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The dairy industry plays an important role in our daily life. It is difficult to realize how fast changes are taking place in the dairy industry. Milk is an important human food, it is palatable, easy to digest and highly nutritive. One of the important factors affecting the total amount of milk produced and the way in which this milk is utilized is the demand for the various products. In order to prepare such a diversity of products, many different processes have been developed by the industry. There are numerous types of milk products such as ghee, butter, paneer, cheese, yogurt, ice cream powder, baby cereal food, cream, and so on. Each of these has been designed to take advantage of some particular property of milk. Dairy products are generally defined as food produced from the milk of mammals; they are usually high energy yielding food products. Enzymes play an important role in the production of cheese. Raw milk contains several native enzymes some of which can be used for analytical and quality purposes for example pasteurization can be assessed by determining indigenous alkaline phosphate activity. India is known as the Oyster of the global dairy industry, with opportunities galore to the entrepreneurs globally. Anyone might want to capitalize on the largest and fastest growing milk and milk products market. The dairy industry in India has been witnessing rapid growth. The liberalized economy provides more opportunities for MNCs and foreign investors to release the full potential of this industry. The main aim of the Indian dairy industry is only to better manage the national resources to enhance milk production and upgrade milk processing using innovative technologies.

The major contents of the book are cholesterol, coronary heart disease and milk fat, cholesterol and cardiovascular diseases, fatty acids & cholesterol, factors affecting cardiovascular disease, application of enzymes in dairy and food processing, utilisation of milk components: casein, advances in the heat treatment of milk, varieties of sheep's cheese, whey cheese, potted cheese, filled cheese, testing butter at different stages, presentation of butter at different stages, condensed and evaporated milk, dried milk powder, skimmed powder, malted powder, butter powder, ghee yoghurt, technology processing of dairy and dairy products, dried milk shake, milk powder, dahi from sweet cream butter milk, packaging of dairy and milk products, dairy farm, dairy products & milk packaging in pouches, etc.

Developments in the dairy industry are enough to justify a revision of a considerable amount of material in this book. This book deals with processes, formulae, project profiles, details of plant, machinery & raw materials with their resources etc. of various dairy products. This book will help all its readers from entrepreneurs to food industries, technocrats and scientists.

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Cholesterol and Cardiovascular Diseases
Fatty Acids & Cholesterol
Factors Affecting Cardiovascular Disease
Dietary Recommendations
Conclusion

2. Application of Enzymes in Dairy and Food Processing
Introduction
Enzymes in Dairy Industry
Enzymes in Food Industry

3. Utilisation of Milk Components: Casein
Extraction of Casein from Milk
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Composition of Co-Precipitates
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Sample Chapter:
Cow milk contains 2.4-6.1% lactose. Milk is a complete food for infants up to 6 months of age, afterwards it acts as a supplement to other foods. One pint of milk supplies about 320 cal. of which 50% is contributed by fat, 20% by lactose, and 21% by protein. Milk is a valuable source of phosphorus, calcium and vitamins. It contains a useful amount of vitamins including vitamin A, thiamine (vitamin B), riboflavin, pyridoxin (vitamin B6), biotin, pentothenic acid and vitamin D, etc. In addition, the fat content is prized both as cream and as the main component of butter.

### Composition of Milk from Various Animals

<table>
<thead>
<tr>
<th>Source</th>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>6.2-7.6</td>
<td>0.6-2.0</td>
<td>2.0-6.2</td>
</tr>
<tr>
<td>Cow</td>
<td>4.2-6.8</td>
<td>2.5-4.0</td>
<td>3.0-6.0</td>
</tr>
<tr>
<td>Buffalo</td>
<td>4.5-4.3</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Goat</td>
<td>4.5-3.7</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>4.9-6.5</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Mare</td>
<td>5.7-7.1</td>
<td>3.1</td>
<td></td>
</tr>
</tbody>
</table>

(A) CONDENSÉD AND EVAPORATED MILK

The concentration of milk by heat serves two purposes—it reduces the bulk for a given quantity of milk and the heat.

Wettability: The wettability of milk powder is an important property and is closely inked with dispersibility. Baker and Bertok (1959) have described a light absorption method for measuring wettability and found that it was highly correlated with dispersibility, but only slightly with solubility. In general, the first two properties were correlated with particle size.

A related property is "sinkability" and Bullock and Winder (1960) have described a method for measuring this as a characteristic related to reconstitutability or dispersibility.

Dispersibility may be defined as the speed with which milk powder assumes a colloidal state when mixed with water. Moats et al. (1959) have described a rapid technique for measuring this in which the amount of powder dispersed is measured by a hydrometer. Using this standard method they found that skim instant powders gave 80 per cent ordinary spray dried 37 per cent and roller dried 10 per cent dispersion. The test is completed in 10 minutes.

Pasteurisation of Milk: The term "Pasteurisation" is coined from the name of the renowned scientist Louis Pasteur, who in 1860-64 showed that unwanted fermentation in wine could be prevented by raising the temperature to 122°F to 1.0°F for a short time. The method was soon afterwards applied to milk and was slowly developed in the larger towns of America and Europe for the purpose of improving keeping quality. The fact that pasteurisation destroyed consideration, Medical bacteriologists were naturally more interested in the public health aspect of pasteurisation than its commercial advantages, but it is not surprising that a process which is simple and cheap to apply and achieved such outstanding effects has increased steadily in popularity and usefulness.

Keeping Properties: There are four main types of concentrated milk:

- Evaporated whole milk.
- Evaporated skim milk.
- Condensed (sweetened) whole milk.
- Condensed (sweetened) skim milk.

Of these (ii) is produced in only small quantities, and (iv) forms a convenient outlet for skim milk when
cream or butter is made.

For the whole-milk products, the milk is usually standardised. Evaporated milk is always homogenised and then sterilised after filling into tins, but condensed milk requires no further heating on account of the preservative action of sugar.

Evaporated milk is invariably sterilised in tins and sold as such, but condensed milk may be packed in barrels and held in these before finally filling into tins or being used for confectionery, etc.

The most important property of the product commercially is its stability which is related to the salt balance (calcium and phosphate) of the original milk. Bacteriologigamisms which can grow under the conditions found in side the tinned products and produce faults, especially certain yeasts in condensed and certain spore-formers in evaporated milk.

