MILK

Milk may be defined as:

- Secretion of the mammary glands intended to nourish the young one.
- Secretion derived from complete milking of one or more healthy milch animals. It should be free from colostrums. It shall confirm to standards prescribed under the Act according to class (It should not contain less than a certain prescribed amount of fat and SNF.). According to PFA act milk could be included in any of the class such as Buffalo milk, Cow milk, Goat milk, Sheep milk, Standardized milk, Reconstituted milk, Recombined milk, Toned milk, Double toned milk, Skimmed milk
- Clean lacteal secretion obtained by complete milking of one or more healthy milch animals, properly fed and kept excluding that obtained within 15 days before and 5 days after calving. It should not contain less than a certain prescribed amount of fat and SNF.
- Complex chemical substance in which fat is present in the form of an emulsion, protein and some mineral matter in colloidal form and lactose together with some minerals in the true solution form, in a continuous phase of water.
- Dietian-milk as nearly most perfect food. It means that milk contain more or less all the nutrients which are required for the normal growth and maintenance of the human beings. It nourishes the young one to some extent full up to 6 months of the age because the newly born young one possesses the reserve store of the nutrients in the body which is gradually exhausted in about 6 months period. After this age when a child is kept entirely on milk he may suffers with certain nutrients deficiency diseases such as anemia (Iron), goiter (Iod) & scurvy (vit. C).

One litre of milk supplies the following daily requirements for human beings

Calcium	**100%**	**Vitamin A**	**30%**
Phosphorus	**67%**	**VitaminB1**	**27%**
VitaminB2	**66%**	**Vitamin C**	**19%**
Protein	**49%**	**Iron**	**7%**

One litre of milk supplies 20% daily energy requirements for human beings

Composition of milk of different species

Species	Protein (g)	Fat (g)	Carbohydrate (g)	Ash (g)
Cow (Exotic)	3.2	3.7	4.6	0.7
Cow (Indian)	3.4	4.4	4.8	0.7
Human	1.1	4.2	7.0	0.1
Buffalo	4.1	6.6	5.0	0.7
Goat	2.9	3.8	4.7	0.8
Sheep	5.2	7.0	4.8	0.9
Camel	4.0	3.1	5.6	0.8
Donkey	1.9	0.6	6.1	0.5
Elephant	4.0	19.5	5.3	0.7
Whale	10.9	42.3	1.3	1.0

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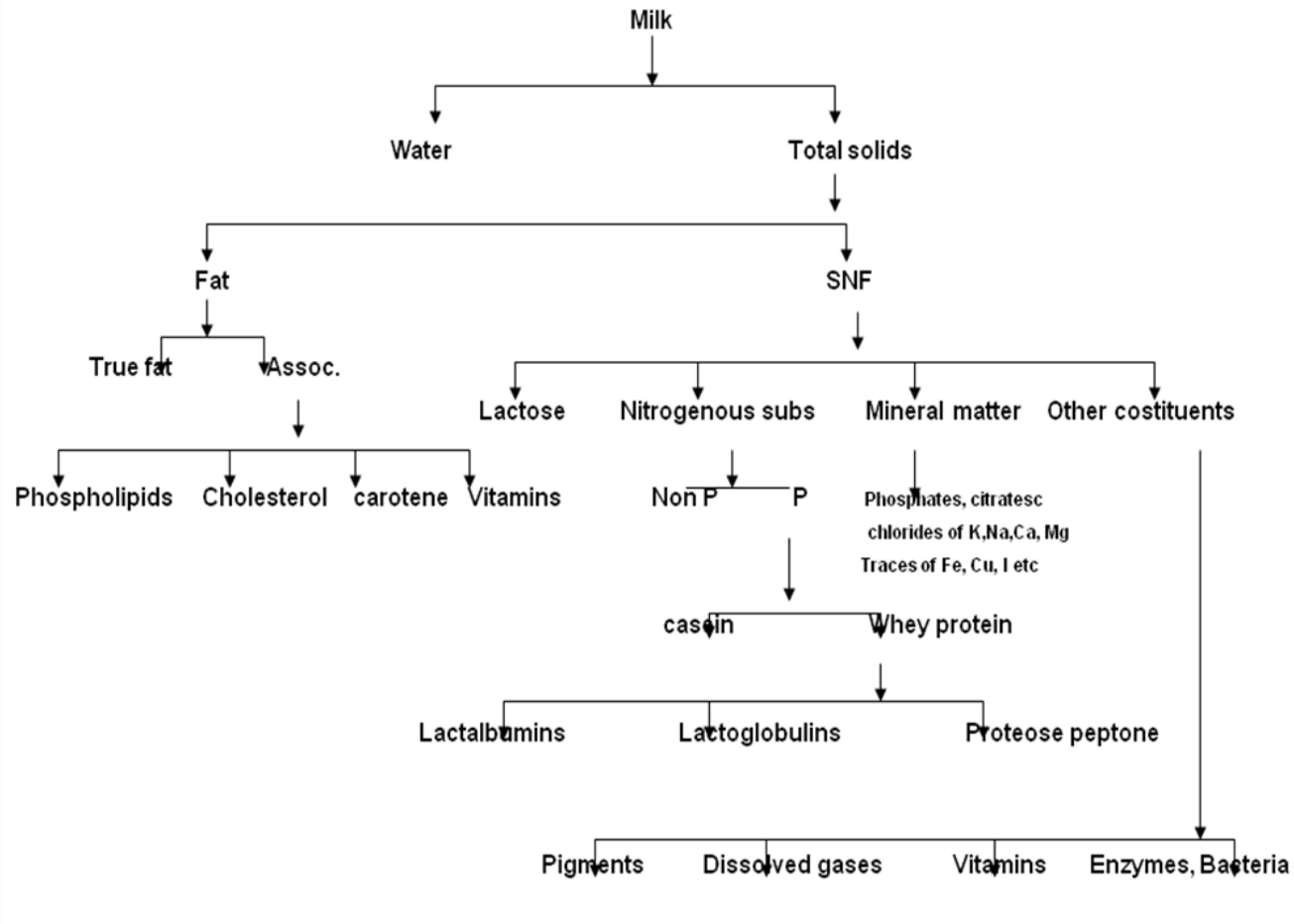
Seal	10.2	49.4	0.1	-

MILK COMPOSITION Milk is composed of large variety of substances. The major constitutes are a) water, b) lipids, c) lactose, d) proteins, e) mineral matter. The minor constituents are enzymes, pigments, vitamins etc.



WATER

The percentage of water in cow's milk is around 87-88. It gives bulk to milk. The other constituents of milk are either suspended or dissolved in it and thus it acts as the dispersing medium. Proteins bind a very small quantity of water and the reset is in free state.

Milk lipids/milk fat

These are the costliest item of our diet. Apart from providing calories, essential fatty acids are fat-soluble vitamins; they play a vital role in imparting rich and pleasing flavour to the dairy products. Lipids are defined as esters of fatty acids and related compounds. Lipids are classified as simple, compound or derived lipids. Single lipids are esters of fatty acid with alcohol. If the esterification is with glycerol the lipid is known as fat and if the esterification is with long chain alcohol, the lipid is known as wax. Compound lipids contain other matters in addition to fatty acids and alcohol e.g. phospholipids, glycolipids etc. Derived lipids are substances which are derived from simple and compound lipids e.g. fatty acids. Milk lipids can be classified into a) true fats (b) fat associated substances. True fat is mixture of so many complex triglycerides. All other substances associated with it are known as fat associated substances. True fats constitute about 98-99% of the total milk lipids, while fat associated

substances constitute about 1-2 % only and so the milk lipids are generally, simply known as milk fat.

Fat in milk is present in the form of fat globules the size of which ranges between 0.1 to22.0 microns, depending upon the species, breed and stage of lactation of the animal. The range for cow milk fat globule is generally 1-5 micron while for buffalo milk it is generally 3-8 microns. The surface of fat globule is bound by a fat globule membrane, which is composed of phospholipids, and proteins bound together in the form of a complex. Thus, it is evident that a major portion of milk lipids is true fat and it is located in the fat globule. Specific gravity of milk fat is around 0.93 and thus it is lower then that milk (S.G.-I.030), therefore, it tends to rise to the top of the milk to form a cream layer. Larger the fat globule, faster is the rate of rising.

Phospholipids

Phospholipids of milk are of 3 types viz. Lecithin, cephalin and sphingomylein Lecithins constitute about 50% of phospholipids, Phospholipids are fat soluble as well as hydrophilic. They are responsible for maintenance of emulsion phase of fat in milk. They form metallic proteinates when come in contact with metals and thus expose the milk fat in the fat globule to oxidation by these metals.

Sterols

Cholesterols is the principle sterol of milk. It differs from phytosterols found in plants and thus presence of phytosterol in ghee sample will indicate adulteration with vegetable fats. Now a days it is believed that cholesterol causes narrowing of LUMEN of the arteries in body thereby causing blood pressure and heart attacks.

Vitamins

Vitamin A, D,E, and K are found associated with fat in milk.

Proteins

Proteins are polymers of Alpha-amino acids and on hydrolysis they yield amino acids. Proteins are imp. from nutrition point of view. They serve as building blocks in the body and are used in repair works also. The 4 basic elements of which proteins are composed are C, H, O and N. In some proteins S and P are also found. As many as 20 amino acids are found to occur in proteins in nature and out of these, barring hydroxyl proline, all the rest 19 are found in milk.

Proteins are generally divided into albumins and globulins according to their solubility. Albumins are soluble in water and dilute salt solutions but globulins are insoluble in water and dilute salt solutions but globulins are insoluble in water but soluble in dilute salt solution. The %age of N in milk is 0.5% and out of it 95% is in the form of proteins and 5% in the form of non-protein nitrogen. Proteins of milk can be divided into 2 categories depending upon their % weight in milk.

i) Major proteins: 2) Minor proteins: Casein and whey proteins are major while enzymes, protease, peptones, and other proteins being in very minute quantities are minor proteins. Nearly 3/4th of the total proteins in milk is casein. If casein is coagulated from milk, the remaining proteins in whey are known as whey protein. They are lactalbumins and lactoglobulin.

Casein

It is synthesized by mammary glands and in nature it occurs only in milk and so it is known as milk protein. In milk, it exists in the form of calcium-caseinate-phosphate complex. Significant quantity of calcium and phosphate and some quantity of citrates and Mg are cow milk casein not only quantitatively but qualitatively also. Casein is not coagulated on boiling. Casein has many uses like in paper, points, plastics, etc.

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Lactalbumins

They resemble the blood albumins but are not identical. They are soluble in water and in milk, their conc. is around 0.30% they are coagulated by general heat treatments but not by acid or rennet. Their coagulation starts at 65^0C and at boiling point they are completely in insoluble form. Lactalbumins are composed of 3 major fractions (1) Beta-lactoglobulin-5-6 of total lactalbumins (2) alpha-lactalbumins 15-20% of total lactalbumins (3) Blood serum albumins – 5-6% of total lactalbumins. The remaining minor fraction comprises of a large variety of other proteins. The alpha-lactalbumin is quite rich in tryptophan.

Lactoglubulins

These are identical to blood serum globulins and are soluble in water. They are coagulated by heat and at 72^0C their coagulation is total. In colostrum, they are present in large quantities and help in transfer of passive immunity from mother to child. Their conc. in normal milk is around 0.1% but in colostrum, it can be as high as 5-10% and so important in the development of immune system. It serves as the "FIRST VACCINE" to the new born.

Colostrum globulins can be further be identified as Euglobulins (true) or pseudoglobulins. Milk proteins are complete proteins and furnish all essential amino acids to our body. Milk proteins have a property to get hydrated and this property is of importance in storage of dried milk products like milk powder or ice cream mix. etc.

Non-protein nitrogen

The 5% of the total nitrogen of milk is distributed in so many NPN substances like uric acid, urea, creatine, ammonia etc. It is believed that these substances and filtered into milk along with globulins. Under stress conditions or physiological disorder the conc. of these substances in milk is slightly increased.

Lactose

It is synthesized by the mammary glands and occurs in nature in milk only and so called as milk sugar. It is about $1/5^{th}$ as sweet as sucrose. It is a disaccharide and on hydrolysis yields one. Molecule of glucose and one of galactose. It plays an important role in colour and flavour of highly heated milk products. If the lactose crystals are large in milk product they give sandy sensation when consumed. Prolonged heat treatment causes browning of milk or milk products because lactose binds with amino group of proteins to form brown pigments (Maillards Reaction). Lactose is important for the development of cerebrocide tissues of brain. Some persons are intolerant to milk because of they are deficit in lactase enzyme in their intestine body which is responsible for break down of lactose.

Mineral matter

Mineral salts: These are different organic and inorganic salts present in milk. They are represented fairly by ash%. These salts are present either in the true solution phase of in colloidal phase, attached with the proteins. The major salts in milk are calcium, phosphates, citrates, sulphates, chlorides, copper sodium and bicarbonates. All others are present in minutes or trace quantities studies of salts of milk is important because they are nutritionally important and more over influence the stability of milk protein. Conc. of salts very with many factors like feed, stage of lactation, disease, etc.

The variation is more in calcium, phosphate and chloride than others. In the beginning of lactation the conc. of sodium, magnesium, chloride, calcium and phosphate is more and potassium is less than normal milk. In the last days of lactation potassium decreases and calcium, phosphate and chloride content increases. In case of under infections the chloride contents may go upto 0.3% in milk while it is only 0.12% in normal milk. The osmotic pressure of milk is equal to that of blood and maintenance of this osmotic equilibrium is necessary for secretion of

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milk in the udder. This osmotic pressure is influenced by the conc. of these salts. Blood plasma is higher in sodium, magnesium and chloride contents while milk plasma is higher in potassium, calcium and inorganic phosphorus and citrates.

The salt in colloidal phase are in equilibrium with the salts in sol. phase in milk and this equilibrium can be tilted to any side depending upon the treatment given to milk e.g. acidification will cause the colloidal ca and phosphate to shift towards solu. phase partially.

MINOR MILK CONSTITUENTS

Pigments

Two types of pigments are found in milk a) fats soluble b) water soluble carotenoids and Xanthophylls are fat soluble while Riboflavin is water soluble. Carotene is responsible for yellow colour of milk, cream, butter ghee etc. One molecule of beta-carotenes yields 2 molecules of vita. A while one molecule of Gamma-carotene yield only one molecule of vit. A carotene is also believed to prevent Oxidation of milk fat. Cow milk is rich in carotene but buffalo milk is devoid of it, because of inability of buffalo to transfer it into milk. In buffalo milk, it is transferred with serum portion of milk. The characteristic greenish colour of whey and skim milk is because of ribroflavin pigment.

Enzymes

They are biological catalyst. They are unimportant from nutrition point of view, rather they are a nuisance-causing break down of some constituents of milk. Their entry into milk is considered just by chance they are

- lipase (fat splitting),
- protease (protein degrading)
- lactase (Lactose degrading)
- phosphatase (Phosphoric acid degrading) and
- many others.

Phosphatase enzyme is used in checking the efficiency of pasteurization since its destruction taken place just before the pasteurization temperature.

Vitamins

In addition to fat soluble vitamins there are water soluble vitamins in milk like B-complex group and vit.C. These are more heat labile than fat sol. Vitamins. The conc. of different constituents of B-complex group is different and from nutrition point of view. They may be sufficient or insufficient.

FACTORS AFFECTING COMPOSITION OF MILK

Milk differs widely in composition or milk is a very variable biological fluid. All milks contain the same kind of constituents, but in varying amounts. Milk fat shows greatest daily variation, then comes proteins, followed by ash and lactose. The composition of milk is influenced by a number of factors; the more important factors are discussed below.

- **Genetic factors**
  - Species,
  - individuality of the animal,
  - breed (in the case of commercial dairying species),
- **Environmental factors**
  - Season
  - Age
  - Milking Interval
  - Completeness of Milking
  - Irregularity in Milking / Interval between milkings

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- Stage of lactation
- Yield
- Exercise
- Excitement
- Hormones
- Udder Diseases / health (mastitis and other diseases)
- Physiological Condition / nutritional status
- Feeding

❑ **Genetic factors**

1. Species: Each species yields milk of a characteristic composition

2. Breed: In general, breeds producing the largest amount of milk, yield milk of a lower fat percentage vice versa. Holstein-Friesian gives less fat (3.5%) where as Jersey gives high fat (about 5%) in cow breeds. Zebu cows can give milk containing up to5.6% fat. Thus selection for breeding on the basis of individual performance is effective in improving milk compositional quality. Herd recording of total milk yields and fat and solids-not-fat (SNF) percentages will indicate the most productive cows, and replacement stock should be bred from these.

3. Individual Variation: Milk of individual cows within a breed varies over a wide range both in yield and in the content of the various constituents. The potential fat content of milk from an individual cow is determined genetically, as are protein and lactose levels.

❑ **Environmental factors**

4. Season: Seasonal variations in milk composition are commonly observed with dairy cattle in temperate regions. In general, milk fat and solid-not-fat percentages are highest in winter and lowest in summer. Milk fat and protein percentages are lower by 0.2-0.4% in summer than winter. Cows calving in the fall or winter produce more fat and solid-not-fat than cows calving in the spring and summer.

5. Age: As cows grow older the fat content of their milk decreases by about 0.02 percentage units per lactation while the fall in SNF content is about 0.04 percentage units. Fat percent increase up to 3 rd lactation and after wards decreases. SNF will be high in the first lactation and slightly decreases as lactations increased.

6. Milking Interval: When milking is done longer intervals, the yield is more with a corresponding decrease in fat and vice versa. Not much effect on solid-not-fat content. The fat content of milk varies considerably between the morning and evening milking because there is usually a much shorter interval between morning and evening milking than between 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, SNF content does not vary with the length of time between milkings.

7. Completeness of Milking: Fore milk contains less fat and strippings (last milk) contains high fat. If the milking is not complete it tests less fat. Not much effect on SNF. The first milk drawn from the udder contains about 1-2% fat while the last milk (or strippings) contains about 5-10% fat. Thus after incomplete milking, milk fat content will be lower than normal. Residual milk (milk remains in the udder after milking) may contain up to 20% fat.

8. Irregularity in Milking: Frequent changes in the milking timings, and frequent changes in milking intervals results less fat and not much effect on SNF.

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9. Stage of lactation: The fat, lactose and protein contents of milk vary according to stage of lactation. The first secretion after parturition namely colostrums high in globules and chlorides and low lactose content. Cow's colostrum contains more minerals, protein and less lactose than milk. Fat % is usually higher in colostrum than in milk. Calcium, Mg, P, and Cl are high in colostrums, whereas K is low. Iron is 10-17 times higher in colostrums than in milk. The high levels of Fe are needed for the rapid increase in hemoglobin in the red blood cells of the newborn calf. Colostrum contains 10 times as much vitamin A and 3 times as much vitamin D as milk. The yield increases and attains maximum within 2-4 weeks and then slowly decrease. When the yield is more, Fat and SNF decrease and vice versa. Solids-not-fat content is usually highest during the first two to three 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. The high protein content of early lactation milk is due mainly to the high globulin content.

