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# THE COMPOSITION OF GOAT MILK IN DIFFERENT TYPES OF FARMINGS

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**Abstract:** Possible differences between compositions of raw goat's milk due to the types of farmings system (organic, conventional and traditional) were investigated. Farms were located in different parts of Republic of Serbia. All animals were loose housed. The capacity of the farm ranged from 50 to 750 French Alpine goats. A total of 72 bulk samples of raw milk were collected from each farm during the year. The principle of analysis of raw milk samples was in accordance to mid-infrared spectrometry and flow cytometry. The following parameters in raw Milk were analyzed: fat, protein, lactose, total solids, somatic cell count, milk urea, and contents of fatty acid: saturated, unsaturated, polyunsaturated and monounsaturated fatty acids. The fixed effect the types of farming and season (winter, spring, summer and fall) have shown a statistical significance difference ($P<0.05$) on all examined milk parameters except to the content of lactose, MU and the number of SCC ($P> 0.05$). The Composition of milk also affected by a number of other factors such as the nutrition of dairy goats, breed and farm management. It is recommended to consider all these factors during the comparison of different farming systems. The results that showed significant differences could be used to improve the breeding technology of dairy goats, and feeding strategies as well as emphasize the importance of using pastures.

**Key words:** milk composition, organic, conventional, traditional, dairy farming, Alpine goats

## Introduction

Variability in goat milk production is caused by living conditions and, in particular, by nutrition. Because of its biological and energy value, goat milk has an advantage in relation to cow milk *(Božanić et al., 2002; Spruzs and Selegovska, 2004; Brito et al., 2011*). Consistent with previous study *(Park and Haenlein, 2010),* the average goat milk composition is the following: milk fat 3.8 %, proteins 3.5 % and lactose 4.1 %. The fat content can vary from 2.4 % to 7.8 %, which is

the component that varies the most *(Park and Haenlei, 2010; Antunac and Samaržija, 2000; Krajinović, 2006).* In goat milk, the content of total solids often varies and primarily depends on the goat breed *(Superchi et al., 2005).* Goat milk quality depends on many factors, such as: goat breed, age, health condition, body weight, lactation length, number of lactation, lactation stadium, length of the dry period, number of daily milking, workers who perform milking, hygiene, kidding, gestation, system of production, diet, accommodation, weather conditions etc. *(Park and Haenlein, 2010; Antunac and Samaržija, 2000; Mioč et al. 2008; Goetsch et al. 2011; Abbas et al. 2014; Krajinović and Pihler, 2014).* Contents of essential fatty acids and fatty acids (FA) are often considered as goat milk quality. In order to understand the impact of goat milk on human diet, it has to be determined what is made of *(Volkmann, 2012).* Different feeding strategies have different impact on the chemical composition of goat milk *(Toledo et al., 2002).* Different nutrients, such as pasture, hay, silage and concentrates, which are used in animal diet, along with various feeding strategies have great impact on the content of FA in milk. Organic raw milk compared with milk from conventional production has a better FA composition; i.e. contains more polyunsaturated fatty acids - PUFA with a higher proportion of omega-3 fatty acids and conjugated linoleic acid (CLA) *(Ellis et al. 2006; Prandini et al. 2009; Kučević et al. 2016).* The mentioned group of fatty acids (especially omega-3) has positive effects on human health. Their activity is associated with the improvement of neurological function *(Contreras and Raport, 2002),* decreases of diabetes, prevention of cardiovascular diseases, and improvement of the immune system *(Pariza, 2003).*

# Materials and Methods

### Animals and System of farming

The 12-mo research was carried out on three goat farms in the northern part of Serbia. All animals were housed in a free stall stable. The capacity of the farm ranged from 50 to 750 French Alpine goats. The first farm with the 60 goats was operated in accordance the conventional principles of farming (CF). The farm still does not produce their own feed; owners buy them instead. The diet corresponded to the daily milk yield of goats and is based on alfalfa and grass hay whereas the share of concentrate is 30-35 % (about 1 kg per day per goat, and it contains corn, barley, wheat and sunflower meal). The second farm with 50 goats was operated under the traditional farming system (TF). This is the only farm which had enabled fulltime grazing for goats. While grazing, goats are spent time on corn, soy and turnip stubbles. They were also consuming sudan grass, clover and forest species such as acacia, ash tree, vine, willow and wild strawberries. Beside this, goats were fed with alfalfa, clover and grass hay. The share of concentrate in the goat diet was

