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FATTY ACID PROFILE OF SOUR DAIRY PRODUCTS PRODUCED BY DIFFERENT STARTER CULTURES

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ABSTRACT

In this research we have investigated the effect of various cultures *(Lactobacillus lactis* subsp. *lactis, Lactobacillus lactis* subsp. *cremoris, Streptococcus salivarius* subsp. *thermophilus, Lactobacillus delbrueckii* subsp. *bulgaricus, Lactobacillus lactis* subsp. *lactis biovar, Lactobacillus diacetilactis, Lactobacillus acidophilus, Bifidobacterium lactis)* on fatty acid composition of soured dairy products (Sana, yoghurt) manufactured using different technologies, with special regard to conjugated linoleic acid (CLA). It was established that the cultures we used and which are also commonly used in the dairy industry, had only a minor effect on fatty acid composition of milk. Although minimal differences were found in case of the individual fatty acids, however, due to the small differences it can be established, that the cultures have no influence on nutritional value of milk fat.

Key words: sour dairy products / composition / fatty acids / starter cultures

1 INTRODUCTION

Milk fat of ruminants contains significant amount of short-chain fatty acids. Their presence in triacylglycerols can be advantageous for the human organism because triacylglycerols containing short-chain fatty acids can be more easily attacked by digestive enzymes. Milk fat contains relatively small amount of unsaturated fatty acids, despite this fact its essential fatty acids content satisfies the requirements of the human organism and due to its animal origin it contains also arachidonic acid (Csapó and Csapóné, 2002). Milk fat can contain also conjugated linoleic acids (CLA) in considerable quantity, which have according to the latest researches many useful physiological effects. Among others their antioxidant effect, that is they prevent the membranes from the attacks of free-radicals, was proven, consequently they can have significant role in the anti-cancer fight (Ha *et al*., 1987; Lee *et al*., 1994).

Composition of dairy products manufactured by adding probiotic bacteria is usually very similar to that of raw milk, since the cultures produce rather aroma materials and they affect fatty acid composition only to a smaller extent. In some cases the CLA content of dairy products increased when linoleic acid was added to the milk (Lin, 2006)

It was also established that CLA contents of dairy products manufactured by fermentation could vary, as certain cultures were capable of producing CLA from linoleic acid during the souring (Sieber *et al*., 2004). They also reported that CLA content of cheeses can increase during maturation, others, however, did not establish such relationship (Lin, 2006). Most of the authors agree that CLA contents of dairy products depend mainly on CLA contents of the milk used for the production; however technological processes can also exert significant effect on CLA content of the product (Salamon *et al*., 2005 a, b). In some cases individual starter cultures were reported to enhance the CLA content of the fermented product, while other could not exert such an effect. The mechanism of the CLA production has not been exactly elucidated and the examination of the different strains

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proceeds. The aim of this research was to determine the effect of eight different starter cultures on the fatty acid pattern of the fermented product, with special regards to CLA. With the application of different starter cultures, two sorts of dairy product (Sana and yoghurt) were manufactured from cow's milk.

2 MATERIALS AND METHODS

2.1 USED BACTERIA AND THE PRODUCTION OF SOURED DAIRY PRODUCTS

Lactic acid producing *Lactobacillus lactis* subsp. *lactis, Lactobacillus lactis* subsp. *cremoris, Lactobacillus diacetilactis* and *Lactobacillus acidophilus* are often used for the production of dairy products manufactured by fermentation, while *Lactobacillus lactis* subsp. *lactis* biovar *dyacetilactis, Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* are used for the production of yoghurt. In the experiments the optimal temperature and duration of the individual species and mixtures were applied where the reproduction was the most intensive.

For the production of soured dairy products a milk supplied to a dairy company in Székelyland was used which was pasteurized at 78 °C for 50 sec. The pure cultures were added to the samples, and then the samples were incubated at temperature that is optimal for the applied bacterium species. The used bacteria and the incubation conditions are shown in Table 1. After the incubation the pH was measured and the samples were deep-freezed.

