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# A Review on Relative Aspects of Milk Lipids of different Animals

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**Abstract:**
Lipids contribute significantly towards nutritional value in milk of various animals. Saturated lipids study provides vital information regarding their role in different medical conditions like atherosclerosis, cancer etc. Due to large number of fatty acids present in milk fat with different structures, it is supposed to be the most complex naturally occurring fat and oil.Different animals can be categorized into two groups -ruminants e.g. cow, buffalo, goat, sheep and camel etc. and non-ruminants like human, pig etc. Milk Lipids of these two groups can be differentiated on quantitative and qualitative basis. Among the ruminants' buffalo and sheep have higher percentage of milk fat in comparison to cow, goat and camel milk fat. In non-ruminants, pig milk has higher fat content than the human milk. Cow, goat, camel and human milk have comparable fat content.
Key words: Lipids, milk-fat , saturated, fatty acid, ruminants', non-ruminants.
**Aim of the study:**Main objective of the study was to compare relative aspects of milk lipids of different animals, as milk lipids contribute significantly towards nutritional value of milk of various animals.
**Introduction:**Lipids are responsible for the flavor and texture of food, especially ghee, butter etc. Lipids contribute significantly towards nutritional value in milk of various animals. Saturated lipids study provides vital information regarding their role in different medical conditions like atherosclerosis, cancer etc. Due to large number of fatty acids present in milk fat with different structures, it is supposed to be the most complex naturally occurring fat and oil. About 400 fatty acids are recognized in milk fat using different research techniques (Chromatography, Spectroscopy etc.).
Specific polar lipids contribute towards positive health effects related to brain health, immunity and heart health etc. Sphingomyelin, plasmalogen and ceramides are proved for anti- tumor activity. Sphingomyelin and gangliosides exhibit anti-infection activity, effects cholesterol metabolism and coronary heart disease. Phospholipids may protect against mucosal damage.
Main deteriorative chemical changes responsible for the sensory, functional and visual defects are milk lipid oxidation, sugar-protein browning i.e. Maillard reaction. Stability of milk fat products towards oxidation is dependent on storage temperature, water activity, heat treatment and packaging.
The use of milk fat can be increased by application of various processing treatments like blending, fractionation, texturization and chemical or enzymatic processes to get improved

milk fat ingredients. Mostly triglyceride composition is changed. Modifications should be done to improve nutritional quality of milk fat.

Different animals can be categorized into two groups -ruminants e.g. cow, buffalo, goat, sheep and camel etc. and non-ruminants like human, pig etc.

Milk Lipids of these two groups can be differentiated on quantitative and qualitative basis.

Quantitative difference: Among the ruminants' buffalo and sheep have higher percentage of milk fat in comparison to cow, goat and camel milk fat. In non-ruminants, pig milk has higher fat content than the human milk. Cow, goat, camel and human milk have comparable fat content.

| Ruminants Fat (%) | Non- ruminants Fat (%) |
|---|---|
| Cow-3.9 | Human- 3.8 |
| Buffalo-7.4 | Pig – 6.8 |
| Goat - 4.3 | |
| Sheep- 7.9 | |
| Camel- 4.0 | |