about 20 % and it was made out of soy, corn, barley and meal. A concentrate with higher percentage of selenium was added to the diet, too. The third farm is the farm which follows organic standards-certified organic farm (OF). On this farm hay and concentrate was produced for 750 French Alpine goats on 600 ha. Goats did not use a pasture. There was an outdoor space for goats, where they could express their natural behavior. Goats were fed with alfalfa, clover and grass hay. The share of concentrate was about 20% of overall diet. Concentrate was produced on farm land and it contained corn, barley, oats and triticale. For all three farms, the average water consumption was about 8 L/day/goat. Also, all three farms were using mineral and salt blocks as diet supplementation.

**Sampling and Instrumental analysis**

A total of 72 bulk samples of raw milk were collected during 12 months research (twice a month, 24 samples per farm). The milk analysis was performed in the Laboratory for Quality Control of Milk, the Faculty of Agriculture in Novi Sad, using a CombiFoss™FT+ analyzer for routine compositional raw milk analysis employing Fourier Transform Infrared "FTIR". This device is a combination instrument consisting of the MilkoScan™ FT+ and the Fossomatic™ FC, techniques comply with: ISO 9622 / IDF 141:2013 and the AOAC official method 972.16. Fossomatic was used for analysis of somatic cell counting in raw milk. The collection of samples is carried out in accordance with the regulations of the International Committee for Animal Recording (ICAR- $AT_4$). The following parameters were analyzed: fat, protein, lactose, total solids, somatic cell count (SCC), milk urea (MU), and contents of fatty acid (FA): Saturated (SFA), unsaturated (UFA), polyunsaturated (PUFA) and monounsaturated Fatty Acids (MUFA).

**Statistical analysis**

The data was evaluated by the *STATISTICA software (Ver. 13 StatSoft Company, 2016).* The average values and variability of examined parameters as well as the effect of factors (types of farmings and seasons as a fixed effect) on investigated milk traits were studied by means of the procedures PROC UNIVARIATE and PROC GLM-General linear model. Quantitatively dependent variables were (fat, protein, lactose, total solids, SCC, MU, SFA, UFA, PUFA, MUFA) by a fixed factors - types of farmings and seasons as independent variables. The model equation used for the evaluation was as follows:

$Yijk = \mu + Si + Rj + eijk$
where:

Yijk – dependent variable (fat, protein, lactose, total solids, SCC, MU, SFA, UFA, PUFA, MUFA);
μ - mean value of dependent variable;
Si - fixed effect of the System i (i = 1, 2, 3);
Rj - fixed effect of the Season j (j = 1, 2, 3, 4);
eijk - other random effects.

Logarithmic transformation was used in order to properly adjust the number of SCC to normal distribution, as follows:

SCC = Log2 (SCC /100000) +3

## Results and Discussion

The fixed effect the types of framings (OF, CF and TF) and seasons (winter, spring, summer and fall) have shown a statistical significance difference ($P<0.05$) on fat, protein, total solids, SFA, UFA, PUFA and MUFA. Significant difference wasn't found in the number of SCC, content of lactose and MU ($P> 0.05$). The average results of raw milk composition are shown in Table 1.

**Table 1. Results of raw milk composition in different types of farming**

| Milk components | Conventional dairy farming | | | | Traditional dairy farming | | | Organic dairy farming | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | mean | SD | CV % | mean | SD | CV % | mean | SD | CV % |
| Fat (g/100 g) | 72 | $3.95^{a}$ | 0.73 | 18.4 | $4.16^{b}$ | 0.93 | 22.3 | $3.08^{c}$ | 0.42 | 13.6 |
| Proteins (g/100 g) | 72 | $2.79^{a}$ | 0.26 | 9.3 | $3.05^{b}$ | 0.18 | 5.9 | $3.76^{c}$ | 0.40 | 10.6 |
| Lactose (g/100 g) | 72 | $4.09^{aaa}$ | 0.05 | 1.2 | $4.07^{aaa}$ | 0.17 | 4.1 | $4.16^{aaa}$ | 0.14 | 3.3 |
| T.solids (g/100 g) | 72 | $11.76^{a}$ | 0.85 | 7.2 | $12.26^{b}$ | 0.95 | 7.7 | $11.97^{c}$ | 0.88 | 7.3 |
| Urea (mg/dL) | 72 | $52.4^{aaa}$ | 10.3 | 19.6 | $48.1^{aaa}$ | 9.1 | 18.9 | $52.8^{aaa}$ | 11.8 | 22.3 |
| LogSCC | 72 | $6.33^{aaa}$ | 1.18 | 18.6 | $6.69^{aaa}$ | 1.54 | 23.1 | $5.68^{aaa}$ | 2.20 | 38.7 |

