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EFFECTS OF FLAX SEED SUPPLEMENTATION TO LACTATING GOATS ON MILK FATTY ACID CONTENT

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Abstract: Goat milk is very valuable and desired food for its high digestibility and unique composition, because contains only small amount of milk protein casein, thus is suitable for casein allergy. The aim of the study was to assess the quality of pastures located in less-favoured areas of Czech Republic and to investigate the influence of that quality on the content of fatty acids in goat milk. Two groups of goats were fed ad libitum intake of meadow hay and concentrate supplements, for experimental group contained 0.1 kg of flaxseed. Results of experimental group shows reduced SFA and increased content of MUFA and PUFA. Flax seed supplementation has an positive effect on increasing CLA in milk fat.

Keywords: goat, milk, flax seed, fatty acids, CLA

INTRODUCTION

Goats are reared worldwide for it´s performance, durability and excellent ability to adapt to demanding conditions. Their milk has an extra special dietary and sensory properties, for which it is prized in many countries. Goat milk was the first animal milk used in human nutrition where still plays an important role (Vejčík and King, 1998). It is very valuable and desired food for their unique composition and high digestibility. Proteins of goat milk are more digestible and their basic amino acids are absorbed easily in comparation to cow milk (Jandal, 1996 and Ceballos et al., 2009) and in

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addition, goat milk contains six out of ten essential amino acids in higher amounts (Haenlein, 2004).
One of milk proteins, casein, may cause allergy to milk. However, goat milk contain this protein only in small amount and for this reason is suitable for people suffering from casein allergy (Raynal-Ljutovac et al., 2008).
The results of chemical composition of milk from different authors are varied. It is influenced by geographic climatic conditions of goats breeding and genetic diversity of animals. This experiment was carried out in the Czech Republic and that is why the results of the Czech Union of sheep and goats were used (Bucek et al., 2009).
On the average in 2008 in the Czech Republic, goat milk contained 3,41 % fat, 3,14 % protein and 4,5 % lactose. From the viewpoint of five past years, fat and protein content slightly increased. Lactose content remains the same (see Bucek et al., 2009). Total milk yield was found to be rapid declinated. It was due to increasing of fat and protein content, likely.
Goat milk in human nutrition has several unique features. It is very similar to breast milk and is easily digestible (Gilbere, 2003). It is very suitable for people with digestive problems. Goat milk is slightly alkaline compared with cow. For that is suitable for people suffering from acidity (Jandal, 1996).

MATERIALS AND METHODS

The aim of this work was to assess the influence of selected feed rate on feed intake goats and their subsequent impact on milk composition. This attempt took place on an organic farm in LFA areas. Animals were divided into two groups. Both, control and experimental group contained 8 goats. Animals were fed ad libitum intake of meadow hay. The concentrate supplements contained 0,5 kg of barley/oat meal (in ratio 1:1) and 0,1 kg of flax seed for experimental group and 0,2 kg of barley/oat meal for control group, respectively. Experiment took 2 months with 14 days of preparation.
Analysis of milk fat, protein and lactose including pH and conductivity measurements were performed by the laboratory of the Department of Veterinary Sciences and product quality University of South Bohemia in České Budějovice. The fatty acids content were determined the Department of Applied Chemistry at the same university by gas chromatography. The results were statistically evaluated by Statistics 9th and ANOVA.

RESULTS AND DISCUSSION

The effect of the composition of diet on the goat milk is shown in Table 1. Average value of milk yield increased in the experimental group by 246 g. The diet has significant effect on the milk yield. No diferences on the content of milk fat, proteins and lactose between control and experimental group were detected.

Table 1. Effect of diet on the mean value of milk

	Contol group	Experimental group	min	max
Milk yield (g)	800	1046	395	1409
Milk fat (%)	2,73	2,78	2,27	3,30
Proteins (%)	2,95	2,95	2,70	3,24
Lactose (%)	4,39	4,39	4,30	4,47

The overview of analysed fatty acids from goat milk which were determined as statisticly significant and conclusive is listed in Table 2. Experimental group shows reduction of C4:0, C6:0, C8:0 and iso C16:0 in comparation to control group. The concentration of C18:2 (CLA) fatty acid was higher ($P < 0.05$) in the milk of goats fed by flax seed diets relative to the control diet.