10. Yield: With increase in yield per milking the percentage of lactose increases, while fat and non-fatty solids decrease.

11. Exercise: More exercise increase fat in milk as body fat is metabolized – no effect on SNF.

12. Excitement: Sexual or freight excitement causes decrease in fat, no effect in SNF.

13. Hormones: Prolactin and thyroid hormone which are essential for milk synthesis increase the fat percentage. Oestrogen has stimulating and depression effect, optimum levels causes increase in fat and higher doser decreases the fat percent.

14. Udder Diseases: Infection of the udder (mastitis) greatly influences milk composition. Mastitis and other udder diseases causes low lactose and casein %, increase in chloride content. Subnormal SNF or salt imbalance is the characteristic of mastitis. Concentrations of fat, solids-not-fat, lactose, casein, β-lactogolbulin and α-lactalbumin are lowered and concentrations of blood of blood serum albumin, Igs, sodium, and chloride are increased. In severe mastitis, the casein content may be below the normal limit of 78% of total protein and the chloride content may rise above the normal maximum level of 0.12%.

15. Physiological Condition / Health: The condition of cow at the time of parturition has effect on fat and SNF content. Healthy cows give high fat and SNF content. Both fat and SNF contents can be reduced by disease, particularly mastitis.

16. Feeding: Underfeeding reduces both the fat and the SNF content of milk, although SNF content is the more sensitive to feeding level. Fat content and fat composition are influenced more by roughage (fibre) intake. The SNF content may fall if the cow is fed a low-energy diet, but is not greatly influenced by protein deficiency, unless the deficiency is acute. Pasture feeding increase both fat and SNF. Pasture feeding increases unsaturated fatty acids in milk. Feeding oils as palm oil, coconut oil increases fat percent where cod liver oil decreases the fat percentage. Starvation increases unsaturated fatty acids in milk.

17. Administration of drugs and hormones: Certain drugs may affect temporary change in the fat percentage; injection or feeding of hormones results in increase of both milk yield and fat percentage.

18. Frequency of milking: Whether a cow is milked two, three or four times a day, it has no great effect on the fat test.

FOOD AND NUTRITIVE VALUE OF MILK

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Milk is an almost ideal food. It has high nutritive value. It supplies body building proteins, bone forming minerals and health giving vitamins and furnishes energy giving lactose and milk fat. Besides supplying certain essential fatty acids, it contains the above nutrients in an easily digestible and assimilable form. All these properties make milk an important food for pregnant mother, growing children, adolescents, adults, invalids, convalescents and patients alike.

Proteins : Milk proteins are complete proteins of high quality i.e. they contains all the essential amino acids in fairly large quantities.

Fat : Milk fat (lipid) play a significant role in the nutritive value, flavour and physical properties of milk and milk products. Besides serving as rich source of energy, fat contains significant amounts of so called essential fatty acids (linoleic and arachidonic). The most distinctive role which milk fat plays in dairy product concern flavour. The rich pleasing flavour of milk lipids is not duplicated by any other type of fat. Milk fat imparts a soft body, smooth texture and rich taste to dairy products. Lastly milk lipids undoubtedly enhances the consumer acceptability of foods, they also serve the best interests of human nutrition, through the incentive of eating what tastes good.

Lactose : The principle function of lactose (carbohydrade) is to supply energy. However lactose also helps to establish a mildy acidic condition in the intestine (which checks the growth of proteolytic bacteria) and facilities assimilation.

Minerals : Practically all the mineral elements found in milk are essential for nutrition. Milk is an excellent source of calcium and phosphorus, both of which together with vitamin D are essential for bone formation. Milk is rather low in Iron, Copper and Iodine.

Vitamins : These are accessory food factors, which are essential for normal growth, health and reproduction of living organisms. Milk is a good source of vitamin A (provided the cow is fed with green feed and fodder), vitamin D (provided the cow is exposed to enough sun light) thiamine, riboflavin etc. However milk is deficient in Vitamin 'C'.

Energy Value : The energy giving milk constituents and their individual contributions are as follows:

Constituents	Energy level (Calories)
Milk Fat	9.3 C / g
Milk proteins	4.1 C / g
Milk Sugar	4.1 C / g
The energy value of milk vary with its composition on average cow milk furnishes 75 C / 100 g and buffalo milk 100 C / 100 g of milk.	

Effect of Processing :

Pasteurization carried out with reasonable care has no effect on Vitamin A, carotene, riboflavin and a number of remaining vitamin B complex and Vitamin D. 10 percent loss of thiamine and 20 % loss in vitamin C will occur. Sterilization increases the losses of thiamine and Vitamin C to 30 – 50 % and 50% respectively, though the remaining vitamins are but little affected.

SOURCE OF BACTERIAL CONTAMINATION OF MILK

Unlike nature's other foods, such as fruits that have a protective cover, milk, with no natural protection is suckled directly by the offspring. In the mammary gland, milk is normally sterile. However, as it is drawn through the udder, the microfloras present in the teat canal contaminate it. Even under scrupulously clean conditions, freshly drawn milk may have 400—600 bacteria/ml.

Sources of microorganisms in milk

Milk at the time of secretion is free of bacteria. However, some microorganisms do migrate from the exterior of cow's udder to teat canal and eventually to the interior of the udder.

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These organisms originate from the coat of the animal, hands of the milker, farm atmosphere, utensils soil, feed and manure. Even the milk aseptically drawn from healthy cows contains *Micrococci, L.actococci,* and *Corynebacterium bovis.* Occasionally, unhealthy cow or milkers can contaminate raw milk with pathogenic bacteria such as species of *Listeria monocytogenes, Staphylococcus aureus,* pathogenic *Escherichia coli, Mycobacterium tuberculosis, Brucella, Salmonella, Shigella, Cornybacteria,* viruses and rickettsia. It should also be noted that moulds, mainly of species of *Aspergillus, Fusarium,* and *Penicillium* could grow in milk and dairy products. If the conditions permit, these moulds may produce mycotoxins, which can be a health hazard.

Main spoilage microorganisms

Among the main spoilage microorganisms are Gram-positive organisms which ferment lactose into lactic acid. Acid-forming bacteria include the typical lactic acid bacteria of fermented milks, cheese and butter cultures *(Lactococcus lactis* subsp. *lactis, Lactococcus lactis* subsp. *crenioris, Leuconostoc* species and *Lactobacillus* species) and those frequently found in stagnant and surface water, causing rapid curdling of milk. There are also gas forming *(Aerobactor aerogenes, Bacillus polymyxa, Clostridium butyricum),* ropy or slimy milk-forming *(Alcaligenes viscosus),* sweet-curdling *(Bacillus cereus)* bacteria. Milk also contains yeasts *(Saccharomyces delbruekii, Candida mycoderma)* and moulds *(Cladosporium, Penicillium, Rhizopus)* that can bring about its fermentation and degradation. In milk, the microorganisms that are principally involved in spoilage are psychrotrophic organisms. Most psychrotrophs are destroyed by pasteurization temperatures, however, some like Pseudomonas fluorescens, Pseudomonas fragi can produce proteolytic and lipolytic extracellular enzymes which are heat stable and capable of causing spoilage. M. luteus, M. varians, and M. freudenreichii, are sometimes referred to as milk micrococci and can result in spoilage of milk products.

Gram-negative pathogenic organisms have been implicated in human illness resulting from consumption of contaminated milk and its products. Coliforms are facultative anaerobes with an optimum growth at 37° C. Coliforms are indicator organisms; they are closely associated with the presence of pathogens but not necessarily pathogenic themselves. They also can cause rapid spoilage of milk because they are able to ferment lactose with the production of acid and gas, and are able to degrade milk proteins. They are killed by HTST treatment, therefore, their presence after treatment is indicative of contamination. Escherichia coli is an example belonging to this group. The presence of coliform bacteria indicates contamination from fecal matter and manure. Associated pathogenic organisms are diarrhoea- and dysentery-causing bacteria belonging to genera *Salmonella* and *Shigella.* If detected in pasteurized milk products, their presence is attributed to post-pasteurization contamination.

Other spoilage organisms found in raw milk include species of *Lactobacillus, Staphylococcus, Acinetobacter, Flavobacterium,* and *Micrococcus.* Their growth results in deterioration of flavour, odour and texture of milk. They are generally killed by proper pasteurization of milk.

Spoilage occurs when microorganisms degrade the carbohydrates, proteins, fats of milk and produce noxious, end products. Milk products as follows;

Spoilage type	Organisms involved	Signs of spoilage
Souring	Lactobacillus sp. Streptococcus sp.	Sour milk, Curd formation
Proteolysis	Pseudomonas sp.Bacillus sp. Bacillus subtilis,	Bitterness

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	B. cereus var. mycoides, Pseudomonas putrefaciens, p. viscose, Streptococcus, liquefaciens, and proteus spp.	
Sweet curdling	Bacillus sp. Proteus sp. Micrococcus sp.	Alkaline pH Curd formation
Lipolysis	Pseudomonas sp. Pseudomonas fluorescens Achromobacter lipolyticum; yeasts, e.g., Candida lipolytica; and moulds, e.g., Pencillium spp.,Geotrichum candidum.	Rancid odour
Gas production	Clostridium sp. Coliform bacteria, Certain yeasts, e.g., Torula cremoris, Candida pseudotropicalis, and Torulopsis sphaerica	Gassiness
Ropiness	Alcaligenes sp.,Klebsiella sp.,Enterobacter sp.	Stringy or slimy milk
Red rot	Serratia marcescens	Red coloration
Grey rot	Clotridium sp.	Gray coloration, Foul smell
Dairy mould	Aspergillus sp. Penicilium sp., Geotrichum sp.	Mouldy appearance

It should also be noted that moulds, mainly of species of Aspergillus , Fusarium , and Penicillium can grow in milk and dairy products. If the conditions permit, these moulds may produce mycotoxins which can be a health hazard.

Thus, if not handled hygienically during production, processing or distribution, milk and milk products may become source of pathogens that may cause food poisoning. There have been a number of foodborne illnesses resulting from the ingestion of raw milk, or dairy products made with milk that was not properly pasteurized or was poorly handled causing post-processing contamination, due to species of *Staphylococci, Enterococci* and *Escherichia* etc. They produce enterotoxins that survive even after milk is heated up to 100°C for 30 minutes. The following bacterial pathogens are still of concern today in raw milk and other dairy products:

- Bacillus cereus
- Listeria monocytogenes
- Yersinia enterocolitica
- Salmonella spp.
- Escherichia coli O157:H7
- Campylobacter jejuni

Several enteropathogenic serotypes of *E. coli* have been isolated from milk and milk products that are heat resistant, surviving pasteurization temperature. The heat-stable property of the *E. coli* enterotoxins, causes food poisoning even if the food has been heat-treated before consumption.

Significance of microorganisms in milk:

- Information on the microbial content of milk can be used to judge its sanitary quality and the conditions of production
- If permitted to multiply, bacteria in milk can cause spoilage of the product

- Milk is potentially susceptible to contamination with pathogenic microorganisms. Precautions must be taken to minimize this possibility and to destroy pathogens that may gain entrance
- Certain microorganisms produce chemical changes that are desirable in the production of dairy products such as cheese, yogurt.

STANDARD PLATE COUNT (PC)

Count per ml	**Quality / grade**
< 2,00,000	Very Good
2 Lakhs – 1 million	Good
1-5 millions	Fair
> 5 millions	Poor

FLUID MILK

Type of milk	**Standards for satisfactory quality**		
	SPC/ml or gm (Max)	**Coliform count** (in PCT) **/ml or gm (max.)**	**Other tests**
1. Pasteurized milk	30,000	Absent in 0.01 ml	Phosphatase test-ve
2. Sterilized milk	-	-	Spore count/ml = 5 (max)
3. Flavoured milk			
i) Pasteurized	50,000	10	Phosphatase test-ve
ii) Sterilized	-	-	Spore count/ml = 5 (max)

CLEAN MILK PRODUCTION

What is clean milk?

*Clean milk is the milk that comes from
-the clean udder of clean and healthy milch animal,
-drawn by clean people,
-using

- clean utensils
- clean equipment &
- clean methods

-kept and handled in clean environment

Although there are no legal standards with regard to bacteriological quality of milk, it is important that the bacterial population in milk is as low as possible. Milk could be a potential carrier of disease causing microorganisms. Since most of the organisms gain entry into the milk after it leaves the udder, their population could be fairly controlled by proper sanitary care during production and handling. Any extraneous material that comes to the milk adds large number of microorganisms to it. These microorganisms could be pathogenic or non pathogenic in nature. However, the presence of both the types in milk are objectionable because they can cause spoilage as well as health hazard if milk is consumed before they are destroyed. It

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becomes more important to emphasize the need of clean milk production where hygienic practices are seldom observed.

In western countries the problem of milk borne disease has been solved completely by strict laws. Animals are periodically tested for the contagious diseases and all measures are taken to produce milk free from pathogenic organisms. In India most of the milk is produced in rural areas where sanitary conditions are far from satisfactory; all possible efforts should be made to secure milk with low bacterial count, free from visible dirt and pathogenic microorganisms. The following factors should be borne in mind while considering clean milk production.

Health of the Animals: Milk should be drawn only from healthy animals. Animals should be free from infectious diseases. Udder should neither be affected by mastitis nor should thereby any wound. Those animals, which are either sick or have infection of any kind, should be segregated and either should not be milked or milk produced by them should be handled separately.

Milking barns: It is essential that he place where milking is done is kept clean, the barns should be well ventilated and there should be adequate lighting arrangements. Cleaning of barns should be done at least one hour before the milking starts. Accumulation of dung and urine in the barn should be avoided. It should be protected from files, mosquitoes, rats, cockroaches and birds etc. If possible while washing of the walls etc. should be done periodically.

Animal Housing Management	
For new sheds	**Existing sheds**
-Have pucca-flooring	-Keep clean & dry
-Ensure proper ventilation	- Wash everyday & spray fly repellant
-Ensure drainage of dung &urine	-Remove dung periodically, away from the shed
-Provide clean &potable water	-Install Gobar gas plant for proper use of dung

Cleaning of Animals: The animals should be given a bath before milking. If it is not possible the udder and the adjoining parts should be washed thoroughly. Teats should be cleaned with disinfectant solution and dried with a clean cloth dipped in such solution of chorine, bleaching powder or potassium permanganate. Clipping of hairs in udder region, grooming and brushing the animal before milking will help to minimize the bacterial population in milk.

Animal Health Management	**Feeding Management**
*Insure the animals	*Feed the animal with clean, healthy diet
*Check for mastitis periodically	*Clean water trough & manger everyday
*Get the animals examined for infectious diseases	*Don't feed animal with feeds having mould growth
*Follow vaccination schedules	*Don't feed animal with left over feeds

Health and cleanliness of milker: The milker should be free from contagious diseases and should be in sound health. It is important to understand that the health of the milker is as important as the health of the animal. Milker should be clean the hands before milking with clean water and the hands should be wiped off with a cloth previously dipped in disinfectant solution. Sneezing, smoking as well as chewing of tobacco should be avoided just before and during milking.

Personal Hygiene **Disease control**	**Personal Hygiene** **Cleanliness**	**Behavioral Practices** **During milking avoid**
• No communicable disease • No open cut	• Clean cloth • Hair cut/tie up hair	• Smoking& chewing • Spitting & Coughing

• No sores • No boils or infected wounds • No abnormality • No stomach upset	• Trimmed beard • Nails cut • Covered all cuts/blisters • Washed hand with soap	• Scratching & Sneezing • Eating &drinking • Nose poking • Pet cuddling etc.

Using small topped milking pails: Normally 50% of the dirt that falls in the milk could be prevented by using small-topped containers. Use of hooded milking pails are helpful in preventing the dirt, coming to milk during milking as compared with open top milking pails. Milking pails should be washed immediately after milking is over. They should be washed with clean water followed by detergent washing and finally with clean water. Use of soda ash or surf will help to remove milk solids from the container. The milking pail after proper washing should be sterilized either by heat treatment or keeping it under the bright sunlight. Chlorine or bleaching powder solution of proper strength can also be used for rinsing the milk pails, which will effectively control bacterial population.

Cleaning of utensils From the milking pails milk is generally transferred either in milk cans or other containers. In order to minimize bacterial number in milk, all the containers with which milk comes in contact must be properly cleaned and sterilized. There should be no accumulation of milk solids in these containers and they should be properly covered.

Straining of milk: The process of staining helps to remove large size objects, which come to the milk from the external sources. For straining the milk either metallic strainer or muslin cloth could be used. Use of cotton pads for staining milk become more effective. One should clearly keep in mind that proper cleaning and sterilization of strainer as well as cloth before they are used, is a primary requirement for achieving the objectives of clean milk production.

Cooling of Milk: Milk should be cooled to less than 5^0C as quickly as possible after milking. This process will help to check the growth of microorganisms, which have gained entry into milk. Lower temperatures check bacterial growth; therefore possible efforts should be made to reduce the temperature of milk after it is drawn from the udder of animal. Freshly drawn milk has a temperature approximately 38^0C which is highly suited for the bacterial growth.

Tips for successful milking

*Clean cattle shed and clean environment *Clean animal*Clean bedding *Remove udder hair twice yearly *Correct milking procedure *Discarding the fore milk *Testing for mastitis *Udder washing *Udder wiping/drying *Washing the hands and milking vessel*Teat cup dipping using disinfecting after milking*Make the cattle stand for at least for 30 min. after milking. Provide feed if necessary *Disinfecting teat can reduce teat surface bacteria by 75 %*Use of separate vessel for washing the udder and for milking

MILK COLLECTION

Parameters of raw milk quality

- ✓ Microbial content
- ✓ Somatic cell count
- ✓ Integrity of fat globule as affected by mechanical handing
- ✓ Organoleptic attributes
- ✓ Chemical residues (antibiotics, pesticides, environmental pollutants)
- ✓ Adulterants

Raw milk cooling

Under tropical conditions (Indian), if milk is not chilled immediately after it drawn from animal,

the bacterial numbers in milk are rarely less than 1 million cells per ml by the time the milk is collected; they become several million cells by the time the milk is delivered at the dairy for processing.

Milk leaves the udder at body temperature of about 38°C. The bacterial load may grow rapidly and bring about curdling and other undesirable changes if milk is held at *the* ambient atmospheric temperature.

Storage temperatures also influence the keeping quality or the useful commercial life of milk e.g. a sample of milk having a useful commercial life of five hours at 37^0C, will remain in good condition for ten hours at 25^0C and for 15 hours at 20^0C.

In view of the importance of temperature of storage on the keeping quality of milk, freshly drawn raw milk should be promptly cooled and held at 4°C till processing to preserve it against bacterial deterioration. Therefore cooling of milk immediately after production to a temperature below 10^oC has been universally practiced in Western countries to arrest bacterial multiplication.

Importance of milk chilling

Milk contains only a few microorganisms when drawn from udder. Their number increases during subsequent handling. The common milk microorganisms grow fast between 20° and 40°C. The effect of storage temperature on bacterial growth in milk is shown in Table 1. It also shows that 10°C is a critical temperature for milk. Freshly drawn milk should, therefore, be promptly cooled to below 5°C and also held at that temperature until processing.