2.2 CHEMICAL EXAMINATIONS

2.2.1 DETERMINATION OF FATTY ACID COMPOSITION

Sample preparation: A sample quantity containing approx. 0.5–1.0 g fat was mixed with 8–20 cm^3 of hydrochloric acid (37%) and boiled for an hour in a water bath. After having cooled down, 7 cm^3 of ethanol was added. Lipids were extracted with 15 cm^3 diethyl ether and 15 cm^3 petrol ether (b.p.<60 °C), and the organic layers were combined. From a portion of this solution, containing approx. 150–200 mg fat, the solvents were removed at 80 °C under reduced pressure (a complete evaporation not necessary).

Transesterification: To the residue 4 cm^3 of 0.5 M sodium hydroxide methanol solution was added and boiled until all the fat drops disappeared (approx. 5 min), then 4 cm^3 of 14% boron trifluoride methanol solution was added, boiled for 3 min, finally 4 cm^3 of hexane, dried on water-free sodium sulphate was added, boiled for 1 min, and the mixture was allowed to cool down. Saturated aqueous sodium chloride solution was added

Table 1: *The used bacteria and the conditions of the incubation*

No.	Used bacteria	Temperature of the incubation (°C)	Time of the incubation (hour)	pH
1.	Lactobacillus lactis subsp. lactis, Lactobacillus lactis subsp. cremoris	27	7	4.36
2.	Lactobacillus lactis subsp. lactis, Lactobacillus lactis subsp. cremoris	27	8	4.43
3.	Lactobacillus lactis subsp. lactis, Lactobacillus lactis subsp. cremoris, Lactobacillus delbrueckii subsp. bulgaricus, Streptococcus salivarius subsp. thermophilus	27	7	4.90
4.	Lactobacillus lactis subsp. lactis, Lactobacillus lactis subsp. cremoris, Lactobacillus lactis subsp. lactis biovar	28	8	4.56
5.	Lactobacillus lactis subsp. lactis, Lactobacillus lactis subsp. cremoris	28	14	4.56
6.	Lactobacillus delbrueckii subsp. bulgaricus, Streptococcus salivarius subsp. thermophilus	46	6	4.21
7.	Lactobacillus delbrueckii subsp. bulgaricus, Streptococcus salivarius subsp. Thermophilus, Bifidobacterium lactis	46	6	4.30
8.	Bifidobacterium lactis, Streptococcus salivarius subsp. thermophilus	46	6	4.22

Table 2: *The C6-C16 fatty acid content of milk and dairy products*

	Fatty acid *					
Sample	Caproic acid	Caprylic acid	Capric acid	Lauric acid	Myristic acid	Palmitic acid
No. 1.	1.10	0.85	1.93	2.29	9.35	27.31
No. 2.	1.60	1.30	2.90	3.26	11.33	26.66
No. 3.	1.21	0.91	2.08	2.50	9.81	27.53
No. 4.	1.22	0.96	2.18	2.63	10.21	27.85
No. 5.	**1.30**	**1.00**	**2.26**	**2.66**	**10.63**	**29.13**
No. 6.	1.55	1.18	2.68	3.03	10.91	27.97
No. 7.	1.27	0.96	2.14	2.50	9.60	28.00
No. 8.	1.11	0.90	2.05	2.43	9.53	27.11
Pasteurized milk	1.40	1.10	2.46	2.90	10.88	27.73
Raw milk	1.14	0.92	2.13	2.56	10.07	27.70

* In relative weight% of fatty acid methyl esters. The numbers in the table show the cultures summarized in Table 1.

and after having separated the organic layer was collected into a 4 cm^3 vial containing water-free sodium sulphate and was directly examined by gas chromatography.

