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Change of feeding affects fatty acids profile of goat's milk

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Abstract

Aim of this study was to analyse the effect of beginning of grazing on fatty acids (FA) profile of goat's milk. In all milk samples profile of basic FA was determined. Proportion of "goaty flavour" fatty acids: C6:0, C8:0 and C10:0 in milk fat was the lowest (P<0.01) when goats were fed only indoors and was the highest when goats were 7 days on pasture. Proportion of C18:2 *cis* 6 in milk fat varied between sampling times from 2.54 to 2.63 g·100 g^{-1} FA. C18:3 *n* - 3 was the highest 1.25 g·100 g^{-1} FA when goats were fed only indoors, after 7 days of grazing decreased to 0.93 g·100 g^{-1} FA (P<0.01). On the other hand, conjugated linoleic acid (CLA) in milk was lowest 0.55 g·100 g^{-1} FA when goats were fed only indoors. After 7 days of grazing CLA in milk increased to 0.91 g·100 g^{-1} FA (P<0.01). During next sampling days CLA decreased to 0.65 g·100 g^{-1} FA. Development of SFA, MUFA and PUFA of goat's milk after start of grazing was in this experiment different than published most of authors. However, described changes of fatty acids profile of goat milk confirm significant effect of beginning of grazing on milk fat composition.

Keywords: beginning of grazing, fatty acids, goat, milk fat composition

Introduction

Goat milk is biologically valuable drink, which besides basic nutrients contains also substances beneficial for human health. The properties of goat milk are, positive effect on nervous system, it helps to ductless gland, improves immune system and has positive effect by skin diseases. Consumption of milk and milk products has in Slovak Republic long tradition (Šramková et al., 2007). New research shows positive effect of milk consumption (3 to 4 times weekly) and yogurt (5 times weekly) on health status of patients with cardiovascular disease (Lorková et al., 2017). However, milk is one of sources of saturated fatty acids (SFA) and high SFA intake is associated with an increase of coronary heart disease. On the other hand, consumption of milk and dairy products, with unsaturated FA enhanced profile, may provide more protection from cardiovascular disease in both healthy and at-risk population (Markey et al., 2015). The proportion of FA in milk depends on many

factors such as the genetic (Miluchová et al., 2014; Trakovická et al., 2015); lactation stage (Kuchtík et al., 2015); health status (Vlček et al., 2016); bud main factor is nutrition (Pajor et al., 2014). Nowadays the FA profile of food is an important factor of human nutrition and health. Milk is a source of FA and therefore, the aim of this study was to determine the effect of beginning of grazing on FA profile of goat's milk.

Materials and methods

Experiment was realized in a RD Pod Skalkou, Tvrdošín, SVK (49° 19' 14.6293897" N, 19° 32' 38.8314056" E). In this study, lasting from middle of April to end of June, 150 goats White Shorthaired (different parities) were used. Average milk production per goat and day was 2 litres. Pool milk samples were taken before start of grazing and then in following time periods: 7th, 37th, and 67th day after start of grazing. Pool milk samples were collected twice a day after morning and afternoon milking, in triplicate. Each sampling day contained six milk samples that were used for analysis. From November to 22nd of April goats were only indoors, fed with meadow hay (*ad libitum*) and every day during milking received grain feed with protein concentrate in amount of 0.6 kilogram per head (0.2 kg crimped oat + 0.3 kg mixture of barley:corn 2:1 and 0.1 kg protein concentrate). From 22nd of April to end of June goats stayed all day long on the pasture, however the feeding with grain feed and protein concentrate during milking, as well as *ad libitum* feeding with meadow hay during night remained. Meadow hay and pasture has the same botanical composition. Meadows as well as the pasture land around farm RD Pod Skalkou are original permanent grasslands characterised as a biotope of mesophyte grasses with around 50 different strains of grasses, herbs and scrubs. All year goats had water and mineral block lick *ad libitum*.