T. Solids - Total Solids; LogSCC - Logarithmically Somatic cell count; SD -Standard deviation; CV% - Coefficient of variation; $^{a,b,c}$Values in the same row indicate significant differences at the level ($P<0.05$); $^{a,a,a}$Values in the same row indicate insignificant differences ($P>0.05$);

The content of milk fat was the highest in the traditional farm (4.16 %) compared to the organic (3.08 %) and the conventional farm (3.95 %). The content of proteins was the highest in the milk from the organic farm (3.76 %). The lactose

content was the highest in the milk which comes from the organic farm (4.16 %), followed by the milk from the conventional (4.09 %) and traditional (4.07 %) farm. The highest content of total solids were found in the milk from the traditional farm (12.26%), followed by the milk from the organic (11.97 %) and conventional farm (11.76 %). The content of MU was the highest in OF (52.8 mg/dL) and the lowest in TF (48.1 mg/dL). The highest average number of SCC was found in the milk from the traditional farm (2.273, 735/mL; log 6.69). In the organic milk, average SCC was 2.026, 150/mL (log 5.68) and in the conventional one it was 1.384, 800/mL (log 6.33).

Comparing three farms in terms of milk fat content showed that there was a statistically significant difference between the organic and the conventional, and the organic and traditional farm ($P<0.05$). These results are in accordance with other research in which systems based on pastures result with a high content of fat *(Morand et al., 2007)*, because the diet rich in fibers has a major influence on milk fat content. It can be assumed that the greatest influence on this difference was made due to the share of concentrate and fresh grass in goat diet *(Goetsch et al., 2011; Abbas et al. 2014).* Fluctuation of milk fat content could be affected by a number of other factors such as breed, stage of lactation, season (agro-climatic conditions), loss of appetite etc. *(Park and Haenlein, 2010; Krajinović and Pihler, 2014; Maroteau et al., 2014; Rahmann, 2007).*Values of the coefficient of variation (CV) and standard deviation (SD) indicate that the variability of fat is under the influence of biological and breed characteristics of dairy animals too *(Kučević et al., 2011).*

Comparing these three farms in terms of protein content showed that there was statistically significant difference between the organic and conventional, and between the organic and traditional farm ($P<0.05$). The reason for higher protein content from the organic farm is the significantly higher share of high quality alfalfa and clover hay in diet. In addition, genetic variations have an impact on the content of protein too *(Brito et al., 2011).*

The analysis of variance showed no statistical significance between the three farms regarding somatic cell count, but it should be noted that the values from the traditional and organic farm were higher than the average. Differences in number of SCC in milk (especially high values) between farms depend on environmental factors, specifically slightly worse milking and breeding conditions *(Přidalová et al., 2009).* Right away after leaving the udder, the milk of healthy cows, kept in adequate breeding conditions, is almost sterile and contains the minimum number of microorganisms (8.933 CFU / ml) (*Kučević et al., 2013*). On the organic farm, the reason for high SCC in goat most likely depends on the frequent occurrence of mastitis. Inflammation of the mammary gland was accompanied by the changes in the number of SCC, mainly as an increase in SCC in diseased quarters of udder. To contamination came mainly during and after

milking (after leaving the udder) due to the activity of microorganisms from the environment.

The content of milk urea revealed the proteins/energy ratio in the diet i.e. it is balanced or not. It is used as an indicator of a rather higher amount of proteins in diet or lower amount of energy (carbon hydrates). The content of MU is linked to the protein intake through the diet. This fact can be perceived in research in the same way in relation to the highest content of MU (52.8 mg/dL) and proteins (3.76 %) on the organic farm. Higher values of MU indicate an the imbalance of protein and energy, but MU concentration was also influenced by a whole range of factors: feeding, breed, stage and number of lactations, body weight, daily production and chemical composition of milk, somatic cell count, season and milking *(Čobanović et al., 2015).*

The average content of SFA, UFA, PUFA, MUFA fatty acids in the raw milk (all types of farming) is presented in Table 2.

