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Fatty Acid Profile and Lipid Preventive Score of Fat in Milk of Tsigay and Karakachan Sheep Reared in the Rhodopes Mountain

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Abstract

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The study was performed on individual sheep milk samples, obtained from 2 groups of sheep with 5 animals in each, reared in the Rhodopes mountain: Group I - Tsigay sheep and Group II - Karakachan sheep. The milk was analysed during the April-July period when sheep grazed on pastures. Four milk controls were performed at one month interval, according to the Instruction of milk productivity control.

The extraction of milk fat was performed by the method of Rose-Gottlieb, the solvents were evaporated on a vacuum-rotary evaporator and obtained fat was frozen at -18°C until analyzed. The methyl esters of fatty acids were analyzed on a Pay Unicam 304 gas chromatograph with flame ionization detector, capillary column EC™ WAX (30 m x 0.25 mm, I. d.; 0.25 μm film) and hydrogen as a carrier gas. The groups of fatty acids, the fatty acid ratios and the lipid preventive score were calculated.

It was found out that the Tsigay sheep milk had a higher content of capric acid than Karakachan sheep milk (10.31% and 7.49%, respectively). The sum of caproic, caprylic and capric acids was higher in sheep milk from group I - 18.01 % vs 16.73% in group II. The least variable fatty acid ratios were C18:0/C16:0, C18:1/C16:0, C12:0/C10:0, C18:3/C18:2 and C4:0/C6+8. The polyunsaturated fatty acids content was similar in both groups (4.96% 5.00%). Although the difference was insignificant, the milk of Tsigay sheep had closer values between the lipid preventive score and fat content.

Key words: sheep milk, milk fat, fatty acid, lipid preventive score

Introduction

Since ancient times, sheep breeding has been an important branch of agriculture, underlying in the overall image and means of subsistence of people from mountainous and premountainous regions. During their historical development, the local breeds and strains of sheep were habituated to particular natural and climatic en-

vironments. In the Rhodopes mountain region, sheep from the Karakachan and Tsigay breeds appeared and were widely spread. The call for sheep milk and dairy products (various types of cheese and yoghurt) imply both quantitative and qualitative investigation of milk fat components.

Numerous data evidence that the high intake of saturated fatty acids increases the risk of cardiovascular diseases. On the contrary, monounsaturated and polyunsaturated fatty acids have a protective effect against this type of risk (Judd et al., 1998; Lichtenstein et al., 1999). Therefore, the amount of essential and most important groups of fatty acids could be used as a criterion for fat quality. Richard and Charbonnier (1994) proposed an equation that could be used for evaluation of the possible preventive effect of fats in foodstuffs via the so-called lipid preventive score (lipid index) that provides information for the degree of prevention of cardiovascular risk of a given fat.

Milk fat content is especially important for consumers' health. The studies from the past years contributed considerably to the scientific knowledge related to the importance of fats in nutrition (Lomascolo et al., 1994; Templeman and Tivey, 1997; Najera et al., 1999; Wojtowski et al., 2001).

In Bulgaria, several publications report on the fatty acid composition of sheep milk (Chomakov, 1975; Dimitrov et al., 1995; Dimov et al., 1997; Mihaylova and Djorbineva, 1997; Dimitrov et al., 2001; Mihaylova et al., 2004; Mihailova et al., 2005). The first results for the total content of conjugated linoleic acid (CLA) in sheep milk and sheep dairy products from the Rhodopes Mountain (Mihaylova, 2003; Mihaylova et al., 2003) and Sredna Stara Planina regions (Mihaylova et al., 2004a; Mihaylova et al., 2004b) are communicated.

The aim of the study was to establish the fatty acid profile of milk fat obtained from Tsigay and Karakachan sheep reared in the Rhodopes Mountain region with regard to evaluation of milk fat via the lipid preventive score.

Material and Methods

The study was performed on individual raw milk samples obtained from two sheep breeds reared under equal conditions in the Complex Experimental Station - Smolyan: Group I - Tsigay breed and Group II - Karakachan breed. The milk samples were obtained in April-June (spring-summer period) when sheep were grazing on pastures. Four control examinations were done at one month interval, according to the Instruction of milk productivity control. Milk samples were obtained monthly from 5 sheep of group (with average milk productivity) during the control examinations, proportionally to morning and evening milk yield.

