Effect of Residual Feed Intake, Gender, and Breed Composition on Plasma Urea Nitrogen Concentration in an Angus-Brahman Multibreed Herd

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Feed efficient beef cattle appear to more efficiently utilize absorbed diet protein than feed inefficient beef cattle.

Summary

Plasma urea nitrogen can be used as an indicator of N use and excretion by an animal. The objective of this research was to assess the effect of residual feed intake (RFI) on plasma concentration of urea N (PUN) in 188 bulls, heifers, and steers (mean body weight = 652 lb, SD = 82 lb) ranging from 100% Angus to 100% Brahman. Calves were assigned to pens in a GrowSafe feeding facility by sire group and sex, and self-fed a total mixed ration (corn, cottonseed hulls, chopped grass hay, cottonseed meal, molasses, and mineral-vitamin supplement; 90% dry matter (DM), 14% crude protein (CP), 0.7 Mcal/lb DM of NEm, and 0.4 Mcal/lb DM of NEg). The pre-trial adjustment period lasted 21 d. Individual daily feed intake was collected during the 70-d feeding trial; body weights were recorded every 2 wk. Blood (jugular) was drawn on d 56 for PUN. Residual feed intake was computed as the difference between actual and expected feed intakes. The RFI groups were high (RFI > mean + 0.5 standard deviation (SD)), medium (RFI between ± 0.5 SD), and low (RFI < mean – 0.5 SD; SD = 4.4 lb DM/d). Data (PUN) were analyzed using a mixed model. Fixed effects were sex of calf, RFI group, and Brahman fraction of calf; daily feed intake was a covariate. Random effects were sire and residual. Overall ADG was 2.74 ± 0.55 lb/d. Brahman PUN concentration was greater than Angus (P<0.01). Sex affected PUN (P<0.01) concentration with bulls having the lowest and heifers the highest. PUN concentration was related to RFI (P=0.02), indicating that more feed efficient animals also had lower PUN.

Introduction

Analyzing plasma urea nitrogen (PUN) concentration is a useful indicator of protein status within a group of animals, and can be used to predict nitrogen (N) utilization and excretion (Kohn et al., 2005). Nitrogen is a component of protein and urea is a waste product of protein utilization and metabolism. With similarly fed and managed animals, high PUN levels would indicate inefficient utilization of absorbed protein for growth and other animal functions, and conversely, low levels would indicate efficient utilization.

Canadian researchers have reported that the digestibility of diet crude protein (CP) was moderately positively related to feed efficiency in growing beef cattle (Nkrumah et al., 2006). However, the relationship between utilization of absorbed protein and N and feed efficiency has not been investigated using the advanced feed intake technology now available such as the GrowSafe™ system. The GrowSafe system allows the measurement of individual animal feed intake for cattle reared in groups. We hypothesize that feed efficient beef cattle will also be more efficient in the utilization of absorbed protein and resulting in less N loss to the environment. Thus, the objective of this initial study was to determine the effect of residual feed intake (RFI) on PUN concentration in growing bulls, heifers, and

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steers ranging from 100% Angus to 100% Brahman.

Residual feed intake was used as the measure of feed efficiency as it is phenotypically independent of average daily weight gain (ADG) and has become the preferred measure of efficiency of feed utilization (Koch et al., 1963; Archer et al., 1997). Residual feed intake is defined as the difference between actual and expected feed intake, therefore the lower the RFI, the better the feed efficiency.