Meadow hay and pasture as well as all collected milk samples were analysed for FA profile using Agilent 6890A GC (Agilent technologies, U.S.A.) at Department of Animal Nutrition (SUA in Nitra, Slovakia). Fatty acid profile (g·100 g^{-1} FA) of hay and pasture was as follows: C12:0 0 vs. 0.28; C14:0 0.87 vs. 0.62; C16:0 14.05 vs. 9.66; C18:0 2.43 vs. 1.28; C20:0 1.09 vs. 0.44; C22:0 1.08 vs. 0.63; C24:0 0.81 vs. 0.44; C16:1 1.62 vs. 1.12; C17:1 0 vs. 0.66; C18:1*cis*9 9.56 vs. 1.64; C18:2*cis*6 20.6 vs. 17.2; C18:3*n*-3 36.8 vs. 63.2; ΣSFA 20.3 vs. 13.4; ΣPUFA 57.4 vs. 80.4; ΣMUFA 11.2 vs. 3.4; Σn3/Σn6 1.79 vs. 3.68 and Σn6/Σn3 0.56 vs. 0.27 respectively.

Gained results were statistically processed by one-way ANOVA. Description statistic, SEM and effect of feeding either only indoors, or with pasture on milkfat composition were calculated using IBM SPSS v. 20.0. Differences of means between sampling periods were tested by Tukey HSD test. $P<0.05$ was considered significant.

Results and discussion

The composition of FA profile of goat's milk before and in three following sampling times after start of grazing is shown in Table 1. Between FA in milk from goats fed only indoors and values obtained on 7th day after start of grazing came to significant ($P<0.01$) increase in C6:0, C8:0, C10:0, C11:0, C12:0, C13:0, CLA and to significant ($P<0.01$) decrease in C17:0, C20:0, C22:0, C14:1, C16:1, C18:1*cis*9, C18:3n-3, C20:4n-6, C20:5n-3. These changes resulted in to increase of ΣSFA ($P<0.01$) and

Σn6/Σn3 ratio (P<0.01) and to decrease in ΣMUFA and ΣPUFA both with (P<0.01) after start of grazing. Despite the increased intake of PUFA and decreased intake of SFA due to beginning of grazing, all samples of goat's milk collected after beginning of grazing contained less PUFA and more SFA compared to milk when goats were fed indoors only with hay and concentrates. Ongoing obscurity in effect of herb feeding on FA in ruminant milk. Petersen et al. (2011) concluded that due to an increased transfer rate from feed to milk the concentration of n3 and n6 FA increased in milk when feeding fresh herbs, which disagrees with results of this study. The effect of start of grazing and number of days when goats were on a pasture on FA profile was except C14:0 and C15:0 significant (P<0.01). ΣMUFA and ΣPUFA was the highest in milk when goats were fed only indoors, whereas ΣSFA was in this sampling time the lowest.

