uniform.

Storage: After sterilization cans of evaporated milk are unloaded from the sterilizer, and cooled by water spray. The cans are then shaken mechanically to break any curd or lump which might have formed during sterilization to have homogenous consistency. Excessive shaking is avoided as it may decrease viscosity. As evaporated milk is a sterilized product it may be stored at or below room temperature. The present trend is to store at below room temperature to check deterioration in quality and thereby prolong keeping quality.

5.4 Dried milk- Definition- types and standards

5.4.1 Definition

Dried milk or milk powder is obtained by removal of water from milk by heat or other suitable to produce a solid containing 5.0% or less moisture. Whole milk, partially skimmed milk or skimmed milk may be used for drying.

Dried milk

i. Legal standards (PFA standards)

(a) Milk powder: Milk powder means the product obtained from cow or buffalo milk, or a combination thereof, or from standardized milk, by the removal of water. It may contain added calcium chloride, citric and sodium citrate, sodium salts of orthophosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding 0.3% by weight of the finished product, and 0.01% of Butylated Hydroxy Anisole (BHA) by weight of the finished product. Such addition need not be declared on the label. For improving dispersibility, it may contain lecithin to maximum limit of 0.5%. Milk powder shall contain not more than 5.0% moisture and not less than 26.0% milk fat. The maximum acidity expressed as Lactic Acid shall not be more than 1.2%. The plate count shall not exceed 50,000 per gram and Coliform shall be absent in 0.1 gm of the powder.
The minimum solubility of the product shall be as follows:

<table>
<thead>
<tr>
<th>Solubility</th>
<th>Roller Dried</th>
<th>Spray Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>85.0</td>
<td>98.5</td>
</tr>
</tbody>
</table>

The process of drying shall be mentioned on the label. The spray-dried product shall be in nitrogen or mixture of nitrogen and carbon dioxide hermetically sealed containers.

(b) Skimmed Milk Powder: Skimmed milk powder means the product obtained from the skimmed milk of cow or buffalo milk or combination thereof, by the removal of water. It may contain added calcium chloride, citric acid and sodium citrate, sodium salts of ortho phosphoric acid and poly phosphoric acid (as the linear phosphate) and sodium phosphate, not exceeding 0.3% by weight of the finishes product. Such addition need not be declared on the label. Skimmed milk powder shall not contain more than 1.5% milk fat and moisture shall not exceed 5.0%. The plate count shall not exceed 50,000 per gram and Coliform shall be absent in 0.1 gram of the powder. The minimum solubility of the product shall be follows:

<table>
<thead>
<tr>
<th>Solubility</th>
<th>Roller Dried WMP</th>
<th>Spray Dried WMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>85.0</td>
<td>98.5</td>
</tr>
</tbody>
</table>

The process of drying shall be mentioned on the label.

(c) Partly skimmed milk powder: Partly milk powder means the product obtained from partly skimmed cow or buffalo milk, or a combination thereof, by the removal of water. It contain added calcium chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly phosphoric acid (as linear) it need to be declared on the label. Partly skimmed milk powder shall not contain more than 5.0% moisture and the fat content of the product shall not be more than 1.5. Butylated Hydroxy Anisol (BHA) not exceeding 0.01% by weight of the finished product may be added. The exact fat content shall be indicated on the label. The minimum solubility of the product shall conform to the following standards:

<table>
<thead>
<tr>
<th>Solubility</th>
<th>Roller Dried</th>
<th>Spray Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>85.0</td>
<td>98.5</td>
</tr>
</tbody>
</table>

The product of drying shall be mentioned on the label. The spray-dried product shall be packaged in hermetically sealed containers.
(d) Partly skimmed milk powder (sour): Partly skimmed milk powder (sour) used in industry like bakery may contain sodium bicarbonate as a neutralizer provided that the resultant product is labelled as ‘UNFIT FOR DIRECT CONSUMPTION’. The total amount of food additives including neutralizers added shall, however be same as prescribed for partly skimmed milk powder. It shall conform to other standards prescribed for partly skimmed milk powder except that solubility percentage will be 75% minimum by weight.

ii. BIS Standards

Milk powder (IS : 1165-2002): It shall be prepared by spray drying of standardized milk obtained from fresh cow milk or buffalo milk or a mixture thereof. The standardized milk shall be free from additives. All processing and drying should be carried out in a manner that minimizes the loss of nutritive value, particularly protein quality.

- For improving the dispersibility of the product, lecithin to a maximum extent of 0.5% by mass may be added and declared on the label.
- The product may contain added calcium chloride, citric and sodium citrate, sodium salts of ortho phosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding 0.63% by mass of the finished product. Such additions need not be declared on the label.
- Milk powder may contain maximum of 0.1% of butylated hydroxyanisole (BHA) by mass of the finished on the label.
- The product shall also confirm to the requirements given in table 5.1

Description

The material shall be white or with greenish tinge or light cream in colour. It shall be free from lumps except those that break up readily under slight pressure, and shall be reasonably free from scorched particles. It shall be free from extraneous matter.

Flavour and Taste

The flavor of the product or of the reconstituted milk shall be pleasant and clean. It shall be from off flavour (may have slightly cooked burnt not the burnt flavour).
Table 5.1 Compositional and Microbiological specification of milk powder.

<table>
<thead>
<tr>
<th>S.no</th>
<th>Complications</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture % by mass, max.</td>
<td>4.0</td>
</tr>
<tr>
<td>2.</td>
<td>Total milk solids, % by mass, Min</td>
<td>96.0</td>
</tr>
<tr>
<td>3.</td>
<td>Fat, % by mass, Min</td>
<td>26.0</td>
</tr>
<tr>
<td>4.</td>
<td>Insolubility index max</td>
<td>2.0 ml</td>
</tr>
<tr>
<td>5.</td>
<td>Total ash (on dry basis) % by mass, max</td>
<td>7.3</td>
</tr>
<tr>
<td>6.</td>
<td>Titratable acidity (lactic acid) % by mass, Max</td>
<td>1.2</td>
</tr>
<tr>
<td>7.</td>
<td>Bacterial count per gm Max.</td>
<td>40,000</td>
</tr>
<tr>
<td>8.</td>
<td>Coliform count</td>
<td>Absent in 0.1 kg.</td>
</tr>
<tr>
<td>9.</td>
<td>Coagulase positive Staphylococcus aureus</td>
<td>Absent in 0.1 kg.</td>
</tr>
<tr>
<td>10.</td>
<td>Salmonella</td>
<td>Absent in 25 kg.</td>
</tr>
<tr>
<td>11.</td>
<td>Shigella</td>
<td>Absent in 25 kg.</td>
</tr>
</tbody>
</table>

Partly skimmed milk powder: The material shall be of the following two types.

- **Type - 1:** Partly skimmed milk powder: The product obtained from partly skimmed milk of cow or buffalo milk or a combination thereof by the removal of water through spray drying or roller drying.

- **Type-2:** Partly skimmed milk powder (Sour): The product from partly skimmed milk of cow of buffalo milk or a combination thereof by the removal of water through spray drying or roller drying primarily for use by industry like bakery.

- **The type - 1:** Product may contain chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding 0.3% by mass of the finished product. Such additions need not be declared on the label. Butylated hydroxyanisole (BHA) not exceeding 0.01% by mass of the finished product, may be added. Such additions need not be declared on the label.

The type 2: The product may also contain sodium bicarbonate as a neutralizer provided that the resultant product is labelled as ‘Unfit for Direct
Consumption’. The amount of food additives including neutralizer added shall, however be same as for type 1 product.

The product shall also confirm to the requirement given in table 5.4.

Table 5.2 Requirements for partly skimmed milk powder

<table>
<thead>
<tr>
<th>S.no</th>
<th>Characteristics</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Type1</td>
</tr>
<tr>
<td>1.</td>
<td>Moisture % by mass, Max</td>
<td>4.0</td>
</tr>
<tr>
<td>2.</td>
<td>Total solids (milk solids and added salts) % by mass, min</td>
<td>96.0</td>
</tr>
<tr>
<td>3.</td>
<td>Milk fat percent by mass, More than Less than</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26.0</td>
</tr>
<tr>
<td>4.</td>
<td>Insolubility index, m, max (a) Roller dried (b) Spray Dried</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>5.</td>
<td>Total ash (on dry matter basis) % by mass, Max</td>
<td>8.2</td>
</tr>
<tr>
<td>6.</td>
<td>Titratable acidity (as lactic acid) % by mass, Max</td>
<td>1.5</td>
</tr>
<tr>
<td>7.</td>
<td>Bacterial count per gm, Max</td>
<td>50,000</td>
</tr>
<tr>
<td>8.</td>
<td>Coliform count</td>
<td>Absent in 0.1g</td>
</tr>
</tbody>
</table>

Skimmed milk powder

(i) **Standard grade**: The product obtained from water through spray drying or roller drying.

The product may contain added calcium chloride, citric acid and sodium citrate, sodium salts of ortho phosphoric acid and poly phosphoric acid (as linear phosphate) not exceeding 0.3% by mass of the finished product. Such addition need not be declared on the label.
The product shall also confirm to the requirements given in table 5.6

Table 5.3 Requirements for skimmed milk powder, standards grade

<table>
<thead>
<tr>
<th>S.no</th>
<th>Characteristics</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture % by mass, Max</td>
<td>4.0</td>
</tr>
<tr>
<td>2.</td>
<td>Total solids (milk solids and added salt) % by mass, Min</td>
<td>96.0</td>
</tr>
<tr>
<td>3.</td>
<td>Milk fat % by mass, Max</td>
<td>1.5</td>
</tr>
<tr>
<td>4.</td>
<td>Insolubility index ml, Max (a) Roller dried</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>(b) Spray dried</td>
<td>1.5</td>
</tr>
<tr>
<td>5.</td>
<td>Total ash (on dry basis)% by mass Max.</td>
<td>8.2</td>
</tr>
<tr>
<td>6.</td>
<td>Titratable acidity (as lactic acid)% by mass Max.</td>
<td>1.5</td>
</tr>
<tr>
<td>7.</td>
<td>Bacterial count per gm. Max</td>
<td>50,000</td>
</tr>
<tr>
<td>8.</td>
<td>Coliform count</td>
<td>Absent per 0.1g</td>
</tr>
</tbody>
</table>

(ii) **Extra Grade**: Skimmed milk powder extra grade shall be the material prepared by spray drying of fresh skimmed milk of cow or buffalo or a mixture thereof. The skimmed milk shall be free from additives. The product shall be free from whey and buttermilk. The product shall comply with the requirements given in table 5.8.

Table 5.4 Requirement for skimmed milk powder, Extra Grade

<table>
<thead>
<tr>
<th>S.no</th>
<th>Characteristics</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture % by mass, Max</td>
<td>3.5</td>
</tr>
<tr>
<td>2.</td>
<td>Total solids (milk shall and added salts) % by mass, Min</td>
<td>96.5</td>
</tr>
<tr>
<td>3.</td>
<td>Fat % by mass, Max</td>
<td>1.25</td>
</tr>
<tr>
<td>4.</td>
<td>Insolubility index Max</td>
<td>0.5 ml</td>
</tr>
</tbody>
</table>
5. **Dairying**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Total ash (on dry basis) % by mass Max</td>
<td>7.3</td>
</tr>
<tr>
<td>6.</td>
<td>Titratable acidity in ml (of N/10 NaOH) Max</td>
<td>19.5</td>
</tr>
<tr>
<td>7.</td>
<td>Lactate content, mg/g, Max / 100g</td>
<td>1.5</td>
</tr>
<tr>
<td>8.</td>
<td>Scorched particles Max, 100g</td>
<td>15mg</td>
</tr>
<tr>
<td>9.</td>
<td>Coliform count</td>
<td>Nil in 0.1g</td>
</tr>
<tr>
<td>10.</td>
<td>Bacterial count per gm, Max</td>
<td>40000</td>
</tr>
<tr>
<td>11.</td>
<td>Coagulase positive Staphylococcus aureus</td>
<td>Absent in 0.1 g</td>
</tr>
<tr>
<td>12.</td>
<td>Salmonella</td>
<td>Absent in 25g</td>
</tr>
<tr>
<td>13.</td>
<td>Shigella</td>
<td>Absent in 25g</td>
</tr>
</tbody>
</table>

### 5.5 Drum Dried Powder

On an industrial scale, milk is commonly dried by application of roller drying or spray drying. There are various modifications of both systems. Atmosphere roller dried or drum drier was first introduced in 1855 in Great Britain and was most popular drying process till the middle of 20th Century. Vaccum drum driers were designed between 1889-1909 in Ekenbery (Sweden), Pass burg, (Germany) and Govers (USA). Roller drying with two rolls, invented in 1902 by John A. Jhost of USA. Who was the first to use for drying milk and milk products. Spray drying process was developed during the early part of this century. Because of its relative advantages over roller drying process, spray-drying process has now almost completely replaced roller drying for the production of milk powder.

### 5.5.1 Roller Driers

**A. Classification**

Roller driers (also known as drum driers) may be classified in a number of ways, viz

(i) **Number of hollow drums and direction of turning of drums.**

   (a) Single drum
   (b) Twin drum (Turn away at the top)
   (c) Double drum (Turn together at top towards centre)
(ii) \textbf{Pressure surroundings the product.}

(a) Atmosphere

(b) Vacuum

(iii) \textbf{Method of placing the product on the drum surface.}

(a) Trough or reservoirs above for top feed

(b) Spray or splash food

(c) Trough below for pan feeding

(d) ? below for dip feeding.

(iv) \textbf{Method of obtaining vacuum (For a vacuum drier)}

(a) By steam ejector

(b) By vacuum pump

(v) \textbf{Material of construction of drum}

(a) Steel

(b) Alloy steel

(c) Stainless steel

(d) Cast iron

(e) Chrome or nickel plated steel

\textbf{Note}

(i) Cast iron usually used. The wear is excessive on stainless steel drum and the double drum atmosphere drier is most commonly used in the dairy industry.

(ii) Vacuum drum driers are essentially the same as atmospheric units except that the drums are enclosed so that a vacuum can be maintained on the product drying. The single drum with top feed is more commonly used for vacuum drying. A thicker film is obtained with top feed.

\textbf{B. Drum Description and Steam Flow}

The drums are normally horizontal, hollow cylinders, 2 to 4 ft. in diameter and 3 to 12 ft in length. Drums are carefully machined both from inside and outside so that the thickness of the drum throughout its length is same. This assist in uniform heat transfer and drying. The most used construction in the
dairy industry is a double drum drier, which works under atmospheric pressure. Drums are mounted parallel to each other, about 0.5 to 0.7 mm (0.02-0.03) apart. Care is taken to properly align the drums. Further one drum is mounted on a stationary bearing, while the other a flexible one, so that it can be moved to provide the desired between the drums. The speed of drums is adjustable and usually kept between 14-19 rpm depending on a concentration of milk and on the pre-set moisture content in the resulting milk powder. The product is removed after 3/4 to 7/8 of a revolution by a scraper knife. The blade of the knife (also called the Doctor blade) forms an angle of 15-30° with the roller surface. The metal used for the knife should be softer than the drum. The product is in contact with the drum for about 3 seconds or less.