The following scheme summarises the methods of manufacture:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Evaporated Milk</th>
<th>Condensed Milk (Sweetened)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage tank--</td>
<td>Storage tank--</td>
<td>Storage tank--</td>
</tr>
<tr>
<td>Pre-warming 90°F</td>
<td>Pre-warming 90°F</td>
<td>Pre-warming 90°F</td>
</tr>
<tr>
<td>Filtration or clarification--</td>
<td>Filtration or clarification--</td>
<td>Filtration or clarification--</td>
</tr>
<tr>
<td>Cooling--</td>
<td>Cooling--</td>
<td>Cooling--</td>
</tr>
<tr>
<td>Standardising--</td>
<td>Standardising--</td>
<td>Standardising--</td>
</tr>
<tr>
<td>Preheating 205°F (or higher)</td>
<td>Preheating 170°F</td>
<td>Preheating 170°F</td>
</tr>
<tr>
<td>Sugar added--</td>
<td>Sugar added--</td>
<td>Sugar added--</td>
</tr>
<tr>
<td>Vacuum Concentration 130-145°F at 24-27 in.-</td>
<td>Vacuum Concentration 130-145°F at 24-27 in.-</td>
<td>Vacuum Concentration 130-145°F at 24-27 in.-</td>
</tr>
<tr>
<td>Homogenisation 2.500 lb at 140°F</td>
<td>Homogenisation 2.500 lb at 140°F</td>
<td>Homogenisation 2.500 lb at 140°F</td>
</tr>
<tr>
<td>Cooling 60°F</td>
<td>Cooling 60°F</td>
<td>Cooling 60°F</td>
</tr>
<tr>
<td>Seeding-Lactose, etc.</td>
<td>Seeding-Lactose, etc.</td>
<td>Seeding-Lactose, etc.</td>
</tr>
<tr>
<td>Balance tank--</td>
<td>Balance tank--</td>
<td>Balance tank--</td>
</tr>
<tr>
<td>Filling Cans--</td>
<td>Filling Cans--</td>
<td>Filling Cans--</td>
</tr>
<tr>
<td>Sterilising 240°F, for 20 min-</td>
<td>Sterilising 240°F, for 20 min-</td>
<td>Sterilising 240°F, for 20 min-</td>
</tr>
<tr>
<td>Cooling--</td>
<td>Cooling--</td>
<td>Cooling--</td>
</tr>
<tr>
<td>Labelling--</td>
<td>Labelling--</td>
<td>Labelling--</td>
</tr>
<tr>
<td>Storage--</td>
<td>Storage--</td>
<td>Storage--</td>
</tr>
<tr>
<td>Evaporated Milk--</td>
<td>Evaporated Milk--</td>
<td>Evaporated Milk--</td>
</tr>
</tbody>
</table>

The milk containing 86-88% water is a bulky and perishable foodstuff which can be evaporated or concentrated to yield a product of 74%. In order to avoid any necessity to boil the milk, modern technique states that evaporated milk is concentrated under vacuum.

For carrying on the evaporation, the milk is kept under vacuum of 28" of mercury at a temperature of 50-55°C and continued until the water content has been reduced to 74%. The consistency of evaporated milk is improved if small amount of calcium chloride, sodium phosphate or sodium nitrate are added. The quantity should not exceed 0.1% of the final evaporated milk.

Process Description for Evaporated Milk

(a) Pre-Warming (or Fore Warming)-This affects both heat stability and viscosity. Previously, a temperature of 2030°F for ten to fifteen minutes was used, but now higher temperatures for a shorter time are used and give heat stability without loss in viscosity.

(b) Condensing-This may be carried out in a steam-coil jacketed pan (commonest in England), a calandria vertical tube evaporator) a forced circulation or a multiple effect evaporator). The vacuum is partly created and mainained by condensation of the steam derived from the milk by surface or jet-type condenser. With water at 60°F, about 2½ gallons of water are required to condense 1 lb. of water evaporated.

The chief technical difficulty in condensing is to avoid frothing and entrainment (carry-over of tiny particles
of milk) which result in contamination of the condenser and lead to effluent trouble. Entrainment is reduced by the use of an interceptor.

The determination of the end-point (striking) is usually made by density measurements using a special hydrometer.

(c) Homogenising—This is usually effected at a pressure of about 2500 lbs. per square inch at a temperature of about 130°F. Homogenisation not only keeps the fat evenly distributed, but also increases viscosity. It usually decreases the heat stability slightly.

(d) Stabilising—After rapid cooling sodium bicarbonate, sodium citrate or phosphate may be added at the rate of about 0.25 per cent to increase the heat stability.

(e) Filling Out—The greatest care against contamination must be exercised, and the filling machine thoroughly cleaned and sterilised immediately after use. Foaming may be avoided or reduced by adjusting the product to about 60°F before filling.

(f) Sterilising—The filled and sealed cans are sterilised or autoclaved in a retort at a temperature of about 240°F for about twenty minutes. Faulty tins are usually due to:

Poor quality milk.

Insufficient heating.

Unhygienic conditions in filling.

Improperly sealed cans.

Condensed Milk (Sweetened)
The term condensed milk usually implies whole milk which has been partially evaporated and to which a proportion of sugar has been added. Condensed milk is a valuable food because it contains the nutrients from the milk and the presence of the comparatively high concentration of sugar keeps it from 'going bad' for a considerable length of time after the can or other container in which it is packed has been opened. A characteristic composition of condensed milk is:

<table>
<thead>
<tr>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Butter fat</td>
</tr>
<tr>
<td>Mineral content</td>
</tr>
<tr>
<td>Lactose plus added sugar</td>
</tr>
<tr>
<td>Water</td>
</tr>
</tbody>
</table>

Process Description for Condensed Milk

When whole milk is used, it is standardised by addition of cream or separated milk to bring the fat and solids-not-fat to a ratio of 1: 2.44. In Great Britain the whole milk product must contain 9 per cent fat and 22 per cent solids-not-fat, and the skim product a milk solids of at least 26 per cent.

(a) Pre-heating—This is the most important stage in manufacture and the conditions vary considerably. Formerly, a temperature of about 170°F, for about fifteen minutes was used, but there is now a tendency to use higher temperatures for a shorter time.

Pre-heating destroys bacteria and especially yeasts and moulds (which are so important as spoilage agents in condensed milk). Enzymes increase heat stability and tends to reduce age thickening. For the last it is important to avoid temperatures between 180°F and 210°F. Presumably treatment at this temperatures range initiates changes which continue slowly to produce age thickening.

(b) Addition of Sugar— It is essential to boil the sugar solution to destroy all yeasts and spores. The amount may be adjusted to the milk, or the milk adjusted for the sugar to give a final concentration of 42-45 per cent. The boiled sugar solution may be drawn into the pan just after the milk has started to condense.

(c) Condensing—This usually takes place at a vacuum of 25-27 inches mercury and at a temperature of 130°F to 140°F, when all the milk has entered, evaporation continues until the 'striking-point' is reached.
Whereas with evaporated milk density is the only safe criterion, with condensed milk the concentration of sucrose may be used, and this is measured with a refractometer. Alternatively, density may be used. Some manufacturers use both.

Although viscosity increases sharply as this striking point is reached this property is not commonly used owing to the natural variations in the viscosity of the milk.

