INDIAN IQ

DAIRY TECHNOLOGY

INDIAN IQ INSTITUTE

Dairy Technology

Dairy is a place where handling of milk and milk products is done and technology refers to the application of scientific knowledge for practical purposes.

S.No	Constituents	Buffalo	Cow	Goat	Liquid skimmed milk
1	Moisture (g)	81.00	87.50	86.80	92.10
2	Protein (g)	4.30	3.20	3.30	2.50
3	Fat (g)	6.50	4.10	4.50	0.10
4	Minerals (g)	0.80	0.80	0.80	0.70
5	Carbohydrates (g)	5.00	4.40	4.60	4.60
6	Energy calories (kcal)	117.00	67.00	72.00	29.00
7	Calcium (mg)	210.00	120.00	170.00	120.00
8	Phosphorus (mg)	130.00	90.00	120.00	90.00
9	Iron (mg)	0.20	0.20	0.30	0.20

Average milk composition of different species

Species	Water	Fat	Protein	Lactose	Ash
Friesian cow[1]	87.92	3.40	3.13	4.86	0.69
Sindhi cow[2]	86.07	4.90	3.42	4.91	0.70
Gir cow[2]	86.44	4.73	3.32	4.85	0.66
Tharparkar cow[2]	86.58	4.55	3.36	4.83	0.68
Sahiwal cow[2]	86.42	4.55	3.33	5.04	0.66
Crossbred cow[2]	86.54	4.50	3.37	4.92	0.67
Buffalo[3]	82.76	7.38	3.60	5.48	0.78
Goat[4]	87.10	4.25	3.52	4.27	0.86
Sheep[5]	81.00	7.90	5.80	4.50	0.80
Camel[6]	86.50	3.10	4.00	5.60	0.80

PFA Standards for different class of milk in India

Class of milk	Designations	State and Union Territories	Minimum percentage	
			Milk fat	Milk solids-not-fat (SNF)
Buffalo milk	Raw, pasteurized, boiled, flavoured and sterilized	Assam; Bihar; Chandigarh; Delhi; Gujarat; Maharashtra; Haryana; Meghalaya; Punjab; Sikkim; Uttar Pradesh; West Bengal; Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Dadra & Nagar Haveli; Goa; Daman & Diu; Kerala; Himachal Pradesh; Jammu & Kashmir; Karnataka.	6.0	9.0
	-do-	Kerala; Lakshadweep; Madhya Pradesh; Manipur; Mizoram; Nagaland; Orissa; Pondicherry; Rajasthan; Tripura; Tamil Nadu.	5.0	9.0
Cow milk	-do-	Chandigharh; Haryana; Punjab.	4.0	8.5
	-do-	Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Dadra & Nagar Haveli; Delhi;Goa; Daman & Diu; Gujarat; Himachal Pradesh; Jammu & Kashmir; Karnataka; Kerala; Lakshadweep; Madhya Pradesh; Maharashtra; Manipur; Meghalaya; Nagaland; Pondicherry; Rajasthan; Sikkim; Tamil Nadu; Tripura; Uttar Pradesh; West Bengal.	3.5	8.5
	-do-	Mizoram; Orissa;	3.0	8.5
Goat or sheep milk	-do-	Chandigharh; Haryana; Kerala; Madhya Pradesh; Maharashtra; Punjab; Uttar Pradesh.	3.5	9.0
	-do-	Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Dadra & Nagar Haveli; Delhi;Goa; Daman & Diu; Gujarat; Himanchal Pradesh; Jammu & Kashmir; Karnataka; Kerala; Lakshadweep; Manipur; Meghalaya; Mizoram; Nagaland; Orissa; Pondicherry; Rajasthan; Sikkim; Tamil Nadu; Tripura; West Bengal.	3.0	9.0
Mixed milk	-do-	All India	4.5	8.5

Standardized milk	Pasteurized, flavoured and sterilized	All India	4.5	8.5
Recombined milk	-do-	All India	3.0	8.5
Toned milk	-do-	All India	3.0	8.5
Double toned milk	-do-	All India	1.5	9.0
Skimmed milk	-do-	All India	Not more than 0.5	8.7
Full cream milk	Pasteurized, and sterilized	All India	6.0	9.0

Note- Buffalo milk is because buffaloes are more effective at converting beta-carotene — an antioxidant with a distinctive yellow colour — into vitamin A.

Important Points-

- Total Solid, SNF, Fat and Protein is highest in sheep and buffalo milk and water is highest in mare milk, lactose is highest in human milk.
- Fresh milk contains **84–87% water** in which all other constituents of milk are dissolved and in which are dispersed two different systems, namely fat globules enclosed within their protective membrane as an oil-in-water emulsion, and protein, containing casein molecules and insoluble salts in a colloidal suspension.
- Rank of India is 1st in total milk production and 2nd in cow milk production.
- Per year growth rate in milk production is approximately 5%
- The all-India per capita availability of milk is **427 grams per day** in 2020-21.
- National Dairy Development Board was established in 1965 in **Anand, Gujarat**.
- National Milk Day- **26 November**
- World Milk Day- **1st June**
- **Operation Flood and White Revolution** is related to Milk production.
- Milk is good source of calcium, protein, fat soluble vitamins (A,D,E&K), 22 minerals, phosphorus, potassium, zinc, magnesium, phosphorus, iron, sodium, copper, manganese etc. Vitamin C is absent in milk.

Physical Properties of Milk-

Colour and optical properties

Milk appears turbid and opaque owing to light scattering by fat globules and casein micelles. Optical properties are influenced by the manner of scattering of light by the molecules. Light scattering occurs when the wavelength of light matches the magnitude of the particle. Thus, smaller particles scatter light of shorter wavelengths and vice versa. Beta-carotene, the carotenoid precursor of vitamin A, is responsible for the creamy colour of cow milk. The greenish tinge in whey is due to the presence of riboflavin. Refractive index of milk is an optical property and ranges from 1.3440 to 1.3485 at 20ºC.