**Table:Quantitative difference in milk lipids of ruminants and non- ruminant's milk.**

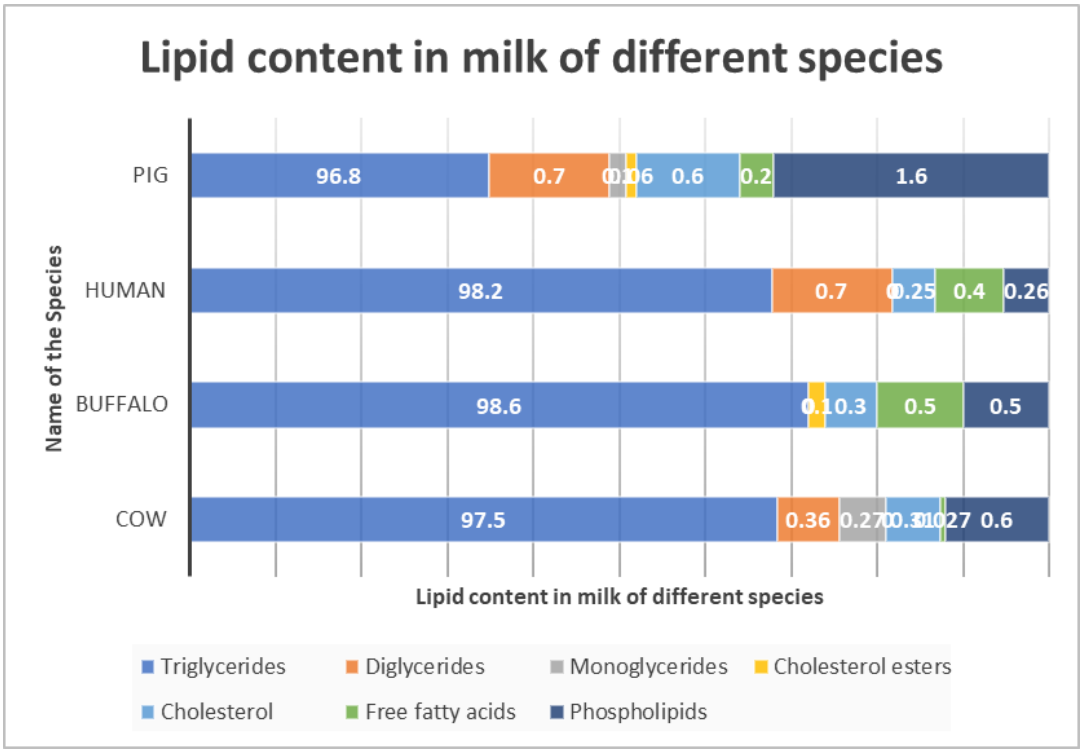
**Qualitative differences are based on the composition of the milk lipids. Fat globule sizes of ruminants as well as non-ruminant's milk are almost same (2-5 µm) and 1.5 to 3.0 billions/ml**.

Ruminants Non- Ruminants

| Lipid class | Cow | Buffalo | Human | Pig |
|---|---|---|---|---|
| **Triglycerides** | 97.5 | $98.6^{H}$ | 98.2 | $96.8^{L}$ |
| **Diglycerides** | $0.36^{L}$ | - | $0.7^{H}$ | $0.7^{H}$ |
| **Monoglycerides** | 0.27 | - | Trace | 0.1 |
| **Cholesterol esters** | Trace | 0.1 | Trace | 0.06 |
| **Cholesterol** | 0.31 | 0.3 | $0.25^{L}$ | $0.6^{H}$ |
| **Free fatty acids** | $0.027^{L}$ | $0.5^{H}$ | 0.4 | 0.2 |
| **Phospholipids** | 0.6 | 0.5 | $0.26^{L}$ | $1.6^{H}$ |

