

The Conjugated Linoleic Acid (CLA) Contents of Various Milk and Dairy Products and Affecting Factors

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ABSTRACT: Due to a variety of positive effects on human health, conjugated linoleic acid (CLA) including geometric and positional isomers of linoleic acid, which is omega-6 essential fatty acid, has gained importance in recent years. Although there are many food items containing CLA, meat, milk and dairy products derived from ruminant animals are richer in terms of CLA. These products are the basis of human diet. Although there are studies performed abroad on CLA contents of various milk and dairy products and the factors affecting them, there are only a few compilations about CLA in Turkey. The conducted studies particularly intended for increasing the CLA in milk and milk products is not sufficient in numbers and a gap exists about this issue.

KEYWORDS: CLA, dairy products, animal breeding.

I. INTRODUCTION

The conjugated linoleic acid (cis-9, trans-11) that contains geometric and positional isomers of linoleic acid (LA), which is Omega-6 essential fatty acid, is produced in the rumen of cattle and other ruminants through the microbial biohydrogenation of linoleic and linolenic acids. The cis-9 trans-11 C18:2 isomers of CLA in the ruminant milk fat forms 75% of the total CLA. A great number of studies were carried out to determine the effects CLA on human health and it was found out in these study results that the essential fatty acids have many different physiological and biological effects on health. Because of its positive effects on human health such as the body fat reducing effect of CLA, boosting the immune system, the effect of antiatherogenic, the effect of anti-carcinogen, lowering cholesterol, stimulating growth, inhibiting cardiovascular disease, the effect of bone mineralization, protecting against diabetes, enhancing muscle growth, the effect of the antibacterial and antioxidant, CLA has attracted a lot of attention, and increasing the amount of the CLA in animal products was brought to the agenda due to the mentioned benefits ([1], [2], [3], [4], [5], [6], [7], [8]).

Despite the fact that CLA is found in many foods, meat, milk and dairy products from the ruminant animals are richer in terms of CLA and are important sources of nutrients for humanity [5]. CLA has a significant potential in improving the quality of human life. The tendency of milk lipid enrichment has led to new productions enriched with omega-3, omega-6 fatty acid and other components in the dairy industry and these components affect the human health in positive way [4]. Investigating various content of milk and milk products of CLA, analyzing the factors that affect content of milk and milk products of CLA and increasing the amount of CLA in the animal foods may provide the potential to improve animal production of CLA. As a result of the positive effects of the CLA on health, so much effort have been put forward to increase CLA content in milk that is to say that increase the value of milk [9].

II. THE CONTENT OF CLA IN MILK AND DAIRY PRODUCTS AND AFFECTING FACTORS

One of the priorities of the manufacturers is to achieve protein and fat content and high production levels with suitable animal feeding. These are the substances that determine the quality of animal products. The composition milk and fat and their quality on the feeding strategy (level of the fat and different types in animal feeding) is very crucial [10]. The

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CLA contents of animal based foods are affected by several factors. The increase in the product's fat content will also increase the content of the CLA. The composition of rations depends on the season so the fat content of milk varies. The fat content of milk changes in fall and winter depending on animal feeding just like the CLA contents [4]. Çelebi and Kaya [5] indicated that CLA quantities of animal products may vary depending on the nutritional status of the animal and added that CLA contents of animals (their products, too) fed with the grassland and green fodder are much higher than those that are fed with artificial feed. It was also identified that the rate of CLA in the milk animals grazing at the higher altitude is higher compared to those that graze at the low altitude and explained that the situation is the result of the rich meadows that the animals graze at the higher altitude [4].

Animal feeding is the most important factor affecting the milk concentration of CLA. The average total CLA content of milk samples from milk, light milk and fruit milk were found to be 1.020%, 0.965% and 0.961% respectively [11]. In the milk of animals into whose rations CLA amount was added, albeit small, an increase was observed. Again in a conducted study where the products were obtained by adding fish fat and vegetable oil into rations of various ruminant animals (cattle, sheep), an increase in the amount of CLA was observed but no change in the amount CLA was observed in the non-ruminant animals (pigs and poultry). The other factors affecting the CLA content of the milk in animals are factors such as in species, age, growing season [12],[4].

Sheep milk fat content of CLA was 2.4% in May but it fell to 1.3% ($p < 0.0001$) from in August and went up to 2.6% in September ($p < 0.001$). The α -linolenic / linoleic acid ratio in pasture example was 4.36 in May but it then fell to 1.97 in August again increased to 3.14 in September. The seasonal variations in pasture are directly responsible for the content of CLA and are indirectly responsible for the proportion of CLA in the milk fat. The seasonal changes in the sheep milk fat content of CLA primarily depend on grass (pasture) oil and α -linolenic acid content. About 0.6% of the total fatty acid is the cow milk fat and the CLA concentration of sheep milk is comprised about 1% of total fatty acids. The changes in CLA levels of milk are affected by lactation minimally and race while feeding milk is the most important factor affecting the concentration of CLA [6].

It was noted in the study by Tsiplakou et al. [3] that there was a big change in the CLA content of milk fat among the ones consuming the same nutrition but added that the animal breed was not influential. Moreover, it was mentioned that there was a negative but insignificant correlation between the milk fat and the CLA concentration and they went on informing that there wasn't a correlation between the CLA content of milk fat and milk productivity. The biggest (the most important) resource of CLA is the milk and the meat of the ruminant animals [3].

Morand-Fehr P. et al. [13] stated in their study that there was a positive correlation between the CLA content of milk fat and the ratio of legume meadows.

