

Livestock Efficiency

Use of methylglyoxal as a tool in predicting ruminal nitrogen status

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THE STORY IN BRIEF:

A three year study was conducted to determine the effects of protein supplementation to cattle grazing dormant winter forage on ruminal production of methylglyoxal (methylglyoxal). These results indicate methylglyoxal production is associated with a nutrient imbalance of carbohydrate and protein. Further research is necessary to determine the origin of methylglyoxal in the ruminant model. More information regarding the conditions conducive to methylglyoxal production and methylglyoxal's improved sensitivity, may potentially lead to development of a cost effective, producer friendly method of methylglyoxal quantification. This would be advantageous to the producer, offering yet another tool to aid in diet and supplement formulation, which could augment their bottom line.

THE PROBLEM:

A three year study was conducted to determine the effects of protein supplementation to cattle grazing dormant winter forage on ruminal production of methylglyoxal (methylglyoxal). Methylglyoxal is a toxic α -ketoaldehyde produced by rumen microbes in response to excess glucose and insufficient nitrogen (N), as is often the case when ruminants graze dormant forage. Ruminants produce methylglyoxal through an alternate shunt of the glycolytic pathway. Ruminants may produce methylglyoxal when fed high concentrate diets, or in the case of the current study, diets high in dormant forage with insufficient N. Both scenarios create conditions in the rumen with carbohydrate being in excess and inadequate protein (N) in relation to the needs of the microbial population. In addition to production of methylglyoxal via glycolysis, this toxin may result from amino acid breakdown and/or metabolism of fatty acids (Beisswenger et al, 2005; Lodge-Ivey, 2004).

OBJECTIVES: The objective of this study was to determine if methylglyoxal production could be used as a predictor of nutrient imbalance when cows grazed dormant range in New Mexico.

EXPECTED OUTCOMES: Methylglyoxal will be a more sensitive measure of nutrient status of the rumen since it is produced by the microbial population of the rumen in response to nutrient stress.

DURATION: 21 November 2004 to 15 February 2007 for three years

APPROACH:

Six ruminally-cannulated mature cows (average BW = 638.33 ± 50 kg) were assigned to two treatments using a completely random experimental design. Treatments consisted of: 36% CP cottonseed meal supplement fed 3x / week (900 g head⁻¹ • feeding⁻¹) and no supplement (salt and mineral only). Dormant pastures grazed were typical of central NM winter forage (yr 1: 8.2% CP, 75.1% NDF; yr 2: 7.0% CP, 65.4% NDF and yr 3: 6.7% CP, 68.3% NDF; DM basis). Ruminal fluid was collected every other week from mid-November to mid-February for a total of 5 sampling days and was analyzed for ammonia, pH, and methylglyoxal.

RESULTS:

Treatment did not affect ruminal ammonia (P = 0.94), pH (P = 0.96), or methylglyoxal (P = 0.17). Year (yr) of study influenced ammonia (P < 0.04), pH (P < 0.01), and methylglyoxal (P < 0.01) concentrations. Ruminal pH values were different (P < 0.01) for years 1, 2, and 3 (5.89, 6.33, and 5.59 ± 0.096, respectively). Ruminal ammonia in yr1 was 57.0% higher (P < 0.01) than year2 and 61.7% higher (P < 0.01) than year 3. Methylglyoxal was 55.6% higher (P < 0.01) in year2 than year1 and 48.8% higher (P < 0.01) in year 3 compared to year1. Ruminal methylglyoxal differed by day (P < 0.01) and was lower for collection 1 than 5 (0.87 vs. 2.27; P < 0.01). These data indicate that yearly forage quality is important for ruminal bacteria metabolism. In year 1 carbohydrate and N were better balanced compared to years 2 and 3. This was supported by greater methylglyoxal production in year 1 vs. years 2 and 3. Additionally, methylglyoxal production differed by day which may be indicative of methylglyoxal being a sensitive indicator of declining forage quality during the grazing season.

POTENTIAL APPLICATION: Further research is necessary to determine the origin of methylglyoxal in the ruminant model. More information regarding the conditions conducive to methylglyoxal production and methylglyoxal's improved sensitivity, may potentially lead to development of a cost effective, producer friendly method of methylglyoxal quantification. This would be advantageous to the producer, offering yet another tool to aid in diet and supplement formulation, which could augment their bottom line.

EDUCATIONAL PLAN:

5. Develop publications on factors and conditions that are conducive to ruminal methylglyoxal production to be used for extension and teaching purposes, including:
 - Agricultural experiment station bulletin on the impact of strategic supplementation
 - Western Section of the American Society of Animal Science annual meeting

REFERENCES:

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