(d) Cooling and Seeding-In order to obtain the smoothest possible texture, the crystals of lactose should be as small as possible. This is obtained by rapid cooling and "seeding" with finely powdered lactose or old condensed milk at a temperature of about 85°F. Condensing is the only type of manufacture the dairy industry in which "trade secrets" are maintained and the art of condensing depends mainly on the control of cooling and seeding. Some firms adopt practices which are not mentioned in the ordinary literature.

(e) Packing-Whether filled into barrels drums, or tins, it is essential to sterilise these efficiently, otherwise serious mould and yeast contamination may occur.

(B) DRIED MILK POWDER

The most important use of the dried milk is as food for children. The extensive use of dry whole milk, dry buttermilk and dry skim milk is in bakeries, confectioneries, hospitals and ice cream manufacturers. The composition of dried milk products is given below:

<table>
<thead>
<tr>
<th>Product</th>
<th>Moisture %</th>
<th>Fat %</th>
<th>Protein %</th>
<th>Lactose %</th>
<th>Ash %</th>
<th>Lactic Acid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried Whole Milk</td>
<td>4.925</td>
<td>925</td>
<td>7.38</td>
<td>85.0</td>
<td>5.8</td>
<td>-</td>
</tr>
<tr>
<td>Dried Skim Milk</td>
<td>4.9</td>
<td>0.4</td>
<td>5.7</td>
<td>34.9</td>
<td>5.3</td>
<td>-</td>
</tr>
<tr>
<td>Dried Buttermilk</td>
<td>7.46</td>
<td>436</td>
<td>135</td>
<td>65.8</td>
<td>8.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Dried Whey</td>
<td>7.1</td>
<td>512</td>
<td>268</td>
<td>97.52</td>
<td>1.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

By drying the milk, high nutritional content of milk, its specially nutritious protein, its calcium, the group of B-vitamins and the vitamins A and D from its butter fat can more conveniently be preserved. It is advisable to start with a good fluid milk to obtain good dry milk.

There are three main types of plants for producing milk powder or dried milk.

Roller dryer.
Spray dryer.
Vacuum roller dryer.

Most of the powder in Great Britain is produced by roller dryer, but there is an increasing amount made by the spray process. Vacuum roller plants are not used in Great Britain. Roller and spray dried powders differ considerably in their appearance and properties. Roller powder is creamy in colour, granular or almost "crystalline" in appearance, and has a characteristic tallowy of "oxidised fat" odour. Spray powder is a fine white powder which re-constitutes more easily than roller powder on account of the milder heat treatment and smaller size of particle. However, roller powder is of better bacteriological quality as the milk receives a more intensive heating. Recent changes in the treatment of milk for spray drying involving a higher temperature of preheating have resulted in powder of better sustainable quality from the bacteriological and chemical point of view. Since milk powder contains about 3 per cent of moisture, 1 gallon of milk of 12.4 per cent total solids will yield about 1.3 lb. of powder. With skim milk 1 gallon produces about 0.9 lb. of powder.

As a form of manufacture, powder has received a high priority during and since the war due to the demand for National Milk Powder for baby foods. At the present time, whole milk roller powder reinforced with vitamin D is used, spray powder being considered less suitable on account of its inferior bacteriological quality and poor keeping quality.

The most important practical property of milk powder is its "solubility" which is measured by the proportion which can be reconstituted into solution or colloidal suspension in water. Spray powder usually gives figures of about 99 per cent. While roller powders give figures of about 90 per cent.

It should be noted, however, that the solubility of a powder may be increased considerably by neutralisation
of the milk since the excess sodium ions bring more protein and phosphate into solution. Milk for spray powder is not commonly neutralised but for roller powder milk is frequently neutralised down to a "lactic acid" acidity of 0.12 per cent on even less. When considering solubility figures of powders therefore, consideration must be given to:
The method of testing; and
The degree of neutralisation.
Unfortunately there is no official method of measuring solubility, and slight differences in technique can easily lead to considerable differences in results. It is often difficult to have a consensus between laboratories for this reason. The amount and nature of the sediment when the two types of powders are reconstituted are highly characteristic and together with the odour and taste usually enable the reconstituted milk to be readily identified.
In concentrates of 50 per cent total solids ageing and crystallisation of the lactose may result in from 10 to 90 per cent.
Of the fat becoming free on foam drying (extractable by carbon tetrachloride) this excess can be prevented by heating the concentrate immediately before drying, a free fat value of less than 10 per cent being possible. Free fat can be decreased by increasing homogenisation pressure, and it increases with decreased powder particle size. Dispersibility is slightly decreased by increasing free fat (Tamsma et. al., 1959).
Roller Drying-The basic type is the Just-Hatmaker, and consists of two steam heated rollers about 5 feet long by 2½ feet in diameter. They have a clearance of about 0.02 in., which may vary according to the conditions of precessing.
The cylinders are heated by steam at a pressure of 40-70 lb. per square inch, corresponding to temperature of 285-302oF. and revolve inwards at the top. The film of milk which forms is so thin that it cannot be seen on casual inspection, and this is scrapped off by the steel knife. The smoothness and straightness of the rollers are factors of the highest importance in obtaining a first class powder, as failure to remove the entire film clearly means a burning-on the film and consequently the appearance of brown lumps is the powder. The film also falls into a box or channel containing a screw conveyor. It is desirable to cool the powder as soon as possible in order to make the powder friable and minimise oxidation of the fat. The powder is finally sieved and the satisfactory fraction packed into tins (usually 1/2 cwt.) or special bags. Whole milk powder in Great Britain must contain 26 per cent fat which corresponds to a milk of about 3.25 per cent fat. If therefore, the milk is below this value, which may happen in some parts of the country at some times of the year, it must be standardised by the addition of cream.
The economic aspect is controlled chiefly by the number of operators required for a given output, steam being cheap and the maintenance of the plant low. Output may be increased by:
Higher steam pressures.
Precondensing.
The trend of thought now is to increase pressure and work with faster revolving drums. Where condensing equipment is available, the milk may be precondensed up to about 15 per cent total solids; further concentration may lead to burning on the rollers.
A standard pair of rollers may dry 90 gallons in one hour; precondensing may raise this to 120-130 gallons per hour.
Spray Drying-This method consists essentially in directing a spray of hot, precondensed milk into a current of hot air. There are three main types:
Simple spray.
Revolving sprinkles.
Spray drying plant is much bulkier than roller drying of a given output and spray powder costs more to produce. The product is, however so much better, in the author's opinion, that it can only be a matter of time before nearly all milk powder is produced by the spray process. The confectionery and other industries will doubtless continue to accept roller powder.

The stages in spray drying are essentially the following:
1. Reception
2. Clarification or filtration
3. Cooling
4. Storage
5. Preheating (1600°F)
6. Precondensing at about 110oF to about 42 per cent total solids
7. Atomising in chamber hot air entering at about 330oF and leaving at about 200oF
8. Separation of powder

The modern plant can dry 1,000 gallons per hour, and those parts coming into contact with liquid milk should be made of stainless steel.

