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Fatty Acid Composition of Bovine Milk: It Matters for Health and Nutrition

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Bovine milk is the nutrient rich liquid, white in colour produced by mammary glands of domestic cows (*Bos primogenius*), primarily Holsteins, Jerseys and Guernsey breeds. India is the world's top milk producer (239.30 million tonnes in 2023-2024) with 24% global production, led by high buffalo and cow milk volumes (Dept. of animal husbandry and dairying 2025). Tamil Nadu produces 145.88 lakh litres daily, contributing 5.38% of India's total, with prominent cooperative AAVIN milk (Cow breed: Holsteins, Jerseys and Friesian) (AAVIN 2025).

It has long been considered one of nature's most complete foods, providing essential nutrients such as proteins (3.5%), Lactose (4.9%), fat (4.2% to 5.5%), vitamins (0.1%), and minerals (0.8%). and 87% water (FAO 2025). Among these, the fat component of bovine (cow) milk plays a particularly important role in taste, supports absorption of fat soluble vitamins (A,D,E and K) and serves as energy sources. Milk fat is a complex mixture of 400-500 fatty acids of which 15 have an estimated 95% weight of total fatty acid pool in the milk (Micinski *et al.*, 2012). It also has significant biological and functional importance. Understanding the fatty acid composition of bovine milk helps to explain its nutritional value and its growing relevance in health-conscious diets.

Total Fatty acid composition of bovine milk

Fatty acids are the building blocks of milk fat, mainly present in the form of triglycerides. Bovine milk contains more than **400 different fatty acids**, making it one of the most complex natural fats. The sum of fatty acids (mg/g fat) consist of Short Chain Fatty acids (SCFA) from C4:0 to C10:0 consist of 63.46, Branched Chain Fatty Acid (BCFA) consist of 7.11, Odd Chain Fatty Acid (OCFA) consist of 11.76, Saturated Fatty Acid (SFA) consist of 368.60, Monounsaturated fatty acid (MUFA) consist of 140.38 and Polyunsaturated fatty acid (PUFA) consist of 16.22. These fatty acids each group vary in chain length and degree of saturation, which influences their digestibility, metabolic effects, and impact on human health (Paszczyk *et al.*, 2022).

Saturated Fatty Acids (SFA):

Saturated fatty acids (SFA) make up about 70% of total fatty acids in bovine milk. Common saturated fatty acids include butyric acid (C4:0), caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), palmitic acid (C16:0), and stearic acid (C18:0) accounts for approximately 10% of total SFAs supports cholesterol metabolism, cell membrane structure formation, signalling and act as energy derivatives (Dayrit *et al.*, 2015). Short chain fatty acids, such as butyric acid, are unique to dairy fat and are easily digested. Butyric acid has attracted attention due to its potential role in improving gut health, exhibits anti-inflammatory effect and anti-carcinogenic property, and supports colon health by maintaining intestinal barrier integrity. While medium chain fatty acid like capric acid possess antimicrobial properties inhibit metabolic disorders (Mensink *et al.*, 2019)

Monounsaturated Fatty Acids (MUFA)

Monounsaturated fatty acids account for approximately **25% of milk fat**. The most abundant MUFA in bovine milk is **oleic acid (C18:1 cis-9)**, which is recognized for the cardioprotective properties. Oleic acid improves cholesterol balance by reduction of low density lipoprotein (LDL) cholesterol and increases the high density lipoprotein (HDL), thereby reduces the inflammation and oxidative stress. Palmitoleic acid (C16:1), act as lipokine by regulating lipid metabolism and insulin sensitivity. MUFAs also contribute to the creamy texture and pleasant mouthfeel of milk and dairy products (Calder *et al.*, 2015).

Polyunsaturated Fatty Acids (PUFA)

Although present in smaller amounts (**about 2–5%**), polyunsaturated fatty acids in bovine milk are nutritionally significant. These include **omega-6 fatty acid as linoleic acid LA (C18:2 n-6)** and **omega-3 fatty acids as α -linolenic acid ALA (C18:3 n-3)**. The highest content of PUFA (21.01 mg/g fat) was present in the pasteurized milk. LA maintains cell membrane integrity, immune and inflammatory responses. While ALA long chain fatty acid contains arachidonic acid (AA), Eicosapentaenoic acid (EPA) and Docosahexanoic acid (DHA) contributes to cardio protective property, neural development of brain, retina and act as anti-inflammatory effect. Milk also contains **conjugated linoleic acid (CLA)**, a unique fatty acid contains cis-9, trans 11 isomer (rumenic acid) naturally produced in the rumen of cows. CLA has gained popularity due to its potential benefits such as anti-carcinogenic, anti-atherogenic, anti-diabetic and anti-obesity properties. Grass-fed cows typically produce milk with **higher levels of omega-3 fatty acids and CLA**, making feeding practices an important factor in milk quality (Shingfield *et al.*, 2013).

Factors Influencing Fatty Acid Composition

The fatty acid profile of bovine milk is not fixed and varies depending on several factors. Different cattle breeds vary in their ability to synthesize and desaturation fatty acids due to genetic different in enzymes such as stearoyl-CoA desaturase which affects oleic acid content and CLA content. Stages of lactation were also affects the fatty acid composition by higher level of long chain fatty acids in early stage of lactation and increased denovo synthesis of short and medium chain fatty acid at mid stage of lactation. Due to metabolic disorder, energy imbalance, inappropriate feeding formulation can alter the fatty acid composition. During summer season higher level of unsaturated fatty acid produced when compared to winter due to the feed availability difference. Management of frequency of feeding, milking frequency, housing condition contribute to variation in milk fat composition. These factors highlight the importance of sustainable and natural dairy farming practices.

Bovine Milk in Modern Diets

With rising interest in functional foods, bovine milk is increasingly valued not just as a basic food but as a source of health-promoting fatty acids. Products such as A2 milk, organic milk, and grass-fed dairy are gaining popularity due to their improved fatty acid profiles. Consumers today are becoming more aware that quality matters more than fat quantity, prefer minimally processed dairy products. Choice of milk from well-managed dairy systems can provide beneficial fatty acid along with proper refrigeration and freezing prevent oxidation of sensitive polyunsaturated fatty acids.

Conclusion

The fatty acid composition of bovine milk is complex, diverse, and nutritionally valuable. While saturated fatty acids dominate, milk also contains beneficial monounsaturated and polyunsaturated fatty acids, including omega-3 and conjugated linoleic acid. Factors such as cow diet, breed, and farming practices significantly influence milk fat quality. The Meta research on fatty acid composition encourages a **balanced and informed perspective**, recognizing bovine milk as a natural source of essential and functional fatty acids that support overall health. As dietary science evolves, bovine milk continues to hold an important place in human nutrition.

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