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Effect of Age, Pregnancy, and Diet on Urinary Creatinine Excretion in Heifers and Cows

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Summary

A series of total urine collections was conducted to evaluate effect of age, pregnancy and diet on creatinine excretion in heifers and cows. To test effect of age on creatinine excretion, 31 animals ranging from 5 to 104 months of age were fed a hay diet supplemented with dried distillers grains (DDG). There was no difference in creatinine excretion across age. Cows fed the same diet were sampled to determine effect of pregnancy on creatinine excretion. Pregnancy did not affect daily creatinine excretion. Two collection periods were conducted to determine if diet alters creatinine excretion. In period 1, heifers were fed a hay diet supplemented with DDG; in period 2, heifers were fed a finishing diet. Creatinine excretion was lower in heifers on the finishing diet. Age and pregnancy did not influence creatinine excretion; however, diet may affect creatinine excretion in growing heifers.

Introduction

Since the introduction of the metabolizable protein system, it has become essential to quantify microbial protein supply in cattle. Purines are products of microbial protein degradation, and can be detected in duodenal flow and used to estimate microbial production. Further degradation products, purine derivatives, can be found in the urine of cattle and also used to estimate microbial production. For this latter technique to accurately estimate daily microbial production, 24-hour urine volume must be determined. This can be accomplished with total urine collections with urinary catherization or urine funnels or by collecting a random "spot" sample and calculating the 24-hour urine volume with a urinary marker. This latter technique is less invasive and can be used in a production setting. Creatinine, a urine metabolite, has been shown to be effective at estimating daily urine output. As product of muscle metabolism, creatinine is directly related to muscle mass, and has been significantly correlated to live weight. To calculate urine volume, 24-hour creatinine excretion must be determined. The constancy of 24-hour creatinine excretion must be evaluated for it to be a viable marker of urine output. Therefore, the objectives of this study were to test the effects of age, pregnancy and diet on the constancy of creatinine excretion.

Procedure

A series of total urine collections was conducted to evaluate the effect of age, pregnancy and diet on creatinine excretion in heifers and cows. Thirty-one heifers and cows (BW range = 216-1479 lb) were fed either a hay diet supplemented with dried-distillers grains or a finishing diet that was 90% concentrate and 10% forage. Animals were fitted with indwelling urethral catheters, housed in individual stanchions, and intake was limited to 2.0% of body weight. Urethral catheters were attached at each animal's hip and connected to tubing that led to a 2 L urine collection bag. Urine from each animal's bag was drained at 2 hour intervals from 6:00 a.m. to 6:00 p.m. Urine was allowed to accumulate from 6:00 p.m. to 6:00 a.m. then drained. Drainage was measured and recorded to the nearest 10 mL, and a 45 mL sub-sample was taken. Sub-samples then were composited by animal within day according to sample volume at each 2-hour interval, diluted for analysis, and stored at -4°F.

For each collection, urine was collected continuously over a 5-day period. Daily composite samples for each animal were analyzed for creatinine using the Jaffe Reaction (Sigma Diagnostics, Procedure

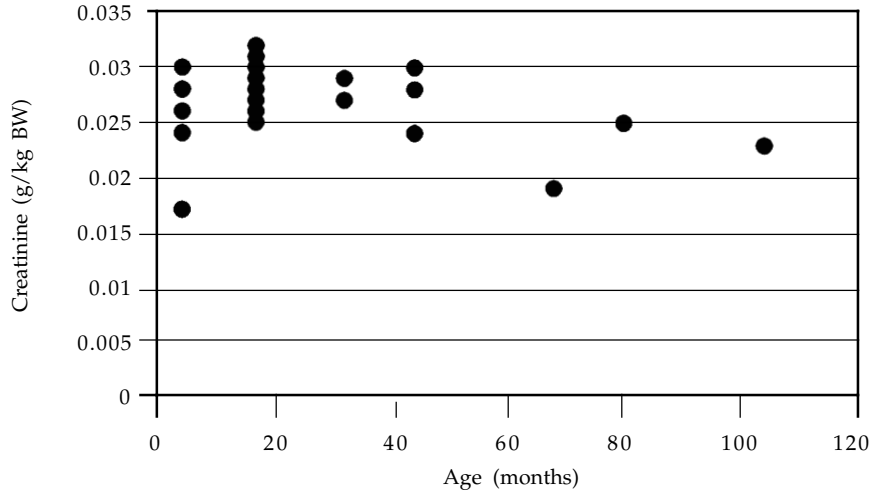

Figure 1. Relationship between average daily creatinine excretion and age of heifers and cows ranging from 5 to 104 months of age.

