K.S. RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE – 637 215
60 FT 501 – DAIRY TECHNOLOGY

UNIT I

INTRODUCTION

Scope and Importance of Indian Dairy Industry

India has been the leading producer and consumer of dairy products worldwide since 1998 with a sustained growth in the availability of milk and milk products. Dairy activities form an essential part of the rural Indian economy, serving as an important source of employment and income. India also has the largest bovine population in the world. However, the milk production per animal is significantly low as compared to the other major dairy producers.
Moreover, nearly all of the dairy produce in India is consumed domestically, with the majority of it being sold as fluid milk. On account of this, the Indian dairy industry holds tremendous potential for value-addition and overall development.

Dairy Industry in India Size in 2022	INR 14,899.8 Billion
Dairy Industry in India Forecast in 2028	INR 31,185.7 Billion
Dairy Industry in India Growth Rate (2023-2028)	13.2%

Milk – Definition, Type of Market Milk

Definition

Milk is a white liquid food produced by the mammary glands of mammals it is the primary source of nutrition for young mammals before they are able to digest solid food.
Milk is an emulsion or colloid of butterfat globules within a water-based fluid that contains dissolved carbohydrates and protein aggregates with minerals.

Type of Market Milk

There are various types of milk available in the market for commercial consumption and below are the types of milk

Homogenized milk:

In homogenized milk, the fat globules are broken up mechanically to less than 1 micron in diameter so that fat does not rise to the surface to form a cream layer. The process consists of forcing milk heated to about 57 to 60^0C (135-140^0F) through a very small orifice at high pressure. All homogenized milk should be pasteurized after homogenization to destroy the enzyme-lipase which otherwise would cause the milk to become unfit for human consumption within a few hours due to the development of bitterness and rancidity. One disadvantage of homogenized milk is that milk fat cannot be separated as cream in a cream separator. The fat in homogenized milk is more readily digested by infants than that from ordinary milk.

Standardized Milk

In standardized milk, the fat content is maintained at 4.5 % and S.N.F. at 8.5 %. It is prepared from the mixture of buffalo milk and skim milk.

Toned Milk

Toned milk is prepared by mixing reconstituted from skim milk powder with buffalo milk containing 7.0 % fat. The fat content of the toned milk should not be > 3 % and S.N.F. 8.5 %.

Double Toned Milk

This is prepared by admixture of cow's or buffalo's milk or both with fresh skimmed milk or by admixture with skim milk reconstituted from skim milk powder or by partial removal or addition of milk to skim milk. It should be pasteurized and show negative phosphatase test. Its fat content should be less than 1.5 % and S.N.F. not less than 9 %.

Recombined Milk

Recombined milk is a homogenized product prepared from milk fat, non-fat milk solids and water. It should be pasteurized and show a negative phosphatase test. Its fat content should be less than 3 % and S.N.F. 8.5 %

Filled Milk

Filled milk is a homogenized product prepared from refined vegetable oil and non-fat milk solids and water. Its fat content should not be less than 3 % and S.N.F. 8.5 %.

Sterilized Milk

Standardized cow's or buffalo's milk is sterilized in bottles by heating continuously to a temperature of 115^{o}C for 15 minutes to ensure destruction of all micro-organisms and preservation at room temperature for not less than 85 days from the date of manufacture. It shall be sold only in the container, in which milk was sterilized.

Ultra-high temperature (UTH) processed milk

Milk is heated at temperatures higher than those used for pasteurization, 138°-150°C for 2-6 seconds. Then, under sterile conditions it is packaged into presterilized containers, which are aseptically sealed so that spoilage organisms cannot enter. Hydrogen peroxide may be used to sterilize the milk packing materials. UHT milk can be stored unrefrigerated for at least 3 months. UHT milk has cooked flavor due to denaturation of the whey protein β lactoglobulin. Off flavors develop due to chemical and enzymatic activity. The addition of flavorings to milk masks off flavor.

Flavored Milk

Flavored milk may contain cardamom, pista, banana, strawberry, chocolate, coffee or any other edible flavor, edible food color and cane sugar. It is either pasteurized or sterilized and the Shelf life can be high if it is sterilized. Research has shown that carbon dioxide when added to milk creates a unique sensation in the mouth that actually makes milk more thirst quenching. It is also showed that carbon dioxide could extend the shelf life of dairy products by displacing some of the oxygen needed for spoilage bacteria to grow. A non-fat milk-based drink contains the same nutrition as skim milk. It is designed to appeal to kids through the addition of interesting flavors and a bit of carbonation. It is being commercially produced.

<u>Composition of Milk and Factors affecting Composition of Milk</u>

Composition of Milk

Whole cow's milk contains about 87% water. The remaining 13% contains protein, fat, carbohydrates, vitamins, and minerals. Processing techniques remove fat to produce lower fat varieties: "reduced fat" contains 2% milkfat, "lowfat" contains 1% milkfat, and "nonfat" or "skim" has virtually no milkfat. Cows are often pregnant while they are milked, so dairy milk contains hormones like insulin-like growth factor-1 (IGF-1), estrogens, and progestins. Some cows are given additional hormones to increase milk production.

Table: 1 Composition of Milk

Main constituent	**Range (%)**	**Mean (%)**
Water	85.5 – 89.5	87.0
Total solids	10.5 – 14.5	13.0
Fat	2.5 – 6.0	4.0
Proteins	2.9 – 5.0	3.4
Lactose	3.6 – 5.5	4.8
Minerals	0.6 – 0.9	0.8

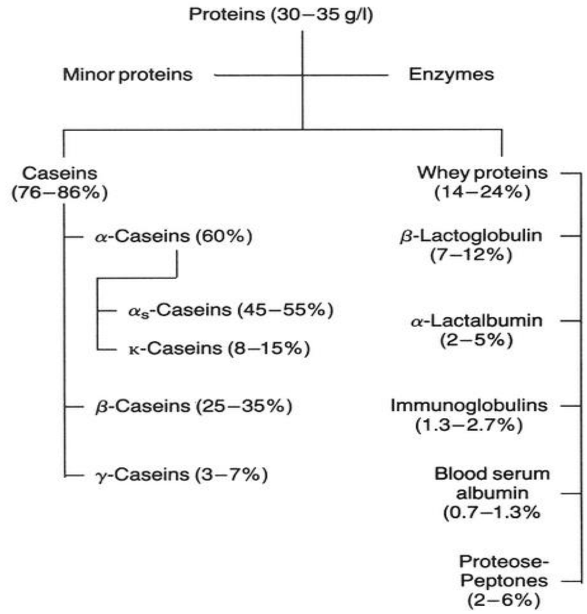


Fig 1: Proteins and Enzymes in Milk

Table 2. Distribution of milk salts between the soluble and colloidal phases.

Salts	**Total**	**Dissolved**	**Colloidal**
	(mg/100 ml of milk)		
Calcium	1320.1	51.8	80.3
Magnesium	10.8	7.9	2.9
Total phosphorus	95.8	36.3	59.6
Citrate	156.6	141.6	15.0

Factors affecting Composition of Milk

Genetic

Milk composition varies considerably among breeds of dairy cattle: Jersey and Guernsey breeds give milk of higher fat and protein content than Shorthorns and Friesians. Zebu cows can give milk containing up to 7% fat. The potential fat content of milk from an individual cow is determined genetically, as are protein and lactose levels. Thus, selective breeding can be used to upgrade milk quality. Heredity also determines the potential milk production of the animal. However, environment and various physiological factors greatly influence the amount and composition of milk that is actually produced. Herd recording of total milk yields and fat and SNF percentages will indicate the most productive cows, and replacement stock should be bred from these.

Interval between milkings

The fat content of milk varies considerably between the morning and evening milking because there is usually a much shorter interval between the morning and evening milking than between the evening and morning milking. If cows were milked at 12-hour intervals the variation in fat content between milkings would be negligible, but this is not practicable on most farms. Normally, solids-not-fat content varies little even if the intervals between milkings vary.

Stage of lactation

The fat, lactose and protein contents of milk vary according to stage of lactation. Solids-not-fat content is usually highest during the first 2 to 3 weeks, after which it decreases slightly. Fat content is high immediately after calving but soon begins to fall, and continues to do so for 10 to 12 weeks, after which it tends to rise again until the end of the lactation.

Age

As cows grow older the fat content of their milk decreases by about 0.02 percentage units per lactation. The fall in solids-not-fat content is much greater.

Feeding regime

Underfeeding reduces both the fat and the solids-not-fat content of milk produced, although solids-not-fat content is more sensitive to feeding level than fat content. Fat content and fat composition are influenced more by roughage (fibre) intake. The solids-not-fat content can fall if the cow is fed a low-energy diet, but is not greatly influenced by protein deficiency, unless the deficiency is acute.

Disease

Both fat and solids-not-fat contents can be reduced by disease, particularly mastitis.

Completeness of milking

The first milk drawn from the udder is low in fat while the last milk (or strippings) is always quite high in fat. Thus, it is essential to mix thoroughly all the milk removed, before taking a sample for analysis. The fat left in the udder at the end of a milking is usually picked up during subsequent milkings, so there is no net loss of fat.

System of Pricing of Milk

In India, four systems of milk procurement (viz., Direct, Contractor, Agent and Co-operative systems) are popular. The organized sector with 575 processing plants and milk product factories in the Co-operative, Public and Private sectors has not captured major share in the milk trade which is still dominated by the traditional sector. It has been estimated that about 67% of total milk production is marketed, out of which 51% is the share of traditional channels and remaining 16% is through the organized sector. The low capital demands of traditional systems make it hard to replace. The organized dairies collect milk through one or combination of the following systems:

Direct system

In this system, organized processor (Public, Co¬-operative or Private) collects milk directly from the producers by establishing village procurement centers.

Contractor system

The processors purchases milk from the contractor according to the terms of contract such as quality, quantity, price, etc.

Agent system

The processor appoints agents to procure milk in particular area. Payment for the milk is made directly to the producers while the agent gets the commission.

Co-operative system

At the village level, the farmers form a co-operative society, which establishes the milk collection center's'. The society collects milk twice a day and delivers it to the milk collection center's where the milk is weighed, tested and the price paid to farmers. The payment is based on fat content or fat + SNF content in the milk. The village society supplies/sells milk to its own District co-operative dairy plant. It transports milk in cans by trucks or through insulated road milk tankers, preferably via a chilling center.

Chilling Centers / Bulk Milk Cooling Centers

If the dairy plant is far away from the collection center, then the collected milk is first brought to a centralized chilling center/ bulk milk cooling unit. Here, milk is cooled to 4°C and stored in insulated storage tanks of 5000-20,000 L capacity. Subsequently, the chilled milk is transported in insulated Road milk tanker to the dairy plant. The transportation of milk from the chilling center to the dairy plant usually takes place once a day.

Nutritive Value of Milk

Milk has good quality protein and the biological value is > 90, though milk contains only 3-4 % protein. Lysine is one of the essential amino acids which is abundant in milk proteins. Milk is the only substance that contains lactose. Milk sugar due to its controlled glycemic effect, is preferred as a source of carbohydrate. The fat of milk is easily digestible. It contains linoleic acid (2.1 %) linolenic acid (0.5 %) and arachidonic acid (0.14 %). Skimmed milk does not contain any fat. Buffalo milk contains high amount of fat.

Table 3: Nutritive value of Milk

Food	Moisture (g)	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Vitamin A (IU)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin B12 (µg)
Buffalo's Milk	81.0	117	4.3	6.5	5.0	210	130	0.2	160	0.04	0.10	0.1	0.14
Cow's Milk	87.5	67	3.2	4.1	4.4	120	90	0.2	174 *	0.05	0.19	0.1	0.14
Human Milk	88.0	65	1.1	3.4	7.4	28	11	-	137	0.02	0.02	-	0.02

PHYSICO – CHEMICAL PROPERTIES OF MILK

Milk is a complex colloidal dispersion containing fat globules, casein micelles and whey proteins in an aqueous solution of lactose, minerals and a few other minor compounds. Its physical and chemical properties depend on intrinsic compositional and structural factors, extrinsic factors such as temperature and post-milking treatments. An understanding of these properties is important in the technological and engineering design and operation of milk processes and processing equipment, the design of modern methods of milk analysis, the determination of milk microstructures and the elucidation of complex chemical reactions that occur in milk.

Colour

The color is a blend of the individual effects produced by the colloidal casein particles and the dispersed fat globules, both of which scatter light, and the carotene (to some extent xanthophyll) which imparts a yellowish tint. Milk ranges in color from **yellowish creamy white (cow milk) to creamy white (buffalo milk)**. The intensity of the yellow color of cow milk depends on various factors such as breed, feeds, size of fat globules, fat percentage of milk, etc. The greater the intake of green feed, the deeper yellow the color of cow milk the larger the fat globules and higher the fat percentage, the greater the intensity of the yellow color. **Skim milk** has a **bluish**, and **whey** a **greenish yellow color** (which in milk is masked by the other constituent's present).

Flavor

The flavor of milk is composed of smell (odor) and taste. The flavor of milk is a blend of the sweet taste of lactose and salty taste of minerals, both of which are damped down by proteins. The phospholipids, fatty acids and fat of milk also contribute to the flavor. Changes in the flavor of milk occur due to type of feed, season, stage of lactation, condition of udder, sanitation during milking and subsequent handling of milk during storage. The sulfhydryl compounds significantly contribute to the cooked flavor of heated milks.

Specific Gravity

The density or specific gravity of milk may be determined by either determining the weight of a known volume or the volume of a known weight. The common types of lactometers are Zeal, Quevenne, etc. Milk is heavier than water. The average specific gravity ranges (at 60°F) from 1.028 to 1.030 for cow milk, 1.030 to 1.032 for buffalo milk and 1.035 to 1.037 for skim milk. The specific gravity of milk is influenced by the proportion of its constituents (i.e., composition). Milk fat is the lightest constituent, the more there is of it, the lower the specific gravity will be, and vice versa. However, although buffalo milk contains more fat than cow milk, its specific gravity is higher than the latter's; this is because buffalo milk contains more solids-not-fat as well, which ultimately results in a higher specific gravity.

Boiling Point

The boiling point of milk is close to the boiling point of water, which is 100 degrees C, or 212 degrees F at sea level, but milk contains additional molecules, so its boiling point is slightly higher. How much higher depends on the chemical composition of the milk, so there isn't a standard boiling point of milk that you can look up. However, it's only a fraction of a degree off, so the boiling point is very close to that of water.

Freezing point of Milk

Milk freezes at temperatures slightly lower than water due to the presence of soluble constituents such as lactose, soluble salts, etc., which lower or depress the freezing point. The average freezing point depression of Indian cow milk may be taken as 0.547°C (31.02°F) and buffalo milk 0.549°C (31.01°F). The freezing point test of milk is a highly sensitive one and even up to 3 per cent of watering can be detected. Boiling and sterilization increase the value of freezing point depression, but pasteurization has no effect. The fat and protein contents of milk have no direct effect on the freezing point of milk.

Refractive Index

The refractive index of milk is sometimes used to indicate adulteration especially watering. The refraction of light by a solution depends upon the individual molecular substance present and upon their concentrations. The total refraction is sum of the individual refractions of the constituents present in the solution. The refractive index of the milk then is the refractive index of the solvent plus the indices of the solutes. The freezing point determination is more reliable than the refractive index for detecting added water. The average refractive index of cow milk has been found to be 1.3461 and that of buffalo milk 1.3477 at 40℃.

Acidity and pH of Milk

Acidity

Freshly-drawn milk is amphoteric to litmus, i.e. it turns red litmus blue and blue litmus red. However, it shows a certain acidity as determined by titration with an alkali (sodium hydroxide) in the presence of an indicator (phenolphthalein). This acidity, also called Titratable Acidity (T.A.) as it is determined by titration, is known as 'natural' or 'apparent' acidity and is caused by the presence of casein, acid-phosphates, citrates, etc., in milk. The natural acidity of individual milk varies considerably depending on species, breed, individuality, stage of lactation, physiological condition of the udder, etc.

pH

The pH of normal, fresh, sweet milk usually varies from 6.4 to 6.6 for cow milk and 6.7 to 6.8 for buffalo milk. Higher pH values for fresh milk indicate udder infection (mastitis) and lower values, bacterial action.

Viscosity

Viscosity of milk depends on the temperature and the amount and state of dispersion of the solid constituents, mainly casein and fat. Viscosity of the whole milk at 25°C is about 2.0 cP. Cooler temperatures increase viscosity due to the increased voluminosity of casein micelles whereas temperatures above 65°C increase viscosity due to the denaturation of whey proteins. An increase or decrease in pH of milk also causes an increase in casein micelle voluminosity. The effect of agitation on viscosity is not uniform. Sometimes, agitation causes partial coalescence of the fat globules, hence increasing the viscosity and at other times, agitation may disperse fat globules that have undergone cold agglutination, leading to a decrease in viscosity.

Surface Tension

The surface tension of water is 72.8 dyne/cm at 20°C. Milk and dairy products have a lower value due to fat and protein. Surface tensions for milk and dairy products (all data in dyne/cm*)* are:

Raw milk	49 – 51	Standardized milk	51
Skimmed milk	52 – 53	Cream	42 – 45
Buttermilk	39 – 40	Lab whey	51 - 52

UNIT II

COLLECTION AND INSPECTION OF FRESH MILK

Raw Milk Collection – Cooling and Transportation

In most of the developed countries, production of milk is confined to rural areas, while demand is mostly urban in nature. Hence, the milk has to be collected and transported from production points to processing including chilling centres and distributions points in cities. In rural India, milk production is largely a subsidiary activity to the agriculture in contrast to organized dairying in Western countries. Small farmers and landless labourers usually maintain 1-3 milch animals. This situation makes the task of milk collection complex. With the growth of the organized dairy industry in India, a trend towards establishing modern farms has gained momentum for milk production with a herd of 100-300 cows/buffalo in line with the practice adopted in advanced countries. These farms have the facilities of machine milking and bulk milk cooling.

Milkshed

It is the geographical area from which a city dairy receives its fluid milk supply. The allocation of definite milk sheds to individual dairies for the purpose of developing the same is now being considered in India.

Direct system

In this system, organized processor (Public, Cooperative or Private) collects milk directly from the producers by establishing village procurement centers.

Contractor system

The processors purchases milk from the contractor according to the terms of contract such as quality, quantity, price, etc.

Agent system

The processor appoints agents to procure milk in particular area. Payment for the milk is made directly to the producers while the agent gets the commission.