The extraction of milk fat was performed by the method of Rose-Gottlieb. Afterwards the solvents were evaporated on a vacuum-rotary evaporator and obtained fat was frozen at -18°C until analyzed. The methyl esters of fatty acids were analyzed on a Pay Unicam 304 gas chromatograph with flame ionization detector, capillary column EC™ WAX (30 m x 0.25 mm, I. d.; 0.25 μm film) and H_2 as a carrier gas. The fatty acids groups and the fatty acid ratios were determined by calculation and the lipid preventive score by the equation of Richard and Charbonnier (1994).

The data were statistically processed Statistica for Windows (Release 4.3, Stat. Soft., Inc., 1994).

Results and Discussion

The content of saturated fatty acids in Karakachan and Tsigay sheep milk is presented in Table 1. The milk of Karakachan sheep had a slightly higher caproic and caprylic acid contents than the milk of Tsigay sheep. The differences for caproic acid were statistically significant ($P<0.01$). Capric acid concentration was by 27% higher in Tsigay milk ($P<0.001$), and consequently, the sum of caproic, caprylic and capric acids was higher in milk from group I - 18.01% vs 16.73% in group II.

Our data about caproic acid content (C6:0) in milk from group I were similar to the data reported by Mihaylova et al. (2004) in Stara Zagora sheep (4.00%), but considerably higher than the values obtained by Dimitrov et al. (2001) for South Corriedale sheep milk (2.10%).

The caprylic acid concentration (C8:0) in this study was slightly higher than the respective data reported by Mihaylova et al. (2004b) in the same sheep breeds, but reared in the Sredna Stara Planina region. Also, the values obtained in sheep milk from group II were similar to those in the milk of Stara Zagora sheep - 4.01% (Mihaylova et al., 2004).

The content of capric acid (C10:0) in Tsigay milk were similar to the data of Dimov et al. (1997) in the milk of Black Maritsa sheep (10.19%), but significantly higher than those in Stara Planina Tsigay sheep 5.90% (Mihaylova et al., 2004b).

The lauric (C12:0) and myristic (C14:0) acids contents were lower than the values communicated by other authors for sheep milk Dimov et al. (1997), Kafedjiev and Mihaylova (1998), Mihaylova et al. (2004), etc. The differences between studied groups were statistically significant only for lauric acid concentrations ($P<0.05$).

Table 1
Saturated fatty acids, g/100 g fat (mean±SD) (n=20)

Fatty acids	Group I	Group II
C 4:0	5.90 ± 0.681	5.81 ± 0.522
C 6:0	4.11 ± 0.847	5.26 ± 1.051
C 7:0	0.24 ± 0.125	0.28 ± 0.108
C 8:0	3.59 ± 0.710	3.98 ± 1.006
C 9:0	0.32 ± 0.228	0.42 ± 0.221
C 10:0	10.31 ± 1.568	7.49 ± 1.087
C 11:0	0.16 ± 0.104	0.19 ± 0.131
C 12:0	3.48 ± 0.941	4.14 ± 0.906
C 13:0	0.15 ± 0.063	0.20 ± 0.069
C 14:0	8.20 ± 0.889	7.47 ± 2.088
C 15:0	0.76 ± 0.365	0.65 ± 0.407
C 16:0	22.50 ± 2.017	23.64 ± 1.972
C 17:0	0.79 ± 0.193	1.38 ± 0.524
C 18:0	8.73 ± 0.765	9.07 ± 0.769

In sheep milk from group II there were more palmitic acid (C16:0) but the differences were statistically insignificant ($P>0.05$).

The difference in stearic acid (C18:0) levels in milk fat between both groups was small and insignificant ($P>0.05$). It is known that stearic acid concentration determines at a certain extent fat solidity and its melting temperature. Our values were similar to those of Mihaylova and Djorbineva (1997) in the milk of crosses of Local Stara Zagora sheep with either the East Friesian breed (8.91%) or the

Pleven Blackhead breed (8.73%), but lower than the respective values in the milk of Stara Planina Tsigay (11.25%) and Karakachan sheep (10.42%), reared in the Stara Planina region (Mihaylova et al., 2004b).