The drums are heated internally by feeding steam at about 60-70°F (150°C) into the centre of the drum at one end of the shaft through the hub. The requirements of steam is 1.2-1.3 kg per water evaporated. The condensate, that moves to the bottom of the drum, is removed by pump or siphoned continuously.

In atmospheric driers, drying takes place at atmospheric pressure. In vacuum driers, however the drier is enclosed in a vacuum chamber, which is maintained at 27-29 inch Hg vacuum. A better quality product is obtained in vacuum driers, but besides being costly, the process becomes complicated.

C. Flow of product

The milk may be placed on the roller in the natural form or pre-concentrated in an evaporator before it is fed to the drum drier. The degree of concentration varies with the design of the dryer. The milk is usually preheated and placed in reservoirs between the upper portions of the drums. Milk level between drum must be uniform for control of the moisture in the dried product. The general rule is that a single drum dryer can handle milk of higher concentration than double-drum dryer. The scraper blade removes the dried materials from the drum. The film of dry milk forms a continuous sheet from knife to the auger trough, which is above level with the bottom of the drum. The broken edge is subsequently milled, sized and packaged. Usually quality difficulties are encountered briefly while starting the drying operation. A common practice is to exclude the initial dried product from the lot until the product is satisfactory in appearance the drum operation is normal. Water vapour above the drier are continuously removed by providing a hood above the drums.

D. Factors Affecting Production

Following factors affect the rate of drying on drum dryer.
Fig. 5.2 Preparation of Drum Dried Milk powder
Pre-concentration of milk: Increased pre-concentration milk up to 18% T.S. increased rate of drying.

Milk Feed Temperature: Increased milk feed temperature up to 160°F increase drying rate.

Height of milk in the trough: Increased height of milk in height trough over the drum increase capacity.

Drum Gap: If drums are farther apart, leakage may occur. The thickness of the film, on the drum is directly related to the distance between the two drums.

Drum Speed: Only slight increase in drying rate as drum is increased. As speed increase the film becomes thinner so that amount of water evaporated and amount of powder produced remain approximately the same.

Steam pressure: With increase in steam pressure, the drying rate increase. Too high a steam pressure results in scorching of the film. An increase in steam pressure from 55 to 65 psi results in approximately 10% increase in production.

5.6 Spray Dried Milk Powder

The predominant method of drying milk and milk products is spray drying. The condensed milk from the evaporator is pumped to a balance tank and from the repassed through a filter introduced into drying chamber with or without preheating. The solubility of skim milk powder is not affected up to a preheating temperature of 80°C. Feeding cold concentrate milk to drier may result in sticking to the chamber causing more burnt or scorched particles in the final powder. Either a pressure nozzle or spinning disc is used for atomizing the concentrate into the fine droplets and exposing to a current of hot air in the spray-drying chamber.

Due to increased surface area, and to the high latent heat of water evaporation (2.26 ML/Kg), sprayed, particles release their moisture quickly thereby causing an immediate temperature drop of the incoming air. While the inlet temperature reaches up to 215°C, the temperature in the chamber drops down almost instantly to the temperature of outlet air (about 95°C in one stage drying). Residual moisture is one of the most important of outlet properties of milk powder both from a quality and an economic point of view.

The outlet temperature is usually used as the parameter by which the final moisture of the product is controlled. The outlet temperature depends on a large number of factors. The chamber design, the residence time of milk particles
in the chamber, the final desired moisture content in the powder and the design of powder collecting systems controlling the air inlet and outlet temperatures. Dry product is taken away immediately after drying.

The powder coming out of the drier is preferably cooled to 30°C by a secondary air stream before packaging and storage. Cooling is done to prevent clumping. Sticking and heat-damage to the product. Prolonged heating causes staleness in non-fat dry milk and jeopardizes the flavour and keeping quality of dried milks. On prolonged exposure of the powder to heat, the fat has a tendency to melt and oil off. The fat thus becomes the continuous phase. Some of it covers the surface of the dried milk particles and is exposed to air and light and subjected to oxidation.

In two-stage it is also important to control the intermediate moisture, i.e. The moisture of the powder at exit from the drying chamber because it influences many other properties including solubility index, particle density, bulk density, agglomeration etc. Because there is some gain in moisture content during pneumatic conveying and blending and a ?extent storage, it is normal to produce powder from the dryer of lower moisture content than that by the specification so that the final powder remains with in specification. Spray drying has numerous important advantages compared to other drying techniques. The whole process proceeds very rapidly; air residence time in the chamber is up to 30 seconds. Because of this and because drying is accomplished at lower drying temperatures, the product has excellent properties.

**Foam Spray Drying**

Foam spraying can be accomplished by forcing the gas into liquid through the pump before atomizing nozzle supplying the drier. Air is commonly used as added gas for making foam dried whole milk. Foam spray drying provides a means of using most conventional spray drying equipment for drying liquids up to maximum of 60% totals solids as compared to 50% on a particular drier, for obtaining as instant type powder and provides procedure for increasing the capacity of conventional equipment and profits as well. Foam spray gives more uniform particle size in the dried product. Foam spray dried powder has improved dispersibility, but poor sinkability due to occluded air when reconstituted in water. However the foam spray milk powder has lower bulk density and hence higher packaging, storage and transportation costs.
Short Answer Type Questions

1. What is “Evaporated milk”?
2. Define condensed milk.
3. Define “Dried milks”.
4. Write the composition of skim milk powder.
5. Write the composition of Whole milk powder.

Long Answer Type Questions

1. Write the preparation method of condensed milk.
2. How do you prepare evaporated milk.
3. Explain the method of manufacture of drum dried milk powder.
4. Explain the method of manufacture of Spray dried milk powder.
Structure
6.1 Classification of indigenous milk products with examples
6.2 Khoa
6.3 Khoa based sweets
6.4 Channa
6.5 Channa base sweets
6.6 Paneer
6.7 Kheer
6.8 Kulfi

Learning Objectives
After studying this unit, student will be able to

• Understand about indigenous milk products.
• Know about Khoa, Channa, Paneer, Kheer and their based sweets.

6.1 Classification of Indigenous milk products with examples
Innumerable types of traditional dairy products are prepared in our country (Table 6.1) Some of them have attained national status while many
other are still very region specific. The types of indigenous dairy product popular on an area/region chiefly depends on the followings factors.

- Quantity of milk available
- Dietary habit of the people
- Market demand
- Purchasing power of the consumers
- Religious and ceremonial occasions
- Profitability
- Shelf life
- Other local conditions such as facilities available, seasonal ban on product manufacture, etc.

Table 6.1 Classification of traditional milk products

<table>
<thead>
<tr>
<th>Principle</th>
<th>Primary intermediate products</th>
<th>End products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat desiccation</td>
<td>Khoa</td>
<td>Khoa based sweets (Burfi, Peda, Gulabjamun, Kalakand Milk cake, Kunda etc.)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Rabri</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Basundi</td>
</tr>
<tr>
<td>Heat and acid</td>
<td>Channa</td>
<td>Channa based sweets, (Rasogolla, Sandesh, Cham-Cham etc.) Culinary dishes/direct consumption</td>
</tr>
<tr>
<td>Fermentation</td>
<td>-</td>
<td>Dahi</td>
</tr>
<tr>
<td></td>
<td>Chakka</td>
<td>Srikhand, Srikhand vadi</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Misti doi</td>
</tr>
<tr>
<td>Phase inversion and concentration of fat</td>
<td>Makkhan</td>
<td>Ghee</td>
</tr>
<tr>
<td>Frozen Cereal based</td>
<td>-</td>
<td>Kulfi/Kulfa</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Kheer</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Payasam</td>
</tr>
</tbody>
</table>
6.2 Khoa

Khoa is an important indigenous milk product. It is conventionally prepared from continuous boiling milk on open kettle until desired desiccation (normally 72 to 75% total solids) and texture is achieved. According to one estimate, 5.5% of total milk product is converted into khoa. This amount is equivalent to 3 million kgs/khoa/per day. Khoa is used as base material for a variety of sweets, such as burfi, peda, gulabjamun, milk cake, kalakhand etc.

(i) Standards

PFA Standards of Khoa:
According to PFA khoa is a product obtained from cow or buffalo milk or combination thereof by rapid desiccation and having not less than 30% fat on dry matter basis of the finished product.

(ii) BIS requirement for different types of Khoa

According to BIS, khoa is a heat coagulated milk product obtained by partial dehydration of milk of buffalo, cow, sheep and goat or their admixture. It shall not contain any ingredient foreign to milk except the addition of citric acid in Danedar khoa added to develop the desirable characteristics. Three types of khoa are manufactured, viz. Pindi, Danedar, and Dhap. The requirement as per BIS are given in table 6.1 and specific characteristics as below.

(iii) Pindi

It is characterized as a circular are ball of hemispherical shape with smooth and homogenous body and mixture. The grains are very small and uniform size throughout the mass. The product has characteristic heated/cooked flavour. It is used for the manufacture of various varieties or burfi and peda.

(iv) Danedar

It is characterized by its granular texture and uneven body. The size of grains depends upon the amount of acidulant added and the acidity of milk used. Citric acid when added should normally be less than 0.1% (preferably 0.02%). This type of Khoa is used as a base for the preparation of kalakhand, milk cake, and pastries where granulation is desirable.
(v) Dhap

This type is characterized by loose and sticky body and smooth texture. It is normally pre-pendi stage and thus contain higher moisture. Dhap khoa is prepared for its use in preparation of gulabjamun, pantua so that balls of smooth surface can be prepared.

Table 6.2 BIS requirement for different types of khoa

<table>
<thead>
<tr>
<th>S.no</th>
<th>Characteristics</th>
<th>Pindi</th>
<th>Danedar</th>
<th>Dhap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total solids% by mass, min</td>
<td>65</td>
<td>60</td>
<td>55</td>
</tr>
<tr>
<td>2.</td>
<td>Fat, % by mass (on dry basis) min</td>
<td>37</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>3.</td>
<td>Total ash, % by mass (on dry, basis max)</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>4.</td>
<td>Titratable acidity (as lactic acid by mass, Max)</td>
<td>0.8</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>5.</td>
<td>Coliform count/g, max</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>6.</td>
<td>Yeast &amp; mould counts, g, max</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

vi. Chemical composition of Khoa

The composition of market khoa shows great variations. The main reason for this variation is that manufacture of khoa is largely in the hands of private traders (halwais) who do not adopt standard practices for khoa manufactures. The composition of khoa has been give in table 6.3.

Table 6.3 Gross chemical composition of khoa

<table>
<thead>
<tr>
<th>Constituents (%)</th>
<th>Market samples (range)</th>
<th>Laboratory Khoa from buffalo milk</th>
<th>Laboratory Prepared khoa from cow milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>20-40</td>
<td>32.0</td>
<td>30.4</td>
</tr>
<tr>
<td>Fat</td>
<td>22-39</td>
<td>24.2</td>
<td>22.2</td>
</tr>
<tr>
<td>Protein</td>
<td>16-26</td>
<td>18.3</td>
<td>18.8</td>
</tr>
<tr>
<td>Lactose</td>
<td>17-33</td>
<td>22.0</td>
<td>24.9</td>
</tr>
<tr>
<td>Ash</td>
<td>3-5</td>
<td>3.5</td>
<td>3.7</td>
</tr>
</tbody>
</table>
• Khoa prepared from standardized buffalo milk (5.8% fat and 9% SNF) under controlled conditions.

• Khoa prepared from cow milk standardized to 4.0% fat and 8.6% SNF

Factors affecting composition of khoa

The large variations in the market samples are attributed to the following factors

i. Types and quality of milk used: The composition of cow and buffalo milk is different in respect of total solids, fat, protein, and lactose. Therefore, the use of these milk as such or their combination (without standardization) produces khoa of different composition. Buffalo milk khoa normally contains moisture and higher fat levels, but lower contents of protein, lactose and ash in cow milk khoa. Adulteration of milk with water or removal of fat milk also affects the composition of khoa.

ii. Method of preparations: In the conventional methods adopted by halwais and unskilled workers, the desiccation of milk is done just by their past experience, which is bound to vary from lot to lot. Removal of more moisture during desiccation leads to decrease in moisture and increase in all other solids is known where the removal of less moisture has opposite effect on the composition of khoa. The use of mechanized and continuous method produces khoa of more consistent quality.

iii. Degree of heat treatment: Higher degree of heat treatment, result into very fast desiccation of milk solids particularly at the final stage. This may reduce the moisture content to greater extent and increase all other milk solids in khoa.

iv. Manner of handling and packaging: Leaving khoa in the hot surface of heating kettle for a longer time in the conventional method of preparation or in the open trays in the continuous khoa milk process, cause method evaporation of moisture thereby changing its final composition. Improper protection/package of khoa also leads to coarse surface and decrease in the moisture content.

v. Storage conditions: Storage of khoa in dry conditions or humid conditions, particularly when improperly protected, also results into compositional changes. The storage of khoa for longer time will have more drastic effect in these conditions.
6.3 Khoa Based Sweets

6.3.1 Introduction

Milk sweets are an integral part of the socio cultural life in the Indian sub-continent. These are consumed on special religious occasions, social events and at the end of our daily meals. Milk sweets offered to guest reflect an expression of the warmth of hospitality. In early Buddhist and Jain work, there is mention that the sweets were prepared from thickened milk named as Sihakesara and Morandeka.

Buddha allowed his followers to take some sweets on journey on routes where it was difficult to get foodstuffs. In the Maurya period the sweets were prepared from concentrated milk with the addition of honey, jaggery or sugar. In the post-Gupta period (AD-750 to 1200), milk was used in various forms, such as concentrated semi solid and in powder forms for either direct consumption or for sweet making.

It is evident from historical evidences that the art of preparing sweets from surplus milk was developed centuries ago. In the present era to earn profit to the traders, That is why, now their manufacture is not confined to only small confectioneried (halwais), but many organized and large players in the milk business have entered in this lucrative venture. Amongst the various milk sweets, khoa based sweets, namely burfi, peda, gulabjamun, milk cake, Kalakhand and Kunda occupy more commercial significance than other sweets.

6.3.2 Burfi

Burfi is popular milk based confection in which the material is essentially khoa. Sugar in different proportions and others ingredients incorporated according to the demand of consumers, several varieties of burfi are sold in the market depending on the additives present, viz., plain mawa, pista, nut, chocolate, coconut and rava burfi. A lot of variation can be observed in physical attributes of market samples. Good quality burfi, however is characterized by moderately sweet taste, soft and slightly greasy body and smooth texture with very fine grains. Colour (except chocolate burfi) should be white or slightly yellowish. The shape of burfi is either square or rectangular.