**Table: Lipid content in milk of different species.**



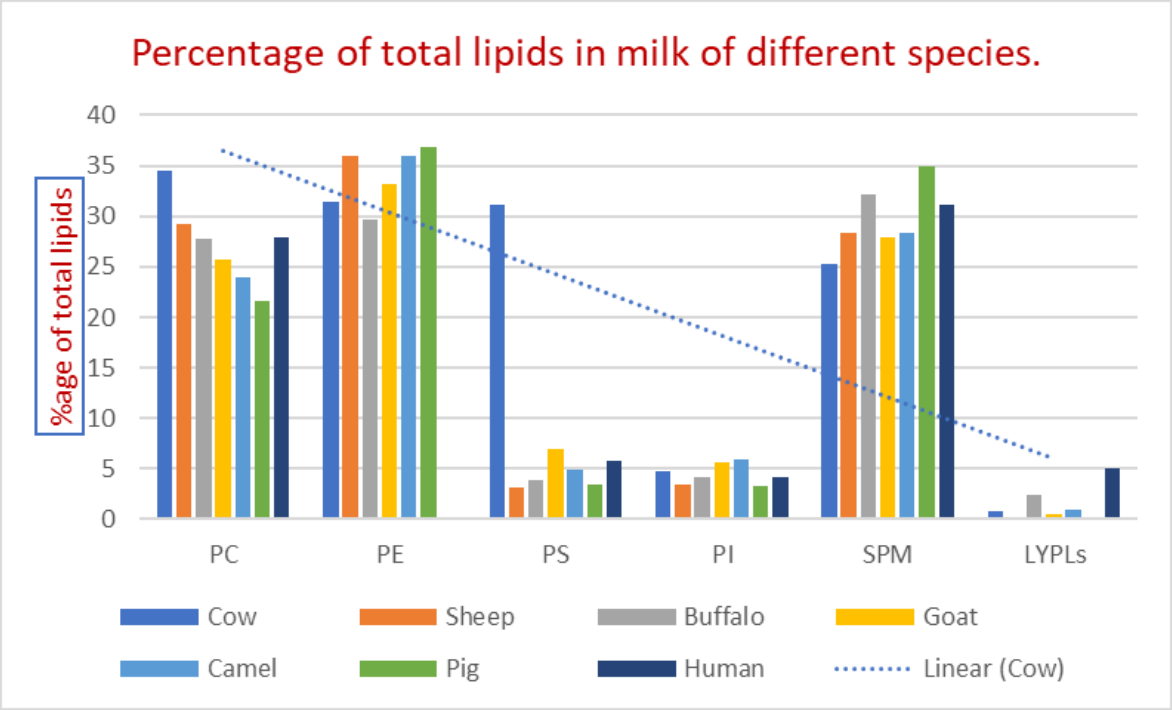

Significant observation in milk of all the animals are:

- Triglycerides are major lipid class accounting for 97 to 98% of total lipids. They are always accompanied bydiglycerides, triglycerides and monoglycerides, cholesterol, free fatty acid and phospholipids.
- Compositional data obtained from various animals are found to be sufficiently same as suggested by compare able mechanisms of synthesis and secretion of milk fat in various animals.
- Generally, marked similarities of relative proportion of each of phospholipids among different animals are found. This can be attributed to the fact that these perform the same structural function in each animal.

**Phosphoplipids:**

| Species | PC | PE | PS | PI | SPM | LYPLs |
|---|---|---|---|---|---|---|
| Cow | 34.5H | 31.4 | 31.1L | 4.7 | 25.2 L | 0.8 |
| Sheep | 29.2 | 36.0 | 3.1L | 3.4 L | 28.3 | - |
| Buffalo | 27.8 | 29.6 | 3.9 | 4.2 | 32.1 | 2.4 |
| Goat | 25.7 | 33.2 | 6.9 H | 5.6 | 27.9 | 0.5 L |
| Camel | 24.0 | 35.9 | 4.9 | 5.9 H | 28.3 | 1.0 |
| Pig | 21.6L | 36.8H | 3.4 | 3.3 L | 34.9 H | - |
| Human | 27.9 | 25.9L | 5.8 | 4.2 | 31.1 | 5.1 H |

Table: Phospholipids (molecular %age of total lipid phosphorus) in milk of different animals
PC- phosphotidyl choline, PE- phosphotidyl ethanolamine, PI- phosphotidyl inositol, PS- phosphotidyl serine, SPM- sphingomyelin, LYPLs- Lysophospholipids.




**Sterols:** cholesterol is the majors sterol component for most of the milkbut small amounts of other sterols are also found. In ruminant milk, in addition to the cholesterol following strerols are also present.

i. β- sitosterol, lanosterol
ii. Dihydrolanosterol
iii. 3,5-cholestadiene-7-one
iv. 7 dehdrocholesterol
v. Campesterol and Stigmasterol (Plant sterols)
vi. 5 avenasterol

In non-ruminants like human milk, in addition to cholesterol Phytosterols (Plant sterols) are also present.