Table 2. Statisticly significant fatty acids analysed from goat milk

	Control group		Experimental group					
	mean	SD	mean	SD	t	p	F-value	p
C4:0	3,902	0,517	2,973	0,792	2,886	0,010	2,351	0,269
C6:0	2,898	0,346	2,208	0,662	2,678	0,016	3,652	0,099
C8:0	1,841	0,296	1,403	0,434	2,456	0,025	2,145	0,323
isoC16:0	0,314	0,024	0,273	0,041	2,466	0,025	2,914	0,169
C16:0	26,486	2,092	28,532	1,710	-2,346	0,031	1,496	0,544
C18:2 CLA	0,368	0,050	0,524	0,104	-3,903	0,001	4,310	0,065

The comparation of content of fatty acids between control and experimental group, devided according to length of the chain, is shown in the Table 3.
Fatty acids were devided accorning to lenght of the chain to short chain fatty acids (SCFA) presented only by C4, medium chain fatty acids (MCFA)

C6-C12, long chain fatty acids (LCFA) C13-C21 and very long chain fatty acids (VLCFA) presented by C22 – C24.
The mean of SCFA and MCFA were reduced by flax seed suplement, LCFA and VLCFA were increased contrary to control group.

Table 3. Overview of fatty acids devided according to length of chain

	Control group		Experimental group					
	mean	SD	mean	SD	t	p	F-value	p
SCFA	3,902	0,517	2,973	0,792	2,886	0,010	2,351	0,269
MCFA	12,721	2,038	10,159	3,002	2,082	0,053	2,169	0,316
LCFA	83,151	2,134	86,642	3,541	-2,470	0,024	2,753	0,192
VLCFA	0,108	0,023	0,112	0,057	-0,166	0,870	5,894	0,028

The average values of fatty acids in goat milk are listed in Table 4. Results of saturated (SFA), mono-unsaturated (MUFA) and poly-unsaturated (PUFA) fatty acids between experimental and control group are compared.

Table 4. Fatty acids content in milk

	Control group		Experimental group					
	mean	SD	mean	SD	t	p	F- value	p
SFA	69,756	1,916	67,044	4,589	1,566	0,136	5,739	0,030
MUFA	26,456	1,771	28,779	4,594	-1,350	0,195	6,730	0,019
PUFA	2,446	0,187	2,639	0,345	-1,433	0,170	3,411	0,117

Differences in mean values of fatty acids content between experimental and control group are showed in figures. The concentration of saturated fatty acids was reduced by flax seed supplement (see Figure 1.) The decrease of SFA content could be also influenced partially by progress of lactation. The effect of lactation stage on the concentration of fatty acids in goat milk was observed by Strzałkowska et al. (2009, 2010).
The concentration of unsaturated fatty acids was increased as shows Figure 2 and Figure 3.
PUFA belong to fatty acids of a favourable effect on human health, however, a proper ratio of n-3/n-6 acid groups should be maintained, with the maximum value being 1/5 (Samková et al., 2008).
Flax seed contains a high oil level (40 % of total seed weight), and α-linolenic acid constituting 55 % of total fatty acids of the oil (Gao et al., 2009).