(i) Method of preparation of Burfi

The manufacture of burfi is mainly restricted to private traders (milk confections) although the past decade serious efforts have been made to develop mechanized systems for organized daries. The flow diagram of a batch method, the variables of which have been optimized in the laboratory to produce burfi of consistently good quality is shown in Flow 6.3.1.
Dhap Khoa made from fresh buffalo milk is desirable for making burfi. Khoa is taken preferably in double-jacketed stainless steel hemi-spherical kettle and heated up to 60°C by steam. In the traditional method, shallow Karahi made up of mild steel is used and the heating source is kerosene oil or LPG burner. Khoa is thoroughly worked at about 60°C by a wooden ladle (long handle with flattened end). Sugar is added preferably at about 50°C to achieve a completely homogeneous and smooth mass. At this stage, heating is discontinued and additives may be added depending on the type of burfi. Burfi base is poured into previously greased (with desi ghee) shallow trays. The trays are left at room temperature for cooling and setting of burfi. Dressing of burfi with nuts, silver foil etc is done at this stage. Finally, pieces of required shape and sizes are cut and packaged in suitable boxes.

6.3.3 Peda

There are several varieties of peda and their method of manufacture also vary from region to region depending on the consumers requirements. Consistently, the quality of peda varies extremely. The range of variations in sensory quality of peda is given as follows.

- Colour: White to light yellow to complete brown
- Flavour: Slightly cooked to burnt
Texture - Soft granular
Shape  - Normally round
Size    - Varies from 20-30g.

Peda is more popular than all other khoa based sweets. The reason is that peda is considered to be a pure food and offered as ‘Prasad’ during religious worship in Hindu temples as well as on religious celebrations. Two types of peda, viz, plain (creamy or white colour) and brown (Lal) peda are available in market. Most of the information available in literate relates to plain peda. Normally peda is more hard and granular than burfi.

(i) Method of preparation of Peda

Different methods are used for the preparation of peda, depending on the type and scale of production. For example (a) traditional method at small and large scale and (b) Industrial / mechanized method. The method for making (Lal) peda is different from these methods. All these techniques are described as below.

(a) Traditional Method : This method is basically identical to that of burfi preparation where in a mixture of khoa and sugar is heated at low fire with sufficient working and kneading till desired texture is attained. Peda is normally made into round balls of about 20-25 g size by rolling between the palms. Given below shows the flow diagram of a standardized batch method for making plain peda.

Fig. 6.3.2 Flow diagram of preparation of peda by traditional method
The following modifications in method of preparation of peda are made to meet special requirements.

- Sugar is added immediately after first boiling or before condensing of milk to develop more burnt and caramelized taste grainy texture. This method is used in Katch District of Gujurat.

- Khoa and sugar are cooked with or without ghee for a long time to obtain completely brown colour peda (Lal peda) of long quality. This method is adopted in Mathura (UP) and Dharwad (Karnataka) districts.

- For getting a white product, sugar is added to khoa and mixture is heated at relatively slow heat. Sometimes sodium sulphate (Ran bleaching agent) is also added for extra whiteness.

(b) Industrial/ Mechanized method: Recently some dairy plants have undertaken preparation of peda using mechanized units and Rheon shaping and forming other ingredients. They use planetary mixer for admixing sugar with khoa and also other ingredients. Different steps and equipment required for this industrial method of manufacture of peda, being adopted by Sugam Dairy, Baroda are shown in Fig 6.3.2.

In the process, khoa having about 72% TS is prepared on a continuous khoa making unit. In case such a high total solids is un-achievable, khoa with low TS is heated at 60°C in a steam jacketed kettle to obtain required TS. This khoa transferred to a planetary mixer and sugar @ 30% of khoa is added. These are mixed thoroughly. The flavouring/ colouring ingredients and other additives (depending on the type of peda and market demands) are properly mixed. The peda mass is then stored at 50°C for about 10 hours so that the temperature of whole lot is adjusted to about 40°C. This low temperature of product is considered necessary for proper functioning (forming/ shaping of peda balls) of Rheon machine. The peda balls are formed, wrapped and packed by automatic machine.

![Diagram of peda production process]

Milk → Continuous khoa making machine → Hot khoa (60°C) → Addition of sugar @ 30% of khoa → Flavour and other ingredients -> Planetary mixer → Mixture stored at 50°C for 10 hours → Rheon forming and packaging machine
6.3.5 Gulabjamun

Gulabjamun is popular sweet prepared in all parts of India. Like other sweets, the manufacture of gulabjamun is also largely in the hands of halwais who adopt small scale batch method. Though, there is large variations in the sensory quality of gulabjamun, the most likes product should have brown colour, smooth and spherical shape, soft and slightly spongy body free from both lumps and hard central core, uniform granular texture, mildly cooked and oily flavour, free from doughy feel and contain a piece of currant or cashew nut in the centre.

6.3.6 Kalajamun and Pantua

(i) Kalajamun

As the name reflects, it is also a khoa based sweet round in shape like gulabjamun but its colour is too dark, almost black like Jamun. It is also called as Kalajamun in certain parts of India. The sweet is sold without syrup. It is
method of manufacture is very much similar to that of gulabjamun with the exception that its deep fat fried at very high temperature for longer time, which results in too dark colour. The surface of kalajamun is hard with surface crust whereas the inside is soft and granular with stuffing. kalajamun is packaged and stored without sugar syrup.

![Fig. 6.5 Kala Jamun](image)

(ii) Pantoa

Pantoa has its origin in the eastern region of India. Its appearance is similar to gulabjamun but the ingredients used are different. The dough of pantua is made of a mixture of khoa and channa, along with other ingredients such as maida and backing powder.

![Fig. 6.6 Pantoa](image)

According to one method it consists of channa and khoa (40% each), maida (3%) arrowroot (3%), suzi (3%) ground sugar (0.6%) and baking powder (0.3%). The method of manufacture of pantua is almost same as of gulabjamun. The ingredients are properly kneaded to form dough of smooth consistency with about 40% moisture. Spherical balls of about 12 grams are prepared and
fried in vanaspati ghee at 120°C and after obtaining deep brown colour they are transferred to hot sugar syrup (60°C) having concentration of 550 Brix. The composition of pantua prepared by this method and of market samples is shown. Since channa is added along with khoa, the texture of pantua has more spongy and chewy characteristic than that of gulabjamun.

Table 6.3.6 Comparative chemical composition of pantua

<table>
<thead>
<tr>
<th>Constituents (%)</th>
<th>Laboratory prepared product</th>
<th>Market samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids</td>
<td>59.7</td>
<td>57.7-68.3</td>
</tr>
<tr>
<td>Fat</td>
<td>15.5</td>
<td>8-11</td>
</tr>
<tr>
<td>Proteins</td>
<td>8.7</td>
<td>6.7-7.9</td>
</tr>
<tr>
<td>Ash</td>
<td>0.67</td>
<td>0.32-0.53</td>
</tr>
<tr>
<td>Sucrose</td>
<td>27.1</td>
<td>37.8-43.6</td>
</tr>
<tr>
<td>Other carbohydrates</td>
<td>7.7</td>
<td>NA</td>
</tr>
</tbody>
</table>

6.3.7 Kalakhand

Kalakhand is also an important milk based sweet popular all over the country. Though, the chemical composition of kalakand is almost similar to burfi, the organoleptic characteristics of the two differ to great extent. Kalakand has more distinct cooked flavour, brown colour, greasy or moist body and grainy texture as compared with burfi. It is particularly characterized in its large size grains. So far no composition standards for kalakand have been laid down under either the PFA Act or the BIS.
(i) Chemical Composition

The gross composition of kalakand does not differ significantly from that of burfi. All those factors that are responsible for variations in the chemical composition of burfi and peda, also effect the composition of the kalakand.

(ii) Method of preparation

Buffalo milk is preferred for kalakand making. However the quality need not to be as fresh as required for burfi and peda. Slightly substandard or returned milk having titratable acidity up to 0.8% (no sour flavour) can be used for making kalakand.

Standardized buffalo milk (minimum 5 percent fat and 9.0 percent SNF) is taken in a kettle and heating started. On boiling, 0.1 percent citric acid, dissolved in small quantity of water, is added to the milk. If milk has developed acidity, there is no need to add citric acid. Boiling is continued with vigorous stirring ad scraping till pat formation stage. At this stage, sugar @ 6-7 percent is added to the contents of kettle and mass is spread over the surface. Nuts may be added at this stage and mixed properly. Kalakand so produced is removed to suitable trays for packaging.

6.3.8 Milk Cake

Milk cake resembles kalakand except for its colour and flavour. The colour of milk cake is more intense brown with horizontal of white or light down. It has distinct caramelized flavour and large size hard grains with typical gummy texture. Though milk cake is consumed all over the country, particularly in northern parts it has more preference.
6.4 Channa

Channa is an Indian traditional milk product formed by heat and acid coagulation of milk followed by draining of whey. It is used as a base and filler for the preparation of a large number of Bengali Sweets such as rasogulla, sandesh, rasmalai, cham cham, channa-murki, rajbhog etc. Its preparation is mainly confined to the cottage sector, largely in the eastern parts of India, notably West Bengal, Bihar and Orissa, and more recently in Bikaner district of Rajasthan. However, channa based sweets are gaining popularity in other parts of the country.

6.4.1 Standards of Channa

Prevention of Food Adulteration (PFA) Act does not differentiate between paneer and channa. The PFA Act terms channa as a product obtained from cow or buffalo by precipitation with sour milk, lactic acid or citric acid. It should contain not more than 70% moisture, and its milk fat content should not exceed 13 percent of the dry matter.

6.4.2 Chemical Composition of Channa

The chemical composition of channa is influenced by the type of milk, fat level milk, temperature of heating, condition for coagulation of milk, draining whey and moisture content in the finished product. The amount of whey removed and the fat loss in the whey indirectly affect the composition of channa. A comparative chemical composition of channa made from cow and buffalo milk is presented.

Table chemical composition of channa

<table>
<thead>
<tr>
<th>Product</th>
<th>pH</th>
<th>Moisture (%)</th>
<th>Protein</th>
<th>Fat</th>
<th>Lactose</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow milk Channa</td>
<td>5.7</td>
<td>53.4</td>
<td>17.4</td>
<td>24.8</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Buffalo milk Channa</td>
<td>5.4</td>
<td>51.7</td>
<td>14.4</td>
<td>2.3</td>
<td>1.9</td>
<td></td>
</tr>
</tbody>
</table>

Production of channa involves coagulation of casin along with entrapped fat and colloidal and water soluble components of milk (in proportion to the term retained such as lactose, whey proteins, minerals, and vitamins) by addition of suitable coagulant to hot milk, followed by draining of whey from the coagulated curd. Channa contains fairly high level of fat and proteins as well as some minerals. It is also a good source of fat-soluble vitamins A, D, E, and K. So, its nutritive value is fairly high. Its nutritive value is further enhanced by the entrapment of whey proteins that are rich source of essential amino acids. The nutritive value of channa is presented.
Table Nutritive value and channa and casein

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Channa</th>
<th>Casein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological value</td>
<td>88</td>
<td>--</td>
</tr>
<tr>
<td>Digestibility coefficient</td>
<td>92</td>
<td>--</td>
</tr>
<tr>
<td>PER value</td>
<td>3.1</td>
<td>2.8</td>
</tr>
<tr>
<td>NPU</td>
<td>71.5</td>
<td>83.54</td>
</tr>
<tr>
<td>NPR</td>
<td>5.25</td>
<td>4.55</td>
</tr>
<tr>
<td>Calorific value (k cal)</td>
<td>250-280</td>
<td>--</td>
</tr>
</tbody>
</table>

6.4.3 Factors affecting quality of channa

Cow milk is preferred for channa making because it yields soft and spongy body and smooth textured product, which is suitable for making channa based sweets. Buffalo milk because of many inherent differences in physio-chemical make up than that of cow milk, poses many technological problems in preparation of channa and channa based sweets. The quality of channa depends mainly on the initial composition of milk, type and quality of milk, the conditions of coagulation, the technique of straining/pressing and the losses of milk solids in the whey.

(i) Type of Milk

Cow milk produces channa with moist surface, light yellow colour, softy body, smooth texture and mildly acidic flavour. Cow milk channa is more suitable for Bengali sweets preparation than buffalo milk channa; the latter being hard in body and coarse in texture besides whitish in colour and a greasy surface. Sweets particularly rasogulla prepared from buffalo milk channa are comparatively hard, coarse hard, coarse and less spongy. Goat milk can also converted into acceptable quality channa, which is suitable for sweet preparation.

(ii) Quality of milk

Minimum fat level of 4 percent in cow milk and 5 percent in buffalo milk is necessary for producing good quality channa. The low fat milk results in a hard body and coarse texture in channa, whereas higher fat is also not desirable as it produces greasiness in the channa sweets. For manufacture of good quality channa, sweets milk (fresh milk is the best suitable raw material as developed acidity or sour milk tends to produce too acidic flavour and bitter taste, which makes it unsuitable for preparation of sweets). The addition of neutralizer to
acidic milk, however helps in obtaining channa which can be satisfactory is used for making sandesh of an acceptable quality. The adulteration of milk with starch results in a gelatinous mass on coagulation, which is undesirable for sweet making. The mixing of colostrum in milk tends to produce a weak and pasty body and texture in the coagulated mass, which exhibits its unsuitability for sweet making.

(iii) Type of Strength of Coagulant

The body and texture of channa is influenced by the conditions of coagulation such as pH of coagulation strength of coagulating solution, type of acid, speed with which the milk is stirred during coagulation and temperature and time of coagulation. In order to obtain desirable body and mixture its should be sufficiently heated near the boiling temperature for better protein-to-protein interaction. The optimum pH of coagulation of milk is around 5.4 and temperature of coagulation is about 82°C. The coagulation of milk should be affected with in one minute with gentle stirring. A satisfactory strength of coagulating acid solutions is 1-2 percent. Lactic acid tends to produce a granular texture which is desirable for rasogulla making whereas, citric acid tends to produce a partly product, which is suitable for Sandesh manufacture.

Generally organic acids like citric, lactic or their slats (calcium lactate), lemon juice and sour whey are used as coagulant. Sour whey with about 0.9 percent acidity is most widely used for channa making. Calcium lactate is another commonly used coagulant.

The concentration of coagulant solution is also an important factor which affects the quality of channa. Low acid strength (0.5%) results in very soft body and smooth texture suitable for rasogulla but unsuitable for sandesh making, while high acid strength (8 percent) results in hard body and less smooth texture, suitable for sandesh making and for rasogulla. The optimum strength of coagulant solution should be between 1 to 2 percent citric acid or Lactic Acid to produce good quality channa suitable for making both kinds of sweets. To get satisfactory quality channa from buffalo milk, 1 percent citric acid solution or 0.5 percent lactic solution is recommended. Sour whey of 0.9 percent acidity is suitable for channa making. Six percent calcium lactate solution produces most satisfactory quality channa.