**Table 2. Results of fatty acid in raw milk in different types of farming**

| Fatty acid (g/dL) | Conventional dairy farming | | | | Traditional dairy farming | | | Organic dairy farming | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | mean | SD | CV % | mean | SD | CV % | mean | SD | CV % |
| SFA | 72 | $2.01^{A}$ | 0.35 | 17.4 | $2.00^{B}$ | 0.30 | 14.9 | $2.24^{C}$ | 0.38 | 16.9 |
| UFA | 72 | $0.78^{A}$ | 0.10 | 12.8 | $1.01^{B}$ | $0.21^{b}$ | 20.7 | $0.59^{C}$ | 0.10 | 16.9 |
| MUFA | 72 | $1.01^{A}$ | 0.12 | 11.8 | $1.17^{B}$ | 0.20 | 17.0 | $0.84^{C}$ | 0.15 | 17.8 |
| PUFA | 72 | $0.38^{A}$ | 0.02 | 5.2 | $0.33^{B}$ | 0.02 | 6.0 | $0.31^{C}$ | 0.03 | 9.6 |

SD - Standard deviation; CV% - Coefficient of variation; $^{A,B,C}$Values in the same row indicate significant differences at the level (P<0.01);

According to the results in Table 2, it is evident that there was a highly statistically significant difference between the types of farming in all tested parameters (P<0.01). The milk produced in organic dairy farming had a significantly higher concentration of SFA (2.24 g/dL) and the lowest concentration of UFA (0.59 g/dL). The share of UFA (1.01 g/dL) and MUFA (1.17 g/dL) fatty acid was higher in the milk from the traditional farm and the content of PUFA was the highest in the milk from the conventional farm (0.38 g/dL).

The content of UFA in the organic (0.593 g/dL) compared to the conventional milk (0.780 g/dL) is contradictive to other results (24) where it been stated that milk from the certified organic farms contains higher concentrations of UFA than the milk from conventional farms with high inputs. The highest content of UFA and MUFA has been identified in the milk from the traditional farm which

is the only farm with fully organized grazing. This corresponds to the results gained from other research because a pasture has a great impact on the content of FA in milk by reducing content of SFA and increasing content of UFA *(Morand et al., 2007; Ferlay et al., 2007; Decandia et al., 2007; Tudisco et al., 2010; Kučević et al., 2016; Sampelayo et al., 2007).* On the other hand, this corresponds to the content of SFA, which is the lowest in the milk from the traditional (2.015 g/dL) and conventional (2.012 g/dL) farm, compared to the milk from the organic farm (2.248 g/dL). Fresh grass had a strong impact on FA content in milk by increasing the percentage of PUFA *(Morand et al., 2007; Aplocina and Spruzs, 2012)* which justifies the content of polyunsaturated PUFA in milk from the traditional (0.330 g/dL) and conventional (0.382 g/dL) farm, but not the content in the organic milk (0.311 g/dL).

## Conclusion

The fixed effect the types of farming and season (winter, spring, summer and fall) have shown a statistical significance difference on all examined milk parameters except to the content of lactose, MU and the number of SCC. The Composition of milk also affected by a number of other factors such as the nutrition of dairy goats, breed and farm management. The contradictory results in the investigated farming systems are probably related to different feeding strategies and feed components (including pasture). Therefore, most of the authors, who had conducted similar studies, pointed out that the composition of raw milk is mostly influenced by nutrition. Regarding the diet of goat, special consideration should be given to the access to fresh grazing, silage type, cereal feeding etc., because nutritionals factor takes a greatly impact on the composition of goat's milk.

