

**MILK YIELD, MILK COMPOSITION AND SOMATIC CELL COUNT OF DAIRY GOATS GIVEN N-3 UNSATURATED FATTY ACIDS DIET SUPPLEMENT**

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*Research of the effects of n-3 unsaturated fatty acids (PUFA, particularly eicosapentaenoic acid-EPA;  $\alpha$ -linoleic acid-ALA; docosahexaenoic acid-DHA) on goat's milk production (daily milk yield; daily fat, protein and lactose content) and somatic cell count and the persistence of this effect after terminated supplementation was conducted on 62 machine-milked Alpine breed goats kept at an indoor Alpine farm. After adoption period the animals were randomly allocated according to supplement addition into control group (G-4) with no added supplement and test groups (G-1; G-2; G-3) where a supplement containing PUFA was added over a period of five days. Measurements of milk yield and sampling (70 mL) for analysis of milk composition during the adoption period, supplementation period and first five days after supplementation were done every day at each milking (morning and evening). From the 5<sup>th</sup> to the 50<sup>th</sup> day of the after supplementation period, measurements and sampling occurred every fifth day. Based on the obtained results it could be concluded that the PUFA dietary addition alters the quantity and the quality of produced milk. DHA and EPA supplementation increase daily milk yield, while ALA supplementation induces a decrease of milk yield. When milk content is taken into consideration, the effects are contrary. Regarding somatic cell count, the highest effect on reduction was determined when ALA supplement was added. The mentioned effects persisted after the dietary supplement was withdrawn. The obtained results could be used in dietary supplementation planning in respect to the desired effects. Further research with the aim of determining the fatty acid composition of milk fat is needed.*

*Key words: goats, milk composition, milk yield, n-3 unsaturated fatty acids supplementation, somatic cell count*

INTRODUCTION

Goat's milk contains a high proportion of saturated fats the consumption of which could be considered as a risk factor for cardiovascular disease (Ney, 1991).

Polyunsaturated fatty acids (PUFA), which have been associated with a reduction in the above mentioned risk factor, are deficient in goat's milk (Daviglius et al., 1997; Albert et al., 1998). Ruminants diet supplement with different types of protected fats modify the composition of milk fat making it more suitable for human consumption (Grummer, 1991; Ashes et al., 1997). Gagliostro and Chilliard (1992) found that supplementation of PUFA in the goat's diet, depending on the level of added supplement and on the quantity of food consumed, alters the quantity and quality of produced milk. Ashes *et al.* (2000) determined a decrease of milk yield after PUFA supplementation. Same authors observed a negative effect of supplemented eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) on milk fat synthesis. Sanz Sampelayo et al. (2004) noticed that when the diet of lactating goats was supplemented with a ruminant metabolism-protected fat that was particularly rich in PUFA, milk yield, as well as fat and protein yields and PUFA content of milk fat increased. Chilliard *et al.* (2001) concluded that the effect of PUFA supplementation in ruminants' diet on milk production depends on supplementation quantity and duration of supplemented diet. Košmelj *et al.* (2001) in a study of PUFA supplementation effect on somatic cell count (SCC) in goat's milk determined a decrease in SCC as a consequence of  $\alpha$ -linoleic acid (ALA) addition. The objective of the present experiment was to investigate the effect of n-3 unsaturated fatty acids dietary supplementation on milk yield, milk composition and somatic cell count of dairy goats and the persistence of this effect after the supplemented diet is withdrawn. The results of conducted experiment could be utilizable in designing feed supplementation strategies aimed to obtain milk of a more desirable composition, as well as to determine if PUFA supplementation could be an appropriate and economic method to reduce SCC in goat's milk.

## MATERIAL AND METHODS

### *Experimental design*

The experiment was carried out on an indoor Alpine farm where 62 Alpine breed goats with average body weight of 51 kg ( $\pm 6$  kg) were kept. Regarding the lactation stage, goats were 4 to 20 weeks following parturition with the weaned goatling. The goats were machine-milked every day at 6.00 ( $\pm 30$  min) in the morning and at 6.00 ( $\pm 30$  min) in the evening. According to diet supplement addition, the experiment was divided into 3 periods: 1<sup>st</sup> – before supplementation (A01, ..., A09); 2<sup>nd</sup> – supplementation (B01, ..., B05); and 3<sup>rd</sup> – after supplementation (C01, ..., C50). The first nine days of experiment (A) was the adoption period after which the animals were randomly allocated into 4 groups. Group G-1 (15 animals) where supplement containing eicosapentaenoic acid (EPA) was added (oil produced by Pronova Biocare, Norway; and containing 94.93 wt% of EPA); group G-2 (15 animals) where the added supplement contained  $\alpha$ -linoleic acid (ALA) (linseed oil produced by A.C.E.F. Lex, and containing 57.84 wt% of  $\alpha$ -linoleic acid; 19.10 wt% of oleic acid and 14.35 wt% of linoleic acid); group G-3 (15 animals) where the supplement contained docosahexaenoic acid, DHA (oil produced by Nippon Chemical Feed Co; and