Table 1 Effect of storage temperature on bacterial growth in milk

Milk held for 18 hours at temperature (°C)	Bacterial growth factor
0	1.00
5	1.05
10	1.80
15	10.00
20	200.00
25	1 2O00000

- ✓ Multiply initial count with this factor to get final count.

Upgrading raw milk quality

Clean milk production aims at improving the raw milk quality through phased interventions in the milk cycle from udder of the milch animal up to the dairy plant dock.

For achieving it, the following seven-point farmer awareness programme could be launched

- ✓ Cleanliness of dairy farm and its surroundings.
- ✓ Hygienic milking practices like cleaning of udder and cleanliness of milkers.
- ✓ Use of clean milk-handling vessels.
- ✓ Quick delivery of milk at the village-level dairy cooperative societies (DCS).
- ✓ Cleanliness of DCS and its personnel.
- ✓ Fast receiving of milk through automatic milk collection stations.
- ✓ Immediate cooling of raw milk at DCS or early transportation of milk to dairy plant dock in clean stainless steel cans/insulated tankers.

In-can cooling: Portable refrigeration units may be employed for in-can cooling of milk by direct immersion of cooling coil. The cooling coil is kept immersed in the can till the desired cooling temperature is attained. Such a unit is fitted on a trolley and is suitable for cooling 5—7 cans (200—280 litres of milk) at the farm.

Bulk milk cooler: This method is more suitable for handling 500—2,500 litres of milk/day. it is

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increasingly being used by village-level milk collection centres in India. From the bulk milk coolers, milk is pumped into insulated road milk tankers for transportation to the dairy plant. Bulk milk coolers are usually horizontal, semi-circular or vertical cylindrical tanks with an inner jacket and an outer insulated body. To effect cooling, the inner shell of the tank has provision for either chilled water around its external periphery or a direct expansion cooling coil from a mechanical refrigeration system. Milk is either directly poured into the tank or pumped through a balance tank. Milk coming in contact with the inner shell of the tank is cooled to around 4°C. The agitator inside the tank helps maintain uniform cooling of milk.

Plate chiller: It is widely used for large-scale cooling of milk (5,000—50,000 litres/day) at the chilling centres. They are highly efficient, compact and easily cleanable. In a chiller, a number of gasketed plates are tightly held between the frames. These plates are so arranged that a flow passage for milk exists on one side of the plate and the cooling medium (usually chilled water) on the other side. There is a counter-current flow between the milk and the chilled water through alternate plates. It helps in efficient transfer of heat from milk to the cooling medium—chilled water which results in quick chilling of milk. The chilled milk flows from the plate cooler to the insulated or chilled water-jacketed milk storage tank for storing milk at 4°C. A mechanical refrigeration system with ice bank tank ensures supply of chilled water to the plate cooler.

PROCUREMENT OF MILK

Procurement of milk comes in picture when the place of milk production is away from its place of consumption. Since, in India most of the milk is produced in remote rural areas and it is required in larger quantities by the urban population, systematic efforts are needed to bring it from the rural areas to the cities. This is the first step of the market milk industry particularly in India where specialized dairy farms do not exist.The various sources through which milk is procured by the dairies could be classified under the following categories:

1 Directly from the producer
2. Through the middlemen,
3. Through agents or contractors,
4. Through cooperative societies,
5. Directly from the dairy/processing plant.

***Directly from the milk producers*:** In this system of milk procurement individual milk producers supply milk to the dairy independently. There is no obligation of any kind on either party. Dairy has the right to fix the price for the milk and producers have no say in this matter.

Drawbacks: (a) Milk producers are normally exploited by offering low price.
(b) There is no assured market for the milk through out the year because of the seasonal variations.
(c) Producers do not get incentive for increasing milk production.
(d) The profits earned by the dairy are not shared by the milk producers.
(e) Dairy does not provide facilities to increase milk production nor takes care of social and economic needs of the producers.

***Through the middlemen*:** In this system of milk procurement dairies receive milk through the middlemen who may be milk producers as well. These people buy milk from the milk producers in the rural areas and supply to dairy. Dairy has no contact with the producers directly. Sometimes milk producers are given loan for the purchase of the animals with the agreement that the milk produced by the animal will be sold to the money lender only.

Disadvantages: (a) Price for the milk received by the producer is very low,
(b) Prices are fixed by the middlemen,
(c) All the profits go to middlemen only,

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(d) No help is given to the producer for increasing milk production,
(e) Milk producer generally remains a debtor.

***Through the Agent/Contractor*:** In some dairies milk is received through authorized agents or contractors. Dairy enters into an agreement with the agent/contractor for the supply of certain quantity of milk for a specific period. Normally the price for the milk, its quality and quantity in different seasons is mutually agreed upon. Other details such as mode of payment, timings, transportation of milk, settlement of dispute if any and penalties for failures etc. are decided at the time of making agreement.

Shortcomings: (a) Milk producer is exploited by the agents/contractor.
(b) Producer does not get the real price for his produce.
(c) Profit is not shared with the producers.
(d) Prices for the milk are fixed by agents or contractors
(e) No facilities are provided to the producers for increasing milk production,
(f) Producers do not have freedom to find better market for their produce,
(g) No efforts are made for the social upliftment of the milk producers,

***Through Cooperative Societies*:** In this system of procurement, milk producers form a cooperative society at the village level and several societies join together to form a milk union at the district level and likewise federation at stae level. Unlike the other systems of procurement, the milk producer is the owner of the dairy.

Adventages:

a) Producers has the right to decide the price of milk
b) Producers get the share of profit made by the dairy.
c) This system gives shelf-reliance to the producers for solving their problems in a collective manner.

***Directly from Dairy /Processing Plant*:** Due to improvement in refrigeration and transport facility, it has now become possible to procure milk in bulk quantities from distant places. One dairy situated thousand kilometers away can get milk from another dairy. The example of this type of dairy is Dairy in Bombay and Calcutta getting their supplies from Amul Dairy located in Anand (Gujrat). Mother Dairy Delhi is another example which gets milk from dairies of Uttar Pradesh, Madhya Pradesh, Haryana, Rajasthan and Punjab. There are several other dairies where this system of procurement exists.

TRANSPORTATION OF MILK

Transportation of milk is an important operation in market milk industry. In India bulk of the milk is produced in the rural area and it has to be transported as raw milk from the place of its production to urban dairies for processing and ultimate consumption. Due to adverse climatic conditions and excessive cost on refrigeration, transportation of milk must be regularly done twice a day (morning and evening). The transport system should therefore be most efficient and economical. There are various modes of transportation based on various considerations. The most common means of transportation of milk are discussed below:

1. *Head Load*: Generally producers carry their produce on their head to the collection or chilling centre. This is commonly practiced in hilly areas where the volume of milk to be transported is less and the other means of transportation are not convenient. In villages generally ladies carry small quantity of milk on their head to the village milk cooperative society. The practice of head load transportation of milk is restricted to 3 to 5 liters of milk for a short distance.

2. *Shoulder Sling*: This method of transportation is again restricted to hilly areas where other means of transportation are not easily available. When the milk is slightly more, then it can

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conveniently be carried on head, this method is practiced. The quantity of milk may vary from 10 to 20 /.

3. *Bullock cart or Tonga*: The size and design of cart or Tonga differs from place to place. Simultaneously, the volume of milk transported by bullock cart or Tonga and distance covered varies accordingly. Both these means of transportation are employed in areas where the area is plain and some kind of road exists. Though Tonga is faster than bullock card, yet they are considered suitable for shorter distances and comparatively for a smaller volume. If the farmer has the facilities for transporting milk on his own then these modes of transportation are adopted.

4. *Bicycle*: In the recent years use of bicycles in the rural areas has increased tremendously. People use bicycle more conveniently than another means of conveyance. Appreciable percent of milk sold in the urban area by the unorganized sector is brought on the bicycle. Door to door delivery of milk by the milkman Gowala is invariably by bicycle up to 40/ of milk for a distance of about 10 to 15 km on a bicycle is a common sight in this country. It is faster more convenient and easily accessible to milk producers home. It is also a cheaper mode of transportation of milk.

5. *Cycle Rickshaw or Auto rickshaw*: They have more capacity than bicycle where big vehicles can't ply conveniently. Bicycle rickshaw and auto rickshaw are employed for transportation of milk. Cycle rickshaw can carry more load than bicycle and auto rickshaw can carry more than cycle rickshaw. Auto rickshaw can carry 250 to 500 l milk for a distance of 15 to 20 km. These modes of transportation involved less initial expenditure and their maintenance is also comparatively cheaper.

6. *Boat*: This method of transportation of milk is limited. Though in some places where rivers have to be crossed or producer himself is owner of boat may find it convenient to transport milk through boat. Normally, small boats carry about 200 l of milk for short distances.

7. *Motor Truck*: As the automobile industry in India has shown remarkable progress, use of motor trucks as a means of transporting milk in truck has become very popular. Almost all the dairies make use of motor trucks for the transportation of milk particularly when the milk is to be transported in cans. They carry approximately 0.5 to 3.5 ton load for more than 100 km. Due to improvement in road facilities and construction of all season roads, motor trucks have been found most effective means of transpiration.

8. Railway Wagon: Railways have been most dependable means of transportation though less popular in this country Railway wagons are economically only when substantial quantity of milk are to be transported for comparatively longer distance. Railway wagons can carry approximately 10 to 12 tones of load for more than 100 km. They are considered, economical and feasible where handling is large.

9. Tankers (Rail and road): Insulated stainless steel tanks are mounted either on the road or rail truck. They are definitely meant for bulk handling and for long distance transportation. Recently a good number or rail as well as road tankers are in use. These tankers are outcome of technological advancement in the field of design and development of equipment within the country. Contribution made by the NDDB and IDC in providing these facilities is remarkable.

Selection of mode of transportation

The following factors may be responsible for adopting a particular mode of transportation of milk:

1. ***The geographical location of the place*:** In hilly areas where roads are not developed and other means of transportation do not exist, transportation of milk is either by head-load or shoulder sling process where in the small quantity for shorter distances could be covered by head load method while shoulder sling method could be adopted for slightly more volume for loner distances. In places where river is to be crossed the mode of

transportation is byroad only.

2. ***Volume of milk*:** For large volumes, rail or road tankers are preferred. If the volume of the milk to be transported is less, it could be transported either on bicycle or on cycle rickshaw or auto rickshaw.
3. ***Available Resources*:** If the organization is having road tankers and facilities exist in the chilling recollection centre for loading them, road or rail tankers ;are used. Here the volume of milk to be transported is also a contributory factor. In the absence of such facilities the transportation of milk will be only by motor trucks which carry milk in cans.
4. ***Cost of transportation*:** One of the most important factors for consideration is the expense involved in the transportation. Motor trucks and tankers (road and rail) are considered most economical for larger volume of milk and longer distances to be covered. For small volume of milk and short distance transporting by bicycle is most economical.

***Owned vs Hired*:** Some dairy organizations transport milk by their own transport facilities while others manage with hired transport facilities. When factory develops it own transport facility. It normally becomes too expensive and highly cumbersome. Apart from the initial investment on vehicles, it involves a complete section of maintenance and operational personnel. A considerable time, energy and money is involved in these section and yet the system is neither completely satisfactory nor cost effective. Hired transport facilities are very effective and they relieve the management from several evils. Most of the dairy organizations in India therefore transport milk by hired transport system. It is economical because of low initial investment and low maintenance expenses. The dairy should have an agreement with the organization regarding the rates, mode of payment, liabilities on account of delays spoilage of milk, accidents, etc. Pilferage during transit or change in the quality of milk during transpiration is the responsibility of the transport authority. Heavy penalties are imposed for the lapses on the part of transporters.

LEGAL STANDARDS OF MILK
FSSA standards for different classes and designations of milk in India

Class	Designation	State and Union Territories	Min % fat	Min %MSNF
Buffalo milk	Raw, pasteurized, boiled, flavoured and sterilized	Assam; Bihar; Chandigarh; Delhi, Gujarat; Haryana; Maharashtra; 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

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	-do-	Kerala; Lakshadweep; Madhya Pradesh; Manipur; Mizoram;Nagaland; Orissa; Pondicherry; Rajasthan; Tripura; Tamil Nadu.	5.0	9.0
Cow milk	-do-	All India	3.2	8.3
Goat or sheep milk	-do-	Chandigarh; 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; Himachal Pradesh; Jammu &Kashmir;Karnataka; Lakshadweep; Manipur; Meghalaya; Mizoram;Nagaland; Orissa; Pondicherry; Rajasthan; Sikkim;Tamil Nadu; Tripura; West Bengal.	3.0	9.0
Camel milk	-do-	All India	2.0	6.0
Full cream milk	Pasteurized , flavoured &sterilized	All India	6.0	9.0
Mixed milk	-do-	All India	4.5	8.5
Standardized milk	-do-	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
Skim milk	-do-	All India	> 0.5	8.7

DIFFERENT TYPES OF MILK

Full Cream Milk

It is milk whose fat and / or solids not fat content have been adjusted to certain pre determined level. The adjustment can be done by partially skimming the fat in the milk with a cream separator or by admixture with fresh or reconstituted skim milk in proper proportions. In India, as per FSSA Rules (2011), the Full Cream milk for liquid consumption should contain a minimum of 6.0 per cent fat and 9.0 per cent solids not fat.

Standardized Milk

It is milk whose fat and / or solids not fat content have been adjusted to certain pre determined level. The standardization can be done by partially skimming the fat in the milk with a cream separator or by admixture with fresh or reconstituted skim milk in proper proportions. In India, as per FSSA Rules (2011), the standardized milk for liquid consumption should contain a minimum of 4.5 per cent fat and 8.5 per cent solids not fat.

Recombined Milk

It refers to the product obtained when butter oil (otherwise known as dry / anhydrous milk fat), skim milk powder and water are combined in the correct proportions to yield fluid milk. In India, as per FSSA Rules (2011), the recombined milk should contain a minimum of 3.0 per cent fat and 8.5 per cent solids not fat.

Reconstituted /Rehydrated Milk

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

Toned Milk

Also called single toned milk, refers to milk obtained by the addition of water and skim milk powder to whole milk. In practice, whole milk from buffalo is mixed with reconstituted spray dried skim milk for the production of toned milk. In India, as per FSS Rules (2011), the toned milk should contain a minimum of 3.0 per cent fat and 8.5 per cent solids not fat.

Double Toned Milk

Refers to milk obtained by the addition of water and skim milk powder to whole milk. Usually buffalo whole milk is mixed with reconstituted spray dried skim milk. In India, as per FSS Rules (2011), the double toned milk should contain a minimum of 1.5 per cent fat and 9.0 per cent solids not fat.

Sterilized Milk

This is defined as milk, which has been heated to a temperature of 100°C or above for such lengths of time that it remains fit for consumption for at least 7 days at room temperatures. Usually the milk is heated to108-111°C for 25 to 30 min. Commercially sterilized milk is rarely sterile in the strict bacteriological sense. This is because the requirements for the complete sterility conflict with the consumer's preference for normal colour and flavour in the sterilized product.

Requirements for sterilized milk

The sterilized milk must keep without deterioration i.e. remain stable and be of good commercial value for a sufficient period to satisfy commercial requirements be free of microorganisms harmful to the health of the consumer i.e. toxigenic, pathogenic organisms and toxins be free of microorganisms liable to proliferate i.e. it should not show signs of bacterial growth

Flavoured Milk

It is milk to which some flavours have been added. When the term milk is used the product should contain a milk fat percentage of a least equal to the minimum legal requirement for market milk. But when the fat level is lower (1-2 per cent) the term 'drink' should be used.

Homogenized Milk

It is milk, which has been treated in such a manner as to insure break up of fat globules to such an extent that after 48 h of quiescent storage no visible cream separation occurs on the milk; and the fat percentage of the milk in the top 100 ml of milk in a quart bottle or proportionate volumes in containers of other sizes, does not differ by more than 10 per cent of itself from the fat percentage of the remaining milk as determined after thorough mixing. In the properly homogenized milk, the fat globules present in the milk are split in to less than 2 microns in size.

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Soft Curd Milk

It is milk that forms a soft curd when coagulated with rennet or pepsin under standardized procedure. Soft curd milk has a curd tension of less than 25 g.

Mineralized Milk

It is milk to which some minerals have been added.

Vitaminized or Irradiated Milk

Vitaminized milk is milk to which one or more vitamins are added.

Irradiated milk

Irradiated milk is milk in which the vitamin D content has been increased by exposure to ultra violet rays. Addition of vitamins (and minerals) to milk is called fortification and such milk is called fortified milk. The vitamins and minerals may be added singly or in combination as multi-vitamin and mineral milk preparations.

Frozen Concentrated Milk

It refers to milk, which has been partially concentrated and then solidified by freezing.

Fermented Milk

It is a well known fact that the fermented milk products are nutritionally superior and have improved digestibility and palatability when compared to plain milk but the therapeutic benefits of the concerned bacteria in the fermented milk products can be demonstrated in vivo only with viable biomass of starters of human origin viz. Lactobacillus and Bifidobacteria. Milk

It refers to such milk, which has been made by employing selected microorganisms to develop the characteristic flavour and / or body and texture.

Acidophilus Milk

It is fermented milk, produced by development in milk of a culture of Lactobacillus acidophilus. It is claimed that acidophilus milk has therapeutic and health promoting properties. It is also claimed that the growth of Lactobacillus acidophilus under the conditions existing in the intestinal tract will replace undesirable putrefactive fermentations with a beneficial lactic fermentation.

Bulgarian Buttermilk

It refers to such milk produced by fermentation with Lactobacillus bulgaricus. The temperature of incubation will be usually higher in the range of 40 – 43°C with a higher acidity in the finished product.

Bifidus Milk

The starter bacteria have to remain viable at the time of consumption and capable of surviving in the intestinal tract to get maximum benefits from fermented milk. These bacteria should also be able to establish in the intestinal epithelium in sizable number by replacing resident harmful pathogens. The above said conditions can almost be met by Bifidobacteria when compared to other starter cultures.

The bifidus milk will provide incredibly excellent nutritional health benefits, especially for infants and growing child.

Kumiss

This is a lactic acid – alcohol fermented milk originated in Russia. The culture used for fermentation may be Lactobacillus acidophilus or Lactobacillus bulgaricus. The finished product contains a higher alcohol content of up to 2.5 per cent.

Kefir

It is a self carbonated milk beverage containing 1 per cent lactic acid and 1 per cent alcohol. The fermentation is usually done by kefir grains, which contains Streptococcus lactis, Betabacterium caucasium, keir bacilli and lactose fermenting yeasts.

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Condensed Milk

Condensed milk is a milk product obtained by evaporating part of water of whole milk, or fully or partly skimmed milk, with or without the addition of sugar. The term 'condensed milk' is commonly used when referring to full cream sweetened condensed milk whereas the term evaporated milk is generally used while referring to full cream unsweetened condensed skim milk. Skimmed milk products are known as sweetened condensed skim and unsweetened condensed skim milk respectively.

