MILK

Topics covered

- Retrospect and prospects of milk industry in India.
- Composition and nutritive value of milk
- Physico-chemical properties of milk.
- Factors affecting composition of milk.

Retrospect and Prospect

- Kaira District Cooperative Milk Producers' Union (AMUL) – 1946
- National Dairy Development Board (NDDB) – 1965

- Operation Flood: landmark project of India's National Dairy Development Board
- **launched on 13 January 1970**
- **Phase I- (1970-1980)**
- **Phase II (1981–1985)**
- **Phase III (1985–1996)**

- Future Expectations - Total milk production by 2034: 330 million tonnes

Dairy industry Scenario in India

Total milk production	230.58 million tonnes
Top milk producing state	Uttar Pradesh (15.72%) Followed by Rajasthan and MP
Per-capita availability of milk	459 grams per day
Maximum per-capita availability	Punjab(1283 gms per day) Followed by Rajasthan and Haryana
Per capita milk recommendation (ICMR)	300gm/day

INDIA - 1st in the world in terms of total milk production

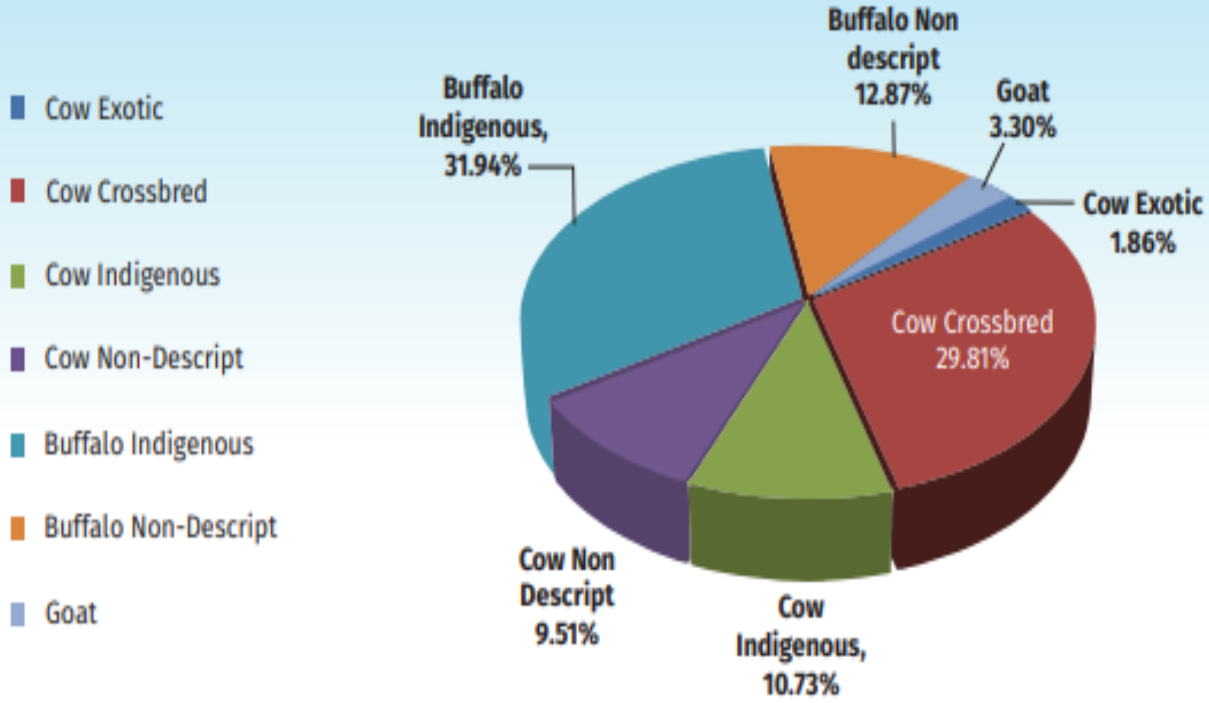
World Milk Day: 1st of June
National Milk Day: 26th November

Year 2024 theme - Moving towards a healthy tomorrow

Milk Man Of India/ Father of white revolution in India: Dr. Verghese Kurien

Type	Production
White revolution	Milk
Blue Revolution	Fish
Brown Revolution	Leather
Golden Revolution	Honey
Silver Revolution	Egg/Poultry
Red Revolution	Meat

GRAPH 2.2: SPCCIES-WISE MILK CONTRIBUTION IN 2022-23



Milk: whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy milch animals, excluding that obtained within 15 days before or 5 days after calving, colostrum-free, and containing the minimum prescribed percentage of milk fat and milk solid not fat (as per FSSR, 2011)

Composition – Water (85-87%)
- Total Solids (12-15%)

* Fat

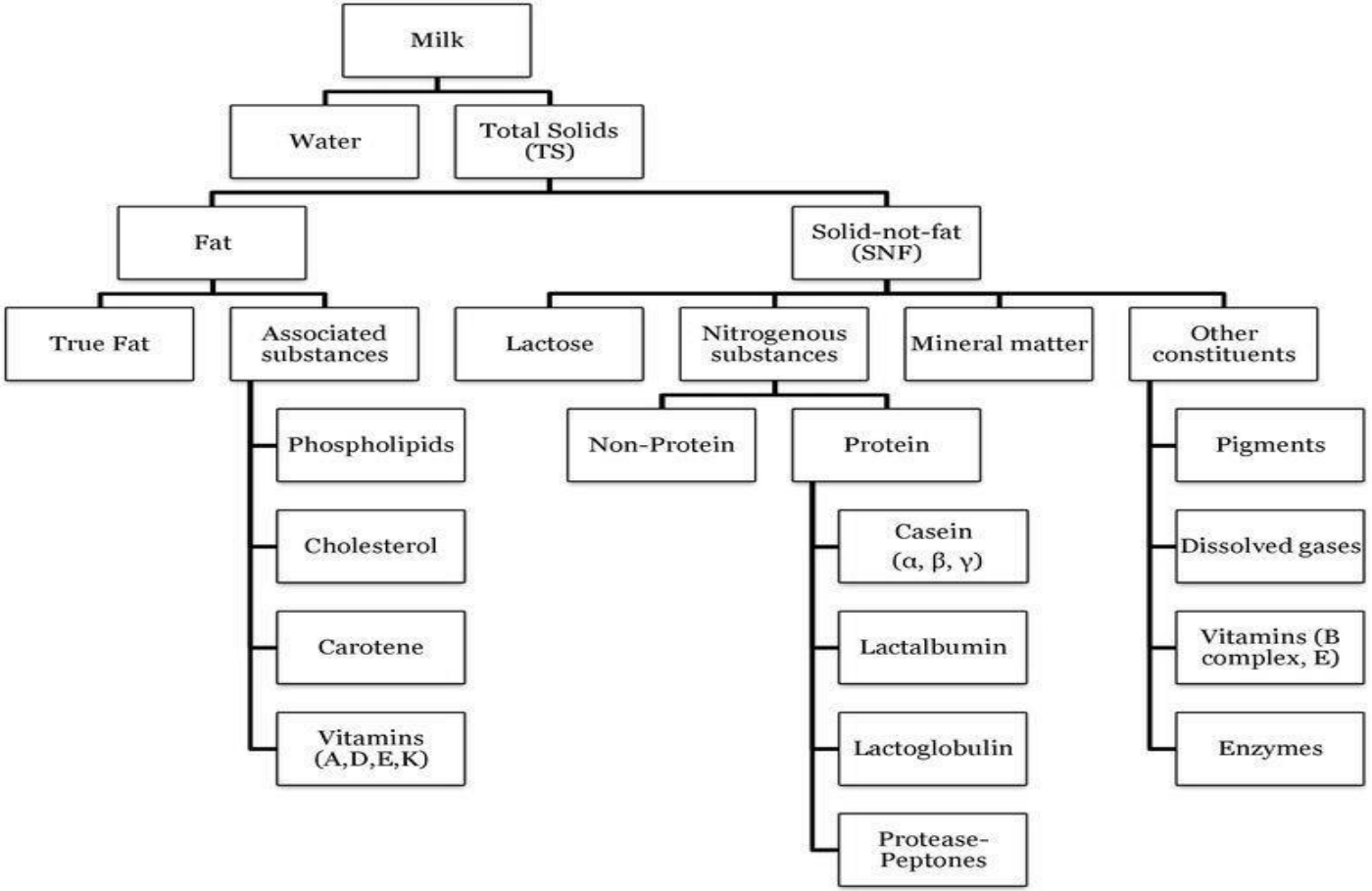
* Protein (Casein + Whey Proteins + NPN)

*Lactose (Milk Sugar)

*Minerals, Vitamins, enzymes, pigments

- Market milk: whole fluid milk sold for direct consumption
  - not includes which is consumed on the farm or used for manufacturing dairy products

Milk Constituents



MILK FRACTIONS

- Milk Plasma (Skim Milk) = Milk – Fat
- Milk Serum (Whey) = Plasma – Casein micelles
- SNF = Proteins, lactose, minerals, acids, enzymes, Vitamins
- Total Solids = SNF + Fat
- True constituents: fat, casein, lactose

Composition of Various Species

	Water	Fat	Protein	Lactose	Ash
Cow	86.6	4.6	3.4	4.9	0.7
Buffalo	84.2	6.6	3.9	5.2	0.8
Sheep	79.4	8.6	6.7	4.3	1.0
Goat	86.5	4.5	3.5	4.7	0.8
Sow	89.6	4.8	1.3	3.4	0.9
Mare	89.1	1.6	2.7	6.1	0.5
Ass	90.0	1.3	1.7	6.5	0.5
Camel	86.5	3.1	4.0	5.6	0.8

DIFFERENT TYPES OF MARKET MILK

Type of Milk	Fat % (min)	SNF % (min.)
Cow milk	3.5	8.5
Buffalo Milk	5	9
Standardized milk	4.5	8.5
Toned milk	3	8.5
Double Toned milk	1.5	9
Skim milk	0.5 max	8.7
Recombined milk	3	8.5

Sheep, Goat- 3% Fat 9% SNF

Skim milk - 8.7% SNF

Toned & recombined – 3% fat & 8.5% SNF

Cow, toned, standardized, recombined – 8.5% SNF (RCT S)

Buff, sheep, goat, double toned – 9% SNF (BDSG)

Fat percentage – buffalo > standardized > Cow > Toned, recombined > double toned > skim

MILK FAT

- Most Variable constituent/ Economically most important
- Exist in form of glycerides (glycerol + fatty acids) – most commonly triglycerides
- **oil in water type emulsion**
- present in form of fat globules (ranging from 0.1 to 22 microns) stabilized by fat globule membrane
- average size of 2 to 5 microns (cow 1-5 & buffalo 3-8)
- fatty acids---- Saturated FA -65% MUFA- 30% PUFA 5%

Elephant – 18%

Highest fat %- Aquatic mammals

True fat – 98-99% (most common triglycerides)

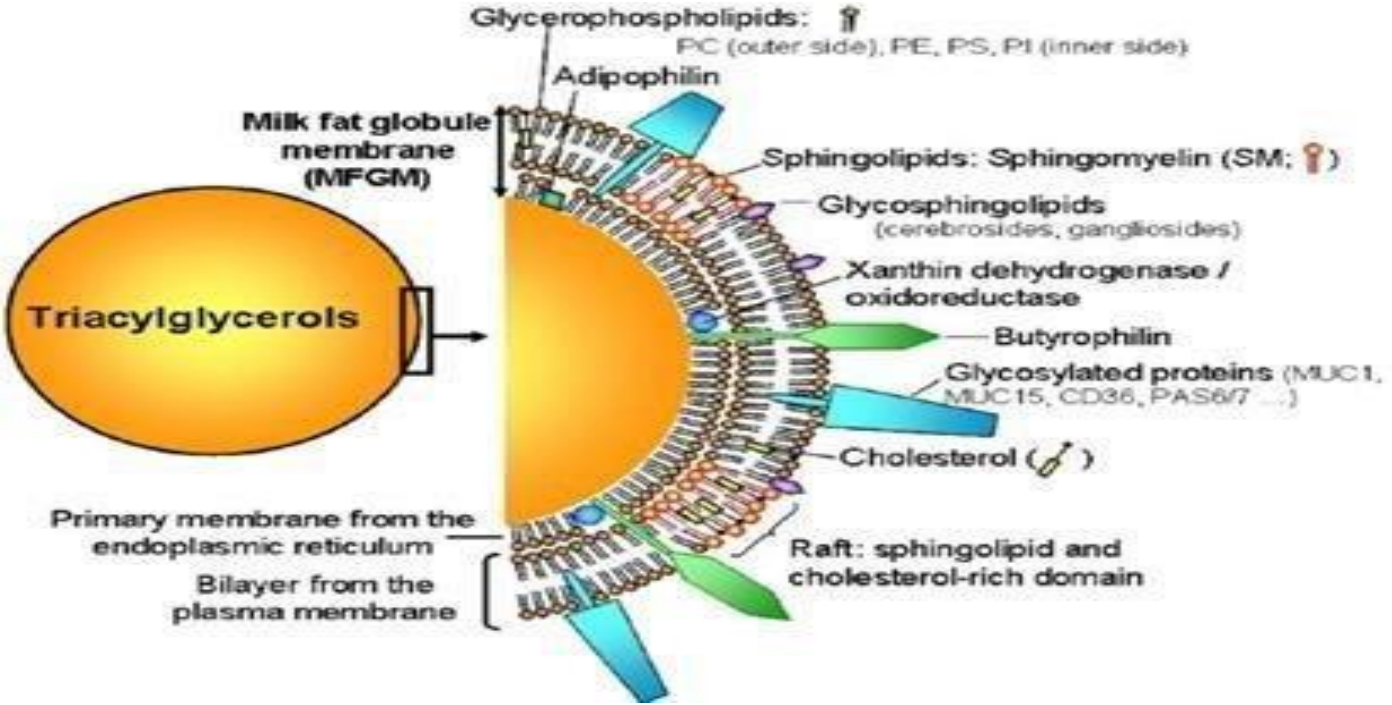
Associated fat – 1-2%

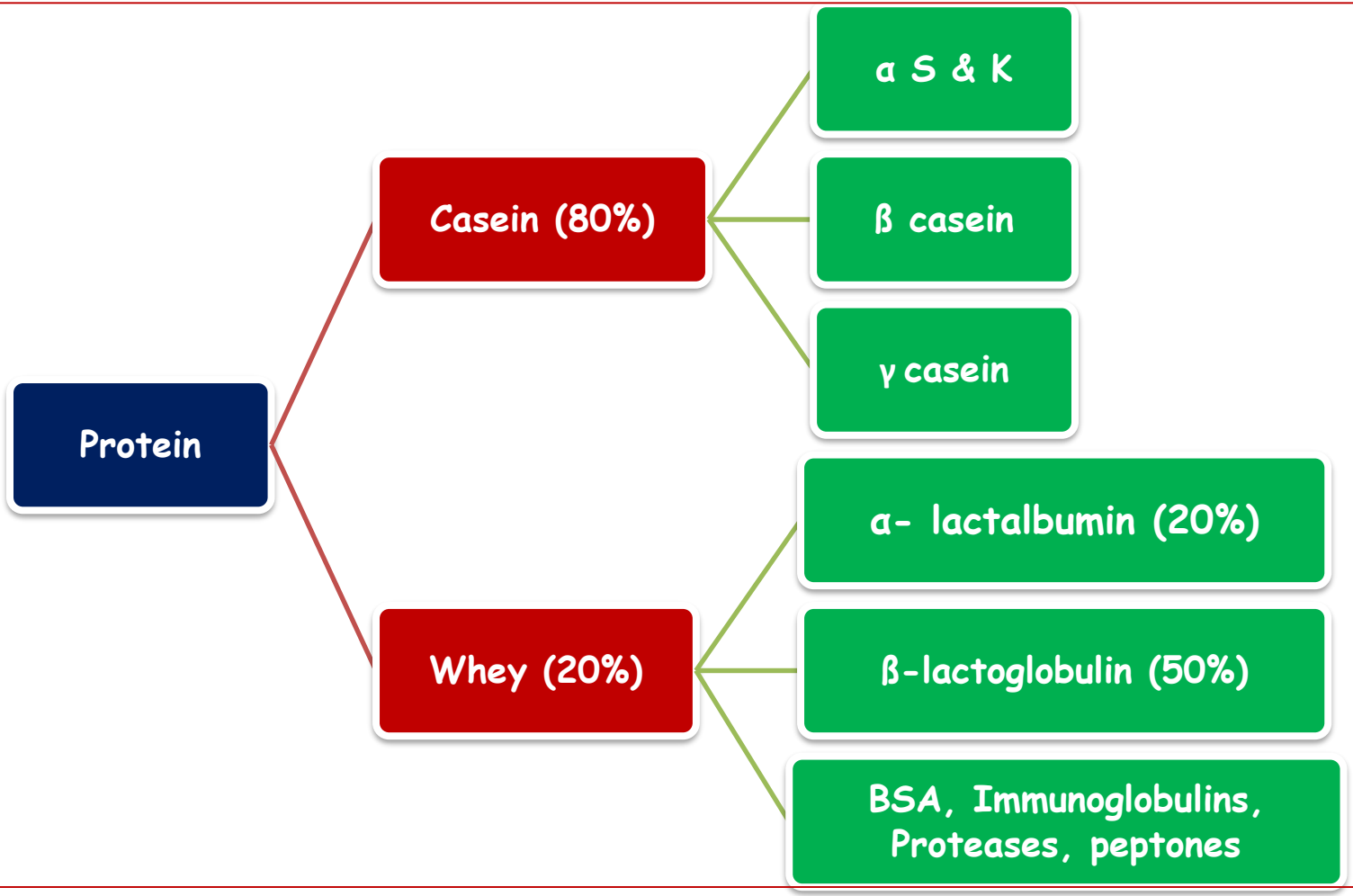
- phospholipids : lecithin, cephalin and sphingomyelin