The amount of coagulant required to achieve optimum coagulation depends upon the type of milk also on its acidity and buffering capacity. Usually 2.5 to 3.5 of citric acid or 3.0 to 3.9 g of lactic acid per litre of milk is necessary for complete coagulation. The requirement of acid is lower in case of buffalo milk. Nearly 600 ml of sour whey is needed to produce suitable quality channa
from 1 litre of milk. The quantity will largely depend upon the extent of acidity developed in the sour whey. About 6 to 12% of calcium lactate is required per kg of milk for coagulation, depending on the coagulation temperature.

(iv) Coagulation Temperature

Channa of satisfactory quality from cow milk can be obtained at a coagulation temperature of about 80°C. The optimum coagulation temperature for making channa from buffalo milk is around 50°C. The amount of coagulant required for completing the coagulation of milk increases with the lowering of coagulation temperatures. As the coagulation temperature decreases, the moisture retention in channa increases leading to its softer body and smoother texture.

(v) pH of Coagulation

The optimum pH for channa making from cow and buffalo milk is 5.4 and 5.7 respectively. The pH of coagulation principally regulates the moisture content and the body and texture which are best obtained at the above pH. An optimum of 5.3 has been reported when making channa from cow milk using calcium lactate as coagulant. Higher speed of stirring during coagulation reduces the moisture content in channa and increases its hardness, whereas, with lower speed the reverse holds true. Slow stirring (40-50 rpm) is preferred to avoid foam formation.

(vi) Method of straining

The method of straining of coagulated mass affects the body and texture of paneer, moisture retention and solids recovery in channa. The coagulated mass should be collected in fine cloth and hung to remove moisture.

In case of channa, external pressure is not applied for removal of moisture from the coagulated mass. Method of straining is an important factor which affects the body and texture of channa by influencing the moisture retained it. In general two types of straining is employed viz. Immediate or delayed. Immediate straining is carried by promptly gathering the coagulated mass and tying it up and a piece of fine cloth and then hung up for draining out the whey and cooling the channa. In case of delayed straining process, the coagulated mass is left in whey either as such or loosely enclosed in piece of cloth, so as to cool it to ambient temperature and thereafter it is hung for removal of whey. The delayed straining results in more retention of moisture in channa as compared to immediate straining method. Delayed straining produces a comparatively soft and smooth texture channa than immediate straining. Higher moisture increase moisture, increased yield, improved texture recovery of solids and lower hardness in channa is contained when delayed straining is employed. Channa made by
6.5 Channa Based Sweets

6.5.1 Introduction

Channa is used as base and filler for the preparation of large number of Bengali sweets such as rasogulla, sandesh, rasmalai, rajbhog, chann murki, cham cham etc. In the channa based sweets, milk protein constitute the basis of structure and texture of the product. Depending on the texturization process adopted during manufacture. The end product may be fibrous and chewy with good water holding characteristic and grainy with low water binding properties such as channa murki. The textural characteristics such as rasogulla and rasmalai and on the other hand end product maybe soft, hard and grainy with low water binding properties such as channa murki. The textural characteristic of the end product can be manipulated by including small amount of additives such as starch, flour, amylase, CMC etc. The milk fat also influences the textural profiles as well as the flavour of the end product.

6.5.2 Rasogulla

Rasogulla is undoubtedly the most popular traditional Indian milk sweet prepared from channa. It is undisputed king not only of Bengali sweets but also of all Indian sweets. This soft, sweetest ball of channa soaked in sugar syrup has delighted the taste buds of millions of sweet loving clientele for more than hundred years. It is difficult to trace the origin an history of this sweet, however according to a report, it was made for first time in 1868 in Kolkata at present known as ‘Bag-Bazar’ by the sweet confectioner - Mr. Nobin Chandra Das. There are various types of rasogulla sold in the market. These include ordinary type, spongy variety covered with syrup and diabetic rasogulla. Spongy rasogulla differs in terms of taste, texture body and succulence as compared to ordinary rasogulla. Diabetic rasogulla is prepared by replacing sucrose with low caloric sweetners or with alcoholic sugar such as sorbitol to cater the need people suffering from diabetes or health conscious consumers. The Bureau of Indian standards (BIS) has laid down the standards for a rasogulla, which are presented.

BIS standards for Rasogulla

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>45-55%</td>
</tr>
<tr>
<td>Milk fat</td>
<td>5%</td>
</tr>
<tr>
<td>Sucrose</td>
<td>45%</td>
</tr>
<tr>
<td>Protein</td>
<td>5%</td>
</tr>
</tbody>
</table>
Requirement for syrup

- Acidity of syrup (ml of N/10 NaoH required to neutralize 100 ml of the syrup) max: 6.0
- Concentration of syrup (max): 550 Brix
- Coliform count, per gram (max): NIL

Method of preparation

Rasogulla is prepared from soft and freshly made channa. Cow milk is preferred for the production of rasogulla because it gives soft, spongy and juicy product. Use of channa made from buffalo or mixed milk is avoided because of its somewhat hard body and coarse and grainy texture. As such buffalo milk channa is not suitable for rasogulla making. Now, attempts have been made to develop new methods of production of rasogulla from buffalo milk.

For rasogulla production, channa is kneaded into smooth paste and then small balls of about 15-20 mm diameter and 10-12 grams in weight are made. The surface of balls should be smooth and free from any cracks. In case of buffalo milk channa, arrowroot, semolina, and baking powder are mixed and kneaded manually to a smooth paste. One kg of channa yields about 90-100 rasogullas. Rasogulla balls are cooked in sugar syrup having 50-60 percent sugar concentration for about 15-20 minutes.

During cooking, a small amount of water is continuously added to maintain sugar concentration. This make up for the loss of water due to evaporation. About 10 percent of cooking solution is replaced by fresh one, every time it is reused to cook another batch or rasogulla.

After cooking rasogulla balls are soaked in 40-45 percent sugar syrup for about 1-23 hours. The rasogulla are cooled to room temperature and finally stored at refrigeration temperature. The flow diagram for manufacture of rasogulla from cow milk and buffalo milk is presented in fig 7.1 and 7.2 respectively.
(ii) Rasogulla Mix Powder

In order to meet the demand of rasogulla around the year and also to make the product at place of scarcity, R&D studies have been undertaken to develop a process for production of dried rasogulla mix. Skim milk is concentrated to desired total solids level by using ultrafiltration process. The retentate is standardized for desired level of fat using the cream. This mixture is spray dried. Certain additives and binders are dry blended in the standardized retentate powder to yield dried rasogulla mix. Rasogulla prepared from milk powder is reported to yield good flavour and soft and spongy body and texture.

(iii) Yield

The yield of rasogulla is about 260 grams per 100 gram of cow milk channa. In case of buffalo milk, the yield of rasogulla is about 240 grams/100 grams of channa.

Channa cow milk

```
Cow Milk
↓
Standardization (3.5-4.0% fat)
↓
Boiling
↓
Filtration
↓
Cooling (80°C)
↓
Coagulation (0.5 - 1.0% citric acid solution)
↓
Draining
↓
Cooling of coagulum
↓
Draining
↓
Channa (55-58% moisture)
↓
Kneading
↓
Balls making (8-10 g each)
↓
Cooking of balls (50-60% syrup for 15-20 min)
↓
Soaking in syrup
↓
Cooling
↓
Storage
```
Sandesh is the most popular channa based sweet delicacy of the eastern parts of India, especially West Bengal where there is a traditional custom to send some ‘Sandesh’ along with a good message to relatives and friends. Utilization of channa for sandesh production is greater than for all the Bengali sweets, including rasogulla. It is estimated that, about 80 % of channa produced in Kolkata is converted into sandesh.

Sandesh is known for its taste, palatability and aroma as rich source of milk protein, fat, sucrose, and fat-soluble vitamins. It has firm body and smooth texture, palatability and composition. Three distinct varieties of sandesh are
popular: soft grade (naram-pak) hard grade (kara-pak) which has a soft body and smooth has higher moisture content than he hard grade sandesh. Kara-pak has firm body and dry appearance. Kachagola possesses raw-channa like flavour moist appearance, soft body and coarse, grainy texture.

(i) Sandesh from cow Milk

Cow milk is standardized to 4.0 percent fat and thereafter channa is prepared by coagulation at 80°C using 2.0 percent citric acid solution or pasteurized sour whey. Channa is kneaded or ground into smooth paste and divided into two equal lots. Ground sugar, at the rate of 30 percent of total weight of channa is mixed with one lot of channa. The mixture is then slowly cooked with continuous stirring and scraping in a shallow vessel and the temperature is raised upto 75°C. When patting stage has reached, the second lot of channa is also mixed to it. Heating and scraping of this mixture is continued till a final temperature of 60°C is attained. There after the mix is cooled to room temperature and moulded in desired shape and size. The production process of soft grade sandesh is presented.

(ii) Sandesh from buffalo milk

For making good quality sandesh from buffalo milk, the process for making channa is slightly modified. The buffalo milk is standardized to 4.0 percent fat and heated to boil. When boiling has attained it is discontinued, and milk is diluted with water (30 percent the volume of milk). The diluted milk is then coagulated at 70°C using channa thus obtained mass is kneaded to smooth paste. The remaining steps are same as to that of cow milk sandesh production.

```
Channa
| Grinding/Kneading to smooth paste |
| Dividing into two equal parts    |
| Addition of sugar               |
| Cooking (75°C)                  |
| Addition of remaining channa    |
| Heating (60°C)                  |
| Cooling (37°C)                  |
| Mouldings/hooping/Slicing       |
| Storage (5-6°C)                 |
```
(iii) Yield

The average yield of sandesh from cow and buffalo milk is about 16.50 and 20.50 percent, respectively.

(iv) Composition

The chemical composition of sandesh from cow and buffalo milk.

**Table Chemical composition of sandesh from cow or buffalo milk**

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Cow milk</th>
<th>Sandesh Buffalo milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>25.50</td>
<td>27.14</td>
</tr>
<tr>
<td>Fat</td>
<td>19.90</td>
<td>18.50</td>
</tr>
<tr>
<td>Protein</td>
<td>18.50</td>
<td>19.75</td>
</tr>
<tr>
<td>Sugar</td>
<td>34.50</td>
<td>33.80</td>
</tr>
<tr>
<td>Ash</td>
<td>1.65</td>
<td>1.90</td>
</tr>
</tbody>
</table>

The chemical profile of market samples of three types of sandesh is presented in table.

**Table Chemical profile of market sample of sandesh**

<table>
<thead>
<tr>
<th>Attributes (%)</th>
<th>Soft grade</th>
<th>Hard grade</th>
<th>Kachagola</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>24.10</td>
<td>13.40</td>
<td>33.90</td>
</tr>
<tr>
<td>Fat</td>
<td>18.70</td>
<td>20.50</td>
<td>15.50</td>
</tr>
<tr>
<td>Protein</td>
<td>16.10</td>
<td>16.70</td>
<td>12.80</td>
</tr>
<tr>
<td>Sucrose</td>
<td>38.60</td>
<td>46.40</td>
<td>35.80</td>
</tr>
<tr>
<td>Ash</td>
<td>1.70</td>
<td>1.70</td>
<td>1.40</td>
</tr>
<tr>
<td>Titratable acidity(%LA)</td>
<td>0.88</td>
<td>0.82</td>
<td>0.70</td>
</tr>
<tr>
<td>FFA (OA)</td>
<td>0.41</td>
<td>0.34</td>
<td>0.46</td>
</tr>
<tr>
<td>Free fat (percent of total fat)</td>
<td>68.60</td>
<td>80.80</td>
<td>56.90</td>
</tr>
</tbody>
</table>
6.5.4 Definition and method of manufacture of Rasmalai

(i) Definition

Rasmalai is a channa based sweet prepared essentially by suspending flat circular shaped rasogulla in sweetened condensed milk. Rasmalai is popular all over India, particularly in eastern and northern parts. It is very delicate, spongy and chewy sweet that has detectable taste. It is also flavoured with saffron and pista. The product is refrigerated and served chilled.

(ii) Method of manufacture

Milk is heated with continuous stirring in open pan to evaporate to about one-half of its original volume. At this stage sugar is added at the rate of 4.0% of original milk. The heating and stirring is continued at slow fire till content is reduced to about one-third of its original volume. The addition of sugar during heating imparts pleasant flavour and palatable taste to the end product. Subsequently flat circular shape rasogulla is added to this concentrated milk and content is further heated for few minutes (2-5min). Thereafter, the container is removed from the fire and content is allowed to cool to room temperature, chilled and stored under refrigeration. The product is served chilled. Rasmalai has limited shelf life of 3-5 days. The flow chart for manufacture of Rasmalai is presented.

Flow chart for manufacture of rasmalai

```
Milk
↓
Evaporation concentration (50% of its original volume)
↓
Addition of sugar (4% or original milk)
↓
Addition of flat rasogulla
↓
Heating (2-5min)
↓
Cooling / Chilling
↓
Packaging
↓
Storage (4-6°C)
```
6.5.6 Definition and method of manufacture of channa murki

(i) Definition

hanna-murki is a sugar-coated sweet. This product is very popular in the northern parts of the country. It is mainly served during weddings and feasts. Channa-murki has the shape of small cubes coated with sugar and has a firm body and close-knit texture. Buffalo milk is preferred for the preparation of this sweet.

(ii) Manufacture

Channa or paneer is cut into small cubes of about 10. The cubes are cooked in boiling sugar syrup (of 3 strings consistency) in an open vessel (Karahi) for about five minutes with gentle stirring. The vessel is removed from the fire and stirring is continued till the sugar is coated uniformly around the cubes. The cooked cubes are then removed from syrup. After cooling, a few drops of Kewara flavour are sprinkled. The product may be coloured using food grade colour in sugar syrup. The final product contains moisture 13.3%, fat 17.4%, protein 11.6%, sugar 56.1%, and ash 1.6% percent. The flow chart for manufacture of channa murki is presented in.

6.5.7 Let us Sum up

Channa is used as an intermediate base for preparation of a wide variety of milk-based Bengali sweets. Its preparation is mainly confined, largely in the eastern parts of India, and more recently in Bikaner district of Rajasthan. It is
claimed that the production of rasogulla in Bikaner is more than the kolkata, where cow milk is available in large quantity. However, channa based sweets are quite popular in other parts of India. India’s total production of channa is estimated at 200,000 tonnes and the value of channa-based sweets, around Rs.70,000 million. Channa is used as a base and filler for the preparation of large number of Bengali sweet such as channa-based sweets, milk protein constitutes the basis of structure and that of the product.