The unsaturated fatty acids content (both mono- and poly-) in sheep milk is given in Table 2. It could be noticed that amounts of caproleic acid (C10:1) were present only in the milk from group I. The myristoleic acid level (C14:1) was higher in Tsigay sheep milk whereas that of palmitoleic acid (C16:1) - in group II, the differences between groups being statistically significant for both acids ($P<0.05$). Out of monounsaturated fatty acids, the highest content was that of oleic acid (C18:1).

The essential fatty acids (EFA) linoleic (C18:2) and linolenic (C18:3), were determined at much lower amounts than the oleic acid, the linoleic acid concentrations being higher than linolenic ones. Our data about the linoleic acid levels were considerably higher than the results of Kafedjiev and Mihaylova (1998) in an earlier study of bulked milk from the same sheep breeds - 1.33% in Karakachan and 1.34% in Tsigay sheep milk.

Table 2

Unsaturated fatty acids, g/100 g fat (mean±SD) (n=20)

Fatty acids	Group I	Group II
C 10:1	0.31 ± 0.168	-
C 12:1	0.19 ± 0.084	0.19 ± 0.067
C 12:2	0.14 ± 0.045	0.21 ± 0.124
C 14:1	0.47 ± 0.285	0.28 ± 0.164
C 16:1	0.61 ± 0.147	0.90 ± 0.274
C 16:2	0.16 ± 0.046	0.19 ± 0.114
C 18:1	24.18 ± 2.930	23.70 ± 2.205
C 18:2	3.04 ± 0.310	3.06 ± 0.533
C 18:3	1.66 ± 0.205	1.51 ± 0.185

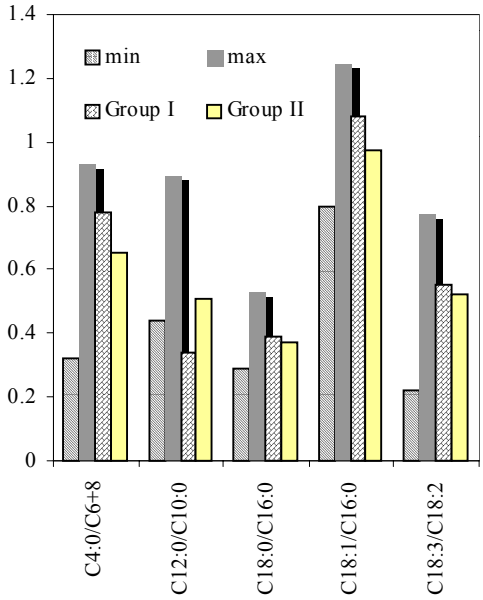


Fig. 1. Ratios between fatty acids

The obtained values for the different fatty acids showed that the most stable ratio in the milk of both studied groups were those of C18:0/C16:0, C18:1/C16:0, C12:0/C10:0, C18:3/C18:2 and C4:0/C6+8 (Figure 1).

The content of the main groups of fatty acids is given in Table 3. The total amount of short-chain fatty acids (from C4 to C10) was slightly higher although insignificantly ($P>0.05$) in Tsigay sheep milk than in Kara-kachan milk.

Our data for short-chain fatty acids content in both breeds showed somewhat higher values than those reported by Dimov et al. (1997) in the milk of Black Maritsa sheep - 20.14%, but considerably higher than the data of Mihaylova et al. (2004b)

Table 3

Groups of fatty acids, g/100 g fat (mean±SD) (n=20)

Fatty acids	Group I	Group II
short-chain	24.78 ± 3.212	23.43 ± 1.678
medium-chain	37.44 ± 2.157	39.25 ± 2.609
long-chain	37.62 ± 2.882	37.33 ± 2.168
SFA	69.24 ± 2.554	69.97 ± 2.119
UFA	30.76 ± 2.554	30.03 ± 2.119
MUFA	25.76 ± 2.737	25.07 ± 2.129
PUFA	5.00 ± 0.437	4.96 ± 0.538
EFA	4.70 ± 0.430	4.56 ± 0.602

in the milk from Tsigay and Karakachan sheep reared in the Stara Planina region - 14.7% and 15.95%, respectively.

