

Topic on

**Composition of milk, major and minor constituents of milk,
physico-chemical, microbial and nutritional properties of milk
and preservation of raw milk**

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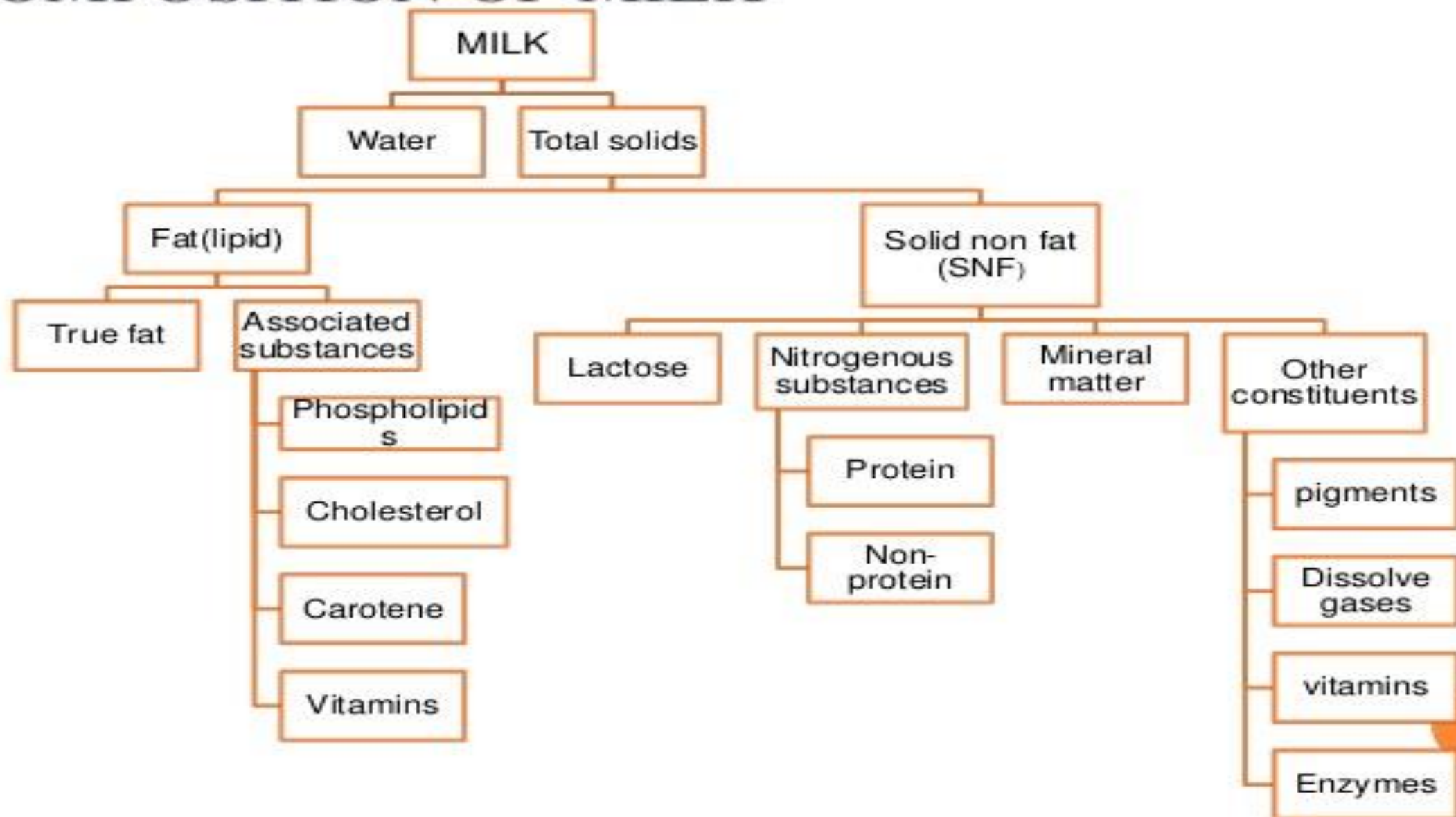
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MILK

- Milk can be defined as the whole, fresh, clean, lacteal secretion obtained by complete milking of udder of one or more healthy milch animals, excluding that obtained within 15 days before or 5 days after calving or such periods as may be necessary to render the milk practically colostrum free and containing the minimum prescribed percentages of milk fat and milk solids not fat (SNF).