Owing to the milder heat treatment and general nature of the spray drying process, it is essential to keep the entire plant in good hygienic condition, especially in those parts where warm milk is held for any time. Such part of it should be regarded as pasteurising plant and stripped, cleaned and sterilised after running for a certain period.

Laboratory Control- Roller powder should be checked for moisture, which should not exceed 3 per cent and fat which in the whole milk product must be at least 26 per cent. There are usually no bacteriological problems with roller powder.

Spray powder should be chemically checked as for roller powder and requires more attention bacteriologically.

This is the most important property of milk powder from the keeping quality point of view. Drying in vacuum over a desiccant might be expected to be the most accurate method, although heating in air at 103oC, is the routine method (B.S.I. 1951). For milk powder a temperature of 80oC can be used to avoid browning (Kruisheer and Eisses, 1956) but it has been shown (Eisser 1956) that a temperature of 90oC must be used for the P2 S5 in vacuo method to measure all the moisture including that of lactose hydrate. This worker has compared a number of methods and obtained the following results using the above method as a yardstick.

Solubility: - Stuart and Martin (1959) have drawn attention to the importance of water hardness in solubility tests. Calcium and magnesium sulphates exert a considerable effect, but calcium bicarbonate improves solubility. Zeolite softened waters may give better values than distilled water.

(C) SKIMMED MILK POWDER

Milk contains different nutritional components. These components vary with change of seasons and change of places of cattle feed. Skimmed milk powder is prepared with skim milk which contains about 0.05 per cent fat. Skimmed milk powder contains 5% or less moisture and fat not more than 1.5%.

Uses and applications
Milk powder is used as a food.
Milk powder is used as an alternative of ordinary milk.
Cheese, Yogurt, Ice cream, Lassi, Tea, etc., can be prepared with skimmed milk powder.
Skimmed milk powder is used almost in every home.

Plant and Machinery
Centrifuge or cream separator with accessories
Pasteuriser with cooling arrangements
Ordinary filters
Milk reception tank
Water softener
Steam boiler
Vacuum pan
Cyclone collector
Miscellaneous equipments as laboratory testing equipment
Automatic milk powder filling sealing machine
Air-compressor with air heating arrangement.

Manufacturing Process
Fresh milk is filtered and warmed and then cream is separated by centrifugal action and we get skimmed milk and after that it is pasteurised. After pasteurization milk is concentrated up to 40% moisture in the vacuum evaporator. Concentrated milk is pumped into spray dryer in which air enters at temp 150-2300C and leaves at 75-100oC depending upon the drier characteristics. Fine particles of dry milk are separated through cyclone separator.
Dried milk powder is cooled and packed in plastic lined draft paper bags.

(D) MALTED MILK POWDER
(Indian Patent Nos. 64457 and 64458)
Because of their high nutritive value and pleasing flavour, malted milk products are popular for infant and invalid foods as food beverages. Malted milk powder is used as a food for invalids and convalescents and malted milk beverages flavoured with cocoa are employed as a substitute for coffee, tea etc.
Imports and Indigenous Production: During the past years considerable market has been developed for these products in India. The demand has, however, been so far met mostly from imports.
Existing Technique: The method of manufacture of malted milk products, usually employed involves the preparation the malt extract by mashing barley malt with gelatinished wheat and concentrating the mash liquor under vacuum. Fresh milk and salts are added to the mash liquor. The mix is concentrated under vacuum to a viscous mass. This material is then stirred with large volumes of air and a high vacuum is applied when the whole mash swells up the dries. The dried product is powdered and packed.
These hitherto known methods, however, can be worked in places where a plentiful supply of fresh milk is available. Moreover, they require elaborate machinery like mashing vats for obtaining mash liquors, pasteurisers and milk handling equipments, concentrators and a special vacuum pan for final drying.
Process Developed: With a view to minimise some of the drawbacks, Central Food Technological Research Institute has developed a process which consists in mixing concentrated malt extract with milk powder fat and carbohydrates and drying in vacuum drier. The product is powdered and packed in suitable containers.
The salient features of the process are the use of milk powder in place of liquid milk and concentrated malt extract in place of mash liquor prepared from green or kilned malt, which reduces amount of water to be removed.
Scale of Study, Consumer trails, etc.: The process has been tried on a batch scale unit where batches of 50 lbs, have been successfully prepared. The product has been subjected to limited consumer trials at the Institute and is reported to compare favourably with similar products of foreign origin both in taste and taste and flavour. The shelf life of the product is about one year at 37oC.

(E) Butter
Butter is a fat concentrate which is obtained by churning cream. It is normally obtained from cow's or buffalo's milk. First of all, cream or curd is obtained from the milk and then it is converted into the butter. Butter contains about 80% fat by weight. Some time salt is added in the butter for flavour and carotene as colouring matter.
The composition of butter is
Fat80.4%
Moisture16.3%
Curd0.7%
Salt2.6%

Properties of Butter
Butter is a yellow colour fat due to the pressure of carotenes and xanthophyll, season also affects the colour of butter. Butter can readily absorb odours from the atmosphere. The presence of foreign odour and flavours in butter depreciates its market value, so it is important to protect it from undesirable odour.

Manufacturing Process (Butter)
In the manufacturing of butter cream is separated from milk with the centrifugal action. Cream is separated and thereafter acidity and other properties are tested. Then neutralization is done to adjust the acidity of cream to keep pH 6.8-7.0 by addition of alkaline salts like calcium oxide, calcium hydroxide, calcium carbonate, magnesium oxide and other salts.
Pasteurization of the cream is done after neutralization to improve its keeping quality as long as standard requires. Milk is kept at 165°F for 30 minutes for removal of cream by using a vacuum chamber in conjunction with pasteurization. After pasteurization, cream is immediately cooled, upto 68-72°F, 5-10% of the starter is added. Keeping cream at 70°F for several hours a fermentation takes place. A characteristic flavour and aroma will be imported for the cream to be carried into the resulting butter.
Colour of butter depends upon the season. It is therefore a standard practice to add edible colours to cream before churning, usually based on flavour, odour, acidity and appearance.
After adding these ingredients butter is cut into desirable size and packing of pieces is done, it is placed at low temperature in cold storage.

(E) GHEE
Ghee is a concentrate fat, obtained by the removal of water and solids from butter or cream. About 33% of total milk produced in India is converted into ghee. Making of ghee is a convenient method for the preservation of fat. Ghee has a natural sweet pleasant odour, agreeable taste. The ghee should be free from sediment or foreign colouring matter.
The colour and other physical properties of ghee depends upon the manufacturing process, place and seasons. Ghee obtained from cow's milk is yellowish and that obtained from buffalo's milk is whitish.
Composition of Ghee
Butter fat99.5-99.8%
Moisture0.1-0.3%
Acidity0.2-0.5%
Peroxide0.0-0.1%

Properties of Ghee
The colour of ghee depends upon the raw material, season, place, etc. Ghee prepared from buffalo’s milk is white in colour, and on heating it becomes colourless and transparent.
Use of Ghee
It is used as cooking fat.
In ice-cream manufacturing.
It is used in the confectionery industry.
It is used in manufacturing of various types of fat spreads.

