

Project Summary

Inhibiting Ruminal Lipolysis to Alter Gut Microbial Ecology and Prevent Biohydrogenation of Unsaturated Fats

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Background

Diets high in saturated fats are associated with certain negative health effects in humans such as coronary heart disease. Enhancing beef's fat profile to reduce the concentration of saturated fat could be beneficial to increasing consumer demand. Saturated fats in meat from ruminant livestock animals are largely a result of microbial biohydrogenation within the rumen, which rapidly saturates and thus limits the availability of free unsaturated fatty acids for absorption and assimilation. Numerous strategies involving supplementation of ruminant diets with alternative ingredients such as flaxseed, canola, soybean or fish oil have been tried as a way to increase the amount of unsaturated fatty acids passing the rumen with varying degrees of success.

There are some limitations to supplementing cattle diets with too much oil as it can inhibit digestive processes such as cellulolysis and fiber digestion. Lypolysis is necessary for biohydrogenation to occur, so the researchers hypothesized that inhibiting ruminal lipolytic activity may promote ruminal bypass of dietary lipids, thus improving beef's fat profile.

Doing so might also promote more ideal absorption and assimilation of mono- and polyunsaturated fatty acids from grass or concentrate diets as well as from various oilseed or marine oil supplements. Inhibition of ruminal lipolysis may also minimize detrimental effects of free fatty acids on ruminal digestion, which would potentially allow oil supplements to be fed at a higher level.

The overall objective of this project was to develop methods to enhance the degree of preferred mono- and polyunsaturated fatty acids in beef products.

Methodology

This project was conducted in three phases. In the first phase, the researchers sought to determine the level of lypolytic activity expressed by rumen bacteria. Specific strains were isolated to develop anti-lypolytic egg yolk antibodies.

Rumen bacteria strains (*Anaerovibrio lipolytica*, *Butyrivibrio fibrisolvens*, *Clostridium chauvoei* and *Propionibacterium acnes*) were either obtained as purified strains or isolated from fresh ruminal fluid from a cannulated cow. The bacterial strains were administered to laying hens to produce anti-lypolytic egg yolk antibodies.

In the second phase of the project, the effectiveness of the developed antibodies was tested against the lipolytic activity of mixed populations of rumen bacteria.

In the third phase, the researchers evaluated the effect of glycerol (2 percent and 20 percent) and 2.0 mM zinc chloride ($ZnCl_2$) solution were tested for their potential inhibitory effect against ruminal lipolysis in vitro.

Findings

Results from these experiments demonstrated that the developed egg yolk antibodies raised against preparations of the ruminal lipolytic bacteria *Anaerovibrio lipolytica* and *Butyrivibrio fibrisolvens* reduced rates of ruminal lipolysis, as measured by free fatty acids (FFA), by 50 percent.

This experiment also demonstrated that glycerol supplementation inhibited ruminal lipolysis by nearly 50 to 80 percent, depending on the amounts added. The researchers are planning further experiments to determine the nature of the inhibition and the effect of intermediate supplemental amounts, and whether it is persistent during long-term administration. Glycerol is produced as a byproduct of the biofuels industry and depending on cost, may be available for use as a feed supplement.

The researchers were unable to obtain sufficient quantities of purified lipase to generate anti-lipase antibodies, but the researchers felt such antibodies would be even more effective in inhibiting ruminal lipase activity. Future projects are planned to examine if this would be the case.

Implications

The results of this project provide evidence that inhibiting bacterial fat degradation may promote ruminal passage of unsaturated fats and thus greater incorporation of beneficial fats into beef products. The researchers are planning further studies to optimize the fat-protecting effect of these antibody and glycerol supplements in order to make their application cost-effective and feasible for beef producers.

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