Materials and Methods

Weaned beef cattle (n = 188; 7 to 8 mo of age; average initial body weight of 652 lb) were evaluated in a 70-d feed intake study. There were 11 bulls, 93 heifers and 84 steers from 6 breed groups: Angus (A; n = 25), Brahman (B; n = 28), ¾ A ¼ B (n = 36), Brangus (5/8 A 3/8 B; n = 31), ½ A ½ B (n = 43), and ¼ A ¾ B (n = 25). After weaning (August or early September), the calves grazed on bahiagrass (*Paspalum notatum*) and received a preconditioning diet for 3 to 6 wk in preparation for their feed intake trial at the Feed Efficiency Facility at the UF North Florida Research and Education Center in Marianna. This facility is equipped with GrowSafe^{TM} technology to measure individual feed intake in cattle housed in groups. The calves were assigned to pens of 15 or 16 head of either heifers or steers, or bulls and steers by sire, body weight and breed group. After assignment, the calves were self-fed a total mixed ration (corn, cottonseed hulls, chopped grass hay, cottonseed meal, molasses, and mineral-vitamin supplement; 90% DM, 14% CP, 0.7 Mcal/lb DM NEm, and 0.4 Mcal/lb DM NEg) for the duration of the study. The pre-trial adjustment period lasted 21 d. Individual daily feed intake was collected during the 70-d feeding trial; calf body weight was recorded every 2 wk. Blood (jugular) was drawn on d 56 into heparin-containing tubes; plasma was separated and analyzed for urea N (Coulombe and Favrean, 1963). The study started mid-October and ended in mid-December of 2007.

Residual feed intake was computed as the difference between actual and expected intakes. Expected feed intake was estimated as a linear regression of average daily feed intake on average daily gain and metabolic mid-weight. The RFI groups were high (RFI > mean + 0.5 SD), medium (RFI between ± 0.5 SD), and low (RFI < mean - 0.5 SD; SD = 4.4 lb DM/d).

Data (PUN) were analyzed using a mixed model. Fixed effects were sex of calf, RFI group, and Brahman fraction of calf; daily feed intake was a covariate. Random effects were sire and residual.

Results and Discussion

In this study, daily feed intake was used as a covariate for PUN statistical analysis as feed intake in itself can influence PUN concentration (Eggum, 1970). Day 56 was chosen for blood sampling as it is well into the 70-d feeding period and still be at the time of year in which climatic conditions would be comfortable for the cattle.

Overall cattle performance and PUN concentration are summarized in Table 1. Growth performance and feed intake were as expected given the age and size of the calves, the diet composition, and the climatic conditions. Mean RFI equaled 0 by design and varied plus or minus by 4.4 lb (one standard deviation). Calves with a negative RFI ate less feed than predicted for a given weight gain (feed efficient animals) whereas those with a positive RFI ate more for a given weight gain (inefficient animals).

Feed efficiency and average daily feed intake were affected by RFI grouping ($P < 0.01$; Figure 1). As expected, average daily gain was not affected by RFI grouping ($P > 0.10$) indicating that RFI was independent of this parameter.

Concentration of PUN was affected by RFI grouping, in that feed efficient cattle had lower PUN concentrations than feed inefficient cattle ($P = 0.02$; Figure 2). This finding indicated that feed efficient animals were more efficient in the utilization of absorbed protein for growth and other body functions than inefficient cattle. Another benefit would be less urea-N excreted via urine in the efficient animals as compared to the inefficient animals.

Sex of calf affected PUN concentration ($P < 0.01$; Figure 3). This effect was expected due to differences in hormone types and concentrations. Androgens increase utilization of protein-N by the animal to a greater extent than estrogen.

Breed grouping also affected PUN concentration ($P < 0.01$; Figure 4). In general, as the Brahman fraction increased from 0 to 100%, PUN concentration increased. This would indicate that Brahman cattle are not as efficient in the utilization of absorbed protein as Angus cattle. This effect may be due to the greater feed intake and poorer feed efficiency in Brahman versus Angus cattle noted in a companion study (Elzo et al., 2009).

The main result of this initial study indicated that more feed efficient cattle had lower PUN indicating that they were more efficient in the utilization of absorbed protein than inefficient cattle. Further testing is needed to confirm this initial finding.