-steroids, cholesterol, fat soluble vitamins (A,D,E,K)

-pigments: carotene, xanthophyll (fat soluble)

FAT GLOBULE MEMBRANE COMPLEX




Protein
Casein (80%)
α S & K
ß casein
γ casein
Whey (20%)
α- lactalbumin (20%)
ß-lactoglobulin (50%)
BSA, Immunoglobulins, Proteases, peptones

PROTEINS

- exists in colloidal form causing scattering of light responsible for white color of milk
- consist mainly of casein (80%) and whey proteins(20%)
- Casein exists only in milk (3%in cow and 4.3% in buff) and is **found in the form of a calcium caseinate phosphate complex.**
- casein- contains phosphorus and coagulate or precipitate at pH 4.6.
- serum (whey) proteins- do not contain phosphorus, and remain in solution in milk at pH 4.6.
- The principle of coagulation formation at reduced pH is the basis for cheese/curd formation
- Riboflavin gives color to whey protein while casein is responsible for white color of milk

CASEIN- Phosphoprotein

- The caseins in milk form complexes called micelles that are dispersed as colloidal suspension in the water phase of milk as Ca-caseinate phosphate complex
- casein micelles - subunits of the different caseins (α-s, ß, γ). α casein – responsible for stabilization of micelle in milk: Kappa casein: site of action of rennin
- ß casein two parts A1 & A2 (67th A.A.- A1 Histidine & A2 Proline). A1 produce Beta casomorphin 7 (BCM-7) during digestion
- Casein Can be Precipitated by acid, rennet, alcohol, heat
- Adhesiveness of milk – because of Casein – used for glue making

WHEY/ Serum Proteins

- approximately 50% ß-lactoglobulin, 20% a-lactalbumin
- blood serum albumin, immunoglobulins, lactoferrin, transferrin, and many minor proteins and enzymes.
- Responsible for milk allergy
- ß-lactoglobulin -----carrier of vitamin A
- a-Lactalbumin ------ critical role in the synthesis of lactose
- Lactoferrin and transferrin ---- role in iron absorption and transportation
- Immunoglobulins ---- major Ig G1
- Serum proteins present as colloidal solution

CARBOHYDRATES

- lactose – milk sugar - made up of Glucose + galactose
- Exists as true solution in milk serum
- Least variable component of milk
- Helps in absorption of calcium and phosphorus from intestine
- Maillard or Browning reaction: occurs at ultra high temp. between the lactose and protein (lysine A.A. in milk)
- Isomerisation: lactose to lactulose (laxative and and antineoplastic agent)
- two forms -- a- and ß-lactose anomers.
- a-monohydrate lactose crystals - sandy texture in the ice cream and condensed milk

VITAMINS AND MINERALS

- Ca:P in milk- 1:2
- Good source of Na, K, Mg
- **Poor source of Iron, Cu**
- Poor source of Vitamin C, K
- Good source of Vitamin B complex
- Lactose and minerals – responsible for osmotic pressure and taste of milk

Mineral	*Bovine (mg/dl)*
Calcium	125
Magnesium	12
Sodium	58
Potassium	138
Chloride	103
Phosphorus	96
Citrate	175
Sulfur	30

Source. Adapted from Jenness, 1974.

Most abundant mineral in milk - Potassium

MILK ENZYMES

- lipase - lipoprotein lipase - associated with casein micelles and FGM
- protease - plasmin (help in desirable flavor & texture in Cheese) - associated with casein micelles
- Alkaline Phosphatse : heat sensitive enzyme used as indicator of pasteurization. Causes oxidation and rancidity of fat
- lactoperoxidase: present in milk serum; antibacterial properties
- Catalase: insignificant in normal milk but increased concentration reflects udder infection
- Lysozyme: very limited amount in bovine milk

Preservation	e.g. Lactoperoxidase, sulphydryl oxidase, superoxide dismutase
Deterioration	e.g. Lipoprotein lipase, proteinase, acid phosphatase, xanthine oxidase
Markers of heat treatment	e.g. Alkaline phosphatase, lactoperoxidase, catalase, γ-glutamyl transpeptidase
Markers of mastitis infection	e.g. N-acetyl-β-D-glucosaminidase, catalase, acid phosphatase
Antimicrobial activity	e.g. Lysozyme, lactoperoxidase
Commercial source of enzymes	e.g. Ribonuclease, lactoperoxidase

PIGMENTS & GASES

- Carotene – responsible for yellowish color of cow milk

-- converted to Vitamin A in Buffalo by carotenase enzyme

- Carotene content – Cow milk 30 µg/g while in Buffalo 0.25 - 0.48 µg/g

- Riboflavin/lactochrome/lactoflavin – greenish tinge in whey

- **Gases : major Carbon dioxide, Nitrogen, Oxygen**

Q. Proteins in milk are present in one of the following form (PPSC 2016)

a) Emulsion

b) Soluble

c) Colloidal

d) Suspension

Q. According to norms of Preservation of Food Adulteration Act (PFA) 1976, cow milk should contain not less than (RPSC 2013)

(1) 8.5 percent SNF and 3.5 percent milk fat

(2) 7.5 percent SNF and 3.0 percent milk fat

(3) 6.5 percent SNF and 2.5 percent milk fat

(4) 9.5 percent SNF and 2.0 percent milk fat

Q. According to PFA Rules (1976), buffalo milk should not contain less than……percent of SNF and not less than ……..percent of milk fat. (MPPSC 2021)

(A) 8.5,6-0

(B) 9-0,5-0

(C) 9-0,6-0

(D) 8-5, 4-5

Q. One litre of normal milk from milch animal contains approximately gram of water. (MPPSC 2023)

- [A] 560 to 580
- [B] 760 to 780
- [C] 860 to 880
- [D] None of the above

- Sandiness defect during ice-cream making is due to higher content of (MPPSC 2023)
- [A] stabilizer [B] lactose [C] fat [D] emulsifier

- What are the main constituents of milk contributing to maintaining the osmotic pressure of milk? (MPPSC 2021)

(A) Sodium and Chloride

(B) Lactose and Chloride

(C) Sodium and Lactose

(D) Casein and Citrate

The most variable constituent of milk is (OPSC 2014)

(a) Protein (b) Fat (c) Ash (d) None of the above

- Standard milk contains (PPSC 2022)

a) 4.5% Fat & 8.5% SNF

b) 5% Fat & 8.5% SNF

c) 3% Fat & 9% SNF

d) 5% Fat & 8.7% SNF

- Fat content of cow milk is (MPPSC 2019)

(A) 2.5% (B) 3.5% (C) 5.5% (D) 4.5%

- According to the Prevention of Food Adulteration (PFA) Rules, 1976, the standards for different classes of milk in UP, which of the following is Correctly matched? (UPPSC 2022)

(a) Pasteurized Buffalo Milk 7.0, 9.0

(b) Raw Cow Milk 4.0, 8.5

(c) Toned Milk 3.0, 9.0

(d) Standardized Milk 4.5, 8.5

Casein constitutes _____% of milk protein (TPSC)

a. 50
b. 90
c. 99
d. 80

- Fat % of toned milk is (TPSC)

a. 1.5
b. 3
c. 4.5
d. 6

Names of the species are arranged with regard to an increasing order of fat% content in milk. Identify the correct order :

A) Cow, goat, sheep, buffalo
B) Goat, cow, buffalo, sheep
C) Sheep, cow, goat, buffalo
D) Goat, sheep, cow, buffalo.

Nutritive value

- Energy value
- Cow milk: 75 kcal/ 100gm
- Buffalo milk: 100 Kcal/ 100gm
- Milk Fat 9.3 Kcal/g; Protein and Sugar- 4.1 kcal/g
- Cholesterol content:
- Cow Milk: 3.14 mg/g
- Buffalo Milk: 0.65 mg/g
- Good source of Vitamins except C & K
- Good source of minerals except Fe & Cu
- High biological value proteins (85-95)
- Essential fatty acids like linoleic and Arachidonic acid

Antimicrobial properties of Milk

- Specific antimicrobial agents:
- Immunoglobulins, Complement, Bifidus factor

- Non Specific antimicrobial agents : Lactoferrin, Lysozyme, lactoperoxidase, Lactanins

Physico-Chemical Properties of MILK

Importance of Properties

- For detection of adulteration
- For determining quality of milk
- Helps in processing of milk & milk products
- Helps in evaluating the physical changes during processing

Physical State: Water-continuous phase

MILK	OIL IN WATER
Fat	oil in water emulsion
Lactose, ash	True solution in milk serum
Cholestrol	True solution in fat
Protein	Colloidal form in milk

Acidity and pH

* Freshly drawn milk: Amphoteric in nature - amino acids existing in zwitter ionic form
* pH of milk – 6.6
* cow 6.4-6.6
* Buffalo 6.7-6.8

- pH will be higher in mastitic milk and lower in colostrum

- Buffering action: proteins, phosphates, citrates, CO_2

- Titratable acidity = natural acidity + developed acidity

- Natural or apparent acidity : freshly drawn milk have some acidity because of its constituents like casein, acid phosphates, citrates, CO_2 (SNF) ranging from 0.13 to 0.14% for cow and 0.14-.15% for buffalo

Real or developed acidity: due to formation of lactic acid by bacterial fermentation

COLOR

- white ---- due to scattering of light by colloidal particles
- Yellow color because of carotene.
- intensity of yellow color increases when cow fed with green fodder.
- Buffalo milk is white in color due to the absence of carotene which is converted to vitamin A
- Dilute acid or rennet addition will result in a distinct greenish yellow color due to the pigment riboflavin (because of pptn of casein)
- Whey - greenish yellow (Riboflavin) while Skim Milk has bluish tinge (lactochrome)

- Yellow: *Pseudomonas synxantha*
- Blue: *Pseudomonas cyanogens*
- Black: *Pseudomonas nigrifaciens*
- Red: *Serratia marcescens*
- Green: *Pseudomonas fluorescens*

FLAVOUR

- Sensory property in which both taste and smell interact
- Most important parameter while judging
- sweet taste because of lactose
- chloride responsible for salty taste (in mastitis and in late stages of lactation)
- Richness in taste: due to Phospholipids
- Cooked flavor- **sulfhydryl** compounds – due to overheating
- Cowy flavor – in ketosis due to acetone
- Barny Flavor – poor ventilation
- Malty Flavor: *Streptococcus lactis var. maltigenes*

Density & SPECIFIC GRAVITY

- Density measured by – Pycnometer Or hydrostatic balance
- Specific gravity measured by Lactometer at 15.6 °C or 60 °F
- Lactometer – Quevevene or Zeal's
- SG= 1+ CLR/1000

- Cow milk : 1.028-1.030
- Buffalo milk : 1.030-1.032
- Skim milk : 1.035-1.037
- Colostrum : 1.070 (high concentration of TS)

Water : 1 Fat : 0.93
Protein : 1.346
Lactose : 1.666
SNF : 1.616 Ash: 4.12

- Fat – lightest constituent
- Milk Heavier than water

- Increased by addition of skim milk, removal of fat or lowering the temperature
- lowered by addition of water, addition of cream or by increasing the temperature

Recknagel phenomenon

- increase in SG of fresh milk by 0.001 as time advances due to hydration of proteins
- SG should be determined after
  - 1 hour of milking
  - heating milk at 40 °C and then cooling

Freezing Point

- lower than milk due to Lactose and salts
- No effect of fat and protein on freezing point
- Lowered FP by: sourness and addition of preservatives
- Increased FP: by addition of water

Average Freezing point	
Cow milk	- 0.555 °C
Buffalo milk	- 0.560 °C
Goat milk	- 0.575 °C
Sheep milk	- 0.588 °C

Freezing Point Depression

- Freezing point depression (FPD) - decrease in the freezing point of a solvent caused by the addition of a solute
- **Measured by Hortvet Cryoscope**
- Average FPD of cow milk is - 0.547°C and of buffalo is - 0.549°C
- Addition of water: Freezing point moves closer to 0 ° C (0.006 ° C for every 1% water added). Up to 3% water can be detected
- Boiling & Sterilization increase FPD while pasteurization has no effect

Surface Tension

- Stress at the surface of liquid
- The surface tension of milk at 20 ° C is 54.5 dynes/cm
- decreases as temperature raised (at 60 ° C: 40-45 dynes/cm)
- Measured by falling drop or Platinum ring method using **Tensiometer**
- ST of milk lower than water mainly due to proteins
- Presence of Fat, acidity and churning lowers ST

- **Oxidation Reduction Potential:** +0.2 to 0.3 volts
- MBRT, Resazurin test based on O R potential

- **Viscosity:** 1.5-2 centipoises (Cow 2 Buffalo 1.8 skim milk 1.5)
- Viscosity in milk - due to casein and fats
- Homogenization increases viscosity by uniform distribution of fat molecules

- **Boiling point: 100.15-100.17 ° C**

- Refractive index: measured by Zeiss refractometer
- Values 1.344 to 1.348

Q. Hortvet apparatus is generally used to determine which physical property of milk? (RPSC 2013)

(1) Boiling point

(2) Freezing point

(3) Electrical conductivity

(4) Density

- Non specific germicidal factor present in milk (KPSC)

a. Immnunoglobulins
b. Bifidus factor
c. Lactoferrin
d. None of the above

When the milk is adulterated with water, freezing point depression will

A) be lowered

B) increase

C) reach towards 0°C

D) be maintained

The pH of milk is

A) 7.0

B) 6.5

C) 4.5

D) 6.6

specific antimicobial compounds present in milk (KPSC)

a. Immnunoglobulins
b. Bifidus factor
c. Complement
d. All of the above

Milk boiling temperature is (OPSC 2014)

(a) 100°C (b) < 100°C (c) > 100°C (d) 80°C

Natural activity in milk is due to (OPSC 2014)

(a) Citrates (b) Carbonates (c) lactate (d) Acetate

Opsc 2018

Specific gravity of milk is:

(A) 0.94 (B) 1 (C) 1.030 (D) 1.050

Which contributes richness of flavour of milk?