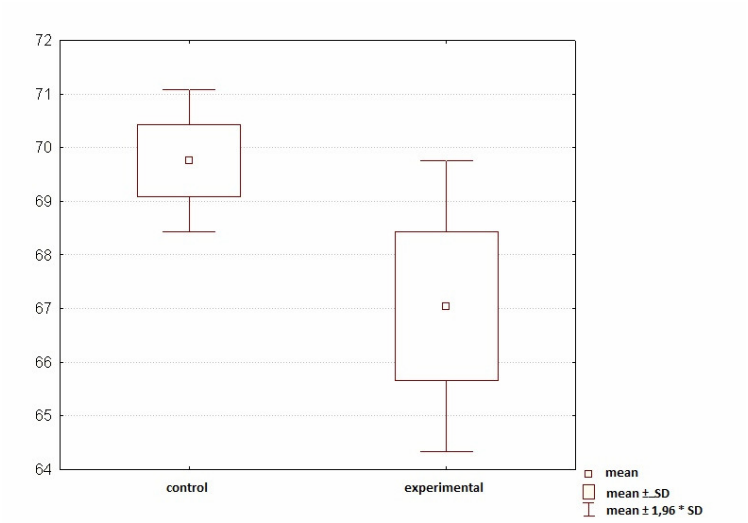

Figure 1. Mean of SFA content in milk in control and experimental group

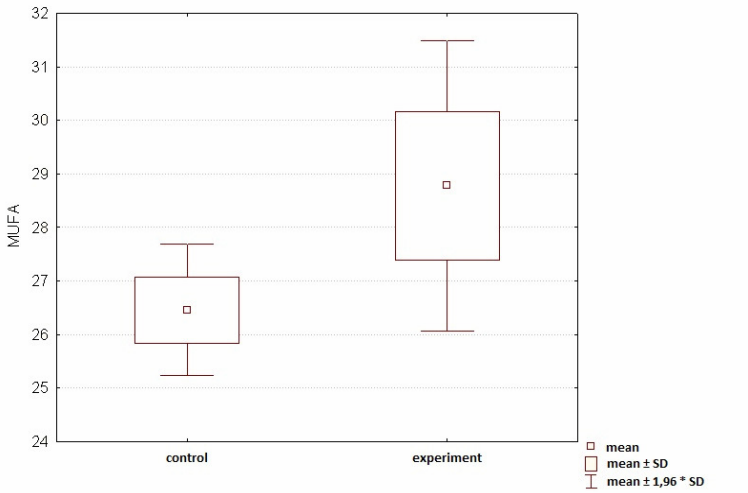

Figure 2. Mean of MUFA content in milk in control and experimental group

Park et al. (2007) presents the mean value of CLA in goat milk fat is 0,65 %, while sheep milk contain 1,08 % and cow milk 1,08 % CLA in milk fat. Addition of flax seed to the diet of goats resulted in increasing of unsaturated fatty acids content in milk. Similar values were founded by Král (2010). Our results are the same as Rusníkova et al. (2012) and Ryšavý et al. (2012) reported. The positive effect of flax seed supplementation to lactating ruminants confirmed Zhang et al. (2006). In their experiment were used

lactating ewes. In experiment by Čermák (2013) which was used on grazing goats were found similar results - during grazing the content of SFA in goat milk fat continuously decreased. Opposite trend was recorded for MUFA. A significant increase of herb proportion contributed to a highest content of PUFA (including CLA) in milk fat. The pasture had simillar effect on the milk composition as suplementation by flax seed.

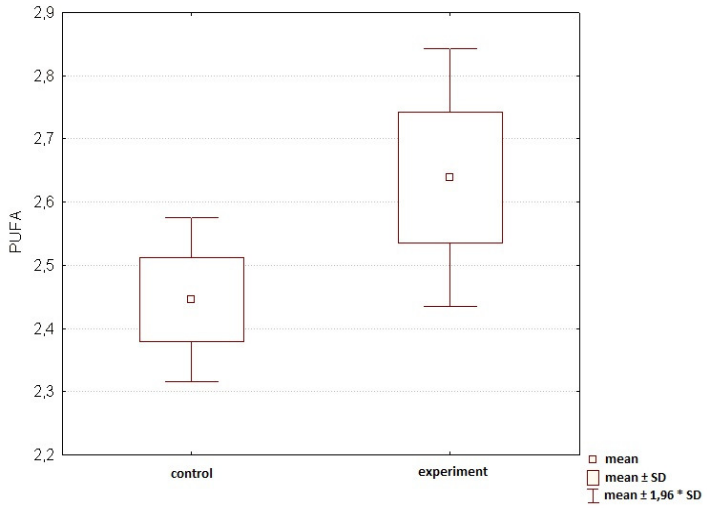

Figure 3. Mean of PUFA content in milk in control and experimental group

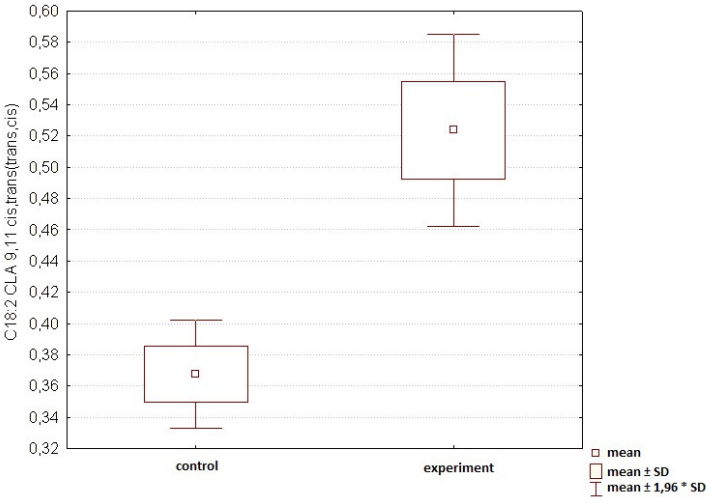

Figure 4. Mean of CLA content in milk in control and experimental group

CONCLUSIONS

Supplementation of flax seed to lactating goats has significant effect on milk composition and afterwards on improvement of milk quality. Results of experimental group showed increase of milk yield, in analyses of total fatty acids of goat milk was determined reduction of C4:0, C6:0, C8:0 and iso C16:0 acid. The concentration of CLA was higher ($P < 0.05$) relative to the control diet. Results also showed reduced mean of SCFA and MCFA, however LCFA and VLCFA were increased. The content of SFA was reduced, content of MUFA and PUFA raised. The decrease of SFA content could be also influenced partially by progress of lactation.

