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## Effect of dietary linseed oil and malate on conjugated linoleic acid in rumen fluid, plasma and milk fat, and lipogenic enzymes in mammary gland and milk somatic cells in lactating goats

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### ■ Abstract

Plant oil in the diet is known to enhance milk fat composition and alter milk fatty acid profile owing to changes in the supply of fatty acid precursors and/or activity of lipogenic enzymes both in the mammary gland and in somatic cells in lactating goats. Twelve Sannen goats were used in a 3 × 3 Latin square design with 28-d experimental periods. Treatments comprised basic diets containing no additional oil (CON), linseed oil (LO; 4% of diet DM), or LO with malate (LOM; 2% of diet DM). Relative to the CON, LO and LOM enhanced milk fat yield (P=0.047) and milk fat content (P<0.015). The LO and LOM increased concentration of plasma glucose (P<0.03) and TC (P<0.026) in plasma compared to the CON. Feeding the LO and LOM diet increased concentration of C18:0 (P<0.019 – P<0.047), *trans*-11C18:1 (P<0.015 – P<0.039), *cis*9, *trans*11-CLA (P<0.001 – P<0.002) and C18:3 n-3 (P<0.001 – P<0.038) in rumen fluid from 1 h to 6 h post-feeding compared to the CON diet. The LO and LOM supplementation increased the proportions of the 9c-C18:1 (P<0.013), VA (P<0.001), *cis*9, *trans*11-CLA (P<0.035), *trans*10, *cis*12-CLA (P<0.022) and α-C18:3 (P<0.001) in the plasma lipids. Relative increases in milk fat VA secretion were greater for LOM (+366%) than for LO (+313%), and *cis*9 and *trans*11-CLA secretion were greater for LOM (+304%) than for LO (+237%) compared to CON. The LO and LMO in the diet decreased milk secretion of C4:0, C8:0, C10:0, C12:0, C14:0 (P<0.012) and C16:0 (P<0.016). The mRNA expression of LPL and SCD was increased in the somatic cell and in mammary gland by LO and LOM supplementation in the diet compared to the CON diet and a higher SCD mRNA expression for LOM-supplemented diet groups was observed compared to LO- supplementation in the diet. A substantially increased CLA proportion in milk induced by the supplementation of linseed oil with malate and associated with a higher SCD gene expression suggests that LO supplemented with malate may have a coordinate effect on the mRNA of the mammary enzymes involved in milk fat synthesis. The mRNA expression of key enzymes in milk somatic cells may indicate that milk somatic cells are a valuable tool for evaluating the information regarding gene expression of enzymes involved in lipid metabolism.

■ **Key words:** linseed oil • malate • conjugated linoleic acid • mammary lipogenic enzymes • somatic cell • lactating goat

### ■ References:

- [1] Bauman DE, Griinari JM. Nutritional regulation of milk fat synthesis. *Ann Rev Nutr.* 2003; 23: 203–227.
- [2] Livak KJ, Schmittgen TD. Analysis of relative gene expression data using real-time quantitative PCR and the 2<sup>-ΔΔC<sub>T</sub></sup> method. *Methods.* 2001; 25: 402–408.