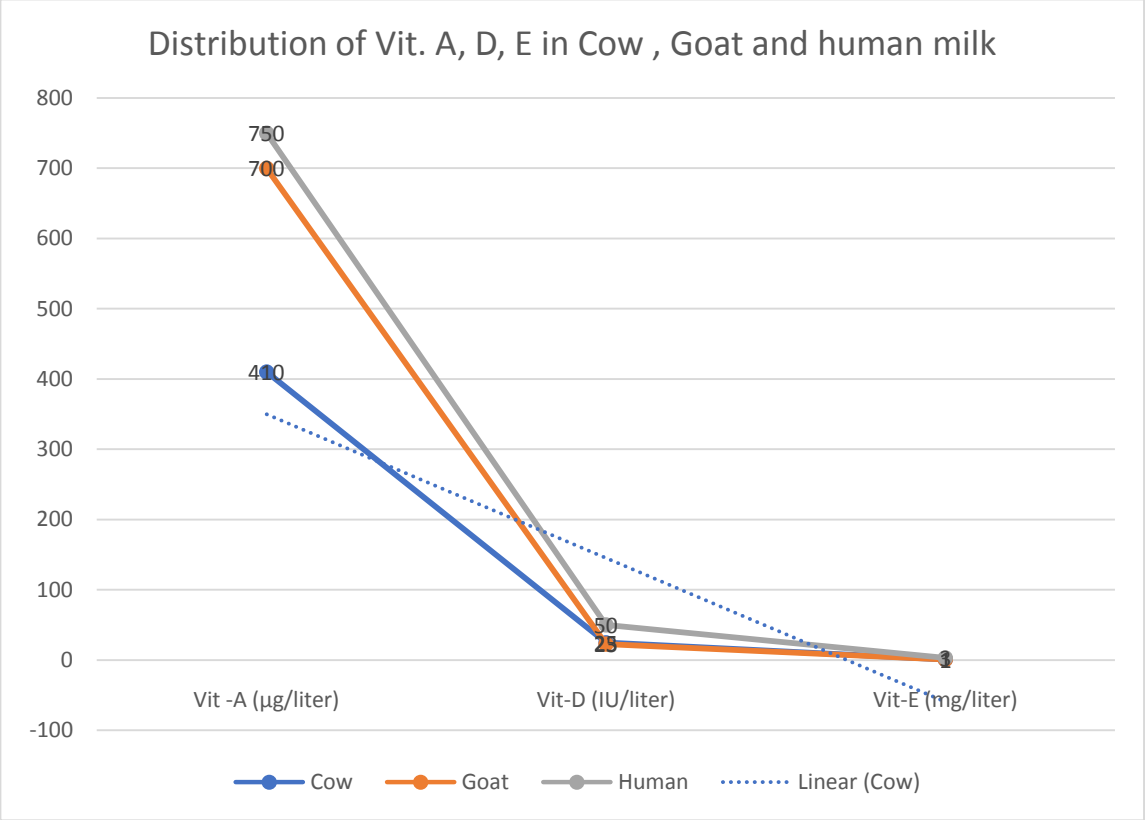
Carotenes/ carotenoids are present in cow milk and human milk whereas Buffalo milk and goat milk carotenes are absent.

**Fat-soluble vitamins in milk:**Non-ruminants(human) contain more vitamin-A, D, E than ruminants (cow, goat). Cow milk contains α-tocopherol, another detectable tocopherol is γ-tocopherol. In human milk, in addition to α-tocopherol, appreciable amount of β-, γ-,δ-tocopherols and γ-tocotrienol are also found.

| Animals | Vit -A (µg/liter) | Vit-D (IU/liter) | Vit-E (mg/liter) |
|---|---|---|---|
| **Cow** | 410 | 25 | 1 |
| **Goat** | 700 | 23 | Less than 1 |
| **Human** | 750 | 50 | 3 |

Table: Fat soluble vitamins in milk of different animals.




**Fatty acid composition of milk lipids of ruminants and non-ruminants:**

More than 400 distinct fatty acidsare detected in cow milk(ruminants), 184 Fatty acids are detected in human milk (non-ruminant). However, concentration of only few fatty acids is present in appreciable amount. Thus, only these fatty acids should be taken into consideration for relative comparison of milk fatty acids of different animals. Fatty acids of milk fat come from- Plasma lipids (in turn come from diet and body synthesis i.e. from lipolysis of adipose tissue and from synthesis de novo in the mammary glands.

Fatty acid composition of ruminant and non- ruminant milk lipids is found to be different. Diet has remarkable effect on fatty acid composition of milk of different animal species, e.g. Fatty acid composition of milk of non-ruminants is readily altered by the change in diet. It is highly dependent on the fatty acid profile of the diet. An increase in the concentration of a particular fatty acid like unsaturated fatty acid in the diet causes an increase in the concentration of this unsaturated fatty acid in the milk of non- ruminants. On the other hand, changes in the level of unsaturated fatty acids in the diets of ruminants have comparatively little effect on the composition of milk fatty acids, as extensive bio- hydrogenation occurs in the rumen. So, an increase in the unsaturated fatty acids of diet of ruminants will not increase levels of unsaturated fatty acids in milk of ruminants. Dietary linoleic acid (9C, 12C-18:2) is in part hydrogenated by the rumen mono-oleic acid to stearic acid -18:0 (major product). During this hydrogenation, small amounts of conjugated linoleic acid (9C, 11 t, -18:2) CLA and vaccenic acid (11t-18:1) are also formed.