(A) Phospholipid (B) Galactolipid (C) Glycolipid (D) Cholesterol

- Which of the following agents does not contribute to natural acidity of milk (HPSC 2023)

a. Lactic acid

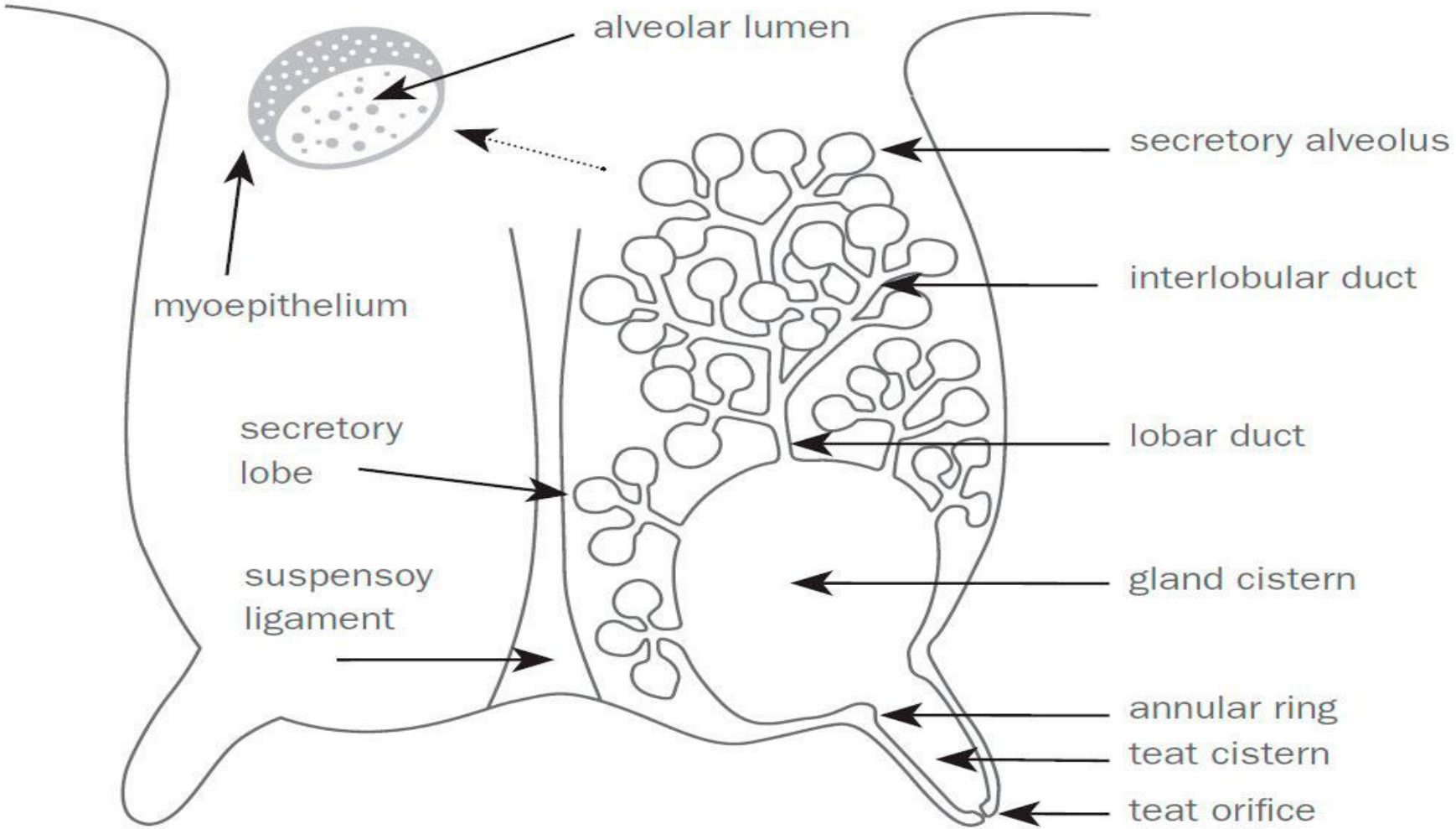
b. Citrates

c. Phosphates

d. Dissolved CO2

- Which of the following is not a part of lactoperoxidase system in milk (HPSC 2018)

a. Phosphatase
b. Hydrogen peroxide
c. Thiocyanate
d. Lactoperoxidase


alveolar lumen
secretory alveolus
myoepithelium
interlobular duct
secretory
lobe
lobar duct
suspensoy
ligament
gland cistern
annular ring
teat cistern
teat orifice

Physiology of lactation

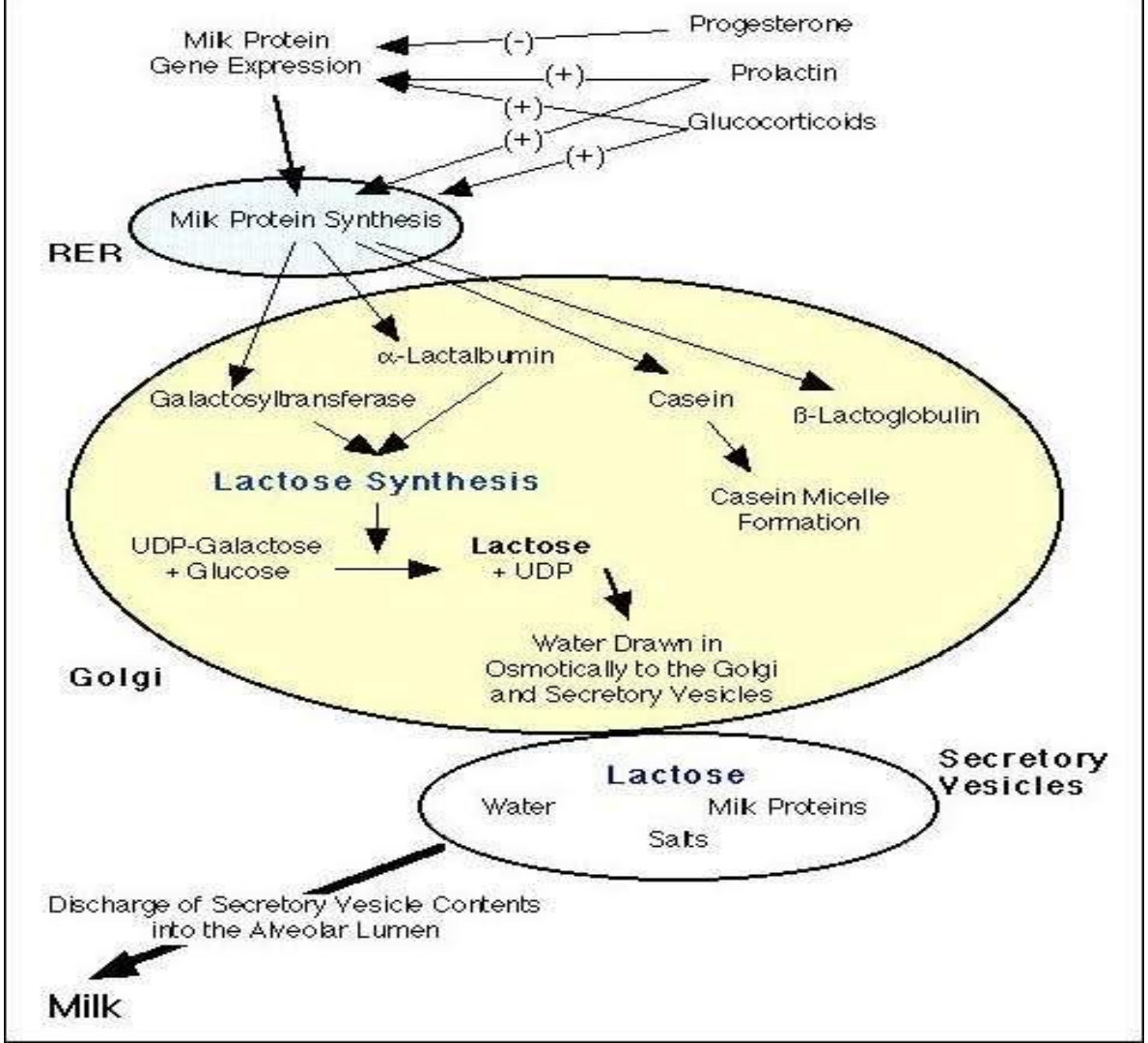
- Stages of lactation –
- Mammogenesis: development of mammary gland
- Lactogenesis: initiation of milk secretion
- Galactokinesis: ejection of milk
- Galactopoiesis: maintenance of milk secretion
- Process includes
  - uptake of amino acids
  - uptake of sugars
  - uptake of milk fat precursors
  - uptake of immunoglobulins, Vitamins, Minerals

Amino acids to proteins

- At rough endoplasmic reticulum (RER).
- transferred from the RER to the Golgi apparatus
- Caseins and other proteins undergo post-translational processing in the Golgi.

Glucose to Lactose

- Entry of glucose via GLUT1. Some part of the glucose is converted to UDP-galactose
- **In Golgi**, **Glucose, galactose and alpha lactalbumin** enters in reaction catalyzed by enzyme **Galactosyl transferase** resulting in formation of lactose.
- formation of lactose in the Golgi results in drawing water into the cell


Milk Protein
Gene Expression
(-)
Progesterone
(+)
Prolactin
(+)
(+)
Glucocorticoids
(+)
Milk Protein Synthesis
RER
α-Lactalbumin
Galactosyltransferase
Casein
ß-Lactoglobulin
Lactose Synthesis
Casein Micelle
Formation
UDP-Galactose
+ Glucose
Lactose
+ UDP
Water Drawn in
Osmotically to the Golgi
and Secretory Vesicles
Golgi
Secretory
Vesicles
Lactose
Water
Milk Proteins
Salts
Discharge of Secretory Vesicle Contents
into the Alveolar Lumen
Milk

Fat precursors to milk fat

- synthesized on the smooth endoplasmic reticulum (SER)
- **Acetate and ß – hydroxybutyrate-important precursors**
- Fatty acids are derived either from blood (mostly long chain C14 to C18) or *de novo* synthesis of short to medium chain fatty acids (C4-C12) in mammary gland.

Hormones Involved

	Prolactin	Mammary growth; initiation and maintenance of lactation
	GH	Stimulates milk production
Post pituitary	Oxytocin	Milk ejection
Thyroid gld	T3, T4	Stimulates O2 consumption, protein synthesis and milk yield
	Calcitonin	Calcium and phosphorus metabolism
Adr cortex	Glucocorticoids	Initiation and maintenance of lactation
Adr medulla	Epinephrine, norepinephrine	Inhibition of milk ejection
Ovary	Estradiol	Mammary duct growth
	Progesterone	Mammary alveolar –lobule growth, inhibition of lactogenesis
Placenta	Estradiol	Mammary duct growth
	Progesterone	Mammary alveolar –lobule growth, inhibition of lactogenesis
	Placental lactogen	Mammary growth

FACTORS AFFECTING MILK YIELD & COMPOSITION

1.Species
2.Breed
3. Individuality
4.Interval of milking
5. Frequency of milking
6. Disease and abnormal condition
7.Portion of milking- (Fore milk and Stripping)
8. Stage of lactation
9. Feeding
10. Season
11. Age
12. Condition of cow at calving
13. Administration of drugs and hormones

- ❖ Maximum milk production: 4th Lactation
- ❖ Peak milk Yield : 3-6 weeks post calving
- ❖ Breed:

- HF: Highest milk yield/ lactation and lowest milk fat
- Highest milk fat : Cow: Exotic – Jersey (5.5%) Indian – Red Sindhi

  Buffalo: Bhadawari (milk fat 14%)
- Foremilk is low in fat(1%), while the last milk (strippings) is always quite high in fat (10%)

- Basic unit of milk Synthesis: Alveoli
- The proportion of milk stored in cistern/alveolus: Goat-80:20, Sheep:-50:50 , Cattle:-30:70 , Buffalo & Camel :-5:95 , Sow:- 0:100
- Hormone responsible for let down of milk: Oxytocin (Half life: 5-7 minutes – normal milking time)--- synthesized in hypothalamus--- secreted by post. Pituitary)
- Hormone responsible for Holding of milk: Epinephrine
- Milk letdown without oxytocin reflex: Goat
- Blood supply: Artery: external pudic Vein: Subcutaneous abdominal vein (milk vein)

Cooling & Transportation Of Milk

- Common milk bacteria grow best b/w 20-40°C
- Freshly drawn raw milk should be promptly cooled to 5°C or below till processed

- Metals for dairy equipments: 18:8 stainless steel (18% Chromium & 8% Nickel) or aluminum alloy

- Green corrosion product Verdigris – when stored in Copper vessels

Temp. for 18 hours	Bacterial growth factor
0	1.0
5	1.05
10	1.80
15	10.00
20	20.00
25	120000.00

Cooling

- In can or Can immersion method
- Surface cooler
- In tank or bulk tank cooler

Preservatives in milk

- Mercuric Chloride: 300- 800 ppm
- Formalin: 0.4/100ml
- Hydrogen Peroxide
- Potassium dichromate

LP system

- lactoperoxidase- enzyme (bovine milk - 30 µg/ml)
- Thiocyanate- substrate
- Hydrogen peroxide – Promoter

sodium thiocyanate and H2O2 when added in 14:30 mg/ litre improves keeping quality to 10Hr at 37 °C

bactericidal to Gram-ve and bacteriostatic to Gram +ve

Standardization

- adjusting the fat and solids-not-fat (SNF) content of milk to meet specific standards or requirements.
- By removal of excess fat or addition of skim milk or cream
- standardized milk must have a minimum fat content of 4.5% and SNF content of 8.5%

Pasteurization

- process of heating every particle of milk to at least 63°C for 30 min or 72°C for 15s or to any temperature-time combination which is equally efficient, in a properly operated equipment.
- After pasteurization, the milk is immediately cooled to 5°C or below.
- started by Louis Pasteur in Wine and Dr. Soxhlet in milk

Importance and Drawbacks

- **Importance of Pasteurization**

  - To render milk safe for human consumption by destroying all the pathogenic microorganisms.

  - To improve keeping quality of milk by killing almost all spoilage organisms (85-99%)

- **Drawbacks of Pasteurization**

  • It diminishes the cream line or cream volume (by denaturation of cryoglobulins)

  • Pasteurized milk may increase the renneting time.

  • It fails to destroy bacterial toxins and Accumulation of milk-stone in the heating section

METHODS OF PASTEURIZATION

1. Batch or holding pasteurization (LTLT)	63 ° C for 30 minutes
2. High Temperature Short Time (HTST) pasteurization/ Flash pasteurization	72 ° C for 15 sec
3. Electric pasteurization	Using electricity for 15-20 sec
4. Vacuum pasteurization (vacreation)	under reduced pressure by direct steam
5. Ultra high temperature pasteurization	135 ° C to 150 ° C for no hold
6. In- bottle pasteurization	63-66 ° c for 30 minutes
7. Stassanization	74 ° c for 7 sec
8. Uperization/ultra – pasteurization	150 ° c for a fraction of a second

LTLT

- Batch or Holding pasteurization
- heated to a minimum of 62.7°C and held at this temperature for minimum 30 min and cooled as rapidly as possible to 4°C.
- The LTLT pasteurizer may be of three types

- *Water – jacketed vat*
- *Water–spray type*
- *Coil-vat type*

HTST - Flash pasteurization

- **Modern method** : 72 ° C for 15 sec
- regenerative heating and cooling in plate heat exchanger
- Heating by hot water or steam
- Coolant: Chilled water or glycol

- Pressure in HTST: Pasteurized milk 15 psi; raw milk 14 psi; heating/cooling media 12-13 psi

* Regeneration efficiency: 85-90%

= temp. after regenerative heating – initial temp. / temp. after final heating – initial temp.

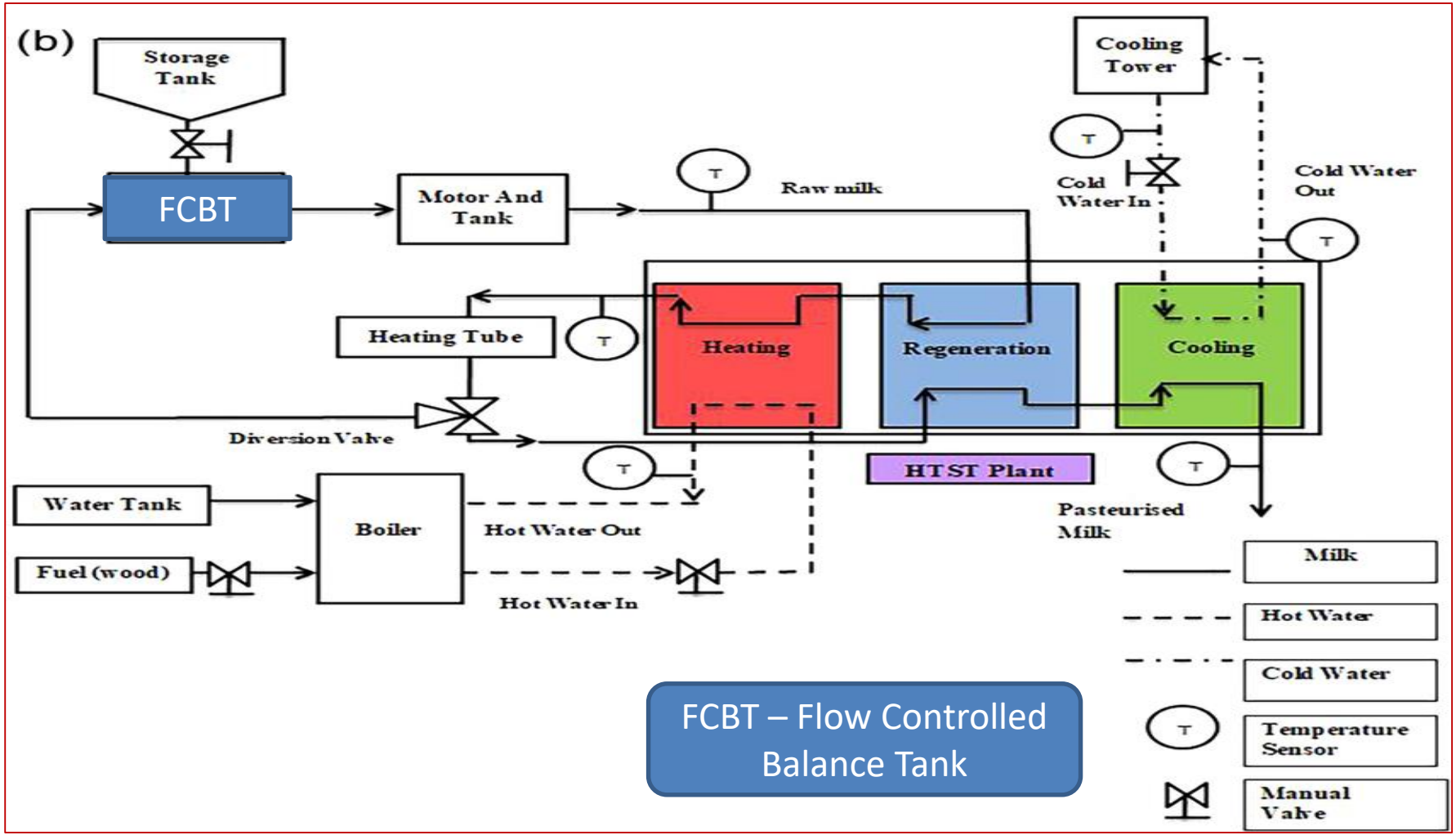
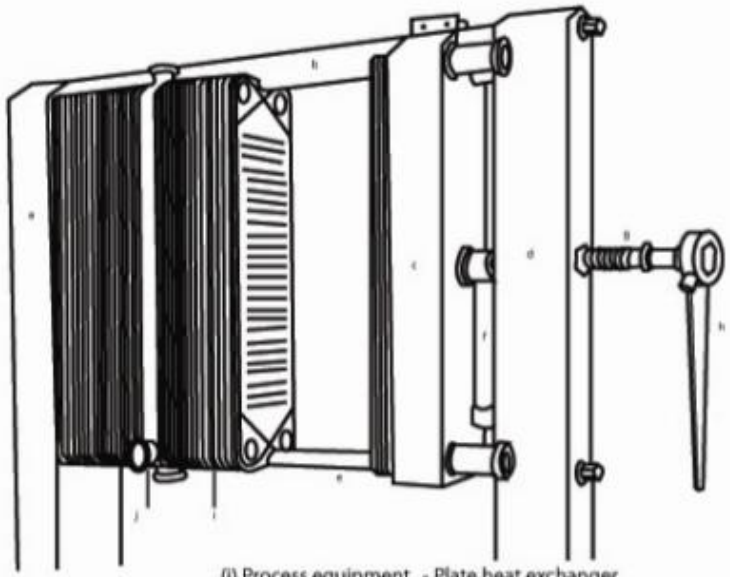