Co-operative system

At the village level, the farmers form a co-operative society, which establishes the milk collection centers. The society collects milk twice a day and delivers it to the milk collection centers where the milk is weighed, tested and the price paid to farmers. The payment is based on fat content or fat + SNF content in the milk. The village society supplies/sells milk to its own District co-operative dairy plant. It transports milk in cans by trucks or through insulated road milk tankers, preferably via a chilling center. Besides milk collection, the society also provides the technical input services such as the A.I, veterinary aid; concentrated cattle feed and fodder seeds. They also give counselling to the society members to enhance milk production.

Chilling Centers/Bulk Milk Cooling Centers

If the dairy plant is far away from the collection center, then the collected milk is first brought to a centralized chilling center/ bulk milk cooling unit. Here, milk is cooled to 4°C and stored in insulated storage tanks of 5000-20,000 L capacity. Subsequently, the chilled milk is transported in insulated Road milk tanker to the dairy plant. The transportation of milk from the chilling center to the dairy plant usually takes place once a day.

Cooling of Milk

Milk is cooled immediately after milking to below 10°C. within 4 hours to prevent/retard the multiplication of thermophilic and mesophilic bacteria including disease producing and food poisoning organisms until the milk reaches the dairy. The extent of control of growth of microorganisms is dependent on type of organisms. Staphylococci do not grow below 10°C. Growth stops for most types of B. coli, B. proteus and Micrococci between 0°C and 5°C. If milk is stored cold for too long time, there can be an undesirable increase in psychotropic organisms which produce extremely heat resistant lipases and proteases.

Raw milk storage temperature (°C) for a period of 18 hours	Bacterial growth factor*
0	1.00
5	1.05
10	1.80
15	10.00
20	200.00
25	1,20,000.00

* Bacterial growth factor by multiplying with the initial count of bacteria gives the final count.

Fig 1: Bacterial Growth rate at different time intervals

Equipment for Cooling/Chilling of Milk

Can (container) Immersion: The fresh milk immediately after milking, is placed in a container (preferably metal) which is gently lowered into a tank/trough of cooling water. Cooling of milk will slowly take place and if the water is cold enough, the milk temperature will be reduced low enough to allow the milk to be marketed/processed. The milk inside the cans may be stirred with the help of plunger for uniform quick cooling.

Surface Cooler: An improvement of water cooling is a metal surface cooler, where water flows through the inner side and milk flows over the outer surface in a thin layer. A well-designed water cooler will reduce milk temperature almost instantaneously. The cooled milk is received below in a receiving trough, from which it is discharged by gravity or a pump.

Plate Heat Exchanger: This is the most widely used very effective equipment for chilling of milk by the commercial dairy plants. Several stainless-steel plates are mounted on a solid stainless-steel frame in which the milk to be chilled and chilling water flow alternatively and counter-currently. The number and size of plates in the exchanger depend upon the capacity of the plant which may vary as per requirement. This method of chilling is more efficient, more hygienic, involves less manual labor and cost effective.

Tubular Cooler: This consists of two concentric tubes; inner tube usually carries the milk to be chilled while cold water is passing through the hollow space in between the pipes. The length and diameter of both the tubes are determined according to the capacity of the plant. The flow of the milk and chilled water is in opposite direction, i.e. counter-current. The tubular cooler is efficient, where milk is not exposed to atmosphere.

Bulk Milk Coolers: These consist of a double jacketed vat fitted with a mechanical agitator. It also has provision for circulation of chilled water which comes from the chilled water tank. Normally, milk is chilled and subsequently stored at low temperature until transported to processing units for further processing. Bulk milk coolers are generally installed at chilling centers.

Rotor Freeze: Rotor freeze provides spray of chilled water outside the cans obtained by mechanical refrigeration system and passing through the perforated tubes around the neck of the can. With this system, milk temperature is brought down to 10°C from 35°C within 15 minutes.

Transportation of Milk

Type of transport vessel	Advantages
Milk can	i) Handling small quantities of milk possible ii) Hygienic, if cleaned and sanitized properly
Tanker	i) Quicker mode of transport ii) Lower cost for large quantity of milk iii) Better temperature control iv) Less risk of contamination from dust, etc. v) Time and labour saving in loading and unloading vi) Overall saving of detergent, etc.

Fig 2: Types of Cooling storage for Milk

<u>Inspection and Quality Control of Raw Milk</u>

Quality Control of Milk

Milk quality control is the use of various tests to ensure that milk and milk products are safe, healthy, and meet the standards for chemical composition, purity, and levels of bacteria and other micro-organisms. A quality control system will test milk and milk products for quality, and ensure that milk collectors, processors and marketing agencies follow the correct methods. Having such a system will cost a lot of money. But it is important to have a good system, because it will provide benefits to everyone involved in the dairy industry.

Milk producers: with a good quality control system, farmers can get a fair price in accordance with the quality of milk.

Milk processors: the milk processor who pays the farmer can be sure that the milk is of good quality and is suitable for making various dairy products.

Consumers: they will pay a fair price, e.g. moderate price for medium quality, high price for excellent quality.

Government agencies: with a good system, the government can protect the health of consumers, prevent contaminated and sub-standard products, and ensure that everyone pays or receives a fair price.

Platform Tests of Milk

Platform tests or milk reception tests are the commonly used names for the tests carried out by the persons responsible for raw milk collection and/or reception. The tests in question are rapid quality control tests - organoleptic tests being of crucial importance - whereby the milks of inferior or questionable quality can be screened out before the milk leaves its original container and is mixed with bulk milk during milk collection and/or reception. This is of crucial importance from the point of view of processing and quality of end products, because one single lot of milk of poor quality can spoil the rest of the milk it is mixed with. Application of platform tests does not directly involve laboratory analysis of raw milk samples but in suspected cases a sample from milk should be taken to the laboratory for further inspections for quality.

Sl.No.	Name of the test	Purpose
1.	Organoleptic test	To determine the quality form external appearance of milk
2.	Alcohol test	To determine abnormal milk such as mastitis milk
3.	Total solid and SNF test	To determine the fat& in the milk
4.	Test with Lactometer	To determine if any adulteration with water is there based of specific gravity
5.	Freezing test	To determine whether water is added and to determine the density
6.	Sediment test	To determine the extent of visible dirt in the milk
7.	Clot on Boiling Test (COB)	To determine the maximum heat stability of milk
8.	Dye reduction test or Resazurin test	To determine the extent of bacterial contamination and its growths in milk

Fig 3: Platform test for Milk

Smell, Appearance and Temperature

Organoleptic Test

The organoleptic test is one of the fastest and cheapest tests to check the quality of the milk. In this method of milk quality control, the person inspecting the produce relies on his sense of taste and smell to judge the quality of the milk. The milk under inspection is checked for irregularities in color and appearance. Then, it is smelled/tasted for any odor or sour taste. The packaging of the container is also inspected to understand the hygiene conditions of the area of production. This test is not very accurate.

Sediment Test

The procedure is done to determine the cleanliness of the milk. The advantage is that it is cheap. There are five standard grades that can be applied to milk: Excellent, Good, Fair, Poor, and Very Bad. The poor or very bad quality milk is rejected based on comparison with the standard disc.

Acidity/ Clot on Boiling test

Milk is kept as such at room temperature, there will be increased in the acidity which is called as developed acidity. If acidity is increased to more than 0.2 percent, there is coagulation due to heat treatment, which is the result of dissociation of calcium casein and salt. The acidity of milk that results in a positive test is usually greater than 0.22 percent (as lactic acid) or has abnormally high protein content, such as colostrum milk. Because such milk cannot withstand heat treatment during processing, it is not appropriate for distribution or processing as liquid milk.

Lactometer test

If the milk appears during organoleptic inspections to be too thin and watery and its color is "blue thin" it is suspected that milk contains added water. Lactometer test serves as a quick method for determination of adulteration of milk by adding water. The lactometer test is based on the fact that the specific gravity of whole milk, skim milk and water differ from each other's. Alcohol In case there is any reason to suspect that milk is sour, alcohol test is used as platform test for rapid determination of elevated acidity of milk. Anyhow, if the result of alcohol test indicates too high acidity in milk a sample from milk is to be taken to the laboratory for further testing of titratable acidity.

Fat Test

The traditional standard reference method for fat analysis is based on either weight or volumetric determination. There are many analytical methods for the determination of the fat content of milk; the Gerber test is widely used all over the world. The test is a volumetric method in which fat is separated from milk by centrifugal force. Sulphuric acid is used to dissolve the protein that forms the membrane around the fat (fat globules) and amyl alcohol is added to improve the separation of fat from other solids.

Solids–Not–Fat

It is done for assessing the quality of milk and for payment purpose. The doubtful quality milk is subjected to laboratory tests. The advantage is that it is quick and cheap. Values can be obtained by using the formulas:

TS (%) = 0.25 (L) + 1.22 fat % + 0.72, Where L- lactometer value

SNF = TS - Fat %

Dye Reduction Tests

MBRT Test

Methylene Blue Dye Reduction Test, commonly known as MBRT test is used as a quick method to assess the microbiological quality of raw and pasteurized milk. This test is based on the fact that the blue color of the dye solution added to the milk get decolorized when the oxygen present in the milk get exhausted due to microbial activity. The sooner the decolourisation, more inferior is the bacteriological quality of milk assumed to be. This test is widely used at the dairy reception dock, processing units and milk chilling centers where it is followed as acceptance/rejection criteria for the raw and processed milk

Grading of raw milk based on MBRT

MBRT test may be utilized for grading of milk which may be useful for the milk processor to take a decision on further processing of milk. As per BIS 1479 (Part 3): 1977 criterion for grading of raw milk based on MBRT is as below:

Table 1: Time and rating for analyzing the MBRT Test

Time	Rating
5 hrs and above	Very good
3 to 4 hrs	Good
1 to 2 hrs	Fair
Less than ½ hrs	Poor

Resazurin Test

Resazurin is a type of test that defines the quality and consistency of the milk. It also determines the bacteria that are present in the milk. This test is designed to assess the quality of **raw milk.** It is a rapid test of three hours that suggests the milk whether is all good or bad for us. The resazurin test gives the bluish characteristic color to the milk that is all based on the quality of the milk. The milk quality is considered by only noting the color change degree of the milk.

Color Chart

The **dye resazurin** has been made familiar for the replacement of the methylene that is blue. This resazurin test of milk has some definite color charts that will help to indicate the quality of the milk. Some colors form while the sample milk is running through the resazurin test. Those colors are such as excellent blue. The light blue, good purple, fairy purple, bad pink, white, and many colors are more prominent.

Fig 4: Color chart for Resazurin Test

Mastitis Test

CMT is a simple, inexpensive and rapid screening test for mastitis. The test is based on the increase in number of leucocytes and alkalinity of mastitis milk. These changes are due to inflammatory exudation and increased contents of basic salts during inflammation. The accuracy of this method is found to be 88.66%. Fresh, unrefrigerated milk is tested using the CMT for up to 12 h; reliable readings can be obtained from refrigerated milk for up to 36 h.

Table 2: CMT Test Inference

CMT Score	Description	Interpretation
N (Negative)	No change	Healthy quarter
T(Trace)	Slime formed that disappeared with continuous movement of paddle	Sub-clinical mastitis
1(Weak)	Distinct slime, but no gel formation	Sub-clinical mastitis
2(Distinct positive)	Viscous with gel formation that adhered to margin	Severe mastitis infection
3(Strong positive)	Gel formation with convex projection, the gel did not dislodge after swirling movement of the paddle	Severe mastitis infection

Neutralizer test

Neutralizers are added to neutralize the acidic sour milk. The addition of alkalis is not permissible under law. Some of these alkalis are highly injurious to health. To overcome this problem by means of a few simple test they can be detected in milk added as neutralizer. Freshly drawn milk has an acidity of 0.12-0.16 per cent expressed as lactic acid. With the passage of time the acidity increases during souring of milk. Any acidity above 0.18 per cent lactic acid coagulate milk.

Rosalic acid test for the detection of carbonate and bicarbonate in milk

Rosalic acid test is used for the detection of carbonate and bicarbonate in milk. This is a very simple, reliable and quick test for their detection. Rosalic acid reacts with carbonate and bicarbonate and give rose red colour in their presence. The intensity of colour depends upon the amount of these chemicals present.

Alkalinity Test

The presence of neutralizers can generally be detected by determining the alkalinity of ash. A known quality of milk is heated and converted into ash. The alkalinity of ash is estimated by titration against a decinormal standard hydrochloric acid in the presence of Phenolphthalein indicator. Values abnormally high would indicate neutralization of milk

UNIT III

PROCESSING OF MILK

PROCESSING OF MARKET MILK

In most of the developed countries, production of milk is confined to rural areas, while demand is mostly urban in nature. Hence, the milk has to be collected and transported from production points to processing including chilling centres and distributions points in cities. In rural India, milk production is largely a subsidiary activity to the agriculture in contrast to organized dairying in Western countries. Small farmers and landless labourers usually maintain 1-3 milch animals. As a result, small quantities of milk are produced, in a scattered manner all over the country. This situation makes the task of milk collection complex. With the growth of the organized dairy industry in India, a trend towards establishing modern farms has gained momentum for milk production with a herd of 100-300 cows/buffalo in line with the practice adopted in advanced countries. These farms have the facilities of machine milking and bulk milk cooling.

STEPS INVOLVED IN PROCESSING

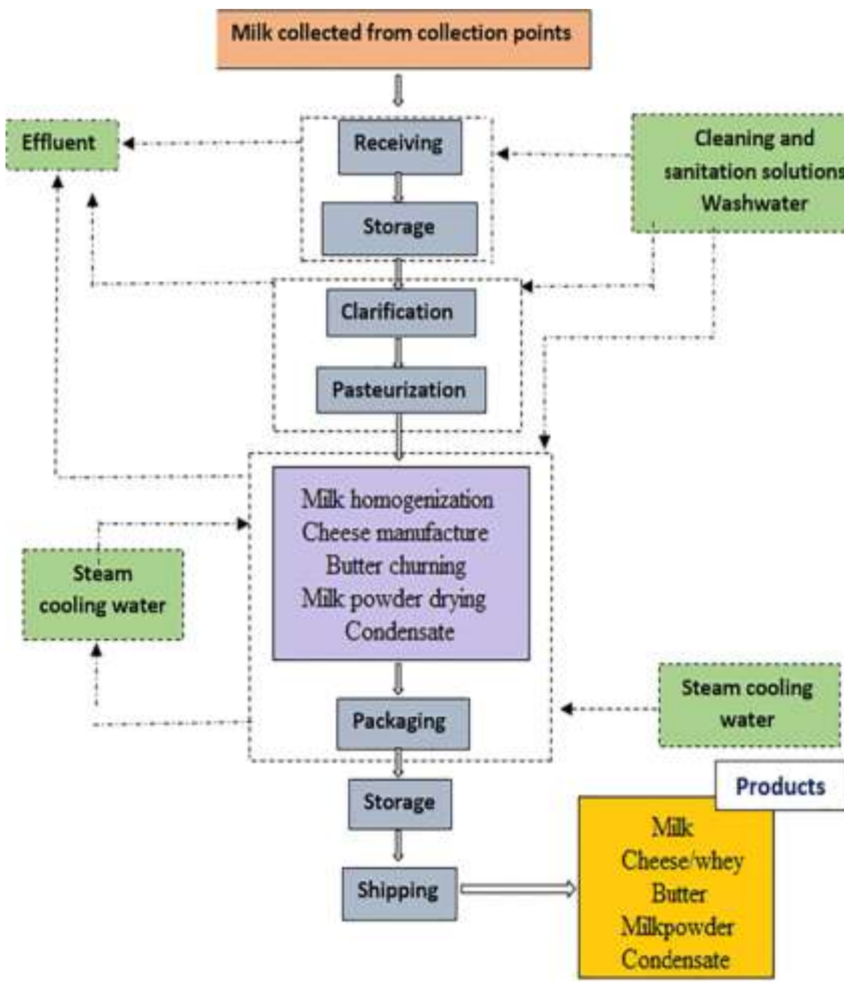


Fig 1: Processing of Milk

FILTRATION AND CLARIFICATION OF MILK

Filtration

Raw milk is filtered using a pump that forces it across the porous surface of a filter. The pressure on either side of the filter is different, which forces any particles that are smaller than the pore size of the filter to pass through. These particles might include water, fat, protein, minerals, bacteria, somatic cells, and other tiny elements. Larger particles, like flakes, straw, hair, insects, or clots, are not able to pass through, so they are prevented from passing into the bulk tank. There are a variety of methods that are used for milk filtration. The common goal of all methods is to separate various substances from one another. In the dairy industry, that means separating unwanted particulates from the milk. There are four different membrane filtration processes that are typically used to filter milk.

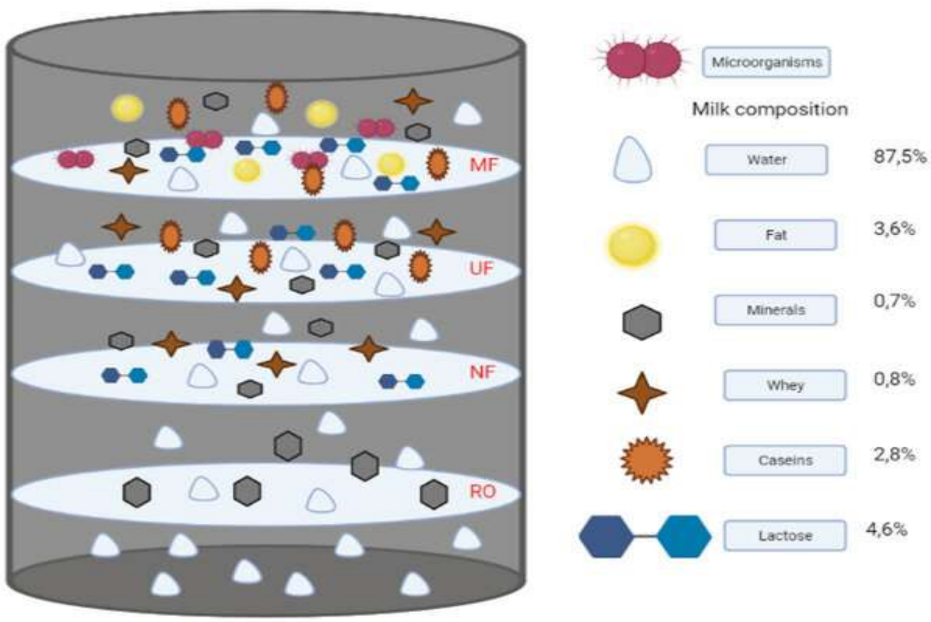


Fig 2: Types of Filtration for Milk

Ultrafiltration

Ultrafiltration is a medium pressure-driven membrane filtration process. Ultrafiltration is based on a membrane with a medium-open structure allowing most dissolved components and some non-dissolved components to pass, while larger components are rejected by the membrane. In the dairy industry UF is widely used in concentration of whey protein concentration and milk protein concentration and/or standardization

Fig 3: Ultrafiltration of Milk

Micro Filtration

Microfiltration is a low pressure-driven membrane filtration process based on a membrane with an open structure. It allows dissolved components to pass, while most non-dissolved components are rejected by the membrane. In the dairy industry, microfiltration is widely used for bacteria and spore reduction and fat removal in milk and whey, as well as for protein and casein standardization.

