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REVIEW OF THE FATTY ACID CONTENT OF DOMESTIC MILK AND ITS IMPORTANCE

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Abstract

The fatty acids in milk from various species of domestic animals have many important benefits for the human body. The physical chemical characteristics of milk are influenced by many factors: animal nutrition, lactation period, storage conditions and treatments to which it has been subjected. Milk fat is directly determined by the characteristics and the different proportion of fatty acids in its composition. The fat contains over 70 different fatty acids, which sets it apart from all other animal fats. Fats are of vegetable and animal origin, vegetable fats are generally liquid (oils) and animal fats are solid (lard, butter). Fatty acids are of two types saturated and unsaturated. The saturated ones have only simple sigma type bonds (butyric, capronic, caprylic, capric, lauric, myristic, palmitic, stearic acid, etc.). Unsaturated acids contain a pi bond and have longer chains (palmitoleic, oleic, linoleic, etc.). It was found that cow's milk has a low fatty acid content of about 2-3%. This paper is a review of the fatty acid content of milk from different species and their importance.

***Key words**: benefits, factors, fatty acids, milk fat, species.*

INTRODUCTION

The content of fatty acids varies between certain limits being influenced by the breed of the animals, the way of feeding, the season in which the milk was harvested and the organoleptic and physical chemical properties of milk fat are directly determined by the different characteristics and proportion of fatty acids in its composition. Milk fat, especially short-chain, polyunsaturated, cis and trans conjugated fatty acids and other components of milk are considered to be beneficial to human health (Parodi, 2004; Ascherio, 2002; Williams, 2000). The fat content of milk rich in saturated fatty acids has been claimed to contribute to heart disease (Chisholm et al., 1996). Butyric acid is considered a potent inhibitor of cancer cell proliferation (Watkins et al., 1999). Belury (2002) demonstrated that unsaturated fatty acids, omega-3 polyunsaturated fatty acids, such as linolenic acid and conjugated linoleic acid, would help prevent breast and skin disease, with beneficial effects on the health of animals used in experiments. Butter enriched in conjugated linoleic acid reduces the incidence of breast tumors in rats (Ip et al., 1999). The concentration of fatty acids in milk is influenced by the diet of the animals, by the feed/concentrate ratio (Griinari et al., 1998).

There were seasonal differences in the diet of cows fed fresh pasture, with a higher content of fatty acids in milk (Precht & Molkentin, 2000; Lock & Garnsworthy, 2003).

Fatty acids are divided into: saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, acetylenic fatty acids, we also have fatty acids with special structure: branched, cyclic, epoxy, hydroxyl, with ketone group (Pece et al., 2007). Fatty acids are distinguished by the number of carbon atoms followed by two dots, the number of double bonds and in parentheses, the position and configuration of double bonds (Karlson, 1975).

MATERIALS AND METHODS

The data present in this paper resulted from analyzes performed by various authors in the literature using High performance liquid chromatography (HPLC) method. Gas chromatography is currently the most commonly used pathway for fatty acid analysis. High performance liquid chromatography today covers approximately 80% of the analysis of molecular substances: organic, organo-metallic and inorganic including highly polar or thermally labile compounds as well as high molecular weight compounds (natural or synthetic). Data were analyzed from the literature on the fatty acid content of milk samples from different animal species: cattle, goats, sheep, buffalo.

RESULTS AND DISCUSSIONS

The fatty acid content of the milk of domestic species

The energy value of milk from different animal species is related to the concentration of certain compounds, especially the amount of fat (Barłowska et al., 2011). Milk fat makes a major contribution to the nutritional properties of milk and its technological adequacy. The fat is synthesized in the milk cells of the udder. Lipids form inclusions, which gradually increase in size and eventually migrate to the top of the cell from which they are discharged as globules into the collecting lumen (Barłowska et al., 2011). The highest concentration of conjugated linoleic acid (CLA) was found in sheep's milk followed by cow's and buffalo's milk and the lowest content was found in goat's milk (Table 1). The presence of CLA includes many properties, the most biologically active is the cis-9, trans-11 (octadecadienoic) configuration diene, it is claimed to inhibit the onset and development of skin, breast, colon, and stomach cancers (Parodi, 1999), while its trans-10, cis-12 isomer is thought to prevent obesity (Bawa, 2003; Wang & Jones, 2004). CLA would inhibit the development of osteoporosis (Watkins & Seifert, 2000), improve lipid metabolism, lower blood glucose, and stimulate the immune system (O'Shea et al., 2004). Donkey's milk is very rich in myristic acid (C 14:0), palmitic acid (C16:0), palmitoleic acid (C 16:1 trans), arachidonic acid (C 20:4, n-6), eicosapentaenoic acid (C 20:5, n-3) and C 22:6, n-6. Sheep's milk is rich in butyric acid (C 4:0), caproic acid (C 6:0); caprylic acid (C 8:0); margaric (C 17:0), stearic (C 18: 0), C 18:1 t11 trans, TFA. Cow's milk is rich in C 14: 1 c9 cis; C 16:1 c9 cis; C 18:1 c9 cis; C 18:2 c9, t11 (CLA); C 18:2 t10, c12 (CLA); C 18:2 cis. Goat's milk was found to be rich in capric acid (C 10:0); lauric acid (C 12:0); C 18:2 t9, t12 trans.