(b)
Storage Tank
FCBT
Motor And Tank
Raw milk
Cooling Tower
Cold Water In
Cold Water Out
Heating Tube
Heating
Regeneration
Cooling
Diversion Valve
HTST Plant
Water Tank
Boiler
Hot Water Out
Fuel (wood)
Hot Water In
Pasteurised Milk
Milk
Hot Water
Cold Water
Temperature Sensor
Manual Valve
FCBT – Flow Controlled Balance Tank

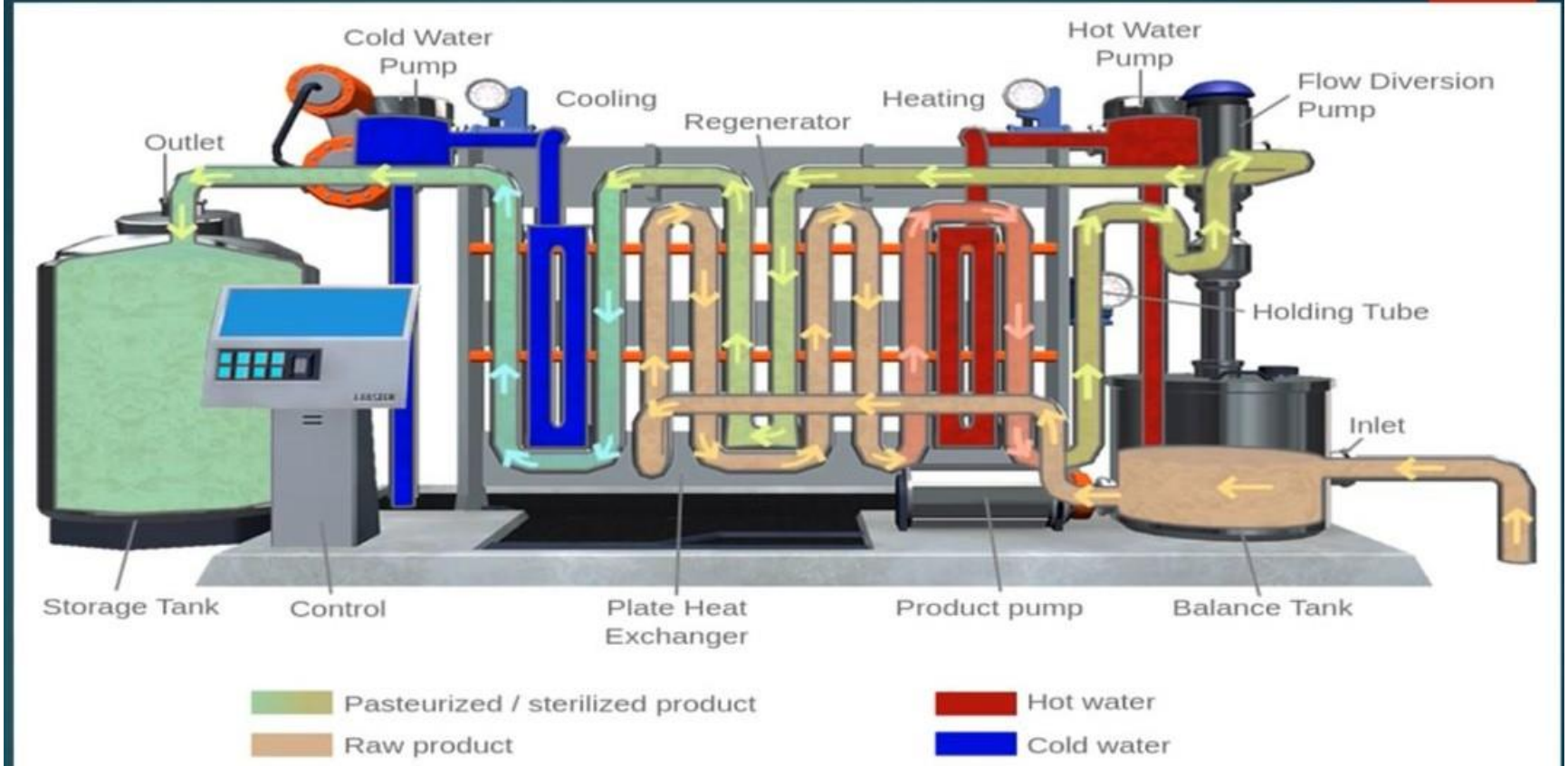
Plate Heat Exchanger



(i) Process equipment - Plate heat exchanger

a. Head Frame, b. Guide bar, c. Follower, d. End support, e. Carrying bar, f. Hinged distance piece, g. Tightening screw device
h. Detachable retchet spanner, i. Bank of plates, j. Connector grid with inlet and outlet bosses

HTST


Cold Water Pump
Cooling
Regenerator
Heating
Hot Water Pump
Flow Diversion Pump
Outlet
Holding Tube
Inlet
Storage Tank
Control
Plate Heat Exchanger
Product pump
Balance Tank
Pasteurized / sterilized product
Raw product
Hot water
Cold water

ADVANTAGES

- complete destruction of Phosphatase enzyme
- Phosphatase Test : Detect adequacy of pasteurization
- Pasteurization --- carried out at a heat treatment temperature above that for phosphatase inactivation and yet below that for cream line reduction.
- Pasteurization ensures **complete destruction of pathogens**, **negative alkaline phosphatase test** and least damage to the cream line

- Vacuum pasteurization (vacreation) : pasteurization of cream under reduced pressure by direct steam

-equipment used is called vacreator

Thermization: 62° C - 65° C for 15-20 seconds

- Sterilization : 115 ° C for 15 min. or 145 ° C for 3 sec to ensure preservation of milk at room temperature for a period of not less than 15 days.
- Sterilized milk shall show a negative turbidity test

Index organism for pasteurization : Coxiella burnetti

Shelf life of milk

- At room temp. for 3 hour immediately after milking
- Cooling at 5°C : 24 hours
- Pasteurization: 4-7 days
- UHT : few months

Loss of nutrients

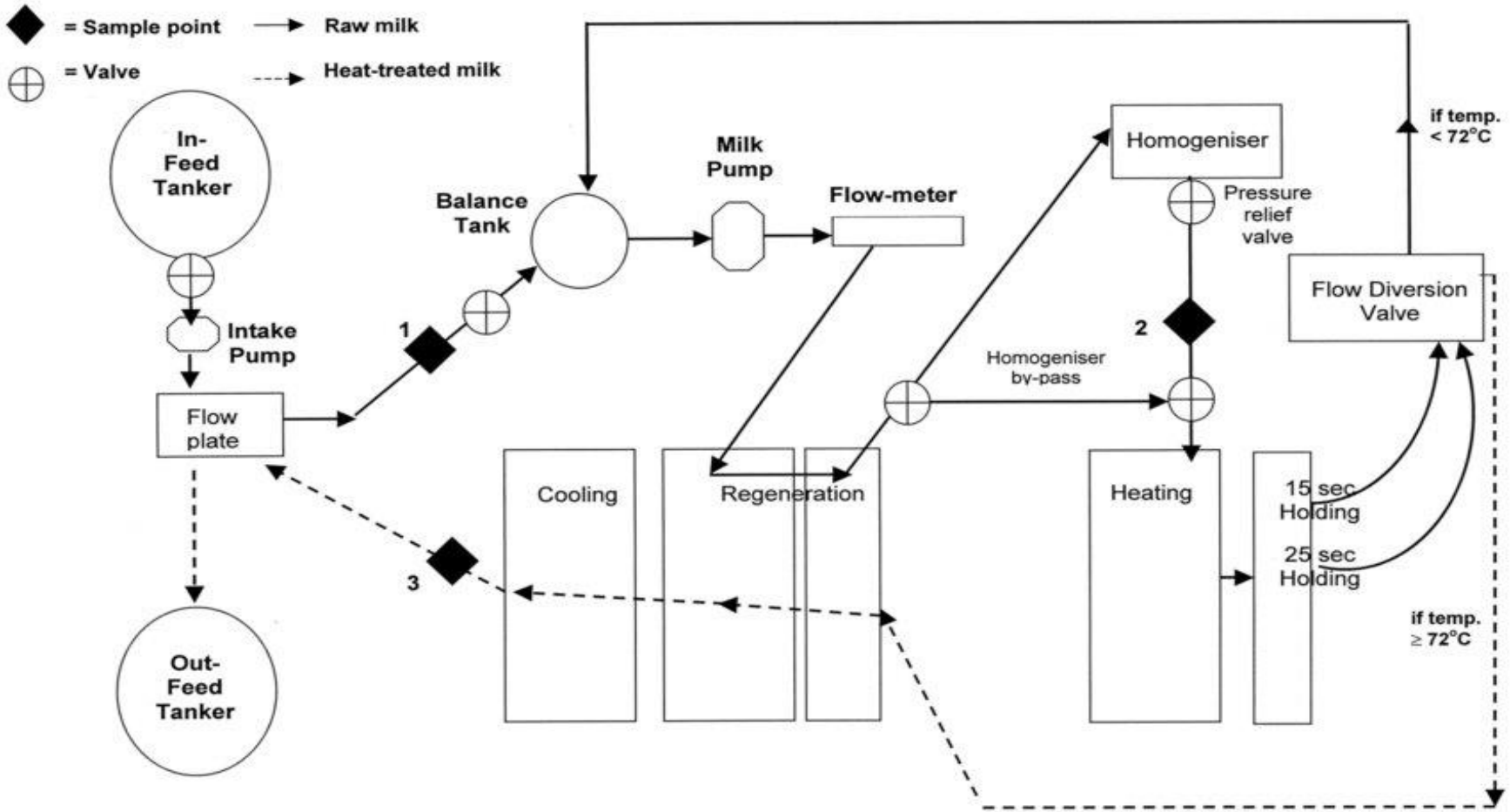
- **Pasteurization:** 10% Vitamin B1 and 20% of Vitamin C. Lactose - not much influenced by the normal pasteurization conditions
- **Sterilization:** 30-50% Vitamin B1 and 50% of Vitamin C
- Lactose- browning and isomerisation reactions

BACTOFUGATION

- process of removal of microorganisms from milk using centrifugal force.
- Most of the microorganisms are inactivated by pasteurization. However, the highly heat resistant spores survive pasteurization
- special form of separation of microorganisms (99%), mainly spore formers (Bacilli/Clostridia)

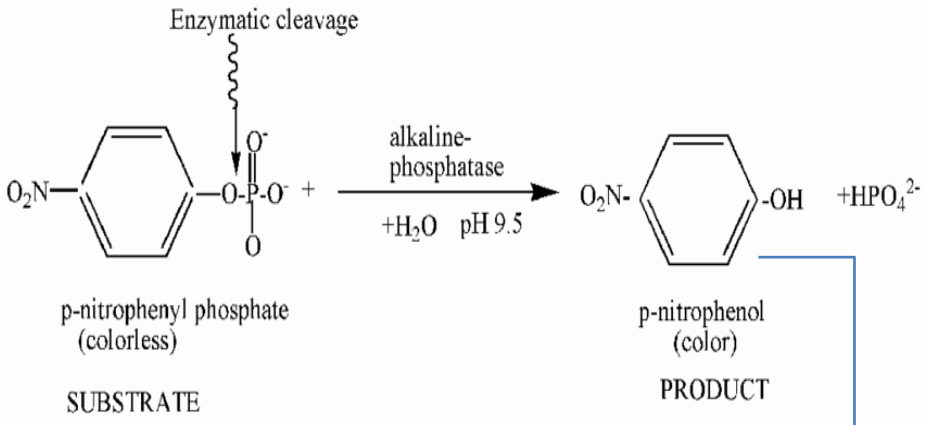
Homogenization

- Process in which fat globules in milk are broken down in to smaller size (<2 μm) and distributed evenly into milk serum by applying high pressure.
- surface area increases by a four- to six- fold
- No cream can be separated from homogenized milk
- Principle: milk is forced at high pressure through a narrow valve with velocity 100 - 200 m/s. This can cause high shearing stresses, cavitations and micro-turbulence. The globules becomes deformed, wavy and then breakup.
- Temperature of 65-70°C (to inactivate lipase enzyme) and a pressure of 150 - 200 bar (15-20 MPa) and additional 5-10 Mpa in two stage homogenization


= Sample point
Raw milk
= Valve
Heat-treated milk
In-Feed Tanker
Balance Tank
Milk Pump
Flow-meter
Homogeniser
Pressure relief valve
if temp. < 72°C
Flow Diversion Valve
Intake Pump
1
2
Homogeniser by-pass
Flow plate
Cooling
Regeneration
Heating
15 sec Holding
25 sec Holding
3
Out-Feed Tanker
if temp. ≥ 72°C

Efficiency of pasteurizarion

- Scharer Rapid Phosphatase Test.



Blue

- The shelf life of pasteurized milk kept at less than 8°C is: (PPSC 2016)

a) 1-2 days b) 3-5 days c) 6-8 days d) 10-15 days

- An indicator organism for efficient pasteurization is: (PPSC 2022)

a) Mycobacterium tuberculosis

b) Coxiella burnetti

c) Mycobacterium bovis

d) Bacillus anthracis

- Due to homogenization, area of milk fat increases (UPPSC)

(a)2 times (b) 3 times (c) 4 times (d) 5 times

- Efficacy of pasteurization is judged by: (PPSC 2016), (OPSC, MPPSC)

a) Dye reduction test

b) Alkaline phosphatase test

c) Amylase test

d) Malachite test

- Which of the following is not a part of lactoperoxidase system in milk (HPSC 2018)

a. Phosphatase
b. Hydrogen peroxide
c. Thiocyanate
d. Lactoperoxidase

- In a positive phosphatase test, a para-nitrophenol is liberated that gives……. colour under alkaline condition. (MPPSC)

[A] pink [B] violet [C] blue [D] yellow

- In the HTST type of pasteurisation of milk the temperature and time is (RPSC 2013)

(1) 73 °C to 76 °C for 60 seconds

(2) 75 °C to 78 °C for 45 seconds

(3) 72.2 °C to 72.8 °C for 15 seconds

(4) 74.2 °C to 75.2 °C for 30 seconds

COLOSTRUM V/S MILK

- colostrum – 1st milk or beestings (fed 1/10th of the body weight for 3-5 days)
- less water and lactose compared to milk
- More protein, fat, immunoglobulins, total solids
- contains trypsin inhibitor to protect immunoglobulins from digestion
- antibodies transfer doesn't occur through placenta in ruminants
- IgG1 > IgM > IgA > IgG2 (IgG1 most abundant immunoglobulin in bovine milk while IgA in human mik)
- Contains Bifidus factor (Human milk)

Constituents	colostrum	milk
Water	70-74	87
Total solids	28	13
Fat	1-12(6)	4
Protein	**21.3**	**3.3**
Globulin	15.1	0
Casein	4.7	2.8
lactalbumin	1.5	0.5
lactose	**2.5**	**4.9**

Dairy Microbiology

- Milk is sterile at secretion in the udder
- contaminated by bacteria even before it leaves the udder
- Bacterial count of milk – 500-1000/ml (10000/ml when drawn in to pail)
- Freshly drawn milk has a temperature of approximately 38^0C which is highly suitable for bacterial growth.

