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Biologically active and trans fatty acids in cow's milk and Bulgarian kashkaval

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Abstract

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Cow's milk and dairy products are the primary sources of CLA. Essential fatty acids from groups of ω-3 and ω-6 are a vital component of nutrition for humans and animals.

This study aims to identify biologically active and anticancer components in cow's milk and changes in the production of Bulgarian kaskaval.

Saturated fatty acids are increased in the produced Bulgarian kashkaval compared to the original milk reliable during the period considered ($P < 0.01$). Saturated fatty acids in Bulgarian kashkaval production increased due to oxidation processes of technological nature at the expense of polyunsaturated fatty acids.

Trans vaccenic acid in milk during the considered period accumulates ($P < 0.001$) and reaches its maximum value on May – 2.64 g/100g of fat, and the examined kashkavals were characterized by the same change curve, but with high reliability of the results between batches April/ May and April/June – $P < 0.001$.

The CLA content in cow's milk varies and, at the end of the period, decreases during the lactation, similarly establishing variation in Bulgarian kashkaval, but due to the process of evaporating, it decreased between 2 and 5 times from Bulgarian kashkaval to cow's milk.

Essential fatty acids also reduce the impact of technological processing. The ratio between the two groups of biologically active fatty acids in milk varies from 2.60 to 3.47 and decreases from 3.25 to 2.40 in manufactured Bulgarian kashkaval.

Keywords: cow's milk; Bulgarian kashkaval; CLA, omega-3; omega-6
Abbreviations: FA – fatty acids; SFA – saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – polyunsaturated fatty acids; TFA – trans fatty acids; CLA – conjugated linoleic acid; ω-3 – omega-3 fatty acids; ω-6 – omega-6 fatty acids; C18:1trans11 (VA) – vaccenic acid; FAME – fatty acids methyl esters

Introduction

Milk is a whole and easily digestible food product containing water, protein, milk sugar, mineral salts, enzymes, vitamins, hormones, immune systems etc. The concentration of CLA in cow's milk is increased by dietary modification, particularly the use of polyunsaturated fatty acid supplementation (Castillo et al., 2013; Patoo et al., 2014). The reason for the increase in the amount of conjugated linoleic acid in grazing ruminants has yet to be well studied. However, pastures are thought to contain a high level of PUFA (polyunsaturated fatty acids), a source of CLA and vaccenic acid. Therefore, the supplementing dairy cows with concentrates during pasture farming determines the quality and quantity of milk. Feeding pasture to the exclusion of a total mixed ration (concentrate mixture) results in an increase in the level of CLA in milk fat (Kuczaj et al., 2004; Kuczaj et al., 2006; Castillo et al., 2013; McGrath et al., 2016; Silva-del-Río et al., 2017; Wasowska & Puppel, 2018). The content of biologically active components in dairy products depends on their presence in raw milk and the technological production process. Cow's milk obtained by feeding animals with corn silage over 60% of the ratio produces a low content of trans-vaccenic acid from 1.1 to 2.2% and of CLA from 0.4 to 0.6%. Switching cows from winter manure feeding to grass mixture consumption increased CLA concentration from 0.5 to 1.7%.

CLA content increases with free grazing and using various vegetable oil supplements (Nudda et al., 2014; Jarzynowska & Peter, 2017). Milk from cows fed fresh forage, particularly rich in multiple pastures or forage legumes, has a higher ratio of unsaturated to saturated fatty acids and a high content of the nutritionally essential trans fatty acids (CLA and vaccines acid) compared to cows fed with silage or hay.

Dairy fat from cows fed grass or legume silage has a more favourable nutritional composition than cows fed corn silage. A disadvantage of the first dairy fat is easier oxidation. The design of dairy fats results from complex interactions of different types of forage, animal, and environmental factors, with the kind of forage being only one of the elements influencing the quality of milk fat (Kalač & Samkova, 2010; Wangdi et al., 2016).

Essential fatty acids from groups ω-3 and ω-6 are a vitally important component of human and animal nutrition. However, a significant imbalance between the two groups of fatty acids was found, where the level of ω-3 acids was deficient. Linoleic and linolenic acids are essential for humans but are not synthesized in the body (essential fatty acids).