The sum of medium-chain fatty acids (from C11 to C17) was appreciably elevated in sheep milk from group II than in group I ($P<0.05$). These data correspond to the results of Dimov et al. (1997) for Black Maritsa sheep milk - 38.29%, but are considerably higher than the data communicated by Mihaylova et al. (2004b) for milk of Stara Planina Tsigay sheep (34.04%) and Karakachan sheep (33.4%), reared in the Sredna Stara Planina region.

The total sum of short- and medium-chain fatty acids in Tsigay sheep was 62%, whereas in the Karakachan sheep - 63%, which was similar to the data of Mihaylova et al. (2005), obtained in milk from milk sheep crosses.

The data for the total amount of long-chain fatty acids (over C18) in studied milk were almost identical in both studied groups and significantly higher than the concentrations determined in an earlier study of Kafedjiev and Mihaylova (1998) in bulked milk of the same breeds, reared in this region.

The total content of saturated fatty acids (SFA) was slightly higher in the milk from group II and that of unsaturated fatty acids (UFA) - in group I, the differences being not statistically significant ($P>0.05$). For monounsaturated fatty acids (MUFA) the sum was higher in Tsigay sheep, whereas for polyunsaturated fatty acids (PUFA) there was no difference.

MUFA, similarly to PUFA, have a pre-

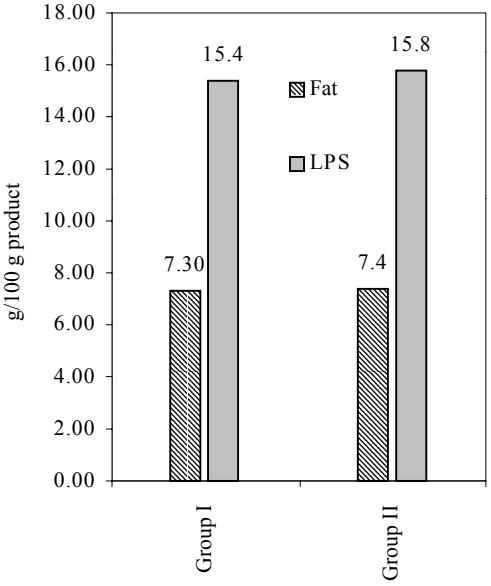


Fig. 2. Lipid preventive score

ventive effect with regard to cardiovascular diseases. They are more resistant to oxidation because of their lower unsaturation whereas the higher level of PUFA is related to easier oxidation of fat due to the high degree of unsaturation. The ratio of SFA/UFA as well as that of SFA/PUFA could be used as coefficients providing information for fat quality and the balance of fatty acid content of a given foodstuff. The high value of the SFA/PUFA ratio (13.85 in group I and 14.11 in group II) as well as the low values of SFA/UFA (2.25 and 2.33 for groups I and II respectively) showed that there was a difference in the unsaturated fatty acids content and the total balance of fatty acid concentrations that was important for both foodstuff quality and its oxidative potential.

On the basis of total fat contents in the milk of Tsigay (Odjakova et al., 2002) and Karakachan (Odjakova et al., 2002a) sheep and the main groups of fatty acids (Table 3), the lipid preventive score (LPS) could be calculated. The optimal balanced fatty acid content is obtained when the values of SFA, MUFA and PUFA are such that the LPS were equal to the total fat content (FC). Although with an insignificant variation, closer values of LPS and FC was determined in Tsigay sheep milk (Figure 2).

The consumption of fats whose LPS and FC values are equal (LPS=FC) or maximally similar, is helpful from the point of view of their preventive effect against the risk of cardiovascular diseases. This is extremely important for evaluation of the nutritive and biological value of foodstuffs.

Conclusions

Tsigay sheep milk had a higher content of capric acid than Karakachan sheep milk (10.31% and 7.49%, respectively). The sum of caproic, caprylic and capric acids was higher in sheep milk from group I - 18.01% vs 16.73% in group II.

Polyunsaturated fatty acids contents were equal in the milk of both studied groups (4.96%-5.00%).

The least variable fatty acid ratios were C18:0/C16:0, C18:1/C16:0, C12:0/C10:0, C18:3/C18:2 and C4:0/C6+8.

Although the difference was insignificant, the milk of Tsigay sheep had closer values between the lipid preventive score and fat content.

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