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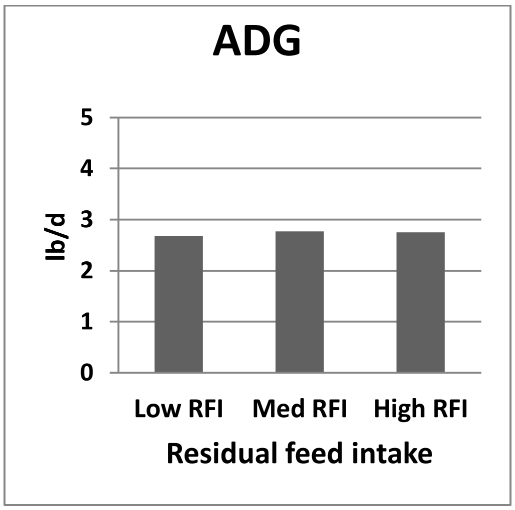
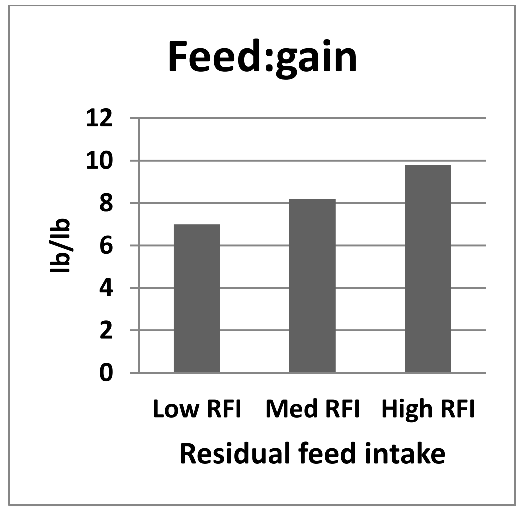
Table 1. Overall summary of growth performance and plasma urea nitrogen concentrations in growing beef cattle during the 70-d test feeding period

Trait	Mean	Standard deviation
Avg. daily feed intake, lb	23.5	4.6
Feed efficiency (feed:gain), lb/lb	9.0	2.5
Average daily gain, lb	2.74	0.55
Residual feed intake, lb/d	0	4.4
Plasma urea-N at d 56, mg/dL	11.9	2.9





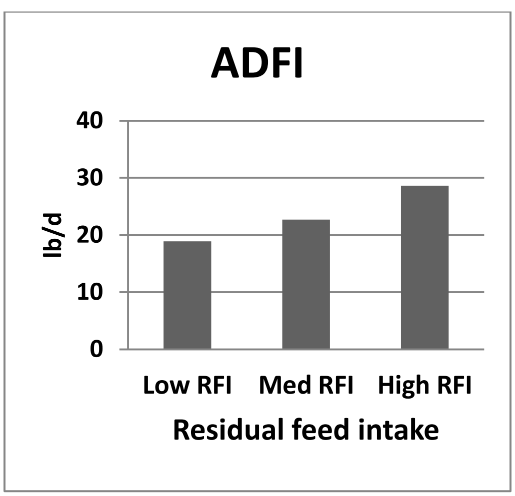


Figure 1. Residual feed intake grouping for average daily weight gain (ADG), average daily feed intake (ADFI), and average feed efficiency (Feed: gain) during the 70-d test feeding period (SE = 0.05 and $P > 0.10$ for ADG, SE = 0.5 and $P < 0.01$ for ADFI, and SE = 0.4 and $P < 0.01$ for F:G; least square means).