SOURCES OF CONTAMINATION

a) Interior of the udder: bacterial count of milk varies between 500 and 1000/ml
b) Environmental: bacteria accumulated on the surface of body get dislodged during the milking process and enter the pail contributing a load of 10,000 bacteria or more per ml. of milk
c) Milker or Handler: typhoid fever, diphtheria, scarlet fever, septic sore throat
d) Utensils
e) Wholesaler, retailer and the vendor
f) During transportation

Type of bacteria	Temp. range	Optimum growth temp.	Example
Mesophilic	20 & 40°C	37°C	S. aureus, E. coli
Thermophilic (Heat loving)	55-70° C	55° C	Bacillus stearothermophilus
Thermoduric (spore forming)	60-63° C	35-37°C	Micrococcus varians
Psychotropic (Cold loving)	Can survive refrigerated temp.	15 - 20°C	Pseudomonas sp. Alkaligenes sp.
coliforms		37° C	E.coli

Spores can survive UHT

Thermophilic – can survive and grow above pasteurization temp. while Thermoduric Can survive but not grow

TYPE OF MICROBES

Lactic acid bacteria (LAB): GRAS bacteria

- Homofermentive: able to ferment lactose to lactic acid e.g. *Lactobacillus acidophilus, L. delbrueckii, L. Helveticus*

-Heterofermentative: which produces end Products other than lactic acid e.g. *Lactobacillus brevis*, *Lactobacillus fermentum*, *Lactobacillus reuteri*

Milk fermentation

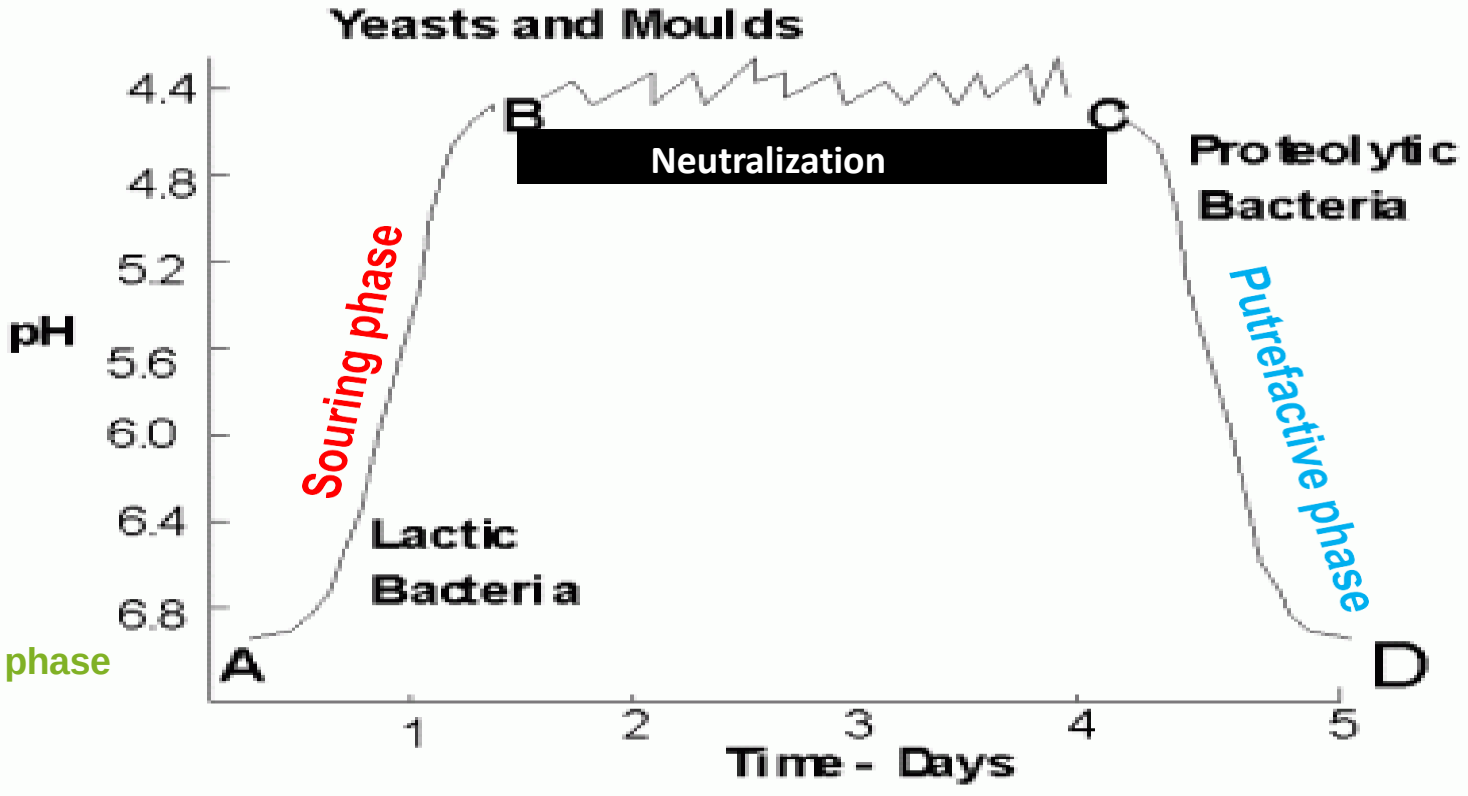
The process by which a change is produced in milk through microbial activity

General fermentation

1. Germicidal (Destruction phase)
2. Souring phase
3. Neutralization
4. Putrefactive phase

Specific fermentation

1. Souring
2. Souring & gassiness
3. Proteolysis
4. Alkaline fermentation
5. Ropiness



Germicidal phase

F Natural Fermentation of Raw Milk

Souring/ curdling

due to the production of acidity (lactic acid from lactose) by lactic acid bacteria

Sour flavor is because of volatile acids, diacetyl and acetaldehyde

normal acidity of fresh milk	0.13 to 0.15%
Milk sours	0.20 to 0.25%
milk curdles	0.50 to 0.65%

- e.g. Lactococcus, Lactobacillus, Leuconostoc, Streptococcus and Enterococcus.

ROPINESS OR SLIMINESS

- growth of bacteria leading to change in consistency of the product that forms threads or viscous masses when poured.

-Ropiness because of Polysaccharides and Mucins

E.g. **Alcaligenes viscolactis** – More common, B.cereus, B.subtlis, Coli aerogenus group

PROTEOLYSIS

- casein or some insoluble casein derivatives are broken down to water soluble compounds through the action of microbes or their enzymes
- E.g. Pseudomonas, Bacillus
- Important for development of body and texture in Cheese

SWEET CURDLING

- curdling without pronounced acid production
- Due to production of rennin like enzymes by bacteria which causes precipitation of casein without production of acid
- E.g. Bacillus cereus , B. subtilis, E.coli

LIPOLYSIS

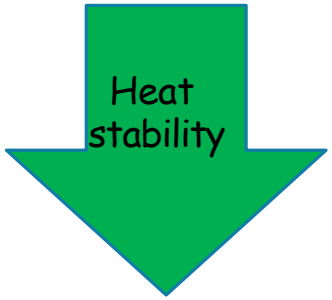
- hydrolysis of milk fat by lipase resulting in to the accumulation of free fatty acids

- butyric & caproic responsible for off flavors

- E.g. Pseudomonas

- Gas forming bacterias: Coliaerogenus, Clostridium
- Coliaerogenus group – E.coli, Klebsiella, Enterobacter – possess the enzyme β-galactosidase, which is critical for lactose fermentation
- Stormy Fermentation: *Clostridium perfringens*

PLATFORM TESTS



Organoleptic tests – Color, Flavor & taste

Acidity/pH

Alcohol alizarin, Clot on boiling, Alcohol test

2 min resazurin test

Lactometer

Organoleptic tests

Also called Rapid Platform tests

Flavor:

- Rancid - Pseudomonas fragi,
- phenolic flavors - Bacillus circulans
- Fishy flavor - Pseudomonas icthyosmius, due to conversion of lecithin to trimethylamine.
- Cooked flavor is due to the sulfhydryl group

- Taste: Bitter taste in milk may be due to Serratia liquefacines

- Sediment test

Tests for acidity

- Clot on Boiling (COB) Test: give indication about the susceptibility of milk to heat processing and its keeping quality.
- rapid method to determine the acidity in milk
- Milk with high acidity (More than 0.17% LA) gets coagulated on boiling.
- Other test to determine acidity : Alcohol test, pH test, Alcohol alizarin test

LABORATORY TESTS

Test	Interpretation	Remarks
Dye reduction test	extent of bacterial contamination	MB reduction test, Resazurin test
Direct microscopic count	type of microorganism	Both live and dead bacteria
Standard plate count	extent of bacterial contamination	Only live bacterias
Freezing point	adulteration of milk with water	Most sensitive test for detecting adulteration with water
Coliform count	faecal contamination	Should be less than 100cfu/ml in raw milk

DYE REDUCTION TESTS

1. Methylene blue reduction test: to find relative number of bacteria in a milk sample

- Very good: not decolorized in 5 hours
- Good: decolorized in less than 3-4 hours
- Fair: decolorized in less than1-2 hours
- Poor: decolorized in less than $\frac{1}{2}$ hour

2. Resazurin reduction test : procedure similar to Mbreduction test. Result in 10minutes

STANDARD PLATE COUNT

- basis for grading milk
- gives rough estimate of viable microbial growth in the sample
- All plate counts are expressed as the number of cfu /ml.
- SPC doesn't indicate the quality of microbial populations in terms of pathogens and non-pathogens.
- generally accepted as the most accurate and informative method of testing bacteriological quality of milk

STANDARD PLATE COUNT

Bacteria CFU/ml	Grade
Up to 2 lakhs	Very good
2-10 lakh	Good
10-50 lakh	Fair
More than 50 lakh	Poor

SPC for pasteurized milk – not more than 30,000 cfu /ml

Bacteriological standards of raw milk (IS-1479 PART III-1997)

Grades	Direct microscopic count per ml (lakhs)	Standard plate count per ml (lakhs)	Methylene blue reduction time (hr)	One hour resuzurin disc. (No.)	Presumptive coliform test (in 0.01 ml) i.e. 1 in 100
Very good	NS	< 2	> 5	NS	absent
Good	< 5	2-10	3-4	4 or higher	absent
Fair	5-40	10-50	1-2	3.5 to 1.0	absent
Poor	40-200	> 50	< 1/2	0.5 to 0	present
Very poor	> 200	NS	NS	NS	NS

NS : Not specified

Bacteriological standards of pasteurised milk (IS-6397-1971)

Test	Requirement
Standard plate count	Maximum 30000 cfu/ml
Coliform count	absent in 1:10 dilution
MBRT	more than 4 hr
Alkaline phosphatase	test negative

ADULTERANTS

- Adulteration --- addition of cheaper & resembling substances to milk or removal of one or more valuable constituents (like fat).

Common adulterants in milk:

1. Water – most common adulterant in milk
2. Starch, cane sugar
3. condensed milk or milk powder
4. urea, detergents, sodium bicarbonate
5. mixing of cow & buffalo milk

Iodine solution Test	Starch adulteration in milk
Nitric acid	Skim milk powder
Bromocresol purple solution	Detergent in milk
p - dimethyl amino benzaldehyde	Urea adulteration in milk
Resorcinol	Cane sugar detection
Rosallic acid test	Sodium Carbonate
Storch's peroxidase test	Heated milk in fresh milk
Hansa Serum (Hansa Test)	Mixing of cow & buffalo milk
Picric acid solution/ Mercuric Nitrate	Gelatin in milk
Delvo kit test	Detect antibiotic and sulpha residues
Lactometer reading, freezing point, nitrate detection	Water in milk
Baudin test	Vegetable oil adulteration in ghee

Table 3. Important tests to detect adulterants in milk

Adulterant	Test	Interpretation
Thickening agents		
Starch	Boil 10 ml milk --> cool and add 1 ml of 5% iodine	Blue colour
Gelatin	10 ml milk + 10 ml mercuric nitrate, shake + 20 ml water and shake well. Filter. Filtrate + equal volume of saturated aqueous picric acid.	Yellow ppt.
Cane sugar	2 ml milk + 1 ml HCl + 0.1 g resorcinol, boil for few minutes	Red colour
Sucrose	10 ml milk + resorcinol	Red colour
Milk powder	10 ml milk + 1 drop formalin place at 60°C for 10 minutes	Peculiar odour
Skim milk powder	10 ml milk + few drops of nitric acid	Yellow colour
Calcium carbonate	10 ml milk + 1 ml conc. HCl	Effervescence
Sodium bicarbonate	5 ml milk + 10 ml alcohol + rosalic acid solution (1:10)	Rose red colour
Urea	i) 0.2 ml urease + 0.1ml 0.5% bromothymol blue + 5 ml milk	Faint blue colour within 10 min for urea and dark Blue colour for synthetic milk.

FAT ESTIMATION

- Gerber test (Fucoma Test)
- Babcock test
- Rose Gottileb and Adam's test

Total Solids & SNF estimation

- Gravimetric Method
- Lactometer Method
- Infrared Spectroscopy
- Formulas- Richmond, Babcock, Fleischmann's

CONDENSED OR CONCENTRATED MILK

Concentrated milk – product obtained by evaporating part of the water of whole or skim milk with or without addition of sugar

- Condensed milk: full cream sweetened milk
- Evaporated milk: full cream unsweetened milk
- Skimmed milk products: sweetened and unsweetened
- Unsweetened condensed milk – Evaporated milk
- ratio of concentration of milk solids: 1: 2.5 for full cream products and 1: 3 for sweetened condensed skim milk

	Fat %	Milk Solids % (minimum)
Evaporated milk	8% (minimum)	26
Condensed milk	9% (minimum)	31
Evaporated Skim milk	0.5% (maximum)	20
Condensed skim milk	0.5% (maximum)	26

Cane Sugar in sweetened milks: 40% (minimum)

Seeding

- Crystallization of lactose by the addition of fine powder of lactose or small quantity of condensed milk from previous batch.
- Purpose: **forms very small crystals** in the supersaturated solution

- Pilot Sterilization test: to determine the amount of chemical stabilizer to be added in evaporated milk
- Baume Hydrometer test- most commonly used for density test of condensed milks
- Storage temp.- 5-16 **°C**

Dried milks

- Dried milk or milk powder: moisture content 5% or less

	Whole Milk powder (WMP)	Skim Milk powder (SMP)
Moisture % (max)	5	5
Fat %	26 (minimum)	1.5 (max)
Solubility index	15 if roller dried and 2 if spray dried	

Milk Drying Systems

- **Cold**
  - **Freezing out water And centrifuge**
  - **Freezing milk. And sublimation.**
- **Heat**
  - **Film, Roller or Drum Drying**
    - **Atmospheric Or Vacuum**
  - **Spray Drying – commercial method**
    - **Compressed Air, Pressure Spray or Centrifugal Disc**

Spray drying method:

Receiving milk

Cooling

5 ºC

Pre-heating at 71 ºC.

Filtration/clarification

Heat

Combination of 82 ºC for 15 minutes

Condensing

concentration of 35-40 % total solids is produced

Pumping

preheated concentrate at 71º C is forced through the atomizer pressure of 2500 psi.