Flavour of milk

The natural sweet flavour of milk is due to the combined effect of its components. Off-flavours are very quickly developed in milk owing to several factors. The feed consumed by animals may lead to some undesirable flavours. Bacterial growth in milk causes fruity, barny, malty or acid flavours. Enzyme activities also may lead to unnatural flavours, rancidity due to lipase action being a classic example. **Oxidative reactions** may cause a cardboard flavour in milk. Processing of milk may produce cooked flavours.

Specific gravity and density

Milk is heavier than water. The specific gravity of cow milk varies **from 1.018 to 1.036** and of buffalo milk from **1.018 to 1.038**. Though specific gravity varies with temperature, (lower at higher temperature and vice versa), the rate of this variation is not uniform.

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.

Surface tension

The surface activity of milk is related to proteins, fat, phospholipids and fresh fatty acids present in it. Homogenization and heat sterilization increase the surface tension of milk. **Milk has a surface tension of 50 dyne/cm at 20°C.**

Freezing and boiling points of milk

The freezing points of cow and buffalo milk vary **from -0.512 to -0.572ºC** and from **-0.521 to -0.575ºC** respectively. Freezing point of milk is mainly used to determine added water. The boiling point of milk is **100.17ºC.**

Acidity and pH

Freshly drawn milk has a pH value in the range of **6.5 to 6.7** and contains **0.14 to 0.18% titratable acid** calculated as lactic acid. There is no developed acidity in freshly drawn milk, the slightly lower than the neutral pH being attributed to the presence of carbon dioxide, citrate, casein etc.

Heat stability of milk

Heat stability is defined as the length of time required to induce coagulation at a given temperature or the temperature required to induce coagulation in a given time. The stability of milk system at the high

processing temperatures to which milk is exposed for the manufacture of certain products is very important.

Composition of Milk

Factors that influence the chemical composition of milk are individuality of the animal, breed variation, seasonal changes, weather, age and health of the animal, managerial practices including nature and quality of feed, stage of lactation, the quarter of the udder of the animal from which milk is drawn, different fractions of milking etc.

Detection of Common Preservatives, Neutralizers and Adulterants in Milk

Boric acid and borates

When a strip of turmeric paper is dipped into adulterated milk sample that has been acidified, it turns into characteristic **red colour indicating the presence of boric acid** and or its salt.

Formalin or formaldehyde

Formalin is added in milk as a preservative, as it checks the rise in acidity. Acidified milk containing formalin or formaldehyde forms characteristic violet colour with ferric salts and other oxidizing agents. *There are mainly two tests namely Hehner and Lech tests that are commonly followed.*

Hehner test

To 10 ml of the milk sample, 0.5 ml of 10% ferric chloride solution is added. Thereafter, 5 ml of concentrated sulphuric acid is added carefully down the side of test tube to form a separate layer without mixing with milk. **Presence of a violet coloured ring at the junction of two liquids indicates the presence of formaldehyde.**

Lech test
To 5 ml of milk in a test tube is added equal volume of concentrated hydrochloric acid containing 1 ml of 10% ferric chloride solution. The contents are heated over a flame for 5 min and the tube rotated or shaken to break the curd. **Development of violet colour indicates the presence of formaldehyde.**

Hydrogen Peroxide

Hydrogen peroxide acts as an antimicrobial agent thereby, checking the development of acidity. Addition of 2 drops of 2% freshly prepared aqueous solution of paraphenyl diamine hydrochloride to the **adulterated milk sample gives intense blue colour, thus indicating the presence of hydrogen peroxide.**

Neutralizers

Chemicals such as carbonates or bicarbonates are added to milk in order to disguise developed acidity. **Presence of rose red colour indicates addition of sodium hydroxide, potassium hydroxide and/or calcium hydroxide while pink colour points to the addition of sodium bicarbonate, potassium carbonate or calcium carbonate.**

Detection of Common Adulterants

Sugar

Resorcinol produces **red colour** with sucrose in an acidic medium.

Starch

Iodine solution gives intense blue colour with starches. Three ml of well-mixed milk is boiled over a Bunsen burner. After cooling, one drop of 1% iodine solution is added and mixed well. The appearance of an intense blue or bluish violet colour indicates the presence of added starch.

Urea

There are two methods by which added urea can be detected in milk. To 5 ml of well mixed milk sample, 5 ml of para-dimethylamino benzaldehyde solution is added and mixed. **The development of an intense yellow colour indicates the presence of urea.**

In the second method, 5 ml of 24% TCA solution is added to 5 ml of well-mixed milk sample in a test tube. The contents are filtered through Whatman No. 42 filter paper, and 2% of NaOH solution and 0.5 ml of 2% sodium hypochlorite solution are added to one ml of the filtrate. After thorough mixing, 0.5 ml of 5% phenol solution is added. **The development of blue or bluish-green colour indicates the presence of urea.**

Pond water

Several unscrupulous milk vendors dilute the milk with unclean water waterways such as ponds. To detect its presence, a clean test tube is rinsed with 5 ml of milk sample and decanted. Along the side of test tube, **1-2 ml of 2% diphenylamine solution** is added. The appearance of **blue colour** indicates presence of pond water.

Synthetic Milk

In recent times raw milk has sometimes been adulterated with the so called 'synthetic milk' usually prepared out of vegetable oil emulsified with the help of commonly available commercial detergents and other compounds such as urea, glucose etc.

Fat Determination

Gerber method and Rose Gottlieb method.

Hansa Test

To detect presence of **buffalo milk in cow milk.**

Milk Adulteration and Lactometer

- ✓ Adulteration is an unwanted and inferior mixing process in food. The food-added material or material is referred to as adulterants. Water is the most common milk adulterant. A lactometer can detect water adulteration in a milk. The density of the milk decreases when water is added to the milk and this is detected via a lactometer. The less than 1.026 reading of the lactometer shows milk adulterating by water. Adulteration simply signifies mixed impurities and pure means unadulterated.