containing 74.75 wt% of DHA, 5.84 wt% of EPA and 2.05 wt% DPA.); and control group G-4 (17 animals) where no supplement was added. n-3 unsaturated fatty acids were supplemented in the amount of 20 g/day through a tube which was introduced into the oesophagus every morning during milking over a period of five days. In the 1<sup>st</sup>, 2<sup>nd</sup> and first five days of the 3<sup>rd</sup> experimental period measurements of milk yield and sampling (70 mL) for analysis of milk composition occurred every day at each milking, while from the 5<sup>th</sup> to the 50<sup>th</sup> day of the 3<sup>rd</sup> experimental period, measurements and sampling occurred every fifth day. For analysis of milk fat and protein content MilkoScan 133 B was used for the, while Fossomatic 5000 was used for the determination of somatic cell count.

#### *Statistical analysis*

For data preparation, statistical analysis and figure drawing the SAS/STAT package was used (SAS Institute Inc., 2000). Effects of the experimental group and experimental periods on daily milk yield; daily fat, protein and lactose contents; and on somatic cell count were tested by GLM procedure with a nested design. Duncan's Multiple Range Test was used for testing the differences between groups.

## RESULTS AND DISCUSSION

Figure 1 (A, B, C and D) shows the effects of both, the experimental time and the experimental group on milk production (daily milk yield and content). All analyzed traits were significantly ( $p < 0.05$ ) affected by the above mentioned factors while the interaction between them was not significant ( $p > 0.05$ ). The lowest milk production (figure 1A) was observed in goats fed with ALA supplement (G-2) while the highest milk yield was produced by goats with DHA supplementation (G-3). Significant difference ( $p < 0.05$ ) in yielded milk was determined between tested groups during supplementation (B01 – B05) and after supplementation (C01 – C50) periods. Decrease in milk production regarding advanced lactation stage (period C25 – C50) was determined in all groups. Gagliostro and Chilliard (1992) determined that milk production increased when the ruminants' diet is supplemented with a protected fat. Increase of milk yield could be due to the greater energy density presented by the supplemented diet. Giger *et al.* (1987); Sauvart *et al.* (1987); and Sanz Sampelayo *et al.* (1998) reported that in goats, milk production is more affected by the animals' energy balance, than by the characteristics of the diet. Sanz Sampelayo *et al.* (2002) determined that supplemented PUFA did not influence goat's milk production, while Sanz Sampelayo *et al.* (2004) obtained that the quantity of milk produced by the goats supplemented during one month period with 9% PUFA was higher than the corresponding value for the non-supplemented animals. Same authors concluded that supplementation gives rise to a more positive energy balance which results in increased milk production. Ashes *et al.* (2000) determined a decrease of milk yield after supplementation of PUFA. Chilliard *et al.* (2001) deduced that effect of PUFA supplementation in ruminants' diet on milk production depends on supplementation quantity and duration. Holter *et al.*