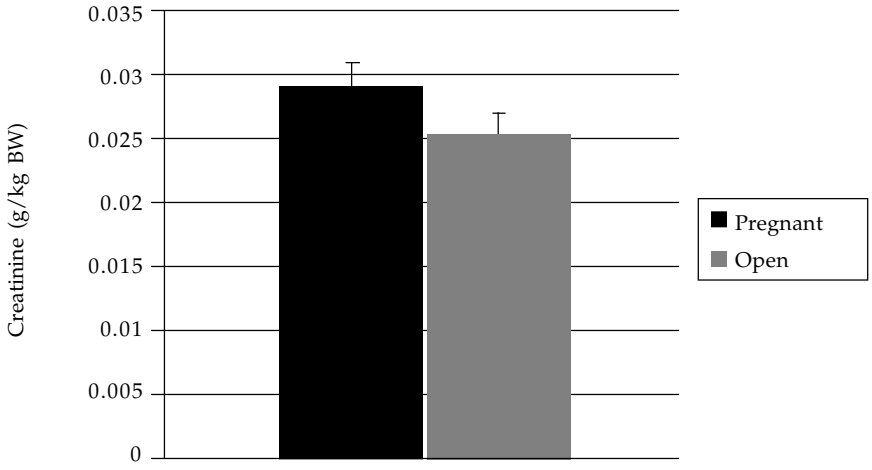

Figure 2. Average daily creatinine excretion of pregnant and open cows. SE = 0.0016 g/kg BW. Pregnant not different from open ($P > 0.05$).

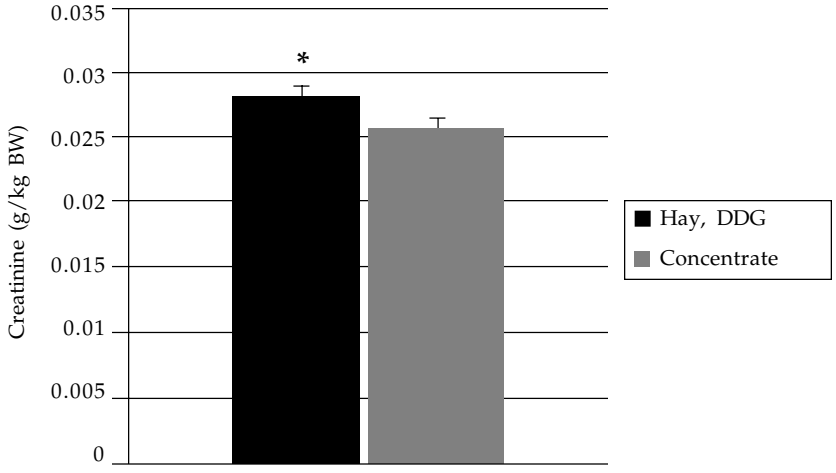

Figure 3. Average daily creatinine excretion of heifers fed either a hay diet supplemented with dried distillers grains or a finishing ration (90% concentrate: 10% roughage). SE = 0.0006 g/kg BW. * Treatments differ ($P < 0.05$).

#558). Each animal then was averaged over the 5-day period and creatinine values were expressed as g/kg BW by multiplying creatinine concentration by measured 24-hour volume and dividing by individual animal body weight.

To test the effect of age on creatinine excretion, 23 animals (BW range = 216-1479 lb) ranging from 5 to 104 months of age were fed a hay diet supplemented with dried distillers grains (DDG). Five pregnant and 8 open cows (BW = 1258 $\pm$ 129 lb) fed a hay diet supplemented with DDG were sampled to determine the effect of pregnancy on creatinine excretion. To determine if diet alters creatinine excretion, 8 heifers (BW = 970 $\pm$ 107 lb) were sampled for 2 urine collection periods. In period 1, heifers were fed a hay diet supplemented with DDG. In period 2, heifers were fed a finishing diet containing 90% concentrate and 10% forage.

Results

Results for the effect of age on creatinine excretion are presented in Figure 1. It was anticipated, due to differences in body composition over age, animals would excrete differing amounts of creatinine. There was no difference in creatinine excretion across all animals with respect to month of age ($P = 0.16$). Range of creatinine excretion across all cows and heifers was 0.017 to 0.032 g/kg BW, demonstrating variation in creatinine excretion across all animals.

Pregnancy had no effect on creatinine excretion in cows ($P = 0.09$; Figure 2). Pregnant cows excreted an average of 0.029 g/kg BW of creatinine compared to 0.026 g/kg BW for open cows. Excretion of creatinine across cows was variable and could account for the inability for a difference to be detected between open and pregnant cows.

Heifers consuming the hay diet supplemented with DDG excreted more creatinine than when

(Continued on next page)

consuming the finishing diet ($P < 0.05$; Figure 3). When heifers were fed the hay diet, they excreted an average of 0.028 g/kg BW, compared to 0.026 g/kg BW when fed the finishing diet. The two diets were formulated to be quite different. The hay/DDG diet would be expected to give 1 lb/day gain, while the finishing diet would give 3+ lb/day gain. Further, the hay diet supplies fiber as the primary energy source for the rumen microbes and the resulting endproducts to the heifer. The finishing diet is starched-based, producing a different microbial population and different endproducts. These two diets represent the extremes, yet the difference produced in creatinine excretion was only 9.6%. Using the NRC, the heifers were estimated to be approximately 15% fat when consuming the hay diet. After the adaptation and treatment period, heifers were estimated to be approximately 18% fat when fed the finishing ration. If 30-40% of the diet difference can be explained by greater percentage fat when the heifers were fed the finishing ration compared to the hay ration, then the impact of diet on creatinine is small.

For creatinine to be a viable marker for urine output, creatinine excretion must be independent of any physiological and environmental factors or we must be able to account for their influence. Animal-to-animal variation will require that either numerous animals be used for experiments or that latin square or switchbacks designs be used.

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