Cattle responses to small inclusions of lipids in the diet

Diogo Fleury Azevedo Costa, PhD

Costa DFA. Cattle responses to small inclusions of lipids in the diet. Appl Food Sci J. 2017;2(1):14.

The retention time of digesta in the rumen of cattle grazing tropical forages is long and extensive biohydrogenation occurs. The conjugated linoleic acid (CLA) levels that are found are low but would still result in a significant level in the products so formed. Many supplements contain low levels of lipids or even if found in a high concentration in the supplement, are fed at a low level with the end result being that the supplement cannot markedly change the fatty acid profile in the rumen fluid. Some small but significant changes can occur e.g. with coconut oil and fish oil. The level of CLA that is found and the likely level of inhibitory isomers of CLA suggest that this would not result in an inhibition of lipid synthesis especially given the long retention time and biohydrogenation of unsaturated fatty acids.

Key Words: *Lipid; Diet; CLA; Biohydrogenation*

The lipids consumed by cattle are exposed to microbes initially within the rumen where unsaturated fatty acids (FA) undergo biohydrogenation (1). The time available for biohydrogenation is directly related to the retention time (RT) of the digesta in the rumen, and the source and amount of lipids in the diet will affect the FA profile reaching the intestines. This process, common to all ruminants, will influence fat composition in milk (2,3) or deposition in meat thereof (4,5). Tropical forages have longer RT than temperate forages and so the extent of biohydrogenation is not known but suspected to be almost complete. In addition, various isomers of conjugated linoleic acid (CLA) (e.g. t10 c12 CLA) inhibit lipogenesis (4,6) but the levels found under supplementation of tropical forages is not known. Costa et al. (7) supplemented beef cattle with low levels of a variety of lipid sources varying in FA profile simulating what might occur in field supplementation. Biohydrogenation under these circumstances of long RT (from 14-18 h) was complete and only low levels of CLA were found, certainly too low a level of any isomers of CLA known to inhibit lipid synthesis in the mammary gland or adipose tissue (8). Coconut oil increased other fatty acid proportions in the rumen fluid, e.g. lauric and myristic acids and fish oil increased the long chain FAs known to inhibit methane synthesis (9). The CLA level was only different in RF between cottonseed and fish oil treatments. Costa (10) found that the RT of fluid in cattle grazing wet season tropical forages ranged from 8-11 h, whilst dry season values reached 20 h. These values are longer than temperate forages and there was extensive biohydrogenation under these circumstances with no evidence of high enough levels of isomers of CLA known to inhibit lipid synthesis. Both Bauman et al. (6) and Smith et al. (4) outlined the inhibitory mechanism of t10 c12 CLA in the transcription of key genes involved in de novo synthesis of lipid in the mammary gland and subcutaneous fat. Whilst these mechanisms occur, it would appear from the current studies of tropical forages that, based on their FA composition and even with common supplements that contain high levels of lipid, the combination of RT, FA profile of the pasture and biohydrogenation, results in a FA profile low in polyunsaturated FAs (PUFA) and also too low in inhibitory CLA isomers to affect lipid synthesis. The CLA profile of tropical forages and common supplements and in the rumen of animals supplemented with these is low even of the beneficial isomers of CLA (7,10). Under extensive grazing scenarios the inclusion of oils in the diets would be impractical and most likely the addition of these oils would be through small quantities remaining in processed protein supplements that are commonly used. As indicated by Costa et al. (7), small quantities of oils in these supplements would most likely not be translated into major differences in FA profile of meat or milk. Of interest is the CLA content of rumen fluid of cattle grazing tropical forages which, while low, is still significant enough to be a significant contributor to CLA intake of people consuming these products. The levels found in the current studies for total FAs containing 18 Carbon chains ranged from 20 up to 40%, not being significantly different to control treatment with hay only. Values for the same FAs in the rumen fluid of cattle grazing temperate forages are above 70% of total FAs (11). The overall impact of Costa et al. (7) is that FA profile of oils were only partially translated into the rumen fluid of steers fed a tropical grass, which indicate that great changes could not be expected in products obtained from ruminants grazing tropical forages and consuming small quantities of lipids presents in protein supplements commonly fed to cattle.

REFERENCES

1. Jenkins TC. Lipid metabolism in the rumen. J Dairy Sci 1993;76:3851-63.
2. Bauman DE, Harvatine KJ, Lock AL. Nutrigenomics, rumen-derived bioactive fatty acids and the regulation of milk fat synthesis. Annu Rev Nutr. 2011;31:299-319.
3. Vahmani P, Fredeen AH, Glover KE. Effect of supplementation with fish oil or microalgae on fatty acid composition of milk from cows managed in confinement or pasture systems. J Dairy Sci. 2013;96:1-11.
4. Smith SB, Kawachi H, Choi CB, et al. Cellular regulation of bovine intramuscular adipose tissue development and composition. J Anim Sci. 2008:1-38.
5. Schmid A, Collomb M, Sieber R, et al. Conjugated linoleic acid in meat and meat products: A review. Meat Sci. 2006;73:29-41.
6. Bauman DE, Baumgard LH, Corl BA. et al. Biosynthesis of conjugated linoleic acid in ruminants. Proc Am Soc Anim Sci. 1999.
7. Costa DFA, Quigley SP, Isherwood P, et al. The inclusion of low quantities of lipids in the diet of ruminants fed low quality forages has little effect on rumen function. Anim Feed Sci Technol. 2017;234:20-8.
8. Bauman DE, Perfield II JW, Harvatine KJ, et al. Regulation of fat synthesis by conjugated linoleic acid: Lactation and the ruminant model. J Nutr. 2008;138:403-9.
9. Boeckaert C, Mestdagh J, Clayton D, et al. Micro-algae as potent rumen methane inhibitors and modifiers of rumen lipolysis and biohydrogenation of linoleic acid. Commun Agric Appl Biol Sci. 2004;69:127-130.
10. Costa DFA. Response of cattle to algae and fatty acids in the diet. School of Agriculture and Food Sciences, The University of Queensland, Brisbane, QLD, Australia. 2013:215.
11. Sun XQ, Gibbs J. Diurnal variation in fatty acid profiles in rumen digesta from dairy cows grazing high-quality pasture. Anim Feed Sci Technol. 2012;177:152-60.

Animal Sciences and Industry, Kansas State University, Manhattan, Kansas, USA

Correspondence: Diogo Fleury Azevedo Costa, Animal Sciences and Industry, Kansas State University, Manhattan, Kansas, United States of America. Telephone +1 7853709748, e-mail diogo@ksu.edu

Received: December 20, 2017, Accepted: December 29, 2017, Published: December 31, 2017