Scientific Papers. Series D. Animal Science. Vol. LXII, No. 1, 2019
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

RESEARCH ON THE FATTY ACID COMPONENT OF GOAT MILK, OBTAINED IN DIFFERENT BREEDING SYSTEMS

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Abstract

The aim of the research was to evaluate the productive performance of Saanen goats by applying an optimizing modern food rations formula. The experiments were realized between 1.05-2015-2.11.2016 in 2 farms of Constanta County, Romania. Experiments were conducted on two groups of 30 females in full lactation with an average weight of 55 kg, breeding in anintensive system(Group I) and semi-intensive system (Group II). The experiment lasted 130 days; during this period the milk production was recorded and samples were taken monthly for analysis, in particular the concentration of fatty acids and food consumption. Milk samples were processed by gas chromatography.Between the two groups at the same time changes in fatty acids were recorded for significantly increasing concentrations of monounsaturated fatty acids (MUFA-28.94 g FAME / 100 g fat) and polyunsaturated fatty acids (PUFA-4.86 g FAME / 100 g), as well as an improvement of the Ω3: Ω6 ratio to the second group (20.66). In conclusion the breeding system, energetic and protein level of food ratio was influenced the milk production and the fatty acids composition.

Key words*: goat, nutrition, milk production, fatty acids.*

INTRODUCTION

In recent years, the goat sector in Romania has continuously grown, so from 750,000 goats in 1997, the total number of goats has increased to over 2,000,000 goats in 2017. At the same time, the breed structure has changed due to the massive import of goats specialized in milk production, among which the most numerous are Saanen and Alpine breeds. These breeds are intensively used to improve milk and meat production in Carpatina and Alba de Banat local goat breeds. The main motivation for numerical growth of goats is: 1) the existence of favorable breeding conditions in Romania; 2) the increase in consumption of milk and processed products from goat milk due to its special qualities for human health; 3) more accessible reproductive and growth conditions for goat farmers compared to dairy cows. The nutritional composition of goat's milk is influenced by different factors: season, stage of lactation, breed, genetics, nutrition, environmental factors. Goat milk contains about 87% water, 4% carbohydrates, 4% lipids, 3-4% protein, about 0.5% minerals (including 120 mg of calcium) and vitamins (Morand-Fehr et al., 2007; Park et al., 2007). The whole goat milk contains about 35 g/l of fat composed of 99.5% lipids and 0.5% liposoluble substances (cholesterol, vitamins A, D). Lipids essentially have an energetic role (9 kcal/g). Goat milk contains a wide variety of fatty acids (FA), classified according to the length of their carbon chain and the number of double bonds. Goat FA contains about 65-70% of saturated FA and 30-35% unsaturated FA (USDA 2004). The large amount of medium chain fatty acids has benefits to human health.

The quality of the goat milk, especially on fatty acidcomposition is influenced by leguminous plants (Shingfield et al., 2008). Goat milk contains a higher amount of short chain fatty acids, being richer in butyric acid (C4:0), caproic (C6:0), capric (C8:0), capric (C10:C18:1), myristic (C14:0), palmitic (C16:0), linoleic (C18:2), which have numerous benefits for human health (Park, 2007; Haenlein, 2004; Tudisco et al., 2010; Kučević et al., 2016). The objectives of this study was to evaluate the milk productions and biochemical composition of milk fatty acid on Saanen imported goats, breeding inintensive and traditional systems.

MATERIALS AND METHODS

The experiments was made in 2015 in two farm of Dobrogea County on imported Saanen goats, at their 3th lactations. At Elcomex Agroindustrial SA farm the Saanen goats were reared in intensive system of breeding.The goats received one feed ration which contained 2.86 UNL, calculated for >3 kg milk production/day. The feed ratio was formulated by a computer program and it contains a daily intake of 2.86 UNL, 208 g PDIN, 205 g PDIE, 18.7 g Ca and 8.25 g P. At Ciocarlia farm, lot 2 of the Saanen goats were reared in traditional system of breeding.

The goats received one feed ration which contained 2.27 UNL calculated for 2 kg/day milk production. The feed ratio had a daily intake of 2.27 UNL, 147 g PDIN and 146 g PDIE, 15.19 g Ca and 4.41g P. The goats grazed daily 6 hours, the cereals were administered during milking and the hay and the straw after the evening milking.