| | Short chain | | | Medium chain | | | Long chain | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **4:0** | **6:0** | **8:0** | **10:0** | **12:0** | **14:0** | **16:0** | **16:1** | **18:0** | **18:1** | **18:2** | **18:3** | **$C_{10}$** |

| | | | | | | | | | | | | | to $C_{22}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cow** | 3.3 | 1.6 | 1.3 | 3.0 | 3.1 | 9.5 | 26.3 | 2.3 | 14.6 | 29.8 | 2.4 | 0.8 | T |
| **Buffalo** | 3.6 | 1.6 | 1.1 | 1.9 | 2.0 | 8.7 | 30.4 | 3.4 | 10.1 | 28.7 | 2.5 | 2.5 | T |
| **Sheep** | 4.0 | 2.8 | 2.7 | 9.0 | 5.4 | 11.8 | 25.4 | 3.4 | 9.0 | 20.0 | 2.1 | 1.4 | - |
| **Goat** | 2.6 | 2.9 | 2.7 | 8.4 | 3.3 | 10.3 | 24.6 | 2.2 | 12.5 | 28.5 | 2.2 | - | - |
| **Human** | - | T | T | 1.3 | 3.1 | 5.1 | 20.2 | 5.7 | 5.9 | 46.4 | 13.0 | 1.4 | T |
| **Pig** | - | - | - | 0.7 | 0.5 | 4.0 | 32.9 | 11.3 | 3.5 | 35.2 | 11.9 | 0.7 | - |

**Table: Principal fatty acids in milk triglycerides from various species.**

- Ruminant milk fats have relatively high concentration of short chain fatty acids, especially butyric acid $C_4$and hexanoic acid $C_6$which are rarely found in milk of non-ruminants.
- Medium chain fatty acids $C_{10:0}$, $C_{12:0}$, $C_{14:0}$ present more in ruminant milk fat and less in non-ruminant's milk fat.
- Non-ruminants (human and pig milk fat) contain mainly $C_{16}$ ($C_{16:0}$, $C_{16:1}$) and $C_{18}$ (all 18:0,18:1,18:2, 18:3 together) fatty acids i.e. their major bulk of fats is from $C_{16}$ and $C_{18}$ together including saturated and unsaturated fatty acids. Generally, they contain more of 18:1 and 18:2.
- Ruminants milk fat contain relatively low concentration of PUFA (especially EFA linoleic acid, 18:2) because of bio-hydrogenation in the rumen.
- Unlike ruminants, most ruminants get and absorb unchanged appreciable amount of PUFA from the diet. Thus, linoleic acid (18:2) and to some extent linolenic acid (18:3). Are reasonably high in non-ruminants.
- High concentration of 16:1 in pig milk fat is due to the activity of palmityl-CoA desaturase in the mammary gland of this species (pig).
- Ruminants milk fat is a relatively saturated milk fat. Short chain fatty acids help to maintain the desired degree of liquidity at body temperature. This maybe helpful for efficient secretion.
- Ruminant milk fat contains low content of linoleic acid. This can be due to the requirement of the new-born (neonatal ruminants) appears to be lower as compared to that of non-ruminants. That's why bovine formula which is based purely on bovine milk, may not meet the needs of human infants especially linoleic acid. That's why most of the manufacturers now supplementing commercial infant formula with vegetable oils to compensate the potential deficiency.

**Fatty acid composition of cholesterol ester:** Fatty acid composition of cholesterol ester of ruminants as well as non-ruminants resembles that of triglycerides. Only difference is that ruminant milk cholesterol esters do not contain significant amount of shorter chain fatty acids. $C_{18:1}$ is more in cholesterol esters of human milk, whereas $C_{18:1,\ 18:2,\ 18:3,\ 20:3,\ 20:4}$are more in cholesterol esters of cow milk.

**Fatty acid composition of phospholipids:** Phosphotidyl choline (PC) and phosphotidyl ethanolamine (PE) are the main phospholipids of milk.Ruminants' milk also contain low amounts of poly unsaturated fatty acids.

**Conclusion:** Milk Lipids are responsible for the flavor and texture of food, especially ghee, butter etc.Lipids contribute significantly towards nutritional value in milk of various animals. These are rich source of essential fatty acids, fat soluble vitamins (Vit A, D, E) and other growth promoting factors. It is believed that milk fat improves mental health, longevity and physical appearance. Ruminant milks have higher fat and protein content in comparison to non-ruminant milk.

The use of milk fat can be increased by application of various processing treatments like blending, fractionation, texturization and chemical or enzymatic processes to get improved milk fat ingredients. Mostly triglyceride composition is changed. Modifications should be done to improve nutritional quality of milk fat.

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