2.3 CONDITIONS OF THE GAS CHROMATOGRAPHIC ANALYSIS

Instrument: Chrompack CP 9000 gas chromatograph. Column: CS-Sil 88 (FAME), 100 m × 0.25 mm. Detector: FID 270 °C. Injector: splitter, 270 °C. Carrier gas: He, 235 kPa. Temperature program: 140 °C for 10 min; at 10 °C/min up to 235 °C; isotherm for 26 min. Injected volume: 0.5–2 µl.

3 RESULTS AND DISCUSSION

The ratio of C6-C16 fatty acids in the fat of soured dairy products produced by different cultures is shown in Table 2. while the ratio of C18 fatty acids is shown in Table 3. The fatty acid composition of pasteurized and raw milk was practically identical within the limit of error of the measurement that is, heat treatment did not exert a significant effect on the fatty acid composition. The fatty acid pattern of pasteurized and fermented milk was also very similar for most of the cultures used. The nutritional value of different soured dairy products regarding fatty acid composition seemed to be practically the same.

Individually evaluating the fatty acids, it can be established that in the range of C6:0 and C14:0 the results practically coincide. For palmitic acid the highest value

Table 3: *The C18 fatty acid contents of milk and dairy products*

	Fatty acid *				
Sample	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Conjugated linoleic acid
No. 1.	12.85	25.64	2.13	1.67	0.49
No. 2.	10.93	25.93	2.32	1.46	0.51
No. 3.	12.48	23.59	2.10	1.62	0.49
No. 4.	11.97	24.45	2.10	1.61	0.50
No. 5.	10.67	28.58	2.76	1.32	0.47
No. 6.	11.15	25.75	2.20	1.45	0.46
No. 7.	12.32	24.50	2.01	1.61	0.48
No. 8.	13.17	24.13	2.13	1.60	0.51
Pasteurized milk	11.50	24.30	1.95	1.55	0.46
Raw milk	12.50	25.02	2.06	1.67	0.48

* In relative weight% of fatty acid methyl esters. The numbers in the table show the cultures summarized in Table 1.

was found in the case of the aroma and carbon dioxide producing culture containing *Lactobacillus lactis* subsp. *lactis* and *Lactobacillus lactis* subsp. *cremoris* (No. 5), whereas in each other cases the results were almost identical. The highest value for stearic acid was measured when culture No. 8. (*Bifidobacterium lactis, Streptococcus salivarius* subsp. *thermophilus*) was applied. The lowest concentration was found for culture No. 2 (*Lactobacillus lactis* subsp. *lactis*, *Lactobacillus lactis* subsp. *cremoris,* 8 hours of incubation) and 5. (*Lactobacillus lactis* subsp. *lactis*, *Lactobacillus lactis* subsp. *cremoris*).

The oleic acid content varied from 24.1 to 28.6% with the highest value of culture No. 5. (*Lactobacillus lactis* subsp. *lactis*, *Lactobacillus lactis* subsp. *cremoris*). Product produced with this culture also gave the highest ratio of linoleic acid. In the case of linolenic acid the values of fermented products are in the same range as that of the control.

Conjugated linoleic acid content of raw milk was measured to be 0.48%, and this value changed considerably neither due to pasteurization nor fermentation. That is, the examined cultures did not increase the amount of CLA, although they did not reduce the initial CLA concentration of raw milk.

In summary, it can be said that due to the cultures we used and which are also commonly used in the dairy industry, original fatty acid composition of milk barely changed. Minimal discrepancies could be found for the individual fatty acids between the cultures, but these differences are so slight that it cannot be supposed that they could be supported also statistically by examinations carried out in higher numbers.

4 CONCLUSIONS

The starter cultures commonly used in the production of dairy products in Székelyland did not exert an important effect on the fatty acid composition of the products. During fermentation the change in the ratio of the fatty acids was minimal. Although we were not able to find stains that are capable for the formation of CLA, it can also be postulated that the initial CLA content of raw milk was preserved during the production of these sour dairy products. Besides fermentation heat treatment neither induced considerable changes in the fatty acid composition, as the time and temperature conditions were too mild for the extensive autooxidation of unsaturated fatty acids.

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