Rasogulla, which is soft, sweet ball of channa soaked syrup has delighted the taste buds of millions of sweet loving clientele for more than hundred years. There are various types of rasogulla sold in the market. They include ordinary type, spongy variety, covered with syrup and diabetic rasogulla. Spongy rasogulla differs in terms of taste, texture body and succulence as compared to ordinary rasogulla. Diabetic rasogulla is prepared by replacing sucrose with low calorie sweetener or with alcoholic sugar such as sorbitol to cater the people suffering from diabetes or health conscious consumers.

Cow milk is preferred for the production of rasogulla because it gives softy, spongy and juicy product. Use of channa made from buffalo or mixed is avoided because of its some what hard, coarse and grainy body and texture. As such buffalo milk channa is not suitable for rasogulla making. Now attempts have been made to develop new method for production of rasogulla from buffalo milk. Rasogulla mix powder has been developed form skim milk concentrated to desired level of fat use cream. This mixture is spray dried. Certain additives are dry blended in the standardized retentate powder to yield dried rasogulla mix.

Sandesh is the most popular channa based sweets delicacy of the eastern parts of India, especially West Bengal. Sandesh is known for its taste, palatability and aroma and as rich source of milk proteins, fat, sucrose, and fat-soluble vitamins. It has firm body and smooth texture. Several varieties of sandesh are sold in the market and each variety differs in appearance. Flavour, body and texture, palatability and composition. Three distinct varieties of sandesh are popular, soft grade (naram pak) hard grade (Kara pak) and raw grade (Kachagola).

Rasmalai is a channa based sweet prepared essentially by suspending flat circular shaped rasogulla in sweetened condensed milk. It is very delicate, spongy and chewy sweet that has a detectable taste. It is also flavoured with saffron and pista. The product is refrigerated and served chilled. Channa-murki is a sugar-coated channa based sweet. It is mainly served during weddings and feasts. Channa - murki has the shape of small cubes coated with sugar and has
a firm body and close-knit texture. Buffalo milk is preferred for the preparation of this sweet.

### 6.6 Paneer

Paneer refers to the milk product obtained by the acid coagulation of hot milk and subsequent drainage of whey. The acids commonly used are citric, lactic, acetic etc., and sour whey or cultured whey can also used for coagulation of milk. The phenomenon of coagulation involves the formation of large structural aggregates of proteins in which milk fat and other colloidal and soluble solids are entrained with whey.

![Fig 6.11 Paneer](image)

Paneer is a popular indigenous variety of soft cheese. Cheese manufactured using high heat, acid precipitation and without starter culture is practiced in many countries of South Asia and Central and South American Latin America. White cheese, found throughout South and Central America and Mexico and the Caribbean Islands is a product that is quite similar to paneer. Nomads of South West Asia regions to product the first to develop several distinctive cheese varieties. One of the unique Iranian nomadic cheese is called paneer Khiki. It was originally developed by the well-known Bakhtiar tribe that resided in Isfahan (in summer) and Sharz (in winter) when salted, it is known as paneer-e-shour. While paneer is a staple food of Nomads in Afghanistan. When made from raw milk, it is called paneer-e-khom, and from boiled milk, paneer-e-pokhta. Paneer is traditionally consumed in these countries with dry fruits and nuts in form of desert. The earliest form of paneer might have obtained by curdling milk with a little sour milk, piece of creeper called putika, bark of Palasa tree or Kuyala (Jujuka).
It may be conjectured that term paneer was introduced into India by the Persian and Afghan invaders who came through Baluchistan and Karakoram mountain pass of Himalaya. It is probably for this reason that, paneer making practice is mainly confined to the North West Frontier region of India, and so southern parts of Jammu and Kashmir due to the influence of foreign settlers in these regions. However it was only during the past five decades that paneer has spread to other parts of India and enjoys the status of national culinary dish in the country. It is vegetarian delight.

6.6.1 Standards of paneer

The regulatory standards for paneer and channa are identical. It has been defined under the prevention of food Adulteration Act (PGA) 1954, as paneer means the product obtained from cow or buffalo milk or a combination of precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0 percent moisture and milk fat content shall not be less than 50.0 percent of the dry matter.

Skim Milk Paneer

Skimmed milk paneer means the product obtained from cow or buffalo skimmed milk by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0 percent moisture. The milk fat content of the product shall not exceed 13.0 percent on the dry matter basis.

6.6.2 Chemical composition of paneer

If is made without starter culture or rennet and results from the acid precipitation of milk temperatures. The phenomenon of coagulation involves the formation of large structural aggregates of proteins in which milk fat and other colloidal and soluble solids are entrained with whey. Good quality paneer is characterized by a typical mild acidic flavour with a slightly sweet taste. It has firm, cohesive and spongy and a closely knit, smooth texture. Paneer is a highly nutritious and wholesome food. It is rich source of milk protein and milk fat is one of the best method of conserving milk solids in highly concentrated form. Paneer is used as a base material for the preparation of large number of culinary dishes. Paneer contains on a average approximately 54.0 percent moisture 27% milk fat, 17.5 percent proteins 1.5 percent minerals and lactose.

The chemical composition of paneer depends mainly on the type of milk, composition of milk. The condition of coagulation the technique of straining/pressing and the losses of milk solids in the whey. An average chemical composition of paneer given in table.
Table 6. Typical chemical composition of paneer

<table>
<thead>
<tr>
<th>Product</th>
<th>Moisture (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Lactose (%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paneer (Buffalo milk)</td>
<td>52.3</td>
<td>27.0</td>
<td>15.8</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Paneer (cow milk)</td>
<td>52.5</td>
<td>25.0</td>
<td>17.3</td>
<td>2.2</td>
<td>2.0</td>
</tr>
</tbody>
</table>

6.6.3 Factors Affecting quality of paneer

Good quality paneer is characterized by a white colour, mildly acidic, nutty flavour, spongy body and closely-knit texture. Paneer is best made from buffalo milk. Cow milk yields an inferior product in terms of body and texture. It is criticized to be too soft, weak and fragile and unsuitable for frying and cooking. The quality of paneer depends mainly on the initial composition of milk, type of the milk, the conditions of coagulation the technique of straining/pressing and the loss of milk solids in the whey.

A minimum of 5.5% fat in buffalo milk and 4.5% fat in cow milk is necessary for producing a desirable good quality paneer where as a lower fat level than the above in the milk results in the hard body and coarse texture with increased chewiness. The higher fat content in milk is also not desirable since it produces greasiness, softness and weak body and texture in paneer. The higher fat in milk results in more loss of fat in whey.

The various technological parameters affecting the quality of paneer are discussed here under fat. Level in milk. The fat content of paneer increases with the increase in fat level in milk while the protein and carbohydrate percentage decreases. To meet the PFA standards for paneer which require a minimum of 50% fat on dry matter basis, a minimum of 5.8 percent fat in buffalo milk having 9.0% SNF is essential. A fat : SNF of ratio of 1 : 1 : 65 has to be maintained. High values of fat in the milk for paneer making would result in unnecessary economic loss to the paneer trade. Higher fat in milk also results in lower moisture retention in paneer and, therefore a loss in term of yield. Paneer of good quality can never hold moisture beyond 60 percent and thus the value of 70% as the maximum limit for moisture in paneer as stipulated in PFA standards as appears to be too high.
Table 6.69 Effect of fat content of milk of paneer composition

<table>
<thead>
<tr>
<th>Fat in milk</th>
<th>Moisture</th>
<th>Fat</th>
<th>Protein</th>
<th>Ash</th>
<th>FDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>54.6</td>
<td>22.2</td>
<td>18.9</td>
<td>1.9</td>
<td>48.7</td>
</tr>
<tr>
<td>5.8</td>
<td>54.1</td>
<td>23.5</td>
<td>18.2</td>
<td>2.4</td>
<td>51.2</td>
</tr>
<tr>
<td>6.0</td>
<td>53.2</td>
<td>17.9</td>
<td>2.3</td>
<td>1.7</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Fat on Dry Matter Basis

(i) Heat treatment

The yield and total solids recovery increases with increase in heating temperature while solids in whey decreases. This is due to complex formation between whey protein and casein. At higher temperature, casein act as scavenger for serum proteins, which are otherwise lost in whey. Temperatures beyond 90°C, however, cause deposition of milk solids on the heating surface resulting in an overall solids loss. Milk heated at 90°C without any holding surface resulting in paneer with a total solids recovery of about 66.0%. The recovery does not increase appreciably on holding the milk at 90°C and is, therefore, not required.

(ii) Temperature of Coagulation

The moisture and yield of paneer decrease consistently with an increase in temperature of coagulation as shown. The recovery of total solids increase directly with the coagulation temperature while the solids loss in whey decreases. The coagulation temperature is conspicuous on the body and texture of paneer. Coagulations at 60°C results in paneer with a very soft, loose and weak body and also more loss of solids in whey. Coagulation temperature higher than 70°C results in hard and dry paneer. Coagulation at 71°C produces desirable body and texture characteristics in paneer.

Table Effect of coagulation temperature on yield and solids recovery of paneer

<table>
<thead>
<tr>
<th>Coagulations Temp. °C</th>
<th>Moisture</th>
<th>Yield</th>
<th>T.S. Recovery</th>
<th>T.S. in Whey</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>59.5</td>
<td>22.8</td>
<td>59.9</td>
<td>6.2</td>
</tr>
<tr>
<td>70</td>
<td>55.1</td>
<td>21.7</td>
<td>63.0</td>
<td>6.0</td>
</tr>
<tr>
<td>80</td>
<td>49.9</td>
<td>20.1</td>
<td>65.3</td>
<td>5.9</td>
</tr>
<tr>
<td>90</td>
<td>48.8</td>
<td>20.0</td>
<td>66.3</td>
<td>5.8</td>
</tr>
</tbody>
</table>
(iii) **pH of coagulation**

The pH of coagulation effects the yield. Solids recovery and quality of paneer. Paneer obtained on a coagulation above pH 5.4 is not favourable and has a soft, weak and crumbly body. When coagulated at pH 5.1 paneer has a coarse flavour and a hard body. The optimum solids recovery and sensory properties are obtained when the pH of coagulation is in the range of 5.30-5.35. Approximately which is required per litre milk for achieving the proper coagulation.

(iv) **Type of strength of coagulants**

Strong solutions of citric acid results in paneer with acidic taste, hard body and higher losses in whey. Diluted solutions (0.5 percent) give slightly better solids recovery but the volume of the coagulant required increases too much making handling difficult. A solution of 1 percent concentration is optimum for effective coagulation to get good manufacture of paneer without any loss of its yield and quality. These include inorganic acids such as hydrochloric and phosphoric (0.6 percent solutions) and acidophilus whey. Hydrochloric acid is the most economical among the chemical coagulants. The use of citric acid in partially sourced whey instead of water reduces the requirement of citric acid and increases the solids recovery without any loss of paneer quality. Whey cultured with Lactobacillus acidophilus @ 2 percent and incubated overnight at 37°C can be effectively used as substitute for citric acid lactic acid.

(v) **Method of straining/Pressing**

The straining and pressing of coagulated mass effect the body and texture of paneer, moisture retention and solids recovery in paneer. The coagulated mass should be collected in fine both or hoop with fine cloth and gently pressed with appropriate application of weight pressure.

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### 6.7 Kheer

#### 6.7.1 Definition

Kheer is an Indian dessert prepared by the partial dehydration of whole milk in a Karahi over a direct fire together with sugar and usually rice or occasionally semolina. It is popular throughout the country.

#### 6.7.2 Chemical composition

The average chemical composition of laboratory made kheer (prepared under standardized conditions in a stainless steel kettle).
Chemical composition of Kheer (percentage)

6.7.3. Food and nutritive value

Containing all the solids of milk, is an approximately two-fold concentration plus additional sugar the food nutritive value of kheer is fairly high.

6.7.4 Standardized method of preparation

1. Fresh, sweet, cleaned milk (cow or buffalo) is standardized to 4.0 percent fat and vigorously boiled in a jacketed stainless steel pan or kettle for at boiling 37\textdegree c or 3 to 5 minutes accompanied by constant stirring-cum-scraping with a Khunti. High grade (preferably basmati) rice @ 2.5 percent of milk, pre-cleaned and washed with cold water before use, is now added. The mixture is gently boiled, with periodical stirring-cum-scraping. When the concentration is about 1.8:1, clean good quality sugar is added @ 5 percent of milk. Gentle heating is continued for another 3 to 5 minutes till a final concentration of about 2:1 is obtained. Heating should be stopped somewhat before this stage, depending on the manufacturers judgement. The kheer should now be packed and then stored under refrigeration.

Fig 6.12 Kheer

6.7.5 Yield

The yield of kheer is highly variable depending on the percentage of total solids of milk the amount of rice/ semolina and sugar added and the ratio of concentration of the mixture required to arrive at the desired consistency (adjusted by experience) in the finished product. If the ratio of concentration is about 2, yield of the finished kheer should be about 50 percent of the milk used.
67.6 Keeping Quality

The average shelf-life of kheer is 2 to 3 days at 37 ± 10°C and 10 to 15 days at 4 ± 10°C. Its storage life could be increased significantly by the addition of niacin (to the hot product at the end of the manufacturing process and before packaging).

6.4.7 Uses

For direct consumption as a dessert.


6.8.1 Kulfi

This is an indigenous ice cream frozen in small containers, while the milk is boiling, it is sweetened by an addition of sugar and the product is concentrated to approximately 2 : 1. To this concentrate when it has cooled are added malai (indigenous cream) crushed nuts and a flavour (commonly rose or vanilla). The mix is placed in triangular, conical or cylindrical moulds are closed capacities made of galvanized iron sheets. The moulds are closed on top by placing a small disc over them and the edges made air tight with wheat-dough. (Modern moulds are made of plastic, generally conical in shape with screw-up plastic tops). The mix-in-mould is frozen in a large earthen vessel containing a mixture of ice and salt in the ratio of 1 : 1.

Note: Malai refers to the creamy layer formed on the surface of milk, which has usually been heated, very slowly, to boiling temperatures and then left to cool undistributed. This creamy layer is then skinned off and finds various uses, viz for direct consumption with sugar, as a source of cream in sweets, puddings and fruit, in the preparation of kulfi malai-ka-baraf etc. Owing to its higher fat content and larger fat globules, buffalo milk gives higher yield and is used for the preparation of malai. According to the PFA Rules (1976), malai

6.8.2 Malai-ka-baraf

This term is loosely applied to a variety of frozen products in which sweetened milk or malai may form the chief ingredient. They may also be prepared from diluted milk thickened with some fruit pulp etc., with a dash of colour and flavour. (The latter kind is usually sold in the market).