COMPOSITION OF MILK



Percentage composition of various constituents of milk

S. N.	Animal	Water	Fat	Protein	Lactose	Ash
1	Cow	86.6	4.6	3.4	4.9	0.7
2	Buffalo	84.2	6.6	3.9	5.2	0.8
3	Sheep	79.4	8.6	6.7	4.3	1.0
4	Goat	86.5	4.5	3.5	4.7	0.8
5	Camel	86.5	3.1	4.0	5.6	0.8
6	Sow	89.6	4.8	1.3	3.4	0.9
7	Human	87.7	3.6	1.8	6.8	0.1

Milk constituents

S.N.	Major Milk Constituents	S.N.	Minor Milk Constituents
1	Water	1	Phospholipids
2	Milk Fat (Lipid)	2	Cholesterol
3	Milk Protein	3	Pigment
4	Milk Sugar/ Lactose	4	Enzymes
5	Mineral Matter/ Ash	5	Vitamins

Major Milk Constituents

1. Water : Constitutes the medium in which the other milk constituents are either dissolved or suspended.

2. Milk fat (lipid) The bulk of the fat in milk exists in the form of small globules, which average size of approximately 2 to 5 microns in size (range 0.1 to 22 microns). Fat exist in oil in water type emulsion.

Chemically milk fat is composed of a number of glyceride esters of fatty acids; on hydrolysis, milk fat furnishes a mixture of fatty acids and glycerol.

3. Milk proteins :

- ✓ Proteins are among the most complex of organic substances.
- ✓ Proteins are composed of a large number of amino acids, some are essential and others are none essential Amino acids.
- ✓ The essential amino acids are necessary in the diet for the formation of body proteins.
- ✓ The proteins of milk consist mainly of casein and whey proteins (Beta-lactoglobulin, alpha-lactalbumin, etc).
- ✓ Casein exists only in milk and is found in the form of a calcium caseinate phosphate complex.

4. Lactose / Milk sugar :

- ✓ Lactose, a disaccharide sugar exists only in milk.
- ✓ It is in true solution in the milk serum.
- ✓ It is 1/6th as sweet as sucrose.
- ✓ Lactose is responsible under certain conditions for the defect known as sandiness in ice cream and sweetend condensed milk.

5. Mineral Matter / Ash :

- ✓ Present in small quantity. Major salt constituents- K, Na, Mg, Ca, P, So₄, HCo₃, Citrate.

Minor Milk Constituents

1. Phospholipids:

- ✓ In milk three types of phospholipids exist, viz., lecithin cephalin and sphingomyelin.
- ✓ Lecithin important constituent of the fat globule membrane.
- ✓ Lecithin is contributes to richness of flavour of milk and other dairy products.
- ✓ Phospholipid are excellent emulsifying agents.

2. Cholesterol:

- ✓ This appears to be present in true solution in the fat, as part of the fat globule membrane complex and in complex formation with protein in the non fat protein of milk.

3. Pigments:

- a) Fat soluble, such as Carotene and Xanthophyll.
- b) Water soluble, such as Riboflavin.

4. Enzymes: These are biological Catalysts which can hasten or retard chemical changes themselves participating in the reactions. The important milk enzymes and their specific actions are as follows-

- a) Amylase (diastase) is a starch splitting enzyme.
- b) Lipase is a fat splitting enzyme leading rendering rancid flavour.
- c) Phosphatase is capable of splitting certain phosphoric acid esters (basis of phosphates test for checking pasteurization efficiency).
- d) Protease is capable of splitting protein. Peroxidase and catalase decomposes hydrogen peroxide.

