Colostrum Growth Factors

Platelet-derived growth factor (PDGF)

Epidermal growth factor (EGF)

Insulin-like growth factor-1(IGF-1)

Vascular endothelial growth factor (VEGF)

Vascular endothelial growth factor (VEGF)

Milk constituents: -

1--Water The water content of milk and dairy products ranges from around 4 to 88% (w/w) and is the principal component in milk, cream, ice-cream, yogurt and most cheeses. The moisture content of foods {Water activity (a_w)} is an index of the availability of water for microbial growth & multiplying if water is **unavailable** for **pathogenic** or **spoilage-**causing bacteria to growth & multiply, food is well **preserved** and has a longer **shelf life**. (a_w) is defined as the ratio between the vapor pressure of the water in a food system (p) and that of pure water (Po). (aw) plays a very important role in food technology.

Water is the most important diluents in foodstuffs and has an important influence on the physical, chemical and microbiological changes which occur in milk & dairy products.

Milk Lipids: Milk lipids (3 to 5%) exists as a globule emulsified in the aqueous phase (87%) of milk. Fat-in-water emulsion. The lipids content of milk importance include:

1- Lipids in milk provide a major source of energy value.

2- Economically because milk is sold on the basis of fat.

3- Nutritive value, milk lipid is source of fat-soluble (A, D, E, K.) and essential fatty acids (fatty acids which cannot be synthetized by higher animals spatially linoleic acid C18:2).

4-Milk lipids also contribute to the palatability of the diet.

5- Milk lipids Plays a significant role in flavor, rheological properties of milk and milk products, it imparts a soft body, smooth texture and rich taste to dairy products.

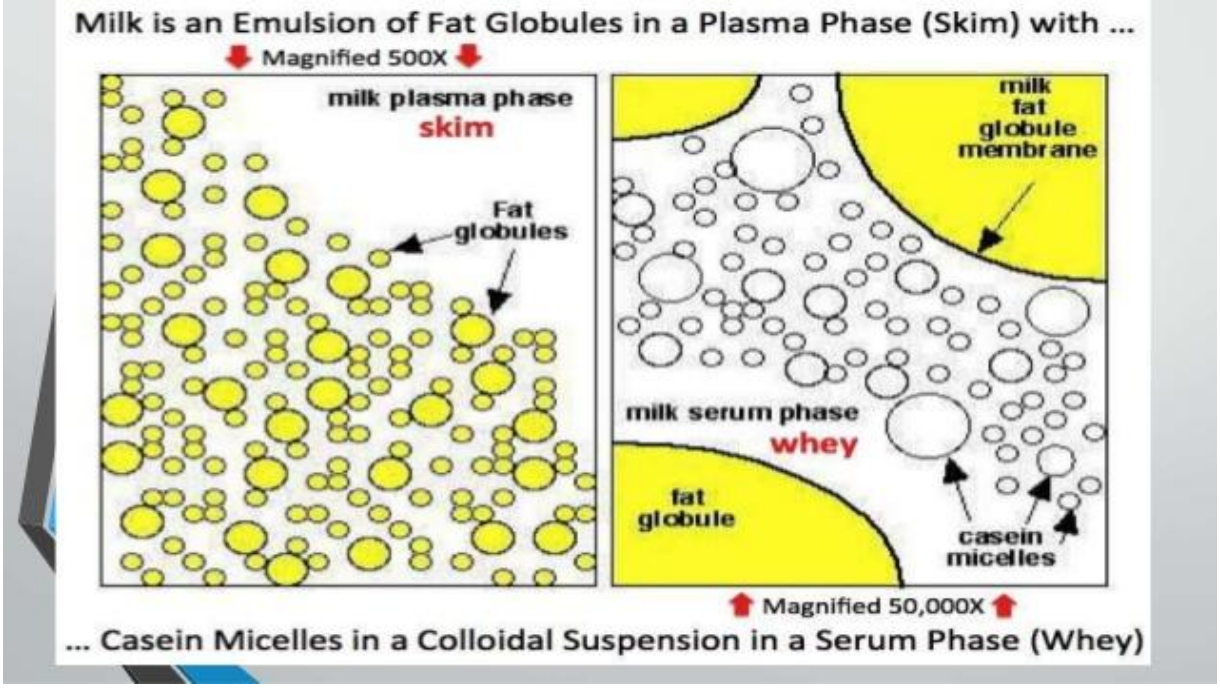
Milk lipids compositions:

Lipids of fresh milk are complex mixture of many fractions widely differ in chemical structure but all are dissolved in non-polar solvents and not dissolve in polar solvents (water).

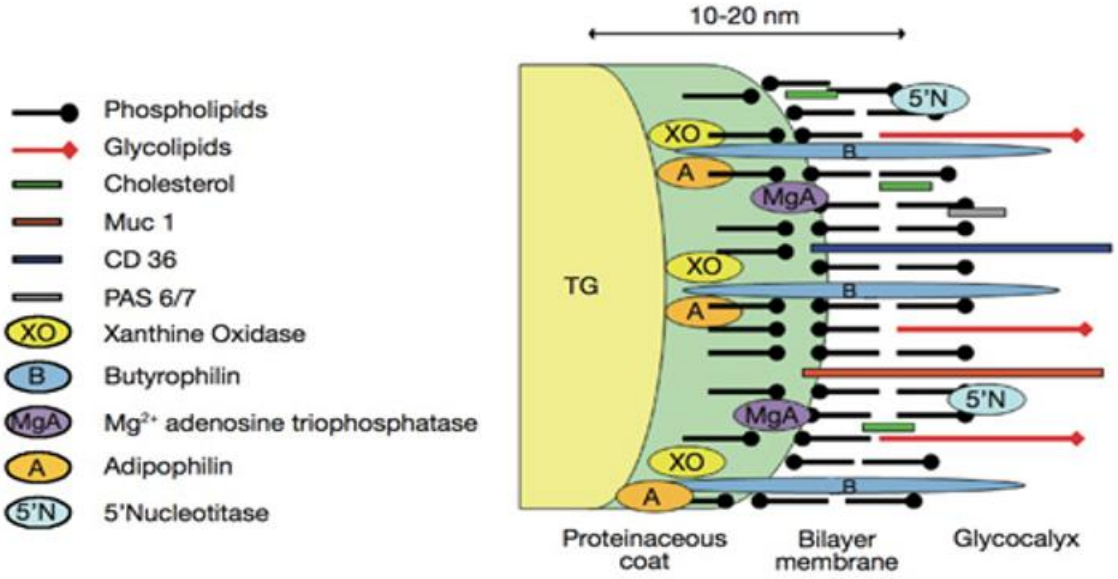
Lipids	**percentage**	**Position**
Triglycerides:	**98.3**	**Core of Globule**
Phospholipids	**0.8**	**Core of Globule, Globule Membrane, Milk Plasma**
Sterols	**0.32**	**Core of Globule, Globule Membrane, Milk Plasma**
Free fatty acids	**0.1**	**Core of Globule, Milk Plasma**
Cerebrosides	**0.1**	**Globule Membrane, Milk Plasma**
Carotenoids	**0.02**	
Waxes	**Traces**	**Core of Globule**
Fat soluble Vitamins	**µg\gm fat**	
Vitamin A **Vitamin E** **Vitamin D** **Vitamin K**	**7-8.5** **2-50** **Traces** **Traces**	

Milk fat globule:-

More than 95% of the total milk lipid is in the form of a globule as an oil-in-water emulsion ranging in size from 0.1 to 22 microns in diameter.