Presence and changes of ΣSFA, ΣMUFA and ΣPUFA before and after start of grazing are similar to finding of Pajor et al. (2014). Short-chain free FA play a role in the "goaty flavours" of goat's milk. Presence of FA responsible for unpleasant aroma of goat's milk (C6:0, C8:0, C10:0) were the lowest when goats were fed only indoors with hay and concentrates and the highest when goats were 7 days on pasture. Similar as in this study, Salari et al. (2016) determined between spring and summer decrease in presence of C6:0, C8:0 and C10:0 in goat milk. C18:2*cis*6 remain during all sampling times relative stabile in range from 2.54 to 2.63 g·100 g^{-1} FA. These values of C18:2*cis*6 are like finding of Tudisco et al. (2010). They found values of C18:2*cis*6 in organic farming system 2.77 g·100 g^{-1} FA, which was higher than in conventional farming 2.07 g·100 g^{-1} FA. Proportion of C18:3n-3 in milk after start of grazing decreased from 1.25 to 0.93 g·100 g^{-1} FA and then slowly increased to 1.1 g·100 g^{-1} FA. Presence of C18:3n-3 was lowest at 7th day of grazing, which disagrees with finding of Kuchtík et al. (2015). They published the highest presence of C18:3n-3 at the beginning of lactation and authors assigned this fact to effect of the best quality of pasture in that period. It is known that some plants are characteristic with content of typical polyphenols (Brindza et al., 2015), type and relative abundance of dietary polyphenols was found to be positively correlated to concentration of linoleic and α-linolenic acid in ruminant milk (Kälber et al., 2011). Goat's milk is one of sources of CLA, which is considered to have beneficial physiological properties and can improve human health. The start of grazing increased value of CLA in goat's milk from 0.55 to 0.91 g·100 g^{-1} FA, however in the following sampling times value of CLA decreased in end of May to 0.74 g·100 g^{-1} FA and then in end of June to 0.65 g·100 g^{-1} FA. This decrease of CLA disagrees with results of Tudisco et al. (2010), they found in milk of goats in organic farming system increase of CLA from 0.5 in April to 0.97 g·100 g^{-1} FA in June. However, Meľuchová et al. (2008) described in milk fat of ewes on pasture increase of CLA between April and May, and then decrease in milk CLA between May and June, which is similar to results of this study. Khanal and Olson (2004) connected this lower milk CLA levels with the time required for adaptation of rumen microbes to a changing diet as well as physiology of milk fat synthesis based on type and quantity of fatty acids supplied with diet. Decrease of milk CLA isomers is correlated with decrease of α-linolenic acid content in grass lipids during pasture season (Meľuchová et al., 2008).

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Table 1. Fatty acids profile of goat's milk during experiment (g·100 g^{-1} FA)

	OI (n = 6)	7DoP (n = 6)	37DoP (n = 6)	67DoP (n = 6)	Range	SEM	P-value
C 4:0	1.62^{A}	1.65^{A}	1.82^{B}	1.85^{B}	1.6-1.89	0.028	**
C 6:0	1.9^{A}	2.38^{B}	2.35^{B}	2.23^{B}	1.76-2.38	0.06	**
C 8:0	2.22^{A}	3.17^{B}	2.88^{BC}	2.52^{AC}	1.99-3.17	0.105	**
C 10:0	6.67^{A}	10.28^{B}	9.25^{B}	8.19^{AB}	5.73-10.29	0.409	**
C 11:0	0^{A}	0.16^{B}	0^{A}	0^{A}	0-0.16	0.017	**
C 12:0	2.88^{A}	4.27^{B}	3.66^{C}	3.05^{A}	2.69-4.27	0.148	**
C 13:0	0^{A}	0.12^{B}	0^{A}	0^{A}	0-0.12	0.012	**
C 14:0	8.58	9.24	9.14	9.13	8.07-9.24	0.115	
C 15:0	0.93	0.92	0.91	0.96	0.9-0.96	0.007	
C 16:0	24.2^{A}	23.4^{A}	23.2^{A}	26.4^{B}	23.2-26.2	0.3	**
C 17:0	1.28^{A}	0.75^{B}	0.74^{B}	0.87^{B}	0.7-1.41	0.069	**
C 18:0	10.9^{A}	11.1^{A}	13.8^{B}	13.2^{B}	10.4-13.8	0.34	**
C 20:0	0.24^{A}	0.18^{B}	0.25^{A}	0.29^{C}	0.18-0.29	0.01	**
C 22:0	0.08^{A}	0^{B}	0.12^{AC}	0.14^{C}	0-0.14	0.018	**
C 14:1	0.12^{A}	0^{B}	0^{B}	0^{B}	0-0.13	0.016	**
C 16:1	0.8^{A}	0.54^{B}	0.42^{C}	0.55^{B}	0.42-0-84	0.041	**
C 18:1 *cis* 9	26.4^{A}	18.5^{B}	18.6^{B}	18.4^{B}	18.4-27.1	1.04	**
C 18:2 *cis* 6	2.59^{AB}	2.54^{A}	2.6^{AB}	2.63^{B}	2.54-2.64	0.009	**
C 18:3 *n* - 3	1.25^{A}	0.93^{B}	1.1^{AB}	1.08^{AB}	0.93-1.38	0.038	**
C 20:4 *n* - 6	0.18^{A}	0.13^{B}	0.11^{B}	0.13^{B}	0.11-0.2	0.009	**
C 20:5 *n* - 3	0.15^{A}	0^{B}	0^{B}	0^{B}	0-0.15	0.02	**
CLA	0.55^{A}	0.91^{B}	0.74^{C}	0.65^{AC}	0.48-0.91	0.038	**
ΣSFA	61.4^{A}	67.6^{B}	68.1^{B}	68.7^{B}	60.5-68.8	0.89	**
ΣPUFA	4.11^{A}	3.6^{B}	3.81^{AB}	3.84^{AB}	3.82-3.85	0.06	**
ΣMUFA	27.3^{A}	19^{B}	19.1^{B}	18.9^{B}	18.9-28.1	1.09	**
Σn3/Σn6 ratio	0.48	0.35	0.41	0.39	0.35-0.55	0.018	*
Σn6/Σn3 ratio	2.13^{A}	2.88^{B}	2.47^{AB}	2.56^{AB}	1.83-2.88	0.091	*

