



Salahaddin University- Erbil



College of Agricultural Engineering Sciences

Department of Animal Resources

2nd Stage/ 2nd Semester

“Dairy Science and Technology”

Physicochemical properties of milk1

February 2024

Dr. Salih Mustafa Salih

salih.salih@su.edu.krd

Composition of Milk

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

Physico- chemical properties of milk

- The physico-chemical properties of milk and milk products affect most of the unit operations used during their processing.
- These operations include fluid flow, heat transfer processes, mixing, emulsification and homogenisation.
- Some of the rheological properties are also used for assessing and monitoring the quality of products such as cream, butter and cheese.
- There are two approaches to obtain, data for physical properties. The first is to use **data available in the literature**; the second is to determine the values **experimentally**.

What are the examples of Physiochemical properties of milk?

- Physical state
- Colour & appearance
- Flavour
- Taste
- Smell
- Acidity and pH
- Density
- Viscosity
- Surface tension
- Foaming and cream
- Refractive index
- Specific heat
- Specific gravity
- Electrical conductivity
- Oxidation-reduction potential
- Boiling point
- Freezing point

Why is Importance to determine the physicochemical properties of milk?

- 1- It helps in detection of adulteration.
- 2- helps in determining quality of milk
- 3- Helps in processing of milk and milk products.
- 4- Helps in evaluating physical changes in milk and milk products.

What is the Physical State of Milk?

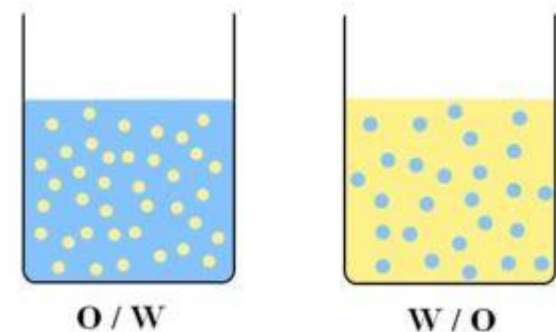
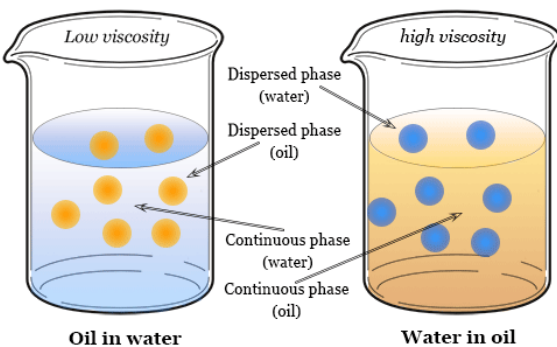
- In Milk water is present as continuous phase in which other constituents are either dissolved or suspended.
- Lactose and portion of minerals salts form Solution.
- Protein and Remainder of minerals form colloidal.
- Fat forms Emulsion.

Emulsion of Milk

Emulsion is a suspension of droplets of one liquid into another liquid.

- Milk is an emulsion of fat in water.
- Butter is an emulsion of water in fat.
- The solute is known as the dispersed phase and the solvent is known as the continuous phase.
- Other examples of emulsion include margarine, mayonnaise, cream, and salad dressing.

Types of Emulsions



Colloidal of Milk

- A colloidal solution is when matter exists in a state of division in between a true solution, which is sugar in water, and a suspension, which is chalk in water. The characteristics of a colloid are small particle size, electrical charge, and affinity of the particles for water molecules.
- In milk, the whey proteins are in colloidal solution.
- The casein proteins in colloidal suspension.



COLLOID vs CRYSTALLOID



Milk Mixed with Water
Colloid



Salt Dissolved in Water
Crystalloid

Examples of Colloids



Jellies



Whipped Cream



Pumice Stone



Mist



Milk

Colour and optical properties

- Milk appears turbid and opaque owing to light scattering by fat globules and casein micelles.
- Optical properties are influenced by the manner of scattering of light by the molecules.
- The opacity of milk is due to its content of suspended particles of fat, proteins and certain minerals.
- The colour varies from white to yellow depending on the carotene content of the fat.
- Colour of milk- casein , fat globules & carotene.
- Buffalo milk = white
- Cow milk = light yellow
- Skim milk = light bluish
- Whey = greenish yellow
- Skim milk appears slightly blue because casein micelles scatter the shorter wavelengths of visible light (blue) more than the red.