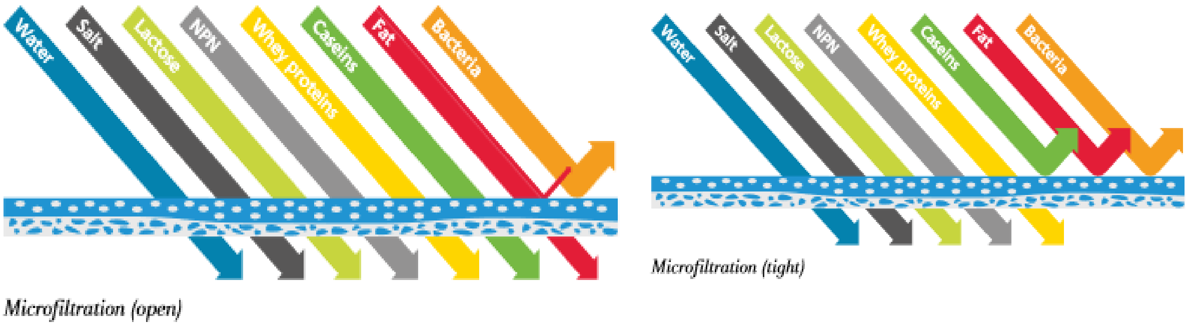


Fig 4: Microfiltration of Milk

Nanofiltration

Nanofiltration is a medium to high pressure-driven membrane filtration process. Generally speaking, nanofiltration is another type of reverse osmosis where the membrane has a slightly more open structure allowing predominantly monovalent ions to pass through the membrane. Divalent ions are - to a large extent - rejected by the membrane. In the dairy industry, nanofiltration is mainly used for special applications such as partial demineralization of whey, lactose-free milk or volume reduction of whey.

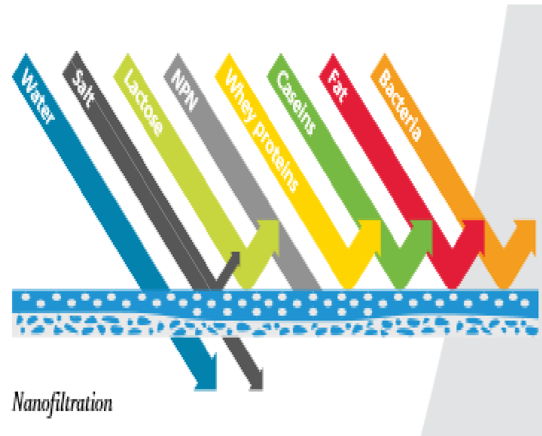


Fig 5: Nanofiltration of Milk

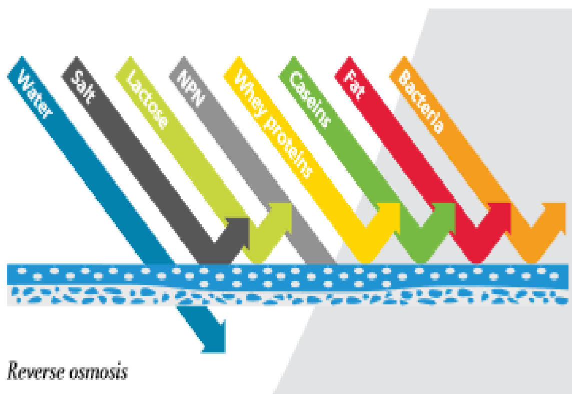


Fig 6: Reverse Osmosis of Milk

Reverse Osmosis

Reverse osmosis is a high pressure-driven membrane filtration process which is based on a very dense membrane. In principle, only water passes through the membrane layer. In the dairy industry, reverse osmosis is normally used for concentration or volume reduction of milk and whey, milk solids recovery and water reclamation.

Clarification

As an alternative to filtration, clarification can also be employed to remove insoluble impurities especially the finer ones. It involves the use of a centrifugal machine called 'clarifier'. Thus, clarification is a process of subjecting milk to a centrifugal force in order to eliminate the finer but heavier particles from milk, somatic cells, dust particles, etc. Although part of bacteria is also removed along with the extraneous matter, clarification cannot be considered an effective means of bacteria removal. Hence, one should be aware that it cannot be a substitute for a suitable heat treatment in order to ensure safety against pathogenic (disease-causing) microorganism.

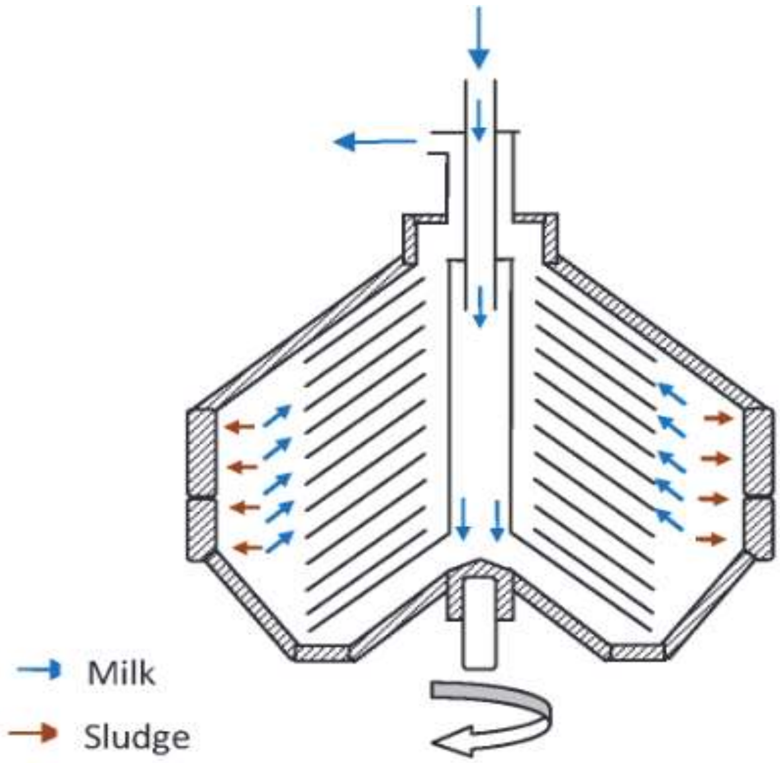


Fig 7: Schematic diagram of Clarifier

The clarifier consists of conical discs stacked over each other which rotate inside the clarifier bowls. Milk is introduced into the separation channels at the outer edge of the disc stack, flows readily inwards through the channels towards the axis of rotation and leaves through the outlet at the top (Fig. 6). Particles, which are denser than the continuous milk phase, are thrown back to the perimeter. the sludge gets collected in the space around the disc and milk being lighter moves up towards the outlet. The amount of solids that collect will vary however it must be manually removed from the centrifuge at regular intervals. From the studies it has been established that warm clarification of milk, e.g. at 50 to 55°C is preferred to cold clarification.

<u>CREAM SEPARATION</u>

When milk is allowed to stand un-disturbed for some time, an upward motion of the fat globules takes place, leading to the formation of a surface layer on milk in which the percentage of fat is considerably increased. This upward motion of fat based on the fact that milk fat is lighter than the skim milk portion. At 16°C, the average density of milk fat is 0.93 and of skim milk is 1.0404. Therefore, when milk (a mixture of fat and skim milk) is subjected to either gravity or centrifugal force, the two components, cream (fat-rich portion of milk) and skim milk (reduced-fat portion of milk), by virtue of their differing densities, separate from each other.

Purpose of cream separation

- To obtain a fat-reduced or fat-free milk
- To concentrate milk fat for the production of high-fat products
- To standardize the fat content of milk
- To recover fat from milk

Cream separation by gravity method

When milk is allowed to stand undisturbed for some time, there is a tendency of fat to rise. The velocity or rate at which the fat globules rise is given by the following equation, which is known as Stoke's Law:

$$\mathbf{V = (2/9) * Gr2 * (ds - df) / N}$$

Where,

V = rate of rise of fat globule in centimeter per seconds
r = radius of fat globule
G = Force of gravity (981 dynes)
η= Viscosity of skim milk
ds = density of skim milk
df = density of fat globule

From, Stoke's Law it is observed that theoretically velocity increases with:

- Increasing radius of fat globule,
- Increasing difference in densities of skim milk and fat
- Decreasing viscosity of skim milk

Cream separation by centrifugal method

Milk is fed to machine through flow regulator. Milk comes to regulating chamber from milk basin by milk faucet. When milk enters the revolving bowl through milk regulator of machine, it is subjected to a gravity and centrifugal force. Centrifugal force is about 3000 to 6000 times more than gravitational force. When fat and skim milk are subjected to centrifugal force, the difference in density affect the fat and skim milk i.e. (heavier Portion) affected more intensely than the fat (lighter portion). So skim milk is forced to the periphery and fat portion (cream) moves towards the center. Cream and skim milk forms separated vertical walls within the bowl and goes out through separate outlets near the axis of rotation. The cream outlet is at higher level than skim milk outlet. The rate or movement of a fat globule in machine is estimated by following Stoke's equation.

$$\mathbf{V = r2 *((as - df) / n) * N2 * R * K}$$

Where,

V = rate of movement of a single fat globule
r = radius of fat globule
ds = density of skim milk
df = density of fat
N = Revolution per minute of bowl
R = Distance of fat globule from axis of rotation.
K = Constant
N = Viscosity of skim milk

It will be seen from the above that the speed (rate) of cream separation is increased by:

- greater radius of the fat globule
- greater difference in density between skim milk and fat
- greater speed of the bowl
- greater size of the bowl
- lower viscosity of skim milk

Particulars	Gravity Method	Centrifugal Method
Nature of force causing Separation	Gravitational force	Centrifugal force
Speed of separation	Extremely slow	Practically instantaneous
Direction of movement of fat and skim milk particles	Vertical	Horizontal
Bacteriological quality of cream or skim milk	Low	High
Fat % of cream	10-25% only	18-85 %
Skim milk	0.2 % above	0.1 or below
Scale of operation	Small	Large
Fat % recovered in cream	not more than 90	99-99.5

Fig 8: Gravity Method Vs Centrifugal Method

BATCH, FLASH AND CONTINOUS HTST PASTEURIZER

Pasteurization

It is a process, named after scientist Louis Pasteur, that applies heat to destroy pathogens in foods. For the dairy industry, the terms "pasteurization," "pasteurized" and similar terms mean the process of heating every particle of milk or milk product, in properly designed and operated equipment, to one of the temperatures given in the following chart and held continuously at or above that temperature for at least the corresponding specified time:

Temperature	Time	Pasteurization Type
63°C (145°F)*	30 minutes	Vat Pasteurization
72°C (161°F)*	15 seconds	High temperature short time Pasteurization (HTST)
89°C (191°F)	1.0 second	Higher-Heat Shorter Time (HHST)
90°C (194°F)	0.5 seconds	Higher-Heat Shorter Time (HHST)
94°C (201°F)	0.1 seconds	Higher-Heat Shorter Time (HHST)
96°C (204°F)	0.05 seconds	Higher-Heat Shorter Time (HHST)
100°C (212°F)	0.01seconds	Higher-Heat Shorter Time (HHST)
138°C (280°F)	2.0 seconds	Ultra Pasteurization (UP)

Fig 9: Pasteurisation Temperature and Time

Fig 10: Milk Pasteurisation Temperature

Batch Pasteurization

The terms "batch pasteurization", "vat pasteurized" and "low heat pasteurized" shall mean the process of heating every particle of milk or milk product, in properly designed and operated equipment, to a minimum temperature of 69ºC (155ºF) and held continuously at or above that temperature for at least 30 minutes.

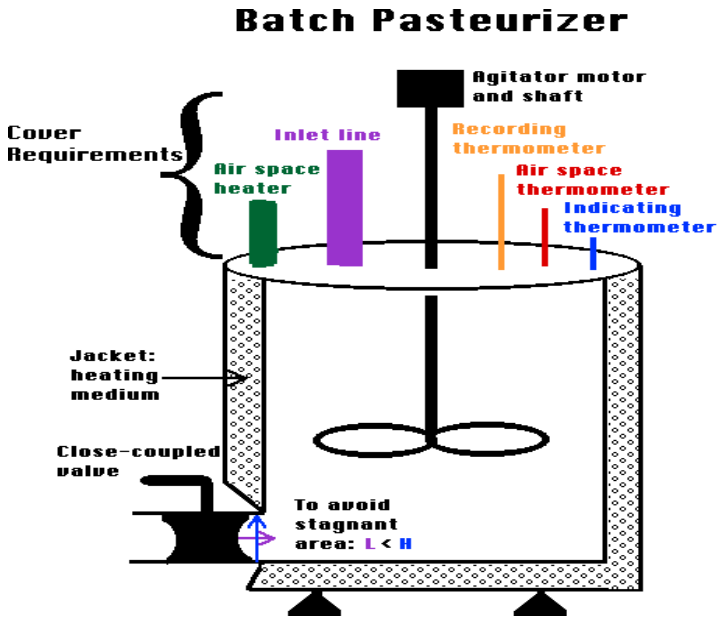


Fig 10: Batch Pasteurizer

Flash Pasteurisation

The standard US protocol for flash pasteurization of milk, **71.7 °C (161 °F) for 15 seconds** in order to kill *Coxiella Burnetii* (the most heat-resistant pathogen found in raw milk), was introduced in 1933, and results in 5-log reduction (99.999%) or greater reduction in harmful bacteria. The common applications of flash pasteurization include milk, beer, and fruit juices. Because flash pasteurization involves mild heat, it holds several advantages over other forms of heat treatment:

- There is minimal change in flavor, color, and nutrients
- It economically saves time and space
- Heats product uniformly, reducing cooked taste to a minimum
- Beneficial enzyme inactivation is obtained

Continuous Pasteurizers

The HTST pasteurizer gives a continuous flow of milk. The HTST process involves heating milk to 72-75^{0}C with a 15 second holding time before it is cooled. One of the main advantages of continuous systems over batch systems is that energy can be recovered in terms of regeneration. Regeneration efficiencies up to 95% can be obtained, which means that a pasteurized product requiring heating to 720^{0}C would be heated up to more than 680^{0}C by regeneration when initial temperature of milk is 4 deg C. Although high regeneration efficiencies result in considerable saving in energy, they necessitate the use of larger surface areas because of the lower temperature driving force and there is a slightly higher capital cost for the heat exchanger.

SINGLE STAGE AND TWO STAGE HOMOGENIZER

Homogenizing in the dairy industry is used principally to prevent or delay the formation of a cream layer in full cream milk, by reducing the diameter of the butterfat globules. The average storage temperature and duration of storage play an important part in determining the requirement of homogenization of milk, whether, as in pasteurized milk, it is stored for 1 to 2 weeks at refrigerator temperatures, or, as in UHT milk, at room temperatures for longer period. In the past it has been very rare for pasteurized liquid milk to be homogenized, although the flavor of milk becomes fuller by homogenizing.

However, Homogenization process has become more common for Toned milk also. Sterilized milk, evaporated or condensed milk and sterilized cream are generally homogenized. Ice cream mixes, milk for yoghurt production and milk for milk powder manufacture are also homogenized.

Milk, cream, condensed milk	Prevention of cream separation
Coffee cream	Improvement in flavour, increased Whitening power, increase in Viscosity
Yoghurt	a more stable gel
Ice cream mix	less fat separation during freezing
Full cream milk powder	less separation of free fat

Fig 11: Role of Homogenization in Milk Products

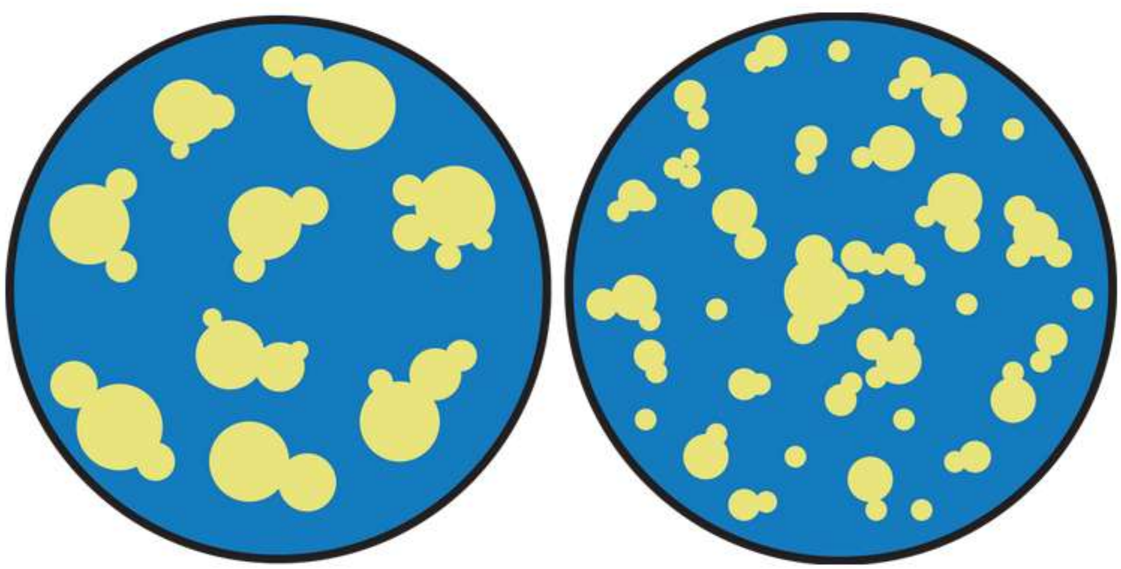


Fig 12: Homogenization break down of fat globules into smaller globules

SINGLE-STAGE AND TWO-STAGE HOMOGENIZATION

Homogenizers may be equipped with one homogenizing device or two connected in series, hence the names single-stage homogenization and two-stage homogenization. The two-stage system is illustrated in Figure 6.3.5.
In both single-stage homogenization and two-stage homogenization, the whole homogenization pressure (P_1) is used over the first device. In single-stage homogenization, the back pressure (P_2) is created by the process. In two-stage homogenization the back pressure (P_2) is created by the second stage. In this case the back pressure can be chosen to achieve optimal homogenization efficiency. Using modern devices, the best results are obtained when the relation P_2/P_1 is about 0.2. The second stage also reduces noise and vibrations in the outlet pipe.
Single-stage homogenization may be used for homogenization of products with high fat content demanding a high viscosity (certain cluster formation).

