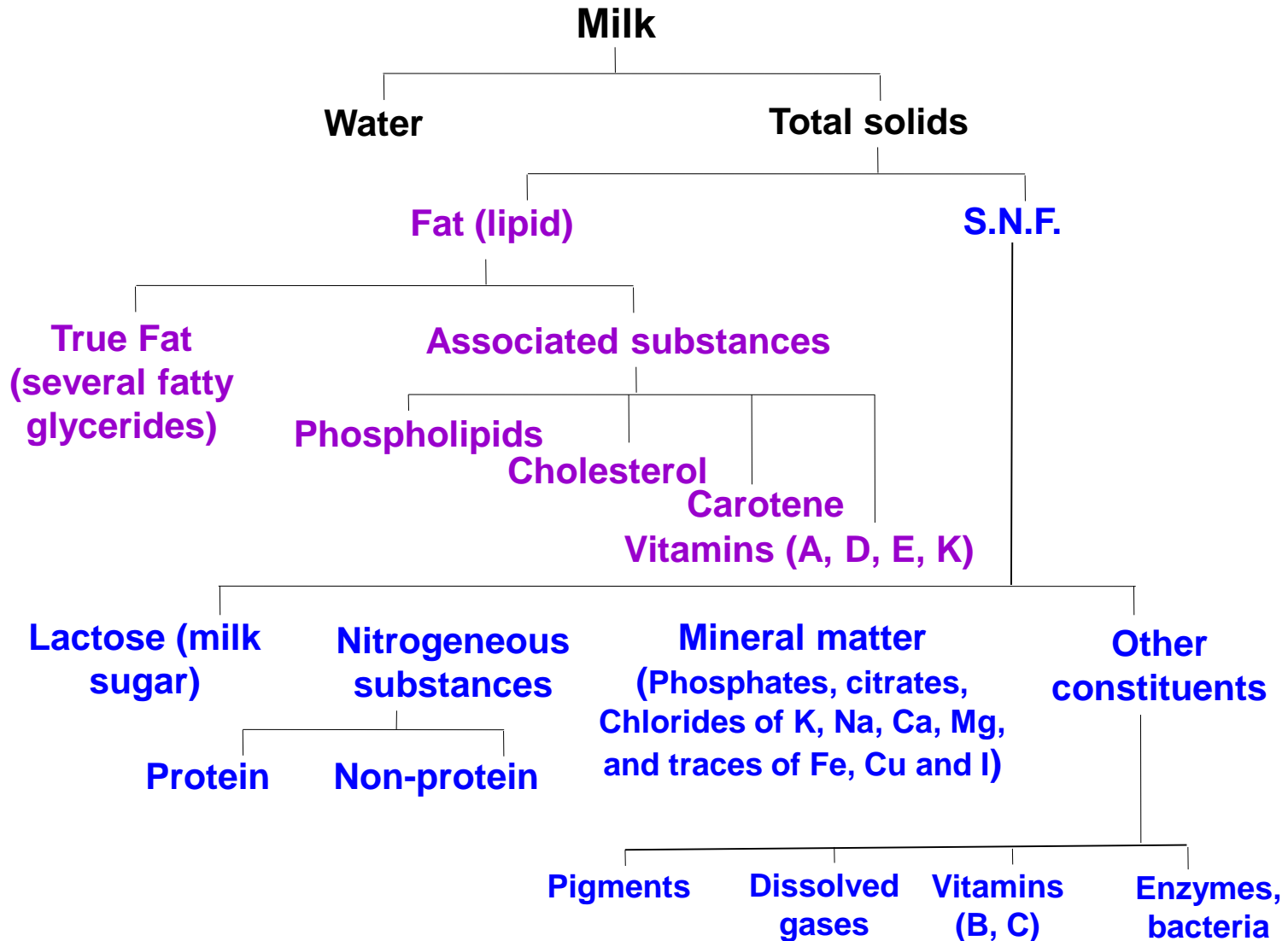


PROPERTIES OF MILK

Different constituents of milk



Variation in major constituents of different milk

	Water	Fat	Protein	Lactose	Ash
Buffalo	84.2	6.6	3.9	5.2	0.8
Camel	86.5	3.1	4.0	5.6	0.8
Cow (Indian)	86.07	4.9	3.42	4.91	0.7
Cow (Foreign)	86.6	4.6	3.4	4.9	0.7
Goat	86.5	4.5	3.5	4.7	0.8
Human	87.7	3.6	1.8	6.8	0.1
Skim milk	90.6	0.1	3.6	5.0	0.7
Butter milk	91.0	0.4	3.4	4.5	0.7

REMEMBER.....

- Milk contains **all essential amino acids** in fairly large quantity.
- It is an excellent source of **Ca, P**, both of which together with **Vit D** are essential for bone formation.
- It is a good source of **Vit A** (provided the cow is given sufficient green feed and fodder), **Vit D** (provided the cow is exposed to enough sunlight), thiamine, riboflavin, etc. **But milk is deficient in Vit C.**
- Milk fat, besides giving energy contains significant amount of essential fatty acids (linoleic and arachidonic), which gives the characteristic flavor.
- **Lactose (CH)** provides energy. It also helps establish a mild acidic reaction in the intestine (which checks the growth of proteolytic bacteria and facilitates assimilation).