The ratio of concentration of milk solids is about 1: 2.5 full cream milk products and 1: 3 for the preparation of sweetened condensed skim milk.

According to the rules specified by the FSSR (2011), the various standards governing condensed milks have been given as follows:

Sweetened condensed milk is the product obtained from cow or buffalo milk or a combination thereof, or from standardized milk, by partial removal of water and after addition of cane sugar.

Sweetened condensed milk should contain not less than 9.0 percent milk fat, and not less than 31 per cent milk solids and 40.0 per cent cane sugar.

Unsweetened condensed milk (evaporated milk) is the product obtained from cow or buffalo milk or a combination therefore, or from standardized milk, by partial removal of water.

Unsweetened condensed milk should contain not less than 8.0 percent milk fat, and not less than 26 per cent milk solids.

Sweetened condensed skim milk is the product obtained from cow or buffalo skimmed milk or a combination thereof by the partial removal of water and after the addition of cane sugar.

The standards for sweetened condensed skim milk is it should contain not less than 26.0 percent of total milk solids and not less than 40.0 percent cane sugar. The fat content should not exceed 0.5 percent by weight.

PROCESSING OF MILK

Reception of milk

Reception of milk refers to a process of making the decision retarding the acceptance of milk for further processing. Whether the milk is acceptable or not, has to decided by the person in charge of the reception section. The place where this process is carried out is known as reception dock, receiving platform or raw milk receiving dock (RMRD). Since the future processing of milk mainly depends upon its quality, the decision of accepting the milk, must be made very carefully. The process of reception includes following operations: a) Unloading or Emptying, b) Sampling, c) Testing, d) Weighing or Measuring and Recording.

a) *Unloading or Emptying*: Milk is generally brought either in milk cans or in tankers. The first operation in the reception dock is unloading of milk cans or emptying or m ilk tankers. As soon as vehicle arrives at the reception dock all the efforts should be made to get the milk properly inspected. The milk cans are unloaded from the vehicle and are generally placed on the conveyors. The lids are removed and each can is subjected to rapid sensory evaluation. In case of milk tankers, milk is pumped out with the help of a milk pump, which normally passes through a flow meter where the volume of milk pumped is automatically recorded. Milk is taken to the dump tank from where sample is taken for quality evaluation.

b) *Sampling*: Sampling of milk is one of the most important aspects of entire operations. The validity of correct decision will be based on the sampling procedure. Only representative samples should be used for evaluating the quality of milk received. Any fault committed during the process of sampling will have its repercussions on the entire operations. The technique of sampling and the volume of milk taken for individual sample will depend upon the size and the number of containers. Sample should be taken after thorough mixing of milk with the help of

plunger in a proper sample bottle.

c) *Testing*: The tests, which are conducted on the reception dock, are called platform tests. These tests must be easy to perform, must give quick and reliable results, and should not require complicated and elaborate equipment. The time taken to perform these tests must be very short. The accuracy of these tests mainly depends upon the experience and sincerity of the individual who is conducting the tests. The following tests are included under platform tests. a) Organoleptic tests, b) Clot of boiling.

d) *Weighing or Measuring and Recording*: When milk is received from the individual producers either at the collection centre or in the dairy, it is generally measured by the approved measures. In case the milk is received at the dairy from the individual societies or collection centres, its weight is recorded before it is dumped into the dump tank. Milk is poured in the weighing tank and its weight is known from the dial balance. When milk is brought in the tankers to the dairy, then either the volume of milk is known, through the marks provided in the tanker or from the flow meter through which it is passed. The important point to be recorded for each supply should include date, time, source from where received, volume/weight of milk received, fat and specific gravity, quality of milk and signature of receiver.

e) Washing of cans: For large operations automatic can washers, sterilizers and dryers are used.

1. Rotated type: which is operated by one man, who places the cans and lids in the machine for washing and removes them after they are washed and dried. The cans and lids in inverted position are moved through rotated platform divided into sections. Under the plate form are located series of tanks having working solutions. Cans get continuous spray of various solutions both inside and outside through circulating pumps and the solutions return to the tanks, it is rotated at intervals.

2. Straight through or tunnel type: In which unwashed cans placed on one hand and the conveyer deposits the can and lids and the other in strive and dry conditions. The main operations are: 1: Prerinsing with clean water 2) stream 3) detergent solution washing 4) hot air drying 5) hot water rinsing. The rinsing water would be warm enough to melt and remove any fat that may remain in the fat, as well as to rinse the other milk solid from the inner surface. The detergent solution should have proper strength at suitable temperature approximately 40-50^{0}C. In order to remove e all the milk solids from the cans, cans are then rinsed by hot water to ensure complete drainage of milk, constituents as well as detergent solutions. The clean cans arte sterilized by steam having temperature. of approximately 110-112^{o}C. Finally, the cans are dried with the help of hot air. All these operations are carried out in quick succession the process is continuous.

***Straining, Filtration and Clarification*:** When milk is drawn from the udder of animal, it is exposed to atmosphere. Several substances from the atmosphere come to the milk. Any substances that is not a normal constituents of milk is called foreign material or extraneous material. The foreign materials may be soluble in milk or insoluble. The insoluble substances which remain in suspension of settle down are called sediment in milk. All the foreign materials whether soluble or insoluble in milk are considered undesirable and their presence is highly objectionable.

Generally extraneous materials found in milk consists of dust, dirt, fodder pieces, hair flies, dung leaves etc. The presence of such substances not only affects the quality of milk as such but they are accompanied by large number of microorganisms, which deteriorate the quality of milk, if their growth is not checked.

i) Platform tests:

A) Organoleptic: i) Smell (Odour):

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- Excellent indication of org. quality.
- Ascertain very quickly (few seconds)

Procedure:

- Cover of each can is removed, inverted and raised to the nose.
- Representative of can
- Top milk may be noted for smell.
- By replacing in cool and shaking the can vigorously – Test may be repeated.

Grader: Trained nose – generally relies on great extent in the acceptance/rejection of the intake milk on the odour test alone – free from all flavours.

ii) Appearance: After the odour test by observing the milk in each can for:

→ any floating extraneous matter
→ Off flavour
→ Partially churned milk (fat globules)
→ Free from 1, 2, 3.

iii) Temperature:

→ Temp. at which it is coloured – indicate the quality
Experience grander – just by touching of can
→ below 5^0C.

iv) Sediment:

→ Shows in visible foreign matter → clean milk production/supply
→ Not daily, often to ensure a clean milk supply.
→ Method by which maxi. Sediment will be revealed should be considered
→Method check on milk production and handling of milk on the farm.

A low sediment:

→ Low bacterial count – Not necessary
→ Pointer rather milk having been filtered on the farm.

v) Acidity:

vi) Lactometer Reading:

→Adulteration of water – drawback – heavy water – solids

Sampling: → i) Chemical analysis
→ ii) Bacteriological analysis – strict precautions regarding:
- Sterility of the sto
- Sampler
- Sample bottles

Mixing: Manual
Mechanical
→ Composite sample – preservation –4% formal in (40% below)

Quality control tests for milk and their significance.

Name of test	Purpose	Remarks
Acidity	Final acceptance/rejection	PT (Platform Test)
Alcohol (Ethanol)	Heating stability	PT
Alcohol (Alizarin)	Heat stability pH	PT
C.O.B.	Heat stability	PT
L.R.	Addition of water	PT

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Dye-reduction Test	Bacterial contamination and growth	PT (resazurin)
DMC	Type of Micro org.	LT (Laboratory test)
SPC	No. cont. & growth	LT
Freezing point	Water adulteration	LT
Fat and SNF	Payment	LT
Adulterants	Payment	LT
Neutralizers	Payment	LT
Preservative	Payment	LT

ii) Preheating → Heated 35-40^{0}C for sufficient filtration/clarification.
→ Essential – incoming milk is cold.
→ flow will hamper
→ Temp. viscosity and more efficient filtration
→ Plate heat exchanger
→ Tubular heater

iii) Filtration/clarification:
→ Improve aesthetic quality of milk by removing visible foreign matter.
* Less dirting with milk
* No need of heating
* Slow flow
→ Staining
→ Centrifugal sedimentation

Type of filter/clarifiers: Cold
Warm

Filters: i) Cloth or Pad – smallest
ii) Frame
iii) Perforated metal – not break under pressure of milk.
iv) Enclosure – filling at inlet or outlet of sanitary piping.

Clarifiers: Similar to centrifugal cream separator
→ Only one outlet - cream & M
→ Disc similar in diameter, large space is provided so as to accumulate slime than separators.
→ Milk distribution holes – outer edges of disc. Near the centre in separator

iv) Storage → Raw and pasteurized milk
→ Equal to one day's intake – more nearly working day for processing.
→ Storage tanks are most important items of equipments.
→ Ease in sanitation, preferably by the circulation cleaning method.
→ Insulated or refrigerated – maintain temp. during holding period.
→ Agitation should be adequate for homogeneous mixing, but gentle enough to prevent churning and incorporation of air.

Objective

i) To maintain milk at a low temp. so as to prevent deterioration in quality prior processing of product manufacturing.

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ii) To facilitate bulking of the raw milk supply which will ensure uniform composition.
iii) To allow for uninterrupted operation during process.
iv) To facilitate standardization of milk.

HEAT TREATMENT TO MILK

8.1 PASTEURIZATION – DEFINITION – OBJECTIVES, ADVANTAGS AND DISADVANTAGES.

Pasteurization term has been coined after the name of Louis Pasteur of France, who in 1860 – 64 demonstrated that heating wine at a temperature between 122 to 1400F (50 to 60oc) killed the spoilage organisms and helped in preservation. The application of this term "Pasteurization", although Louis Pasteur pioneered studies on heat treatment for preservation, pasteurization of milk was first attributed to Dr. Soxhlet of Germany in 1886.

Definition : The term pasteurization as applied to market milk today refers to the process of heating every particle of milk to at least 63oc (145oF) for 30 Mts. or 72oc (161oF) for 15 seconds or to any temperature – time combination which is equally efficient in approved and properly operated equipment and finally cooling to 4oC. As per international Dairy federation (IDF) pasteurization is defined as a process applied to a product with an object of minimizing possible health hazards arising from pathogenic micro organism associated with milk by heat treatment, which is consistent with minimal chemical, physical and organoleptic changes in the products.

Objectives:

1. To render the milk safe for human consumption by destruction of cent percent pathogenic microorganisms.
2. To improve the keeping quality of milk by destruction of almost all spoilage organisms(85 to 99 percent).

Need: As it is difficult to exercise strict supervision over all milk supplies, it becomes necessary to pasteurize milk so as to make it safe for human consumption. Any impairment of nutritive value is of the slightest extent.

Objections

1. Pasteurization encourages slackening of efforts for sanitary milk production.
2. It may be used to mask low quality milk.
3. It diminishes significantly the nutritive value of milk.
4. It reduces the cream line or cream volume.
5. Pasteurized milk will not clot with rennet.
6. Pasteurization may be carelessly done; it gives false sense of security.
7. It fails to destroy bacterial toxins in milk.
8. In India, pasteurization is not necessary; as milk is invariably boiled on receipt by the consumer.

Formulation of Standards:

The following considerations were involved in the formulation of standards for pasteurization.

Bacterial Destruction: Cent percent for pathogens. Mycobacterium tuberculosis, being considered the most heat resistant among pathogens, was chosen as the index of organisms for pasteurization earlier. Now it is considered that "Q" fever organism "Coxiella bernette" was considered the heat resistant organism among pathogens. Any heat treatment (i.e. temperature – time combination), which kills T.B. / Q fever organism, also destroys all other pathogens in milk.

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Cream Line reduction: The cream line or cream volume is reduced progressively with increase in temperature – time of heating. The consumer judges the quality of milk on the basis of the cream line).

Phosphatase inactivation: The complete destruction of phosphatase by pasteurization. (The phosphates test is used to detect inadequate pasteurization).

Thus the standards of pasteurization were such as to ensure

1. Complete destruction of pathogens
2. Negative phosphates test and
3. Least damage to the cream line. As T.B. germs are destroyed by a heat treatment slightly lower than that for phosphatase inactivation, pasteurization is carried out at a heat treatment temperature above that for phosphatase inactivation and yet below that for cream – line reduction as shown below:

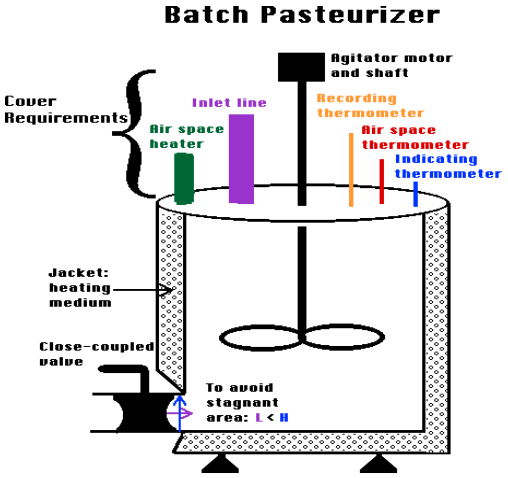
Particulars 30 Mts. 15 Seconds

To kill T.B. Germs	138 o F / 58.9 o C 158oF / 70 oC
To inactivate phosphatase	142o F / 61.1oC 160 o F / 71.1o C
Pasteurization Requirement	143 o F / 61.7 oC 161 oF / 71.7 o C
Creamline Reduced	144 o F / 62.2 o C 162o F / 72.2 oC

Types of Pasteurization :

1. Batch Pasteurization
2. High temperature short time pasteurization (HTST)
3. Ultra – high Temperature pasteurization (UHT)
4. Vacuums Pasteurization
5. Stassanization.

8.2 TYPES OF PASTEURIZATION.



This is also called low temperature – Long time (**LTLT**) method. The milk is heated to 63oC / 145 oF for 30 mts and promptly cooled to 5 oC or below. In this method heating and cooling of the product is done through a metal wall. When the product is heated or cooled gentle agitation is done for rapid heat transfer. Agitation must not be so rapid that whipping or churning occurs. For continuous processing 3 to 5 tanks may be connected in series.

Depending upon the method of heating the batch process may be classified into four types.

1. **Water Jacketed Vat or Flooded tank system** : This is double walled around the sides and bottom in which hot water or steam under partial vacuum circulates for heating and cold water for cooling. The outer wall (lining) is usually insulated to reduce heat loss. The heat exchange takes place through the wall of the inner lining. The difference between the temperature of the heating water and the milk is kept to a minimum. The milk is agitated by slow moving (revolving) paddles / propellers. When heating, the vat cover is left open for escape of off flavours and when holding, the cover is closed. During the holding period, an air space / foam heater (steam or electrically heated) prevents surface cooling of milk.

Advantages : a) Flexibility is use (It is also known as a multipurpose or multi process vat).

2. **Water Spray type** : It consists of an inner tank for product surrounded by an outer tank to form space between the two. A film of hot water is sprayed from a perforated pipe over the outer surface of the tank holding the product. The product is agitated. A rapidly moving continuous

film of hot water provides rapid heat transfer. The temperature of hot water is kept about 72 oC to heat the product to 62oC. The speed of the agitation is 45 to 50 rpm. The over all heat transfer coefficient of a water spray heat exchanges is approximately 1000 k cal / hm2oc .
Advantage : a) Flexibility in use b) It provides quicker control.

3. **Coil-Vat type** : In this method the heating or cooling medium is pumped through a coil placed in either horizontal / or vertical position, while the coil is turned through the products. The turning coil at a speed of about 130 rpm agitates the product. The coil and walls of the tank is constructed of stainless steel. The side and bottom of the tank in insulated . Stream or hot water may be used for heating medium. The overall coefficient about 1000 k cal / hm2oc.
Disadvantage : Coils are difficult to clean, which accounts for decline in their use.

4. **High Velocity liquid type:** A heating or cooling medium is pumped at a high velocity over the outside surface of the tank through pipes surrounding the tank. Vat pasteurization are well suited for small plants and for low volume products. It can handle a variety of products with a wide range of physical characteristics. But vat pasteurization is a batch operation and is slow. It requires manual controls and constant attention must be given to prevent overheating and over holding. Regenerate heating is not possible so heating and cooling of products is relatively expensive.

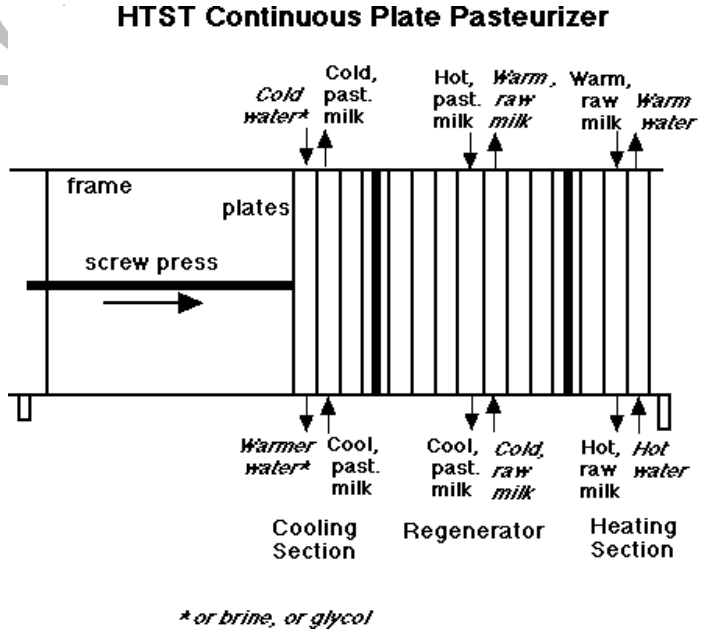
HTST PASTEURIZATION

The HTST system usually employs plate heat exchangers for heating, regeneration and cooling. In this method milk is heated to 72oC for 15 seconds. An HTST unit consists of a balance tank, a timing pump, a regeneration tank, a heating section, a holding section, a cooling section, a flow diversion value (FDV).

HTST pasteurizer was first developed by A.P.V.Co. in the U.K. in 1922.

Milk Flow: The following steps or stages are involved as milk passes through the HTST pasteurization system:-

Balance tank→ pumps → regenerative heating → heating → holding → regenerative cooling → and cooling by chill water or brine. An arrangement for incorporation of the filter / clarifier may be provided after regeneration I, homogenizer after regeneration II etc., in the circuit is also made when desired.



Advantages of HTST System:

1. Capacity to heat treat milk quickly and adequately, while maintaining rigid quality control over both the raw and finished product.
2. Less floor space required.
3. Lower initial cost.
4. Milk packing can start as soon as pasteurization begins, thus permitting more efficient use of labour for packing and distribution.
5. Easily cleaned and sanitized (system adopts well to CIP cleaning).
6. Lower operating costs.
7. Pasteurizing capacity can be increased at nominal cost.
8. Reduced milk losses due to closed system.

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9. Development of thermophiles not a problem as holding time is less.
10. The process can be interrupted and quickly restarted.
11. Automatic precision controls ensure positive pasteurization.
12. This imparts less cooked flavour to the milk.
13. It is well suited for regeneration heating and cooling.