Fig 13: Single stage and Double stage Homogenizer

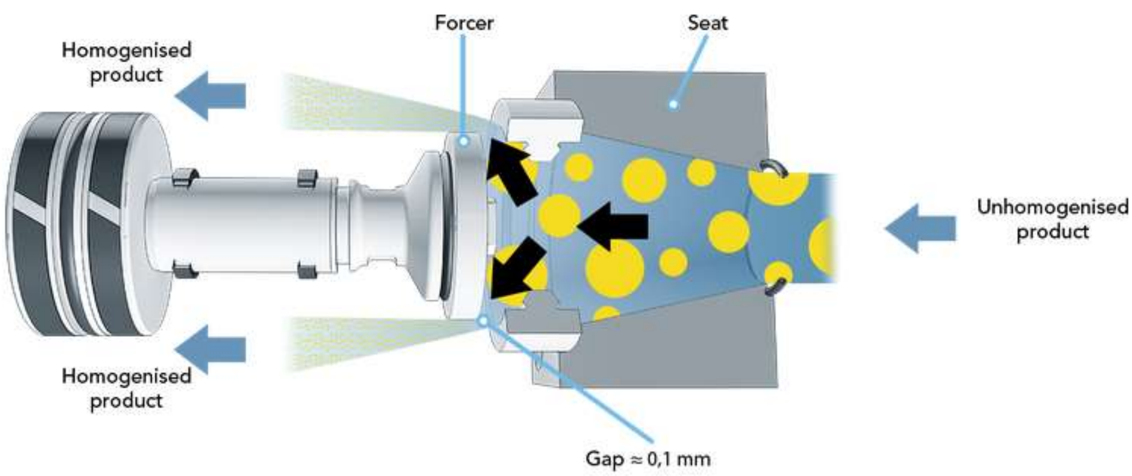


Fig 13: Homogenizer Working

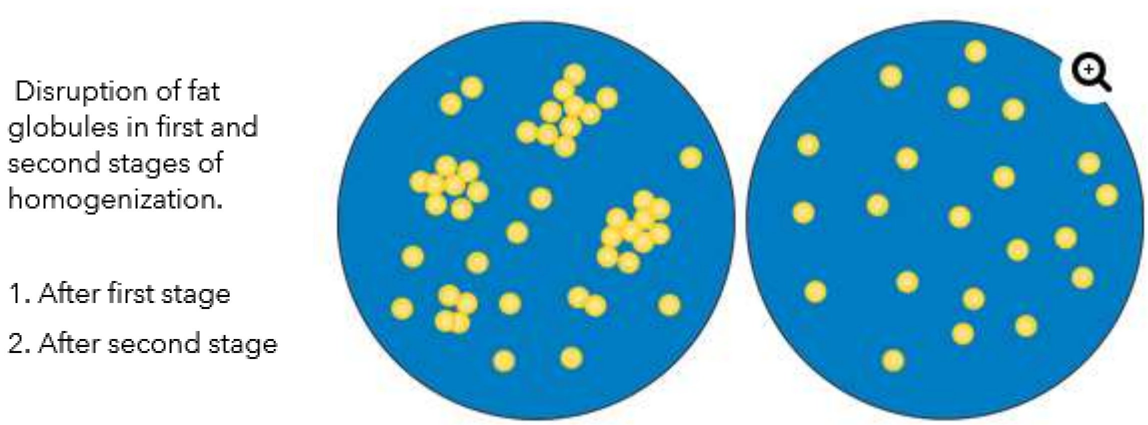


Fig 14: Disruption of fat in single and two stage Homogenizer

TONING OF MILK

Toned milk means the milk 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. Toned milk is the brainchild of D. N. Khurody (an Indian Dairy Pioneer), who is also credited with coining its name. Under his auspices, it was first produced in 1946 in the Central Dairy of the Aarey Milk Colony and marketed in Bombay city. Soon other cities, notably Calcutta, Madras and Delhi started producing and marketing toned milk.

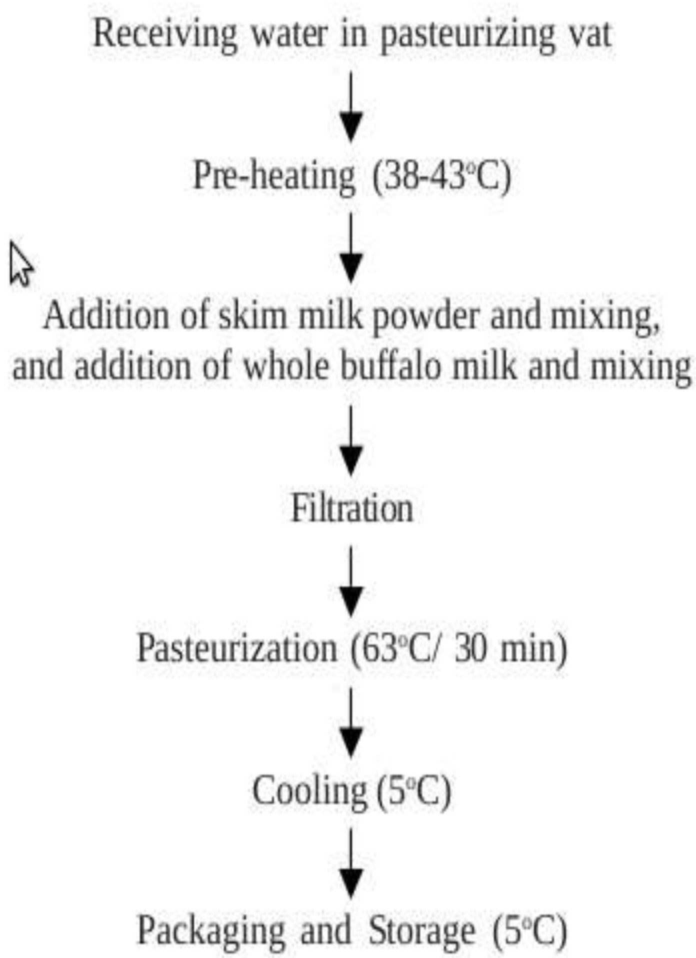


Fig 15: Toned Milk preparation Flow chart

PRODUCTION PROCESS

Standardized Milk

Milk
(Testing of fat & SNF levels)
↓
Pre-heating (35-40°C)
↓
Filtration/ clarification
↓
Standardization (4.5% fat/ 8.5% SNF)
↓
Homogenization 2500 psi/ 65°C)
↓
Pasteurization (72°C/ 15 sec)
↓
Packaging
↓
Storage (<5°C)

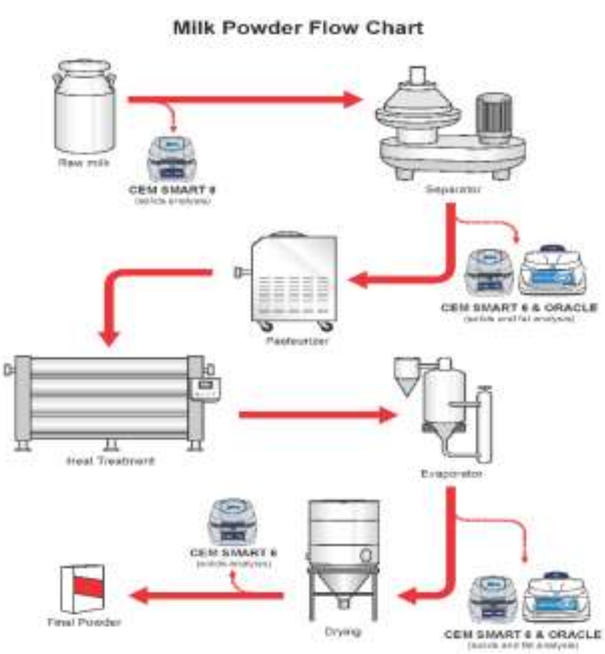
Evaporated Milk

Receiving Milk
↓
Filtration/clarification
↓
Standardization
↓
Forewarming/Preheating
↓
Concentration

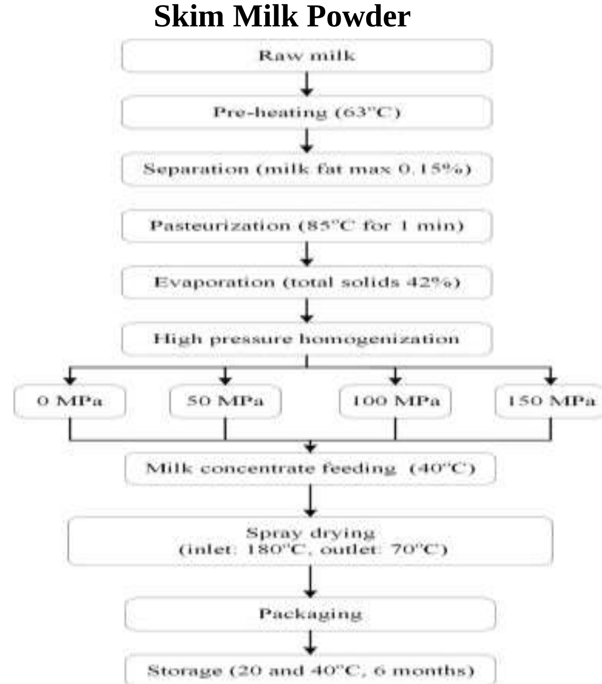
Condensed Milk

Receiving Milk
↓
Filtration/Clarification
↓
Standardization
↓
Pre-heating/Forewarmin
↓
Addition of Sugar
↓
Condensing
↓
Cooling

Whole Milk Powder



Skim Milk Powder



WHOLE AND SKIM MILK POWDER

Whole Milk powder

Whole milk powders are obtained by removing water from pasteurized milk through spray-drying. The powder can contain between 26% and 40% milk fat (by weight) on an "as is" basis, and offers all the nutritional qualities of milk in its dry form.

Skim Milk Powder

Skimmed milk powder is obtained by removing water from pasteurized skim milk by spray-drying. Skimmed milk powder is classified according to the heat treatment used in its manufacture (high heat, medium heat, and low heat). Skimmed milk powder is used in a wide variety of applications.

UNIT IV

STORAGE AND SANITATION OF DAIRY EQUIPMENT

STORAGE AND DISTRIBUTION OF MILK

Storage of Raw Milk

Raw milk is usually pasteurized either by low temperature pasteurization in which the milk is heated to 145 °F or higher for at least 30 minutes, or by high temperature pasteurization in which the milk is heated to 161 °F or higher for at least 15 seconds and then quickly cooled. Pasteurization destroys disease-causing bacteria and extends the shelf life of milk.

They must be designed for easy cleaning and sanitization, preferably through CIP process. Storage tanks consist of a stainless-steel inner shell, a layer of insulation, an outer jacket and necessary fittings for inspection control and cleaning. The tanks should be insulated or refrigerated so that they can maintain the required temperature throughout the holding period. Glass wool, Thermocol, Corkboard, Foam glass or Styrofoam can be used for insulation. Corkboard or foam glass is used in the lower portions of the tank where the insulations may carry a part of the load. Agitation must be adequate for homogeneous mixing, but gentle enough to prevent churning and incorporation of air.

In many storage tanks, chilled water circulation system is provided to maintain the temperature of milk. All closed type of tanks must be equipped with a manhole round (diameter ~ 450 mm) or oval shaped to permit access to the interior for cleaning and inspection. For foam-free entry of milk, a curved filling pipe, which guides the milk towards the wall is used. It is better to fill the tank from below, i.e., by the lowest outlet pipe.

The storage tanks containing raw chilled milk or standardized pasteurized milk are usually located on the first floor. This allows feeding to the milk pasteurizers or even gravity filling of milk. Now-a-days, big sized silos, usually of > 1.0 lakh litres capacity are installed in the dairies on the ground floor only. They are very useful in storing skim milk for feeding to the powder plants. In the dairy industry, rectangular tanks are less preferred as compared to cylindrical tanks, because cleaning of sharp corners (in rectangular ones) is difficult. Secondly, the agitation effect does not reach the extreme corners of rectangular tanks.

Distribution of Milk

India currently represents the world’s biggest market for milk and milk products. In light of its growing population, higher incomes and growing health consciousness, the demand for milk is steadily increasing in the country.

As distribution is the final stage in the marketing of milk and milk products, the facilities for distribution should ensure that the quality of the products are maintained, along with its timely supply. The report finds that currently around 80% of the total milk produced is distributed through the highly fragmented unorganised sector, which includes local milk vendors, wholesalers, retailers, and the producers themselves. On the other hand, the organised dairy industry distributes the remaining 20% of the total milk produced. The report has also identified several challenges in the distribution of milk products in India.

PRINCIPLE AND WORKING OF BOTTLE FILLER

Principle

The liquid filling machine operates on the principle of liquid pressure filling. When the pressure is high, the liquid flows into the bottle using its own weight. This process occurs when the pressure of the liquid reservoir matches the volume of air present in the bottle.

Working of Bottle Filler

Volumetric bottling machines

Manual bottle filling machines use a piston within a cylinder to force liquid into the container.
These normally have a pneumatically powered pump mechanism, set to fill containers with the required volume of liquid, fed from either a floor-standing container or a machine-mounted hopper. Containers are positioned below the filling nozzles and a foot pedal switch to start the filling process. Volumes between 5ml and 25-litres can be handled by volumetric bottling machines and up to 150 containers per minute can be filled, depending on the fill volume, liquid viscosity and level of machine automation.

Vacuum level filling machines

Vacuum bottle filling machines use the rim at the top of the container to form an airtight seal around the filling nozzle. This airtight seal creates a vacuum within the bottle which draws free-flowing liquids from a supply tank into the bottle, via specially designed nozzles. These nozzles have a small hole on the side which is connected to a small internal tube. The height of this hole in relation to the top of the container during filling determines the level of liquid dispensed. The small hole in the nozzle scavenges excess liquid from the filling process and collects it in a receiver for reuse. Vacuum level bottling machines fill containers to the same *height* each time, rather than dispensing the same *volume*. This is particularly useful for glass bottles which will be side-by-side on display shelves in shops. Glass bottles vary in capacity quite a lot, yet vacuum-level filling ensures the level each bottle is filled to is the same, giving a consistent appearance from one bottle to the next. Vacuum level bottling requires rigid containers which won't collapse under a vacuum. Vacuum-level machines have virtually no moving parts, making them incredibly reliable, and can fill up to 120 bottles per minute depending on the container type, number of filling heads and level of automation. Bottles are simply positioned with their top in contact with a sealing ring around the nozzle. The container will start to fill as soon as an airtight seal is made and stop when the pre-determined fill height is reached.

Fig 1: Bottle cleaning and filling Process

Capping machine

A capping machine is an equipment that tightens caps to seal containers or bottles. The machines can either be automatic, semi-automatic, or manual. Capping equipment can improve production speeds and ensure product security. Cap tightening machines use two systems to place a cap on a container. In the pick-off system, a precise cap chute delivers the cap, which is picked up by the bottle as it passes beneath the chute. The system is usually compatible with different caps, including skirted and aluminum caps. It's common in rotary cappers and in-line capping machines.

The other system is known as pick and place. It includes a robotic arm that picks and places caps on the containers. Typically, this system is more versatile since it is compatible with almost every type of cap used in various industries for different products.

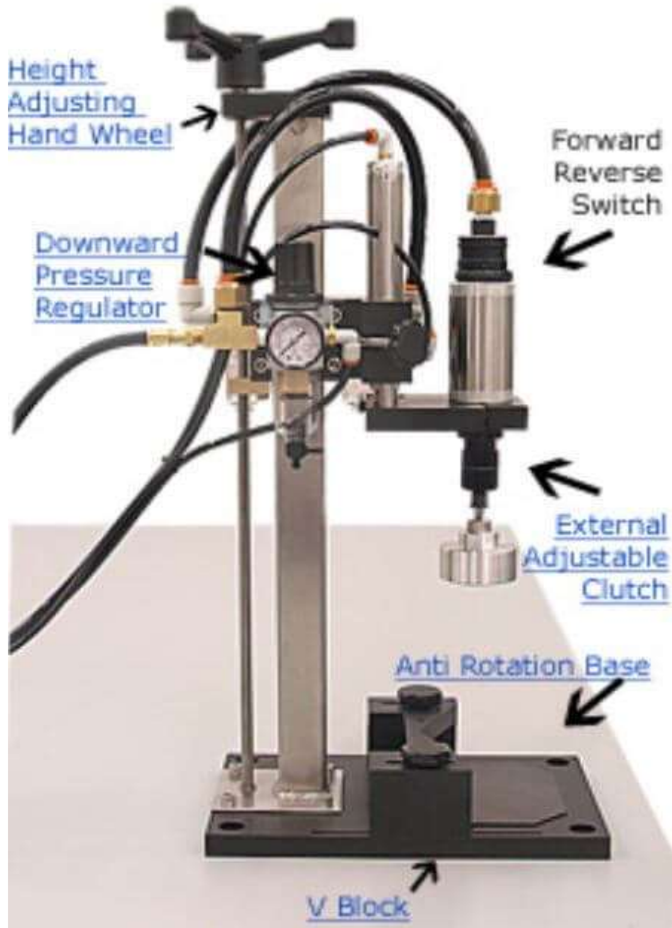


Fig 2: Capping Machine

Types of Capping Machines

The capping machine has the following major types:

Vertical Pluggers

Vertical wheel pluggers are built for speed and high efficiency. The machines are ideal for packaging lines with huge output volumes since the capper works in synchrony with the speed of bottles in the production line. As the containers pass through the machine, they are sealed automatically. All the parts are attached to a spinning wheel, and the line pushes bottles onto the wheel for capping. The synchrony guarantees consistency, speed, and precision regardless of the type and size of caps. The machines are mainly used in production lines to seal containers with plugs and stoppers. Therefore, they are unsuitable for processes that require angled capping.

Chuck Cappers

A chuck capper uses accessories that help the machine grip the caps and tighten them to seal containers. The capper arm descends on the bottle and uses torque to cap the container. The machines are applicable in small and large production lines. Moreover, you can choose the level of automation depending on your production needs and plant size. A manual or handheld capping machine needs manual operation when handling each container.

Semi-automatic models only require the operator to place the caps on the bottle before the cap tightener machine takes over the process. On the other hand, an automatic capping machine requires minimal human intervention when capping the bottles.