- ✓ The instrument is composed of a TEST-TUBE and a METER BULB and is very simple to use. To verify the purity of cow's milk a lactometer is used. Milk is poured into and allowed to be able to stand until cream is formed, so milk content is determined by the depth of the cream deposit in degrees. If it's pure, the lactometer floats and the lactometer sink when it is adulterated or impure. Lactometer is a medium for monitoring the pureness of milk samples.

Methods of pasteurization

- **In bottle pasteurization**

In this case bottles filled with raw milk and tightly sealed with special caps are held at **63 to 66 degrees Celsius for 30mi**n. Then the bottles passed through water space of decreasing temperature, which cool both the product and the bottle. One of the advantages is that it prevents the possibility of post-pasteurization contamination.

- **Batch/Holding pasteurization/Low temperature long time method**

In this case the milk is heated to **63 degrees Celsius for 30 min and promptly cooled to 5 degrees Celsius** or below and thus heating is done indirectly. The heat moves through a metal wall into the product for heating, and out of the product for cooling.

- **High temperature short time (HTST) pasteurization**

In this case large volumes of milk are handled and it gives a continuous flow of milk which is heated to **72 degrees Celsius for 15 sec and promptly cooled to 5 degrees Celsius or below.**

- **Vacuum pasteurization**

This refers to pasteurization of milk and their reduced pressure by direct steam. The equipment used is termed as 'Vacreator' and the process hence is known as **'Vacreation'.**

- **Ultra high temperature pasteurization**

This method consists of temperature-time combinations of **135 to 150 degree Celsius for no hold (a fraction of second)**. The success of this method depends on immediate aseptic packaging.

- **Uprization**

Uprization term means '**Ultra- pasteurization'** where in milk is heated with direct steam up to **150 degree Celsius** for a fraction of second and thus the process is continuous.

- **Flash pasteurization 'HTST'.**

The formulation of the standards of pasteurization includes following points.

1.	Bacterial destruction
2.	Cream line reduction
3.	Phosphatase inactivation

MILK

Milk is one of the most basic of all food. Milk constitutes a complete diet and even for adults, cow's milk includes many essential nutrients particularly calcium. SOURCE: Mankind from time immemorial has used the milk of animals. The milk of cow, buffalo and goat is generally used. In some countries milk of

sheep, mare and camel is also used.

Milk represents a major ingredient in our diet- poured over cereals, drunk in glasses, in tea and coffee- but it also enters the composition of many dishes especially desserts such as ice cream, custard, pancakes, rice puddings etc. it is particularly high in calcium, but it is also fairly in fat.

COMPOSITION:

Whole milk – that is, milk comes from the cow- is composed of water (88%), milk fat (3.25 %), other milk solids (protein, lactose and minerals)- 8.25%.

There are many types of milk consumed though mostly it is cow's milk, goat's milk and sheep's milk.

PROCESSING TECHNIQUES:

Processing

From the time it is milked from the animal to the time of sale, milk has to undergo processing to improve the keeping quality and to make it fit for consumption. The various stages are:

1. **Collection**

Milk is brought to the dairy in clean sterilized vessels, preferably stainless steel.

2. **Holding tanks**

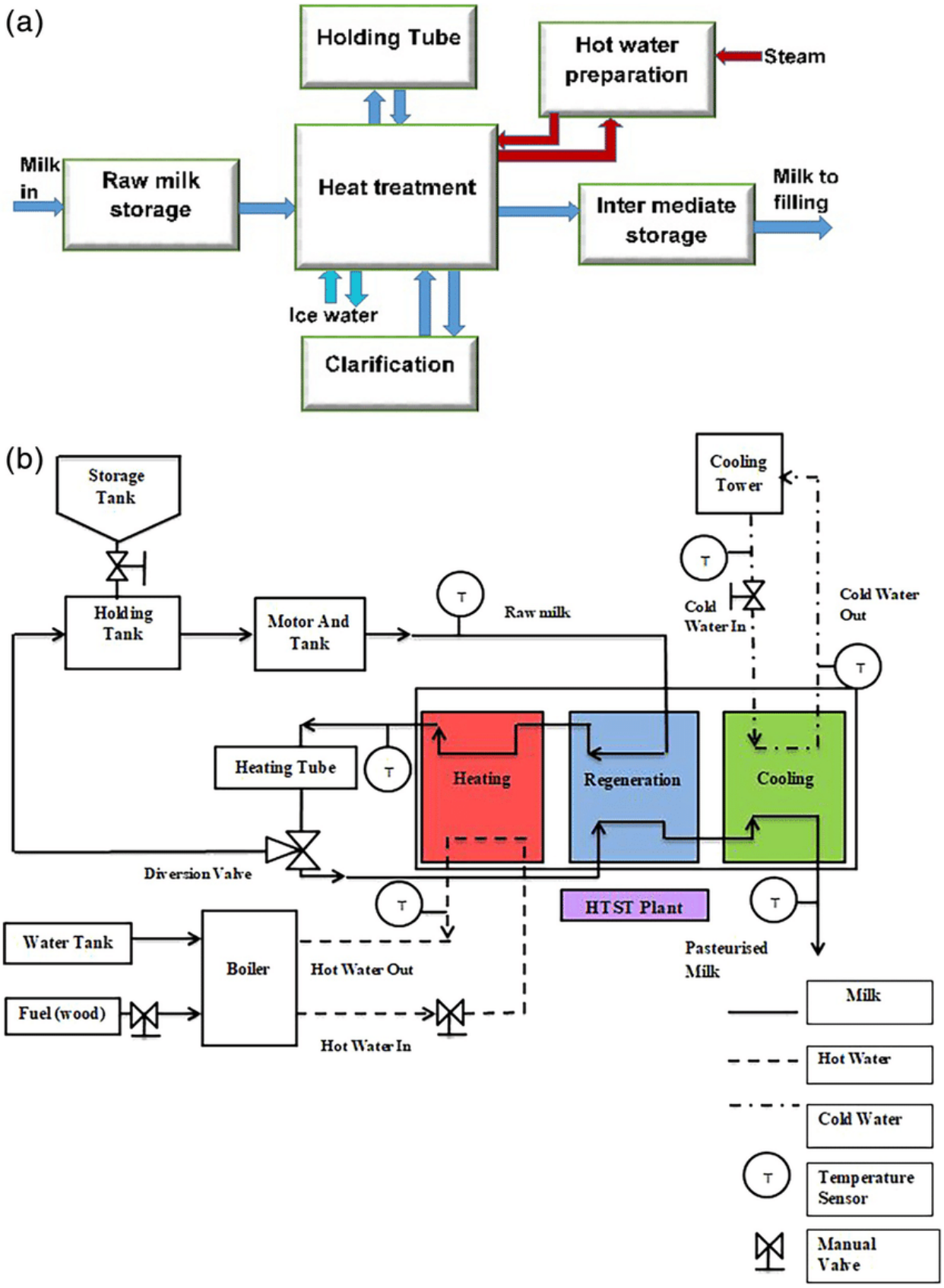
The milk is immediately transferred to holding tanks and is held at 10°C to keep it safe. Cooling is done either in a tank,
jacketed with pipes in which runs a brine solution. Else the milk is run over very cold water pipes.