The fat globules are covered by very thin bilayer member with diameter of (8-10 nm) as surface material consist of (proteins, phospholipids, cerebrosides, enzymes and bound water). The composition and structure of the milk fat globule membrane (MFGM) is not known in detail but it is mainly composed of polar lipids and membrane-bound and associated proteins. The lipid fraction comprising approximately 30% of the membrane material consists of lipids such as phospholipids (25%), cerebrosides (3%) and cholesterol (2%). The remaining 70% of the membrane material are proteins, many of them being enzymes.



The Importance of MFGM

1-MFGM Provides stabilization for fat globules as emulsion in the aqueous environments of milk serum.

2-when ruptured, the fat globules join together into solid mass of fat This is what happens during the production of butter).

3-Protects fat from enzymatic action (Lipase).

4- Helps prevent fat globules to coalescence and flocculation.

It is well known that if raw milk or cream if left to stand, it will separate the cream layer forms very rapidly, within 20 to 30 min., in cold milk. Stokes' Law predicts that fat globules will cream due to the differences in densities between the fat and plasma phases of milk. However, in cold raw milk, creaming takes place faster than is predicted from this fact alone because **IgM** (agglutinin) an immunoglobulin in milk, forms a complex with lipoproteins. This complex, known as **cryoglobulin** precipitates onto the fat globules and causes flocculation. This is known as **cold agglutination**. As fat globules cluster produced, the speed of rising increases and sweeps up the smaller globules with them.

Homogenization of milk prevents this creaming by decreasing the diameter and size distribution of the fat globules; homogenization causes the formation of a recombined membrane which is much similar in density to the continuous phase.

Milk Fatty acid (FA**) compositions.**

Milk fat triacylglycerols (Triglycerides) are synthesized from more than 400 different fatty acids, which make milk fat the most complex of all natural fats. Nearly all of these acids are present in trace quantities and only about 12 acids at the 1% level or higher.

Milk Saturated Fatty Acids:

Fatty acid	**Weight mean**
4:0	4.4
6:0	2.4
8:0	1.4
10:0	2.7
12:0	3.3
14:0	10.9
15:0	0.9
16:0	**30.6**
17:0	0.4
18:0	12.2
20:0 0.2	
S.F.A total	**69.4**

Mono-Unsaturated Fatty Acids

Fatty acid	Weight mean
14:1	0.8
16:1	1.0
17:1	0.1
18:1	**22.8**
Mono USFA cis, total	**25.0**

Poly-Unsaturated Fatty Acids

Fatty acid	Weight mean
18:2	**1.6**
18:3	0.7
Poly-USFA cis, total	**2.3**

Poly-Unsaturated Fatty Acids (trans)

Fatty acid	Weight mean
16:1t	0.4
18:1t	2.1
18:2t	0.2
Poly-USFA trans, total	**2.7**

Conjugated Fatty Acids

Fatty acid	Weight mean
Total CLA	**0.4**

Some notes about milk fat fatty acids:-

1-The content of **saturated fatty acids** is **lowest** in the **summer** when the cows are grazing, and **highest** in the **winter** due to indoor feeding. The content of the **unsaturated fatty acids** shows the opposite pattern with the **highest** amount in the **summer**. when the cows are grazing, and **lowest** in the **winter** due to indoor feeding.

2-butyric fatty acid

$CH_3(CH_2)_2COOH$

is **specific for milk fat** of ruminant animals and is responsible for the **rancid flavor** when it is cleaved from glycerol by lipase action.

3-The saturated fatty acids present in milk accounts for approximately **70% by weight.**

4-The most important fatty acid from a **quantitative viewpoint** is **palmitic acid** (16:0)

$CH_3(CH_2)_{14}COOH$

which accounts for approximately **30%** by weight of the total milk fat fatty acids.

5-Myristic acid (14:0) **$CH_3(CH_2)_{12}COOH$**

& stearic acid (18:0) **$CH_3 (CH_2)_{18}COOH$**

make up 11 and 12% by weight, respectively of the saturated fatty acids.