Raw Materials
Milk
Culture
Lime
Salt
Colour flavour, etc.

Manufacturing Process (Ghee)

Direct Evaporation: It is the old Indian method of manufacturing ghee. In this method, butter is placed in a jacketed open pan and heated by steam or other means. At first heat is applied slowly till the butter melts, then it is heated usually to 108-110°C and stirred. When all the moisture has evaporated, it is filtered and packed into containers.

Decantation: It is a batch process and is generally employed for large-scale manufacturing of ghee, otherwise it is uneconomical. In this method, butter is allowed to stand undisturbed for sufficient time until it stratifies into three layers viz., top scum, middle fat, and bottom scum. The fat layer is drawn from the top and cooled.

Centrifugal Separation followed by Vacuum Drying: It is used for large-scale production of butter oil from butter. Unsalted butter is melted into a vertical jacketed stainless steel cylindrical tank filled with agitator. A tipping tank jacketed at the bottom is filled. Clean water is heated up to 170-174°F by steam. This hot water is sent into centrifugal separator and butter oil also enters. The melt is now separated into oil and scum. The oil flows into float-controlled balance tank and then into the vacuum pump and due to suction here it gets dehydrated. The butter oil is cooled and crystallized under controlled conditions. Crystallisation is done by adding some fine crystalline fats from previous batch.

Packing is done very carefully because it is desirable to avoid reaccretion of the product as it comes out of vacuum dehydrator, care should also be taken to leave a minimum of air in the headspace with an inert gas.

Storage: An anti oxidant ethyl gallate in a concentration of 0.05 per cent is used to increase its shelf life to 3 months. Distribution is done under atmospheric conditions.

Plant and Machinery for Ghee and Butter Manufacturing

- Power centrifugal separator.
- Neutralizing tank.
- Pasteurisation vessel.
- Cooling tank.
- Fermenting tank with heating and cooling arrangement.
- Boiler.
- Churner.
- Vacuum pan.
- Ghee receiving kettle.
- Cutting and packing equipment.

(G) MILK PANEER

Paneer is one of the most important dairy products. The growth rate in production of paneer is increasing steadily the world over. Paneer making is the best method of conserving and preserving milk solids. It provides a palatable milk product of high value which can be kept fresh for a long time. Paneer is an economical source of milk protein. It is rich in calcium, vitamins and is nourishing and an easily digestible food.

Manufacturing Process (Paneer)

First of all, fresh and good quality milk is taken. The best quality paneer is made from milk of 6.0% fat content. The milk is heated up to 82°C for five minutes to kill the pathogens and after heating it is cooled to 70°C, then 10% citric acid is added for coagulation then whey is drained out and milk solids are filled in hoops, it is pressed by weights, after sometime weights are removed and paneer is packed into big pieces. These big pieces are dipped in chilled water at 4-6°C. After 1-2 hours, chilled water is drained out from water bath and the paneer is packed into desired sizes and stored at 4-6°C temperature. It contains about...
26% fat and 55% water.

Fig. 4. Process Flowsheet Diagram for Manufacturing Milk Paneer.  Fig. 5. Process Flowsheet Diagram for Manufacturing Paneer.

Composition
The average composition of paneer may be fat 26%, moisture 55% and T.S. 45%.

(H) YOGHURT
Manufacturing Process
Milk of buffalo or cow is steamed for a minimum of 30 minutes and cooled to a temperature of 43°C and then incubated with 30% yoghurt starter. It is mixed thoroughly, filled into the glass bottles and sealed with aluminium foil caps and kept at 42°C+0.5°C for to 3.5 hours when the coagulum is formed. Then bottles are removed from water and placed into a waterbath. having temperature of 30°C for 30 minutes and transferred to refrigerator for overnight storage.

(I) CHEESE
The making of cheese as a means of preserving the most important constituents of milk in highly concentrated form is in vogue all over the world. It provides a palatable milk product of high food value which can be kept fresh for a long time. Cheese is an economical source of milk protein. It is rich in calcium, vitamins and is nourishing and is an easily digestible food.

In India, cheese is not a much popular food item because animal rennet enzyme is used in its preparation. During World War II, Cheddar cheese was being produced at Anand and Nadiad for the use of the Armed Forces. Soft cheese known as Paneer is made in Punjab by using berries of withania coagulants as the source of a coagulating enzyme for coagulating milk.

Indian Varieties of Cheese: The cheese varieties mentioned above are not very common in India. These are popular only among the people with western habits. In India, mostly cottage cheese is prepared in small quantities and consumed fresh. This cheese is known as paneer.

In West Bengal, Chana is a popular form of fresh cheese, prepared by the precipitation of boiling milk by the addition of citric or tartaric acid.

Dacca cheese is another variety made from whole milk by clotting it with rennet. The curd is broken into small pieces and put into wicker baskets and weights are placed on it to drain away the whey. The weights are removed after 10-14 days, when a thin dry coat is formed on the surface due to evaporation. The cheese is then smoked with wood or cow dung smoke. It may remain well for one or two months.

Surti cheese is made by clotting milk with rennet, and the clot without breaking is transferred to small wicker baskets to drain. The curd is turned frequently to aid drainage. It is immersed in acid when containing salt which makes it firm and salty. The cheese is drained dry. It has a short keeping period of 10-14 days. Bandal cheese is a soft type of cream cheese similar to surti except that it is smoked. It is made from cream and that is why its fat content is higher. The flavour is mellower and the texture softer than that of the cheese made from whole milk.

But its keeping quality is lower than the smoked Daua cheese.

It contains approximately 40 per cent fat and 10-15 per cent protein.

Steps in making Cheddar Cheese: The milk intended for making Cheddar cheese is strained though a muslin cloth in a vat. Both evening and morning milk can be mixed and used. The temperature of the milk is raised to 85% or 86°F by circulating hot water in the jacket of the vat.

Ripening: The milk is then ripened with a suitable starter. The required quantity of a good lactic starter is strained through a muslin cloth into the milk and mixed thoroughly. The milk is occasionally stirred till the desired acidity of 0-19 per cent to 0-20 per cent is reached or when the milk responds of the rennet test.

Colouring: The required quantity of cheese colour is diluted with milk and mixed evenly.

Renneting: The required quantity of rennet is first diluted in water and then mixed thoroughly with milk.
Cutting the curd: When the curd is properly set, it is cut both lengthwise and breadthwise with the vertical and horizontal cheese knives.

Heating: Heating of curd is started gradually along with the development of acidity.

Drawing whey: The whey is drawn through the hair sieve when the acidity of the whey reaches 0-19 to 20%.