A balanced intake of ω-6 and ω-3 fatty acids can only be achieved by prior selection of foods and control over the composition of the incoming essential fatty acids in the body (Larsson et al., 2004; Pajor et al., 2012; Mierliță et al., 2017). The main functions of ω-3 and ω-6 fatty acids are related to the accumulation of energy in the cell, maintenance of body temperature, protection of the skin from drying out, reproduction of certain hormones necessary for cells, cellular biochemistry and for energy metabolism, support the cardiovascular and immune systems (Conor, 2000; Buckley et al., 2005).

The intake of food products with a high content of saturated fatty acids leads to cardiovascular diseases, the main cause of mortality in Europe. Therefore, unsaturated fatty acids and the nutritional balance between omega-3 fatty acids with the primary representative α-linolenic acid and omega-6 fatty acids with the primary representative linoleic acid (C18:2) are of interest to science. A high ratio between the two groups of fatty acids is a prerequisite for coronary heart disease and the formation of blood clots leading to a heart attack, so it is recommended that the ratio does not exceed four units (Wang et al., 2012; de Camargo Talon et al., 2015; Martínez-Fernández et al., 2015).

The present study aims to determine the biologically active and anticarcinogenic components in cow's milk and the changes in Bulgarian kashkaval production.

Material and Methods

Collected cow's milk and the Bulgarian kashkaval obtained from it were examined for the fatty acid composition of the milk fat during the April-June period. The technological milk was obtained from cows of the Bulgarian Rhodope cattle breed in Research Centre of Stockbreeding and Agriculture*, 4700 Smolyan.* Bulgarian kashkaval was produced according to BSS (Bulgarian State Standard) 14:2010. Total lipids were extracted by the Roese-Gottlieb method, using diethyl and petroleum ether and subsequent methylation using sodium methylate (CH_3ONa, Mersk, Darmstadt) and drying with $NaHSO_4.H_2O$. Fatty acid methyl esters /FAME/ were analysed using a gas chromatograph Shimadzu-2010 (Kioto, Japan) equipped with a flame-ionization detector and an automatic injection system (AOC-2010i). Analysis was performed on a CP 7420 capillary column (100 m × 0.25 mm i.d., 0.2 μm film, Varian Inc., Palo Alto, CA). Hydrogen was used as carrier gas and nitrogen as make-up gas. A four-step furnace mode was programmed – starting column temperature – 80°C/min, which was maintained for 15 min, then increased by 12°C/min to 170°C and maintained for 20 min, followed by a further increase of 4°C/min to 186°C for 19 min and up to 220°C at 4°C/min until the process is complete.

The data were processed according to the methods of variation statistics using the statistical package of the computer program EXCEL 2016. The Student's t- test established the reliability of the differences between the studied groups.

Results and Discussion

The analysed cow's milk during the studied period from April to June is characterized by a slight decrease in the content of saturated fatty acids from 68.65 to 67.84 g/100 g fat. Monounsaturated fatty acids are relatively stable – from 22.52 to 26.73, while polyunsaturated fatty acids fluctuate with a tendency to increase on May to 6.01 g/100 g fat and decrease again on June to 5.53 g/100 g fat. In the produced Bulgarian kashkavals, the saturated fatty acids increased compared to the source milk, and the reliability of the increase was established in the first period (April $P < 0.01$) in the individual batches of Bulgarian kashkavals on the months by April to May and April to June ($P < 0.01$) (Figure 1).