A compact cast-iron freezing unit, which is generally an important one consist of a retort connected to an especially designed condenser, is used for
freezing the mix. In rough outline, the method of freezing (in closed system) consists of an outline, the method containing some crude ammonium salts over an open fire, while the condenser is kept immersed in tube of cold water. This heating goes on for nearly 3 hours. Thereafter, the condenser is taken out of the tub and the vessel containing the mix is placed in the annular space in cold water provided in the condenser and the retort. Some wet cloth or gunny is put on the vessel containing the mix. The freezing vessel, wrapped with an insulating material such as paper and felt, and sold by chipping out slices with a sharp knife.

Note: In the first stage when the retort containing ammonium salts is heated, ammonia gas is liberated. This changes into liquid ammonia as it reaches the cooler parts of the condenser. In the second stage, when the condenser comes in contact with atmospheric air, the liquid ammonia evaporates, while doing so, the latent heat for vaporization is extracted from the mix, which then freezes.

Fig 6.13 Kulfi
**Comparison and contrast between ice cream and kulfi/malai-ka-baraf.**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Ice cream</th>
<th>Kulfi/Malai-ka-baraf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of frozen product</td>
<td>Western</td>
<td>Indigenous</td>
</tr>
<tr>
<td>Composition</td>
<td>Standard</td>
<td>Variable</td>
</tr>
<tr>
<td>Scale of Manufacture</td>
<td>Usually large</td>
<td>Usually very small</td>
</tr>
<tr>
<td>Freezer used</td>
<td>Modern batch or continuous</td>
<td>Crude indigenous or imported</td>
</tr>
<tr>
<td>Sequence followed</td>
<td>Freezing first, packaging later</td>
<td>Packaging first, freezing later</td>
</tr>
<tr>
<td>Sanitary conditions followed</td>
<td>Usually high</td>
<td>Usually low</td>
</tr>
<tr>
<td>Overrun</td>
<td>Standard</td>
<td>Practically nil</td>
</tr>
<tr>
<td>Body and texture</td>
<td>Usually soft and smooth</td>
<td>Usually hard and coarse</td>
</tr>
<tr>
<td>Food and nutritive value</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Short Answer Type Questions**

1. Mention any four Khoa based sweets.
2. Define “Somdesh”.
3. Define “Kheer”.
4. Write the chemical composition of pantoa.
5. Mention the composition of Channa.
6. Define “Rasmalia”.
7. What is “Kulfi”?
8. Define “Paneer”.

**Long Answer Type Questions**

1. Write the preparation method of “Khoa”.
2. Explain the method of preparation of “Burfi”.

**Particulars**

<table>
<thead>
<tr>
<th>Type of frozen product</th>
<th>Composition</th>
<th>Scale of Manufacture</th>
<th>Freezer used</th>
<th>Sequence followed</th>
<th>Sanitary conditions followed</th>
<th>Overrun</th>
<th>Body and texture</th>
<th>Food and nutritive value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>Western</td>
<td>Standard</td>
<td>Usually large</td>
<td>Freezing first, packaging later</td>
<td>Usually high</td>
<td>Standard</td>
<td>Usually soft and smooth</td>
<td>High</td>
</tr>
<tr>
<td>Kulfi/Malai-ka-baraf</td>
<td>Indigenous</td>
<td>Variable</td>
<td>Usually very small</td>
<td>Packaging first, freezing later</td>
<td>Usually low</td>
<td>Practically nil</td>
<td>Usually hard and coarse</td>
<td>Low</td>
</tr>
</tbody>
</table>
3. How do you prepare “Gulab Jamun”.
4. What are the factors effecting the quality of Channa?
5. Write the preparation method of “Rasogulla”.
6. Explain the method of preparation Sandesh from Buffalo milk.
UNIT 7

Dairy By Products

Structure

7.1 Classification of dairy by products
7.2 Skim-Milk utilization
7.3 Whey-Utilization
7.4 Butter milk- Utilization
7.5 Ghee residue -utilization

Learning Objectives

After studying this unit, the student will be able to

- Understand about classification of dairy of products.
- Know about skim-milk utilization.
- Know about Whey, Butter milk and ghee residue and their utilization.

7.1 Classification of dairy by products

(a) The important dairy by-products in developed dairying countries is given in Table 7.1

(b) The by-products of the Indian dairy industry are give in Table 7.2
### Table 7.1

<table>
<thead>
<tr>
<th>Main Product</th>
<th>By-product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cream</td>
<td>Skim milk</td>
</tr>
<tr>
<td>Butter</td>
<td>Butter milk</td>
</tr>
<tr>
<td>Cheese</td>
<td>Whey</td>
</tr>
<tr>
<td>Casein</td>
<td></td>
</tr>
</tbody>
</table>

### Table 7.2

<table>
<thead>
<tr>
<th>Main Product</th>
<th>By-product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cream</td>
<td>Skim milk</td>
</tr>
<tr>
<td>Butter</td>
<td>Butter milk</td>
</tr>
<tr>
<td>Ghee</td>
<td>Lassi, Ghee</td>
</tr>
<tr>
<td>Cheese</td>
<td>Whey</td>
</tr>
<tr>
<td>Casein</td>
<td></td>
</tr>
</tbody>
</table>

#### 7.2 Skim-Milk utilization (By-Products and their utilization)

<table>
<thead>
<tr>
<th>By Product</th>
<th>Principle of utilization</th>
<th>Food products made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim milk</td>
<td>Pasteurization</td>
<td>Flavoured milk</td>
</tr>
<tr>
<td></td>
<td>Sterilization</td>
<td>Sterilized flavoured milk</td>
</tr>
<tr>
<td></td>
<td>Fermentation</td>
<td>Cultured butter milk, Acidophillus milk, Bulgarian butter milk</td>
</tr>
<tr>
<td></td>
<td>Concentration</td>
<td>Plain condensed skim milk, low lactose condensed milk</td>
</tr>
<tr>
<td></td>
<td>Drying</td>
<td>Dried skim milk</td>
</tr>
<tr>
<td></td>
<td>Coagulation or/and</td>
<td>Cottage cheese</td>
</tr>
<tr>
<td></td>
<td>Fermentation</td>
<td>Chakka</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quarg, Dahi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Casein</td>
</tr>
<tr>
<td>Butter milk</td>
<td>Fermentation and</td>
<td>Lassi, dahi, condensed buttermilk</td>
</tr>
<tr>
<td></td>
<td>concentration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drying</td>
<td>Paneer, soft cheese</td>
</tr>
<tr>
<td>Whey</td>
<td>Fermentation</td>
<td>Whey beverage, yeast whey</td>
</tr>
<tr>
<td></td>
<td>Concentration</td>
<td>Plain condensed whey, sweetened condensed whey, whey protein, concentrate</td>
</tr>
<tr>
<td></td>
<td>Drying</td>
<td>Whey powder and lactose</td>
</tr>
<tr>
<td></td>
<td>Coagulation</td>
<td>Ricotta cheese</td>
</tr>
</tbody>
</table>
7.3 Whey-Utilization

Utilization of whey has been of great concern in the dairy industries engaged in manufacturing of cheese and coagulated milk products. The techno-economic problems associated with the utilization of whey have been receiving considerable attention and remarkable advancements have been made. Today, modern industrial processing techniques such as ultra filtration (UF), reverse osmosis (RO), new drying methods, hydrolysis, electrodialysis, ion-exchange, fermentation and protein with differing functional and nutritional properties, that could be used in food and dairy industry. The predominant driving force being the development of whey utilization has been strident regulation imposed by the environment pollution agencies all over the world. Other aspect relates to economic return from whey, which contain almost half the solids of original milk. Presence of lactose, protein minerals and water-soluble vitamins make the whey a highly nutritious product.

Fig 7.1 Whey

Being rich source of lactose, whey is food fermentation media for a number of fermented products. In many applications, lactose in whole or deproteinised whey is hydrolysed to glucose and galactose, thereby increasing its sweetness. Such lactose hydrolysed syrups, generally after condensing are mostly utilized in sweet confectionery products and ice cream.

The predicting of whey beverages whey protein concentrates, lactose, and many other products from whey have prominence in advanced dairy countries. But Indian dairy industry is still a novice in this field. It is only during
the about last 12 years that with the economic liberalization and decentralization of the dairy industry, rapid changes are being witnessed in Indian dairy industries. A number of by-product based dairies with large automatic and continuous manufacturing plants have been set up.

Whey cheese like Gjetost, Mysost and Gudbrandsdulsost are produced in Norway, while, Manouri, Anthotryos, Cryzittroa and Giza in Greece. The name of whey cheese in Greece indicate their quality. Ricotta cheese is another cheese, which is popular in Italy and in many others countries.

A major problem with many whey based products is their salty flavour owing to their high mineral content. A small percentage of utilized whey (less than 5%) is demineralized to produce dry demineralized whey for specialized use. These include whey protein based infant formulas other medical and nutritional products that require lactose, special nutritional quality of whey protein and low mineral content. Demineralized whey (25-26% demineralization) can be used in foods such as coffee whitener, soft serve ice cream, milk shakes, whey drinks and caramel, citrus drinks, salad dressing, animal feeds, bakery goods, confectionery coatings and dry mixes.

Despite significant gains in the amount of whey processed, a large amount of whey produced still is disposed off as raw whey. Much of this represents production from all plants, where the cost of purchasing, processing as well as the subsequent transportation and handling clearly exceeds the value of any whey product that might be produced. In small plants, the choice remains some form of disposal, be it municipal by treatment, spreading raw whey on local farm lands for its nutrient value for feeding to local livestock. Further acid whey, because of its high mineral content and low pH pose considerable in utilization and, therefore, mostly remain unutilized.

7.4 Butter Milk Utilization

Butter milk is an important by-product obtained by manufacture of butter. Normally three types of butter milk are produced in our country, viz

(i) Sweet cream butter milk obtained by churning of fresh/pasteurized cream with little or no developed acidity,

(ii) Sour butter milk obtained by churning cultured cream and

(iii) Desi butter milk (lassi) obtained by churning of curd (dahi) during the manufacture of makkhan. The sweet and sour butter milks are produced in the organized sector and lassi at the households level in small quantities. The exact amount of butter milk production in India is not estimated. However, based on the conversion of 6.5% of total milk production into creamy butter, it can be estimated that about 4000 million kg of butter milk is produced in organized
sector annually as a by-product. In addition, a substantial amount of lassi (sour butter milk) is also produced during the manufacture of makkhan directly from fermented milk (curd). Total annual production of butter milk in India is estimated at 35000 million kg.

![Fig 7.2 Buttrer milk](image)

**A. Chemical Composition**

The chemical composition of butter milk varies to a great extent, depending on the amount to water added to cream. Some of the butter manufactures standardize cream with water, thereby decreasing the total solids level of butter milk. The gross chemical composition of butter milk produced under ideal conditions is almost similar to that of skim milk.

**Table : average gross composition and physico-chemical properties sweet cream butter milk and skim milk (obtained from buffalo milk)**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Skim Milk</th>
<th>Sweet Cream Butter Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.S. (%)</td>
<td>10.38</td>
<td>9.88</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>0.09</td>
<td>0.59</td>
</tr>
<tr>
<td>Total proteins (%)</td>
<td>4.27</td>
<td>3.73</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>5.2</td>
<td>4.81</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.82</td>
<td>0.75</td>
</tr>
<tr>
<td>Total phospholipids (mg %)</td>
<td>8.65</td>
<td>78.56</td>
</tr>
<tr>
<td>Titratable acidity (% LA)</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td>pH</td>
<td>6.69</td>
<td>6.86</td>
</tr>
<tr>
<td>Curd tension (g)</td>
<td>66.85</td>
<td>18.84</td>
</tr>
<tr>
<td>Relative viscosity (cP at 30°C)</td>
<td>1.64</td>
<td>1.80</td>
</tr>
</tbody>
</table>
Sour butter milk differ from sweet cream butter milk in respect of titratable acidity. The acidity in sweet cream butter milk varies from 0.10 to 0.14 percent, where as in sour butter milk it is even as high as 1% . However, there is not much difference in the chemical composition of two types of butter milk. Desi butter milk has wide range of composition depending on the quality of milk used for making curd and level of addition of water during churning. Desi butter milk, on average, contains 4% total solids comprising of 0.8% fat, 1.29% protein and 1.2% lactic acidity. The colour of desi butter milk is brownish due to prolonged heating of milk before culturing and the body is not homogeneous as that of factory produced butter milk. When kept undisturbed for sometime, curdy material deposits at the bottom of desi butter milk.

B. Processing and Drying of Sweet Cream Butter milk

Being almost similar in gross chemical composition of skim milk, steps includes during its processing, i.e., separation, clarification, pasteurization, concentration and drying. Rather the heat stability of sweet cream butter milk is considered to be better than skim milk there by making it more suitable for processing to very high heat treatments. Concentration and spray drying of sweet cream butter milk cream butter milk can also be achieved by adopting the same standard condition used for skim milk. The physico-chemical properties of spray dried sweet cream butter milk and skim milk are given.

Table (Physico-Chemical Characterized of spray powders)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Skim Milk</th>
<th>Sweet cream butter milk powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>2.75</td>
<td>2.59</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>1.05</td>
<td>6.38</td>
</tr>
<tr>
<td>Total protein (%)</td>
<td>40.29</td>
<td>97.09</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>48.15</td>
<td>47.00</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>7.76</td>
<td>6.94</td>
</tr>
<tr>
<td>Total phospholipids (mg %)</td>
<td>97.1</td>
<td>625.25</td>
</tr>
<tr>
<td>Titratable acidity (% L.A)</td>
<td>1.39</td>
<td>1.17</td>
</tr>
<tr>
<td>Solubility index (ml)</td>
<td>0.30</td>
<td>0.15</td>
</tr>
<tr>
<td>Bulk density (g.ml)</td>
<td>0.544</td>
<td>0.345</td>
</tr>
</tbody>
</table>

Striking difference between two types of powder are in the high total lipids including phospholipids and low density in sweet cream. The butter milks
powder in comparison with skim milk. The spray dried butter milk powder is less free flowing and dusty because of high fat content in comparison with skim milk powder. Though the high fat content reduces the shelf life of the powder during storage, the high phospholipids will provide better oxidative stability to dried butter milk.

C. Utilization of sweet cream butter milk

Sweet cream butter milk because of its resemblance in gross chemical composition with skim milk, is usually admixed with bulk of skim milk for further spray drying or even product manufacture in dairy plants. Sweet butter milk can be used in beverage form and in the fluid milk industry as a milk extender with specific benefits over skim milk. The other potential uses of butter milk solids are in manufacture of soft varieties of cheese, paneer fermented milk and traditional milk products.