Disadvantages :

1. The system is not well adopted to handling small quantities of several liquid milk products.
2. Gaskets requires constant attention for possible damage and lack of sanitization.
3. Complete drainage is not possible.
4. Margin of safety in the product sanitary control are so narrow that automatic control precision instrument are required in its operation.
5. Pasteurization efficiency of high thermoduric count raw milk is not as great as it is when the holder system is used.
6. Greater accumulation of milk stone in heating section (due to higher temperature of heating).

UHT PASTEURIZATION

Ultra High Temperature pasteurization (UHT) was developed in 1950's. In this method milk is heated to 135 - 150oc for no hold (a fraction of a second).

UHT process is carried out by two main ways.

1. Indirect heating system
2. Direct heating system.

Indirect Heating System: These are self contained continuous sterilizing plants, and are to some extent like the conventional HTST pasteurizing plants, although the operating pressure are higher. The heat is transmitted to the milk through a stainless steel wall. The heat exchanger may be of plate type, tabular coil type or sometimes scraped surface type. The heating medium in steam under pressure. Most of the plants employ either plate or double or triple concentric tube heat exchanger. The operating principle is same for all plants. The operating temperature is achieved by regeneration and indirect steam heating.

Advantages:

1. Produces the milk of high bacteriological quality.
2. Little effect on colour and flavour of milk.
3. Control system are simple compared to direct system.
4. Water and electricity requirements are less than direct system.
5. Stream consumption is same as in the direct system.

Disadvantages:

It forms deposits on the heating surfaces, which is difficult to clean.

Direct Heating System:

In this system product is heated by direct contact with steam. This is accomplished either by injecting steam into the product or by admitting the product in to a chamber containing an atmosphere of high pressure steam (infusion heaters). The injectors are smaller and less expensive than the infuses, but requires a higher operating temperature. The steam used must be of culinary quality and with some products, it may be necessary to remove the steam, which condenses in the product so that the original composition may be maintained. Milk is heated by mixing it directly with steam at high pressure, so that the steam is condensed and gives up its latent heat there by heating the milk almost instantaneously to 140 – 150oc. The excess water is removed by evaporation in a vacuum chamber and the milk is at the same time cooled by the extraction of latent heat. Undesirable volatile odours may also be removed during this evaporative cooling.

Advantages :

1. The plants will run for long period compared to indirect system without cleaning.
2. Produces good quality of product.
3. Off flavours are removed.
4. Able to process variety of products with little modifications.

Disadvantages :

1. High initial cost.
2. High operating cost.
3. More complex and so more difficult to operate.

Stassanization : This type of pasteurization is carried out in tabular heat exchanger consisting of three concentric tubes. The principle of its operation is that heating of milk to the desired temperature by passing it between two water heated pipes through the narrow space of 0.6 – 0.8 mm. The milk is heated to 74oc (165oF) for seven sec. The rest of the process is just like HTST system.

STERILIZATION OF MILK:

Sterilized milk may be defined as milk which has been heated to a temperature of 100oC or above or such lengths of time that it remains fit for human consumption for atleast 7 days at room temperature. Commercially sterilized milk must

a) Keep without deterioration for a sufficient period to satisfy commercial requirement.
b) Be free of micro organisms and toxins harmful to health of consumer.
c) Be free of any microorganisms capable to proliferate, it should not show any signs of bacterial growth.

Sterilization Systems and Plants:

There are three methods of milk sterilization as indicated bellow

a) Incontainer sterilization, in which milk is bottled and heated for 20 to 40 mts at temperature between 110 and 120oC.
b) Ultra high temperature process
c) Two-stage process, where the milk is first sterilized according to UHT process, then bottled and finally subjected to further heat treatment to destroy any spores which may have entered during bottling.

Flow Diagram of sterilization of Milk

Receiving milk
↓
Cooling to 5oC and bulk storage
↓
Pre-heating (35 – 40 oC)
↓
Cooling 5 oC↓
Standardization and storage 5 oC
↓
Preheating (60 oC)
↓
Homogenization (2500 psi at 60 oC)
↓
Clarification (60 oC)
↓
Filling and capping

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↓

Sterilization (108 – 111 oC / 25 – 30 mts)

↓

Cooling (Room Temperature)

↓

Storage (Room Temp)

HOMOGENIZATION DEFINITION - ADVANTAGES AND DISADVANTAGES

Homogenization refers to the processing of forcing the milk through a homogenizer with the object of sub-dividing the fat globules. Homogenized milk is milk, which has been treated in such a manner as to insure breakup of the fat globules to such an extent that after 48 hours of quiescent storage no visible cream separation occurs on the milk, and the fat percentage of the milk in the top 100 ml of milk is a quart of bottle, or of proportionate volumes in containers of other sizes, does not differ by more than 10 percent of itself from the fat percentage of the remaining milk, as determined after thorough mixing (In efficiently homogenized milk, the fat globules are sub divided to 2 microns or less in diameter).

Advantages

1. No formation of cream layer / plug.
2. Fat in milk does not churn due to rough handling or excessive agitation.
3. Better adopted for bulk dispensing, mixing not necessary.
4. More palatable due perhaps to brighter appearance, heavier body and richer flavour.
5. Produces soft curd and is better digested, hence recommended for infant feeding.
6. Less susceptible to oxidized flavour development.

Disadvantages

1. Increased cost of production.
2. Returned homogenized milk difficult to salvage, fat recovery is a problem.
3. Sediment appearance to a greater degree.
4. Curdling is cookery.
5. More susceptible to production of activated or sunshine flavor defect.
6. Greater tendency for milk seepage through bottle caps.

PACKING OF MILK (PREPACK) AND STORAGE

Fluid milk for immediate consumption is packed in glass, plastic or laminated container. The bottles are sealed with aluminium caps. Sachets are single service containers. The four sided tetra pack is a very effective package for fluid milk product.

ASEPTIC PACKING OF UHT MILK

A UHT sterilization system demands reliable aseptic filling avoiding bacterial contamination, because a good sterilization process can be completely nullified by it during and after filling. An aseptic packing system has three main requirements. The container material and any closure system must be adequately sterilized before filling, the filling must take place with uncontaminated sterilized product in a sterile atmosphere and the filled container must be sealed in the similar environment. All the parts must be connected together in such a way as to prevent contamination between the stages.

Distribution of milk

Distribution of milk is the last or final stage of the market milk industry and it means placing the product into the hands of the consumer. The quality of the product alone will not assure its wide distribution, which should be planned and executed intelligently.

Distribution facilities consist of: (i) the physical equipment and personnel required for

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transporting the products from the milk storage rooms to the consumer/retailer; (ii) sales promotion personnel; and (iii) advertising.

A successful distribution programme requires: (i) a product of high quality; (ii) an attractive package; (iii) neat and courteous route salesmen; (iv) delivery equipment of pleasing appearance; (v) efficient use of men and equipment; (vi) effective advertising.

All developed countries today invariably adopt the packaged milk distribution. Nevertheless, unpacked (i.e. loose) milk distribution is quite prevalent in developing countries, as in India. While the unorganized sector of the Indian dairy industry follows the loose milk distribution system, the organized sector pursues the pattern of developed countries.

Due to highly changeable temperatures during most seasons and the lack of refrigeration facilities at the every customer's home in India the milk have to be distributed twice daily. Unsold milk presents a problem of economic disposal. Under tropical conditions, as in India, the returned milk should not be sent again for sale as liquid milk since exposure to high temperatures during its inward and outward journeys subject it to quality deterioration and hence may cause consumer complaints. The unsold milk can be given for separation or utilized for preparation of dahi, etc.

Route organization

In larger organizations, wholesale and retail distribution is usually handled by separate personnel and equipment and loading of supply is made directly from the storage rooms through one or more doors or using a long loading platform with conveyors from the milk storage rooms. In case of small plant, the same vehicle may deliver both wholesale and retail supply. Using platform trolleys in the storage room with orders for the different routes makes loading of supply. The platform trolleys are then wheeled onto the loading platform and finally loaded into the delivery trucks

Wholesale: For economical operation, the truck should be utilized for a maximum number of hours per day for milk distribution. Wholesale routes handle larger volumes and have fewer stops likes Factories, hospitals, jails, restaurants, schools, etc.

Retail: In retail distribution small quantities are delivered at many places like stores, milk booths etc

Distribution systems:

These include (for both wholesale and retail sales) the following:

(i) Home delivery
(ii) Milk booths or distribution depots
(iii) Stores
(iv) Coin vending machines/ automatic dispensers
(v) Bulk supply

Coin vending machines/ automatic dispensers:

This dairy has set up milk vending booths in various parts of the city. In each booth there is installed an NDDB designed coin (token) operated milk vending machine, popularly known as the 'push button mini dairy'. The milk holding capacity of these machines varies from 1000 to 13000 litres each. The consumer is expected to bring his/her own container large enough to hold the milk. He/she is expected to go to the concessionaire and exchange money for metal tokens. The container is to be placed under the tap. On inserting the token into the slot, the button lights up. On pressing the button, the first half litre of milk flows out. The process is repeated to get the second milk installment by inserting another token, and so on. The dairy claims that this method enables it to pay more to the milk producers (on account of the savings effected in the cost of packaged milk distribution).

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Systems for collection for the payment of milk: These are credit, cash or advance payment (coupon/monthly, card). Their relative merits and demerits are given in Table

Comparison of different collection systems for the payment of milk

System	Merits	Demerits
Credit	i) Attractive to consumers (as on immediate payment and locking up of money) ii) Rapid deliveries iii) Accounting is easy	i) Losses through bad accounts. ii) Needs special check on amount delivered.
Cash	i) No losses through bad accounts as money collected on the spot.	i) Slows down deliveries as some customers may not bring correct change. ii) Less attractive to customers. iii) Counterfeit coins are a problem. iv) Carrying of large amounts of cash may be risky (for dairy staff.
Coupons	i) No losses through bad accounts. ii) Curbs corruption (especially on the part of dairy staff)	i) Slows down deliveries. ii) Increases the sale price of milk. iii) Less attractive to customers (as money locked up) iv) Final accounting is cumbersome. v) Special check needed for misuse of coupons (lost or stolen from rightful owner). vi) Chances of fraudulent printing of coupons.

Payment of route salesmen: Three different methods are in use:

(i) Flat salary. Gives no incentive to sell more products, secure new customers, etc.;
(ii) Salary plus commission: Most satisfactory;
(iii) Straight commission. Used when the driver owns the route and equipment.

What is organic milk?

No pesticide, antibiotics, hormones.
*Organic practices
*Healthy farm practices

***Organic practices:**

-Organic law strictly forbids hormones or antibiotics treatment of milch animals. When necessary, animals can be treated using homeopathy and aspirin.
-Environmentally safe plant: No use of any herbicides, pesticides or chemical fertilizers.

***Healthy farm practices:**

-Hard Management: Young (heifers) graze in the fields. Milking animals graze on a rotational basis during the spring, summer and fall.
-Balanced Diet: Working closely with an animal nutritionist to guarantee that our herd gets a properly balanced diet of grains, hay, legumes, silage and fresh grasses.
-Milking: Milk the three times a day, if the animal is high yielder, which reduces stress and

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PRACTICAL TO BE COVERED IN THEORY

- ✓ Sampling of milk,
- ✓ Estimation of fat,
- ✓ Solid not fat and total solids,
- ✓ COB,
- ✓ alcohol,
- ✓ acidity,
- ✓ pH,
- ✓ specific gravity,
- ✓ Sediments and
- ✓ Dye tests,
- ✓ Detection of adulteration and preservatives in milk.

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EXERCISE NO.1

SAMPLING OF MILK

A sample is a small portion of milk representing a particular batch/ quantity of milk as a whole.

Since milk is a heterogeneous mixture, because of different densities of its components, i.e. milk -fat and milk serum, it has to be mixed thoroughly for drawing a representative sample.

Objectives

Quality control of milk: -

a) Physico-chemical analysis

b) Bacteriological analysis

Apparatus

Plunger (Disc: 150 mm dia; length: 1 mts)

Sampling dipper (approx. 80 ml capacity)

Sampling tube (length: 600 mm; inside dia: 6 mm)

Sampling bottle (100/150/250 ml).

Procedure

The method of sampling is determined by the purpose and conditions under which sample is to be taken. Different methods of sampling are as follows:

(A) Sampling from individual container

- Mix the milk thoroughly with a plunger. Allow the plunger to fall to the bottom of the container and then bring near the surface of milk as rapidly as possible for not less than 10 times.

OR

- Pour the milk from one container to the other, three or four times. After thorough mixing draw the sample of milk immediately with the help of a dipper.

(B) Sampling from several containers

- Transfer the milk of all the containers into a vat. Mix the milk thoroughly with the help of a plunger and draw the sample with the help of a dipper.

OR

- Mix the milk thoroughly in the individual container with the help of a plunger. Draw proportionate quantity of sample from each container into another vessel. Thoroughly mix the milk samples collected in the vessel and draw final sample with the help of a dipper.

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(C) Sampling from bulk units

- When milk of uniform quality is supplied/carried in bulk units, select random numbers of containers/units to be sampled as per following table:

Total number of units	Random number of units to be selected
1	1
2-5	2
6-20	3
21-60	4
61-100	5
> 100	5+ 1(for each additional 100 units or a fraction thereof)

- Mix the milk of the randomly selected units thoroughly with the help of a plunger and draw sample as described under method (B) above.

(D) Sampling from storage tanks, rail or road tankers

- Mix the milk in the tank/tanker thoroughly by an electric agitator/ compressed air/with the help of a plunger. When plunger is used, it is thrust forward and pulled back, thrust downward and pulled back; thrust backward and pulled back. Repeat this cycle for at least 15 minutes.
- If necessary, determine uniformity of the sample by mixing till such time as complete agreement is achieved between samples taken from manhole and the outlet cock in respect of fat and total solids.
- After proper mixing draw the final sample from the stop cock.

(E) Composite milk sample

- To determine the fat and SNF of suppliers daily deliveries is laborious and expensive. So a composite sample can be taken over a period and then tested.
- Draw proportionate quantities of milk samples during the agreed period of sampling.
- Transfer the sample into the composite sample bottle daily.
- Preserve the composite sample by adding 0.1 ml (36 per cent) formaldehyde for each 25 ml of milk.
- Each time when fresh sample is added, mix the contents of bottle by rotating the bottle.

Precautions

- For chemical examination, the apparatus should be clean and dry.
- For bacteriological examination, the apparatus should be sterilized by heating in a hot-air oven at 160°C for two hours or by autoclaving at 120°C for minimum 15 minutes.
- For chemical examination, test the samples on the same day or store at less than 5^{O}C.
- For cryoscopic examination, use mercuric chloride as preservative
- Preservative should be indicated on the label.
- For bacteriological examination chill the samples immediately in an ice-bath to a temperature less than 5°C and maintain the sample at this temperature till examination.

EXERCISE NO.2

ORGANOLEPTIC TEST

The sensory evaluation of milk is of utmost importance to the market milk industry. The sale of fresh milk is a major activity of the Indian dairy industry. Since milk is consumed in the liquid state by all classes of people, it is judged daily by the consumers. All the five senses viz., sight, smell, taste, touch and sound are used in judging and grading of milk.

Objectives

To accept/reject raw milk on the basis of sensory observations

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Procedure

- Removal of lid of the can
- Smell the milk and lid in case of any doubt, taste it by putting a small quantity on the tongue and spit it out in a spittoon.
- Feel the coldness/warmth of milk from outside the can. In case of doubt, temperature may be observed with the help of a thermometer.
- Observe for any abnormality in colour and extraneous matter in milk

Observations

Smell/odour of milk
Taste of milk
Colour
Sediment
Temperature

EXERCISE NO.3

SEDIMENT TEST

Milk can be scored for sediment either by observing the particles of sediment which may have settled at the bottom of the bottle or by observing the sediment collected on a filter disc.

Objectives.

To assess the cleanliness of milk received

Apparatus

Sediment tester
Sediment discs
Standard sediment discs

Procedure

A. Off-bottom sediment test

- See the constructional features of the sediment tester for road tanker and cans.
- Insert sediment pad in the space provided. Dip the tester in milk up to bottom without disturbing the milk.
- By pulling out the plunger collect milk slowly from different parts of the bottom. Later, press the plunger down.
- Remove the sediment pad and compare with the standard sediment disc pads provided or find out the weight of sediment and grade the milk according to I.S.I. standards.

B. Mixed sample sediment test

- Insert sediment pad in the mixed sample sediment tester.
- Pass a known quantity of the milk (500 ml) through the pad.
- Remove the pad from tester.
- Compare the sediment pad with the standard pad provided or find out weight of sediment and grade the milk according to I.S.I. standards.

I.S.I. STANDARDS FOR GRADING OF MILK

Sediment Observations	Grade
0 .0 mg	Excellent
0 .2 mg	Good
0 .5 mg	Fair
1.0 mg	Poor
2.0 mg	Very poor

EXERCISE NO.4

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CLOT ON BOILING (COB) TEST OF MILK

The development of acid in milk by conversion of lactose to lactic acid makes the milk unstable to heat and milk coagulates on boiling. Generally, milk samples with more than 0.20% acidity give a positive COB test.

Objectives

To determine developed acidity

To know the heat stability for processing of milk

Apparatus

Test tube preferably with a mark at 5 ml

Test tube holder

Boiling water bath

Procedure

- Take about 5 ml of milk in the test tube.
- Bring it to boiling point in the water bath and hold for about five minutes.
- Remove the test tube and rotate it in an almost horizontal position.
- Examine the milk on sides of the test tube for precipitated particles or clots.
- Presence of precipitated particles or flakes is indicative of COB positive test.

Observations

Results of COB test

Interpretations

Sample = Negative/positive

EXERCISE NO.5

ALCOHOL AND ALCOHOL-ALIZARIAN TEST OF MILK

The salts of milk are in a particular ratio with each other. When this ratio is disturbed because of colostrum, late lactation or udder infection, milk becomes less stable to heat. Developed acidity also makes the milk unstable to heat.

A. ALCOHOL TEST

0bjectives

To study the stability of milk to processing particularly for condensing and sterilization.

To detect abnormal milk such as colostrum, late lactation, mastitic milk and milk with salt imbalance.

Apparatus

Test tube preferably with a mark at 5 and 10 ml

Reagents

Ethyl Alcohol: 68 % (w/v) or 75% (v/v)

Procedure

- Take 5 ml of milk in the test tube.
- Add 5 ml of ethyl alcohol.
- Mix the contents of the test tube by inverting 3-4 times.
- Observe the tube for any clots, flakes or precipitates.
- Presence of flakes or clots denotes a positive test.

Observations

Results of alcohol test

Sample = Negative/positive

B. ALCOHOL-ALIZARIAN TEST

Objectives

To assess the suitability of milk for high heat treatment and also to get idea about the acidity of

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milk.

Apparatus

Test tube

Reagents

Alcohol alizarine solution - 0.2 per cent

Procedure

- Take about 5 ml of milk in a test tube.
- Add equal amount of alcohol alizarin solution (0.2%).
- Mix the contents well.
- Observe for presence of flakes and colour of the contents.