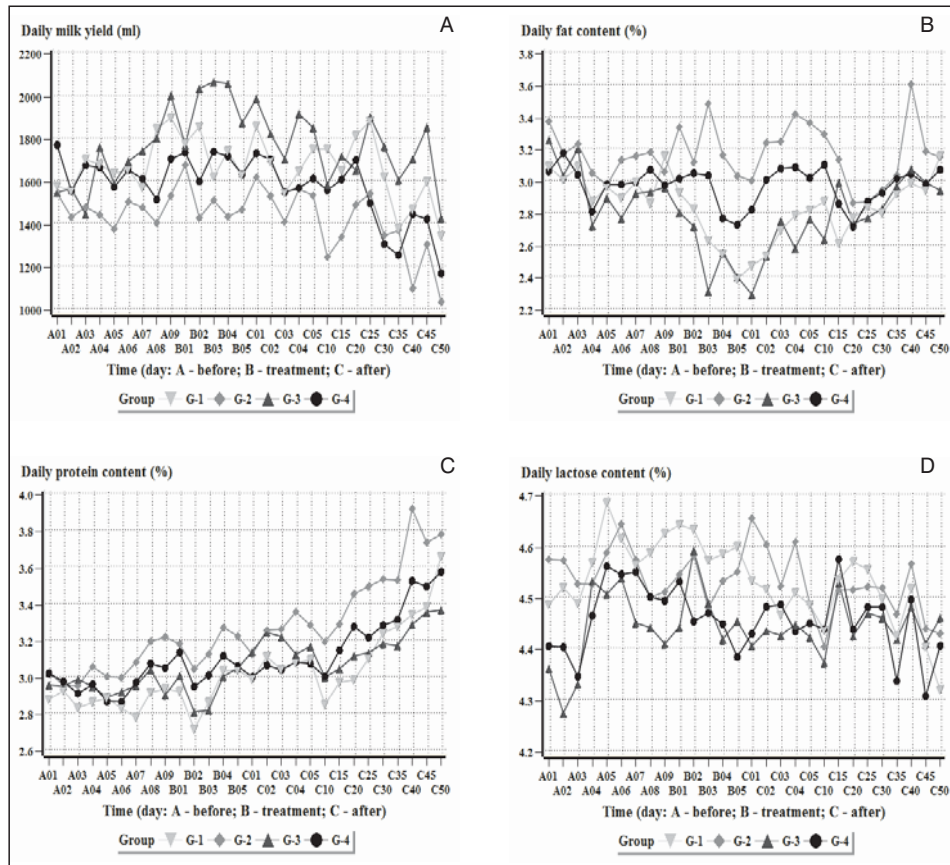


Figure 1. Daily milk yield (mL/day) – A, daily fat content (%/day) – B, daily protein content (%/day) – C, and daily lactose content (%/day) – D during experiment of goats fed with PUFA-supplemented concentrate (G-1, G-2, and G-3) or with non-supplemented concentrate (G-4)

(1992) and Sanz Sampelayo et al. (2002) noticed that when the ruminant diet is supplemented with fats, a greater efficiency is achieved in the use of metabolizable energy for milk production. Prolongation of this effect results in continued increased milk production after withdrawal of fat supplement. The obtained results in this experiment could indicate that DHA (G-3) supplementation gives rise to a more positive energy balance than the EPA (G-1) or ALA (G-2) supplementation. Statistically significant difference ( $p < 0.05$ ) in daily fat and protein content between tested groups was found during supplementation (B01 – B05) and after supplementation (C01 – C50) periods (Figure 1B and 1C). The highest daily fat and protein contents were determined in goats with ALA supplement (G-2) added. The lowest value of fat content was found in goats supplemented with DHA (G-3) while lowest value of protein content was observed

in goats with EPA supplement (G-1). A decrease in average daily fat content in the 2<sup>nd</sup> supplementation day and an increase during the first 10 days in the period after supplementation were determined in all groups. Also, an increase of average daily protein content during the entire experiment was determined in all tested groups. Increase of protein content in goat's milk was also noticed in the study of Kitessa *et al.* (2001). Chilliard (1993); Kitessa *et al.* (2001); and Ashes *et al.* (2000) determined the negative effect of eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids supplementation on milk fat synthesis. Hermansen (1989) remarked that the greater energy intake received as fat could lead to a greater production of milk fat. Garnsworthy (1996) concluded that the introduction of a protected fat into the diet may lead to a decrease the milk protein content and yield. This decrease could be due to reduced food intake, which leads to a lesser degree of microbial protein synthesis in the rumen and consequently a reduced synthesis of protein in the mammary gland. Sanz Sampelayo *et al.* (2004) determined that dietary addition of a PUFA produced an increase in milk fat and protein yields. These effects persisted after the dietary supplement was withdrawn. Figure 2 shows daily log value of somatic cell count during the experiment. Log (SSC) was significantly ( $p < 0.05$ ) lower in goats fed with PUFA-supplemented feed (G-1, G-2, and G-3) in comparison to goats fed with non-supplemented feed (G-4). Decrease in log (SSC) in groups with PUFA-supplement was determined during the 1<sup>st</sup> day of the supplementation period (B01) and continued until the 30<sup>th</sup> day after the supplementation period (C30). The lowest value of log (SSC) was determined in goats with ALA supplement (G-2). Adam *et al.* (1986) reported that ALA incorporates in phospholipids 5 hours after supplementation. Košmelj *et al.* (2001) determined a decrease in SCC in goat's milk as a consequence of ALA supplementation.