Cheddaring: After removing the whey a bed of curd is made at one end of the vat. The curd is cut into lumps of convenient and uniform size and turned over to facilitate the drawing of the whey. The turnings are done frequently to produce a compact body and texture. The lumps are placed one above the other till the desired acidity, body and texture of the curd is obtained.

Milling: When the acidity has reached 0.80-0.90 per cent and the texture is like the meat form the breast of chicken, the curd is ready for milling. Hot iron test should give 3/4 inch to 1/4 inch length of threads. The green cheese is milled into small bits for the purpose of aerating, salting and hooping.

Aeration: After milling, the green cheese is spread in the vat and stirred well for about five minutes for aeration just before slating.

Salting: The required quantity of cheese salt is sprinkled on the cheese and mixed uniformly.

Hooping: The cheese mould is prepared with the cheese cloth and its accessories and the green cheese is pressed inside.

Pressing: After filling the cheese mould it is put under cheese press. The pressure is increased gradually. The green cheese is allowed to remain in the press till the next day.

Hot bath: After taking it out of the press, it is given a hot bath at 14oF for a few seconds.

Dressing the Cheese: The cheese is dressed on the third day and kept in the curing room.

Paraffining: The cheese is paraffined after a week or a fortnight of the preparation of green cheese and kept in the curing room for ripening.

Curing: Cheese is set for ripening at a temperature of 55oF. The cheese should be turned daily at least during the first fortnight after making. Afterwards, every other day will be sufficient.

Important Data for Making Cheddar Cheese

Quantity of starter. 1-3 percent of the quantity of milk.

Acidity of starter. 0.7-0.8 percent.

Quantity of colour. 14-56 g per 456 g of milk or 3 drops per 45 g of milk.

Quantity of rennet. 71-113 g per 454 g of milk depending upon the make (16ml. of standard Hansen's rennet is added to every 45 g of milk).

Quantity of salt. 2.0-3.0 per cent in curd or 28.3 grams for every 1.8 g of curd.

Acidity:
at the time of renneting: 0.19-0.20 per cent lactic acid.
at the time of cutting the cured: 0.11-0.3 per cent.
at the time of drawing of the whey: 0.19-0.20 per cent.
during milling: 0.8-0.9 per cent.
next morning: 0.95-1.1 per cent.
after one week: 1.3 per cent.

(vii) Temperature:
when starter is added 85oF or 86oF.
when rennet is added: 86oF.
after heating: 101-102oF.
in curing room: 55-60oF.
Humidity in the curing room: 80 per cent.
Appliances required for preparing cheddar cheese.

Cheese vat (double jacket).
Wooden board with a rack (covering for the vat).
Cheese knives (vertical and horizontal).
Scale with accessories for weighing.
Moulds with accessories (wooden).
Accessories such as muslin, cheesecloth, acidometer set, rennettest set, thermometers, milk cans, cheese colour rennet, salt, brushes, etc.
Whey strainer (metal).
Ladle (metal).
Hair sieve.
Knife (ordinary).
Bukets (small).
Starter can.
Trap (metal).
Cheese-press with accessories (wooden) etc.

Preparation of appliances for cheese making: Thoroughly clean the appliances with soda and hot water and sterilize in boiling water. Peep the appliances in a clean and hygienic place.

Addition of starter: The starter used should be fresh and active. It should have a pleasantly mild acid flavour, and should be smooth in appearance and free from gas holes.

The quantity of starter to be added depends on a number of factors much as the acidity of milk and the starter, bacteriological condition of the milk, and water. The cheese is desired to be ripened slowly or fast. It should have acidity from 0.7 to 0.8 percent. The quantity of starter generally used is 1 to 3 per cent of the quantity of milk. More starter is needed in winter than in summer.

The ripening of milk helps in checking the growth and activity of the gas-producing bacteria in the curd. It also helps in the separation of whey from the curd after it has been cut.

Addition of colour: The cheese colour is prepared from annatto seeds in an alkaline solution, unlike butter colour which is extracted from refined vegetable oil.

Immediately apply the rennet and the required quantity of annatto extract evenly to the milk and stir well. Usually 2 or 3 drops per 100 pound of milk give a pleasant coloured cheese.

Addition of rennet: The rennet employed in cheese making should always be of very high quality and should be obtained only from well-known and reliable manufacturers. Readymade rennet extract in liquified tablet and powder forms is available in the market.

Dilute the required quantity of rennet in clean cold water approximately six to eight times its volume. Generally, 71-123 g (2.5 to 4 ounces) of rennet extract is used per 454 kilograms (1,000 pounds) to milk depending upon the make. Sixteen milliliters of Standard Hansen’s rennet is added to every 45 g of milk. Apply the solution by pouring it evenly throughout the vat. Mix it gently but thoroughly, so that fat is uniformly distributed in the whole bulk and may not have the chance of rising to the surface of the milk. If the rennet is not properly mixed, it may result in uneven coagulation, higher loss of fat in whey and in cheese yield. Care must, however, be taken to avoid over stirring.

Preparation of rennet: It is an extract from the fourth stomach of sucking calf. The dried stomach is chopped in a shredding machine and soaked in salt brine containing some boric acid as a preservative. After several days, salt is added and the liquid is filtered clear and stored in a cool dark place. After sufficient aging, it is tested and brought to a definite strength.

Detection of first thickening of milk: Gently put a drop of water on the surface of the milk or cause a slight visible depression, the milk has started coagulating.
Causes of incomplete or delayed coagulation: Jarring of milk after coagulation starts. The use of weak or a very small quantity of rennet extract.

Low temperature used for setting.

Abnormal milk containing small percentage of casein or calcium salts.

The presence of formalin and abnormal bacterial flora.

Heated milk or heavily watered milk. The use of badly rusted milk cans.

Causes of uneven coagulation: Uneven temperature of milk in the vat, due to insufficient agitation before coagulation sets in. Adding rennet to milk too soon after heating, while the sides and bottom of the vat are still hot.

Agitation of milk after coagulation begins. Uneven distribution of rennet extract.

Cutting the curd: The main objects of cutting the curd are to facilitate the expulsion of whey and uniform cooking of the curd.

If the curd clearly leaves off the sides of the vat when gently pressed and breaks clearly over an inserted finger, it is ready for cutting. At this stage, the surface of the curd should be free from fat, which can be checked by touching the top layers of the curd with the back of the palm. If the curd is cut when it is too soft, there will be a higher loss of fat and casein in whey, as the soft curd is more likely to be broken and meshed during stirring and other processes. Generally, the time required for the complete setting of curd is two or three times more than the time required for the first thickening. For example, if it takes 10 minutes after adding rennet for the first visible thickening to occur, then it will approximately take 20-30 minutes for the complete setting of curd.

When the curd is properly set, cut it into cubes of uniform shapes and sizes.