However various physico-chemical properties of butter milk differ from that of skim milk. Sweet cream butter milk has lower acidity and curd tension and higher viscosity as compared with skim milk. These differences in physicochemical properties of butter milk and skim milk provide many choice for their selective applications in dairy products manufacture. Butter milk contains high fat content than skim milk which can be reduced to some extent by subjecting it to centrifugal separation. Butter milk contains a larger proportion of protein mixture sloughed from the fat globule milk serum interface by churning process. The amount of fat globule membrane protein (FGMP) is however not as large in comparison with total butter milk proteins. The FGMP are hydrophilic and hydrophobic in nature and their physical properties, nitrogen content and amino acid composition do not correspond with any other milk proteins. The FGMP also contributes a complex mixture of glycerophospholipids to butter milk. Sweet cream butter milk contains about nine times higher phospholipids than skim milk. It has been noticed that phospholipids in butter milk do not have short chain fatty acids. The principal fatty acids are C\textsubscript{16} (Palmitic) and higher acids. Of the total phospholipids fatty acids about 40\% by wt., are saturated acids and other rest are non-conjugated di-to-penta-unsaturated acids. Phospholipids of butter milk include more or less equal proportion of lecithin, sphingomyelin and cephalin together with a small proportion of cerebrosides.

(i) Beverage: As beverage butter milk is consumed in plain and spiced forms throughout the year and highly used as refreshing drink in summer season. A number of state federations and private plants sell plain butter milk in 500 ml and 1 kg pack and salted and spiced butter milk in 200ml pouches. “Sumul chhach” manufactured at sumul dairy in gujarat, is packed in 500 ml packs.
(ii) **Market milk**: The undiluted sweet cream butter milk produced in the recognized dairies is partly admixed with the whole milk for fluid milk supply. It has been observed that, use of sweet cream butter milk in the market milk for toning of buffalo milk improves the palatability, viscosity and heat-stability and reduce the curd tension without adversely affecting the keeping quality. In addition to plain fluid milk it can also be used for the preparation of flavoured milks and milk beverages. The powder made from the mixture of skim milk and sweet cream butter milk is treated as a skim milk powder and used for reconstitution purposes.

(iii) **Fermented milk product**: Curd prepared by incorporating sweet cream butter milk into whole milk has soft-body which is probably due to the change in the electric charge on the casein churning, the presence of phospholipids and other FGM material, and the free fat in the butter milk. Addition of 1-2% skim milk powder is recommended for improving the body of dahi made from buttermilk. As an alternative to curd making, sweet cream buttermilk can be successfully utilized in the manufacture of cultured buttermilk and lassi, in which the firmness is not of much consideration.

(iv) **Paneer**: Buffalo milk has to be standardized to fat and SNF ratio about 1:1.65 to meet the PFA requirements for the manufacture of paneer. The replacement of skim milk with sweet cream buttermilk for the standardization of buffalo milk has been found to increase the yield to paneer by about one percent with altering the organoleptic and textural properties. It is also possible to prepare good quality paneer from low fat milk by incorporating butter milk solids to buffalo milk.

(v) **Cheese**: The preparation of hard varieties of cheese like Cheddar and Gouda involves the adjustment of casein and fat ratio with the help of skim milk. The replacement of skim milk with sweet cream buttermilk results into softer body due to presence of higher amount of fat globule membrane material in buttermilk. Several benefits of utilizing butter milk solids in the manufacture of soft varieties of cheese are decreased waste disposal problems at the creamery, reduction in cost, increased cheese yield and improved flavour, texture, biological value and hypocholesterolaemic effect of cheese.

(vi) **Other uses**: Sweet cream buttermilk can also used for manufacture of some popular indigenous dairy products, e.g., Khoa, Kheer and Rabri. The dried buttermilk can be replaced by the skim milk powder in the manufacturing of gulabjamun mix powder. Because of high lecithin content in buttermilk, it may improve the textural properties of rasogulla. The butter milk powder can also be used in the preparation of ice cream and bakery products.
(vii) Utilization of desi and sour cream butter milk: Desi butter milk (lassi) is an important domestic beverage in India. It has high nutritive and therapeautic value. In addition to normal milk constituents, lassi is also a rich source of vitamins. It is considered to be an excellent thirst quenching and nourishing beverage, particularly during summer months. It is also used for making some popular traditional preparations, e.g., Karhi, Raita, etc. The industrial utilization of lassi cannot be exploited due to lack of proper collection system and day-to-day variations in the composition and quality. Sour cream butter milk has similar utilization as desi butter milk.

7.5 Ghee Residue - Utilization

Ghee residue is a by-product of ghee manufacturing industry and is produced in large quantity (about 91000 tonnes per annum) in India. During the manufacture of ghee, the solids not fat (SNF) present in cream or butter appears in the form of small particles known as ghee-residue. It is obtained after molten ghee has been removed by centrifugal clarifiers. The yield of ghee-residue varies with the method of preparation of ghee. This is due to the variation in the non-fatty serum constituents of the different raw material used for the preparation of ghee. The average yield of ghee-residue is maximum in direct creamery (DC) method (12%) followed by about 3.7% yield in creamery butter (CB) and desi butter (DB) method. Keeping quality of all types of Ghee Residue clarified at 120°C is 3 months. Its shelf life can further be increased to more than 4 months by pressing it and making form.

Physical Attributes: Ghee residue is moist brownish sediment. On average, particle diameter of ghee residue is about 115 μ and density is 1.14g/cm.

A. Chemical Composition

A look at the chemical composition and yield of Ghee Residue obtained from various sources will give an idea of the huge quantity of nutrients in terms of fat, protein, lactose and minerals that go into ghee-residue. There are considerable variations in the chemical composition of ghee-residue depending on the method of preparation, protein (12-39) moisture (8-30) Lactose (2-14) and ash (1-8). Moisture, protein and ash content are more in CB and DB ghee-residue than in DC ghee-residue. Fat content is higher in DC residues than in butter ghee-residue. Lactose content is the highest in DB followed by DC and CB ghee-residue. Thus ghee residue is rich in proteins of lipids, proteins and carbohydrates.
### Chemical Composition and yield of ghee-residue (Hand Pressed)

<table>
<thead>
<tr>
<th>Source residue</th>
<th>Average % fat of source</th>
<th>Chemical Composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moisture</td>
</tr>
<tr>
<td>From buffalo mik</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desi butter</td>
<td>77.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Creamery butter (unsalted)</td>
<td>85.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Sweet cream</td>
<td>67.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Sour cream</td>
<td>67.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Washed sweet</td>
<td>71.0</td>
<td>1.7</td>
</tr>
</tbody>
</table>

### Lipids in ghee-residue

(i) **Analytical constant** : The lipids of ghee-residue have lower Reicher value and polenske value (24: 4, 1.3) but higher iodine value (43.4) in a comparison to those corresponding ghee (3031, 1.6, 33.9) respectively.
(ii) **Fatty acid composition**: The lipids of ghee-residue have less lower chain fatty acids C\textsubscript{4,0} to C\textsubscript{12,0} (5.3%) and total saturated fatty acids (58.7%) and more of unsaturated fatty acids 41.3%) in comparison to those of ghee (10.1, 66.8, 33.2%) respectively. The fatty acid composition of phospholipids shows that it has no fatty acids lower than 12 carbon atoms.

(iii) **Polyunsaturated fatty acids (PUFA)**: Irrespective of the method of preparation, PUFA content of ghee-residue lipids (4.4%) is higher than those of corresponding ghee (2.8%).

(iv) **Phospholipids**: Ghee residue is rich in phospholipids (1-9%). The phospholipids content of ghee-residue is dependent on the method of preparation. It is highest in CB ghee-residue lipids (17.39%) followed by DB ghee residue lipids (94.95%) and the least in DC ghee residue lipids (1.57%). These levels are much higher than those in ghee (0.004 - 0.08%). Phospholipids acts synergistically with reducing substances in ghee-residue and protect it from oxidative defect. Higher phospholipids (a good emulsifier) content of ghee residue is beneficial in development of certain products where emulsification of fat and phase is desired.

The phospholipids content of ghee-residue decrease as the period of heating increase due to transfer of phospholipids from ghee-residue to ghee. While heating cream/butter, only a small fraction of the phospholipids get transferred to ghee, most of the phospholipids remain with the residue because of their polar character. The difference observed in the physico-chemical constant, fatty acids and PUFA contents of between lipids of ghee-residue and ghee are due to the high phospholipids content of ghee-residue.

Proteins in ghee-residue: Soluble nitrogen content of ghee-residue prepared from cream or creamery butter decrease with heating time. This decrease is due to the denaturation of the proteins. The total reducing capacity expressed as mg of cysteine hydrochloride / g of CB ghee residue (26.0) and free sulphhydrly content (\textmu g / g) of ghee-residue (2.90) are much higher than those in ghee (0.075 and 0.02, respectively). These substances are liberated from protein during heat treatment and because of their polar nature are mostly retained in the ghee-residue. Whey proteins, especially B-Lactoglobulin are the main source for these sulphhydrly compounds.

Milk sugar in ghee-residue: Main sugars in ghee-residue prepared at 120\textdegree C content of ghee-residue are glucose. As the period of heating is increased the lactose content of ghee-residue decreases with corresponding increase in galactose and glucose content.
B. Nutritional Properties

Ghee residue is a rich source of protein and fat form containing considerable amounts of mineral and can be used as human dietary supplement. However, the nutritional value of ghee-residue protein is low due to the damage of some essential amino acids during preparation of ghee at high temperature. The lack of lysine in ghee-residue is the most dominant factors in depressing the PER of ghee-residue. The supplementation of ghee-residue with a combination of lysine (8%) methionine (2.5%) and tryptophane (1.4%) increase its nutritional value even slightly higher than the of SMP. It has been observed that skim milk powder (SMP), SMP ghee residue (2 : 1) SMP, ghee residue (1 : 2) and ghee residue diets have protein efficiency ratio (PER) of 3.4, 3.07, 2.46 and 0.66 respectively.

Antioxidant properties: Ghee residue is a rich source of natural antioxidants and its antioxidant properties are due to its constituents affected by various technological constituents. Ghee residue can be used as source of natural antioxidants for improving the shelf life of food products including dairy products where use of synthetic antioxidants is generally not preferred because of their toxic effects.

(i) Contribution of lipid constituents: Phospholipids show the maximum antioxidant activity followed by tocopherol and vitamin. Among the various phospholipids fractions, cepahlin shows the greatest antioxidant activity. The oxidative stability of ghee can be increased in its phospholipids content to 0.1% either through heat treatment or through solvent extraction process. It has been observed that, heating ghee residue with ghee in the ratio of 1:4 at 130°C have maximum transfer of phospholipids from ghee-residue to ghee. These antioxidant concentrates can be added to ghee to give about 0.1% phospholipids so as to increase the keeping quality of ghee.

(ii) Contribution of non-lipid constituents: Among the non-lipid constituents, the amino acid proline, lysine, cysteine hydrochloride and tryptophane show the antioxidant properties. The contribution of proline as antioxidant is maximum, though less than BHA at 0.02%. Further, the addition of lactose, glucose, galactose and their interaction products with protein and phospholipids to ghee also increase the oxidative stability of ghee. As ghee-residue contain large amount of reducing substances including free sulphydryls, such compounds may also contribute to the antioxidant properties of ghee residue.

(iii) Antioxidant properties as affected by the temperature of clarification: The antioxidant efficiency of ghee-reside decreases with increase in the temperature of clarification of ghee. The addition of ghee residue obtained
from ghee prepared at lower temperature (110°C) results in lesser development of peroxides than the addition of ghee-residue prepared at higher temperature (150°C).

(iv) Antioxidant properties as affected by the method of preparation: CB ghee residue has the maximum antioxidant properties followed by DB and DC ghee residues.

**Short Answer Type Questions**

1. Mention any four dairy by-products.
2. What is whey?
3. Write the composition of butter milk.
4. Mention the chemical composition of ghee residue from “Desi butter”.

**Long Answer Type Questions**

1. Write about by-products and their utilization.
2. Write short notes on
   a. Skim milk
   b. Butter milk
3. Briefly write about utilization of sweet cream butter milk.
4. Explain about “Ghee Residue”.

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Paper - II  Milk Products

323
Packing and Storage of Milk Products

Structure

8.1 Definition-Objectives of packing
8.2 Packing materials
8.3 Packing of milk products
8.4 Storage of milk products-desirable conditions.

Learning Objectives

After studying this unit, the student will be able to

• Understand about packing and storage of milk products
• Know about Packing materials and packing of milk products.
• Learn about storage of milk products.

8.1 Definition - Objectives of Packing

Packing means placing a commodity into a protective wrapper or container for easy transport or storage.

Functions

A package must perform the three-fold functions of containing, protecting and merchandising.

(a) To contain the product : The package/container should be adequately large to hold the product. It should have proper constructional
features as so not to allow leakage and spillage. It should have enough strength to withstand handling, transportation and storage hazards. Finally, it should also be compatible with the product.

(b) **To protect the product**: The package should safeguard the product against contamination or loss and damage or degradation due to microbial action, exposure to heat, light, moisture and oxygen, accidental spillage, evaporation, pilferage etc.

(c) **To help in selling the product**: The shape of the package should be favourable to dispensing and reclosure and to its disposal or re-use.

### 8.2 Packing materials and forms

#### A. Materials

These includes paper and paper-based products (coated, or lined), glass, tin-plate, aluminium, oil (wood) Plastic and laminates.

(i) **Paper**: The papers are used commonly in the form of wrapper, cartons, boxes, bags, cups etc.

(ii) **Glass**: Used in the form of bottles, jars, jugs, tumblers etc.

(iii) **Tin-plate**: This consist of a thin sheet (0.025 mm thick) of mild steel coated on both sides with a layer of pure tin. (The tinning may be carried out either by the hot-dipping or electrolytic process.) For packing certain products, it is desirable to use an internally plated can which provides greater resistance to corrosion. Tin plate has the merits of good strength, excellent barrier properties etc., and the demerits are high costs, heavy weight, difficult to reclosure and disposal etc. Used mostly in the forms of cans.

(iv) **Aluminium foil**: It has good barrier properties of grease-proof, non-sorptive, shrink-proof, odourless and tasteless, hygienic, non-toxic, opaque to light, bright in appearance etc.

(v) **Timber**: Odour have an attractive appearance and necessary mechanical strength.

(vi) **Plastics**: Blow-moulded containers such as bottles, cartons, cups, boxes etc.

Flexible plastic packaging film are used as wrappers or sachets/bag/pouches. These are two types viz low, polymers and high polymers. Low polymers these include cellophane (coated with plain or nitrocellulose/saran polyethylene (polythene) treated cellulose etc). High polymers, these are polyethylene, polypropylene, polystyrene, polyvinyl chloride, polyethylene
chloride (cryovac) rubber hydrochloride (pilofilm) polyester, polyamide (nylon) saran (a mixed polymer) etc. Many few films have already been developed and others are in various stages of development.