Spray drying

dried with inlet air at 143-232 º C and the exit air at 74 to 93 ºC

Cooling, Sifting

A12 mesh screen

Packaging ,Storage:

temperatures lower than, 24º C, in a cool, dry place

- Instantization: process by which dried milk are made instant soluble
- Wettability: measure for the ability of a powder to be wetted with water at a given temperature
- Agglomeration: particles collide with each other and adhere
- Skim milk powders more wettable than WMP because of less fat content
- solubility (reconstitutability):
- Spray dried milk (once it has been wetted) - soluble up to 98 to 99%
- roller- drying reduces the solubility of the powder to 80 to 85% by damage to the fat globule – lowest in all methods

Fermented milk

- Acidophilus milk: fermented milk developed with L. acidophilus culture
- Bulgarian milk : L. bulgaricus

Kumiss: originated in Russia - Lactic acid + Alchol fermented milk
- Formerly mare's milk now cow's
- Alcohol content 2.5%

Kefir: 1% lactic acid + 1% alcohol

Filmjolk: Scandinavian sour milk

Functional milk products

- specialized dairy items designed to provide additional health benefits beyond basic nutrition
- lactose-free milk - made by filtering regular milk to remove half the lactose and adding enzyme Lactase
- Filled milk: homogenized product prepared from refined vegetable oil & water.
- UHT processed milk: packed & aseptically sealed in pre-sterilized containers. can be stored Unrefrigerated for at least 3 months
- Designer milk: as per consumer requirement using biotechnology
- Irradiated milk: increased Vitamin D content by UV rays exposure
- Evaporated milk must be fortified with Vit. D

- Recombined Milk: product obtained when butter oil (also called anhydrous milk fat), skim milk powder and water are combined in the correct proportions to yield fluid milk.
- Reconstituted milk: dispersing milk powder in water
- Humanized milk: chemical composition modified to match human milk
- Imitation milk: milk of non dairy origin
- Vegetable toned milk: milk protein of SMP substituted by groundnut protein (MILTONE BY CFTRI , Mysore)

Cream

According to PFA 1976, minimum fat % - 25%
(FSSR, 2011):
1. Low fat cream: milk fat not less than 25.0 %
2. Medium fat cream: not less than 40.0 %
3. High fat cream: milk fat not less than 60.0 %

Classification: based on end use

- Table cream, Light cream, Coffee cream : 20-25% milk fat
- Heavy cream Whipping cream: 30-40% milk fat
- Plastic cream: 65-85% milk fat

PRINCIPLE: Based on the fact that milk fat is lighter than skim milk portion

PARTICULARS	GRAVITY METHOD	CENTRIFUGAL METHOD
NATURE OF FORCE CAUSING SEPARATION	GRAVITATIONAL	CENTRIFUGAL
SPEED OF SEPARATION	EXTREMELY SLOW	PRACTICALLY INSTANTANEOUS
DIRECTION OF MOVEMENT PARTICLES	VERTICAL	HORIZONTAL
FAT % OF CREAM	10-25	18-25
% fat recovered in cream	Not more than 90	99-99.5

- velocity or rate at which the fat globules rise is given by a equation, which is known as Stoke's Law
- In centrifugal method – skim milk on periphery and cream inside
- Cream screw in and skim milk screw out: higher fat% and vice versa

- skimming efficiency: % age of fat recovered in form of cream from milk
- High acidity of milk precipitate casein resulting in clogging of bowl deceasing efficiency of skimming

- can not be separated from Homogenized milk
- Pasteurization : LTLT-> 71 °C for 20 min
- HTST: 95-100 °C for 5-16 seconds

- Vaceration: dilutes the cream and it will lower the fat percentage of cream up to 6 - 8 %

Defects

- Oxidized/oily/Metallic/Tallowy: Fat oxidation due to direct contact of milk with copper or iron, exposure of milk or cream to sunlight, etc.
- Rancid: Fat hydrolysis due to lipase action in milk or cream
- Highly acid/sour

i. Using sour milk for separation

ii. Acid development in cream

Butter

- Balancing wheel of dairy industry
- water-in-oil type emulsion
- Butter fat- 80% (76% in desi butter) Moisture-16 % Salt-3 % and Curd-1.5 % (FSSR)
- No preservative except common salt
- No coloring material except annato or carotene
- Flavoring agent – Diacetyl (not more than 4ppm)

Indian butter: Butter fat-80.2% Moisture-16.3 % Salt-2.5 % and Curd-1.0 %

- fat in water emulsion is changed to water in milk fat emulsion
- Milk→ separated to get cream→ treatment of cream→ conversion to butter → storage
- Coloring agent: natural Annatto, carotene
  - Neutralizers: lime, soda
  - Flavoring agent: Diacetyl

Fisher and Hooker's phase reversal theory

- Churning is process of phase reversal Changing oil in water to water in oil

-agitation of cream causes: coalescence and clumping of fat globules

-ratio of surface area to volume of fat becomes very small

-no longer contains all the buttermilk in stable form

-fat in water emulsion breaks

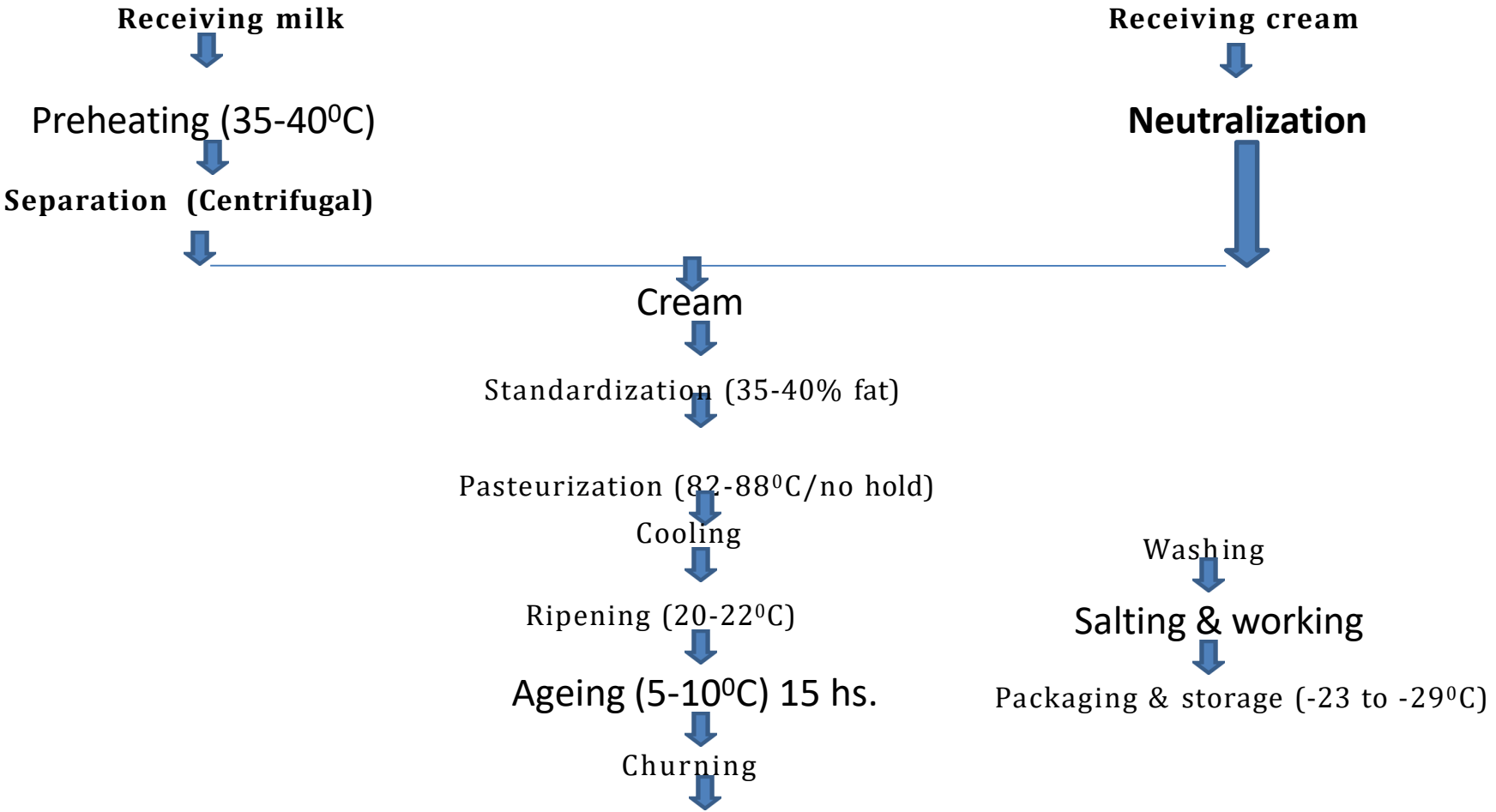
Rahn's foam theory

- foam produced→ fat globule concentrate in foam → bubble due to surface tension--→ foam producing assumes solid character→ foam collapses and fat globules coalesce and butter formed
- based on principle Air/ foam was necessary for churning

king's modern theory

- churning breaks the clusters and causes foam formation
- fat globules concentrated to air bubble in the foam thus brought close to each other to form large particles

Method of manufacture, packaging and storage



Steps in butter making:

- Neutralization of cream: reduce the acidity of cream to 0.14-0.16%
- Standardization of cream: 33-40%
- Pasteurization of cream: 90- 95 ^{o} C for 15 or 105-110^{o}C with no holding
- Cooling and ageing at 5-10 ^{o}C
- Ripening of cream: by mixture of both acid producing (*Streptococcus lactis*, *S.cremories*) and flavour producing (*S.diacetylactis*, *Leuconostoc citrovorum* and/or *Leuc. Dextranicum*, Clostridium butyricum)
- the cream is incubated at about 21^{o}C till desired an acidity is reached.

- Churning of Cream: Winters- 10-13°C
  Summers: 7-9°C (Avg. 9-11)

- Salting & Working: Working of butter is a kneading process in which butter granules are formed into a compact mass
- Storage -23 to -29°C

- Gritty - Undissolved coarse salt, incorrect salting
- Grainy - Incorrect neutralization of high acid cream with lime
- *Yeasty flavour and odour*: fermentation of the cream by Torula Cremoris and Torula sphaerica

Over run

- increase in the amount of butter made from the given amount of fat caused by the presence of **moisture , curd, salt etc in butter**
- $\% \text{ OR} = \frac{B-F}{F} \times 100$

- OR= Overrun in butter(%)
- B= Butter made (kg)
- F= Fat in churn (kg)

ICE CREAM

frozen milk product made by freezing a pasteurized mix with agitation to incorporate air.

should contain not less **than 10%milk fat, 3.5% protein, and 36% total solids**

Composition of Ice cream mix-

Milk/milk powder +sugar + dextrose+ corn syrup+ water + flavour + stabilizer (0.3-0.5%) + emulsifier (0.3-0.5%)

Composition of Ice-cream-

Fat (12-20%) ,SNF (8-15%), Sugar (13-20%).

Role of the constituents in ice cream

1. **Milk fat:** full, rich, creamy flavour

2. **Milk solids not fat:** milk sugar adds to the sweet taste. The milk proteins help to make ice cream more compact and smooth
3. **Sugar:** increase the acceptability of ice cream. The desired sweetening effect is only produced by sucrose.

4. **Stabilizers:** prevent the formation of objectionable large ice crystals in ice cream, especially during storage.

5. **Emulsifiers:** improve upon and provide a uniform whipping quality of the mixture.

- Ice cream without Hardening process: Soft serve or Softy
- overrun due to air - Maximum allowable over run up to 100%
- Sandy Texture: caused by Lactose crystals which do not dissolve readily and produce a rough or gritty sensation in the mouth
- Whipping quality: reduced air cell sizes and a homogeneous distribution of air in the ice cream

Stabilizer- prevent the formation of objectionable large ice crystals in ice cream, especially during storage

-Sodium alginate, methyl cellulose, gelatin

Emulisifier- mainly to improve upon and provide a uniform whipping quality of the mixture, and to produce a drier ice cream with smoother body and texture.

- Egg yolk, sorbitol, propylene glycol esters

Cheese

1) Very hard- less than 25% moisture e.g. Parmesan, Romano

2) Hard – 25 to 36% moisture
a)Ripened by bacteria, without eyes: **Cheddar**
b)Ripened by bacteria, with eyes: Swiss (*Propionibacterium shermanii*)

3.)Soft cheese - 40 % moisture
a)Unripened – Cottage
b)Ripened – Neufchatel

4.) Semi-hard- 36 to 40 % moisture

a)Ripened principally by bacteria: Brick

b)Ripened by bacteria and surface microorganisms: Limburger

c) Ripened principally by blue mould:

i)External – Camembert (*Penicillium camemberti*)

ii)Internal – Gorgonzola, Blue, Roquefort (*Penicillium Roqueforti* and *Penicillium Glaucum*)

- Cottage cheese from Skim milk
- Ricotta cheese from Whey
- Mozarella cheese from buffalo milk
- Cheddar cheese from Cow milk
- Feta cheese from goat milk
- Portuguese cheese from ewe milk
- Withania coagulans/Indian rennet- rennet substitute in the production of cheese

AVERAGE COMPOSITION OF CHEESE

Name	Moisture	Fat	Protein	Ash and salt
Brick	42.5	30.7	21.1	3.0
Camembert	47.9	26.3	22.2	4.1
CHEDDAR	36.8	33.8	23.7	5.6
Cottage	69.8	1.0	23.3	1.9
Cream	42.7	39.9	14.5	1.9
Edam	38.1	22.7	30.9	6.2
Limburger	54.8	19.6	21.3	5.2
Parmesan	17.0	22.7	49.4	7.6
Roquefort	38.7	32.2.	21.4	6.1.

Scientific basis of cheese making

1. First stage is Souring /ripening
2. Second stage is Clotting /coagulation by rennet
3. Third stage is Cutting and drainage of whey.
4. Fourth stage is Matting of the curd.
5. Fifth stage is Maturing /curing

CHEDDAR CHEESE

- type of hard cheese
- Starter culture usually contains Str. Lactis and/or Str. Cremoris
- Hot iron test: to check end of cheddaring
- Starter culture added @ 0.5-1% of milk at 30-31°C
- **Rennet: Rennin (clotting) + Pepsin (proteolysis)** @ 15-25ml/100L of milk
- Color @ 30-200ml/ 1000Kg of milk
- Salting @1-2%

Flow diagram of manufacture

Heart of cheese

Receiving of milk
↓
Preheating (35-40C)
↓
Filtration/clarification.
↓
Standardization
↓
Pasteurization (63ºC/30min.)
↓
Adding starter cultures (ripening)
↓
Adding colour
↓
Adding rennet (clotting) 31ºC
↓
Coagulation ad setting
↓
Cutting
↓
Cooking (up to 37ºC)
↓
Drainage of whey
↓

Cheddaring
↓
Milling
↓
Salting
↓
Hooping
↓
Dressing
↓
Pressing
↓
Drying
↓
Paraffining
↓
Curing/ maturing.

Filtration and clarification

Preheating: 35 to 40 °C

Standardization: In cheese making standardization refers to adjustment of the casein/fat ratio in cheese to 0.68 to 0.70.

Objectives:

1. To regulate the fat in the dry matter of cheese.
2. To produce the maximum amount of cheese per kg of fat in cheese milk.

Pasteurization: The usual temperature time employed for pasteurization of cheese milk is Holder – 63°C for 30min. HTST – 72°C for 15sec.

Addition of calcium chloride

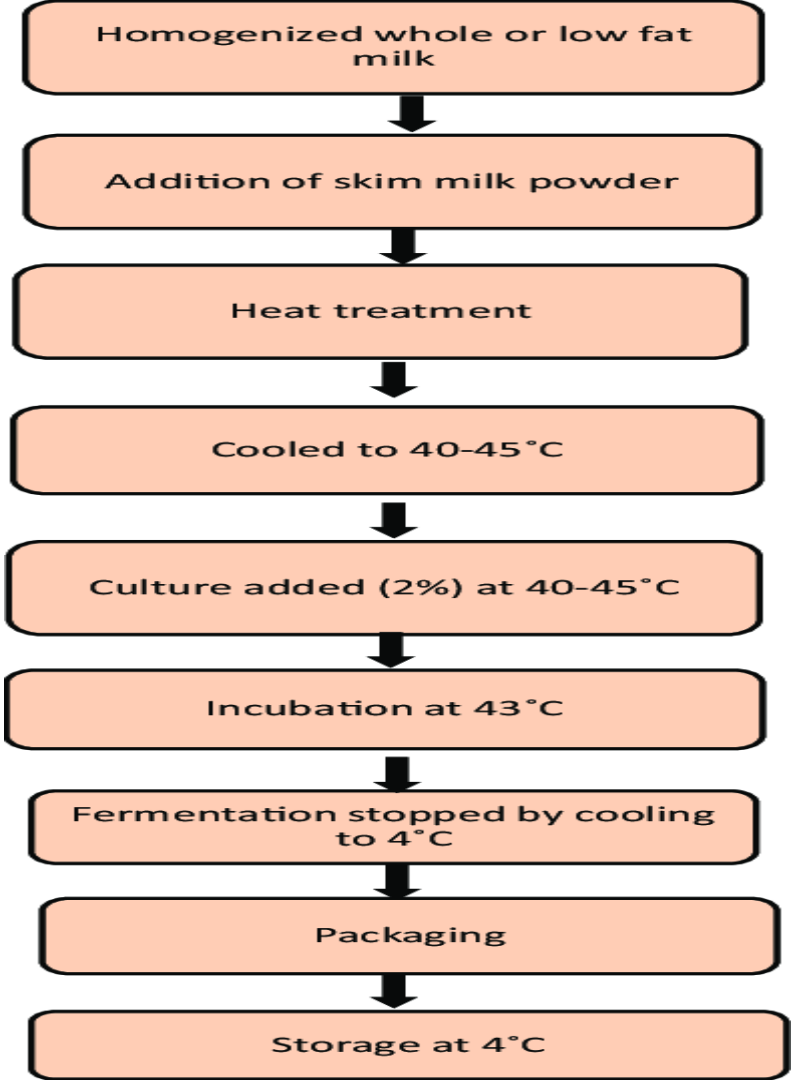
* Excessive heat treatment of milk causes the precipitation of a part of calcium salts in milk.

* It results in slower renneting action and a weaker curd.