^{A} Means within a row bearing different superscripts differ significantly at P<0.01; SEM - standard error of mean; **P<0.01; *P<0.05; ΣSFA - sum of saturated FA; ΣMUFA - sum of mono unsaturated FA; ΣPUFA - sum of polyunsaturated FA; CLA - sum of all isomers of conjugated linoleic acid; OI – middle of April, goats fed only indoors with hay and concentrates; 7DoP – end of April, goats were 7 days on pasture; 37DoP – end of May, goats were 37 days on pasture; 67DoP – end of June, goats were 67 days on pasture.

Kirchnerová and Foltys (2013) concluded that the correlation of fatty acids with lactation stage and milk composition are quite weak and next, the changes in milk fatty acids are caused by the change in the ratio of *de novo* and depot fatty acids. Recommended n6/n3 ratio in nutrition is 5:1 (Hudečková et al., 2011). Values of n6/n3 of goat's milk (Table 1) are under this recommendation. Whereas Kuchtík et al. (2015) determined higher ration of n6/n3 and Salari et al. (2016) published lower ratio of n6/n3 similar as was determined in this study.

Conclusions

Start of grazing of dairy goats affects composition of milk fat. Significant changes were detected by the proportion of C18:2*cis*6, C18:3*n*-3, CLA, ΣSFA, ΣMUFA, ΣPUFA and n6/n3. Proportion of CLA in milk was the highest when goats were 7 days on pasture. Proportion of ΣSFA was at the start of experiment the lowest and after beginning of grazing increased in every sampling period. By fatty acids C6:0, C8:0 and C10:0, which are responsible for the development of unpleasant aroma a significant increase was detected in goat's milk at 7th day after beginning of grazing. Development of SFA, MUFA and PUFA of goat's milk after start of grazing was in this experiment different than published most of authors. Bud in general the proportion of fatty acids in goat's milk fat at the start of grazing can be affected by adaptation of rumen microbes to changing of diet, and during pasture season by different quality of ingested feed, potentially by ingestion of polyphenols or substances with antibacterial action, which can result to a change of milk fat fatty acids composition. Further research of effects of pasture on milk fat quality is needed.

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References

Brindza, J., Ivanišová, E., Grygorieva, O., Abrahamová, V., Schubertová, Z. (2015) Antioxidants from plants in human nutrition and improving health. Acupuncture and Medicine, 3, 40-51.

Hudečková, P., Straková, E., Suchý, P., Kralik, G. (2011) Plants oil in the diet for laying hens. In: Straková, E., Suchý, P., eds. IX. Kábrtovy dietetické dny. Brno: Tribun EU, 144-147.

Kälber, T., Meier, J.S., Kreuzer, M., Leiber, F. (2011) Flowering catch crops used as forage plants for dairy cows:Influence of fatty acid profile and tocopherols in milk. Journal of Dairy Science, 94, 1477-1489. DOI: https://dx.doi.org/10.3168/jds.2010-3708

Khanal, R.C., Olson, K.C. (2004) Factors affecting conjugated linoleic acid (CLA) content in milk, meat, and egg: a review. Pakistan Journal of Nutrition, 3, 82-98. DOI: https://dx.doi.org/10.3923/pjn.2004.82.98

Kirchnerová, K., Foltys, V. (2013) Milk fat fatty acids of cows in year-round ration feeding. Potravinarstvo, 7(SI), 78-81.