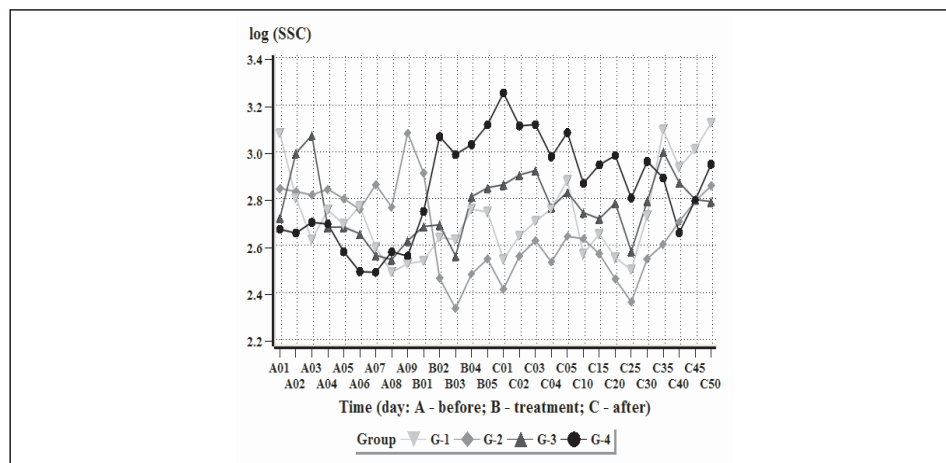


Figure 2 Daily log value of somatic cell count (log (SSC/day)) during experiment of goats fed with PUFA-supplemented concentrate (G-1, G-2, and G-3) or with non-supplemented concentrate (G-4)

### CONCLUSION

Based on the obtained results it can be concluded that the dietary addition of n-3 unsaturated fatty acids alters the quantity and the quality of produced milk. Daily milk yield increases when DHA and EPA supplements are added, while ALA supplement induces decrease of yielded milk. Supplement of ALA gives rise to milk composites increase, while on the contrary, DHA and EPA supplements decrease content of fat, protein and lactose in milk. All tested PUFA supplements decrease log (SSC) value, whilst ALA supplement has the highest effect on the somatic cell count reduction. The mentioned effects persisted after the dietary supplement was withdrawn. The obtained results could be used in dietary supplementation planning in respect to desired effects. Further research with the aim to determine the fatty acid composition of milk fat is needed.

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### KOLIČINA I SASTAV MLIJEKA TE BROJ SOMATSKIH STANICA MLIJEČNIH KOZA HRANJENIH n-3 PUFA SUPLEMENTOM

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#### SADRŽAJ

Istraživanje utjecaja n-3 nezasićenih masnih kiselina (PUFA, posebice eikozapentanoik kiseline-EPA,  $\alpha$ -linolenske kiseline-ALA, te dokozaheksanoik kiseline-DHA) na dnevnu proizvodnju kozjeg mlijeka (količina mlijeka, sadržaj mliječne masti, proteina i laktoze) i broj somatskih stanica te ustrajnost utjecaja po terminaciji dodavanja suplementa provedeno je na 62 strojno mužena grla Alpina pasmine koza. Grla su držana na farmi zatvorenog tipa. Nakon adaptacijskog perioda grla su, sukladno dodatku suplementa, randomizirano raspoređena u kontrolnu grupu (G-4) bez dodatka suplementa te tri testne grupe (G-1; G-2; G-3) sa dodatkom PUFA suplementa tijekom pet dana. Mjerenja količine mlijeka te uzimanje uzoraka za analizu sastava tijekom perioda adaptacije, perioda suplementacije te prvih pet dana nakon perioda suplementacije vršeno je svaki dan pri svakoj mužnji (jutarnja i večernja). U periodu od 5. do 50. dana nakon suplementacije mjerenje i uzorkovanje je vršeno svaki peti dan. Temeljem utvrđenih rezultata može se zaključiti da PUFA suplement mijenja i količinu i kvalitetu proizvedenog mlijeka. DHA i EPA suplement uzrokuju povećanje, dok ALA suplement uzrokuje smanjenje dnevne količine mlijeka. Suprotan je utjecaj utvrđen pri analizi dnevnog sastava mlijeka. Obzirom na broj somatskih stanica, najizraženiji redukcijski utjecaj utvrđen je pri dodatku ALA suplementa. Utvrđeni su utjecaji perzistirali i po prestanku suplementacije. Rezultati utvrđeni tijekom ovog istraživanja mogu se, ovisno o željenim rezultatima, koristiti prilikom planiranja suplementacije hranidbe.

