University of Mosul
Lecture No.: 3
College of Veterinary Medicine
Date: 2025
Unit of Scientific Affairs
Website: https://orcid.org/0000-0003-3671-0998

Lecture title: **Biosynthesis of milk and milk components**

Lecturer Affiliation: **Dept. Veterinary Public Health**

Summary:

Principal Components

The principal chemical components in milk are those present in the largest quantities. Of course, the quantity (in grams) is not paramount in all respects. For example, vitamins are important with respect to nutritive value; enzymes are catalysts of reactions, and some minor components contribute markedly to the taste of milk.
Milk contains varying quantity of lipids, proteins and carbohydrates which are synthesized within the mammary gland. Smaller quantities of minerals and other fat-soluble and water-soluble components derived directly from blood plasma, especially blood proteins and intermediates of mammary synthesis are also present.
The most important components of milk are:

1. Protein: about four fifths of the protein consists of casein, actually a mixture of four proteins: αS1-, αS2-, β-, and κ-casein. The caseins are typical for milk. The remainder consists, milk serum (whey) proteins, the main α-lactalbumin and β-lactoglobulin. Moreover, milk contains numerous minor proteins, including a wide range of enzymes.

2. The fat: is largely made up of triglycerides, constituting a very complicated mixture. The component fatty acids vary widely in chain length. Other lipids that are present include phospholipids, cholesterol, carotene, free fatty acids, monoglycerides, and diglycerides.

3. Lactose or milk sugar is the typical carbohydrate of milk. It is a di-saccharide composed of glucose and galactose.
4. The mineral substances – (K, Na, Ca, Mg, Cl). Milk contains numerous other elements in trace quantities.
5. The miscellaneous components: milk has many miscellaneous components, such as vitamin, enzymes and milk gases.
The total content of all substances except water is called the **content of dry matter**. Furthermore, one distinguishes **solids-not-fat** and the content of **fat** in the dry matter.

1. PROTEINS

The biosynthesis of milk proteins in mammary gland be similar to biosynthesis of any other protein in body tissues. The substrate, amino acids from blood, is transported through the basolateral membrane to mammary secretory cell. The transporting systems may be sodium dependent or independent. Different groups of amino acids require different transporting system. Milk proteins are encoded by specific genes in the genome. The biosynthesis is initiated by gene expression which itself gets initiated by the hormone induced transcription factors.
Figure: Origin of milk proteins

Exampel: one cow product per day 30 L milk = 1 kg proteins

2. Lipids

Milk fat in freshly secreted milk occurs as microscopic globular emulsion of liquid fat in aqueous phase of milk plasma. Milk is an emulsion of oil in water (o/w), butter an emulsion of water in oil (w/o). Most of the milk used in dairy processing typically contains an average of 3.5-3.6% fat.
The variability of milk fat depends upon
1. The individuality of animal.
2. Stage of lactation.
3. Feed.
4. Environmental factors.
5. Stage of milking. Molecular

The functional properties of milk fat are attributed to its fatty acid make up. More than 400 distinct fatty acids have been detected in milk. Typical milk fat consists of 62% saturated, 29% monounsaturated, and 4% polyunsaturated fatty acids. It contains 7-8% short chain fatty acids (C4-C8), which is a unique characteristic of milk fat. Milk fat functions as a concentrated source of energy as well as a source of fat-soluble vitamins A, D, E, and K and essential fatty acids, linoleic, and arachidonic acids.
The biosynthesis of individual fatty acids and their comparative concentration in milk fat has a profound effect on properties and utilization of milk fat. **Saturated fatty acids** are solid at ambient temperature, while **unsaturated fatty acids** are liquid. Their ratio in milk fat has a significant effect on the hardness and the spread ability of butter at refrigerated storage temperature.

There is a correlation between the fatty acid composition of feed lipids and butter hardness. A seasonal effect is seen as well. A softer butter is observed when the cow is on summer pasture or when the ration includes oils that are liquid at ambient temperature.

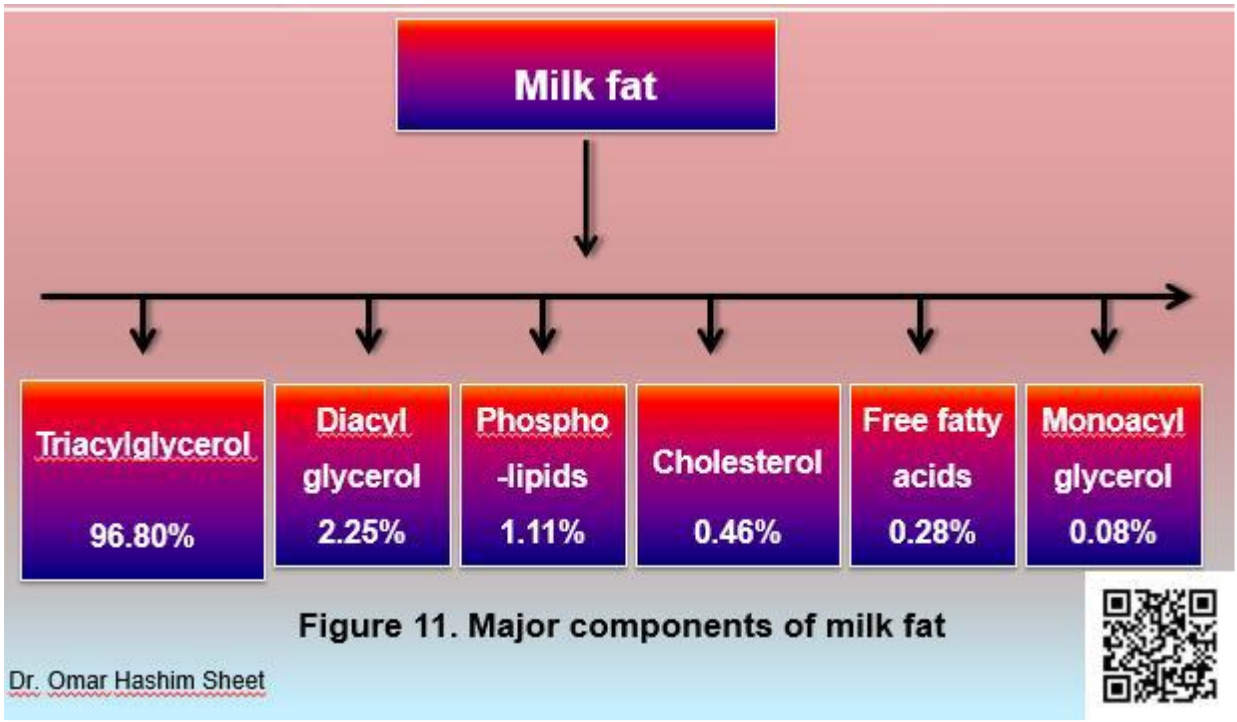

Figure 11. Major components of milk fat