Observations

Range of colour	Presence of flakes	Acidity Per cent
Red to yellow	-	0.18 - 0.36
Brown red	No	0.16
Reddish-brown	Small	0.20
Yellowish-brown	Small	0.24
Brownish-yellow	Large	0.28
Yellow	Large	0.36
Violet		alkaline

EXERCISE NO.6

pH OF MILK USING pH PAPER

Certain indicators show change in colour with the change in pH. The pH paper or strips are impregnated with these indicators such as bromothymol blue (pH 6.0 to 7.6) and bromocresol purple (pH 5.2 to 6.8). pH papers in narrow range and wide range are available.

Objectives

To study the freshness of milk.

Reagents

pH paper strips

Procedure

- Take a small quantity of milk in the test tube.
- Dip the pH strip in the milk.
- Compare the colour changes with standard chart and note the pH.

Precaution

- The results with pH paper are not precise and for more precision pH meter is used.
- The pH strips should be stored in a glass bottle properly stoppered in dry conditions.

Observations

pH

Sample No. = **Interpretation**

Normal milk pH is between 6.6-6.8. pH above 6.9 is indication of mastitic milk/late lactation milk.

EXERCISE NO.7

TITRABLE ACIDITY OF MILK

This test is based on the principle of titration that with similar normality, equal volumes of acid and alkali neutralize each other and the indicator indicates the end point of titration.

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Objectives

To study the quality of milk.

To study the heat stability and fitness of milk for processing

Apparatus

White porcelain dish - 60 ml capacity.

Pipette (10 ml and One ml)

Stirring glass rod

Burette with stand

Reagents

NaOH : 0.1 N

Phenolphthalein indicator: 1 per cent.

Procedure

- Mix the milk thoroughly taking care that no air bubbles are incorporated.
- Take 10 ml of milk with the help of a pipette in the porcelain dish
- Add 10 ml of boiled and cooled distilled water.
- Add 1.0 ml of the indicator solution.
- Titrate against 0.1 N NaOH with continuous stirring till the end point is reached. End point is the pink tint.
- Complete titration with in 20 seconds.
- Take three concordant readings.

Observations

Sample No.

Burette Readings		Volume of N/l0 NaOH used (ml)
Initial	Final	

Average volume = ml

Calculations

$$\% \text{ acidity of milk (as lactic acid)} = \frac{V_1}{V_2} \times N \times 0.09 \times 100$$

where

VI = Volume of 0.1 N NaOH used

V2 = Volume of milk taken

N = Normality of NaOH

EXERCISE NO.8

DETERMINATION OF FAT IN MILK BY GERBER METHOD

Concentrate sulphuric acid digests the proteins and liberates fat. This fat is collected in the fat column of the butyrometer tubes on centrifugation. Iso-amyl alcohol prevents charring of fat.

Objectives

To determine the composition of milk.

To make payments on the basis of fat.

Apparatus

- Milk butyrometer (10 per cent scale for whole milk and 1 per cent scale for skim milk)
- Milk pipette - 10.75 ml.
- Tilt measures or automatic measures: 10 ml, 1 ml.

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- Lock stopper and stopper key.
- Gerber centrifuge.
- Water bath at 65:1:2°C.

Reagents

Cone. H_2SO_4 (specific gravity 1.807-1.812)
Iso-amyl alcohol (specific gravity 0.814 - 0.816)

Procedure

- Warm the sample to 27±1°C and mix thoroughly by inverting sample bottle 3-4 times.
- Take 10 ml of H_2SO_4 into the butyrometer with the help of a tilt measure.
- Add 10.75 ml of milk to the butyrometer with the help of milk pipette in such a way that it forms a separate layer above the acid.
- Add 1.0 ml of isoamyl alcohol with the help of a tilt measure.
- Fix lock-stopper to the butyrometer with the help of stopper-key.
- Shake the butyrometer without inverting till the curd particles are completely dissolved.
- Invert the butyrometer 3-4 times to mix the contents thoroughly.
- Transfer the butyrometer to the water bath for 5 minutes.
- Centrifuge the butyrometer for 5 minutes at the speed of 1200 rpm.
- Take out the butyrometer and note the fat percent from the fat column.

Precautions

- Place the butyrometer in centrifuge diametrically so that it remains balanced.
- For homogenised milk, skim milk and butter milk samples, repeat the temperature adjustment before taking the reading.
- If second determination exceeds the first one, obtain third value for the fat content. Third value should not exceed by more than half the smallest scale division.

EXERCISE NO. 9

DETERMINATION OF THE SPECIFIC GRAVITY OF MILK WITH THE HELP OF A LACTOMETER

The lactometer used in this test is based on the Archemede's principle. If the milk sample is of less density it gives lesser reading and vice-versa. With the help of formulae specific gravity can be calculated from lactometer reading.

Objectives

To study adulteration of milk with water.

Apparatus

Lactometer (ISI)
Lactometer jar
Petri dish
Dairy floating thermometer

Procedure

- Rinse the lactometer and lactometer jar with the given milk sample.
- Fill the lactometer jar with the given milk sample taking care that no incorporation of air bubble takes place.
- Immerse the lactometer gently in the milk in the jar.
- Note down the lactometer reading.
- Take out the lactometer and note down the temperature of milk with the help of thermometer.
- Find out corrected lactometer reading (CLR) with the help of formula.
- Calculate specific gravity from CLR.

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Precautions

- Lactometer reading should be taken at least about 2 hours after milking, when nearly all air, incorporated during milking has escaped.
- Because of surface tension, milk sticks and rises above the actual lactometer reading mark making it invisible. This is around 0.5 above the actual reading and the lactometer reading should be recorded accordingly.
- Before taking the lactometer reading bring the temperature of milk in the range of the temperature of calibration of the lactometer, i.e. 29°C.
- If the sample had been refrigerated warm the sample to 40°C and cool down to about 29°C, which is the temperature of calibration of lactometer.

Observations

Sample No. Lactometer reading Temp (0C)

1

Calculations

(a) CLR = LR + (T -29) x 0.3

where

T is the temperature of milk sample in °C.

Sample No. CLR

$$\text{(b) Specific gravity} = 1 + \left(\frac{\text{CLR}}{1000}\right)$$

Sample No. Specific gravity

EXERCISE NO. 10

DETERMINATION OF TOTAL SOLIDS (T.S.) % AND SNF (SOLIDS-NOT-FAT) % IN THE, GIVEN MILK SAMPLE WITH THE HELP OF A LACTOMETER

Milk drawn from the udder of an animal entraps a large volume of air bubbles, and the fat undergoes a gradual solidification. Due to these factors, a gradual concentration in the volume of milk takes place with a minor and slow increase in the density. The density of milk will vary with the duration and temperature of storage. This variation may be overcome by warming the milk to about 40°C and then adjusting to the desired temperature for lactometer reading.

Objectives

To study the adulteration of milk with water.

To know the chemical quality of milk.

Apparatus

Lactometer (ISI)

Lactometer jar

Petri dish

Dairy thermometer

Fat testing apparatus

Procedure

- Take the lactometer reading and find out the CLR as discussed in Exercise No. 10.
- Find out the fat percent by Gerber method as discussed in Exercise No.9.
- With the help of CLR and fat %, calculate the TS % and SNF %.

Observations

Sample No. Lactometer reading Temp(C) Fat %

1

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Calculations

(a) CLR

Sample No. CLR

1

$$\text{(b) TS\%} = \frac{\text{CLR}}{4} + 1.25\,F + 0.44 \text{ at } 29°C$$

where

F is the fat percent of the sample.

Sample No. TS%

1

$$\text{(C) SNF \%} = \frac{\text{CLR}}{4} + 0.25\,F + 0.44 \text{ at } 29°\,c$$

where

F is the fat per cent of the sample.

Sample No. SNF%

1

EXERCISE NO. 11

DETECTION OF ADDED WATER IN MILK

Water is added by unscrupulous traders to increase the volume of milk and thus make more money by unfair means. When water is added to milk the values for, fat and SNF per cent are reduced and with the help of these values, added water can be detected and calculated.

Objective

Quality control of milk.

Apparatus

Fat testing apparatus

Specific gravity and SNF testing apparatus

Procedure

- Test the sample for fat % as per the procedure given in Exercise 8.
- Test the sample for SNF % as per the procedure given in Exercise 10.

Observations

Cow milk

Sample No. Fat % SNF%

1

Buffalo milk

Sample No. Fat % SNF%

1

Calculations

$$\text{(a) Per cent adulteration in cow milk with water on the basis of fat} = \frac{4-F}{4} \times 100$$

where, F is the fat % of sample.

Results:

Sample No. % water in sample

1

8.5 - S

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(b) Per cent adulteration in cow milk with water on the basis of SNF = $\frac{\text{S}}{8.5} \times 100$

where, S is the SNF % of sample.

Results:

Sample No. % water in sample

1

(c) Per cent water in buffaloes milk on the basis of fat = $\frac{6-\text{F}}{6} \times 100$

where, F is the fat % of the sample.

Results:

Sample No. % water in milk

1

(d) Per cent water in buffalo milk on the basis of SNF = $\frac{9-\text{S}}{9} \times 100$

where, S is the SNF % of sample.

Results:

Sample % water in milk

EXERCISE NO. 12

DETECTION OF STARCH IN MILK

Starch is added by the dishonest traders to mask the adulteration of milk with water and escape detection by visual appearance or by a Lactometer, as it increases the viscosity and lactometer reading. Starch reacts with iodine to give blue colour and is tested accordingly.

Objective

Quality control of milk.

Apparatus

Test tube

Test tube holder

Boiling water bath

Reagents

1 % iodine solution

Procedure

- Take 5 ml of milk in a test tube
- Bring it to boiling point in the water bath.
- Cool down under tap water.
- Add few drops of the iodine solution. Appearance of blue colour, indicates starch in milk.

Observations

Sample No. Negative/ positive

EXERCISE NO. 13

DETECTION OF CANE SUGAR IN MILK

Sugar is added to increase the density to prevent detection of added water. It is tested chemically with the help of resorcinol and HCL.

Objective

Quality control of milk.

Apparatus
Test tube
Test tube holder
Boiling water bath
Reagents
Resocinol powder/flakes
Conc. HCI
Procedure

- Take 15 ml of milk in a test tube.
- Add one ml of conc. HCL and mix.
- Now add 0.1 g (say a pinch) of resocinol and mix.
- Place the tube in water bath for five minutes. If cane sugar is present a red colour will appear.

Observations
Sample No. Negative/positive

EXERCISE NO. 14

DETECTION OF PRESERVATIVES IN MILK

Preservatives are added illegally by the milk traders to prolong the shelflife of milk. These are either bacteriostatic or bactericidal in action and thus prevents acid formation and hence spoilage of milk. The most common preservatives used are formalin and H2O2.

Objective
To detect preservatives in milk.
(a) Formalin
Apparatus
Test tube
Pippete
Reagents
Conc. H2SO4
Ferric chloride solution
Procedure

- Take 10 ml of milk in a test tube.
- Add few drops of ferric chloride solution and mix well.
- Add 5 ml of conc. H2SO4 from side of test tube in such a manner that it forms a layer at the bottom of solution.
- Appearance of violet or blue ring at the junction of milk and acid indicates the presence of formalin in milk.

Observations Present/ Absent
(b) H_2O_2
Apparatus
Test tube
Reagents
Paraphenylene-diamine solution 2% (w/v)
Procedure

- Take about 5 ml of milk sample in the test tube.
- Add few drops of Paraphenylene-diamine solution.
- Appearance of blue colour indicates the presence of H202 in

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Observations Present/ Absent

DETECTION OF NEUTRALISERS IN MILK

Neutralisers are added by milk traders as a malpractice to neutralize the developed acidity so that milk does not coagulate on boiling. The most common neutralisers are carbonates and bicarbonates.

Objective

To detect milk neutralised with carbonates or bicarbonates.

Apparatus

Test tube

Reagents

Diluted HCI

Ethyl alcohol

Rosalic acid solution (1 %)

Procedure- I

- Take about 5 ml of milk in the test tube.
- Add few drops of HCl to it.
- A brisk effervescence indicates presence of carbonates or bicarbonates in milk.

Observations Present/ Absent

Sample No.

Procedure - II

- Take about 5 ml of milk in a test tube.
- Add equal amount of ethyl alcohol (75%) and 3-4 drops of rosalic acid (1 % acqous solution).
- Mix well and observe the colour.
- Presence of rose like colour indicates the presence of carbonates/ bicarbonates in milk.

Observations Present/ Absent

DETERMINATION OF ADDED UREA IN A GIVEN SAMPLE OF MILK

Vendors/retailers frequently adulterate milk with various materials to make profit by fraudulent practices. Urea based synthetic milk is added into milk to increase its volume. Urea added to milk may be detected by adding sodium hydroxide followed by sodium hypochloride and phenol solutions to protein free filterate of milk, which gives the characteristics bluish green colour for urea which persist for 12 hr.

Material required

Glass funnel

Test tube, *test* tube stand

Filter paper Whatman No.-42

Sodium hypo chloride solution 2% (w/v)

Sodium hydroxide 2% (w/v)

Phenol solution 5% (w/v)

Trichloroacetic acid solution (TCA) - 24% (w/v)

Buffer (sodium acetate - acetic acid buffer). Mix equal volume of 1 N sodium acetate and 1 N acetic acid (pH 4.75)

Procedure

- Take 5 ml of milk in a 50 ml conical flask.
- Add 5 ml of sodium acetate - acetic acid buffer or TCA (24%) solution.
- Heat the contents for 3 minutes. (No heating required in the case of TCA).

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- Filter the contents through whatman NO.42 filter paper.
- Collect 1 ml of filtrate in a test tube.
- Add to this 1 ml of sodium hydroxide solution and 0.5 ml sodium hypochloride solution.
- Mix thoroughly.
- Add 0.5 ml of phenol solution.
- Observe for the change in colour, if bluish green colour appears and persists then added urea is +ve.

Observations Present/ Absent

Composition meat, poultry and egg

Food	Water	Protein	Fat	Carbo	Ash
Meat					
Pork	42	11.9	45.0	-	0.6
Lamb	56	15.7	27.7	-	0.8
Beef	60	17.5	22.0	-	0.9
Veal	66	18,8	14.0	-	1.0
Horse	74	20.0	4.0	1.0	1.0
Poultry					
Chicken	66.0	20.2	12.6	-	1.0
Duck	52.8	16.2	30.0	-	1.0
Turkey	58.3	20.1	20.2	-	1.0
Eggs				**%age of wt**	
Whole egg	65.5	11.8	11.0	100	1.7
White	88.0	11.0	0.2	58	0.8
Yolk	48.0	17.5	32.5	31	2.0
	Ca carbonate	Mg carbonate	Ca phosphate		Organic matter
Shell	94.0	1.0	1.0	11	4.0

Handling, storage and distribution of Egg

Egg consists of - Albumin- 60 % (56 - 61 %), yolk- 30 % (27-32 %), shell – 10 % (8-11%)

Nutritive value of egg

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1 Protein- one normal sized egg (50 g without shell) provides 6-7 g of high quality protein which is rich in all essential amino acids. One egg provides essential amino acids equivalent to 200 g of milk.
2. Lipids – they are 33 % saturated, 66 % unsaturated. One egg contains 5-6 g of lipids. Important source of unsaturated fatty acid (mainly oleic)
3. Carbohydrate- very less about 0.36 g. egg is a low calorie food.
4. Vitamins- all essential vitamins are present except vitamin C. Riboflavin, pantothenic acid, B - 6 and vitamin A are present in higher amount.
5. Minerals- Phosphorous and iron are comparatively higher. Trace minerals.

One whole fresh raw egg provides 79.9 calories which is equivalent to one chapatti. Albumin of fresh raw egg provides 15.7 calories. Yolk of fresh raw egg provides 63.7 calories

QUALITY OF EGGS

At the time of laying, eggs may be considered as food of highest quality. Since eggs are rich in all the nutrients, which are required for the growth of microbes, deteriorative changes start soon after laying which may severely affect the sensory attributes of egg.

EXTERNAL QUALITY

- A normal chicken egg is ovate in shape.
- Wide variation in shape may lead to breakages during handling and transport. For easy transportation and merchandising of egg, the egg should possess normal external characteristic. If shape and size are abnormal, the eggs are liable to break.
- Similarly, thin shell and weak shell egg or shell less eggs are liable to break and are unfit for transportation.
- Moreover, eggs with thin shells lose their quality quickly.
- Shell colour and other external characteristics will determine the market acceptability. Clean eggs will be sold at premium price, than dirty eggs.
- The external characteristics of the egg will be assessed by the following methods:
    1. Egg size/ weight
    2. Shape
    3. Shell colour & Texture
    4. Cleanliness
    5. Volume
    6. Specific gravity
    7. Surface area

Egg size or weight

- ✓ Each species of bird has its own standard egg weight.
- ✓ Similarly the egg weight varies between breed and age of the bird.
- ✓ Heavier birds produce heavier egg.
- ✓ A normal chicken egg weighs 55-60gm depending upon the breed and age.
- ✓ The chicken egg will be about 1/30th of the hen's body weight.
- ✓ In case of ducks, the egg weight ranges from 65-70gm, depending upon the breed.
- ✓ When compared to chicken, ducks lay heavier eggs which will weigh 1/25th of its body weight.
- ✓ Goose lay eggs weighing 130-200gm, depending upon the breed.
- ✓ Japanese quail eggs will weigh around 10gm, which will be about 1/15th of its adult body weight.

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- ✓ When compared to body size, Japanese quail lay heavier egg than other species.
- ✓ Turkey egg will weigh 65-70g, ad it is only about 1/60th of its body weight.
- ✓ In all species of birds, older birds lay heavier eggs than younger birds.
- ✓ Record the weight of egg provided to 0.1gm accuracy using triple beam balance.
- ✓ Sometimes the egg size will be extremely small or large as in the case of yolk less/ double yolked eggs which are difficult to transport because they will break during transit.
- ✓ They are sold in the farm itself.

Grading of chicken eggs

- ✓ Eggs are graded and marketed based on
  - o weight and
  - o quality

BIS standards based on weight

- ✓ Extra large - 60 g and above
- ✓ Large - 53 to 59 g
- ✓ Medium - 45 to 52 g
- ✓ Small - 38 – 44 g

As per BIS standards there are 2 quality grades namely A and B

Grade		Weight/egg (gm	Shell	Air cell	White	yolk
Quality grade	Weight grade					
A	Extra large	60&above	Clear, unbroken and sound. Shape is normal	Up to 4 mm in depth. Practically normal	Clear reasonably firm	Fairly well centred. Practically free from defects, outline indistinct
A	Large	53 to 59				
A	Medium	45 to 52				
A	Small	38 to 44				
B	Extra large	60&above	Clear to moderately stained and sound, shape is slightly abnormal	8 mm in depth, may be free and slightly bubbly	Clear, may be slightly weak	May be slightly off centered. Outline slightly visible
B	Large	53 to 59				
B	Medium	45 to 52				
B	Small	38 to 44				

Shape

- ✓ The usual egg shape is "ovate".
- ✓ The shape of the egg plays a major role in packing and transport.
- ✓ The normal shape of an egg can be marred due to diseases like Ranikhet and Infectious Bronchitis.
- ✓ Too small or too large eggs are discarded in the farm itself.