Table 1. Fatty acids of milk from domestic species (% of total fatty acids)

Fatty acids	Cow[a]	Goat[a]	Sheep[a]	The buffalo[a]
C 4:0	3.84[b]	2.46	4.06[c]	3.90c
C 6:0	2.28[b]	2.40	2.78[c]	2.33c
C 8:0	1.69[b]	2.53	3.13[c]	2.41c
C 10:0	3.56[b]	9.38	4.97[c]	2.40c
C 12:0	3.83[b]	4.45[a;b]	3.35[c]	3.09c
C 14:0	11.24	10.16	10.16[c]	10.64
C 16:0	26.66	25.64[b]	23.11[c]	28.02[c]
C 17:0	0.50	0.63	0.76	0.50
C 18: 0	11.06[b]	12.51	12.88[c]	12.58[c]
Total ≤C14:0	23.59	31.37	28.42	24.76[c]
Total SFA	63.94	68.70	65.17[c]	65.86[c]
C 14:1 c9 cis	0.84	0.22	0.58	0.67
C 16:1 c9 cis	1.68	0.67	0.39	1.56
C 18:1 c9 cis	24.72	22.03	23.32	24.10
Total MUFA	27.23	23.39	24.29[c]	26.43[c]
C 16:1 trans	0.31	0.38	0.29	0.37
C 18:1 t11 trans	2.01	1.69	2.69	2.00
C 18:2 t9, t12trans	0.45	0.50	0.44	0.49
Total TFA	2.76	2.66	3.15	2.66
C 18:2 c9, t11 (CLA)	0.59	0.43	0.60	0.39
C 18:2 t10, c12 (CLA)	0.036	0.024	0.032	0.027
Σ (t11, c13, t7, c9) CLA	0.033	0.030	0.041	0.027
Total CLA	0.66	0.48	0.67	0.49
C 18:2 cis	1.96	0.70	1.17	1.55
C 18:3 n-3	0.70	0.82	0.92	0.68
C 20:4, n-6	0.21	0.32	0.20	0.35
C 20:5, n-3	0.15	0.11	0.09	0.18
C 22:6, n-6	0.08	0.09	0.08	0.12
Total PUFA	3.08	2.04	2.45	2.67

[a]Talpur, 2008; [b]Ceballos et al., 2009; Barłowska et al., 2011. SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; CLA, conjugated linoleic acid; TFA, trans fatty acid.

Ceballos et al. (2009) reported goat's milk fat compared to cow's milk fat that would contain 54.6 % more C 6:0 acid, 69.9% C8: 0, 80.2% C 10:0 and 56.3 % CLA and 75% less acid C 4:0. Most important of goat's milk is the high concentration of short-chain fatty acids, such as capric acid and caprylic acid, which are increasingly present in goat's milk. They have been used in therapies for patients with metabolic disorders, cholesterol problems, anemia, bone demineralization and in child malnutrition (Pop et al., 2008). The highest total content ≤ C14:0 was found in goat's milk. In the content of monounsaturated fatty acids (MUFA), cow's milk ranks first with the highest concentration found, followed by buffalo's milk. The concentration of CLA depends on the animal's diet (Michalski et al., 2005). A significant increase in the concentration of CLA in milk was observed in cows fed on pasture compared to cows fed on full mixed rations (Auldist et al., 2002; Loor et al., 2003; Schroeder et al., 2003). Feeding would influence the n-6/n-3 acid ratio in milk (Fedele et al., 2001). The 4:1 n-6/n-3 acid ratio of milk has been influenced by feeding cows fresh fodder (Haug et al., 2007), in summer the ratio may decrease, when cows are fed fresh pasture, they reach close values of 2:1. The 4:1 n-6/n-3 acid ratio of milk has been influenced by feeding cows fresh fodder (Haug et al., 2007), in summer the ratio may decrease, when cows are fed fresh pasture, they reach close values of 2:1. An argumentative report was made on the ratio of n-6 and n-3 fatty acids. People living in the Mesolithic era had an intake of n-6 and n-3 FA in a ratio of 1 to 4:1, while the diet of a modern European man reaches a ratio of 10 to 14:1 (Haug et al., 2007). Consumption of large amounts of n-3 fatty acids, consumed by many Japanese and Inuit population is defined by a lower risk of coronary heart disease and some cancers.

The importance of acids

Milk fat has a high content of saturated fatty acids. The majority of saturated fatty acids are palmitic acid (24-28%), myristic acid (13-14%) and stearic acid (11-12%), and the unsaturated ones are oleic acid (23-28%). Short or medium chain saturated fatty acids do not increase serum cholesterol levels, only palmitic and myristic acids have an effect in this regard (Kansal, 2002).