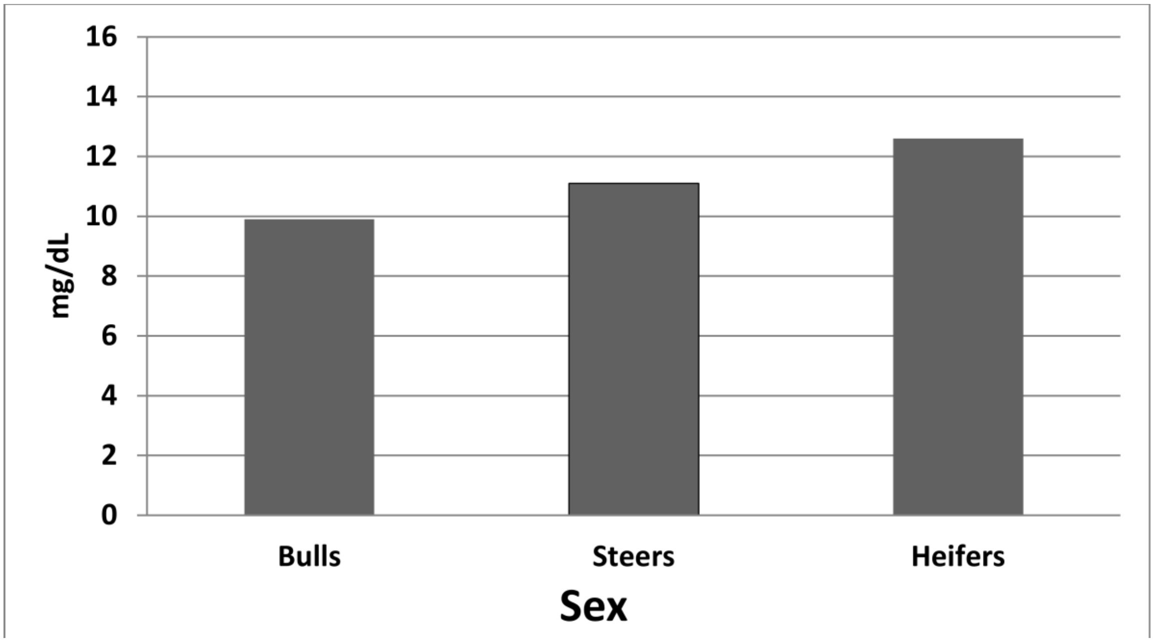


Figure 3. Effect of calf sex on plasma urea nitrogen concentration at d 56 of the 70-d test feeding period (SE = 0.2 and *P*<0.01; least square means).

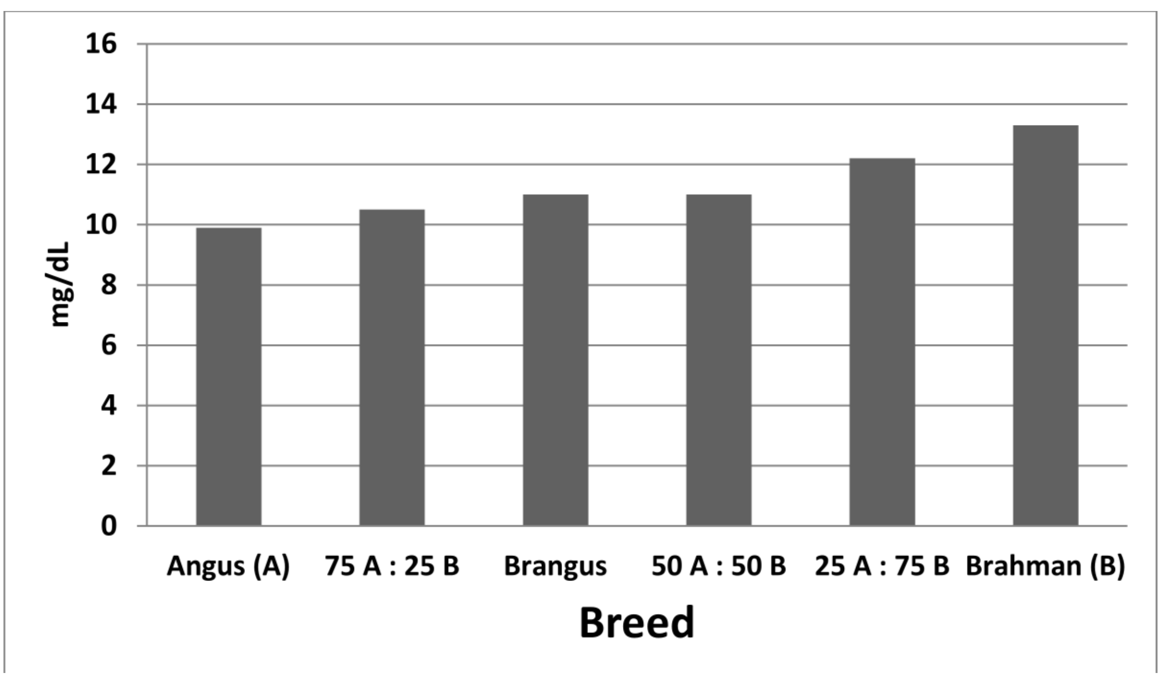


Figure 4. Effect of breed group on plasma urea nitrogen concentration at d 56 of the 70-d test feeding period (SE= 0.6 and *P*<0.01; least square means).