Kuchtík, J., Králičková, Š., Zapletal, D. (2015) Changes in physico-chemical characteristics, somatic cells count and fatty acid profile of Brown Short-haired goat milk during lactation. Animal Science Papers and Reports, 33, 71-83.

Lorková, M., Gažárová, M., Kopčeková, J., Magula, D. (2017) Consumption of milk and dairy products in patients with cardiovascular disease. In: Gálik, B., Zelinková, G., Proceedings of Slovak community for agricultural, forestry, food and veterinary sciences in Nitra: SUA in Nitra, 98-107.

Markey, O., Hobbs, D.A., Givens, D.I. (2015) Public health implications of milk fats: the current evidence base and future directions. Clinical Lipidology, 10, 5-8. DOI: https://dx.doi.org/10.2217/clp.14.66

Meľuchová, B., Blaško, J., Kubinec, R., Górová, R., Dubravská, J., Margetín, M., Soják, L. (2008) Seasonal variations in fatty acid composition of pasture forage plants and CLA content in ewe milk fat. Small Ruminant Research, 78, 56-65. DOI: https://dx.doi.org/10.1016/j.smallrumres.2008.05.001

Miluchová, M., Gábor, M., Trakovická, A. (2014) Analysis of genetic structure in Slovak Pinzgau cattle using five candidate genes related to milk production traits. Genetika-Belgrade, 46, 865-875. DOI: https://dx.doi.org/10.2298/GENSR1403865M

Pajor, F., Kerti, A., Penksza, K., Kuchtík, J., Harkányine, S.Z., Béres, A., Czinkota, A., Szentes, S., Póti, P. (2014) Improving nutritional quality of the goat milk by grazing. Applied Ecology and Environmental Research, 12, 301-307.

Petersen, M.B., Søegaard, K., Jensen, S.K. (2011) Herb feeding increases n-3 and n-6 fatty acids in cow milk. Livestock Science, 141, 90-94. DOI: https://doi.org/10.1016/j.livsci.2011.05.004

Salari, F., Altomonte, I., Ribeiro, L., Ribeiro, N., Bozzi, R., Martini, M. (2016) Effects of season on the quality of Garfanina goat milk. Italian Journal of Animal Science, 15, 568-575. DOI: http://dx.doi.org/10.1080/1828051X.2016.1247658

Šramková, K., Chlebo, P., Kopčeková, J., Durdíková, E., Mrázová, J. (2007) Milk and dairy products consumption in Slovak population. In: Kolesárová, A., Mašányi, P., Lukáč, N., eds. VII. Slovak seminar of animal physiology. Nitra: SUA in Nitra, 307-312.

Trakovická, A., Moravčíková, N., Miluchová, M., Gábor, M. (2015) Analysis of CYP19 gene polymorphism as factor affecting milk production of cattle. Journal of Microbiology, Biotechnology and Food Sciences, 4, 111-113. DOI: https://dx.doi.org/10.15414/jmbfs.2015.4.special2.111-113

Tudisco, R., Cutrignelli, M.I., Calabró, S., Piccolo, G., Bovera, F., Guglielmelli, A., Moniello, G., Infascelli, F. (2010) Influence of organic system on milk fatty acid profile. Small Ruminant Research, 88, 151-155. DOI: https://dx.doi.org/10.1016/j.smallrumres.2009.12.023

Vlček, M., Ofúkaný, M., Kanka, T., Kadlečík, O., Kasarda, R. (2016) Influence of claw disorders on production and reproduction performance in observed dairy cows herds. Acta Fytotechnica et Zootechnica, 19, 35-40. DOI: https://dx.doi.org/10.15414/afz.2016.19.02.35-40