Factors affecting composition of milk



- Species
- Breed: In general breeds giving more amount of milk yield a lower percentage of fat.
- Individuality
- Interval of milking (Longer interval implies more milk with a lower fat test).
- Completeness of milking: If the cow is completely milked the test is normal, or else, the test is lower.
- Irregularity of milking
- Disease and abnormal conditions
- Portion of milking: Fore-milk is low in fat content (less than 1%) while strippings are the highest close to 10%. Other milk constituents are slightly affected on a fat free basis.

Variations can also be observed on day to day milking.

Factors affecting composition of milk



- **Stage of lactation:** The change from colostrum to milk takes place within few days.
- **Yield:** For a single cow, there is a tendency for increased yields to be accompanied by a lower fat percentage and vice versa.
- **Feeding:** Has temporary effects.
- **Season:** The % of both fat and SNF show slight but well defined variations during the course of year.
- **Age:** The fat % in milk declines slightly as the cow grows older.
- **Condition of cow at calving:** A cow would yield milk with higher fat % if it is healthy.
- **Excitement**
- **Administration of drugs and hormones**

Energy values of different milk constituents

Milk fat : 9.3 C/g,
Milk protein : 4.1 C/g,
Milk sugar : 4.1 C/g

Cow milk 75 C/100g
Buffalo milk 100 C/100g

Colostrum

- During approximately the first three days of lactation the buffalo secretes colostrum.
- Colostrum is vital for the newborn calf and its composition reflects the calf's need.
- **Colostrum contains the important proteins; the immuno-globulins, which are the newborn calf's source of antibodies.**
- **The content of iron and copper is markedly higher in the colostrum as compared to normal milk.**

Composition of colostrum

Water (%)	Fat (%)	Total protein (%)	Lactose (%)	Vitamin A (µg/kg)
73	9.55	9.59	7.54	1.8

Changes of milk due to boiling

- Breaks up fat globules
- Decrease the percentage of cream
- Decreases curd tension
- Decomposes proteins
- Destroys enzymes
- Darkens the color
- Coagulates the albumin and forms a scum on the surface
- Gives a cooked taste
- Precipitates the Ca and Mg salts



There may be **stone formation** in milk during heating ????

Important properties of milk

Density and specific gravity

Knowledge of density is important to/for

- monitor changes during processing
- check adulteration
- Separation (centrifugation, cyclone separation)
- Pneumatic/ hydraulic transportation
- Storage

Density and specific gravity

Density, and sp. gravity of milk is usually given at 15.6°C (60° F). (Sp. gr. of water at 4°C).

Sp. Gravity varies according to composition

(Water: 1.00; Fat: 0.93, Protein: 1.346, Lactose: 1.666, salts: 4.23, SNF: 1.616)

Density:

Cow milk : 1.028-1.03

Buffalo milk : 1.03-1.032

Skim milk : 1.035-1.037

Milk powder (bulk density) : 0.83

(Milk powder has a porosity of 43-51%)

Though the buffalo milk contains higher fat, still due to higher SNF also the sp.gr. is more than cow milk.

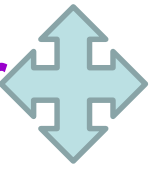
Determination of specific gravity of milk by Lactometer



- A lactometer (or galactometer) is a hydrometer used to test milk.
- The specific gravity of milk does not give a conclusive indication of its composition since milk contains a variety of substances that are either heavier or lighter than water. Additional tests for fat content are necessary to determine overall composition.

The sp. gr. of milk should not be determined for at least one hour after it is drawn from the animal, or else a lower than normal value will be obtained)

Determination of specific gravity of milk by Lactometer



Quevenne is an arbitrary scale used with hydrometers or lactometers in the determination of the specific gravity of milk;

degrees Quevenne = 1000 (specific gravity - 1).

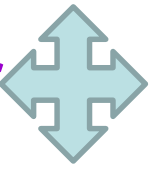
The specific gravity of milk is calculated by dividing the Quevenne's degree by 1,000 and adding 1.

i.e.

if the Quevenne reading is 31, then

$$\text{Sp. gr.} = (31/1000)+1= 1.0031$$

Determination of specific gravity of milk by Lactometer



Correction for temperature

If the temperature is above or below the standard temperature of 60°F, the lactometer reading should be corrected by adding 0.1 to the lactometer reading or 0.0001 to the specific gravity for each °F above 60°F and vice versa for lower temperatures.

Example: If the meter reading becomes 31.0 at 66°F, what is the specific gravity of milk?