6- short-chain fatty acids comprise about 10.9% of total milk fatty acids which include:

1-(C4:0 **Butyric $CH_3(CH_2)_2COOH$**

2-C6:0 **Caproic $CH_3(CH_2)_4COOH$**

3-C8:0 **Caprylic $CH_3(CH_2)_6COOH$**

4-C10:0) **Caprylic $CH_3(CH_2)_8COOH$**

Also named as volatile fatty acids

7-Approximately **25%** of the fatty acids in milk are **mono-unsaturated**

Oleic acid (18:1)

$CH_3(CH_2)_7CH=CH(CH_2)_7COOH.$

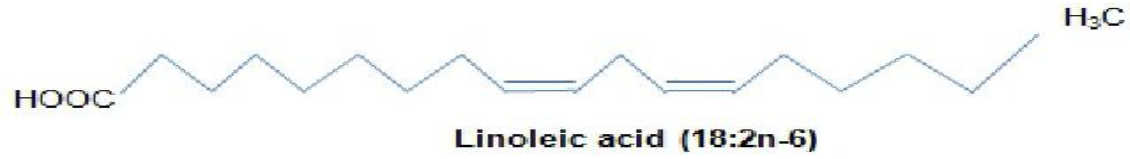
accounting for **23.8%** by weight of the milk total fatty acids.

8-**Poly-unsaturated fatty acids** comprise about **2.3%** by weight of the total fatty acids

the main poly-unsaturated fatty acids are **linoleic acid (18:2cis $\Delta^{9,12}$)**

omega-6 and **α-linolenic acid (18:3cis $\Delta^{9,12,15}$) omega-3**

accounting for **1.6** and **0.7%** by weight of the total fatty acids..



Linoleic acid (18:2n-6)

α-Linolenic acid (18:3n-3)

9-The ratio between **omega-6** and **omega-3** fatty acids is about

2.3:1 .

10-Approximately **2.7%** of the fatty acids in milk are trans fatty acids with one or more trans-double bonds.

The main trans **18:1** isomer is **vaccenic** acid (VA), (**18:1 t, Δ^{11}**)

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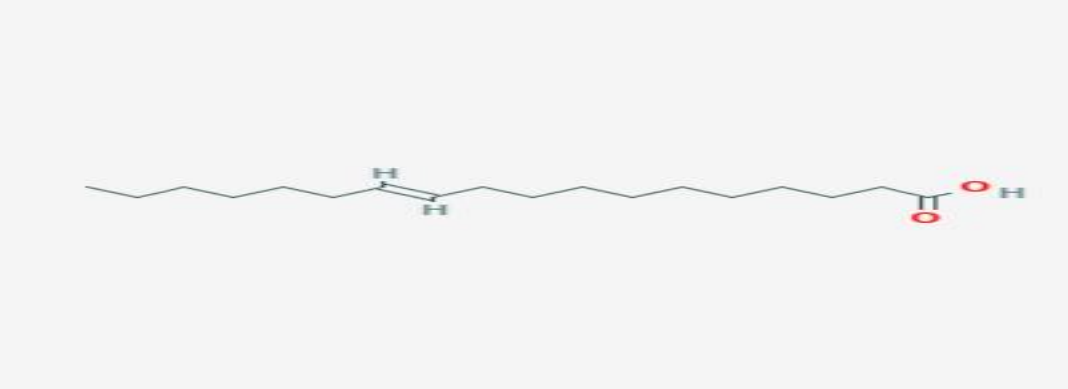


11-Milk fat contains also **conjugated linoleic acid (CLA),** with many different isomers including **rumenic acid** (RA) **(18: cis-9, trans-11 CLA)** which predominates (75_90% of total CLA).

Milk fat compositions

A- Triglycerides or Triacylglycerol (TAG)**:-**

The main milk lipids are a class called triglycerides which are esters comprised of a glycerol backbone binding up to three different fatty acids.