3. **Filtration**

The milk is passed through a series screens and filters to remove sediment and floating particles.

4. **Pasteurization**

It is the process of heating milk to 63.7°C and holding it at that temperature for 30 minutes. This is known as the "Holder Process of Pasteurization". Nowadays, the **Flash Pasteurization** is more commonly used. It is also called the HTST or High Temperature Short Time method, where the milk is heated to 71.6°C for only 15 seconds. Pasteurization makes milk safe for human consumption by destroying pathogenic germs (pathogens). It also helps to increase the shelf life. Flavors of the milk remains unaffected at pasteurization temperature.


(a)
Holding Tube
Hot water preparation
Steam
Milk in
Raw milk storage
Heat treatment
Inter mediate storage
Milk to filling
Ice water
Clarification
(b)
Storage Tank
Holding Tank
Motor And Tank
Raw milk
Cooling Tower
Cold Water In
Cold Water Out
Heating Tube
Heating
Regeneration
Cooling
Diversion Valve
HTST Plant
Pasteurised Milk
Water Tank
Boiler
Hot Water Out
Fuel (wood)
Hot Water In
Milk
Hot Water
Cold Water
Temperature Sensor
Manual Valve

5. Homogenization

At temperature of 60°C, milk is passed under high pressure through small opening of a machine called homogenizer. The main purpose is to **subdivide the fat globules in milk and disperse them evenly** in the entire mass. Fat has a low density and tends to rise to the surface during heating.

6. Bottling

The bottles of selected and uniform size have to be sterilized by steam and hot water and then they are filled with milk, which are capped automatically. Nowadays milk is filled in plastic pouches and these are more economical, easily transported and save storage space. Plastic pouches are easily disposed and are safe to handle.

7. Sterilization

The sealed bottles are now heated for **30 to 40 minutes at temperatures ranging from 104-110°C in steam chambers called autoclaves and then allowed to cool**. Milk can also be sterilized before bottling. It is subjected to temperatures of 135-150°C for just 1 second. This is called the UHT or Ultra Heat Treatment. This process kills off all microorganisms and the very short holding temperature reduces the changes in colour and lined with aluminum foil. Milk is then distributed through various outlets.

Various types of milk:

1. **Untreated milk**: It retains its entire natural flavor. It is advised to boil for 15 minutes before using. It remains good in refrigerator for 24 hrs.
2. **Pasteurized milk**: To kill bacteria by heating milk or other liquids to moderately high temperatures for a short period of time. Milk must be heated to at least 145°F for not less than 30 minutes or at least 161°F for 15 seconds, and then rapidly cooled to 40°F or lower.
3. **Sterilized milk**: is homogenized milk, heated to about 112ºC under pressure for 15 mins in sealed bottle. The bottle is rapidly pulled to 80ºC and then allows reaching lower temperature.
4. **Skimmed milk**: this is the milk without any fat. Basically it is a fat buster, low calorie produce
5. **Fortified milk**: extra nutrients are added to make the milk more nutritive. Usually, vitamin B is used.
6. **Flavored milk**: flavor and color added. Treated with high temperature of 100ºC for about 15 mins, so that they may be kept later at room temperature.

TONNED MILK: toning is done to make buffalo milk resemble in appearance and flavor to cow's milk. It is done by dilution and addition of skimmed milk powder. 40 % of skimmed milk is added to 60 % of buffalo milk. The addition of skimmed milk powder makes up for the dilution of the nutrients, the fat content remains diluted and equal to that of cow's milk.

Concentrated milk:

Evaporated milk – unsweetened milk, evaporated under reduced pressure and reduced to 60% and canned.

Sweetened milk- same as above but sugar is added before processing. Sugar acts as preservatives also. Milk powder-This is the whole milk from which the water is removed by either spray drying or by drying processes

C**ULTURED DAIRY PRODUCTS:**

Cultured dairy products such as yoghurt, butter milk, and sour cream are produced by adding specific bacterial cultures to fluid dairy products. The bacteria convert the lactose to lactic acid, giving the products their body, and tangy and unique flavor.

WHOLE MILK: It comes as pasteurized & has fat content of 3.9 %.

Cream

Cream is the butter fat content of whole cow's milk, separated from the water.

Cream is commercially separated from milk in a creamery, by means of a mechanical separator. The milk is first heated to between 32-49°C (90-120°F) before being run into the separator which operates like centrifugal machine, rotating at very high speed and forcing the milk, which is heavier, to the outside; while the cream, which is lighter, remains at the centre. The cream and the skimmed milk are drained out through separate outlets and by means of a control valve, the fat content is adjusted. The skimmed milk is then heated to 79.5°C (175°F) to kill off any harmful bacteria before being further processed into dried milk etc.

The principal difference between the various types of cream -single cream, double cream, whipping cream, clotted cream and soured cream - is the balance between water and butterfat. This will make them liquid or of a very thick consistency.