5. Vitamins:

- ✓ Although present in foods in very minute quantities, these are vital for the health and growth of living organisms.
- ✓ Fat soluble vitamins A, D, E and K.
- ✓ Water soluble vitamins of B complex group (such as thiamine or B1 , riboflavin or B2, Pantothenic acid niacin pyridoxine or B6 biotin, B12 folic acid etc.
- ✓ Vitamin C (ascorbic acid).

Physicochemical chemical properties of milk

1. **Physical state of milk** - Water is the continuous phase in which other constituents are either dissolved or suspended.

Fat	Emulsion form
Protein	Colloidal form
Lactose	Solution form (Crystalline)
Mineral	Solution & Colloidal both form

2. Acidity of milk-

- ✓ Freshly drawn milk is Amphoteric to litmus, both react with acid and base.
- ✓ Milk shows a certain acidity as determined by titration with an alkali (sodium hydroxide). Indicator- phenolphthalein
- ✓ This acidity called Tritable Acidity (TA) / Natural Acidity / Apparent Acidity.
- ✓ Normal acidity or natural acidity is due to casein, acid phosphates and citrate and to a lesser extent by albumin, globulin and CO₂.
- ✓ Milk of high natural acidity is usually high in their total solids content.
- ✓ Colostrum has high natural acidity because of its high protein content.

- ✓ Natural acidity / Titrable acidity of cow milk - 0.13 to 0.14 %
- ✓ Natural acidity / Titrable acidity of buffalo milk – 0.14 to 0.15 %
- ✓ Developed or Real acidity of milk is due to Lactic acid formed as a result of bacterial action on lactose in milk.
- ✓ The Natural acidity / Titrable acidity is expressed as a percentage of lactic acid.

3. pH of milk-

Cow milk – 6.4 to 6.6

Buffalo milk – 6.7 to 6.8

- ✓ Higher pH values for fresh milk indicate udder infection mastitis and lower value bacterial action.

4. Specific gravity-

- ✓ The term specific gravity as applied to milk means the weight of the given volume of milk compared with the weight of same volume of water at the same temperature.
- ✓ Average specific gravity of milk and its components at 60 °F (15.6°C)

Cow milk : 1.028-1.030

Skim milk : 1.035-1.037

Buffalo milk : 1.030-1.032

Water : 1

Fat : 0.93

Protein : 1.346

Lactose : 1.666

Salts : 4.12

SNF : 1.616



- Specific gravity is measured by lactometer (Zeal, Quevenne) and pycnometer.
- Buffalo milk contains more fat than cow milk and specific gravity of buffalo milk is higher than cow milk, this is because buffalo milk contains more solid not fat (SNF).
- Specific gravity of milk is lowered by addition of water, addition of cream.
- Specific gravity of milk is increased by addition of milk or skim milk, removal of fat.
- Specific gravity of milk should not be determined for at least one hour after it is drawn from animal; a lower than normal value will be obtained due to **Recknagel phenomenon**.

5. Freezing point of milk: Milk freezes at temperature slightly lower than water due to the presence of soluble constituents such as lactose, soluble salts etc, which lower or decrease the freezing point.

- Freezing point of Indian cow milk - 0.547°C
- Freezing point of buffalo milk - 0.549°C
- Freezing point of most of milk sample - 0.530°C

6. Colour of milk:

- ✓ Characteristic white colour or white opalescence of the milk is due to scattering of light by the colloidal particles.
- ✓ Yellow colour of the milk is due to the carotene. The intensity of yellow colour increases in cow milk when they are fed with green fodder.
- ✓ Buffalo milk is white in colour due to the absence of carotene which is efficiently converted to vitamin A.
- ✓ Large fat globule and higher fat % cause intensity of yellow colour increase.