## Sastav kozijeg mleka u različitim sistemima proizvodnje

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## Rezime

Cilj rada je bio da se ispitaju razlike u sastavu kozijeg sirovog mleka dobijenog tokom godine u različitim sistemima proizvodnje (organska/ konvencionalna/tradicionalna). Farme za držanje mlečnih koza locirane su na severu Republike Srbije a životinje su uzgajane slobodnim sistemima držanja. Kapacitet farmi se kretao od 50 do 750 mlečnih koza rase francuska alpska. Ukupno je sakupljeno 72 zbirna uzorka sirovog mleka (2 puta mesečno po farmi). Uzorci su ispitani po metodi infracrvene spektrofotometrije i protočne citometrije a

od parametara u sirovom mleku su analizirani: mlečna mast, protein, laktoza, ukupna suva materija, ukupan broj somatskih ćelija, urea u mleku, sadržaj masnih kiselina (zasićene, nezasićene, polinezasićene i mononezasićene). Uticaj sistemskih faktora sistema proizvodnje i sezone je bio statistički značajan ($P<0,05$) na sve ispitivane parametre osim na sadržaj laktoze, uree i broja somatskih ćelija ($P> 0,05$). Na sastav kozijeg mleka utiče veliki broj drugih faktora kao što je način ishrane, rasa, farmski menadžment itd. Zato je za preporuku da se prilikom poređenja sastava mleka dobijenih iz različitih tipova proizvodnje, u razmatranjem obuhvate i pomenuti faktori. Rezultati istraživanja mogu poslužiti za unapređenje tehnologije odgajivanja mlečnih koza i unapređenja strategije ishrane, sa posebnim naglašavanjem korišćenja pašnjaka u ishrani koza.

# References

ABBAS H.M., HASSAN F.A., EL-GAWAD M.A.A., ENABA K. (2014): Physicochemical Characteristics of Goat's Milk. Life Science Journal, 11: 1s.

ANTUNAC N., SAMARŽIJA D. (2000): Proizvodnja, sastav i osobine kozjeg mlijeka. Mljekarstvo, 50: (1) 53-66.

APLOCINA E., SPRUZS J. (2012): Influence of different feedstuffs on quality of goat milk. In Zinātniski praktiskās konference," Zinātne Latvijas Lauksaimniecības Nākotnei: Pārtika, Lopbarība, Šķiedra un Enerģija", Jelgava, Latvijas Lauksaimniecības Universitāte (LLU). Latvia, 23-24 February, p. 209-214.

BOŽANIĆ R., TRATNIK L., DRGALIĆ I. (2002): Kozje mlijeko: karakteristike i mogućnosti. Mljekarstvo, 52: (3) 207-237.

BRITO L.F., SILVA F.G., MELO A.L.P., CAETANO G.C., TORRES R.A., RODRIGUES M.T., MENEZES G.R.O. (2011): Genetic and environmental factors that influence production and quality of milk of Alpine and Saanen goats. Genetics and Molecular Research, 10: 3794-3802.

CONTRERAS M.A., RAPOPORT S.I. (2002): Recent studies on interactions between n-3 and n-6 polyunsaturated fatty acids in brain and other tissues. Current opinion in lipidology. 13: 267-272.

ČOBANOVIĆ KSENIJA, KUČEVIĆ D., TRIVUNOVIĆ S., PLAVŠIĆ, M. Variability of milk urea on Vojvodina's dairy farms. Sixth International Scientific Agricultural Symposium „Agrosym 2015" Jahorina, October 15 - 18. Book of proceedings 2015. p.1665-1671.

DECANDIA M., CABIDDU A., MOLLE G., BRANCA A., EPIFANI G., PINTUS S., ADDIS M. (2007): Effect of different feeding systems on fatty acid composition and volatile compound content in goat milk. Options Mediterraneennes, Series A, Advanced Nutrition and Feeding Strategies to Improve Sheep and Goat Production, 74: 129-134.