Experiment lasted 130 days; during this period the milk production wasrecorded and average milk samples were collected at the beginning, mid and end of lactation, determining physicochemical parameters using the Funke Gerber automatic milk analyzer. All fatty acids (FA) were determined by gas chromatographic method (GC Perkin Elmer-Clarus 500). The results were statistically analyzed with the ANOVA test.

RESULTS AND DISCUTIONS

The lambing season started at the begining of February till at March 15. The milk collection was started on March. The experimental data are presented in Tables 1-3 and figures 1-2.

Table 1. Dynamics of goat milk fatty acids in terms of milk and protein production; the energy value of reports at the beginning of lactation *(Total FAME g/100 g fat)*

System	I	II
Milk (l)	3.59	1.58
UNL	2.86	2.27
SFA*	72.35	69.69
MUFA*	21.78	25.53
PUFA*	5.49	4.55
UFA*	27.27	30.08
SFA/UFA	2.653	2.317
PUFA/MUFA	0.252	0.178
Total FA	99.62	99.77
Non-detected FA	0.38	0.23

Goat milk is an important source of protein and fat in human nutrition. The mean values of the main fatty acid groups, representing values of FAME total (g FAME/100 g of fat), show variations depending on the lactation stage (at the beginning, middle or end of lactation), age, nutrition, season (Park, 2007; Haenlein, 2004). The analysis of the fatty acid profile of goat's milk was carried out by evaluating the main fatty acid (FA) groups such as saturated fatty acids (SFA), monosaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), unsaturated fatty acids (UFA), ratios between SFA/UFA, PUFA/MUFA, Ω3, Ω6 and the ratio Ω6/Ω3.

Protein and energy levels of the Saanen goat ratios grown in industrial and traditional systems were 2.86-2.27 UNL and were calculated for medium production of 3.5 liters and 2 liters of milk respectively.

Under these conditions, the SFA profile showed high values at the beginning of lactation (72.35/69.69 g FAME/100 g fat), which decreased in the middle of lactation in both groups of animals. The decrease was very high in Group I vs. Group II production of SFA increased to the end of lactation in both groups, showing values of 69.30 and 69.69 g of FAME/100 g of fat.

Table 2. Dynamics of goat milk fatty acids in terms of milk and protein production; the energy value of reports at the at the middle of lactation *(Total FAME g/100 g fat)*

System	I	II
Milk (l)	3.59	1.58
UNL	2.86	2.27
SFA*	46.73	52.58
MUFA*	36.38	40.65
PUFA*	15.11	6.10
UFA*	51.49	46.75
SFA/UFA	0.908	1.125
PUFA/MUFA	0.415	0.150
Total FA	98.22	99.33
Non-detected FA	1.78	0.67

Table 3. Dynamics of goat milk fatty acids in terms of milk and protein production; the energy value of reports at the end of lactation *(Total FAME g/100 g fat)*

System	I	II
Milk (l)	3.59	1.58
UNL	2.86	2.27
SFA*	69.30	69.69
MUFA*	23.02	22.84
PUFA*	5.92	5.92
UFA*	28.94	28.76
SFA/UFA	2.394	2.423
PUFA/MUFA	0.257	0.259
Total FA	98.25	98.4
Nondetected FA	1.75	1.55

In the SFA group there are short chain fatty acidswhich have an even number of carbon atoms, among which there are four fatty acids characteristic of goat's milk: capric acid (C10:0), myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0). Cis oleic acid (C18:1cis-9) is added from the MUFA acid group, which together holds 75% of the total fatty acids in the milk.

In smaller quantities are caproic, caprylicand lauric acids, which are also characteristic of goat milk, giving it a particular taste (Park, 2004; Goudjil et al., 2004). SFA values in Group II were lower, as goats grazed between May and October. Studies have shown that SFAs have lower values because grazing causes a decrease in saturated fatty acids in goat milk (Chiliard, 2004). The MUFA profile is opposite to SFA, meaning that its highest value was placed in the middle of lactation, when the values of the two groups were close, respectively 36.38 and 40.65 g FAME/100 g fat. From this group are highlighted monosaturated fatty acids myristate, pentadecanoic, palmitoleic, heptadecenoic and trans oleic acids. The PUFA profile has a linear pattern in Group II with values between 4.55 and 6.10 g FAME/100 g of fat, while in Group I the highest value was presented in the middle of lactation in the summer time, reaching 5.49; 15.11 and 5.92 g of FAME/100 g of fat.