* Which can be corrected by the addition of **0.001 to 0.03 %** calcium chloride to milk.

Yoghurt

- Fat % - 0 to 5 and total solids 9-20%
- Lactobacillus bulgaricus and Str. Thermophilus – grow symbiotically and responsible for fermentation
- Temp. of incubation: 41-43°C


Homogenized whole or low fat milk
Addition of skim milk powder
Heat treatment
Cooled to 40-45°C
Culture added (2%) at 40-45°C
Incubation at 43°C
Fermentation stopped by cooling to 4°C
Packaging
Storage at 4°C

Dahi/ Curd

- Sweet Dahi with acidity < 0.7%
- Sour Dahi with acidity around 1%
- Sweetened Dahi: by adding 6.25% cane sugar

- Starter culture for sweet dahi: *Streptococcus lactis, Str. cremoris, Str. diacetalactis*
- Starter culture for sour dahi: same as above along with *Lactobacillus bulgaricus and Str. Thermophilus*

Characteristics	Requirement for sweet dahi	Requirement for sour dahi
Acidity, lactic (percentage weight)	0.70	1.0
Yeast and mould count/gm	100	100
Coliform count/gm	10	10
Phosphatase test	Negative	Negative

Dahi v/s Yoghurt

Dahi

- Acidity: 0.6-0.7%
- Flavor due diacetyl (obtained from mother compound acetyl methyl carbinol)

Yoghurt

- Acidity: 0.9%
- addition of artificial sweeteners and flavors
- Acetaldehyde and diacetyl responsible for flavor

Misti Dahi

- Sweetened Dahi: Misti dahi or lal dahi – popular in eastern region of country
- Brown color , cooked and caramelized flavor
- Addition of 6.25% cane sugar

Shrikhand

- sweetened-dewatered dahi. This product is extremely popular Western and some parts of Southern India.
- Minimum fat % 8.5 and total solids 58%
- Titrable acidity not more than 1.4%

- inoculated with culture containing Str. lactis subsp. lactis and Lactococcus Lactis var. diacetilactis

Preparation

- dahi is suspended in a muslin cloth until all the free water has drained off
- The semisolid mass obtained is called Chakka
- In industrial method, skim milk is used initially and sugar is added @ 80% of amount of chakka, required amount of plastic cream having 80% fat added to give at least 8.5% fat to shrikhand

Dairy Products

1. Cultured/ fermented milk products: curd, lassi, Dahi, Chakka, Shrikhand

2. Acid coagulated milk products- Channa, panner

3. Acid and Rennet coagulated milk products- Cheese

4. Heat dessicated/ dehydrated(concentration and coagulation) - Rabri, Basundi, Khoa, Khurchan (23.6%fat)

Chhana-based sweets i. Rasogolla ii. Pantooa iii. Sandesh iv Rasmalai v. Cham Cham vi. Chhana-murki vii. Chhana podo viii. Milk cake

Indian Dairy product	Western counterpart
Kheer/ Basundi	Condensed milk
Khoa	Evaporated milk
Rabri	Clotted cream
Kulfi	Ice cream
Ghee	Butter oil
Lassi	Butter milk
Channa	Lactic coagulated green cheese
Paneer	Soft cheese

Partially desiccated sweetened milk product: Basundi

Partially concentrated and sweetened milk product that contains several layers of clotted cream: Rabri (20% fat)

- Conc. Milk, rice, sugar: Payasam
- Rennet coagulated, small sized soft cheese: Panir

Channa

- milk solids obtained by the acid coagulation of boiled hot milk and subsequent drainage of whey.
- Moisture-53.5% Fat- 25%
- Protein-17.5%
- Lactose-2% Ash-.2%

- should not contain more than 70 per cent moisture and milk fat should not be less than 50 per cent of the dry matter

Preparation

- Boiling of milk in karahi.
- Reducing the temperature of milk to 80°C and required quantity of coagulants is added slowly till the coagulation.
- The strength of the coagulating acid solution is 1-2%.
- Coagulants are lactic (for rosogolla) and citric acid (for sandesh).
- Contents of vessel emptied over a piece of muslin cloth.
- No pressure is applied

- **Yield of channa:**
  - Cow milk is 16-18%.
  - Buffalo milk is 22-24%

- Cow milk preferred for channa making, because it has open texture - yields smooth textured and smooth body product
- Used for making sweets like rosogulla, Sandesh

Sandesh

- sweet of eastern India and Bangladesh
- Made up of Milk, sugar, channa or paneer

It is broadly classified in 3 main varieties:

1. Low moisture / Hard grade – Kara Pak
2. **Medium moisture / Soft grade – Naram Pak**
3. High moisture – Kaccha gola

- Soft grade is the most selling variety in India

PANEER

- Heat acid coagulated milk solid
- moisture 60-70%
- Total solids 30-40% (milk fat not less than 50% of DM basis)
- pressure is applied for removal of whey while in Channa hanged over a hook wrapped in cloth
- Buffalo milk preferred –whitish, sweetish

Flow chart

Standardization of milk to 6% fat

↓

Heating upto 82 ^{o}C for 5 minutes

↓

cooling to 70 ^{o}C

↓

coagulation with 1% citric acid (1.5-2/litre)

↓

Drain the whey

↓

pressed & made it into cubes

↓

hardened in chilled water for 1-2 hours (4-6 ^{o}C temperature)

↓

Cut into pieces and packed

Khoa/ Mawa

- Partially dehydrated (heat coagulated) whole milk product prepared by continuous heating of milk in a karahi over a direct fire, while also constantly stirring-cum-scraping by till it reached a semi solid consistency.
- milk fat content should not be less than 20 percent

- Buffalo milk is preferred over cow milk because it gives higher yield with good quality khoa with soft and smooth body, granular texture.
- Overrun is because of moisture.
- Yield – cow milk: 17-19% while buffalo milk 21-23%

Type of milk	Composition of khoa					
	Moisture	Fat	Protein	Lactose	Ash	Iron(ppm)
Cow	25.6	25.7	19.2	25.5	3.8	103
Buffalo	19.2	37.1	17.8	22.1	3.6	101

three main varieties are "**pindi**" for burfi, "**dhap**" for gulabjamun, pantooa etc., and "**danedar**" used for kalakand

Increase in Iron content :From 2 to 4 ppm in milk, the iron content in khoa exceeds 100 ppm due to scrapping of the pan surfaces during the manufacture

Constituents	Khoa type		
	Dhap	Pindi	Danedar
TS (%) min	55	65	60
Fat (% dmb) min	37	37	37
Protein (% dmb) min	37	37	37
Ash (%dmb) max	6	6	6
Titrable acidity (% LA) max	0.6	0.8	0.9
End uses	Gulabjamun, milk cake	Burfi, peda Pantua	Kalakand,

Khoa

- At room temperature (24-30°C) a rancid flavour is developed on *khoa*
- low temperature (5-10°C) a stale and sour flavour is observed and there is mould growth on the surface
- keeping quality of *khoa* at room temperature-5 days and 10 weeks at 4°C
- **Generally 4 kg of buffalo milk or 5 kg of cow milk yield one kg of *khoa***
- ***Pantua, Kala jamun manufactured from both Khoa and channa***

Ghee

- Clarified butter fat prepared chiefly from cow or buffalo milk.

- Milk fat - 99 to 99.5%
- Moisture Not more than 0.5 %
- Shelf life of ghee- 6-12 months at 21°C
- Buffalo milk preferred being richer in fat content and gives larger yield of ghee
- Flavor of Ghee is because of Lactones

Properties

- Specific gravity: 0.93-0.94
- Refractive index 40-45
- RM number: min. 28 (cotton seed feeding areas 20)
- Polenske number: min. 2 (------do→1.5)
- Solidifying point 28 to 15° C
- Iodine value : 26 to 38
- Saponification number: 220
- Melting point: 28-44° C

- Granularity in Ghee: presence of high melting saturated FA e.g Stearic, Palmitic acid
- buffalo: white color with greenish tinge due to Biliverdin
- cow- golden yellow due to carotene
- Natural antioxidants: Tocopherol, carotene
- Synthetic: BHA, BHT, hydroquinone, gallic acid esters
- BHA level should not exceed 0.02% in Ghee (PFA, 1976)

Ghee may contain BHA not more than 0.02% as antioxidant

Table 4: Agmark standards of *Ghee*

Sr. No.	Tests	All India	Winter regional	Summer
1.	B audouin	Negative	Negative	Negative
2.	Phytosterol acetate	Negative	Negative	Negative
3.	B.R. reading (40°C)	40.0-43.0	41.5-44.0	42.5-45.0
4.	R.M.value (Minimum)	28	23.0	21.0
5.	Polenske value	1.0-2.0	0.5-1.2	0.5-1.0
6.	Moisture (%)	Maximum	0.3	
7.	Free fatty acids (as % Olic acid)			
	Special grade (Red label)	Not more than	1.4	----------
	General grade (Green label)	Not more than	2.5	
	Standard grade (Chocolate label)	Not more than	3.0	----------

PREPARATION

- Ghee is prepared by five methods, namely,
- Desi
- Creamery butter
- Direct cream
- Pre-stratification methods
- Continuous method – industrial method

Desi Method: Fresh makkhan (butter) heated and stirred on a low fire moisture has been removed, further heating is stopped and cooled.

Merits:

1. Desirable flavour, body and texture

Demerits:

1. Extremely small scale in operation
2. Low keeping quality and vitamin content.

Creamery butter method:

- Unsalted creamery butter heated in an ghee boiler at a temperature of 90°C.
- The contents are agitated to prevent scorching.
- The scum, periodically removed,
- When all the moisture have been driven out---end point is indicated by the appearance of effervescence.
- Characteristic ghee flavour emanates at temperature 110-120 °C
- heating stopped, the ghee is filtered

Pre-stratification method:

1. Butter is left undisturbed 80-85 °C for 15 to 30 minutes.
2. Stratifies, into 3 distinct layers
   I. a top layer of floating denatured particles of curd,
   II. a middle layer of fat,
   III. and a bottom layer of buttermilk.
3. Bottom layer of buttermilk contains 60-70 % of solids-not-fat and over 80 % moisture.
4. Buttermilk is removed mechanically without disturbing the top and middle layers.
5. Temperature of the remaining two upper layers is raised to the usual clarifying temperature of 110-120°c.

Direct-cream method: Cream heated in ghee boiler similar to Creamery butter method

Continuous method:

Objective:

To manufacture ghee on an industrial scale

Advantages:

1. Large scale handling
2. Utilization of machines for a large number of operations
3. High fat recovery
4. No stirring, no scrapping and no laborious effort on the part of the ghee operators required.

Test for adulteration

- Valenta test: animal fat adulteration
- Halphens test: for cotton seed oil
- Nitric acid test, Baudin test, Phytosterol test: vegetable oil adulteration

Indian Dairy Products

- Panir: indian variety of rennet coagulated small sized soft cheese e.g. surati panir, bandal cheese
- Kheer/ basundi: partial dehydation of whole milk in karahi
- Khurchan: concentrated, sweetened whole milk product prepared by simmering without stirring in karahi and have fat % of 23.6
- Rabri: concentrated and sweetened milk product containing several layers of clotted cream and have 20% fat

BUTTEROIL

- Butteroil - almost total removal of water and milk solids not fat
- moisture around 0.4%
- Fat: 99.8%

*Anhydrous milk fat(AMF) moisture around 0.1%

By- products of commercial value are obtained during the manufacture of main product from milk.

Main product	By product
Cream	**skim milk**
Butter	butter milk
Ghee	**ghee residue**
Channa/paneer/cheese	**whey**
Curd	lassi

Composition of whey

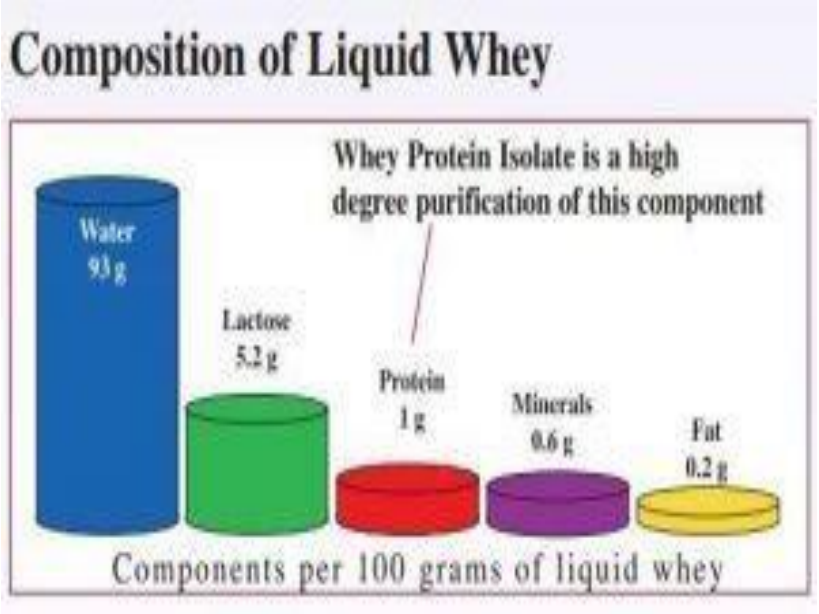


Table 1

Protein	Content in Milk g/L
Major Whey Proteins	
β-lactoglobulin	3.3
α-lactalbumin	0.7
Serum Albumin	0.3
Proteose peptones	1
Minor Whey Proteins	
Immunoglobulin	700mg/L
Lactoferrin	100mg/L
Lactoperoxidase	30mg/L
Lysozyme	0.13mg/L

Adapted from (Modler, 2000).

Product	Packaging Material
Liquid milk	Glass bottles (obsolete) LDPE film Paper laminates for tetra packs
Milk Powder	Tin plate containers, nitrogen packed, and lacquered from outside. Flexible laminates such as metallized PET / BOPP / Aluminium foil / Poly laminates. Refill packs; lined cartons laminated with BOPP / PET, varnished on the outside. Bag-in-box; Powder filled in laminate and packed in cartons.
Butter	Duplex board with vegetable parchment paper Tin plate containers Aluminium foil
Cheese / Cheese spread	Tin plate containers lacquered from inside First packed in aluminium foil and then in duplex board carton Injection moulded PP / HDPE container
Ghee	Tin plate containers lacquered from inside Glass bottles HDPE film pouches
Ice cream	Thermoformed / Injection moulded plastic containers Duplex board carton (poly laminated) Laminates of BOPP (Biaxially Oriented Polypropylene) / PET
Indian Dairy Products	Injection moulded / thermoformed containers (shrikhand, gulab jamun) Stand up laminated pouches

APPENDIX

Bacteriological standards as prescribed by Bureau of Indian Standards (BIS)

Bacteriological standards of raw milk (IS-1479 PART III-1997)

Grades	Direct microscopic count per ml (lakhs)	Standard plate count per ml (lakhs)	Methylene blue reduction time (hr)	One hour resuzurin disc. (No.)	Presumptive coliform test (in 0.01 ml) i.e. 1 in 100
Very good	NS	< 2	> 5	NS	absent
Good	< 5	2-10	3-4	4 or higher	absent
Fair	5-40	10-50	1-2	3.5 to 1.0	absent
Poor	40-200	> 50	< 1/2	0.5 to 0	present
Very poor	> 200	NS	NS	NS	NS

NS : Not specified

Bacteriological standards of pasteurised milk (IS-6397-1971)

Test	Requirement
Standard plate count	Maximum 30000 cfu/ml
Coliform count	absent in 1:10 dilution
MBRT	more than 4 hr
Alkaline phosphatase	test negative

Bacteriological standards of cream (IS-3509-1966)

Type of Cream	Type of count	Level in Cfu/ml or g (lakhs)	Grade
Raw Cream	Standard plate count	< 4	Very good
		4-20	Good
		20-100	Fair
	Coliform count	100	Poor
		< 100	Satisfactory
Pasteurised	Standard plate count	< 60000	Satisfactory
	Coliform count	< 10	Satisfactory

Bacteriological standards of butter (IS-3507-1966)

Yeast & Mold count/ml	Quality
< 20	Good
21-50	Fair
51-100	Poor
> 100	Very poor

Bacteriological standards of ice cream (IS-2802-1964)

Test	Limit
Standard plate count (per g)	not more than 2,50,000
Coliform count (per g)	not more than 90
Phosphatase test	negative

Bacteriological standards of condensed milk (IS-1166-1973)

Characteristics	Full cream	Skim milk
Bacterial count (cfu/g. maximum)	500	500
Test for Coliforms	Negative	Negative
Yeast and Mold count (cfu/g. maximum)	10	10

Bacteriological standards of milk powder (IS-1165-1975)

Types	WMP and extra grade SMP	Standard grade SMP
Total bacterial count, max, cfu/g	40,000	50,000
Coliform count	absent in 0.1 g	absent in 0.1 g
Salmonella	absent in 25 g	not specified
Staph aureus (coagulase positive)	absent in 0.1 g	not specified
Shigella	absent in 25 g	not specified

Bacteriological standards of indigenous dairy products.