Loor et al. [14] mentioned that the most effective method to increase the amount of CLA in milk is to have the animals graze in pastures.

In the study performed by Khanal and Olson [2], the factors affecting the CLA content were grouped into three: a-the factors related with feeding, b-the factors related with animals, c-the factors related with after production processes. The same researchers informed that the CLA content of the meat and milk taken from the cows grazed at the pastures were found to be higher. They also reported that the CLA content of milk, butter and meat were as 72.6, 76.5, 83.5 and 72.0 (% of total isomers) respectively; CLA content of buffalo, goat and sheep milk fat were determined as 0.84, 0.58-1.1, 1.2-3.0 respectively.

Tudisco et al. [15] noted that organic system affected CLA (cis-9, trans-11) highly. Some researchers reported that organic system affected CLA concentration of the milk in buffaloes and goats while some of them alleged that organic and conventional system did not affect the CLA content.

The content of CLA in organic buffalo milk and mozzarella cheese was found to be substantially higher than the content of CLA in conventional milk and dairy products (in organic milk and mozzarella cheese, 7.3 and 9.0 mg/g fat

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respectively; in the milk and mozzarella cheese obtained with the conventional system 5.5 and 6.2 mg/g fat respectively) [16].

Ceballos et al. [17] reported that the total amount of CLA in goat's milk is 62% and this value is higher than cow's milk.

Ahmad et al. [18] noted that Buffalo milk contains higher levels of CLA than the cow's milk does.

Önür [19] described that the mono and polyunsaturated fatty acids and the omega 3 and omega 6 fatty acids in the sheep milk are more in quantity than in goat's milk.

Jahreis et al. [20] detected the total CLA average in sheep, cow and goat milk fat as 1.08%, 1.01% and 0.65% respectively.

In their study Tyagi et al. [21] reported that according to their feeding groups, the average total of CLA (mg/g fat) contents of buffalo milk, Indian cheese (paneer), pure fat (ghee) and cheese that were obtained with 3 different feeding methods were found to be as; 7.7, 13.4, 17.0 in milk, 9.1, 13.4, 18.3 in paneer, ghee 8.2, 12.7, 18.8 and 8.0 12.0, 16.3 in cheese.

Talpur et al. [22] determined the average CLA (cis-9, trans-11 C18: 2) content of milk in the sheep, cows, goats and buffalo as, 0.60, 0.59, 0.43, 0.39 respectively. It was also detected that the CLA (cis9, trans11 C18: 2) content of buffalo milk by season was 0.32 in winter, 0.55 in summer, 0.35 in spring, 0.32 in autumn and the average was found to be 0.39.

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Table 1: Factors affecting CLA content in milk

Factors	Effect on CLA	Relevant reference
Fresh/lush green pasture	Highly positive	[2]
Pasture + full fat extruded soybean	No effect	[2]
Pasture + soy oil	No effect	[2]
Pasture + fish oil	Positive	[2]
Maturity of pasture	Negative	[2]
Diversity in plant species	Positive	[2]
Elevation of pasture	Highland>mountain>lowland	[2]
Fresh cut pasture	Fresh>conserved	[2]
High forage diet	Positive	[2]
High grain diet	Negative	[2]
Raw oil seeds	Minimal	[2]
Roasted oil seeds/meals	Positive	[2]
Extruded oilseeds	Positive, better than roasted oil seeds	[2]
Plant oils	Positive, better than processed seeds	[2]
Fish meal	Positive	[23]
Fish oil	Positive, efficient than plant oils	[2]
Hydrogenated palm oil (HPO)	Positive	[24]
Sunflower oil	Positive, better than HPO	[24]
Canola oil	Positive	[25]
Ca salts of fatty acids	Positive	[2]
Corn oil	Positive	[23]
Trans fats	Positive	[2]
CLA supplementation	Positive	[2]
Species	Ruminants>non-ruminants	[2]
Species	Koyun> inek>keçi	[20]
	Koyun>manda>keçi	[2]
	Koyun>keçi	[3]
		[26]
		[27]
Breed	Holstein>Jersey	[2]
Stage of lactation	Minimal	[2]
Seasons (sheep, goat, buffalo, cow milk)	Summer>spring>autumn>winter	[22]
Products	Cheese>butter>milk>meat	[2]

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III. CONCLUSIONS AND RECOMMENDATIONS

Kurban and Mehmetoğlu [1] reported that the CLA amount in milk can be increased depending on the differences in delta-9 desaturase activity in the breast tissue of cattles and stated that by the genetic selection program CLA producing animals in the optimum capacity can be achieved. From this point forth, the demand for the people's milk and dairy products can be revived and the diversity of dairy products can be increased by placing CLA content-enriched milk and dairy products on the market so that the market share of the product such as buffalo and goat products, which yet unable to obtain increased market place, may find a better place and have an increase in terms of market share.

Despite the fact there is some research on CLA content of milk and dairy products in various countries, only a few reports (compilations) on the CLA content exist in our country. These studies are limited to factors such as feeding, breed, species, lactation period and their effect on CLA and milk.

In order for the revival of especially buffalo farming, which has fallen behind, and the sustainability of goat farming, which has skyrocketed in the past a few years, the special products obtained from the milk of these mentioned animals should be brought into the forefront and should be supported. Buffalo, sheep and goat milks are not easily accessible by the consumer just like cow's milk. These branches of production may achieve the place in market as they deserve by ensuring the product diversity and availability.

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