Shell colour and texture

- ✓ It indicates smoothness and roughness of shell surface and also indicates shell quality.
- ✓ Shell colour is due to the presence of pigments. Ooporphyrin gives brownish colour to the egg shell, which is normally seen in eggs laid by the Asian, the English and the American Class of birds.

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- ✓ The pigments Oocyan causes other blue colour in eggs seen in eggs laid by the breed Aracauna.

Cleanliness

- ✓ This is essential for consumer satisfaction and also to improve and maintain the keeping quality.
- ✓ A dirty egg may harbour harmful microbes which will spoil the egg and render it unfit for consumption.
- ✓ Eggs collected from deep litter will be more dirty than caged eggs, obviously due to dirty wet litter and delayed collection of eggs

Stained or dirty eggs should be cleaned by 1.Dry cleaning (rubbing the surface with sand paper) 2. Wet cleaning- Egg washing is simplest and most effective method. Egg wash water temperature should be at least 11^0C higher than egg temperature. A temperature of 35^0C of water is optimum. Detergents and sanitizers can also be used in water (temperature of water lower than that of egg causes shrinkage of egg content and sucking in of water along with microbes).

INTERNAL QUALITY OF EGGS

Candling is done to observe the internal qualities of eggs though a source of light such as depth of air cell, free or movable air cell, bubbly air cell, blood spots and meat spots in the egg, etc.

- ✓ Depth of air cell
  - o The depth of the air cell is the distance from its top to its bottom when the egg is held air cell upward.
- ✓ Free air cell
  - o An air cell that moves freely towards the upper most point in the egg as the egg is rotated slowly.
- ✓ Bubbly air cell
  - o A ruptured air cell resulting in one or smaller separator air bubbles usually floating beneath the main air cell.

Rate of change in albumin and yolk is function of temperature and movement of CO_2 through shell. To reduce the rate of CO_2 and moisture loss, various shell treatments have been used. Oil spraying is a common practice. Light mineral oil (colorless, odorless, low viscocity) is sprayed within a few hours of production as the rate of CO_2 loss is very high during first few hours. Rate of weight loss is higher in first few days.

Relative Humidity- high relative humidity of 70-80 % is maintained to prevent weight loss.

CANDLE OF EGGS

Candling is a method used to observe the growth and development of an embryo inside an egg which uses a bright light source behind the egg to show details through the shell. It is so called because the original sources of light used were candles. Modern egg candlers or candling lamps are lights with a concentrated beam. LEDs are now preferred because they are very bright, very efficient and have an extremely long life - so no bulbs to replace and the convenience of compact, portable battery powered units which can be used right in the nest. They also put out a cool light rather than a lot of heat that might damage the embryos.

Understand why you need to candle your eggs

1. Proper hatching:

During hatching of eggs, it is good practice to keep track of how the eggs are developing. However, this can be very difficult (if not impossible) without the use of candling.

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- During hatching of eggs at home, it is not impossible to get a 100% hatch rate. Some eggs will not be fertile to begin with (these are called "yolkers") while others will stop developing at some point during the incubation process (these are known as "quitters").

Candling make it possible to identify and remove these yolkers and quitters during the incubation process, otherwise they can begin to rot and eventually burst inside the incubator, contaminating the other eggs with bacteria and creating a very bad smell

SPOILAGE OF EGGS

As egg ages, water migrates from albumin to yolk. Rate of water transfer is a function of holding temperature (higher temperature - higher rate). Migration of water to yolk results in stretching and weakening of vitelline membrane and ultimately its rupture. There is slow movement of lipid material from yolk to albumin. A final consideration in the preservation of egg quality is the maintenance of flavor. Egg picks up flavor very easily from other materials like apples, oranges, decaying vegetables, oil, gasoline, organic solvent. Eggs with such acquired off flavor become unusable. Intensity of stale flavor is more in egg dipped in egg coating oil.

The major cause of spoilage in egg is microbial decomposition. The major spoilage bacteria are species of Pseudomonas, Proteus and Alcaligenes.

Transportation:

Rough handling and vibrations during transportation cause thinning of thick albumin, tremulous and free air cells, eccentric yolk etc.

Methods of preservation

1. **Thermostabilization-** it is coagulating a thin layer of albumin immediately below shell membrane which acts as a moisture and gas barrier. It is similar to oil coating where a protective cover is on the shell. Best results are obtained by holding eggs in an oil bath maintained at 55^0C for 15 minutes or for 8-10 minutes at 58 ^{0}C.
2. **Coating & dipping:** Coating of eggs with casein, wax, dipping in saturated solution of **lime** (lime coating), sodium silicate in water (1: 10 ratio) (water glass coating)
3. **Flash heat treatment-** by immersing eggs in hot water maintained at 160^0F/71^0C for 2-3 seconds. Bacteria present on surface of shell are destroyed and a thin film of albumin just below the shell membrane is coagulated sealing the egg shell from inside.
4. **Cold storage:** This is the best and most efficient method for commercial storage. Eggs for cold storage must be clean, unbroken, and free from fungus and other infections. A temperature of 0oC or 30-32oF and relative humidity of 85-90% is recommended for cold storage of eggs to preserve them for 5 to 8 months. For short period of preservation of 2 to 3 months, eggs can be stored at 10-12oC or 50-55Of with a relative humidity of 60-70%. Intact eggs are held at the lowest possible temperature that will avoid freezing and bursting of the shells. It has been observed that intact eggs do not freeze at temperature between -1.5oC and -2oC and the relative humidity must not go beyond 90%.
5. **Dried and frozen eggs:** This is another method of preserving egg contents or edible eggs. Egg products of commercial utility are prepared by drying or freezing eggs. Albumin flakes, yolk and egg white powder can be produced by drying process. Frozen yolk or frozen egg white can be produced by freezing. For egg white powder production the best known method is spray drying and for albumin flakes, pan or cabinet drying method is mostly adopted.

Egg handling for quality preservation can be summarized as follows:

1. By frequent gathering- three to four gatherings per day as this results in less breakage, fewer dirty eggs and more rapid cooling.

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2. By proper cooling- clean all eggs after gathering, then cooling for 12-24 hrs to at least 13^0C (better 10^0C) before packaging in cases. Lower temperature than 10^0C may cause sweating of eggs when they are removed from coolers.
3. Holding under controlled humidity – relative humidity in holding rooms should be 70 to 80 %. If below 60 %, it causes more moisture loss and above 85 % helps in mould development.
4. By careful handling – to avoid breakage and to prevent damage to air cell as well as interior structure, they should be handled carefully.
5. By proper packaging- it is important to package all eggs. Large end should be uppermost and it is important to see that trays fit smugly. It is also important to pack all eggs in pre-cooled containers. Only containers should be held in coolers overnight.
6. By frequent marketing- twice per week marketing is essential to shorten period between production and consumption. Insulated and refrigerated trucks should be used for transportation.
7. By up to date merchandising- adequate refrigerated holding space at retail outlet. Sale should be from refrigerated counter. All eggs should be cartooned attractively and marked for grades, brands etc. to increase the sale.
8. Proper care at home- holding all eggs in home refrigerators until required for use. For best results, holding time should not be beyond one week..

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Handling, storage and distribution of meat

SOURCES OF FOOD ANIMALS

- Food animals are all animals that are used for human consumption.
- They may be mainly herbivorous animals.
- Food animals are generally of two types viz., Conventional food animals(cattle, buffalo, sheep, goats and pigs) and non-conventional food animals (musk oxen, yak, deer, reindeer, horses, camels, alpaca, llama and vicuna).
- The animals suitable for the food of man should have cloven footed hoof and chew the cud.
- In addition, poultry (chicken, ducks, geese, turkey, pigeons, emu, etc) have become major meat producing species.
- Food animals are kept primarily for the production of meat but they often yield additional products of sufficient value to influence the economics of the total process.

Kind of animals	Carcass yield (%)
Cattle	50 to 54
Sheep and Goat	35 to 50
Veal	63
Pig	65 - 70

- The *carcass yield or dressing percentage* is expressed as a percentage of the live weight of the animals.

  Dressing percentage = ((Live weight of the animal - dressed weight) / live weight) x 100

An purpose to make meat cuts is **to preserve the meat.**

DESCRIPTION OF FOOD ANIMALS

Cattle

- In India, cattle are reared mainly for milk production and draught purpose.

- Slaughter of cow is banned by law in most of the states of India except in Kerala and West Bengal. Slaughter of bullocks does take place at most of the places. Carcass yield varies from50 to 54% depending upon the condition of the animal.

Buffalo

- Indian buffaloes are primarily reared for milk production and slaughtered after their productive period.
- There is a good demand for buffalo meat among the Middle East countries and Malaysia.
- Male buffalo calves with proper feeding and management offer vast potential for good quality and better-priced meat for export. A dressing percentage of 50% is obtained from well-maintained male buffalo calves of less than 3 months of age. The average dressing percentage of Indian buffaloes varies from 50 to 55%.

Sheep

- In arid, semi-arid and mountainous areas of our country which are not suitable for crop farming, sheep are primarily reared both for wool and meat.
- Sometimes milk is also obtained from sheep.
- Sheep and goat skins are fairly valuable and about 90% are recovered from slaughter.
- Almost 5% of total meat is derived from this species by slaughter of 33% sheep population every year.
- India stands third in sheep population in the world with vast genetic resource of as many as 40 breeds.
- In general, an average Indian sheep weighs between 13 to 16 kg at 6 months of age except for *Deccani* and *Magra* (both are dual purpose breed for mutton and carpet wool), which weigh about 20 kg.
- At 12 months of age the average weight varies from 18 to 22 kg except for *Muzaffarnagri* (dual purpose) and *Magra* , which weigh 25 and 28 kg, respectively.
- The dressing percentage of sheep is about 45 to 48%, which may go up to 50% in a well-bred stock.

Goats

- India ranks second largest in the world goat population.
- Since 90 % of goat population is found in Asian countries it is referred as *Asian Animal.*
- It is also regarded as the *poor man's cow* and it has got the distinction of being the most important meat animal of India.
- It forms the choicest of all meats fetching the maximum retail price in the Indian market.
- The preslaughter weight of goats varies from 12 –to 20 kg depending on the size of the breeds.
- Most of the Indian breeds are medium sized.
- The dressing percentage also varies from 43 to 50%
- Tellichery due to its compact body and short stature has a dressing yield of 48-50%.
- Black Bengal and Barbari breeds produce good quality meat and skin.
- Sirohi and Marwari breeds have a meaty conformation.

Pigs

- China has maximum population of pigs.
- Chief characteristic of Pig is that it mature earlier than any other domestic animal i.e. in about 8 months. It has greater power of reproduction and will produce on an average 11pigs per litter and sow produces 2,2 litters per year so one sow produces about 20-22 piglets in a year.
- Pigs should be slaughtered at 6-7 months of age.

- The dressing percentage varies from 65 to 70% in case of desi pigs and 70 to 75% in case of crossbred pigs.
- Breeds of pigs are Landrace, Large white, Large black, British saddle back, Pietrain

Rabbit

- Rabbit is gaining importance among the Indian consumers of the hilly tracks as an alternate source of meat.
- Rabbits are highly prolific, grow rapidly and produce meat from cheap roughages.
- The average live weight ranges from 1.2 to 1.5 kg at 8 weeks and nearly 2 kg at 12 weeks.
- The carcass yield varies from 52 to 58% in different grades.
- Rabbit carcass contains 82% lean meat, which is white in colour and soft in consistency.
- It is comparatively low in sodium and rich in potassium and phosphorus.
- The saturated fatty acids account for more than 60% of the total fatty acids whereas free cholesterol is also relatively low.

Poultry

- Indian poultry industry has made a phenomenal progress in the last few decades.
- It has transformed into a sophisticated industry quite rapidly after the establishment of several franchise hatcheries in 1970s.
- The broilers have a dressing percentage of 65-70%.
- Broiler meat is a true delicacy while it is available at comparatively lower price than chevon or mutton.
- But turkey, ducks, gease and guinea fowl are also reared.

Japanese Quails

- This is another species of poultry, which is gaining importance and growing fast.
- It gains a weight of about 125 Gms at 5 weeks of age. The dressing percentage is about 60.

Common terms used in meat:

Abattoir a building which is licensed for the slaughter of animals and initial preparation of carcases for human consumption, also commonly called a slaughterhouse.

Lairage: accommodation for animals awaiting slaughter (called a lairage)

Bone is the hard, rigid structural tissue that forms the skeleton of an animal.

Ageing (conditioning, maturation, or hanging) the holding of carcases or primal joints at refrigerated temperatures (0 to 4 °C) to improve eating quality (particularly tenderness and flavour).

Beef the meat of all cattle, other than from the young calf (under 8 months of age) which is referred to as veal.

Cattle cow/ buffalo 'Cow/ buffalo beef' comes from animals at the end of their useful period of milk production, usually 5-8 years old at slaughter.

Calf Male calves and many of the females are surplus to the requirement which provides **veal** (Meat from calf). calves grown to 3-4 months (bobby calf, bobby veal - up to 3 months old).

Steer, bullock Males grown to meat weights (450 kg live weight or more).

Bacon meat from the pig which has been preserved by curing with salt, nitrite and/or nitrate.

Pork meat from the pig

Boars The meat of boars which have been used for breeding is usually strongly tainted with the smell of male sex hormone ('boar taint'). Young, uncastrated males, slaughtered at or before puberty, have good feed conversion and conformation and may be free from this taint.

Sheep meat is known as mutton

Goat meat is known as chevon

CARE AND HANDLING OF MEAT ANIMALS

Care of meat animals is get meat of good quality. There are three stages through which animals before slaughter:

1. Live stock housing
2. Transportation
3. Pre slaughter care

Live stock housing:

Basic requirements for welfare of housing of livestock are as under:

1. Provide adequate food, water and care to protect the health and well-being of animals.
2. Proper environment and adequate housing with proper ventilation
3. During extreme weather conditions, cattle should have access to well-drained resting areas and/or to natural or constructed shelter.
4. Provide facilities that allow safe, humane, and efficient movement and / or restraint of livestock.
5. Rapid implementation of herd health programs that address the prevention and treatment of disease.
6. Sufficient light for insection.
7. Provide personnel with training to properly handle and care for cattle.
8. Make timely observations of livestock to ensure basic needs are being met.
9. Flooring should be good which do not harm the animals
10. Wall should be made of material which can be clean easily.
11. There should not be sharp edges in the houses.
12. There should be proper waste disposal facilities.

Transportation:

- The movement of cattle to and from farms, ranches, feedlots and marketing facilities is an important aspect of beef cattle production.
- Proper handling and transportation are important for the safety and welfare of the animals being moved.
- When loading and unloading cattle, personnel should move cattle as quietly and patiently as possible to prevent stress or injury.
- Cattle should be separated by size or gender prior to shipping, and if possible, different groups loaded into separate compartments of the truck or trailer.
- To prevent livestock from falling while in transit, the ride should be a smooth as possible.
- Drivers should avoid sudden starts/stops and sharp turns. Moreover, the floors of trucks and trailers should be clean and slip resistant. While in transit, occasional stops should be made to ensure that cattle are well dispersed and still standing. Severe weather conditions must be considered when transporting livestock.
- As appropriate, adequate ventilation and protection should be provided during transit.
- Provide transportation that avoids undue stress caused by overcrowding, excess time in transit or improper handling during loading and unloading.

PRE SLAUGHTER CARE OF MEAT ANIMALS

Rest: It is necessary to give rest to the animals before slaughter otherwise keeping quality of meat will be reduced. If animals are not rested before slaughter there meat will appear dark, firm and dry (DFD). So a period of 12-24 hrs with a maximum of 36 hrs should be given to animal to maintain the glycogen level in body which is required to convert in lactic acid to attain the optimum pH (5.6) of meat.

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Water: Animal should be given adequate water during rest period so that the bacterial load in intestine is reduced and flush out the intestine content after slaughter.

Feeding: Animal should be fed with sugars after transport to restore the glycogen in the muscle so that ultimate pH (5.6) is achieved.

Fasting: Animal should be fasted for 16-24 hrs before slaughter so that intestines are clean and during slaughter chances of rupture of intestines are reduced.

SLAUGHTERING TECHNIQUES

HUMANE SLAUGHTER

According to slaughter of animals regulations and European Council directives cruelty to animals must be prevented in slaughter house. So animal must be stunned before slaughter so that unconsciousness occurs. This is called humane method of slaughter.

Stunning: It is defined as a process affected by a mechanically operated instrument, electricity or gas anesthesia, without adverse effect on the condition of meat or the offals, which when applied to the animal puts it into a state of insensitivity which lasts until it is slaughtered, thus sparing it in any event needless suffering.

The following methods of stunning are:

Captive bolt pistol

A bolt is attached to the pistol which is propelled forwarded on discharge of the blank cartridge and automatically recoils back into the barrel. Unconsciousness is produced due to sudden jerk known as Acceleration concussion. It is very effective in cattle, sheep and calves but less in pigs because of thick frontal bone.

Free bullet pistol

Bullet is fired from the close range. Bullets may be of hollow pointed type plastic missiles or powdered iron bullets.

Site of shooting: Same as in captive bolt pistol.

Disadvantages:

1. There is destruction of brain tissue so it can not be used for edible purpose.
2. Chances of injury to operators are more.

Pithing

After cattle are stunned, they were usually pithed before bleeding. A long rod is inserted in hole made by penetrating bolts of the pistol. This destroys the medulla oblongata and therefore minimizing reflex muscular action which takes place during sticking and dressing of the carcass.

Carbon dioxide gas anesthesia

This gas blocks the nerve ending and reduces the speed of nerve impulse. Concentration of 65-70% in air is most suitable for pre slaughter anesthesia. This method is used in pigs.

Electrical stunning

It is most widely used method of stunning. This method consists of passing a low (75) voltage current through the brain of animal. Time of application should be 10 sec. Instrument used for passing current resemble a pair of tongs. This method is best for pigs, sheep and goat.

SCIENTIFIC METHOD OF SLAUGHTER: the following steps must be followed**.**

1. Pre slaughter resting and fasting.
2. Ante mortem examination
3. Stunning
4. Sticking
5. Legging
6. Dressing
7. Evisceration

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8. PM Examination
9. Wiping out
10. Chilling

Specifications for removal of offals

Following offals shall be removed

1. Skin
2. Head and tongue
3. Paunch and guts
4. Caul and gut fat
5. Liver, melt (spleen), heart, lungs and trachea
6. Heart or breast fat
7. Sweet breads
8. Genito-urinary organs excluding kidney
9. Feet.

Specifications for offals of pig

1. Head and tongue are not removed before weighing.
2. Feet and tail are not removed
3. In sow, udder is trimmed at discretion of grader.