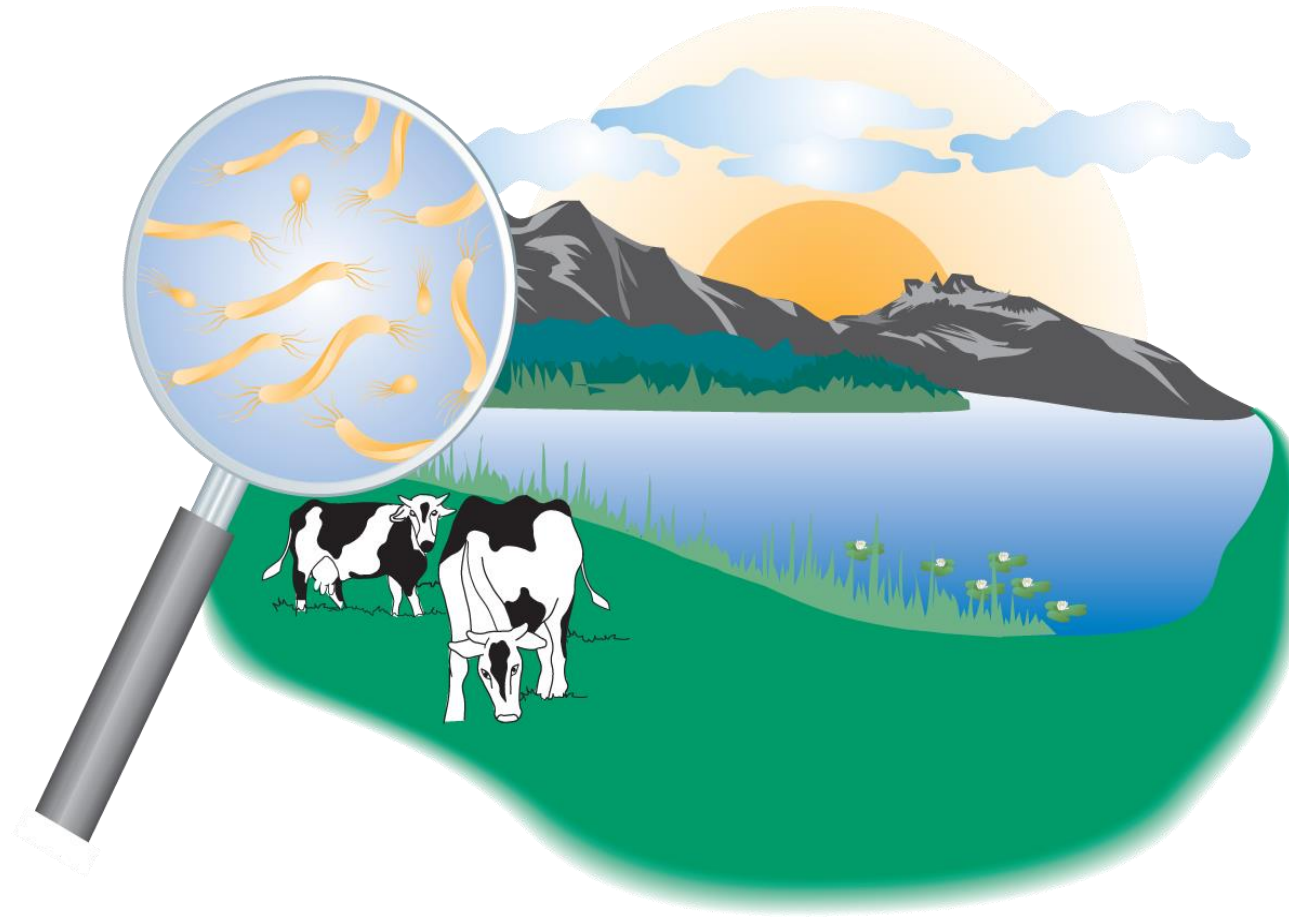


7. Flavour of milk

- ✓ Flavour of milk is a combination of taste and smell (odour). Milk has a characteristic mild, pleasant flavour.
- ✓ Flavour of milk is a blend of the sweet taste of lactose and salty taste of minerals.
- ✓ Taste of lactose is balanced against the salty taste of chlorides.
- ✓ Change in the flavour of milk occur due to-
 - i. Type of feed
 - ii. Season
 - iii. Stage of lactation
 - iv. Condition of udder
 - v. Sanitation during milking
 - vi. Subsequent handling of milk during storage

Microbiology of milk

- The greater bacterial count in milk i.e. the greater number of bacteria per ml of milk, the lower is its bacteriological quality.