Spindle Cappers

Spindle cappers can be automatic or semi-automatic. The system uses rubber disks to spin and seal bottles. The fully-automatic versions have a seamless cap delivery system, but a semi-automatic model requires the operator to place the caps on the containers. The containers pass through different disks that apply torque on the caps to ensure consistent sealing. The cap delivery system consists of a vibrating bowl and a vibrator that supplies the caps seamlessly.

Snap Cappers

Snap cappers seal containers by snapping or pressing the seal on the container. They are often ideal for different containers, and they ensure an efficient and convenient capping process. The sealing machines can use plastic or metal caps to close glass, metal, and plastic bottles. Also, the cappers have an automatic delivery chute to make the process consistent and reliable for any production plant.

Aseptic Filling Machine

Aseptic filling machine is a piece of equipment that is used to fill containers with liquid, solid or hybrid materials. These machines are a common sight on production and distribution lines around the world, but the aseptic machine is a little different — this type of machine sterilizes the containers before the filling process begins, maintaining this sterile environment throughout the whole process. The aseptic filling machine ensures not only that materials are free from pathogens or harmful contaminants but also that packaging is also free from contamination

The sterilization component

The machine will feature a sterilization component that is used to clean all of the materials or items that will enter the system. This cleaning task is carried out automatically, with no need for human intervention, further reducing the chance of contamination. Cleaning is thorough and will include both the inner and outer surfaces of any ampules or containers.

The heating and cooling components

Applying high temperatures helps to make sure that the sterilization process is completed to a satisfactory level. To achieve this, the aseptic filling machine will include heating chambers. Containers pass through these chambers and are heated to a high temperature, killing any remaining pathogens. Different types of filling projects will require different levels of heating, and some industries will apply minimum heating requirements as part of their regulations.

Before filling and packaging can take place, the containers will need to be cooled. This occurs in a cooling chamber where the temperature of containers is reduced to a safe and usable level.

The filling component

Asepsis is a very important aspect of the machine's operation, but the equipment still needs to fulfill a practical purpose — transferring materials into their containers. This will take place in the filling area of the machine, where batches of containers move through the production line to be filled by the machine's nozzles.

Typically, containers will move through the machine on a conveyor system. This is likely to be a belt or track that guides each container or vial tray through the machine in sequence, ensuring that containers remain evenly spaced and that no materials are lost and wasted during the process.

The sealing component

After the containers have been filled, they will need to be sealed before they leave the machine. The specific type of sealing required depends on the product and the container — for example, some pharma products require vials with childproof caps that will need to be applied and sealed according to industry regulations and requirements. This sealing process is critical to the entire operation. It allows manufacturers and distributors to guarantee the sanitary and aseptic credentials of the products they handle.

A closed system

The entire filling process takes place within a closed system, similar to a pharmaceutical clean room. The only objects that can enter this system are loaded onto the conveyor belt and must pass through sterilization and heating chambers before they continue their journey, eliminating the risk of contamination at any other point within the process. This means there is no human intervention in the process. Screens protect the interior of the machine, and no human operators or external agents can reach its inner workings. Basically, facility managers can guarantee that all containers and products are fully sterilized and that no contamination events can take place. Control of the system is often administered via a touchscreen panel on the outside of the machine. This allows facility personnel to make changes and manage the process without the risk of contamination.

Fig 3: Aseptic Filling Machine

CAN WASHERS, BOTTLE WASHERS

Bottle Washer

Pre-wash

Right after the infeed area the bottles are turned upside- down so that the liquid residuals and loose dirty particles fall out of the bottles. Residuals are collected and discharged out of the machine separately. A sieve-belt conveyor may be arranged in order to take solid dirt, such as straws, cigarettes, insects out of the machine. This sieve-belt is at the same time a filter for the waste water. Behind the dirt removal area an internal jetting pipe can be located is present so to further remove dirty particles from inside the bottles as early as possible. Bottles are then submerged and filled with warm water. Water remains within the bottles until they are turned upside-down in the following jet section. The water running out returns to the pre-soak through a sieve-belt filter. This is the first occurrence where the bottles are turned upside down and so broken glass and dirt are collected in the lower part of the tank. An automatic dirt and glass debris removing system is available optionally. The bottles are then pre rinsed with a set of internal sprayers and external showers and moved to the heat recovery submerge bath, where heat is transferred from the cooling zone without any water mixing. The temperature is gradually raised in this zone, exploiting the residual heat of the water received from the rinsing zone.

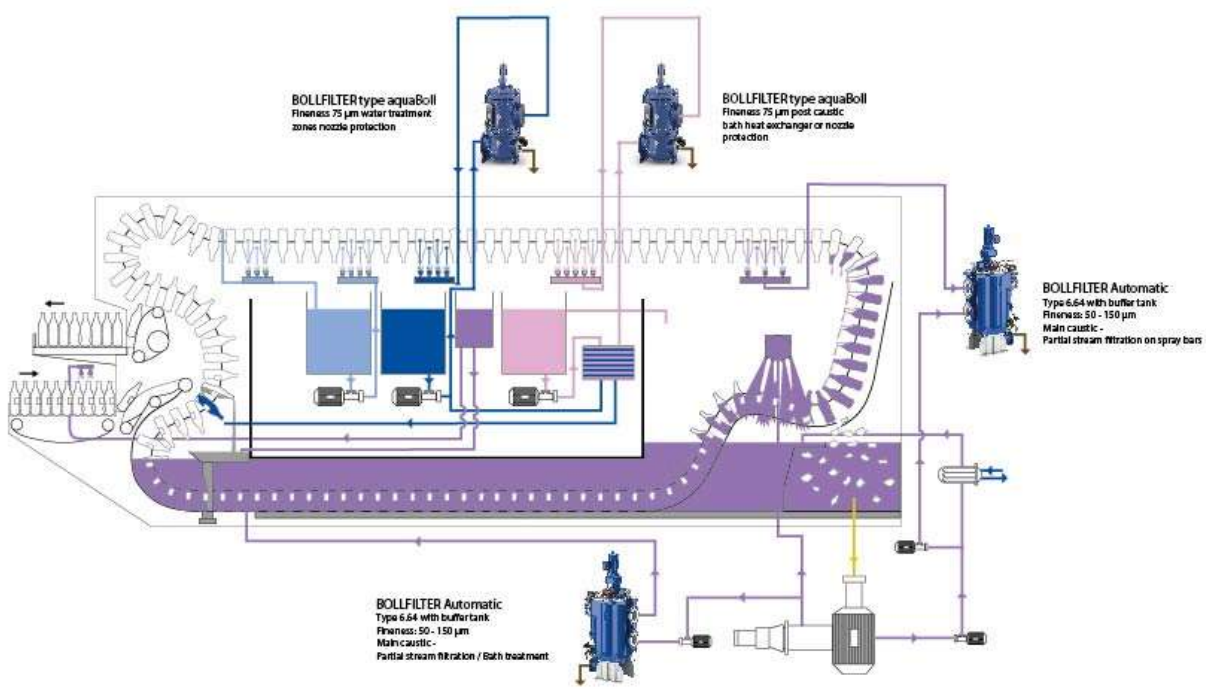


Fig 4: Bottle Washing Equipment

Washing

The bottles are then taken to the actual washing zone which consists of a certain number of identical detergent soaks – the exact number depends on the required treatment time. Bottle washing is in three essential stages: first, the bottle is immersed in the soak, where dirt is chemically attacked by the caustic action of the soda, increased by high temperature; at the second stage, the bottle is emptied to remove the dissolved dirt and the used solution; at the third stage the mechanical action of the internal jet removes the dirt, which had been chemically attacked, so that the remaining dirt comes into direct contact with the detergent solution of the next soak.

Rinsing

The bottles then move on to the rinsing zone, that usually includes an immersion zone and a set of spraying zones. In this zone the temperature is gradually lowered and the detergent solution is removed, both from the bottles and from the carrier beams, through dedicated sets of sprayers. All the rinsing water is then recovered to the pre-washing zone. Every spraying zone consists of a set of high-pressure internal sprays and an external shower. Before discharging the bottles, a final injection with fresh water takes place and, after sufficient drip-off time, the unloading system places the bottle on the conveyor belt.

Can Washers

Hans Washing or Can Scrubber

This method is adopted in all milk chilling centers where less number of cans is to be washed. Construction of can scrubber is shown in figure and described below:

- The scrubber machine is made of 10 SWG G.I. sheet or MS sheet with totally galvanized.
- The machine is painted with 'epoxy' paint to avoid corrosion.
- The can scrubber consists of a tank in which two revolving nylon brushes are mounted on shafts.
- The extension of shafts is properly encased in sealed enclosures and provided with suitable bearings and lubrication points.
- Gland packing is used to avoid the leakage through the shaft.
- A stationary nylon brush is fitted with a bracket on the inner wall for cleaning outside of the cans.
- Side stationary brush is changeable.
- It can be fitted on either side of the inner wall.
- Cylindrical nylon brushes, revolve at a low speed, i.e., 80 to 100 rpm, in opposite directions by a motor and reduction gear unit, give thorough and effective cleaning action on either side of the can.
- Steam and water connections are given to the tank for making warm water for washing operation.
- At the bottom of the tank a drain valve is fitted for easy draining and cleaning of the tank.

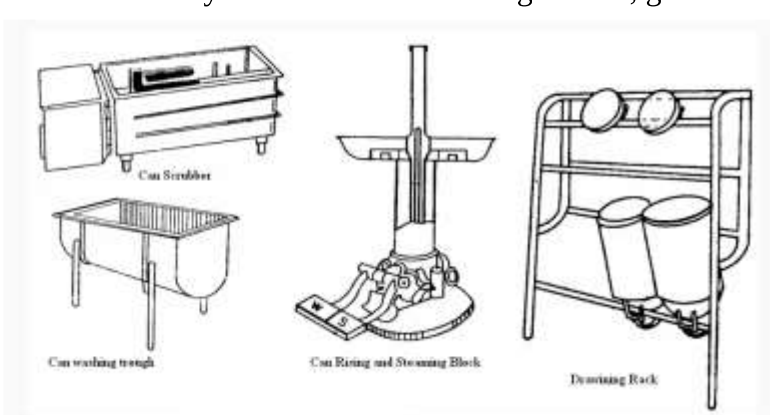


Fig 5: Can washers

FACTORS AFFECTING WASHING OPERATIONS

- The maintenance of bottle washer is essential, day to day as well as periodical inspection, repair and replacements.
- The clogging of jets is a frequent problem and this has to be inspected daily, through leak proof inspection doors provided at the sides of the enclosure.
- Safe lighting is provided inside the bottle washer for this purpose. The steam pressure, water jet pressures are to be maintained.
- If the motors or pipelines are forming scale, it has to be removed.
- Spillage of water jets outside the bottles to which they are directed to must be avoided, due to lack of sufficient pressure or excess pressure.
- The chain conveyor movement should be ensured for smooth movement, without any excess of friction at various wheels provided for change of direction.
- Steam condensate traps must be inspected for proper operation and draining of condensate.
- The strainers provided before jetting rows are to be cleaned time to time.

CIP CLEANING AND DESIGNING OF SYSTEM

Cleaning of dairy equipment and its sanitation are of utmost importance in dairy industry. Cleaning-in-Place (CIP) involves circulation or recirculation of appropriate water rinses and chemical cleaning and sanitizing solutions through plants and equipment which is maintained in the assembled state, such that all contaminated contact surfaces cleaned to acceptably high and consistently reproducible standards. It involves use of hotter, stronger and more soil aggressive chemical solution than manual cleaning. Filters and similar equipment should be taken out during CIP cleaning to prevent their damage.

For effective Cleaning the following aspects are important:

- Design of plant, material used and ancillary equipment should be suitable for CIP cleaning.
- Cleaning procedure to be adopted depending on soil type, detergent type, concentration, temperature, contact time, type of surface.
- CIP cycle must effectively and automatically be controlled with minimum intervention, or unauthorized alteration
- Supervision is important although high degree of automation is available.

The favorable effect of increased temperature in cleaning may be attributed to:

- Loosening of bond between soil and the surface, and increase in wetting.
- Greater turbulence because of decreased viscosity
- Increased solubilization of more soluble constituents of soil e.g. lactose, mineral
- Increased chemical reaction rate which greatly increases the cleaning

It is a general observation that the minimum temperature should be about 3 - 5°C higher than the melting point of fat. The maximum temperature will depend upon the temperature at which the protein in the system is denatured. The turbulence due to velocity of detergent has also a bearing on the cleaning efficiency. A velocity of 1.5 m/s is satisfactory, the hardness of water must be below 50 – 60 ppm for effective cleaning. Presence of > 3 ppm of Iron and > 0.2 ppm of Manganese in water may even stain the surface. Hard water employed in cleaning leads to sludge or scale formation, which reduces the rate of heat transfer, clogs up jets, and leads to wearing of moving parts. Cleaning becomes difficult at above 200 ppm hardness.

UNIT V

MANUFACTURING OF MILK PRODUCTS

PRODUCTION PROCESS

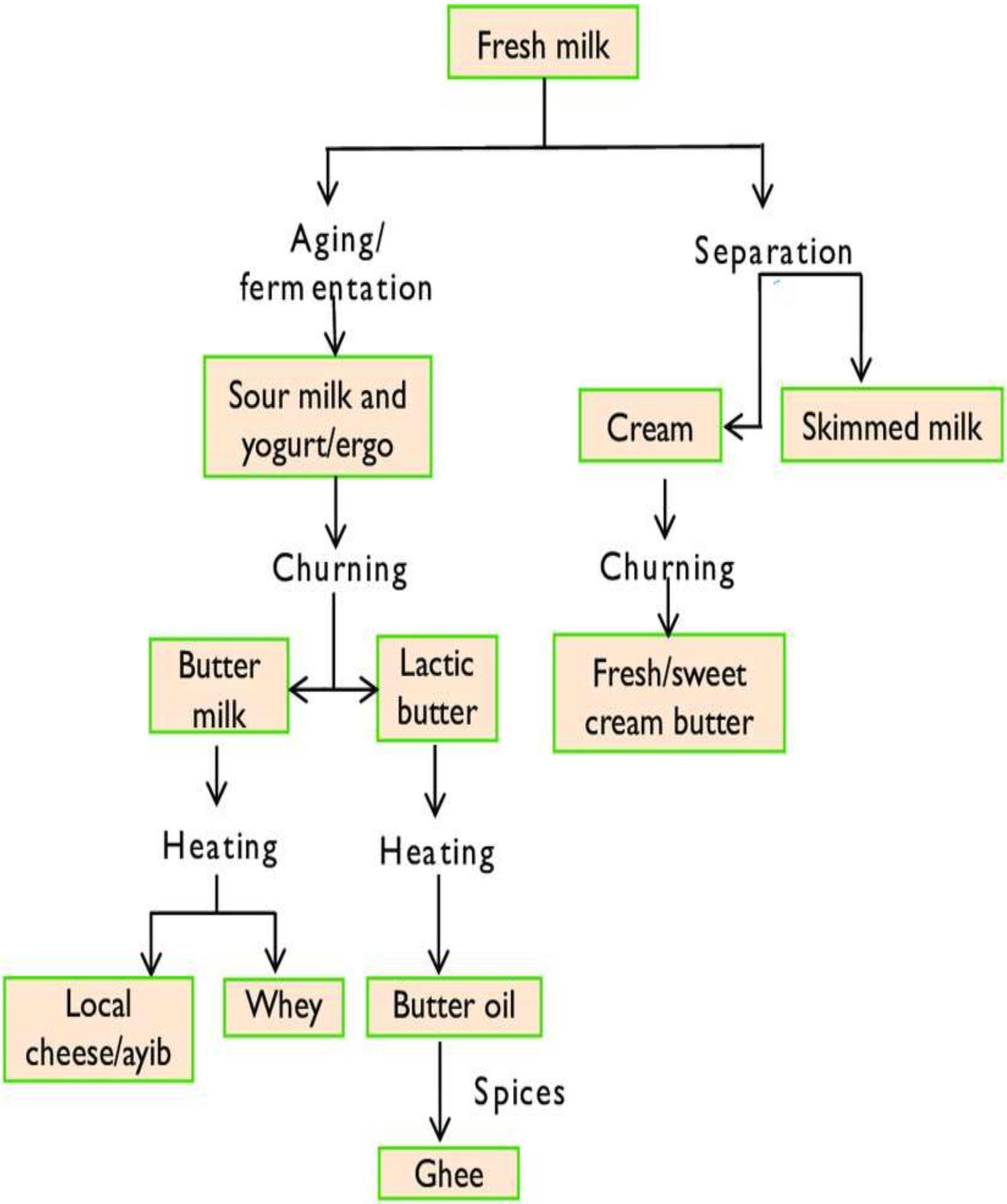


Fig 1: Processing flow chart of Milk to different By products

Cream

The fat content of cream is adjusted to the desired level either by the addition of calculated quantity of water or skimmed milk. This step is referred to as standardization. The use of water or skim milk depends on the purpose for which the cream is required. If the buttermilk is to be used for drying or standardization of milk for products making or for beverage preparation the standardization is done with skim milk. The purpose for which cream is to be used and the suggestion for use of skim milk or water

Purpose	Standardizing agent
Cream for butter preparation	Water
Whipping Cream	Skimmed Milk
Table Cream	Skimmed Milk
Coffee Cream	Skimmed Milk

Fig 2: Cream preparation using standardizing agent

Flow chart of Cream preparation

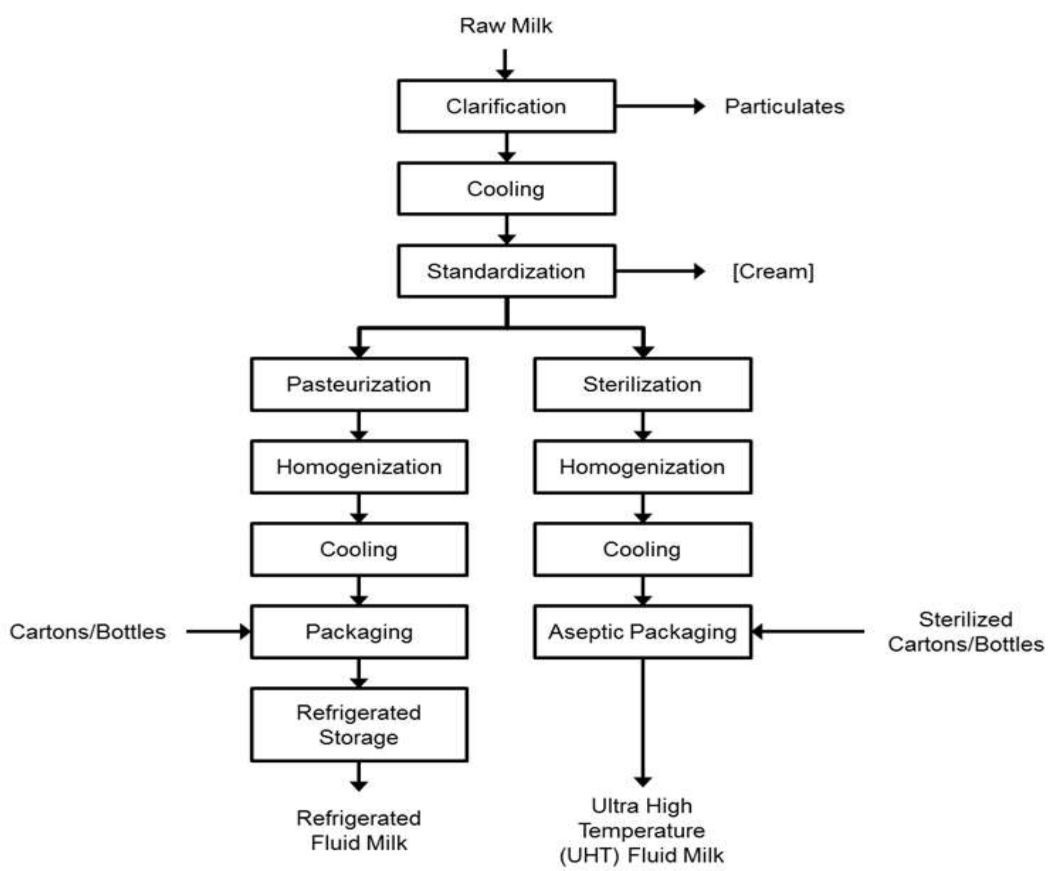


Fig 3: Production flow chart of Cream from raw milk

Butter

India's butter manufacturing industry is well-established, with a long history of producing high-quality butter for domestic consumption and export. Butter production in India uses milk sourced from local dairy farms and cooperatives.