The composition of TAG is usually defined in terms of the kinds and amounts of FA present. The of TAG structure also includes the distribution of FA within the TAG molecule and
among the TAG molecules, as well as the identification of the individual molecular species of TAG.
The structure of the TAG influences the action of lipolytic enzymes and, therefore, absorption; it also influences the flavor of cheeses .The structure of milk TAG is responsible for the melting points, crystallization behavior, and rheological properties of MF as globules.
Bovine ML contains 12 FA in amounts greater than 1%. Therefore,
it would be theoretically possible to have 12 cubed (12 × 12 × 12) or 1728 TAG species if all the acids were randomly distributed. . In general, the SN1 position

binds mostly longer carbon length fatty acids, and the SN3 position binds mostly shorter carbon length and unsaturated fatty acids. For example:C4 - 97% in SN3, C6 - 84% in SN3, C18 - 58% in SN1

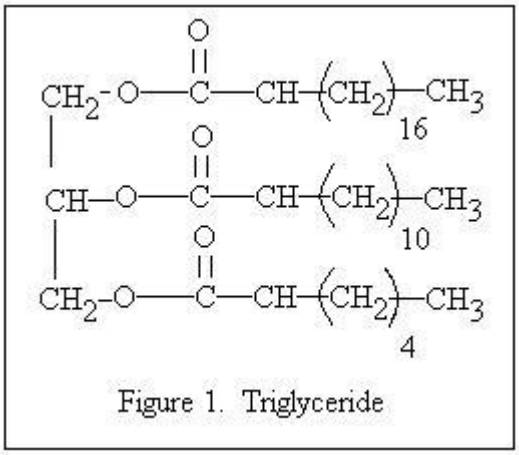


Figure 1. Triglyceride

The most abundant TAGs found in milk

4:0-16:0-C18:1,

4:0-16:0-16:0,

4:0-16:0-14:0

16:0-16:0-C18:1

B- Mono- , diglycerides, The small amounts of and free fatty acids in fresh milk may be a product of early lipolysis or simply incomplete synthesis.

Some physiochemical properties of milk fat:-

Some properties of triglycerides:

1-Refractive index:

Refractive index of milk fat ranged between **1.4527 to 1.4566** The value of milk fat RI is less than that of oils because milk fat contain more saturated and less un-saturated fatty acids than oils.

2-Spicific Gravity:-the specific gravity of milk fat at 20°C is (0.93) **.**

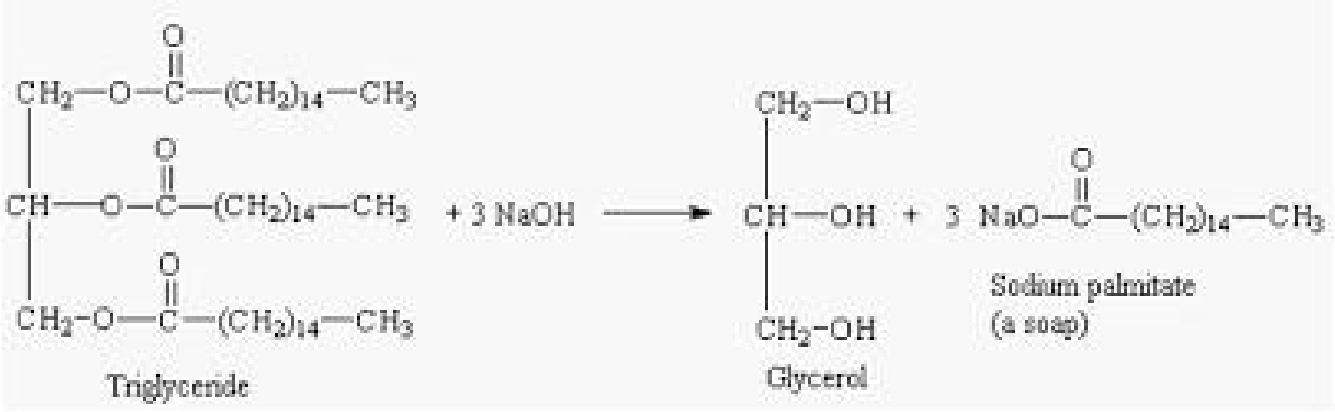
3-Solubility:-Milk fat is readily dissolved by ethyl ether, chloroform, carbon tetrachloride and benzene. It is moderately soluble in acetone, slightly in alcohol and insoluble in water.