Other differences are in the way they have been made and their time for maturing which results in different tastes. Cream has a slight yellow or ivory color and is more viscous than milk. Cream is used in kitchen to give flavor and body to sauce, soups and desserts.

Single Cream: contains **not less than 18% butterfat**. It cannot be whipped due to their being too little butterfat.

Double cream: contains **not less than 45% butterfat**. It can be whipped but not too much as it will turn to butter. It can be used to enrich sauces, but may curdle if boiled along with acid ingredients.

Whipping Cream: containing **not less than 38% butterfat**. It is perfect for whipping as its name indicates. After whipping you will find a difference in texture and a change in volume. Sweetened or unsweetened cream can be used in desserts or can be used as an accompaniment, and is incorporated in mousses to lighten them.

Clotted Cream: contains **not less than 55% butterfat**. It is already very thick so it can be used as it is and not whipped. Soured Cream: These are single creams which contain about 20% butterfat, but have a souring culture in them, and they are matured.

Half and Half: is a mixture of milk and cream in equal quantities and contains about **10-12% butterfat**.

Manufactured Cream

1. Reconstituted Cream

2. It is made by emulsifying butter with skimmed milk or skimmed milk powder. This is not true cream, but a substance which resembles it in appearance.
3. Imitation or Synthetic Cream
4. It is made by the emulsification of vegetable fats with dried egg and gelatin, and then sugar and flavourings are added. It is a product which is frequently used in catering and baking trade, but which is very easily contaminated and liable to cause food-poisoning.

Cheese

Cheese is the curd of or the fresh or matured product obtained by enzyme activity and subsequent separation of whey by drainage, after coagulation of milk, cream, partly skimmed milk, butter milk or a combination of these bases.

The present word cheese is derived from the old English word "Cese" and "Chiese" from the Latin "Caseus". The equivalent words in German" Kase", and French "Fromage", in Spain it is called "Queso", and in Italy "Fromaggio".

The ingredients used for the manufacture of cheese making are Milk, starter, colour, added chemicals, coagulates, salt.

COMPONENTS OF CHEESE MAKING

Milk - The various cheese of the world first owe their character and taste to the type of milk used - double cream, toned, or skimmed milk. The character also greatly depends on the animal the milk came from - cow, goat, ewe, or water buffalo.

Starter - If left in a warm place, milk will sour by itself. This souring is due to the action of bacteria on the milk sugar, lactose, and its conversion to lactic acid or sour milk. To speed up the process of souring and to prevent the milk from becoming bitter and unpleasantly sour, a little warm sour milk from the previous day's milk is added to this batch. This speeds up or starts the process of coagulation, and is known as the starter or starter culture. In the case of pasteurized milk, all bacteria is killed, and hence the starter consists of a combination of cultures grown in the lab.

Rennet - Although the starter culture speeds up the process of souring milk, and would eventually cause it to curdle, it produces quite a sharp, acidic taste. The use of rennet, which is an enzyme from the inner lining of young hoofed animals like lambs and calves, significantly improves the product. Rennet also helps break down the curd into a smooth, even consistency, contributing to the texture and flavor.

TYPES OF CHEESE

1. Fresh Cheeses

Fresh cheeses are usually made by setting the curd with **starter and rennet and are high in moisture**. The young curd is placed in sacks or perforated containers and drained slowly without pressure for a few hours so that the curd retains much of the whey. Once sufficient whey has been drained off, the curds are either mixed or sprinkled with salt. They are now ready to be eaten. For some cheese, like from age fares, the rennet is not added. Such cheese are called 'lactic cheese'. Some fresh cheeses are allowed to mature and grow either a white or bluish grey mould.

Fresh cheeses are always mild and high in moisture and therefore low in fat. They have a slightly acidic or lactic taste. Most are used for cooking but some may be wrapped in leaves or dusted with paprika or fresh herbs for serving as a table cheese.

2. Soft Cheeses

The curd is ladled gently into perforated moulds and left to drain in an atmosphere of high humidity so that the curd does not lose too much whey. After a few hours, the cheeses are turned out of their moulds and left to mature for a few weeks. Their high moisture content, coupled with high humidity, attracts and encourages the growth of classic white pencillium mould, which helps to break down the curd and contribute the flavour and texture of the cheese. The result is a creamy, smooth, interior that looks as though it is almost ready to run.

3. Semi-hard Cheeses

To obtain a firmer cheese, the curd is cut up to release some of the whey before the curd is placed in the moulds. It is then often lightly pressed to speed up the draining. After a day or so, the cheese is turned out of its mould and washed in brine. This seals the rind before the cheese is placed in cellars or ripening rooms where moulds are encouraged to grow.

The lower moisture content means the fermentation process is slower, producing cheeses with a round, full bodied, rather than strong flavour. Their taste often seems to be embodied with the oils and esters of the wild mountain flowers of Europe. When young, semi- soft cheeses have a firm yet springy, school eraser texture, becoming elastic and supple.

4. Hard Cheeses

To make a hard cheese, the curd must be cut more finely - from small cubes to rice-sized pieces. - The smaller the pieces the more whey will be lost from the curd. The curds are then gently heated in a vat to force out more moisture before the whey is drained out. Salt is then added to the curd, which now resembles rubbery, lumpy cottage cheese. They may be cut again before being placed in large, perforated moulds that are frequently engraved with the unique symbol, logo, pattern or name to identify the finished cheese or its maker. This is then sealed and left to mature for weeks or even years. Hard block cheeses are pressed into shape and then matured in special plastic wrap that allows the cheese to age without the development of either mould or rind. The moisture that would normally be lost during maturation is also retained.

5. Blue Cheeses

Blue cheeses are neither pressed nor cooked. Most frequently the curd is crumbled, eliminating much of the whey, then scooped into stainless steel cylindrical moulds, each with a wooden disc on top. The curd remains in the moulds for one to two weeks and is churned frequently to let the weight of the curds to press out more of the whey. Once the cheeses can stand up on their own, they are removed from the moulds, rubbed with salt, and returned to the cellars.