Cream Separation

The butter manufacturing process begins with separating cream from milk using a centrifuge or cream separator. The cream contains butterfat, which is collected for further processing. The cream is then **pasteurized** to kill any bacteria and stabilize for churning. This is done by heating the cream to a specific temperature for a specific period.

Churning

The pasteurized cream is then churned to separate the butterfat from the remaining liquid, which is called buttermilk. Churning is typically done using a mechanical churner. This agitates the cream until the butterfat particles clump together and separate from the buttermilk. The churning process takes around **30 to 45 minutes**, depending on the quantity of cream and the type of equipment used.

Washing

After churning, the butter is washed to remove any remaining buttermilk and to improve the texture and taste of the butter. The washing process uses cold water, which takes 15 to 20 minutes. Washing also removes any impurities present in butter.

Kneading, Shaping and Cooling

After washing, the butter is worked, which involves kneading, shaping, and cooling it to a desired consistency. The working process removes any remaining water from the butter, improving its texture and shelf life. Butter is then shaped into blocks or rolls and cooled to 4 degrees Celsius.

Adding Salt

At this stage, salt can be added if desired. Salt enhances butter flavour and improves preservation. Salt can be added in different amounts depending on the desired taste and functionality.

Packaging

The final product is then packaged and stored at the right temperature until ready to distribute. The packaging must comply with FSSAI regulations and indicate the production date, expiration date, and other information. Butter can be packaged in varied sizes, such as tubs, blocks, or rolls, depending on the manufacturer's and customer's preference.

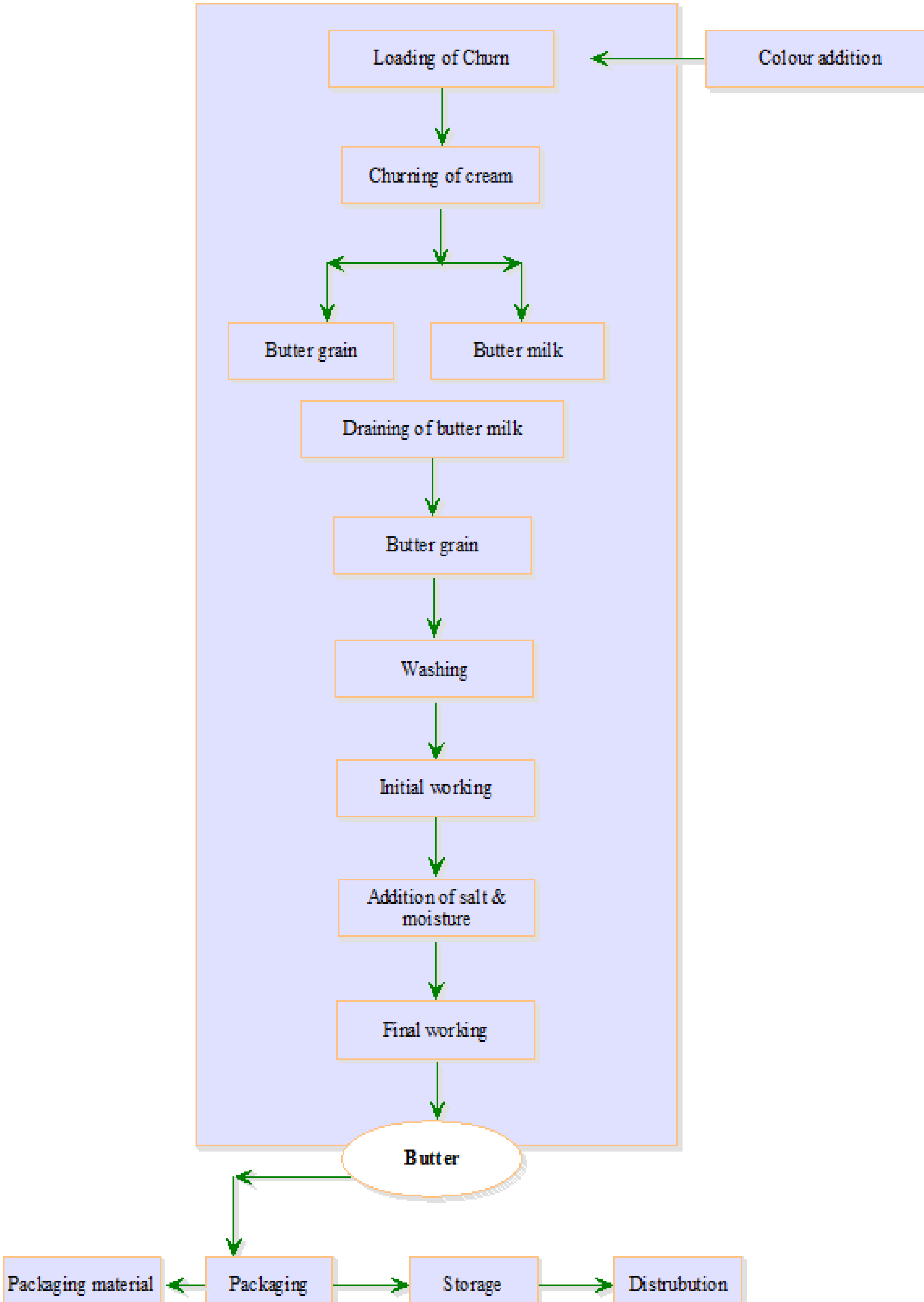


Fig 4: Butter production flow chart

Ghee

Ghee production is the largest segment of milk utilization in India. Most of the dairy plants have ghee production facility to meet the demand of the market as well as to utilize the excess fat in profitable manner. Since simple technology involved in ghee production and relatively less investment for ghee production unit as already plant have steam boiler with them. Method of production varies from small scale to large scale. Cost reduction on energy consumption for production of unit quantity of ghee is the recent trend and equipment are designed to meet the requirement. Following are the various processes available in the industry to make ghee including Desi method which is following largely at rural household level.

The principle involved in ghee preparation include;

- Concentration of milk fat in the form of cream or butter.
- Heat clarification of fat rich milk portion and thus reducing the amount of water to less than 0.5%.
- Removal of the curd content in the form of ghee residue.

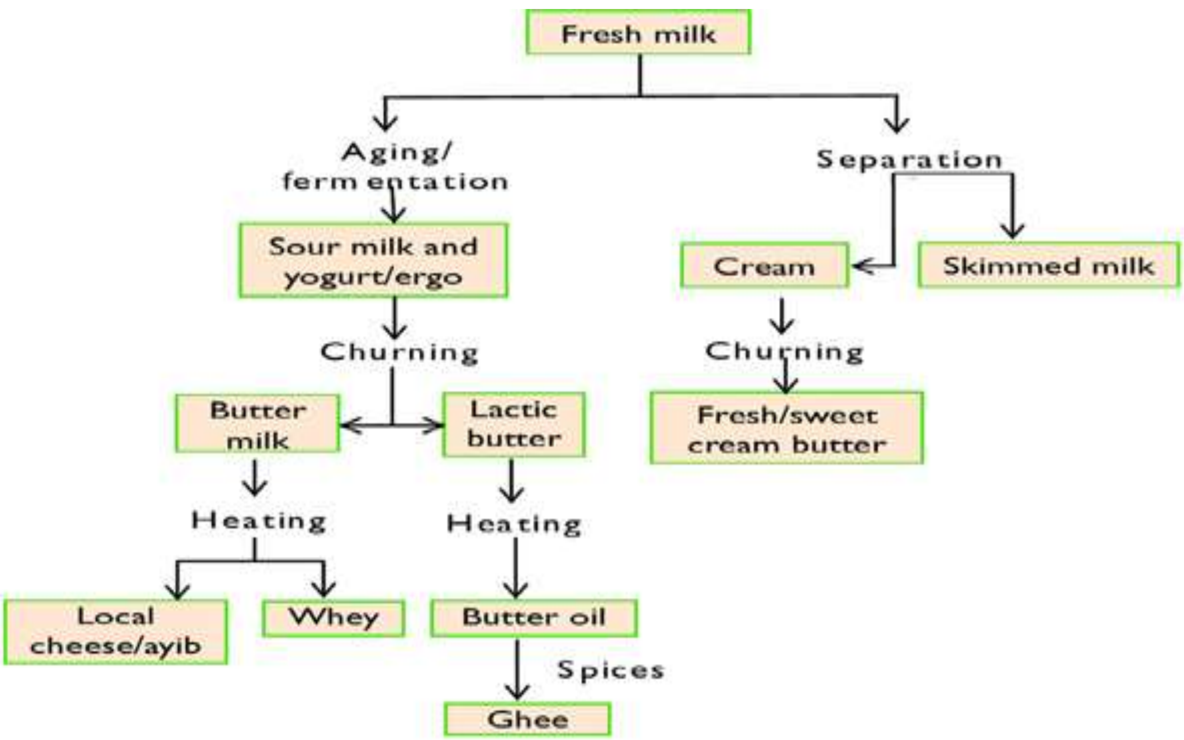


Fig 5: Ghee production Process

Ice Cream

Blending the mixture

The milk arrives at the ice cream plant in refrigerated tanker trucks from local dairy farms. The milk is then pumped into 5,000 gal (18,925 1) storage silos that are kept at 36°F (2°C). Pipes bring the milk in pre-measured amounts to 1,000 gal (3,7851) stainless steel blenders. Premeasured amounts of eggs, sugar, and additives are blended with the milk for six to eight minutes.

Pasteurizing to kill bacteria

The blended mixture is piped to the pasteurization machine, which is composed of a series of thin stainless-steel plates. Hot water, approximately 182°F (83°C), flows on one side of the plates. The cold milk mixture is piped through on the other side. The water warms the mixture to a temperature of 180°F (82°C), effectively killing any existing bacteria.

Homogenizing to produce a uniform texture

By the application of intensive air pressure, sometimes as much as 2,000 pounds per square inch (141 kg per sq cm), the hot mixture is forced through a small opening into the homogenizer. This breaks down the fat particles and prevents them from separating from the rest of the mixture. In the homogenizer, which is essentially a high-pressure piston pump, the mixture is further blended as it is drawn into the pump cylinder on the down stroke and then forced back out on the upstroke.

Cooling and resting to blend flavors

The mixture is piped back to the pasteurizer where cold water, approximately 34°F (1°C), flows on one side of the plates as the mixture passes on the opposite side. In this manner, the mixture is cooled to 36°F (2° C). Then the mixture is pumped to 5,000 gal (18,925 1) tanks in a room set at 36°F (2°C), where it sits for four to eight hours to allow the ingredients to blend.

Flavoring the ice cream

The ice cream is pumped to stainless steel vats, each holding up to 300 gal (1,136 1) of mixture. Flavorings are piped into the vats and blended thoroughly.

Freezing to soft-serve consistency

Now the mixture must be frozen. It is pumped into continuous freezers that can freeze up to 700 gal (2,650 1) per hour. The temperature inside the freezers is kept at -40°F(-40°C), using liquid ammonia as a freezing agent. While the ice cream is in the freezer, air is injected into it. When the mixture leaves the freezer, it has the consistency of soft-serve ice cream.

Adding fruit and sweetened chunks

If chunks of food such as strawberry or cookie pieces are to be added to the ice cream, the frozen mixture is pumped to a fruit feeder. The chunks are loaded into a hopper at the top of the feeder. Another, smaller hopper, fitted with a star wheel, is located on the front of the feeder. An auger on the bottom of the machine turns the hoppers so that the chunks drop onto the star wheel in pre-measured amounts. As the mixture passes through the feeder, the star wheel pushes the food chunks into the ice cream. The mixture then moves to a blender where the chunks are evenly distributed.

Packaging and bundling the finished product

Automatic filling machines drop preprinted pint or half-gallon-sized cardboard cartons into holders. The cartons are then filled with premeasured amounts of ice cream at the rate of 70-90 cartons per hour. The machine then places a lid on each carton and pushes it onto a conveyer belt. The cartons move along the conveyer belt where they pass under an inkjet that spray-paints an expiration date and production code onto each carton. After the imprinting, the cartons move through the bundler, a heat tunnel that covers each cup with plastic shrink wrapping.

Hardening

Before storage and shipping, the ice cream must be hardened to a temperature of -10°F (-23°C). The conveyor system moves the ice cream cartons to a tunnel set at -30°F (-34°C). Constantly turning ceiling fans create a wind chill of -60°F (-51°C). The cartons move slowly back and forth through the tunnel for two to three hours until the contents are rock solid. The cartons are then stored in refrigerated warehouses until they are shipped to retail outlets.

Fig 6: Ice cream Production flow chart

Infant Milk Food

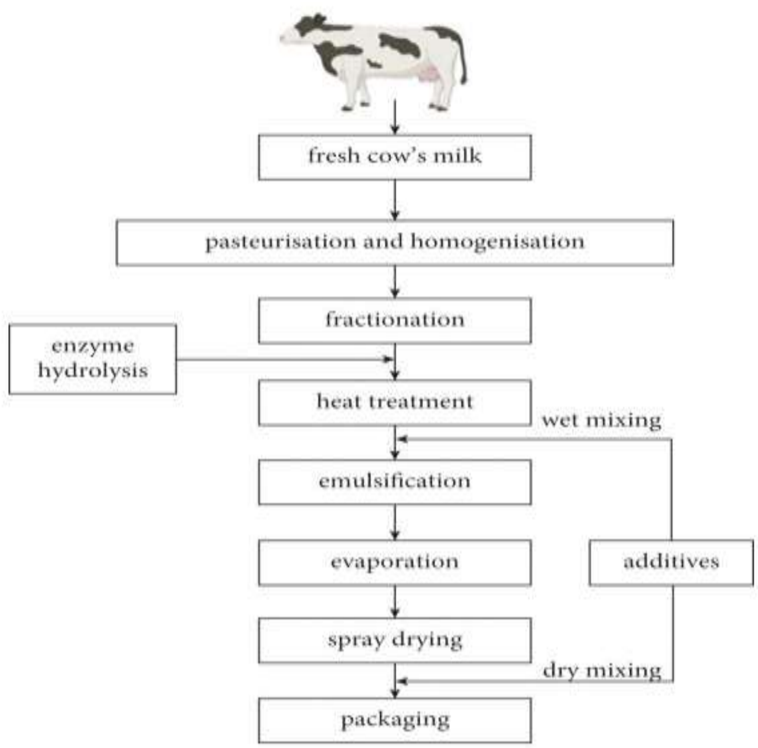


Fig 7: Infant Milk Food Production flow chart

Khoa

Khoa is prepared by different methods depending on the location and quantity of milk available for conversion. Khoa is manufactured by the following four basic methods viz. traditional method, improved batch method, mechanized method and use of membrane technology.

Generally, buffalo milk is preferred for manufacture of khoa as it results in higher yield, smooth texture and soft body with sweet taste. Where buffalo milk is not available, cow milk is used for khoa making but it results in pasty body and slightly saltish taste due to higher chlorides in the product.4 liters of buffalo milk or 5 liters of cow milk which approximately yields 1 kg khoa is used per batch. Filtered milk is taken in a heavy bottomed wide mouth iron pan (karahi) and boiled on a brisk non – smoky fire.

An iron scraper is used for stirring the milk during boiling and also to scrap the milk film forming on the surface during boiling. A rapid stirring and scrapping is carried out throughout boiling to facilitate quick and rapid evaporation of water from milk and also to prevent scorching of milk film on surface.

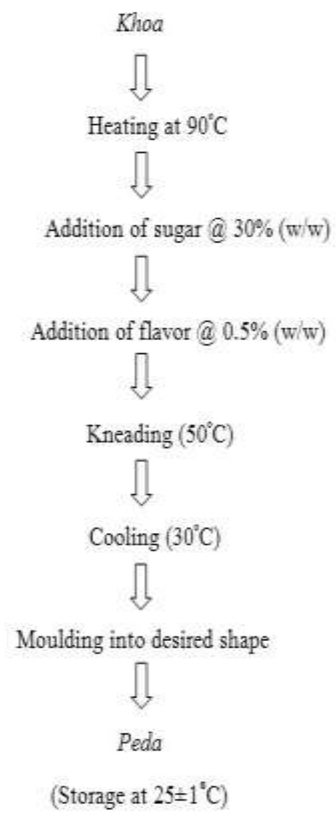


Fig 8: Khoa Making process

If the milk is subjected to high heat treatment with less stirring and scraping at this stage it results in dark colored *khoa* that does not fetch a good price in the market as white/ cream colored *khoa* is preferred for sweets making.