The SFA / UFA and PUFA / MUFA reports are very close among the two milking groups at the beginning, middle and end of lactation. The PUFA fatty acid group varies between 3-5%. Of all fatty acids, alpha and gamma linoleic acids, eicosatrienoic and CLA (conjugated linoleic acid) are the most important goat's milk acids, because they have benefic effects on human health. The majority of FA, from acetic acid (C2:0) to arachidic acid (C20:0),contains an even number of carbon atoms.Five fatty acids (C10:0, C14:0, C16:0, C18:0 and C18:1) represent> 75% of total FA in goat's and sheep's milk. Higher levels of valuable fatty acids with short and medium chain, such as caproic, caprylic, capric and lauric acids, have a much higher rate in goat milk than in cow's milk (Alonso et al., 1999; Goudjil et al., 2004). These FAs are associated with the characteristic flavors of goat cheese and are used to detect milk mixes from different species (Chilliard, 2004). Regardingthe values for Ω3 and Ω6 and the Ω6/Ω3 ratio, the results obtained are presented in Figures 1 and 2.

The values for Ω3 and Ω6 were close between the two groups, 0.6 and 4.5, which determined that the ratio of Ω6 / Ω3 to be 8.35 for goats grown in industrial system and 6.99 for those grown in traditional system.

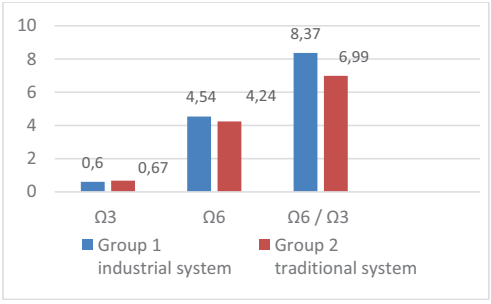

Figure 1. Histogram of fatty acids in relation to milk production

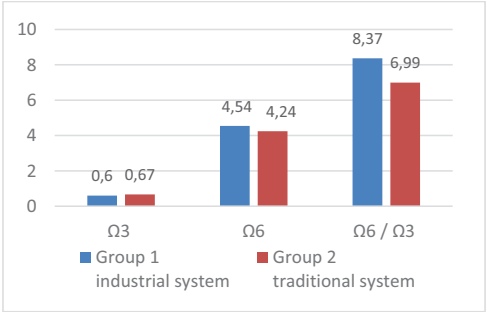

Figure 2. Histogram of Ω3 and Ω6 fatty acids in relation to milk production

Lipids and protein are the most important components of milk in terms of costs, nutrition, as well as the physical and sensory characteristics it confers on goat dairy products. After Park (2006) and Haenlein (2007), the basic composition of goat milk (Mean values per 100 g) are the following amount of constituents: fat (g) 3.8; protein (g) 3.5; lactose (g) 4.1; ash (g) 0.8; total solids (g) 12.2. Goat's milk is less caloric compared to sheep and goat milk and contains only 70 calories per 100 ml; in terms of its composition, it is very close to female milk containing more lactose and fewer proteins (Zamfirescu, 2017).

The biochemical profile of the main biochemical components (fat, protein and dry

substance) from goat's milk obtained from goats in the two growth systems is presented in Tables 4-7.

The goat's milk fat in industrial lot 1 is of maximum value in March (4.08 ± 0.026) and remains high in April and May, then decreases significantly in July and August.

Fat in September and October rose to 3.85% - 3.94% (Table 4). The milk fat profile of the goats kept in the traditional system showed the same fat profile, which had a maximum value in March and April (4.18%-3.91%), after which it declined and remained flat in May (3.6%-3.7%) and reached the initial value in the last lactation month (3.87 ± 0,014%) (Table 6).

The lipid fraction of goat milk is relatively high in saturated fatty acids, which is typical of milk fat from all ruminants.