- Growth of micro organisms:- growth refers to increase in numbers

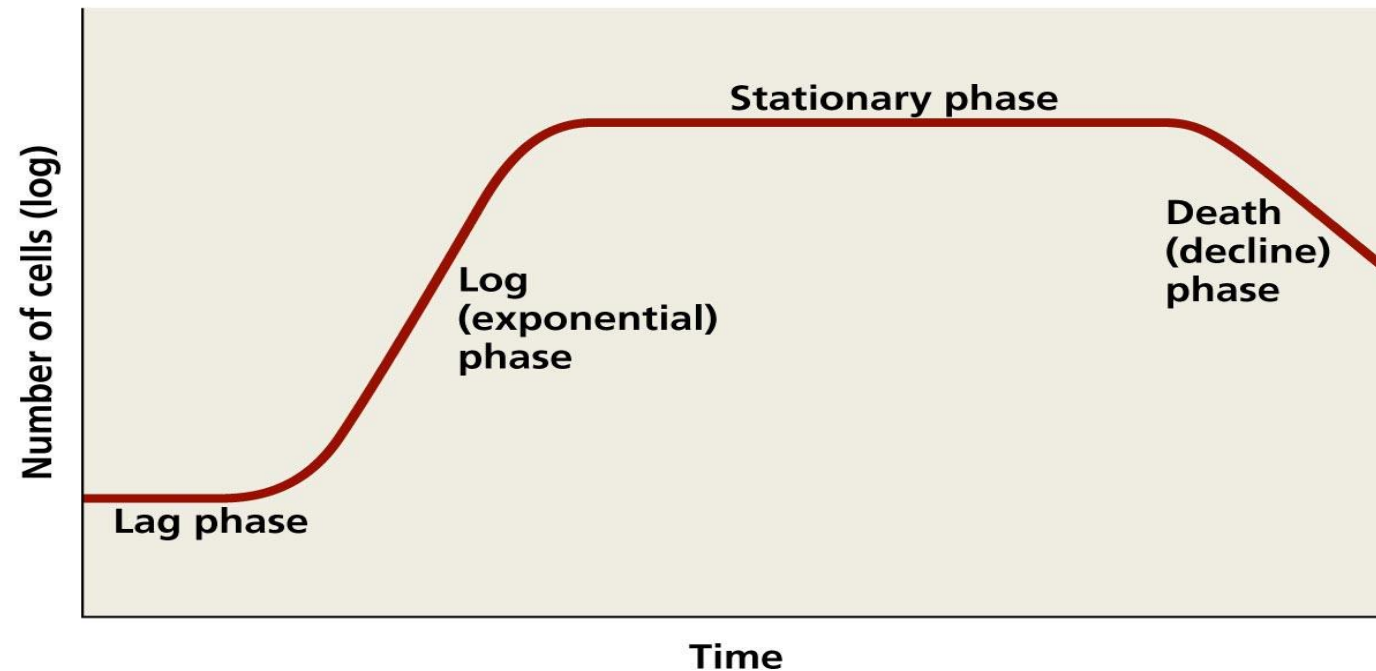
1. Stage of growth: (a) Initial stationary phase

(b) Lag phase (Adjustment phase)

(c) Log phase (Accelerated growth phase)

(d) Maximum stationary phase

(e) Death phase



2. Factors influencing growth: (a) Food supply (b) Moisture,
(c) Air and light (d) Acidity or pH
(e) Temperature (f) Concentration