As the concentration is progressing, the product slowly tends to leave the sides of the pan and starts' accumulating at the bottom and at this stage; the pan has to be removed from the fire. The contents are worked up and the residual heat of the vessel helps in further evaporation of moisture. The contents are transferred to the non-corrosive metal molds and allowed to cool. There are several limitations of this method such as:

- Time and labor consuming
- Large variation in quality
- Poor keeping quality
- Small scale production
- Smoky smell

Channa

Chhana is an acid coagulated product obtained from milk. The curd mass obtained when milk is coagulated with the organic acids such as citric acid, lactic acid at higher temperature and after subsequent drainage of whey, mass of curd obtained is called chhana. It looks off-white, tastes mildly acidic, and has characteristic spongy texture. According to FSSR-1511 chhana means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0 per cent moisture and the milkfat content shall not be less than 50.0 per cent on dry matter. Milk solids may also be used in preparation of this product.

Low fat chhana shall conform to the following requirements

- Moisture not more than 70.0 percent
- Milk fat not more than 15.0 percent of dry matter

Parameters	Cow milk *chhana*	Buffalo milk *chhana*
Moisture %	53.4	51.7
Fat %	24.8	29.7
Lactose %	2.2	2.3
Protein %	17.4	14.4
Ash %	2.1	1.9
pH	5.7	5.4

Fig 8: Composition of Chhana

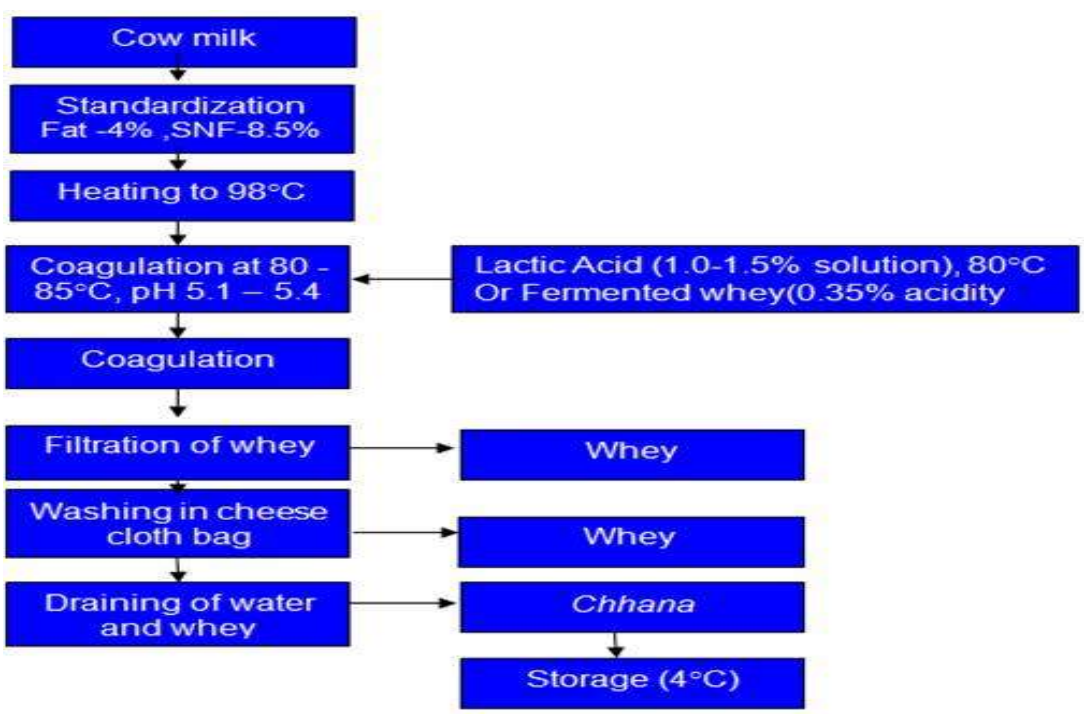


Fig 9: Flow chart for Processing of Chhana

Rabri, Kulfi

Rabri

Rabri is a sweetened concentrated whole milk product with thickened malai layer obtained by evaporation and concentration of milk. Buffalo milk is preferred for preparation of rabri. Two types of concentrated milks were used as base materials for large scale production of rabri. In one process, buffalo milk with 2% fat was concentrated to 35% TS in a scraped surface heat exchanger. In another method buffalo skim milk was concentrated in a vacuum pan to contain 35% total solids. The concentrated milks were heated upto 90˚C followed by addition of sugar @12% of the product. The mixture was then cooled to 70ºC and calculated amount of malai is added to it. The malai could be prepared from buffalo milk by simmering it in an open kettle. However, rabri obtained by these two methods was liked 'slightly' by judges indicating necessity for further improvement in the process.

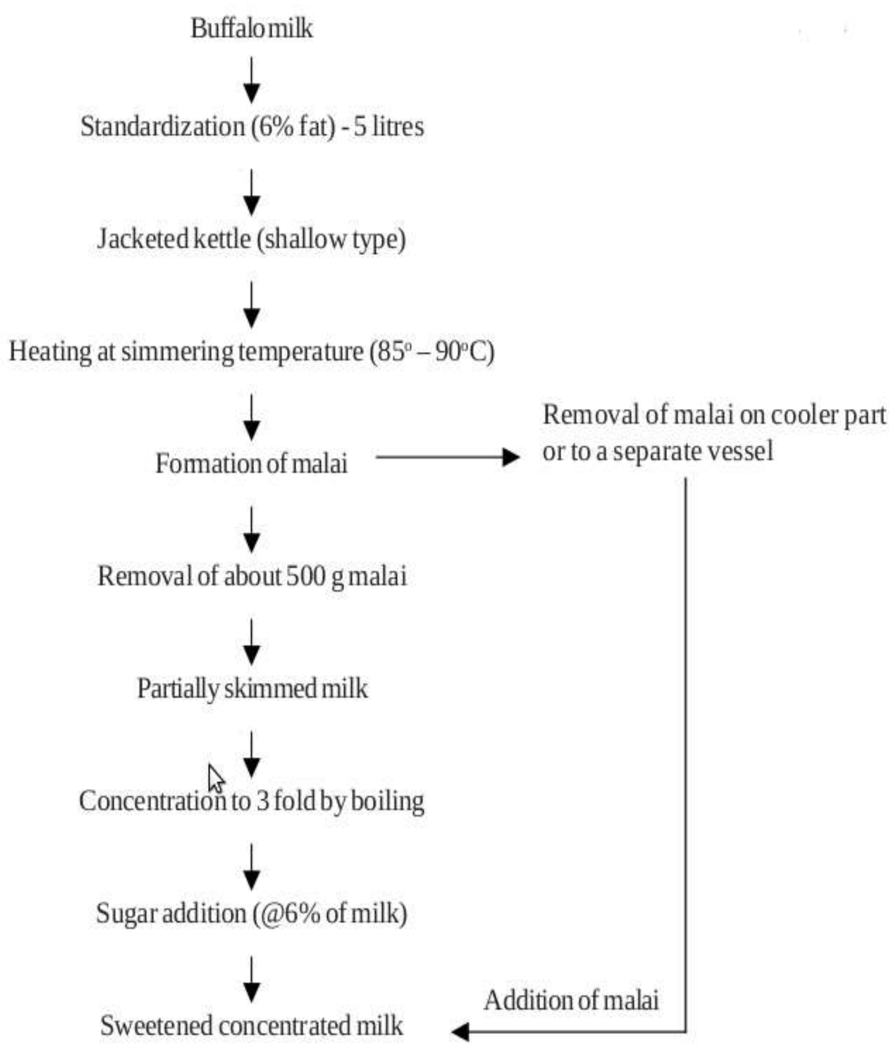


Fig 10: Rabri Manufacturing process

Kulfi

- The milk intended for kulfi making is filtered.
- Then the milk is placed in steam jacketed kettle and heated accompanied by continuous stirring.
- Sugar is added at the concentration so as to obtain 13 percent in the final product.
- Heating and stirring is continued till the milk is concentrated to half of its original volume.
- The concentrated milk is cooled.
- Then khoa, malai and flavouring ingredients are added.
- The mix is filled into cones, which may be made up of aluminium or galvanized sheet.
- Then the lids are placed on the mouth of the cones and sealed by placing dough made up of wheat flour.
- Brine mixture is prepared by adding salt and ice in the ratio of 1:1. The greater the percentage of salt, the lower the temperature of freezing that can be obtained. Kulfi can be frozen quickly in the higher salt-ice ratio.
- The cones are placed in the brine mixture and the vessel covered.
- The earthen pot is shaken intermittently to quicken the freezing process.

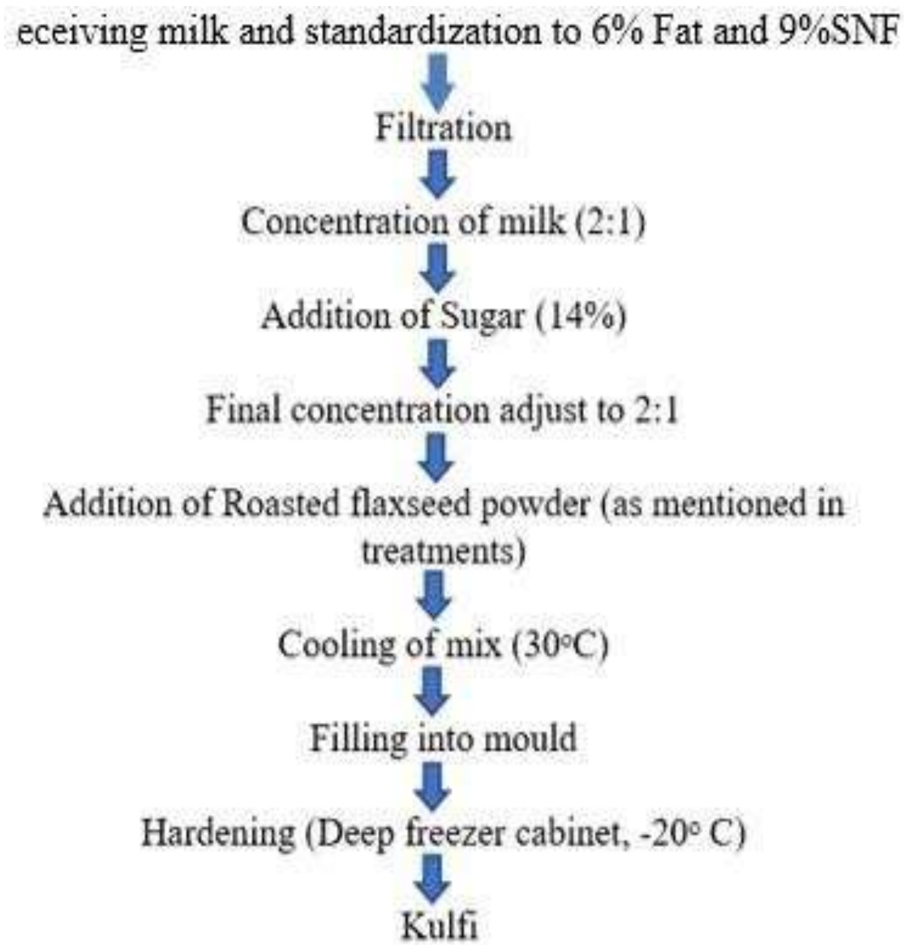


Fig 11: Kulfi Manufacturing Process

FERMENTED MILK PRODUCTS

Yoghurt

Adjust Milk Composition & Blend Ingredients Milk composition may be adjusted to achieve the desired fat and solids content. Often dry milk is added to increase the amount of whey protein to provide a desirable texture. Ingredients such as stabilizers are added at this time.

Pasteurize Milk

The milk mixture is pasteurized at 185°F (85°C) for 30 minutes or at 203°F (95°C) for 10 minutes. A high heat treatment is used to denature the whey (serum) proteins. This allows the proteins to form a more stable gel, which prevents separation of the water during storage. The high heat treatment also further reduces the number of spoilage organisms in the milk to provide a better environment for the starter cultures to grow. Yogurt is pasteurized before the starter cultures are added to ensure that the cultures remain active in the yogurt after fermentation to act as probiotics; if the yogurt is pasteurized after fermentation the cultures will be inactivated.

Homogenize

The blend is homogenized (2000 to 2500 psi) to mix all ingredients thoroughly and improve yogurt consistency.

Cool Milk

The milk is cooled to 108°F (42°C) to bring the yogurt to the ideal growth temperature for the starter culture. Inoculate with Starter Cultures The starter cultures are mixed into the cooled milk.

Hold

The milk is held at 108°F (42°C) until a pH 4.5 is reached. This allows the fermentation to progress to form a soft gel and the characteristic flavor of yogurt. This process can take several hours.

Cool

The yogurt is cooled to 7°C to stop the fermentation process.

Add Fruit & Flavors

Fruit and flavors are added at different steps depending on the type of yogurt. For set style yogurt the fruit is added in the bottom of the cup and then the inoculated yogurt is poured on top and the yogurt is fermented in the cup. For swiss style yogurt the fruit is blended with the fermented, cooled yogurt prior to packaging.

Package

The yogurt is pumped from the fermentation vat and packaged as desired

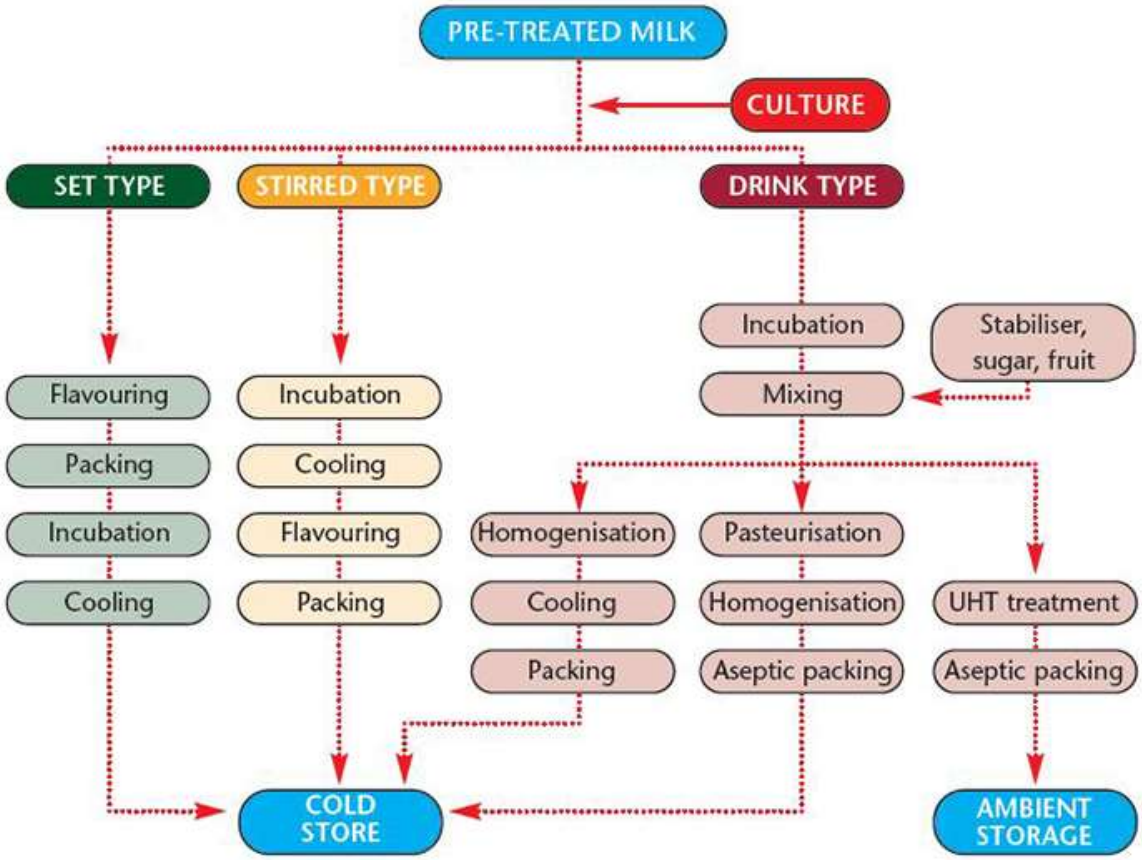


Fig 12: Yoghurt Manufacturing Process

Dahi, Buttermilk and Lassi

Dahi

Butter milk is similar to skim milk in composition except acidity of the product. It is generated during the production of butter from *dahi* by *desi* method. To this butter milk salt, coriander, ginger, onion is added to improve palatability. It is popular because of its aroma, mildly acidic taste developed during fermentation by mixed strains of lactic acid bacteria. In southern part of the country butter milk is prepared by churning high acid curd and addition of water to reduce acidity. Butter milk is consumed directly or along with rice and pickle.

The basic role of starter culture is to bring about acid coagulation of milk and impart characteristic flavour. The culture must be pure, active and free from gas producing microorganisms. Presence of more than one type of lactose fermenting microorganisms in the starter culture is required for the production of diacetyl flavor in dahi. A lactic culture comprising of *Lactococcus lactis subsp. lactis*, *Lactococcus lactis subsp. cremoris* and *Lactococcus lactis subsp. diacetilactis* is used for dahi for lassi making. Setting of milk is terminated at an acidity of 0.70 – 0.80 per cent LA. To the set curd sugar syrup is added which requires sufficient heat treatment (80-90$_o$C) to prevent microbial contamination through sugar. It is also essential to cool the syrup to room temperature before addition to dahi to prevent hardening of fine curd particles and whey separation. Homogenization prevents cluster formation, rising of fat to the surface and improves consistency.

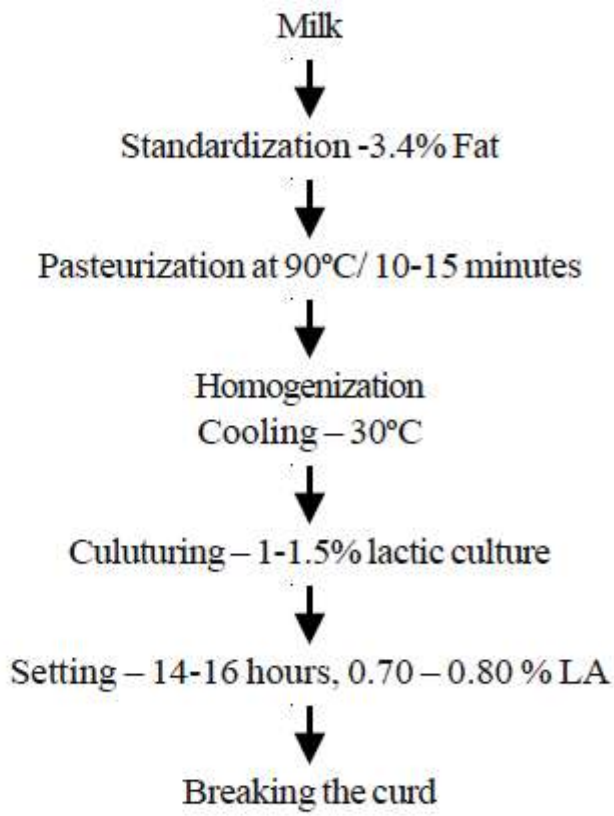


Fig 12: Dahi Manufacturing Process

Lassi

In a typical method of manufacture of lassi, standardized milk (4% fat) is heated to 90oC for 10 min and cooled to 25oC before addition of starter culture (1%). Cultured milk is incubated for 12-16 hr at 25-28oC, the set curd is broken by stirring and sugar syrup is mixed. The mixture is homogenized and packaged after the addition of flavour. On an average the product contains 3 per cent fat., 6-7 per cent SNF and 10-11 per cent sugar.