The process of making cheese can be divided into three fundamental steps. The first is the precipitation of casein into curd. Bacteria that produce lactic acid are infused in to the warm milk to obtain an adequate acidity for the action of rennet and to crowd out less desirable organisms. Then , rennet is added , which causes the caseins to aggregate ,trapping fat globules and whey in the protein network.

The second stage is the concentration of curds .Any free whey is drained off. The curds are cut, pressed, cooked and salted to remove much of the rest.

The final stage is the ripening or ageing of the green curd. It transforms the initially produced bland and either crumbly or rubbery curds into a smooth substance with a pronounced and complex flavour. Ripening is mostly a matter of molecular breakdown caused by the enzymes of microbes , both the original starter bacteria and special ripening organisms.

Preparation of cheese

Preparation of milk

Milk is one of the prime ingredients for making cheese, it is a high protein dairy product made from the milk of animals like cows, sheep, goat, buffalo, yak etc.

Prior to manufacture process, milk needs to be prepared; this is done by pasteurizing the milk, homogenizing it and then clarifying it.

Addition of starter
This is done by two methods:

In ***sour milk cheese*** lactic acid bacteria thickens the milk
In ***sweet milk cheeses*** (most cheeses are of this kind), which are also called *rennet cheeses,* the cheese maker adds rennet- an enzyme taken from the stomach of suckling calves to separate solids in the milk from the fluid.

The rennet causes the milk protein to build up and the milk to curdle without the milk turning sour.

Formation of Coagulum
Addition of starter leads to coagulation of milk into a thick mass called 'young curd' and separation of whey.

Cutting
Firm curd is cut into smaller pieces by use of knives or chains.

Stirring/ Scalding
This process is also carried out for hard cheeses. It expels more whey and shrinks the curd.
This process also speeds up the bacterial metabolism.

Salting

Salt is added into the cheese by wet or dry method as per the recipe. Brining in some cheeses also leads to longevity in shelf life

Moulding or Vatting and Pressing

After salting cheese is put in moulds for it to acquire a particular shape. This can be done in plastic or wooden moulds.

The cheese is pressed which gives it a definite shape. In case of blue chesses pressing is not done.

Finishing

Cheese is de moulded and a rind or coating is given to the cheese. In some cases rind is dried by rubber ash, use of grape must and wrapping it in leaves. Such as Gorgonzola which is coated with plaster of Paris

Ripening/ Maturing
Mostly the harder cheeses are matured. They are matured in caves. A hard cheese can take anything from 8 weeks to a year to ripen and mature.

Famous Cheeses of the world English
Cheddar
Often called American cheese, but it is English and made in the Cheddar Gorge region in Somerset.

Stilton
Considered the "King of Cheeses" and is the best of all English blue cheeses and can take its place confidently alongside the world famous Roquefort in France and Gorgonzola from Italy.

Italian
Parmesan Another well-known flavourer of salad dressings and sauces. It is a hard ripe cheese with a piquant and sharp flavour.

Gorgonzola
Originally produced near Milan in a town called Gorgonzola, from full cream pasteurized cow milk. It has a sharp and spicy taste which is an excellent contrast to the creamy texture of the cheese.

Mascarpone
It is described as curd cheese. Serves as a very good alternative to double cream cheese in tiramisu.

Bel Paese
Another delicious cheese from Italy, which is soft and yellow, sweetish and very mild. Made from pasteurized milk.

Dolcelatte
It is a famous sweet cheese from Italy

Mozzarella
Mozzarella is one of the most famous Italian cheeses, it is used more to give finish to a dish rather than taste. It is a creamy cheese made from Buffalo milk.

Parmigiano - Reggiano
It is a hard cheese with orange rind. It has a strong and fruity aroma, but not over powering. Used in sauces, salads and over pasta and risotto.

Ricotta
Is a soft, moist yet firm cheese.

French Brie and Camembert
Most French cheeses are soft and the luxury end of the scale is two dessert cheeses Brie and Camembert-both almost sauce soft. But an odour of ammonia will tell you when they are past their prime.

Roquefort

Comes from the region of Rouergue of France.
It looks like marble, for its noble paleness is patterned with blue veins and patches. It is made from sheep's milk that is full cream and unpasteurized. Is used for blue cheese dressing for salads.

Reblochon
It has a creamy and supple texture. It has a yellow orange rind with a white mold. The elastic smooth creamy dough has a pleasantly mild taste somewhat reminiscent of hazelnut.

Boursin
Boursin is a soft fresh cheese it comes from Normandy region in France. This is a moist and creamy cheese, it melts in the mouth.

Neufchatel
Comes from Normandy region in France.
It is a soft white cheese with a grainy texture.
It has a slight taste of mushroom and is salty and sharp.

Greece Feta
This is a goat cheese from Greece made from goats or sheep's milk and is an integral part of Greek cuisine.

Swiss Emmenthal
Emmenthal cheese is equated with Swiss cheese all over the world. It is made of raw cow milk and with the addition of rennet. It is a mild cheese with a nutty aroma.
Gruyere
Another delicious cheese from Switzerland, which also has holes though, they are much smaller.

Edam
Named after the small port of Edam, north of Amsterdam, it is a pressed, semi soft cheese of Holland.

Gouda
It accounts for more than 60% cheese in Holland. Gauda is firm, smooth and supple cheese; it has a sweet and fruity flavour. Also had as a breakfast cheese.