4-Melting point:

The melting point of milk is **not sharp (30°C-41°C)** because it is a result of the melting points of the individual fatty acids(complex mixture of individual fatty acids differ in no. of carbon atoms C4-C20 and degree of unsaturation double bond).

5-Saponification Number

The saponification value of milk fat is **(210-233) ,** it is the number of **mg** of **potassium hydroxide** required to **saponify** the fatty acids in **1 g** of milk fat. The saponification number is a measure of the average molecular weight of the triglyceride in a sample. Saponification value of milk fat is higher than that of oils because it contain high level of short and medium chain length fatty acids.



The saponification number of milk fat is(231), peanut oil (190) corn oil (191),soy bean oil (192).Other fats as ole oil, lard and tallow ranged around (192-203).

6-Acid value

The acid value (*A V) is* **milligrams** of **potassium hydroxide** required to neutralize the **free acids** present in **1 g** of milk fat.

acid value of fresh milk fat = **0.4-0.56**

Significance

-Acid value is the measure of hydrolytic rancidity which increase more than normal value (milk fat deterioration). In fresh butter, the ADV will range between **(0.4-0.56). When milk has an ADV more than (1), its flavor has been injured.**

7-Iodine value

The iodine value is expressed as the **grams** of **iodine** absorbed **per 100g** of milk fat. Iodine value (I.V.) is directly related to the degree of unsaturation (Number of

double bonds. I.V. of milk fat is less than that of oils because it contains less amount of un saturated fatty acids compared to oils.

An increase in I.V. indicates high exposure of lipid to oxidative rancidity due to high degree of unsaturation.

Type of fat or oil	Iodine Number
Butter	30-34
Tallow	35-40
Lard	48-64
Olive oil	77-91
Cotton seed oil	104-116
Lin seed oil	175-201

oils have greater degree of unsaturation than the fats , being higher in such fatty acids as oleic and linoleic .milk fat contains less of unsaturated fatty acids than tallow or lard and therefore has a lower iodine number. The iodine number of milk fat **increases** quite sharply during **pasture season** and when **oily feeds are fed** in quantities. It is also increasing during the last few weeks of the lactation period. Thus, any factors increase the proportion of unsaturated fatty acids, increases the iodine number.

8-Reichert Meissl Number

Is the number of milliliters **of 0.1 N alkali (such as potassium hydroxide)**required to neutralize the **volatile water -soluble fatty acids** in **5 g.** milk fat. The Reichert Meissl test determines the amount of **butyric and caproica cids** .The Reichert value is an indicator of how much **volatile fatty acids**

Reichert Meissl of milk fat= **17-35**

It is high compared to other lipids because, milk fat contains high amount of short chain volatile fatty acids. This number is an important means of distinguishing milk fat from other fats. It varies with season of year being highest in March, dropping during the summer and reaching its lowest point in October.

9-Polenske number

Is the number of number of **milliliters of 0.1 N of sodium or potassium hydroxide** to neutralize the **volatile ,water –insoluble fatty acids ,alcohol soluble fatty acids** which are present in 5 g. of milk fat.It is measure of the steam volatile and water insoluble fatty acids,chiefly **caprylic, capric and lauric acids** present in milkfat. Milk fat Polenske Number is range of **(1.2-2.4)**.