Flax seed to lactating goats can be used as nutritional supplement to reduce saturated fatty acids and increase polyunsaturated fatty acids in milk. A significant increase in CLA in milk was achieved by suplementation to goats. This fact has significant effect for human´s nutrition and health.

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REFERENCES

1. Buček, P., Kölbl, M., Milerski, M., Pinďák, A., Mareš, A., Wolf, J., Wolfová, M., Konrád, R., Martínková, E., Kuchtík, J., Kvisová, M., Látalová, J., Škaryd, V., Ryba, Š., Rafajová, M. (2009). *Ročenka chovu ovcí a koz v české republice za rok 2008.* Praha : Českomoravská společnost chovatelů a.s., Svaz chovatelů ovcí a koz v ČR.
2. Ceballos, L.S., Morales, E.R., Martínez, L.P., Extremera, F.G., Sampelayo, M.R. (2009). Utilization of nitrogen and energy from diets containing protein and fat derived from either goat milk or cow milk. *The Journal of Dairy Research. 76 (4), 497-505.*
3. Čermák, B., Král, V., Frelich, J., Boháčová, L., Vondrášková, B., Špička, J., Samková, E., Podsedníček, M., Węglarz, A., Makulska, J. & Zapletal, P. (2013). Quality of goat pasture in less-favoured areas (LFA) of the Czech Republic and its effect on fatty acid content of goat milk and cheese. *Animal Science Papers and Reports. 31 (4), 331-346.*
4. Gao, Y., Sun, t. & Li, J. (2009). Effect of oilseeds rich in linoleic and linolenic acids on milk production and milk fatty acid composition in dairy cows. *Front. Agric. China. 3 (3), 311-318.*
5. Gilbere, G. (2003). Everything was not "within normal range". *Total Health. 25 (1), 27-30.*

6. Haenlein, G.F.W. (2004). Goat milk in human nutrition. *Small Ruminant Research. 51(2), 155-163.*
7. Jandal, J. M. (1996). Comparative aspects of goat and sheep milk. *Small Ruminant Research. 22 (2), 177-185.*
8. Král, V. (2010). *Ověření vlivu krmiv na příjem krmných dávek koz a složení jejich mléka.* Diplomová práce, Zemědělská fakulta JU, Česká republika.
9. Park, Y. W., Juarez, M., Ramos, M. & Haenleinen, G.F.W. (2007). Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research. 68 (1-2), 88-113.*
10. Raynal-Ljutovac, K., Lagriffoul, G., Paccard, P., Guillet, I., Chilliard, Y. (2008). Composition of goat and sheep milk products : An update. *Small Ruminant Research. 79 (1), 57-72.*
11. Rusníková, L., Straková, E. & Suchý, P. (2012). Monitoring the quality of vegetace oils. *In Proceeding of international Animal Nutrition PhD Conference Brno November* 21.11.2012 *(pp 199-204).*
12. Ryšavý, J., Křížová, L. & Janštová, B. (2012). The effect of feeding rumen-protected CLA to lactating dairy cos on fatty acid profile of milk fat. *In Proceeding of international Animal Nutrition PhD Conference Brno November* 21.11.2012 *(pp 205-214).* ISBN 978-80-7375-667-3.
13. Samková, E., Pesek, M. & Špička, J. (2008) *Fatty acids of cow milk and factors affecting their composition.* Vědecká monografie1.vydání. České Budějovice: JU ZF, ISBN 978-80-7394-104-8.
14. Strzałkowska, N., Jóźwik, A., Bagnicka, E., Krzyżewski, J., Horbańczuk, K., Pyzel, B. & Horbańczuk, J.O. (2009). Chemical composition, physical traits and fatty acid profile of goat milk as related to the stage of lactation. *Animal Science Papers and Reports. 27 (4), 311-320.*
15. Strzałkowska, N., Jóźwik, A., Bagnicka, E., Krzyżewski, J., Horbańczuk, K., Pyzel, B., Słoniewska, D. & Horbańczuk, J.O. (2010). The concentration of free fatty acids in goat milk as related to the stage of lactation, age and somatic cell count. *Animal Science Papers and Reports 28 (4), 389-395.*
16. Vejčík, A. and Král, M. (1998). *Chov ovcí a koz.* 1. vyd. České Budějovice: Jihočeská univerzita v Českých Budějovicích Zemědělská fakulta, 1998. 145 s. ISBN 80-7040-297-0.
17. Zhang, R., Mustafa, A. F. & Zhao, X. (2006). Effects of flax seed supplementation to lactating ewes on milk composition, cheese yield, and fatty acid composition of milk and cheese. *Small Ruminant Research 63(3), 233-241.*