ELLIS K.A., INNOCENT G., GROVE-WHITE D., CRIPPS P., MCLEAN W.G., HOWARD C.V. (2006): Comparing the fatty acid composition of organic and conventional milk. Journal of Dairy Science, 89: 1938-50.
FERLAY A., BERNARD L., ROUEL J., DOREAU M. (2007): Diet, rumen biohydrogenation and nutritional quality of cow and goat milk fat. European Journal Lipid Science Technology, 109: 828-855.
GOETSCH A.L., ZENG S.S., GIPSON T.A. (2011): Factors affecting goat milk production and quality. Small Ruminant Research, 101: (1) 55-63.
KRAJINOVIĆ, M. (2006): Ovčarstvo i kozarstvo. Univerzitet u Novom Sadu, Poljoprivredni fakulet Novi Sad.
KRAJINOVIĆ M., PIHLER I. (2014): Tehnologija kozarske proizvodnje. Univezitet u Novom Sadu, Poljoprivredni fakultet, 163-211.
KUČEVIĆ, D., TRIVUNOVIĆ S., RADINOVIĆ M., PLAVŠIĆ M., SKALICKI Z., PERIŠIĆ P. (2011): The effect of the farm size on milk traits of cows. Biotechnology in Animal Husbandry, 27: (3) 951-958.
KUČEVIĆ D., PLAVŠIĆ M., TRIVUNOVIĆ S., RADINOVIĆ M., KUČEVIĆ D. S. (2013): Effect of post - milking teat dipping on hygienic quality of cow's milk, Biotechnology in Animal Husbandry, Vol. 29, 4, 665-673.
KUČEVIĆ D., TRIVUNOVIĆ S., BOGDANOVIĆ V., ČOBANOVIĆ K., JANKOVIĆ D., STANOJEVIĆ D. (2016): Composition of Raw Milk from conventional and organic dairy farming. Biotechnology in Animal Husbandry 32: (2), 133-143.
MAROTEAU C., PALHIÈRE I., LARROQUE H., CLÉMENT V., FERRAND M., TOSSER-KLOPP G., RUPP R. (2014): Genetic parameter estimation for major milk fatty acids in Alpine and Saanen primiparous goats. Journal of Dairy Science, 97: (5) 3142-3155.
MIOČ B., PRPIĆ Z., VNUČEC I., BARAĆ Z., SAMARŽIJA D., PAVIĆ V. (2008): Factors affecting goat milk yield and composition. Mljekarstvo, 58: (4) 305.
MORAND-FEHR P., FEDELE V., DECANDIA M., LE FRILEUX Y. (2007): Influence of farming and feeding systems on composition and quality of goat and sheep milk. Small Ruminant Research, 68: (1) 20-34.
PARIZA M.W. (2003):The biological activities of conjugated linoleic acid, in Advances in Conjugated Linoleic Acid Research (2nd edn), ed. by Christie WW, S´ eb´ edio JL and Adlof RO. AOCS Press, Champaign, IL. 12-20.
PARK Y.W., HAENLEIN G.F.W. (2010): Milk production. Goat Science and Production, 12: (4) 275.
PRANDINI A., SIGOLO S., PIVA G. (2009): Conjugated linoleic acid (CLA) and fatty acid composition of milk, curd and Grana Padano cheese in conventional and organic farming systems. Journal of Dairy Research, 76: 278-82.

PŘIDALOVÁ H., JANŠTOVÁ B., CUPÁKOVÁ Š., DRAČKOVÁ M., NAVRÁTILOVÁ P., VORLOVÁ L. (2009): Somatic cell count in goat milk. Folia Veterinaria, 53: (2) 101-105.
RAHMANN G. (2007): Organic Sheep and Goat Farming. Tagungsreader der Pillnitzer Sommerakademie, 30-45.
SAMPELAYO M.S., CHILLIARD Y., SCHMIDELY P., BOZA J. (2007): Influence of type of diet on the fat constituents of goat and sheep milk. Small Ruminant Research, 68: (1) 42-63.
SPRUZS J., SELEGOVSKA E. (2004): Feeding of goats under conditions of organic farming. Veterinarija in zootechnika, 27: (49) 101-105.
SUPERCHI P., SUMMER A., SABBIONI A., MALACARNE M., FRANCESCHI P., MARIANI P. (2005): Feeding management and production factors affecting goat milk composition and quality. Titratable acidity and rennet-coagulation. Milchwissenschaft, 45: 361-362.
TOLEDO P., ANDERS A., BJÖRCK L. (2002): Composition of raw milk from sustainable production systems. International Dairy Journal; 12: 75-80.
TUDISCO R., CUTRIGNELLI M. I., CALABRÒ S., PICCOLO G., BOVERA F., GUGLIELMELLI A., INFASCELLI F. (2010): Influence of organic systems on milk fatty acid profile and CLA in goats. Small Ruminant Research, 88: (2) 151-155.
VOLKMANN A. (2012): Effects of two different forage to concentrate ratios on the milk performance of dairy goats and on the quality of goat milk and cheese. Master thesis. University of Natural Resources and Life Sciences, Vienna, Austria.

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