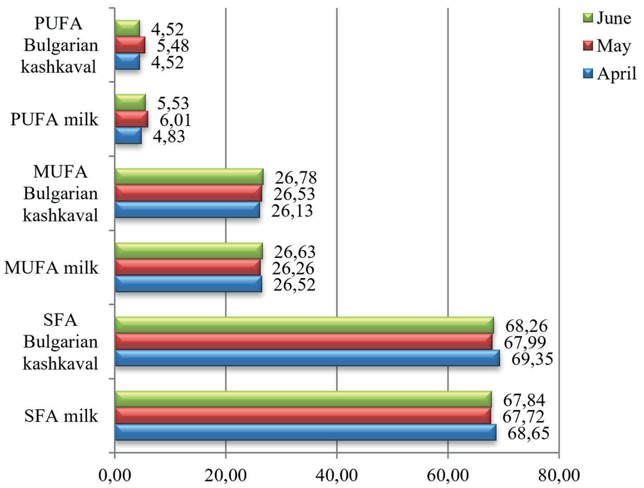

Fig. 1. Groups of fatty acids in cow's milk and Bulgarian kashkaval, g/100 g fat

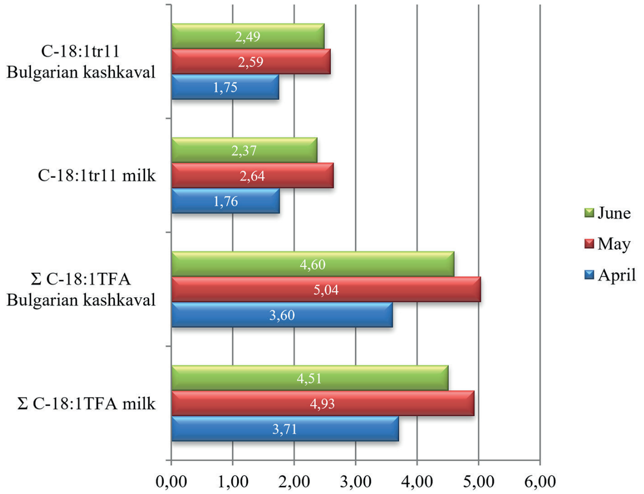

Fig. 2. Trans fatty acids in cow's milk and Bulgarian kashkaval, g/100 g fat

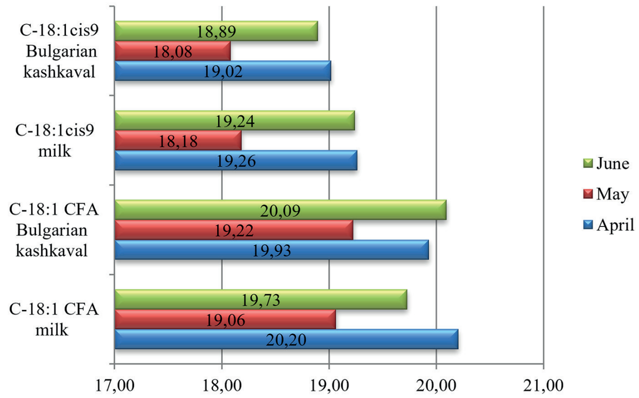

Fig. 3. Cis fatty acids in cow's milk and Bulgarian kashkaval, g/100 g fat

Trans fatty acids in cow's milk have the lowest concentration on April to May. The results were similar for Bulgarian kashkaval produced from collected cow's milk. Statistically significant changes in trans fatty acids on April/May- $P < 0.01$ for milk and on April/May- $P < 0.001$, April/June- $P < 0.001$, and May/June- $P < 0.05$ for Bulgarian kashkaval. Of the trans fatty acids, the most important from a biological point of view is trans vaccenic acid, which during the considered period accumulates ($P < 0.001$) and reaches its maximum value on May – 2.64 g/100 g fat (Figure 2). The examined kashkavals were characterized by the same change curve, but with high reliability of the results between the batches on April/May and April/June – $P < 0.001$.

The cis isomers of oleic acid in cow's milk were at their highest concentration on April, decrease on May, when the animal's diet changes from indoor to pasture, and increase again on June. The production of kashkaval slightly reduced their quantity. Oleic acid (18:1cis9) was synthesized in cow's milk in the lowest amounts on May – 18.18 g/100 g fat and is preserved after technological processing until kashkaval – 18.08 g/100 g fat (Figure 3).

The total content of conjugated linoleic acid in the analysed cow's milk was the lowest in April – 1.39 g/100 g fat, caused by the type of feeding and increased on May and June. The changes in individual months were statistically reliable as follows: April/May- $P < 0.01$ and May/June- $P < 0.05$. In Bulgarian kashkavals, the total content of CLA decreases analogously following lactation, and significant differences were found in the results obtained on April/May- $P < 0.01$, April/June- $P < 0.05$, and May/June- $P < 0.001$. Changes in the technological processing of cow's milk into kashkaval lead to a loss of the total content of CLA in the final product, caused by evaporation processes that cause the destruction of unsaturated fatty acids and their conversion into saturated ones. Conjugated linoleic acid in milk ranges from 1.19 to 1.63 g/100 g fat. The changes in the course of lactation were reliable between April and May – $P < 0.01$, while in the Bulgarian kashkaval, it was found in April/June