Solution:

The corrected lactometer reading is $31.0 + 0.6 =$ or 31.6

Specific gravity : $1 + 31.6/1000 = 1.0316$

Total solids and total SNF: Gerber method

$$\% \text{ Total solids} = 0.25 D + 1.22 F + 0.72$$

$$\% \text{ SNF} = 0.25 D + 0.22 F + 0.72,$$

(Gerber method)

where $D = 1000(d - 1)$, and

$d =$ sp.gr. of milk sample at 20°C ,

F is the fat % in sample.

Total solids and total SNF

Example: What is the amount of total solids and SNF with a milk having 3% fat and density of milk is 1016 kg/m³ (@20°C).

Solution:

$$D = 1000(1.016 - 1.00) = 16$$

$$\% \text{Total solids} = 0.25(16) + 1.22(3) + 0.72 = 8.38$$

$$\% \text{SNF} = 0.25(16) + 0.22(3) + 0.72 = 5.38$$

Freezing point

Fresh whole milk	: -0.506°C to -0.504°C
Indian cow milk	: -0.547°C
Buffalo milk	: -0.549°C
Evaporated milk	: -1.4°C
Sweetened milk	: -15.12°C to -12.04°C

Employed for detection of adulteration.

Souring results lowering in F.P. due to increase in the amount of soluble molecules. **So unsoured samples should be tested.**

Boiling point

For normal milk at atm.pr. is around
100.5°C. (100.2-101°C)

- When conc. is doubled, the b.p. rises by about 0.5°C.
- If conc. is 3:1, b.p. rise is 0.8°C.
- Varies with composition and pressure.
- Addition of solids, salts, sugars, acids, etc. raises the boiling point.

Specific heat

Whole milk : 0.93-0.94 kCal/kg-°K;

Skim milk : 0.95 kCal/kg°K

Varies depending upon the fat content and temperature.

Thermal conductivity

Lamb's equation: $K=0.0801 + 0.568 M_w$

M_w is the moisture fraction

Acidity

Cow milk : 0.13 to 0.14% (natural acidity)

Buffalo milk : 0.14 to 0.15%

The developed or real acidity is due to lactic acid formed as a result of bacterial action on lactose present in milk.

Titration acidity = developed + natural acidity

pH

Normal fresh sweet cow milk : 6.4-6.6

Buffalo milk : 6.7-6.8

Higher pH value \Rightarrow udder infection,

Lower \Rightarrow bacterial action.

The acidity and pH of fresh milk varies with species, breed, individuality, stage of lactation & health of animal.

Viscosity

Materials of high viscosity

- Require a large surface, slow moving type agitator to move them properly.
- Cause a slow moving film on heating and cooling surfaces, and thereby reduce the rate of heat transfer.
- Require high pump pressure for forcing them through pipe lines.

Viscosity

Viscosity of milk forms, $P_a s$

	Temperature, °C			
	10	20	40	80
Whole milk	2.79	2.12	1.24	0.68
Skim milk	2.44	1.74	1.03	0.53
Whey	1.71	1.26	0.82	0.68

Also varies according to composition, age and treatment.

Viscosity increases by

- Increase in concentration
- Homogenization
- Ageing at low temperature.

Viscosity



Newtonian fluids:

Milk, skim milk, cheese, whey permeate, etc.

Non-Newtonian fluids :

Suspensions, pastes, emulsions, etc.

Surface tension

Force per unit length acting on a length of its surface or the work done in increasing its surface area under isothermal conditions.

The surface tension forces are responsible for the finely dispersed liquids to form spherical droplets (minimum surface area to volume ratio).

Surface tension, mNm^{-1}

	Surface tension
Water	72.6
Cow milk	52
Buffalo milk	50.5
Whey	0.68

Color of milk

The color is a blend of individual effects produced by :

- (1) colloidal casein particles and dispersed fat globules, both of which scatter light, and
- (2) carotene (to some extent xanthophylls), which imparts a yellowish tint.

Thus, the color of milk ranges from yellowish creamy white (cow milk) to creamy white (buffalo milk).

The intensity of the yellow color of the cow milk depends on the factors such as breed, feed, size of fat globules, fat percent in the milk, etc.

Color of milk

Greater intake of green feed : Deeper yellow color,

Larger the fat globules and higher fat % \Rightarrow greater is the intensity of yellow color.

Skim milk has a bluish and whey a greenish yellow color.



Refractive index

Indicates adulteration, especially watering.

Average refractive index of cow milk : 1.3461

buff. milk : 1.3477 at 40°C

Total refraction is sum of individual refractions of the constituents present in the solution.

For determination of adulteration, freezing point is more reliable than refractive index.

Flavor

It is composed of smell (odour) and taste.

The flavor of milk is a blend of **sweet taste of lactose** and **salty taste of minerals**, both of which are damped down by proteins.

The phospholipids, fatty acids and fat of milk also contribute to the flavor.

Changes in flavor/ abnormal flavor occur due to



- Type of feed
- Chemical composition as well as chemical changes
- Season
- Stage of lactation
- Condition of udder
- Sanitation and other conditions during milking and subsequent handling of milk, during storage
- Bacterial growth
- Addition of foreign material
- Absorbed materials

Thank You