Product	Standard plate count max (cfu/g)	Coliform count, max (cfu/g)	Yeast and mold count, max (cfu/g)	ISI Manual Reference No.
Khoa	NS	90	50	IS-4883-1980
Burfi	30,000	NS	10	IS-555-1970
Paneer	5,00,000	100	250	IS-10984-1983
Kulfi	2,50,000	100	NS	IS-10501-1983
Chakka	NS	10	20	IS-9532-1980
Shrikhand	NS	10	50	IS-9532-1980
Canned Rasogolla	500	Nil	NS	IS-4079-1967

Microbiological standards for assessing the sterility of utensils/equipments as prescribed by BIS (cited from *Fundamantals of Dairly microbiology* by Prajapati p:44.)

	Rinse method Colony count per liter capacity of can	Swab method Colony count per 900 sq.cm. area of equipment surface
Satisfactory	< 1000	< 5000
Fairly satisfactory	1000 to 5000	5000 to 25,000
Unsatisfactory	> 5000	> 25,000

- Buffalo milk is preferred over cow milk for manufacture of Paneer because (RPSC 2019)

a) Paneer prepared from Buffalo milk is white in colour, sweetish, spongy, nutty flavoured.

b) Paneer prepared from Buffalo milk is very compact and fragile and its pieces lose their identity during cooking.

c) Paneer prepared from Buffalo milk is often substituted for meat in many vegetarian dishes of Indian cuisine.

d) Paneer prepared with buffalo milk is more quantitatively as compared to cow milk.

- Which of the following milk product has the highest fat percentage?

(A) Rasgulla (B) Kulfi (C) Khoa (D) Basundi

- Normal Butyro-Refractometer (BR) reading of ghee at 40 °C varies from

[A] 40-45 [B] 20-25 [C] 30-35 [D] 50-55

- Standardization of cheese milk during cheese making is adjustment of casein/fat ratio of

[A] 0.48 to 0.50

[B] 0.86 to 0.90

[C] 0.68 to 0.70

[D] 0.78 to 0.80

A good quality paneer is obtained by

- a. heating milk to 90° C, cooling to 70° C.
- b. heating milk to 100° C, cooling to 30° C.
- c. and acidifying hot milk by adding 10% citric acid solution.
- d. and acidifying hot milk by adding 1% citric acid solution.

i. a and c

ii. a and d

iii. b and c

iv. b and d

- The moisture content of hard cheese in generally:

(A) 35-40% (B) 40-45% (C) 70-80% (D) None of the above

- The milk having an acidity of 0.72% will:

(A) Curdle on boiling

(B) Coagulate spontaneously

(C) Coagulate followed by liquefaction

(D) Remain normal

- Difficulties are experienced in curdling and ripening of cheese if milk contains:

(A) Antibiotic residue

(B) Pesticide residue

(C) Insecticide residue

(D) All of the above

- According to BIS, the SPC in 'burfi' should not exceed:

(A) 250/g

(B) 3×10^4

(C) 2×10^8

(D) 4×10^7

- The permitted antioxidant in ghee is:

(A) BHA (B) BHT (C) NDGA (D) Ethyl gallate

- The adulteration of animal fat in ghee is tested through:

a) Bomer's Phyto-Sterol Test

b) Valenta Test

c) Baudouin Test

d) Halphens Test

The iron content of Khoa should be more than

(A) 175 ppm (B) 100 ppm (C) 200 ppm (D) 250 ppm

Off Flavors

- **Bitty flavour:** caused by proteolytic microorganisms especially *Bacillus* spp. and *Pseudomonas* spp.
- **Potato flavour:** by *Pseudomonas mucidolens* and *Pseudomonas graveolens*
- Cooked flavor- **sulfhydryl** compounds – due to overheating
- Cowy flavor – in ketosis due to acetone
- Barny Flavor – poor ventilation
- Malty Flavor: *Streptococcus lactis var. maltigenes*
- *Phenolic flavor – Bacillus circulans*
- *Unclean flavor- E.coli*

- Metallic, oily, stale, tallowy, - Metal-induced oxidized off- flavor: Due to lipid oxidation-metal catalyzed
- Light-induced oxidized off-flavour: light catalyzed lipid oxidation as well as protein degradation both are involved.
- Rancid: Extremely unpleasant, due to volatile fatty acids formed through enzymatic hydrolysis of **fat (Caproic, Butyric acid production)**

Acid fermented milk products

- Sweet, sour, sweetened dahi and yoghurt
- Gassy: contaminant yeasts or coli aerogenus organisms
- Bitter: sweet curdling organisms
- Cheesy: due to proteolysis of milk
- **Wheying off**: Free whey floats either on the top or curd floats on top with free whey at the bottom
- Free whey appearance at the top is associated with high acidity, higher temperature and prolonged storage
- Appearance of whey at bottom with curd floating on the top gives an indication of contamination of either milk or starter

Defects in Cream

- Oxidized/oily/Metallic/Tallowy:
- Fat oxidation due to direct contact of milk with copper or iron,
- exposure of milk or cream to sunlight, etc.

- Rancid: Fat hydrolysis due to lipase action in milk or cream

- Bitterness and thinning: Bacillus subtilis

- Highly acid/sour
- i. Using sour milk for separation
- ii. Acid development in cream

Bitty cream

- lecithinase enzyme of *Bacillus cereus var mycoides*
- attacks phospholipid part of fat globule membrane and partly from the coagulation of casein

Defects in Butter

- Gritty - Undissolved coarse salt, incorrect salting
- Grainy - Incorrect neutralization of high acid cream with lime
- *Yeasty flavour and odour*: fermentation of the cream by Torula Cremoris and Torula sphaerica
- Fishy flavor - Hydrolysis of phospholipid to form trimethylamine is one of the reasons attributed for the 'fishy' flavor defect in butter
- Skunk like odor- P. mephitica
- Apple taint – P. fluroscrns

Defects in Ghee

- Rancidity: lipase action (incidence is low), oxidation of fat (more chances) through exposure to light and contact with metal ions e.g. Cu, Fe, etc.
- Dark/Burnt color: Excessive high temperature (> 120 C for some period) of clarification of ghee can lead to 'dark brown' colored ghee

Defects in KHOA

- At room temperature (24-30°C) a rancid flavor is developed on *khoa*

- low temperature (5-10°C) a stale and sour flavor is observed and there is mould growth on the surface

Defects in Cheese

- **Rind rot** – excessive acidity or moisture in cheese before curing
- **Gassiness/ Late blowing in cheese**: Clostridium tyrobutyricum
- **Fish eyes/yeast holes**: Contamination with yeasts (Torula sp.)

Defects in Cheese

- "wheytaint": Acid/ high acid/sour
- Fruity/ Fermented: psychrotrophic bacteria
- Bitter: pseudomonas organisms
- Too firm body: over use of rennet; cooking of curd at too high temperature ; or cutting of curd at a pH more than 4.7
- Weak/soft/mushy: high moisture, low-solid cottage cheese

GMP and HACCP

GMP- Good Manufacturing Practices

HACCP- Hazard Analysis Critical Control Point

HACCP

Hazard Analysis and Critical Control Point (HACCP) System - In order to enhance food safety, every stage of the food production (from purchasing, receiving, transportation, storage, preparation, handling, cooking to serving) should be carried out and monitored scrupulously.

- The HACCP system is a scientific and systematic approach to identify, assess and control of hazards in the food production process.

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- The seven principles of a HACCP System are-

- 1.Analyze hazards
- 2.Determine critical control points
- 3.Establish limits for critical control points
- 4.Establish monitoring procedures for critical control points
- 5.Establish corrective actions
- 6.Establish verification procedures
- 7.Establish a record system

Food safety standards for milk and milk products

- **Food Safety and Standards Authority of India (FSSAI)** is an autonomous body established under the Ministry of Health & Family Welfare, Government of India.
- The FSSAI has been established under the Food Safety and Standards Act, 2006 which is a consolidating statute related to food safety and regulation in India.
- FSSAI is responsible for protecting and promoting public health through the regulation and supervision of food safety.

- The FSSAI has its headquarters at New Delhi.
- The authority also has 6 regional offices located in Delhi, Guwahati, Mumbai, Kolkata, Cochin, and Chennai.
- 14 referral laboratories notified by FSSAI, 72 State/UT laboratories located throughout India.

Legislations

- Prevention of Food Adulteration (PFA) Act (1954) and Rules (1955)
- ISO 9000 Series – 1987 Basically, it consists of five standards, ISO 9000, 9002 and 9003 and ISO 9000 and ISO 9004.
- Agricultural and Processed Food Products Export Development Authority (APEDA) - Indian Apex-Export Trade Promotion Active government body

Empowered by BIS Act, 1986

Aims to provide Third Party Guarantee of quality, safety and reliability

Standard Mark on a product is an assurance of conformity

Enforced by the Agricultural Produce (Grading and Marketing) Act, 1937 under Directorate of Marketing and Inspection (DMI)

Prescribes Grade standards for agricultural and allied sector

Quality Certification Mark

Ensures quality and purity of product

Certifies Third Party Guarantee of Quality

OIE

Office International des Epizooties - January 25th 1924

In May 2003 the Office became the World Organization for Animal Health but kept its historical acronym OIE

The OIE is the intergovernmental organization responsible for improving animal health worldwide.

- Headquarter: Paris

MILK AND MILK PRODUCT ORDER, 1992

The Government of India had promulgated the Milk and Milk Product Order (MMPO) 1992 on 9/6/92 under the provisions of Essential Commodities Act, 1955 consequent to de-licensing of Dairy Sector in 1991.

Objective:

- **To maintain and increase the supply of liquid milk of desired quality in the interest of the general public.**
- **To regulate the production, processing and distribution of milk and milk products.**

Cleaning & Sanitation

- Cleaning is the process in which complete removal of soil (unwanted matter on food-contact surfaces) is accomplished using appropriate detergent chemicals under recommended conditions from the internal and external surface of the equipment

- Some of the precipitates remains intact to equipment after cleaning and forms a film over equipment surface called water stone

- Heat denaturation of protein present on the equipment surface or absorbed by other components forms

Cleaning agents/ detergents

- strong alkali: Sodium hydroxide (caustic soda) potassium hydroxide (caustic potash) – corrosive
- mild alkali: Sodium carbonate and sodium silicates, Trisodium phosphate (TSP) - commonly used
- Mild Acids- phosphoric, tartaric, citric, gluconic acid
- Strong acids- Nitric acid- 1% for stainless steel, HCL, Sulphuric acid
- Polyphosphate and chelating chemicals: tetra phosphate, hexametaphosphate
- Surface active/ wetting agents: Teepol, Acinol – N, common soaps

Material	Cleaning	Sanitization
Tinned steel/ copper	Weak alkalis, together with sodium sulphite as inhibitor, should be used.	All sanitizers may be used.
Bronze	–do–	–do–
Galvanized	–do–	–do–
Aluminium alloy	Weak alkalis, together with sodium silicate as inhibitor, should be used.	–do– –do–
Glass	All alkalis and acids may be used.	–do–
Vitreous enamel	Weak alkalis, together with sodium silicate as inhibitor, should be used.	–do–
Plastics	Cleaning temperatures should not be above the softening point of plastic.	Only chemical sanitizers should be used.
Rubber	Strong alkalis should be used to remove any fatty material stuck to the surface.	–do–

Choice of detergents in organized dairies

S. No.	Ingredients	Quantity	Remarks
1.	Tri-sodium phosphate	850 g.	For general use
	Wetting agent	150 g.	
2.	Tri-sodium phosphate	650 g.	For aluminium utensils
	Sodium meta-silicate	200 g.	
	Wetting agent	150 g.	
3.	Tri-sodium phosphate	750 g.	For tinned utensils
	Sodium sulphite	100 g.	
	Wetting agent	150 g.	

- CIP (Clean In Place) has been opted in milk industry for good cleaning and sanitation.
- The cleaning cycle in dairy comprises following steps-
- Recovery of product residue by scrapping, drainage with water or compressed air.
- Pre- rinsing with water to remove dirt.
- Cleaning with0.15-0.6% alkaline detergent
- Rinsing with clean water.
- Cleaning with acidic detergent.
- Rinsing with clean water (Hardness not exceeding 112mg/L)
- Sodium Hypochlorite/ Chlorine: 200ppm
- Iodophores:25mg/L QUATS: 200mg/L

Residues in milk

Source	Residue
1. Farm animal	Veterinary drugs e.g. antibiotics, hormones, antiparaciticides, etc.
	Feed additives e.g. Trace elements, antioxidants, feed drugs
2. Environment	Agrochemicals e.g. pesticides, growth promoters
	Emissions e.g aerosols, fumes, dusts
	Minerals of the soil e.g. lead, cadmium.
	Environmental organics e.g. mycotoxins
	Radionuclides
3. Milking and processing	Hygiene formulations e.g. cleaning and disinfecting agents, insecticides
	Surfaces e.g. metals, plasticisers
	Microbial products e.g. mycotoxins, bacterial enzymes

Milk-borne diseases

- Food infection: ingestion of viable pathogenic bacteria along with the food
- Food intoxication: Ingestion of toxins already produced by microorganisms in the food
- Toxi-infection: A certain group of organisms which can infect intestines when ingested along with the food and produce toxins in situ to bring about symptoms of poisoning.

Bacterial Disease

- Anthrax: Bacillus anthracis
- Brucellosis: Brucella abortus B. melitensis B. suis
- Campylobacteriosis: Campylobacter jejuni
- Diphtheria: Corynebacterium diphtheriae
- Listeriosis: Listeria monocytogenes
- Salmonellosis: Salmonella typhi S. paratyphi S.enteritidis
- Shigellosis: Shigella dysenteriae
- Streptococcosis: Streptococcus pyogenes
- Tuberculosis: Mycobacterium tuberculosis M.bovis M.avium
- Vibrio parahaemolyticus infection
- Yersiniosis: Yersinia enterocolitica

- Rickettsial disease- Q fever - Coxiella burnetti
- Fungal intoxication - Aflatoxicosis Aspergillus flavus
- Viral Diseases

- Polio myelitis- Polio virus
- Infectious hepatitis - Hepatitis A virus
- Tick borne encephalitis - Group B Arbo virus
- FMD

* Parasitic diseases – Toxoplasmosis, Giardiasis

- Milk borne toxi infections

1. Bacillus cereus poisoning
2. Clostridium perfringens poisoning

- Milk borne intoxication:

- Botulism
- Cholera
- E.coli poisoning
- Staphylococcal poisioning

Mastitis

- Contagious mastitis: *Streptococcus agalactiae* (as natural inhabitant of udder)
- Summer mastitis: *Corynebacterium pyogenes*
- Environmental mastitis: *Streptococcus uberis, coliforms*

- **Direct leucocyte count:** The presence of ≥5,00,000 somatic cells per ml – Acute mastitis (2-5 lakh: subclinical)
- ***Hotis test***: *Streptococcus agalactiae*
- bromocresol purple indicator

- Strip cup test: finding out the presence of fibrin, mucous and clots
- Chloride test: Normal milk has a chloride content of 0.08 to 0.14%. Abnormal milk has more than 0.14%
- Catalase test: measure the increase in catalase depending on the ability of it to break down hydrogen peroxide
- CMT: based on the increase in number of leucocytes and alkalinity of mastitic milk

- Late blowing of cheese is due to:

(A) Coliforms

(B) Bacillus subtilis

(C) Clostridium bothrium

(D) Staphylococcus aureus

- Consumption of even boiled milk may cause:
  (A) Tuberculosis
  (B) Brucellosis
  (C) Q-fever
  (D) Staphylococcal gastroenteritis

RPSC 2019

- The ingestion of viable pathogenic bacteria along with food leads to their lodgement and establishment in consumers organ is termed as
- a) Food infection
- b) Food intoxication
- c) Toxi-infection
- d) Food infestation

RPSC 2019

- Milk and Milk Products Order (MMPO) was promulgated by Government of India in

a) 1973 b) 1975 c) 1992 d) 1995

- The Food Safety Management System (FSMS), main system of export inspection and certification being followed in the Indian food sector is based on international standards Including

(1) HACCP (2) APIDA (3) Auditing

(4) Inspecting the books only of the manufacturer

- Bitter taint and thinning of cream are caused by:

(A) B. stearothermophilus

(B) B. subtilis

(C) Coliforms

(D) Lactococcus

- The pathogenic organisms that contaminate milk from milkers and milk handlers:

(A) S. agalactiae

(B) S. aureus

(C) Bacillus sp.

(D) Micrococci

- Microbial inhibitor used in detergent solution for cleaning of aluminium surfaces:

(A) Sodium sulphate

(B) Sodium metasilicate

(C) Sodium hydroxide

(D) Sodium carbonate

- Salmonellosis is an example for which of the following?

(A) Infectious type of food poisoning

(B) Non-infectious type of food poisoning.

(C) Chemical food poisoning

(D) None of the above