First cut the curd lengthwise and then breadthwise of the vat with the vertical knife, and finally with the horizontal knife to form cubes.

Do not take out the horizontal knife until the whole operation is over. The cutting should be done firmly and quickly. The curd should not overlap in cutting.

Cause of low acidity after cutting: The acidity of whey after the curd is cut, is lower than that to the milk at the time of adding of rennet. This is due to the removal of proteins in the curd and the liberation of certain salt of an alkaline nature which neutralize the acidity in the whey.

Stirring: If the curd cubes are left too long in contact which each other after cutting, they will begin to stick together and form lumps.

Start stirring the cubes soon after cutting to retain the curd in cubes of uniform shapes and sizes. There is a danger of high fat losses during the early stages. Hence, stir the cube gently to avoid smashing the curd.

Development of firmness and acidity in curd: If the milk is overripe when received or is ripened too long before renneting, or if too much starter is added, the acidity may develop faster than the development of firmness in the curd. As a result, although the curd will show the required acidity, it will be too soft in body at the time of drawing whey. In such a case, the whey should be drawn at a lower acidity and the forming process should be accelerated by hand stirring.

On the other hand, if the milk is too sweet or if too little starter is used, the curd may become firm before it shows the desired acidity. In this case, the whey should be drawn off when the curd has matted and is firm enough even if the acidity is low. To develop acidity, it should be kept warm for sometime before milling and salting.

It is however, much better to have too little acidity when drawing the whey, as more acid is developed while matting. Too much acid before drawing of the whey spoils the quality of the cheese.

To develop a firm curd in short time from overripe milk, use a smaller quantity of starter. Set the milk in the vat as soon as possible, so that the curd is ready in about 20-30 minutes. Cut the curd finer than usual to facilitate the drawing of whey. Begin heating soon after cutting. Heat this curd a few degrees higher than
Heating the curd: The curd is heated after cutting. Increase the temperature of the curd gradually at the rate of two degrees fahrenheit for every five minutes depending upon the rate of the growth of acidity until the desired temperature is reached. When the lactic acid formation is slow, one degree fahrenheit every five minutes is sufficient. The final temperature, however, depends on the season of the year; generally a temperature of 101°F in summer and 102°F in winter is considered best.

After heating allow the curd to stand in the whey undisturbed for some time. This assists the curds mat together and bring on the acidity. The acidity in the curd always develops quicker when it is left in the warm whey. However, if the curd is left too long in the whey, it gets too acidic in nature which may result in a sour and dry cheese.

Removing the whey: Draw the whey off when the acidity in the whey tests 0.19-0.20 percent. The curd cubes are firm and spongy.

Cheddaring the curd: Cheddaring is done to give a characteristic body and texture to the curd and to retain the desired moisture content by regulating the removal of whey. It is also difficult to keep the curd in cube forms for a long time. Curd held for a long time in cube forms becomes too dry.

Pressing the cheese: The cheese is pressed to give it an even appearance of uniform size and shape. Pressing also causes the interior of the cheese to fuse together into solid mass and the rind to close up. At first, apply a high pressure sufficient to start drippings. Thereafter, increase the pressure as fast as necessary to keep the drippings running until the full pressure is on. The pressure applied should be gradual and not sudden. The correct pressure will vary according to the size of the cheese piece.

Dressing the cheese: Dressing or bandaging of cheese is done to keep the cheese shape, preserve its coat, prevent loss by evaporation to keep off flies, dirt, etc.

Paraffining the cheese: Cheese is paraffined to protect its rind. It also prevents the growth of mould and minimizes shrinkage of loss in weight.

Curing of cheese: The best temperature for curing or ripening cheddar cheese is 55-60°F. The amount of humidity present in the curing room is important. If the air is too dry the evaporation loss may be excessive, affecting both quality and yield. At the same time, if the air is too moist, the cheese will neither dry properly nor form a perfect rind resulting in mould formation on the surface generally, 80 per
cent humidity is considered suitable.

Turn the cheese daily for at least the first fortnight after making. Afterwards turning on every other day will be sufficient.

A well-made cheddar cheese will develop a good flavour and texture in about three months, and if kept under satisfactory conditions, will retain its good qualities for a year or so.

Procedure when high acidic milk is used:

Set the curd at a low temperature. In extreme case, it should be below 80°F.

Use an extra amount of rennet. This would hasten the coagulation and the firing process.

Cut the curd into smaller pieces. This would facilitate draining of whey.

Cut the curd as soon as possible after coagulation. This will allow the moisture to escape more readily.

Use the higher cooking temperature, the rate of heating may be hastened. Heat the curd rapidly towards the end of the heating period.

Soon after heating, draw the whey down the level of the curd. Stir the curd vigorously at this stage. It will tend to firm the curd more quickly.

In extreme cases draw off the remaining whey and quickly replace it with an equal amount of water having the same temperature. After properly firming the curd draw away the water and stir the curd vigorously.

Spread out the curd in the vat properly and after it has matted, cut into smaller blocks. The blocks should be turned frequently to hasten the removal of the whey.

Use more salt to hasten the loss of moisture and to check the bacterial fermentation.

Procedure (when gas-producing-organisms are present in curd).

Use a higher rate of good quality starter. Ripen the milk to a higher acidity before the rennet is added.

Develop the maximum amount of acidity in the curd before removing the whey. The whey should test approximately 0.2 per cent acidic and the hot-iron test should give one-eighth inch long threads.

Remove enough whey to bring the floating curd cubes down to the bottom of the vat. This quickens the firming process.

Pile the gassy curd higher during the cheddaring operation.

After milling, the curd can be improved by raising it with water at a temperature of 75°F. Proper stirring and airing will help to improve the flavour and texture.

Use a little more salt than usual to check the undesirable fermentation. Press the curd for a longer period. It will prevent the cheese from losing its shape.

Cause of higher fat loss in cheese making—Presence of water and preservatives.

Abnormal composition of milk in which the casein is abnormally low in relation to fat.

Presence of injurious bacterial ferments.

Failure to keep the fat well distributed throughout the milk before and after adding rennet.

Stirring milk just after the rennet coagulation has commenced and before it is completely set.

Cutting the curd in too soft a condition or cutting with dull knives or with rough motions.

Heating the curd too rapidly or at too high a temperature.

Too vigorous stirring of the soft curd at the time of the removal of whey. Excessive piling of curd previous to cheddaring.

Milling at too high temperature or too rapidly.

Salting the curd at a temperature above 90°F or putting a very warm curd in the press.

Too rapid increase of pressure in the press.

Causes of casein losses: Rough handling and cutting of curd. Violent agitation at the time of the removal of whey from the curd.

The use of imperfect strainers.

Any condition that interferes with the complete coagulation of the milk casein by rennet.
Qualities of good cheese:
The flavour of the short-curd cheese should be mild. It should be free from off flavours, whereas aged cheese should have a pronounced cheese flavour.
It must have a smooth surface and sound rind.
The body should be firm and free from gas and mechanical opening.
The cheese could not be crumbled or corky.
The colour should be uniform throughout the body of the cheese.