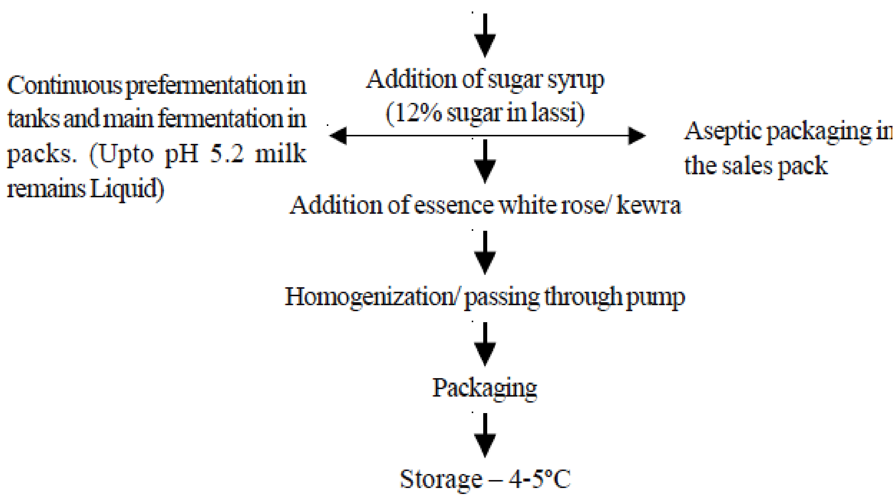


Fig 12: Lassi Manufacturing Process

Buttermilk

Buttermilk, the fluid remaining when the fat is removed by churning cream into butter. It was formerly used as a beverage, but today it is mostly condensed or dried for use in the baking and frozen desserts industry. It has been replaced as a beverage by cultured buttermilk, which is prepared from skim or low-fat milk by fermentation with bacteria that produces lactic acid. The resulting product is thicker than traditional buttermilk but is similar to it in other respects.

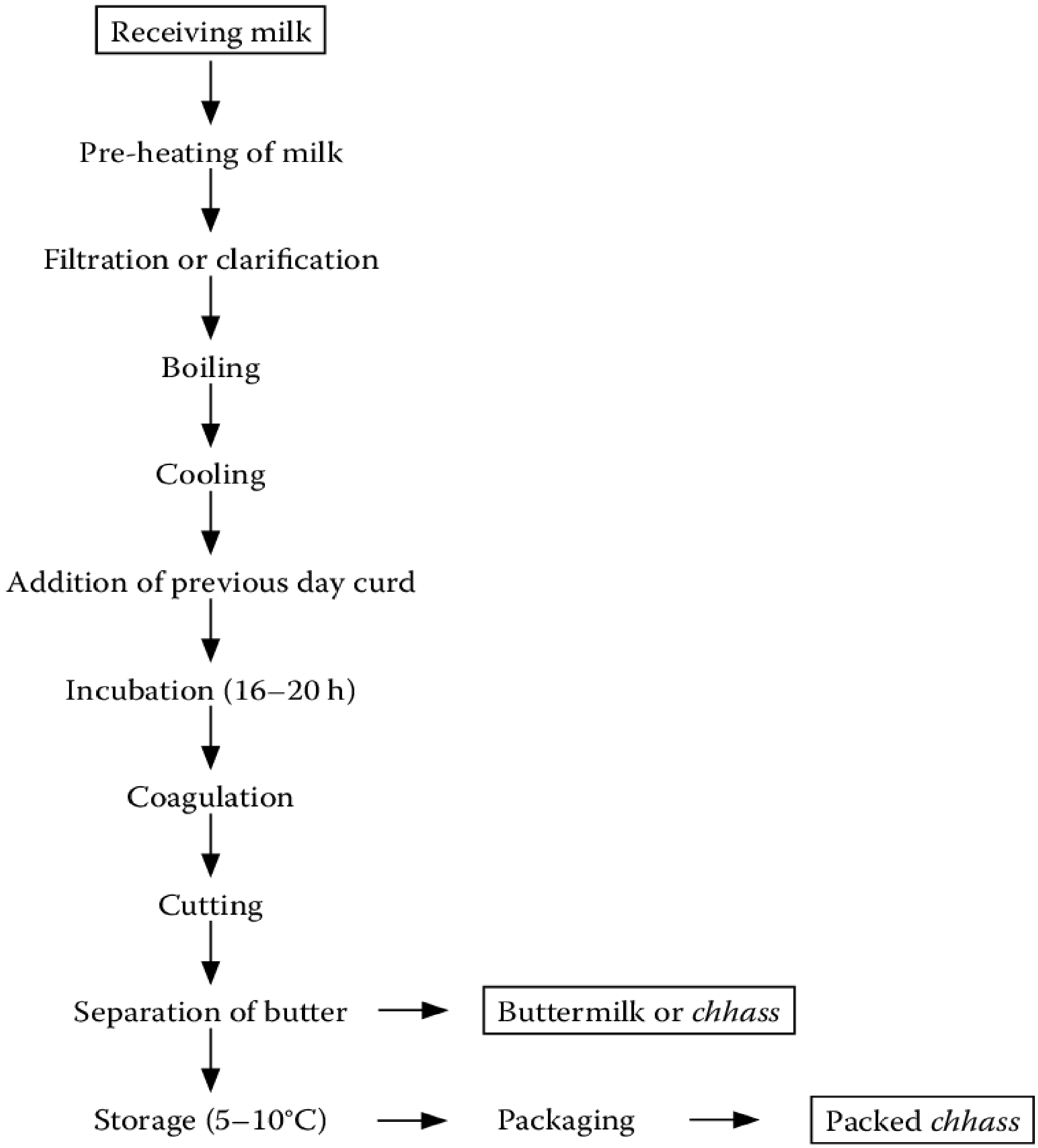


Fig 13: Buttermilk Production Process

Shirkhand

Skim milk is heated to 85°C for 30min, cooled to 30°C and inoculated with LF-40 culture containing *Lactococcus lactis* subsp. *lactis* and *Lactococcus Lactis* var. *diacetilactis* at the rate of 1.0 – 1.5%. After the required acidity of 0.8 to 1.0 is reached, the curd is taken into basket centrifuge or quarg separator to remove whey from the curd. The curd mass or chakka is taken into planetary mixer or scraped surface heat exchanger. Sugar at the rate of 80% w/w, calculated amount of plastic cream (80% fat) to give at least 8.5% FDM in the finished product are added and mixed thoroughly. optional ingredients like colour, flavour, fruits, nuts etc. can also be added at this stage. Then it is packed at room temperature and stored at refrigeration temperature.

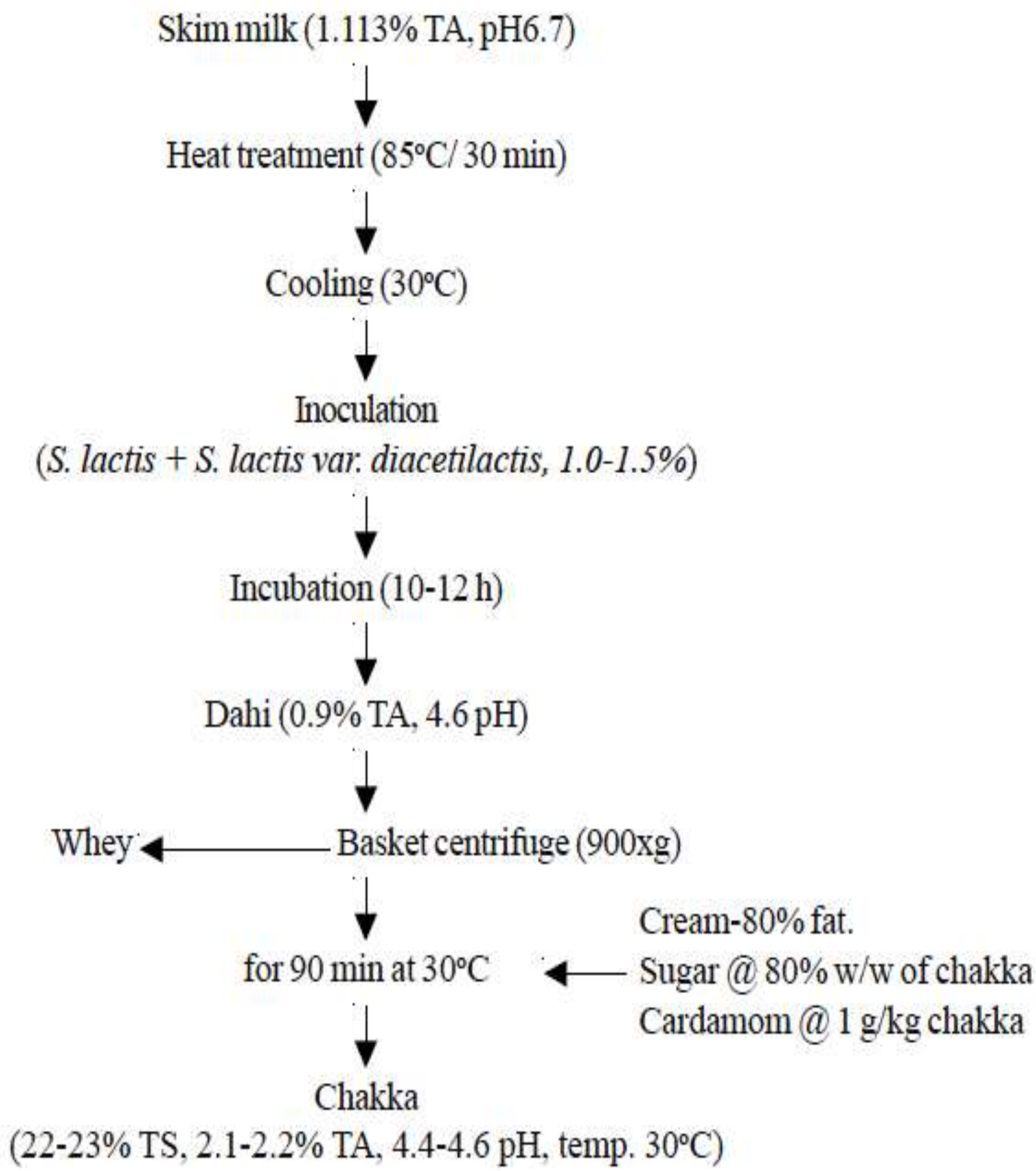


Fig 14: Shirkhand Production Process

Kefir

Kefir is a viscous, slightly carbonated dairy beverage that contains small quantities of alcohol and, like yoghurt, is believed to have its origins in the Caucasian mountains of the former USSR. It is also manufactured under a variety of names including kephir, kiaphur, kefer, knapon, kepi and kippi with artisanal production of kefir occurring in countries as widespread as Argentina, Taiwan, Portugal, Turkey and France. It is not clear whether all kefirs originate from a single original starter culture, since microbial analyses of kefir samples taken from different locations indicate microflora population differences.

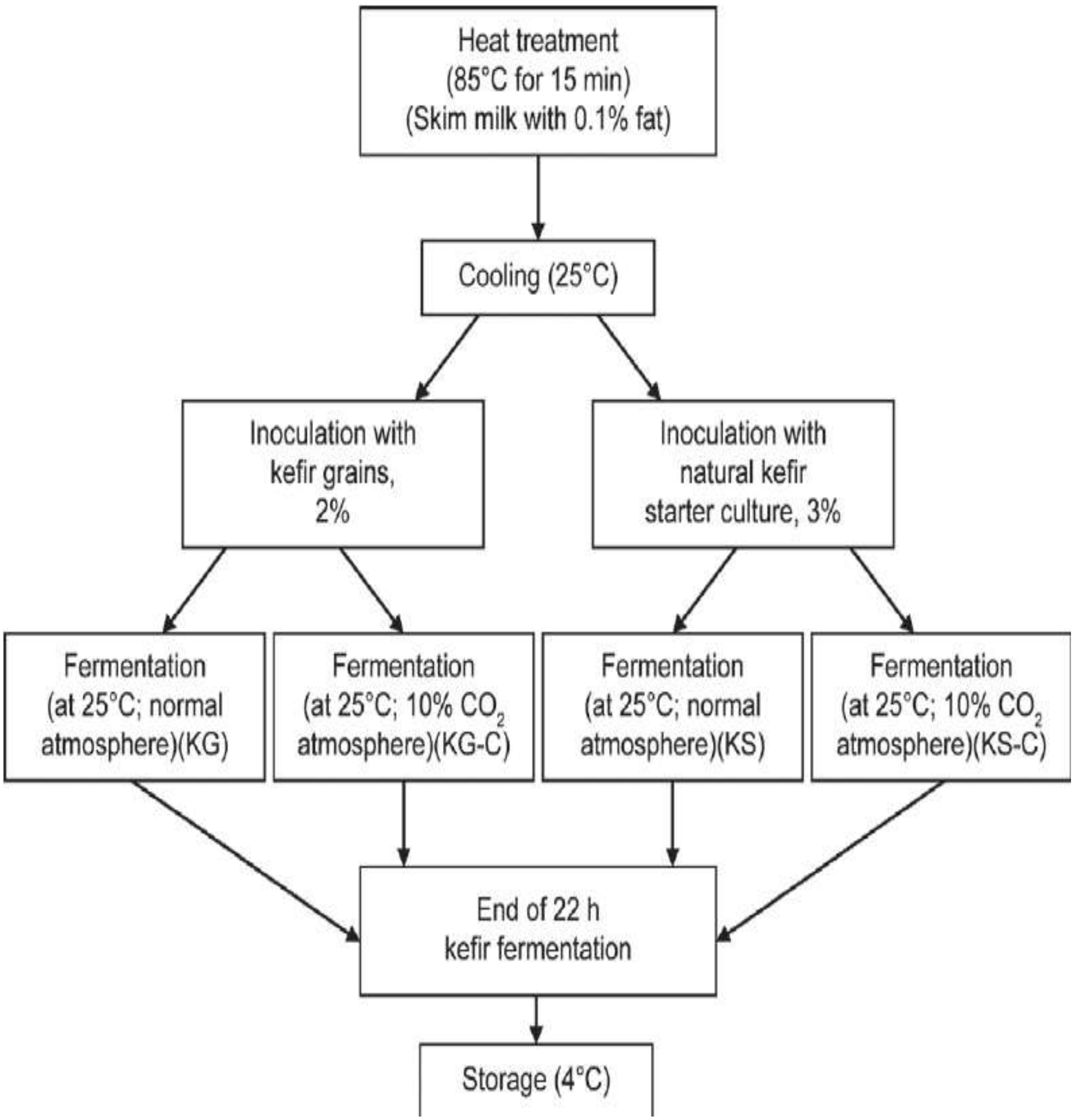


Fig 15: Khefir Production Process

Paneer

Paneer is milk made product common in South Asian cuisine. In eastern parts of Indian Subcontinent, it is generally called Chhena. It is an unaged, acid-set, non-melting curd made by curdling heated milk with lactic acid or citric acid. According to PFA rule it should not contain more than 70% moisture, and the milk fat not less than 50% of the dry matter.

Manufacturing Process

To prepare paneer, food acid (usually lactic or citric acid) is added to hot milk to separate the curds from the whey. The curds are drained in muslin cloth and the excess water is pressed out. The resulting paneer is dipped in chilled water for 2–3 hours to give it a good texture and appearance. From this point, the preparation of paneer diverges based on its use and regional variation. In most cuisines, the curds are wrapped in cloth and placed under a pressure such as a stone slab, for 2–3 hours, and then cut into cubes for use in curries. Pressing for a shorter time (approximately 20 minutes) results in a softer, fluffier paneer. The chilled pieces store in polythene bags for refrigerated and store.

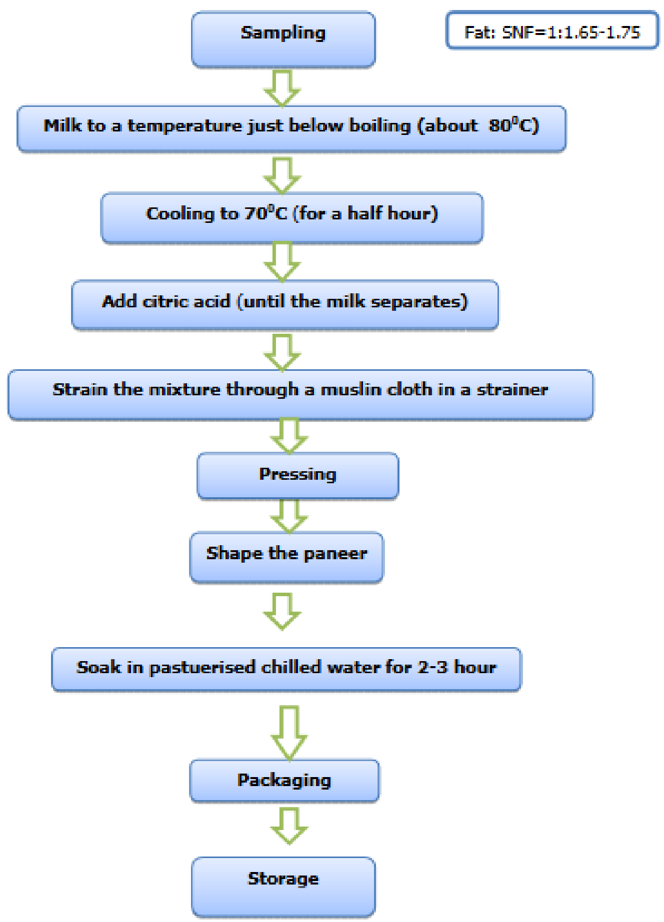


Fig 16: Paneer Production Process