✓ Note: Psychrotropic – 5-7°C

Mesophilic – 20°C to 40°C

Thermophilic (Heat loving) – above 50°C

3. Products of microbial growth:

(a) Enzymes

(b) Decomposition products of fat, proteins, sugars

(c) Pigments

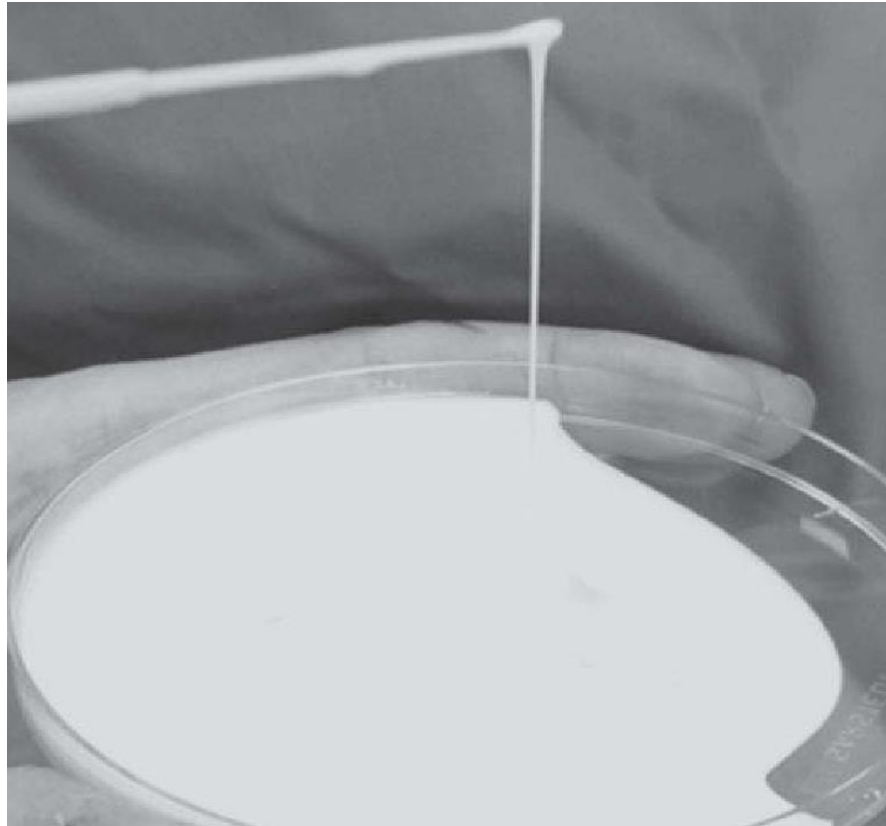
(d) Toxins

(e) Miscellaneous changes

Result of microbial growth in milk

- Souring : transforming of lactose into lactic acid and other volatile acids and compound, primarily by lactic acid bacteria.
- Souring and Gassiness : caused by coli group
- Aroma production : due to production of desirable flavour compounds such as diacetyl (in ripened cream butter)
- Proteolysis: protein decomposition leading to unpleasant odours.

- Ropiness : long threads of milk are formed while pouring.
- Sweet curdling : due to production of rennin like enzyme, which curdles milk without souring.



• **Destruction in micro organism:-**

1. Heat
2. Ionizing radiation
3. High frequency sound wave- supersonic and ultrasonic.
4. Electricity
5. Pressure – 600 times greater than atmospheric pressure.
6. Chemicals- acid, alkalis, hydrogen peroxide, halogen.

Nutritional properties of milk

▪ Introduction:-

- ✓ The primary function of milk in nature is to nourish and provide immunological protection for young mammals.
- ✓ Milk provides excellent support towards human nutrition, as it contains balanced quantities of required nutrients such as protein, fat, carbohydrate, minerals, and vitamins.
- ✓ Milk has a mildly sweet and pleasant flavour which is of wide appeal and is relished by most people and hence is innately palatable.
- ✓ The digestibility of milk is high, which makes it an ideal food for children, adults, invalids and convalescing patients.