The average size of goat milk fat globules is about 3.5 micrometers and is characterized by its high homogeneity that provides lipases with greater surface area of fat for enhanced digestion.

The smaller fat globules found in goat milk allows for better fat dispersion and poor creaming ability of the milk, which provides a natural homogenization that is beneficial to human health (Haenlein et al., 1984; Park, 2006).

Regarding the total protein profile in the milk collected from the two groups of goats, it had characteristic values for the species, namely 3.31-3.52% for the goats in the industrial system and 3.31-3.42% for the goats kept in the traditional system (Tables 4 and 6).

Table 4. The monthly distribution of fat and protein in milk (1, industrial system)

Month	Fat% x±sx	Protein% x±sx
03	4.08±0.026	3.33±0.024
04	3.96±0.025	3.41±0.018
05	3.98±0.026	3.39±0.013
06	3.88±0.022	3.31±0.008
07	3.78±0.011	3.33±0.009
08	3.74±0.014	3.40±0.012
09	3.85±0.0372	3.52±0.011
10	3.94±.0.024	3.49±0.050

The five major proteins in goat milk are β-lactoglobulin, α-lactalbumin, κ-casein, β-casein, and α2-casein (Carles, 1986; Haenlein and Caccese, 1984; Mikkelsen et al., 1987).

Table 5. The monthly distribution of SU% and fat/protein ratio in milk (1, industrial system)

Month	SU% Min/max/x±sx	Fat/protein ratio Min/max/x±sx
03	12.38±0.039	1.22
04	12.61±0.061	1.16
05	12.51±0.045	1.17
06	12.41±0.041	1.17
07	12.25±0.024	1.13
08	12.21±0.028	1.10
09	12.53±0.062	1.09
10	12.72±0.055	1.13

Table 6. The monthly distribution of fat and protein in milk (2, traditional.system)

Month	Fat% Min/max/x±sx	Protein% Min/max/x±sx
03	4.18±0.016	3.38±0.019
04	3.91±0.015	3.42±0.021
05	3.76±0.033	3.39±0.011
06	3.61±0.029	3.31±0.018
07	3.65±0.018	3.32±0.010
08	3.73±0.022	3.31±0.020
09	3.76±0.031	3.34±0.017
10	3.87±.0.014	3.39±0.031

Table 7. The monthly distribution of SU% and fat /protein ratio in milk (2, traditional system)

Month	SU% x±sx	Fat/protein ratio x±sx
03	12.39±0.036	1.23
04	12.55±0.044	1.14
05	12.50±0.042	1.11
06	12.41±0.021	1.11
07	12.36±0.028	1.10
08	12.38±0.029	1.13
09	12.42±0.041	1.13
10	12.59±0.048	1.14

The results obtained are similar to those reported by Bruhn (2000), Chiliard (2003) Park (2006) and Haenlein (2004).

The total dry substance ranged between 12.21%-12.72% for the goats in group 1 and 12.39%-12.59% for the goats in group 2.

The fat / protein ratio in group 1 (Table 5) had a similar value to reference data for goat milk. This indicator was below 1.2 because of the lower fat content during the summer period. The fat/protein ratio is an important indicator for the transformation of milk into cheese (Ricordeau, 1967; Meyer 1998).

Kučević (2016) reports that growth systems influence the quality of milk. In our experiments, the fat, protein, and dry substance profile had close values; they had lower values

during the summer and increased to the end of lactation.

CONCLUSIONS

Growth systems did not have any major influence on the biochemical composition of Saanen's goat milk grown in industrial and traditional systems.
The determination of the fatty acid profile of goat's milk is influenced by the lactation stage.
The SFA general profile was lower in traditional grown, demonstrating that grass can influence the decrease in saturated fat content.
The ratio of fatty acids Ω6 and Ω3 was very high in the Saanen goat milk grown in the two systems, far exceeding the admissible values.
The profile of the main biochemical components in milk, namely fat, protein and dry matter, analyzed over 10 months of lactation, was similar except for fat that had lower values during the summer. This decrease led to a lower fat / protein ratio in the milk collected from the goats raised in the traditional system.

ACKNOWLEDGMENTS

The research was carried out within the framework of PN 3 project: "Effective feedingstrategies for domestic and imported goats for maximizing feed conversion in milkproduction (Nutricap)".

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