PREVENTION OF COMMON DEFECTS IN CHEESE
Sweet or Fruity Flavours: To prevent these flavours, observe strict cleanliness. Aerate the curd well after milling and salting. The use of more salt will also help to overcome this defect.
Feed Flavours: Do not accept any milk containing feed flavours. Use plenty of food starter. Wash the curd lightly with a little warm water before salting and ripen the cheese at a low temperature.
Mouldy Surface: Keep the curing room well ventilated and its shelves clean and dry. Paraffin the cheese properly. Turn the cheese daily in the curing room. Any cheese block, if turns mouldy, should be removed from the curing room.
Greasy Texture: To prevent the defect, avoid using partially churned milk. Also use as low temperatures as possible for cooking cheddaring. Cool the curd properly before salting and pressing. To improve the greasy curd after milling, rinse it well with warm water to remove the free fat from the curd surface, or ripen the cheese at temperature below 60oF.
Open Texture: To avoid an open texture, press the curd well and develop the maximum amount of acidity in the whey before dipping. Also cheddar the curd until all the mechanical holes disappear.
Bitterness: To prevent this defect, use a good quality starter. Reduce the moisture content of the curd increasing the cooking temperature by two or three degrees. Stir the curd more vigorously as the last portion of the whey is being removed and the pile the curd low. After milling, properly aerate the curd. In extreme cases, add a larger quantity of salt.

(J) PROCESSED CHEESE
Select good quality cheese. Clean, crust and reduce it into small bits. Finally grind it.
The complete removal of crust together with a thorough washing is necessary to avoid bacterial contamination.
Next, add water and fusion salt to the ground cheese and heat it for the purpose of liquifying it. There are a number of salts such as sodium citrate and sodium phosphate, normally found in milk, which can be used. The quantity used may vary from 1.5 to 3 per cent according to the consistency desired in the final product. The extent and duration of heating has to be carefully controlled. At a temperature of about 70oC, the liquid has the appearance of a smooth paste cream. Cool and harden the melted mass in molds lined with aluminium foil. The melt has to be cooked gradually to have a fine product.
Cottage cheese made without rennet: Bring the milk to a setting temperature of about 720F, and add enough starter to bring about the coagulation.
The curd is ready for cutting as soon as it becomes jelly like and shows clear whey separating out when cut. As the curd gets very easily broken at this stage, it should be handled gently. This whey which separates, contains about 0.6 percent of lactic acid.
Cut the curd into cubes, each three-eight to one half inch in size with both horizontal and vertical cheddar cheese knives.

(K) SOFT CHEESE
Steps in Processing
Varieties made from cow milk are quite popular in western countries. In the context of popularising this type
of high nutritive dairy product in India NDRI has studied and standardised one soft sweet cheese variety.

The major steps for the production of sweet cheese are described below:

**Fig. 7. Process Flow Diagram for Manufacturing Sweet Cheese**

**Composition:** The composition of Sweet Cheese may range from fat 12-16%, TS-35-40%, moisture 60-65%, sugar 25-30% by weight of soft cheese and essence 1 ml per kg of mix.

Begin heating the curd by circulating warm water for about 5-10 minutes after cutting. The temperature of the water should be kept about 15°F higher than that of the curd itself. Stir well, but very gently at first. The temperature is raised at one degree fahrenheit every five minutes until there is enough whey to enable the curd to float. The rate of heating should then be accelerated.

The maximum temperature reached during heating varies from 95°F to 110°F. The time taken in bringing the curd to the maximum temperature, which is maintained until the whey is removed, is from 40 to 80 minutes. Let 15 to 30 minutes elapse after this temperature is reached before removing the whey. This period however, depends on the temperature, the character of the curd and the body desired. High temperatures and prolonged heating tend to make the curd tough rubbery, granular and dry, the lower the cooking temperature, the smoother will be the body. A mushy curd is often caused by too little application of heat or too rapid heating after cutting.

Remove the curd from the whey, when it does not become milky on being pressed between the fingers. At the time of removal, the curd particles should not have any soft corners.

After the whey is removed, pile up the curd at both the sides of the vat and form a trench in the middle to facilitate proper drainage to the whey.

The flavour of the curd can be improved by washing it at least twice with cold water. The first washing at a temperature of about 70°F cools the curd and removes most of the sour whey. The second one, at a temperature of about 55°F or lower, checks further bacterial growth in the curd.

When most of the free moisture is drained away, apply salt at the rate of one pound to every hundred pounds of the curd.

**Sweet cottage cheese with rennet:** For making sweet cottage cheese use clean skimmed milk, preferably pasteurized. The milk should be set at 68-70°F when the required temperature is obtained, add lactic acid starter at the rate of one percent and thoroughly mix it with the milk.

Add the cheese colour after the starter has been added. Only a small quantity of cheese colour should be used. Mix the cheese and colour with milk before adding the rennet.

Cheese rennet is added at the rate of 1 c.c. to each 1.361g (3 pounds) of milk. First, dilute the rennet using plenty of cold water (about 40 times its volumes) and then mix with the milk.

After the curd has properly set, cut it in the same manner as an ordinary cheddar curd is cut.

After cutting, heat the curd gradually to 110°F. During the heating process, stir the curd gradually. Cook the curd dry enough to obtain a yield of 5-7g from each 45g of milk.

After the curd is cooked, a small amount of fat may be added to improve its taste. This is generally added in the form of rich cream. Ordinarily, 2 to 4 per cent fat should suffice. At the same time, add salt approximately at the rate of 283.5 g (10 ounce to each 45 g of curd).

After the whey has been removed, wash the curd two or three times with plenty of cold water.

**B.I.S. Specifications**

IS:1166-1957-Condensed Milk.
IS:4421-1967-Milk Food, Malted Skimmed.
IS:6397-1971-Pasteurization of Milk.
IS:2785-1964-Hard cheese, processed cheese and processed cheese spread.
IS:4884-1968-Sterilised Milk.

Equipments for Dairy
IS:2495-1963-Cheese Hoops.
IS:2647-1964-Cheese Milk.
IS:4938-1968-Insulated Stainless Steel Milk Storage tank vertical type.
IS:3719-1966-Milk coolers, open surface (with aluminum tubes.)
IS:4743-1968-Setting tanks for ghee.
IS:4767-1968-Steam jacketed ghee pans.
IS:2648-1964-Pipe washing and sterilizing chest.
IS:6591-1972-Rail Milk Tankers.

Dairy Laboratory Apparatus

IS:2311-1963-Fat Extraction apparatus for milk and milk products.
IS:2803-1964-Capillary pipette for direct microscopic count milk.
IS:2803-1964-Capillary pipette for direct microscopic count of milk.

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