The merits of flexible packaging films are they can be easily applied and the packaging process can be readily mechanized. Loss of moisture in dairy products is practically nil. It protects food from attack by micro-organisms, insects etc., it is a cheap and convenient method of packaging. Humidity control of the surroundings air is not necessary during storage etc. Its demerits are not all technical problems in film packaging have been solved. Failure to obtain a perfect seal and remove all air before packaging may lead to spoilage. The most careful attention to detail is necessary else faulty production with results etc.

(vii) Laminates : Laminations are made for the reason of further strengthen the film material (i.e., toughness, tear resistance etc.) Used as sachet/bag/pouch or cartons.

(viii) Others : These include textiles (such as cloth, jute, hessian)

B. Forms

These consist mainly of bottles cartons, sachets, bags, pouches, boxes, jar, casks, barrels, cups and collapsible tubes. Also in use are jars tumblers and sacks.

(i) Bottles : The glass bottle still continues to be the most frequently used package for milk in the world. However in several developed countries, it has already lost ground to single service containers.

Rigid plastic bottles are also in use for milk liquid milk products. The plastics bottle systems in common use are

Beku W. Germany

Humba

Mecaplast Switzerland

Bottle pack

(ii) Carton : This is a common package for milk also used for liquid frozen and coagulated milk products. Cartons are commonly made from ‘food’ grade paper coated on the inside with wax or plastics or lined with paper, plastic films or aluminium foil, or made of laminates. Its merits are maximum
printing, and convenience as a means for stacking milk on supermarket shelves. Retailers in developed countries consider it as the best available package for self service selling. Cartons (paper and board) also play a significant role in the bulk packaging of milk.

Cartons are commonly available either as preformed containers or precut blanks ready to be formed into containers. The carton systems in common use are

- **Perga (Preformed)** - U.K.
- **Pure Pak (Precut)** - U.S.A.
- **Zupak** - W. Germany
- **Block Pak**
- **Tetra Pack (Precut)** - Sweden

(iii) **Sachet/bag/pouch**: Flexible waterproof plastic bags are commonly used for packaging milk and liquid milk products. Since it is difficult to pour from these a jug is usually also provided. The popular laminate for such bags is black or dark brown (to exclude ultra-violet light) or white. The bags may be formed from either a reeled or flat film. Generally it is a form/fill/seal system. Ultra-violet light may be used to sterilize the film. The bags are heat-sealed and cut the common sequence being to bottom-seal, fill move down as sachet length top seal and cut off.

(iv) **Can**: This is commonly used for all types of solid, semi-solid are powdered products. Cans are traditionally made of soldered tin plate steel, generally lacquered on the inner surface to prevent corrosion. Recently aluminium cans have been introduced. Cans are the most convenient for gas packing.

(v) **Box/tub**: May be made of wood or paper board. While wooden boxes/tubs are used for the bulk packing of butter and butteroil with butterpaper/plastic liners, paper board are generally used as over-wraps.

(vi) **Barral/cask**: Commonly made of wood and coated with wax on the inner surface. Used for bulk packaging of sweetened condensed milk, semi-solid butter milk/whey, butter oil etc.

(vii) **Cup**: Made of paper with wax or plastic coating on the inside. Used for frozen and coagulated products.
(viii) Collapsible tube: Generally made of aluminium and lacquered on the inside. Its merit are: low costs, light weightedness, ease of handling and dispensing, product protection, etc. Used for semi-fluid products such as sweetened condensed milk, processed cheese spread etc.,

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**Fig 8.1 Packing materials**

### 8.3 Packing of Milk products

Packaging is a technique of using the most appropriate containers and components to protect, carry, identify and merchandise any product. It constitutes an important link between the manufacturer and ultimate consumer for the safe delivery of the product through different stages of production, storage, transport, distribution and marketing.

Though great efforts have been made in producing high grade processed milks or manufactured dairy products, unless they are delivered in a fresh, sound and suitable form to the consumer, they are likely to be rejected, thus causing enormous wastage. The loss can be offset to a great extent by adequate protective packaging to withstand the hazards of climatic changes, transportation, handling etc.

Because of rapid growth in the economy and consequent improvement in the living standards of the common people, packaging has become important in the distribution process. In today's busy world, many consumers do not have the time to make it to the market. Internet is used to purchase groceries.

Innovative packaging technologies have become a necessity for the devel-
opment of extended shelf life and value added foods and food products. In food industry, the package serves as a barrier to contamination by microorganisms or other undesirable elements like moisture and light. The secondary role of the packaging material is to care for storage and distribution.

The packaging material should satisfy the following conditions.

- It must protect and preserve the commodity from the time it is packaged till the product is consumed.
- It must be suitable for the selected sales and distribution pattern.
- It must protect and preserve the commodity from the time it is packaged till the product is consumed.
- It must be suitable for the selected sales and distribution pattern.
- It must be attractive to the consumer.
- It must be easy to open, store and dispose.
- It must facilitate the handling, storage and distribution.
- It must protect against biological, chemical and distribution damages.
- It must inform the consumer through the medium of labeling.
- It must impart security to the product through a tamper evident design.
- It must act as a marketing and advertising tool.
• It must protect the environment by taking the responsibility of empty packaging material after its use.

• It must be economical i.e. it should neither burn the purse of the consumer nor the producer.

Definition of Packaging

Packaging means placing a commodity into a protective wrapper or container for transport and storage or it can also be defined as a tool that protects and contains goods with the aim of minimizing the environmental impact of our consumption.

The packaging concept is determined by the demand of both the consumer and the product. New technological development, environmental awareness and changes in the consumer market force the packaging technologists to consider an increasing number of factors when designing a package. Packaging materials provide a sort of inert barrier that prevent the interaction of food products with the external environment.

What are all the functions of the packaging material?

The package should perform at least three functions of containing, protecting and merchandising.

What is "containing"?

The package or container should be adequately large to hold the product. It should have proper constructional features so as not to allow leakage and spillage. It should have enough strength to withstand handling, transportation and storage hazards. Finally it should be as compatible as possible with the product.

What is "protecting"?

The package should safeguard the product against contamination, or loss and damage or degradation due to microbial action, exposure to heat, light, moisture, and oxygen, accidental spillage, evaporation, pilferage etc.

What is "merchandising"?

The shape of the package should be favorable to dispensation and reclosure and to its disposal or re use.

Apart from the above discussed three important functions, the packaging material should lend itself to operation in whatever machines are available; be economical; be printable on the outer surface; and the last but not the least, it
should have sales appeal.

**What is the choice of an appropriate packaging material?**

The specific sensitivities of the contents. For e.g. moisture, oxygen etc.

Factors affecting the contents viz. temperature, relative humidity, pH, and the reaction mechanism involved.

- Weight and shape of the container and effect on filling and sealing speeds.
- Contamination of food by constituents of the packaging material.
- Storage conditions - How long the product needs to be protected?
- Biodegradability and recycling potential.

### 8.4 Storage of Milk Products - Desirable conditions

#### 8.4.1 Introduction

Over 50 percent of the total milk production in India consist of buffalo milk. As it has higher fat and total solids content, buffalo milk gives greater outrun of milk products than cow milk. However, due to some basic differences in its physico-chemical properties those of buffalo milk creates a few special problems during product manufacture and storage. A review published over a decade ago highlighted this aspect.

Considerable research on the physico-chemical make-up and standardization of techniques in the manufacture of several product from buffalo milk has been carried out in this country over the past two decades by various scientific and industrial workers. These have been briefly summarized in a recent A-1 to A-3 in this appendix which have been adapted.

#### 2. Basic differences in the physico-chemical properties of cow and buffalo milk

(a) **Compositional differences**: Buffalo milk, in general, contains higher amounts of milk solids, viz, fat proteins lactose, minerals SNF and TS than cow milk as shown in Table A-1.

(b) **Physico-chemical differences**: Buffalo milk normally has a higher pH, acidity buffer value, density, viscosity, and fat globule size than cow milk as shown in Table A-2.
Physico-chemical characteristics of cow and buffalo milks

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Buffalo Milk</th>
<th>Cow Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Buffer value (at pH 5.1)</td>
<td>0.0417</td>
<td>0.0359</td>
</tr>
<tr>
<td>Density at 20°C</td>
<td>1.0310</td>
<td>1.0287</td>
</tr>
<tr>
<td>Viscosity (cp)</td>
<td>2.04</td>
<td>1.86</td>
</tr>
<tr>
<td>Specific Refr. Index</td>
<td>0.2061</td>
<td>0.2059</td>
</tr>
<tr>
<td>Surface tension</td>
<td>55.4</td>
<td>55.9</td>
</tr>
<tr>
<td>Acidity</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>Fat globule size (mm.)</td>
<td>5.01</td>
<td>3.85</td>
</tr>
<tr>
<td>Phosphatase (units)</td>
<td>28</td>
<td>83</td>
</tr>
<tr>
<td>Ultra-violet fluorescence</td>
<td>Greenish-yellow</td>
<td>Pale bluish</td>
</tr>
</tbody>
</table>

(c) Casein differences: It has been established that, the distinct differences in the physico-chemical make up of casein from buffalo milk as compared with that of cow milk. The proportion of micellar casein greater in buffalo milk, while that of soluble casein is very low. The practical size of buffalo micellar casein larger (165 μM) than that of the cow micellar casein (90 μM). The buffalo than the cow micelle. Turbidity studies in a different medium) different buffer system, and also in the presence of rennet, show that turbidity develops more quickly in buffalo milk casein, due perhaps to its higher proportions of calcium.

(d) Whey protein differences: Certain difference has been noticed in the whey proteins of buffalo milk as compared with those of cow milk.

(e) Milk fat differences:

(i) Analytical constant: Buffalo milk fat has a higher Reichert value, saponification value, Kirshner value and melting point, but a lower Polenske value, Iodine value and better refractometer index than cow milk fat.

(ii) Fatty acid composition: Buffalo milk fat is higher than cow milk fat in butyric, palmitic, stearic and oleic acids but lower in caproic, caprylic, lauric and myristic acids as shown in Table A-3.
**Major fatty acid composition of buffalo and cow milk fats**

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Buffalo Milk fat</th>
<th>Cow Milk Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyric</td>
<td>4.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Caproic</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Caprylic</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Capric</td>
<td>1.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Decenoic</td>
<td>Trace</td>
<td>0.3</td>
</tr>
<tr>
<td>Lauric</td>
<td>1.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Myristic</td>
<td>10.8</td>
<td>11.9</td>
</tr>
<tr>
<td>Palmitic</td>
<td>33.1</td>
<td>30.6</td>
</tr>
<tr>
<td>Stearic</td>
<td>12.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Oleic</td>
<td>27.2</td>
<td>27.4</td>
</tr>
<tr>
<td>Linoleic</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Linolenic</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

(f) **Mineral-salt differences**: Buffalo milk contains more calcium and phosphorous (0.02 percent and 0.13 percent respectively) than cow milk (0.12 percent and 0.09 percent respectively). The calcium phosphorous ratio is higher in buffalo milk (2.26) than cow milk (1.96). There are more ratios (calcium and magnesium) in buffalo milk but fewer anions (phosphate and citrate). Lastly the soluble forms of calcium, magnesium and citrate are lower in buffalo milk than cow milk.

3. **Problems in Product Manufacture and storage**

The problems arising out of the compositional physico-chemical characteristics of buffalo milk in the manufacture and storage of various products form the raw materials, together with their specific causes and suggested preventive measures, viz., modified techniques have been summarized below.

(a) **Cheese**: Due to difference in the micellar composition of milk-protein especially casein the fatty acid make up of milk fat in its higher buffer value calcium, casein and fat levels, buffalo milk behaves quite differently from cow milk both during the manufacture and curing of cheese.
The major problems faced by cheese-makers and suggested modified techniques are

(i) Slow ripening (i.e. acidity development) in milk
(ii) Faster rennet action (i.e. low renneting time)
(iii) Excessive syneresis (i.e. lower retention of moisture)
(iv) Slow cheddaring (i.e. mellowing of curd)
(v) Slow curing of cheese (Slow proteolysis and lipolysis causes a delay in the development of the characteristic cheese flavour and body and texture)
(vi) Slightly butter taste in cured cheese (quite often) and
(vii) Hard body and texture in cured cheese.

The modified techniques includes, among the other things

(i) Adjustment of casein/fat ratio 0.70 (same as for cow milk)
(ii) Addition of more starter culture (for proper acidity development)
(iii) Addition of less rennet. To ensure proper renneting time and prevent the development and longer cooking period (To ensure proper development of acidity and greater retention of moisture.
(v) Piling cheese 3 high during cheddaring (For greater retention of moisture) and.
(vi) Curing cheese first at a high temperature (10-12°C) for 2 months for rapid flavour development and then at low temperature (2°C) for desirable body and texture changes.

(b) Condensed milk (sweetened and unsweetened) due to

(i) Difference in micellar composition of milk proteins, especially casein
(ii) Higher level of milk protein (both casein and serum proteins) milk dark and milk sugar
(iii) Higher calcium content and lower heat-stability of milk. Buffalo milk behaves quite differently from cow milk not only during production but also during the storage of condensed and evaporated milks.
The major problems faced by condensed milk manufactures are

(i) Greater likelihood of undesirable gel formation during production of both condensed and evaporated milks.

(ii) Greater incidence of age-thickening during storage of both condensed and evaporated milks.

(iii) Greater possibility of sandiness defect in sweetened condensed milk and

(iv) Greater incidence of browning discolouration and cooked flavour development during storage of both condensed and evaporate milk.

Summary

The bag-in-box system is intended primarily for milk supplies to catering establishments and has not found application to general milk distribution. Aseptic packaging of UHT treated milk in plastic sachets has not been included as this is still in the process of development and must be considered in conjunction with the UHT processing equipment employed. The extra cost of aseptic sachet packaging equipment compared with that for pasteurized milk can be assumed to be in a similar proportion as that for aseptic and normal carton machines. It should be mentioned that a promising UHT system with aseptic filling into plastic sachets is being developed in Finland with electric heating of the milk. Commercial trials are under way.

The keeping quality of dried milk products during storage is of great importance to consumer acceptance. To maintain the high quality of the product during storage, it is necessary to prevent their organoleptic and physico-chemical deterioration.

Packaging of dried milk products, therefore, assumes greater significance. The powder packaging room should be completely isolated to reduce the spread of powder dust. Appearance of common defects in milk powders is influenced by quality of milk used in production, care taken during production, handling and storage, manufacturing conditions, moisture content in the product, metallic contamination, and packaging and storage conditions.

Generally, infant foods are packed in metalised tin containers, which can be sealed, oxygen evacuated and filled with an inert gas. Tin containers having snap on plastic lids are now available. In order to reduce the ever increasing cost of tin containers, laminated flexible packaging material are in great use. The laminated pouches, after packing, inert gas injecting and sealing are then placed into individual cardboard cartons for easy handling.
Short Answer Type Questions

1. Define “Packing”

2. Mention any four packing materials.

Long Answer Type Questions

1. Explain the problems in product manufacture and storage

2. Explain in detail about Packing materials.