Why The
Color Of
Milk Is
White?



Colour and optical properties

- Light scattering occurs when the wavelength of light matches the magnitude of the particle. Thus, smaller particles scatter light of shorter wavelengths and vice versa.
- Beta-carotene, the carotenoid precursor of vitamin A, is responsible for the creamy colour of cow milk.
- The greenish tinge in whey is due to the presence of riboflavin.
- Refractive index of milk is an optical property and ranges from 1.3440 to 1.3485 at 20°C.
- The relation between solids content of milk and refractive index is linear, and the contributions of the several constituents is additive.

Flavour, taste, smell of milk

- Flavour= odour(smell) + taste
- The natural sweet flavour of milk is due to the combined effect of its components.
- Sweetish taste due to lactose.
- Salty taste due to more minerals.
- The fat, fatty acids and phospholipids also contribute to the flavour.
- Milk has a pleasant, slightly sweet taste, and pleasant odour.
- Smell: Freshly drawn milk has a cowey odour which disappears when kept exposed for some time.

off-Flavour of milk

- Factors cause Off-flavours in milk owing to:
 - 1- The feed consumed by animals may lead to some undesirable flavours.
 - 2- Bacterial growth in milk causes fruity, barny, malty or acid flavours.
 - 3- Enzyme activities also may lead to unnatural flavours, rancidity due to lipase action being a classic example.
 - 4- Oxidative reactions may cause a cardboard flavour in milk.
 - 5- Processing of milk may produce cooked flavours.

Acidity and pH of milk

- Freshly drawn milk has a pH value in the range of 6.4 to 6.6 for cow milk, and 6.7- 6.8 for buffalo
- Higher pH values indicate udder infection (mastitis)
- While lower pH values indicate bacterial action.
- However milk shows a certain acidity as determined by Titration with an alkali (NaOH) in presence of an indicator (phenolphthalein) . This acidity is known as **titratable acidity (T.A.)**.
- **TA** is measured in terms of present % Lactic acid



Why milk have Natural/ apparent acidity (N.A.)?

- due to presence of casein, acid- phosphates , citrates whey proten, CO₂ etc of milk gives N.A.
- The higher the SNF content of milk higher is the N.A. of milk and vice versa.
- T.A. of cow milk varies from 0.13-0.14 %.

And for Buffalo milk is = 0.14-0.15%.

- Why milk Developed acidity or Real acidity?
- due to lactic acid formed in the milk as a result of bacterial action on lactose in the milk.
- Titrable acidity= N.A.+ developed acidity

DENSITY OF MILK

- Density is defined as the mass of substance divided by the volume occupied. Its unit in SI is the kilogram per cubic meter (kg m^{-3}). $D = \text{mass} / \text{volume}$
- At 5°C water has a density of 1.00 g/ml or 1000 kg m^{-3} .
- The density of milk varies within the range of 1.027 to 1.033 kg/cm^3 at 20°C .
- **For what reasons the density of milk is used?**
 - 1- to estimate the solids content,
 - 2- to convert volume into mass and vice versa.
 - 3- to calculate other physical properties such as dynamic viscosity.



DENSITY OF MILK

- Factors affecting density of milk/ density depend on:

- 1- The density is temperature dependent, so temperature should always be recorded specially at time of measurement.
- 2- temperature history of the sample,
- 3- composition of the sample (particularly fat content).
- 4- inclusion of air.
- 5- The addition of solids, e.g. minerals, sugar, protein will increase the density,
- 6- The addition of oil and fat will decrease the density.

Why Is Importance To Determine The Density of Milk? Density is useful for:

- 1- monitoring changes occurring during processing. e.g. evaporation, or for checking whether extraneous water has entered the product.
- 2- When dealing with solids, it is necessary to differentiate between solid density and bulk density, particularly with matter and powder.
- 3- when calculating the raw milk quantity,
- 4- When determining adulterations, for automatic fat standardization,
- 5- for the determination of water in buttermilk
- 6- When manufacturing concentrates for long life products.

DENSITY-methods

- A rapid method for the determination of density in milk uses with a hydrometer.
- Lactodensitometer is A form of hydrometer for finding the density of milk
- It is generally measured with a special hydrometer known as a lactometer and the result can be used to estimate total solids.