CHEESES OF THE WORLD

CHEESE	TYPE	COUNTRY	MILK
Cottage	Fresh	Universal	Cow, goat, buffalo
Cream	Fresh	Universal	Full cream milk of cow, goat, buffalo
Mozzarella	Fresh	Italy	Cow, buffalo
Ricotta	Fresh	Italy	Cow
Feta	Fresh	Greece	Ewe, cow, goat
Quark	Fresh	Germany, Austria	Cow
Barbery	Soft	France	Cow
Bel Paese	Soft cream	Italy	Cow
Brie	Soft	France	Cow
Camembert	Soft	France	Cow
Bonchester	Soft	Scotland	Jersey Cow
Munster	Soft, with orange red rind	France	Cow

Stracchino	Soft	Italy	Cow, buffalo
Appenzeller	Semi hard with pale yellow or burnt orange rind	Switzerland	Cow
Caerphilly	Semi-hard with buttermilk flavor	Britain	Cow
Cantal	Semi-hard	France	Cow
Cheddar	Semi-hard	Britain	Cow
Cheshire	Semi-hard	Britain	Cow
Chevre	Semi-hard	France	Goat
Danbo	Semi-hard, caraway flavored, square cheese	Denmark	Cow
CHEESE	TYPE	COUNTRY	MILK
Derby	Semi-hard	Britain	Cow
Edam	Semi-hard with yellow or red wax rind	Netherlands	Cow
Emmenthal	Semi-hard	Switzerland	Cow
Esrom	Semi-hard, with red rind	Denmark	Cow
Gloucester, Double Gloucester	Semi-hard, full cream	Britain	Gloucestershire cow
Gouda	Semi-hard, with yellow or red rind	Netherlands	Cow
Gruyere	Semi-hard, with pea size holes	Switzerland	Cow
Havarti	Semi-hard	Denmark	Cow
Jarlsberg	Semi-hard, with yellow coating	Norway	Cow
Lancashire	Semi-hard	Britain	Cow
Leicester	Semi-hard	Britain	Cow

BUTTER

Butter is fatty substance obtained from churned cream, containing 80% fat, 20% water and whey (milk solids lift from separating process).

- Butter hardens at low temperature and melts when heated.
- **The smoking temperature of butter is 127ºC.**
- Color varies form creamy white to golden yellow. It is the milk protein in the whey that makes butter spoil quickly.
- Most of the butter is made from cow's milk but other are some butter made from the milk of buffalo, yak, goat and sheep is also available.

Processing / manufacturing of butter-

1. **HOLDING:** Cream is pasteurized for 2-4 seconds at 95º C and then the temperature is lowered to 4-5º C and that is kept for several hours to ensure uniform hardening of fat particles.

2. **RIPENING:** When the end product is going to be Lactic butter, only then this step is carried out, in which bacterial culture is added. In this case, the holding temperature will be 15-18º C for 3-4 hours before being cooled to 4-5º C. This gives butter a good flavor and the stage is omitted while making sweet cream butter.

3. **CHURNING:** It is carried out in big stainless-steel containers holding about 100 gallons of cream and the internal churners pass through the cream. This breaks the layer of fat solids which are released and are combined to form a large group of butter fat. After about 30 minutes of churning the butter gets separated from butter milk and floats to the surface.

4. **WASHING AND SALTING:** The butter grains are now washed with ice cold water to remove any butter milk left on the surface of each grain, in order to maximize the keeping quality.

Salting is carried in two ways:

- By adding fine grains of dairy salt.
- By dipping butter grains into brine solution (salt + vinegar) for 10-15 minutes and allowing the butter grains to absorb it.

Types of butter :

There are two types of butter-

1.	Sweet cream butter
2.	Lactic butter.

Butter can be made from any kind of milk. In India, butter is made from buffalo milk. Sweet cream butter : it is also known as fresh cream butter and is made from unripened cream. It can be salted or unsalted. It is soft, creamy texture and a creamy buttery taste.

Lactic butter : This type of butter specially made in Denmark, Holland and france. The cream is mostly pasteurized, inoculated with a culture that ripens the butter, then pasteurized once more to arrest the ripening process.

Note: Unsalted butter /sweet butter- it has mild aroma and slightly sweet flavor, used for making sweet pastries and cakes.

Salted butter –butter was originally salted to preserve it for the winter months when fresh butter was not made. Today salted is added to butter as ingredients. It is not ideally used in preparation of pastries.

Compound butter : these are made by adding a particular natural flavor or color to butter, depending on the type of food with which it is served. It is generally used as an accompaniment e.g. Lobster butter, parsley butter etc.

GHEE

Ghee is obtained by **clarifying butter**. Butter is heated to evaporate water. Pure ghee has a higher keeping quality and is a good cooking medium and shortening agent used in Indian cuisine.

Quality of ghee-

Consumer judge the quality of ghee base on its inherence flavour, colour and appearance. Ghee should have characteristic pleasant, nulty, slightly cooked rich aroma. Ghee flavour is best described as lack of blandness, sweetly rather than acid. Golden yellow to light yellow colour of ghee is appreciated largely. Granular appearance of the product rather more score as it is important quality as well as purity preventer of ghee.

Apart from above sensory characteristics, its chemical and other physical preventers are evaluated to judge the quality of ghee and also to prevent adulteration of ghee.

(i) Refractive Index: It is the ratio of the velocity of light in vacuum to the velocity of light in the sample medium. In case of milk fat reading is normally made at 40 degree C using Abbe refractometer and its values range from 1.4157 to 1.4566. This value is low in comparison to the other fats and oils. The RI if ghee is influenced by both the molecular weight and the degree of saturation of the component fatty acids. RI could be used as indicator of adulteration.
(ii) Iodine Number: It is defined as number of grams of iodine absorbed by 100 g of fat under specified conditions. Thus constant is a measure of the unsaturated linkages present in a fat. The iodine number for milk fat falls within the range of 26 to 35 which is low in comparison to other fat and oils.
(iii) Reichert-Meissl Number (RM Number): This is defined as number of ml of n/10 Sodium hydroxide required to neutralize the steam volatile water soluble fatty acids distilled from 5 g of ghee under precise conditions specified in the method. It is primarily measure of butyric acid and caproic acid. The value for milk fat ranges between 17 to 35 and it is above that of all other fats and oils. Therefore, milk fat contains more of these acids than any of the fats.
(iv) Polenske Number: It is defined as number of ml of N/10 Sodium hydroxide required to neutralize the steam volatile water insoluble fatty acids distilled from 5 g of fat under precise conditions specified in the method. Caprylic acid, capric acids which are somewhat steam volatile but longely insoluble in water are indicated mainly in Polenske number and it ranges from 12 to 24 for milk fat.
(v) Saponification Number: It is defined as the number of milligrams of potassium required to saponify one gram of fat. The value ranges from 210 to 233 and more often falls in the range of 225 to 230. This constant is an indication of the average molecular weight of the fatty acid present. Saponification value is more useful in detecting the presence of minerals oils in ghee as they are not acted upon by alkali and such a sample does not form a homogeneous solution on saponification.
(vi) Melting Point: Melting point for milk fat ranges from 30 degree to 41 degree C as reported in literature.