- ✓ 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 form.
- ✓ All these properties make milk an important food for pregnant and lactating women, growing children, adolescents, adults, invalids, convalescents and patients alike.
- ✓ Energy value - Milk fat 9.3 kc/g
Milk protein 4.1 kc/g
Milk sugar 4.1 kc/g

1. Milk Fat:-

- ✓ Milk fat stays in the stomach longer than carbohydrates and proteins, they improve satiety value of diet.
- ✓ It is a carrier of the fat-soluble vitamins A, D, E and K.
- ✓ The position of double bond linkages along the carbon chain in polyunsaturated fatty acids (PUFA) is of great nutritional importance.
- ✓ Milk lipids also contain phospholipids, which are vital part of brain and nervous tissues.

2. Milk Sugar :-

- ✓ Lactose stimulates the growth of lactobacilli in the large intestine; these organisms synthesize many of the B vitamins.
- ✓ Lactose improves the absorption of several important minerals like calcium, phosphorus and magnesium.
- ✓ It yields one molecule each of glucose and galactose upon hydrolysis, both of which are convertible into glycogen in the human body.



- ✓ Galactose is necessary for the synthesis of the galactosidases of brain and medullar sheaths of nerve tissues and myelin-formation of cerebrosides in infants.

3. Milk Proteins :-

- ✓ Milk proteins are of high biological value. Proteins contribute to building and repair of body, participate in muscular contraction, act as antibodies in the body's immunological defence mechanism, and supply energy.
- ✓ Whey proteins function as binder and transporter of retinol.
- ✓ It also is a carrier of antibodies, hence possessing immunological properties.
- ✓ Antimicrobial components of milk such as immunoglobulins provide passive immunity against enteric and respiratory bacteria and viruses.
- ✓ Colostrum has a very high concentration of immunoglobulins, facilitating quick transfer of immunity to the young born calf.

4. Minerals :-

- ✓ All the known essential minerals other than iron and magnesium are present in milk in varying quantities.
- ✓ Milk is an rich source of calcium and phosphorus, the two major bone building elements.
- ✓ The absorption of calcium from milk is high and is promoted by the presence of lactose, the amino acids lysine and arginine, citric acid and vitamin A are present in milk.
- ✓ Fortification of milk with vitamin D is helpful in increasing calcium absorption.
- ✓ The quantity of iron in milk is less and completely absorbed from the intestine than is iron from other iron-rich foods.

5. Vitamins :-

- ✓ Milk supplies all vitamins essential for human nutrition and health.
- ✓ Vitamin A and its precursors are necessary for good vision, keep mucous membranes healthy and resistant to infection.
- ✓ Bovine milk, particularly colostrum, has high level of vitamin A activity as retinol.
- ✓ Vitamin D is useful in the absorption of calcium and phosphorus.
- ✓ Milk also contains vitamin K that is required for synthesis of prothrombin and useful in normal blood clotting.
- ✓ Milk also contains sufficient vitamin B₁₂ and folic acid, both of which are necessary for synthesis of red blood corpuscles and nucleic acids.

Preservation of raw milk

- **Cooling** :- As soon as milk is received in the plant, it is chilled to 5°C or below and stored cool till used, to prevent deteriorating in its bacteriological quality during the interim period.
- Method :- Can Immersion
 - Can Cooling
 - Vat / tank cooling
 - Surface Cooler
 - Tubular Cooler
 - Plate Chiller
 - Bulk Milk Cooler

▪ **Storage :-**

- ✓ Storage tanks are used in milk plants for the storage of raw, pasteurized or processed products, often in very large volumes.
- ✓ Type of storage tank-
 - (a) Insulating or refrigerated
 - (b) Horizontal or vertical
 - (c) Rectangular, cylindrical or oval





Thank you