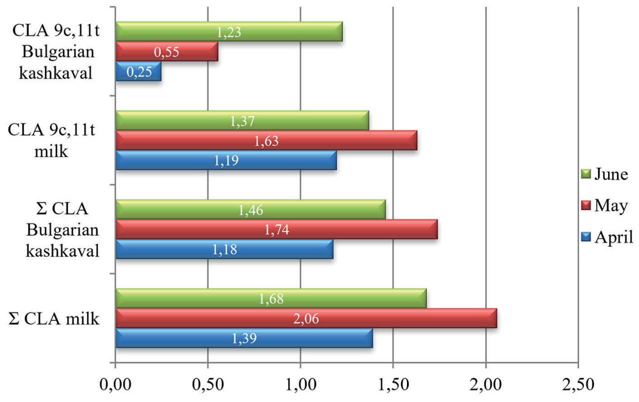

Fig. 4. CLA content in cow's milk and Bulgarian kashkaval, g/100 g fat

– P < 0.01 and May/June – P < 0.001. Kashkaval production results in significant losses of CLA concentration from 2 to 5 times. High statistical reliability was established due to the manufacturing process – P < 0.001 (Figure 4).

The amount of omega-3 fatty acids in cow's milk is the highest on May – 1.24 g/100 g fat, and in the production of kashkaval, they decrease statistically unreliable in batches from April and June and with confidence P < 0.01 on May. Omega-6 fatty acids in milk have the highest concentration on May, and the trend is also maintained in Bulgarian kashkavals but with significantly lower amounts in them compared to milk (Figure 5).

The ratio between the two groups of biologically active fatty acids in milk varies from 2.60 to 3.47 and decreases from 3.25 to 2.40 in manufactured Bulgarian kashkaval.

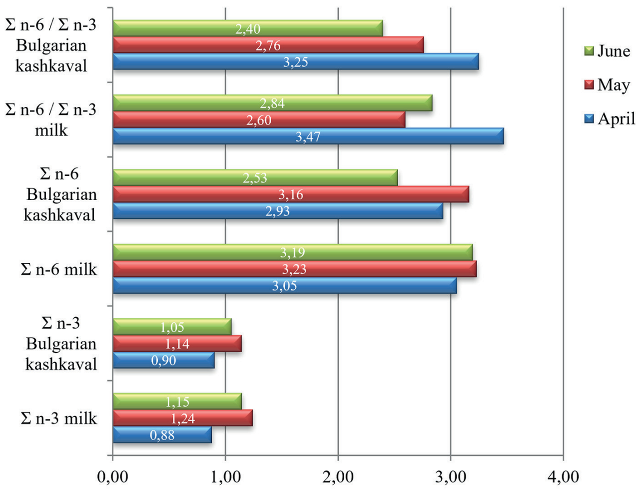

Fig. 5. Content of biologically active fatty acids in cow's milk and Bulgarian kashkaval, g/100 g fat

Conclusion

Saturated fatty acids are increased in the produced Bulgarian kashkaval compared to the original milk reliable during the period considered (P < 0.01).

The conducted research gives us reason to conclude that saturated fatty acids in the production of Bulgarian kashkaval increase, due to oxidation processes of technological factors, at the expense of polyunsaturated fatty acids.

Trans vaccenic acid in milk during the considered period accumulates (P < 0.001) and reaches its maximum value on May – 2.64 g/100 g of fat, and the examined kashkavals were characterized by the same change curve, but with high reliability of the results between batches April/ May and April/ June – P < 0.001.

The content of CLA in cow's milk varies, and at the end of the studied period, it decreases during lactation. Similarly, the alteration was found in Bulgarian kashkavals, but due to the evaporation process decrease between 2 and 5-fold compared to cow's milk.

Essential fatty acids also decrease as a result of technological processing. The ratio between the two groups of biologically active fatty acids in milk varies from 2.60 to 3.47 and decreases from 3.25 to 2.40 in manufactured Bulgarian kashkaval.

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