Experts in the fields of cancer, nutrition, and immunocompetence have come together to analyze the role of milk in the diet on the "nutritional value of milk fat" (California Dairy Research Foundation, 1996). Discussions have shown that atherosclerosis is caused by factors such as diet and genetic inheritance. Some experts believe that atherosclerosis is not a disease due to diet but a metabolic disease, but others have shown that by monitoring cholesterol and changing fat, a change in blood composition can be obtained. Consumption of trans acids is associated with an increased risk of cardiovascular disease, but this combination cannot be applied to fatty acids of animal origin such as vaccenic acid and rumenic acid (CLA) which have anti-atherogenic properties (Parodi, 2004).

Milk fat is easily digestible, this digestibility is 99% while palm oil is 91% (Kansal, 2002). The digestibility of milk fat is due to the dispersion of fat globules in the aqueous phase of milk in the form of emulsion, thus facilitating pancreatic enzymes and intestinal lipases. Milk is rich in short or medium chain fatty acids that are more easily absorbed than long chain fatty acids. The easy digestibility of milk fats makes it a valuable constituent of the diet in diseases of the stomach, intestines, liver, gallbladder, kidneys (Miron and Macovei, 2006).

Bovine milk is low in essential fatty acids (EFAs), linoleic and linolenic. The EFA requirement is 3% of the total calories, 2/3 is provided by the lipids present in cereals, vegetables, etc. There is no justification for replacing milk fats with other fats that have a higher linoleic acid content. Milk fat has a productive effect against tooth decay. Short or medium chain fatty acids with 4-12 carbon atoms that are found in high concentrations in milk fat have antifungal and antibacterial activity (Kansal, 2002). Cow's milk fat can prevent gastrointestinal infections, thus costing whole milk consumption to be associated with fewer gastrointestinal infections than skim milk consumption (Koopman et al., 1984). The results of animal studies do not support the hypothesis that milk fat has a role in the etiology of breast cancer. Daily intake of insulin-like factor-1 and biologically active estrogens in dairy products is insignificant compared to the daily exogenous secretion of these female factors, and bovine growth hormone is biologically inactive in humans (Parodi, 2004).

Milk fat contains many agents with anticarcinogenic potential, such as conjugated linoleic acid, sphingomyelin and other sphingolipids, butyric acid, 13-methyltetradecanoic acid, ether lipids, vitamins A and D. Milk fat has a protective effect against many cancers (breast, skin, stomach, prostate, colon) (Parodi, 2004).

Dairy products are rich sources of CLA, especially the cis-9, trans-11 isomer. The concentration of CLA in milk fat is 3-5 mg/g, of which the cis-9, trans-11 CLA isomer represents

80-90% (Parodi, 1997; Sehat et al., 1998). For this CLA isomer it has been proposed the name rumenic acid (Kramer et al., 1998) name resulting from foods from ruminants (beef, milk) contain large amounts of this isomer.

Numerous physiological properties have been attributed to conjugated linoleic acid. The benefits of the acid include activities such as: anticarcinogenic activity, antilipogenic activity, antiatherosclerotic activity, antidiabetogenic activity, modulator of lipid metabolism and immune function (Miron & Macovei, 2006).

Studies on animals, human culture cell lines, and human epidemiological data suggest that whole milk and dairy products rich in CLA are beneficial foods are good foods for health, because CLA in addition to its antitumor properties is a hypolipidemic and antioxidant nutrient and therefore antiatherosclerotic (Miron & Macovei, 2006).

The bactericidal activities of fatty acids depend on the length of the chain and the strain of the microorganism. Helicobacter pylori has been shown to be sensitive to monoglycerides and medium chain fatty acids (Petschow et al., 1996), and the consumption of a large amount of milk fat inhibited intestinal colonization with Listeria monocytogenes in rats. C 4:0, C 6:0, C8:0, C 16:0 and C 18:0 fatty acids at a concentration of 500 μmol /l had no bactericidal activity. C 14:0, C 18:1 and C 18:2 fatty acids killed only Compylobacter jejuni and Listeria monocytogenes while C 10:0 and C 12:0 fatty acids were found to be toxic to all pathogens tested (Sprong et al., 1999). In rats that consumed milk fat, C 10:0 and C 12:0 fatty acids accounted for 8% and 7% of free gastric fatty acids, respectively. Considering a similar human fatty acid release ratio, the calculated gastric concentration varies between 0.4-0.9 and 0.3-0.7 mol/l for C 10:0 and C 12:0 fatty acids, respectively. Both acids have been shown to be highly bactericidal at 0.5 mol/l, demonstrating that C 10:0 and C 12:0 fatty acids released during gastric digestion of milk fat can prevent gastrointestinal infections (Sprong et al., 2001).

CONCLUSIONS

Assessing the fatty acid profile of milk from different animal species, it is found that saturated and monounsaturated fatty acids have been identified as the most concentrated in all types of milk, while polyunsaturated fatty acids have been identified in relatively low concentrations in milk. In the human diet, essential fatty acids have many benefits for the body. In the human body, fatty acids are a preferred source of energy. Dairy products and meat are often rich in saturated fatty acids.

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