Specifications for dressing

1. Head is removed at the junction of skull. Entire spinal column is left with carcass.
2. Forefeet shall be removed at Knee joint and find feet at Hock joint
3. Fleshing or muscular part of diaphragm (skirt) is left with carcass.
4. Kidney or kidney fat is not removed
5. Udder should be removed from ewe carcass

Conditions for weighing

Because trading generally takes place after 24 hours and weighing is done within one hour, shrinkage of carcass occurs and weight is decreased. To remove this anomaly rebate is given

Dressed lamb, sheep

1. If weighed within one hr of slaughter it is called **hot carcass weight**.
2. If weighed from one – 24 hrs, called **cold carcass wt.**

Hot weight	Rebate
56 lbs and under	1 lb
Over 56 to 72 lbs	1 ½ lb
Over 72 lbs	2 lbs

Pig

1. Hot carcass wt. – within 6 hr of slaughter
2. Cold carcass wt. – within 24 hr of slaughter

Handling, storage and distribution of Poultry meat

Chicken

- ✓ Hens from egg production (‘spent’ hens). Usually about 18 months old, small, and with relatively poor conformation and meat yield. They are cheap and are the main source of manufacturing chicken meat.
- ✓ Broilers. The term means suitable for grilling; in the USA it covers birds up to about 1.5kg dressed weight, but in the UK heavier birds are included, up to 3-4 kg. Age 6-10 weeks.

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- ✓ Broiler breeder hens. These are the parents of broilers after their productive egg-laying life. They are larger and have better meat yield than normal egg-layers. Numbers available are relatively small.

Note that:

- ✓ Flavour is stronger but texture is tougher in the older birds (hens versus broilers).
- ✓ A small proportion of birds may be grown under 'free range' conditions, some laying birds in 'pole barns', etc., but almost all the remainder are grown intensively, broilers in large open houses, hens in cages.
- ✓ Flavour and texture differences due to breed or growing conditions are negligible.

General composition of raw poultry meat

Species	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Food energy (Cal/100g)
Chicken					
i) Broiler (8 wks)	74.0	18.5	6.0	0.80	125
ii) Spent hen	72.0	19.0	6.5	1.25	120
Quail (8 wks)	70.5	20.5	5.5	1.20	125
Duck (8 wks)	58.0	20.0	19.8	.50	300
Turkey (medium fat)	60.0	19.5	18.0	1.00	270

Nutritive value

Poultry meat is a food of high nutritional value. It is higher in protein content as compared to red meats. These proteins are classified under first class category because it contains all the essential amino acids in balanced proportion. Such high protein diet is necessary for growth and development of children and pregnant ladies. In addition, it compensates the day to day wear and tear of tissues of human body.

Chicken meat with low fat provides all the essential fatty acids. These fatty acids constitute cell was, mitochondria and other cell components.

Due to its low energy value, chicken meat is a good food for weight control diets. Chicken meat contains more phospholipids and low cholesterol than other meats, which minimize risks due to diabetes and heart diseases.

Poultry meat is rich in niacin and moderately rich in thiamine, riboflavin and ascorbic acid. It is a good source of iron and phosphorus. Half of iron in meat is present as haeme iron, which is well absorbed (15-20%) compared with only 1-10% of iron from plant foods. Also it enhances absorption of iron from other foods. Meat is richest source of zinc.

Due to high biological value and easy digestibility, it is a choice food for aged persons as well as children. It has the ability to alleviate the nutritional stress conditions in the human beings. It has a good aesthetic appeal. Poultry meat has no religious inhibition and its many products satisfy the variety quest of the consumers.

Turkey

For domestic sale, carcasses may range down to 2-3 kg dressed weight. For manufacturing, mainly male birds are used; these are usually 10-15 kg dressed weight.

Moisture content: Edible portion of chicken broiler contains 71 % moisture, roaster 66 %, hens 56 % and medium fat turkeys about 58 %.

Calories content: broiler contains 151 calories per 100g of meat, roasters 200, hens 302 and medium fat turkeys 268 calories.

Proteins: Cooked poultry meat contains 25 to 35 % protein depending upon part of carcass and the method of preparation. Poultry meat also contains high quality of proteins.

Pre-slaughter Care and Handling

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In the intensive housing system, a great care has to be exercised in catching and crating the birds. All feeders, waterers and other accessory equipment should be moved to one corner of the house before catching and assembling is undertaken. The broilers are generally caught at night under very dim light. Culled and spent hens are caught in the cooler hours of the day, preferably in the afternoon. The birds are caught manually by the shank in a humane way. Stress should be avoided to live birds. Handling of the birds should be proper to prevent injuries, broken legs, deaths etc.

Procurement and transport of live birds

Crates, coops or cages are used to transport birds in vans from the farm to poultry dressing plant. Special attention is paid to prevent overcrowding and suffocation. The loading of birds is carried out in dim light either early morning or late evening to avoid excitement and transported in the cool period without much exposure to sun to prevent excessive shrinkage. Bulk weighing of birds in crates is the general practice at the large sized dressing plants. Shrinkage of 3-4 per cent takes place during pre-slaughter handling and transport. Birds should be kept off feed for 12 hrs before slaughter but enough shrinkage water should be made available. This practice not only helps in easy evisceration but risk of contamination of meat by the intestinal contents is also minimized.

SLAUGHTER OF BIRDS

Fasting: A fasting period of 12-14 hr is desirable, with a liberal supply of clean water.

Ante mortem exam: Helps in production of wholesome meat.

Stunning: Poultry may or may not be stunned. Electrical stunning is commonly used. Hand stunning devices and automatic stunning devices are used for stunning poultry.

Poultry (2 kg)	70 volts	1-3 sec
Turkey (7-9 kg)	90 volts	10 sec

Bleeding: It is done either by cutting the jugular vein behind the jaw, or by decapitation. Bird is left to blend for 2 minutes in case of turkey and 90 second for poultry.

Scalding: Birds are immersed in hot water so that feather follicles are loosened.

Semi scalding: (soft or slack scalding) Birds are dipped in water of temperature 123^0F – 130^0F (around 50-55^0C) for 90-120 sec.

Advantages: It leaves the skin intact, so permits more diverse methods of chilling and freezing.

Disadvantages: It is harder to remove the feathers and more hand picking is required.

Sub scalding: Carcass is scalded in water of 138 – 140^0F (around 59-60^0C) for 30-75 sec. Outer layer of skin is broken down but flesh is not affected.

Advantage: Easy removal of feathers and there is uniform skin color. It is best method for boilers

Hard scalding: Temp. of water is 160^0F – 180^0F (around 71-82^0C) and done for 30-60 sec.

Advantage: Feather removal is easy.

Disadvantage: Flesh of carcass scalded in this manner becomes puffy so that carcass appears plump. Flesh becomes 'doughy' and lifeless. Skin becomes discolored. Hard scalding is mostly followed in water fowl where feathers removal is tough.

Wax picking: Wax bath is also used occasionally. It contains wax, gum and fat. Temp. of both is 132^0F. Time is 90-120 sec. Poultry in immersed in molten wax and after drying it is scrubbed off so that feathers come off with wax.

De feathering (Plucking): Manually it is done by holding the birds firmly by the legs and gripping the wings back between knees. Breast and front of birds is dealt with first. Feathers are pulled off by force or jerk. Now a days de feathering machines having rotating rubber fingers are used. Hard and soft rubber finger are employed for hard (wing) and soft (body) feathers.

Singeing: with the help of flame, hair like appendages (Filoplumes) and pin feathers are burnt.

Washing: To reduce no. of microorganisms of the carcass.
Removing shanks and oil glands: Shanks can be removed by knives, saws, shears. Oil gland (Preen Glands) are also removed
Evisceration: Viscera should be removed carefully. A cut is made around vent and intestines are pulled out. A cut in belly can also be given to open it up and then visceral organs are removed. These can be left attached to carcass for time being for post mortem inspection. Lungs are removed by hand or vacuum apparatus.
Washing and packing: Carcass is washed with potable water to remove blood or any adhering feathers and is packed in polyethylene bags etc.
Processing of giblet
Giblet consists of heart, liver, gizzard. Kidney is also added in giblet if removed from carcass. Sometimes neck is also included. Gall bladder should be removed from liver carefully. It should be pulled out of liver after pinching its neck so that bile does not spill on the carcass. Bile is very bitter and green in color and spoiled portion has to be cut off from carcass leading to economic loss. Pericardial sac and arteries are cut off from heart. Gizzard is removed by cutting in coming (Proventriculus) and out going (duodenum) tracts. Then it is split longitudinally in half, washed and inner lining is removed manually or by gizzard peeler. Giblet is packed in films and stuffed back into body cavity.
PRESERVATION OF MEAT
Meat is an important perishable food commodity as all the nutrients required for the growth of bacteria, yeast and mold (especially water, proteins and minerals) are abundantly available in fresh meat. Several techniques have been adopted for the preservation of meat by controlling microbial contamination and autolytic changes caused by enzymatic action at cellular level. Various techniques
for preservation of meat include-
(I) Drying: It is the oldest of meat preservation. Drying reduces the water activity thereby-
(i) Enzymatic processes within the cells become slow which retard autolytic changes.
(ii) Reduced moisture in the meat is unfavorable for bacteria growth.
Drying may be achieved by-
(a) Sundrying: Most common man cheap method. It is also utilized for the production of biltong in South Africa, pemmican and jerky in North America.
Disadvantages

- ✓ Development of rancidity due to oxidation of fat.
- ✓ Meat is unhygienic.
- ✓ Some time meat becomes hard.
- ✓ Rehydration is poor.

(b) Mechanical drying: In this method, drying of meat is done under hygienic condition in a controlled environment. It may be achieved either in vacuum or adiabatic dryer.
(c) Freeze drying: It is also known as lyophilization. It is a modern technique which effectively preserves both cooked and raw meat. First of all, meat is freezed, now water present in the form of ice crystal is sublimated from meat in vacuum chambers maintained at a pressure of 1 to 1.5 mm Hg. Moisture content of freeze dried product is generally less than 2%. During freeze drying the structure of meat remain unchanged. After rehydration such meat regains its natural colour and flavour.
II) Cold preservation: Preservation by cold is usually carried out at two different temperature ranges-
(1) Preservation by chilling/refrigeration: In strict sense temperature ranging between

5-15^{0C} is chilling temperature whereas temperature ranging between 0-4^{0C} is refrigeration. However, later is popularly known as chilling temperature. Preservation of meat is done by chilling and can be achieved by two methods-

(i) By Ice: Meat is kept in a mixture of ice and salt in insulated cabinets or vats.

Disadvantage

- ✓ Lowering of temperature is very slow.
- ✓ Surface of meat become moist and unattractive.
- ✓ Excessive salting may result in discolouration.
- ✓ Meat may absorb moisture from ice.

Generally this method of chilling is not recommended.

(ii) Mechanical chilling or refrigeration: It is a rapid method chilling. In this method, meat is kept in a chamber or chilling room and cold air (30C) is constantly blown in the room on meat resulting in lowering of temperature.

Relative humidity of chamber should be maintained at 88-92%. Shrinkage of 1-2% takes place as compared to 8% in ice chilling.

(2) Preservation by freezing: Excellent method for preservation of meat for longer duration. It results in very few undesirable changes in qualitative and organoleptic properties of meat as compared to other method of preservation. Most of the nutritive value of meat remains intact during frozen storage. Freezing is of two types-

(i) Slow freezing: Time required for freezing of meat is more which take 3-72 hrs depending on the size of carcass. This method of freezing is not preferred as it may lead to the development of certain undesirable changes on thawing.

(ii) Quick freezing: A temperature of -20^{0C} may be achieved within 30 minutes. This is the excellent method for preservation of meat as it can preserve meat for longer duration with least undesirable effect.

Method of freezing: Several methods of freezing are utilized for freezing meat in meat industry such as-

(i) Still air freezing: In still air freezing, air is the heat transferring medium. Meat freezes very slowly. Same principle is also used in home freezer. Temperature in commercial still air freezing ranges from -10^{0C} to -30^{0C}.

(ii) Plate freezing: In this method, heat transferring medium is metal rather than air. Products are placed directly in contact with metal freezer plate or shelves. Plate temperature ranges from -10^{0C} to -30^{0C}.

(iii) Blast freezing: Most commonly used commercial method for freezing meat products. Cold air is blasted in the freezing room or cabinet with the help of fans to provide rapid air movement. Air velocity ranges from 30 to 1070 meters/minute (mpm) and temperature ranges from -10^{0C} to -40^{0C}. However, air velocity of about 760 m/m and temp of -30^{0C} is most practical and economical in meat industry. Meat should be packaged properly before freezing otherwise dehydration and freezer burn may occur.

(iv) Liquid immersion and liquid sprays: Commercially used for poultry freezing. Products after placing in plastic bags are either immersed in freezing liquid or cold liquid is constantly sprayed on product surface. Liquids utilized for freezing include sodium chloride brine, glycerol and glycols.

(v) Cryogenic freezing: It is a very low temperature freezing with condensed or liquid gases. It may be done either by direct immersion, liquid spray or circulation of cryogenic agent vapours over products to be frozen. Most commonly used cryogenic agents include liquid nitrogen and carbon dioxide.

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III. Heat processing or thermal preservation: Heat is used to kill spoilage and potentially toxic micro-organisms in meat and meat products as well as to inactivate the endogenous enzymes. Two levels of heat processing are employed in meat preservation –

(i) Pasteurization: Moderate heating, most common method for preparation of cooked meat products. Core temperature of the product reaches 58-75^{0C}. Such products need refrigeration for storage.

(ii) Sterilization: Extensive heating above 100^{0C}. Used to prepare commercially sterile meat products. Sterility is achieved in large metal drums known as retorts. Sealed cans are placed in retorts, which are then closed, sealed and heated to reach an internal temperature of 121^{0C} or more. Such products can be stored at room temperature for one or more years.

IV. Irradiation: Radiation may be defined as emission and propagation of energy through space or material medium. For meat preservation electromagnetic radiations are utilized. Radiations having shorter wavelength are more damaging ultraviolet rays, X-rays and gamma rays.

Ionizing radiations: These radiations have a wavelength of 2000 Ao or less and frequently utilized for food preservation. These radiations have enough energy and ionize the molecules which come in their path without appreciably raising the temperature of food thus the process is called as cold sterilization.

Ultra violet rays: A powerful bactericidal agent, non-ionizing, most effective wavelength is 2600 Ao have poor penetration power which limits its use in food preservation. It is utilized for the preservation of food surface only. On the surface of meat, it may catalyze oxidative changes leading to rancidity, discolouration and other undesirable reaction.

β rays: It is a stream of electrons emitted from radioactive substances. Poor penetration power of β rays limits its use in food.

γ rays: These are electromagnetic radiations emitted from excited nucleus of radioactive elements such as CO^{60} and Cs^{137}. γ rays have excellent penetration power. It is the cheapest and most frequently used radiation for food preservation.

X rays: These rays are produced by the bombardment of heavy metal targets with high velocity electrons (cathode rays) within an evaluated tube. X rays have excellent penetration power.

Microwaves: These are electromagnetic waves having frequency between infrared and radio waves. Two frequencies of microwaves which have been frequently used in food preservation include 915 and 2450 megacycles. 915 megacycles means oscillation of molecules about 915 million times/ second. Oscillations of molecules produce heat which causes destruction of microbes.

Unit of radiation: Rad (radiation absorbed dose) and Gray (Gy)

1 Gray = 100 Rads = 1 Joule/ kg

Radappertization: It is equivalent to radiation sterilization or commercial sterilization. Used in canning industry. Level of irradiation is 30 to 40 K Gy.

Radicidation: Equivalent to pasteurization. It refers to reduction of number of viable non spore forming pathogens so that none is detectable by any standard cultural method. Dose level is 2.5 to 10 K Gy.

Radurization: It refers to the enhancement of keeping quality of food by causing substantial reduction in no. of viable spoilage microbes. Dose level is 0.75 to 2.5 K Gy.

V. Chemical preservation

Curing: Curing is the application of salt, nitrite or nitrate, seasoning and other additives to meat. Curing impart flavour and colour to the meat as well as it inhibits the micro-organisms.

Composition of cure-Salt 50 lbs, Sugar 5 lbs, Nitrate 2 lbs, Nitrite 1 lb

Methods of curing

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(i) Dry cure: Curing ingredients are rubbed on meat surface.
(ii) Pickle cure: Meat cuts are immersed in curing solution.
(iii) Injec to cure: Concentrated solution of curing ingredients is injected into meat either by artery or needles at multiple sites in intramuscular tissue.
(iv) Direct cure or addition: Curing agents are added directly to finely ground meat as in sausage mixture.
In pickling 10% solution of curing ingredients is used whereas in injecto cure 25% solution of curing ingredients is used.
Salt: Most essential constituent of curing ingredients and has been utilized from ancient time in preservation. For preservative action it should be used at a concentration of 15% or above but in meat products it is usually used at 1-2 % concentration to impart flavour. Salt exerts its preservative action by-
(i) Dehydration and alteration of osmotic pressure which inhibits growth of spoilage bacteria.
(ii) Slow down the action of proteolytic enzymes in meat.
Sugar: Sugar is used as a curing ingredient to improve flavour and to mask the harshening effect of salt. Sugar at much higher concentration can be utilized as a preservative by causing plasmolysis of microbes.
Nitrite and nitrate: These are used in curing as colour fixatives, to impart cured meat flavour and as a preservative. They have strong antibacterial activity especially against Clostridium botulinum. Hence there effect is also known as Antibotulinum effect. Nitrate react with secondary amines and yield nitrosamine which is carcinogenic in nature hence in most meat processing units nitrate has been replaced by nitrite. Amount of nitrite permitted in finished meat product is 200 ppm but in bacon 120 ppm.
Smoking: It is a procedure in which meat products are exposed to smoke generated by slow burning of hard wood (sesame wood) or saw dust. Smoke contains a large no. of compounds such as aldehydes (formaldehyde), phenols, ketones and organic acids which is responsible for bacteriostatic property of smoke. Phenol acts as a bacteriostatic whereas formaldehyde acts as main bactericidal compound. Nowadays liquid smoke is used as it do not contain carcinogenic polycyclic hydrocarbon compounds.
Acids: Certain acids have bacteriostatic effect. Acids which can be utilized in meat products as a preservative include lactic, acetic, citric, propionic, sorbic, benzoic etc. These acids also impart flavour to the meat products.
Antioxidants: These are used to prevent development of rancidity particularly in fatty foods. They also possess some antimicrobial activity.
e.g. Butylated hydroxyl anisole (BHA), Butylated hydroxyl toluene (BHT), Propyl gallate (PQ), tert- Butyl hydroxyl quinoline (TBHQ), Ascorbic acid, Tocopherol, Lecithin, Tartaric acid etc.
Antibiotics: Antibiotics are the excellent preservative for enhancing the shelf life of meat but their use has been discouraged as it may cause hypersensitivity, drug resistance etc. Antibiotic utilized in meat preservation include nisin, natamysin, tetracycline, subtillin, tylosin etc.

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