Adulteration of ghee in India is more prevalent especially in unorganized sector. Being the most expensive fat people started to adulterate the product to make profits. Major adulterants of ghee are as follows:
i**). Vanaspati (Hydrogenated vegetable oil). Because of close resemblance in its texture most commonly used this as adultrant to ghee.**
ii). Refined (de-odourized) vegetable oil.
iii). Animal body fat.

Government has made it compulsory that all Vanaspati must contain a maximum of 5% of Sesame oil which can be identified in ghee by a simple colour test (known as Baudouin test). By means of this Adultration of ghee with Vanaspati ti an extent of 3% can be detected.

CURD/DAHI

Dahi is a dairy product which is obtained when pasteurized milk or boiled milk is soured using previously cultured milk or by using lactic cultures. Pasteurised milk is cultured with *Streptococcus or*

Leuctonostoc bacterias and remain undisturbed after sealing for 15-20 hours at 22-26 degree Celsius to reach acidity of 0.9.

RABRI

It is prepared concentrated and sweetened product comprising of several layers of clotted cream. The layer of cream formed, as a skin is continuously removed. When the milk is reduced to 1/3 of the original volume, sugar is added and the layer of cream skin is mixed.

KHOA

Khoa is a partially dehydrated whole milk product.

PANEER

Paneer refers to the indigenous variety of rennet-coagulated, small-sized, soft cheese.

CHHENA

Chhena, also called paneer in certain parts of the country, constitutes one of the two chief bases (the other being khoa) for the preparation of indigenous sweetmeats. Chhana refers to the milk-solids obtained by the acid coagulation of boiled hot whole milk and subsequent drainage of whey. The acids commonly used are lactic or citric, in both natural and chemical forms. It should not contain more than 70% moisture, and the milk fat content should not be less than 50.0 per cent of the dry matter.

Please check the below table giving a complete overview of all the tests performed on the aforementioned dairy products:

Material Test	Tests Performe	Test Method
Milk Powder,	Moisture/ Water	IS:1165-1992/ IS:13334-1998
	Total solids	
	Acidity	
	Fat	
	Protein	
Fresh Milk	Total solids	IS: 13688-1999
	Total fat	
	Solids not fat	
	Protein	
	Sugars	
Pure (Deshi) Ghee	Loss on Drying	IS: 13689-1992
	Acidity/F.F.A.	
	BR Value	
	RM Value	
	Polenske Value	
	B.T. Test	
Butter Pasteurised	Loss on drying	IS: 13690-1992
	Fat	
	Acidity	
	Curd	
	Salt	
	Colouring matter	

Various Milk Tests

Milk Testing – Clot on Boiling Test (COB)

Objectives: *To determine the stability of milk for heat processing.*

If 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 caseinate salt. Hence it is essential to know the heat stability of incoming raw milk for further processing.

Milk Testing – Sediment Test

Objective: *To know the extent of visible dirt present in the milk as a mark of clean milk production.*

Sediment test of raw milk will reveal the extent to which visible insoluble matter has gained entrance in the milk. It is a rapid test indication quantitative measure of carelessness in handling the milk and lack of sanitation. But in milk that appears as visible or insoluble sediment is always associated with relative number of microbes. The test is carried out by allowing a measured quantity of milk to pass through a fixed area of a filter disc and comparing the sediment with the prescribed standards.

Milk Testing – Alcohol Test

Objective: *To detect abnormal milk such as colostrum or mastitis milk.*

The alcohol test is used for rapid assessment of stability of milk for processing particularly for condensing and sterilization. The alcohol test is useful as an indication of the mineral balance of milk and not as an index of developed acidity. The test aids in detection abnormal milk such as colostrum, milk from animals in late lactation, milk from animals suffering from mastitis and milk in which mineral balance has been disturbed.

Milk Testing- Resazurin Test

Objective- *To check quality and consistency of the milk.* It also determines the bacteria that are present in the milk. 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 colour to the milk that is all based on the quality of the milk. The milk quality is considered by only noting the colour change degree of the milk.

Through an earlier report, it is found that this test is particularly a chemical indicator that can determine the sanitary quality of the bulked milk. This test is also used to conclude more prominent information on milk quality. This test takes place in an isolated laboratory and there is no point of compromise at the time of the test in the laboratory at any cost. The blue colour of the milk suggests the perfect character of the milk after testing the milk.

Milk Testing – Platform Tests

Objectives: *For examination of milk by adopting rapid test for acceptance / rejection of incoming milk.*

Platform tests include the tests for judging the quality of the raw milk.

These are:

(a) organoleptic evaluation (OE),
(b) Clot on boiling test (COP),
(c) Alcohol test (AT),
(d) Sediment test (ST)
(e) Resazurin test (RT).

The milk is collected from various sources and transported to milk scheme for processing, marketing and distribution. Large quantity of milk is supplied to the plant through different agencies, so that is subjected to check for its suitability. Hence it is essential to examine the milk by using different platform tests.

Milk Testing- Alkaline Test

Objectives: *To verify if the heating process of pasteurization is done correctly.*

The alkaline phosphatase (ALP) is an enzyme normally present in raw milk and it is inactivated in conditions of heat treatment. The temperature of inactivation of ALP is slightly higher than that required for the destruction of pathogenic bacteria. So, the ALP test in pasteurized milk is used to verify if the heating process of pasteurization is done correctly.