Water intake and factors affecting water intake of growing beef cattle[#]

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Abstract

A study was conducted to measure water intake in 7 to 9 mo old growing beef cattle, and to determine the effect of breed composition, gender, dry matter intake and body weight (BW) gain on water consumption. Growing bulls, steers, and heifers (n=146; average starting BW of 276 ± 67 kg) were housed in an open-sided barn for a period of 13 wk. Feed and water intake were measured individually in cattle reared in groups of 16 to 18 animals using the GrowSafe™ system. Cattle were weighed weekly. Mean BW gain was 1.41 kg/d. Mean water intake was 29.98 L ± 8.56 L/ head/d. Cattle of Brahman and Romosinuano breeding consumed less water than British and Continental influenced cattle at the same metabolic BW ($P<0.05$). There was no difference among bulls, steers, and heifers in water intake per kg of metabolic BW. The mean daily temperature remained within the thermal neutral zone throughout the study and had no influence on water intake. Water intake was positively correlated ($P<0.05$) with feed intake and BW gain. There was no relationship between water intake and gain-to-feed ratio.

Keywords: Beef cattle; Growth; Feed intake; Water intake

1. Introduction

There has been very little research on beef cattle water intake. Water has been traditionally considered an inexpensive, readily available, and renewable natural resource. However, this will likely not be true in the future.

Individual feed and water intake have traditionally been measured by housing animals individually. However, studies have shown that animals housed individually significantly alter their performance and behavior when compared to animals housed in production settings (Da Haer and Mercks, 1992; Nielsen et al., 1995; Guiroy et al., 2001; Beatty et al., 2006).

Electronic feeders, such as Calan Gates (American Calan, Northwood, NH), were an early solution to the aforementioned problems associated with intake studies. Electronic feeders isolate individual animals to individual stalls when feeding or drinking but allow them to remain in a group setting. However during eating or drinking, the animal is isolated.

Technology now exists than can measure feed and water intake on an individual basis for cattle reared in groups without obstruction from natural feeding and drinking behaviors. This system (GrowSafe^{TM}, GrowSafe Ltd, Airdrie, Alberta, Canada) uses radio frequency identification (RFID) technology to link intake data to individuals housed in group pens without the need to isolate them artificially at any point.

The purpose of this study was to 1) measure water intake in growing beef cattle, and 2) detect intake differences in water intake between animals of different genders and breed types.

2. Materials and methods

The study was conducted at the University of Florida North Florida Research and Education Center (NFREC) at Marianna in northwest Florida (30.8 N, 85.1 W) in the southeastern USA. The study ran from late September through late December of 2006 for a total of 13weeks. The research protocol was approved by the University of Florida Institutional Animal Care and Use Committee (IACUC number D477).

Growing beef steers (n=61), heifers (n=74), and bull calves (n=11) were housed at the NFREC Feed Efficiency (FE) barn for the duration of the study. This barn at NFREC was designed for use with the GrowSafe^{TM} system and was used for this study. The NFREC FE barn is open-sided and pens have concrete floors; sawdust bedding was used. Pens measured 7.3 m by

14.6 m with steel paneled pen dividers. All pens were under roof and were fully shaded from the sun. Pens were cleaned every other week.

Each animal was fitted with a RFID ear tag (Allflex USA, Inc., Dallas, TX, USA) prior to the beginning of the study. The tag is Computer and Communications Industry Association approved and safe for use with growing cattle. Each pen was equipped with two GrowSafe™ feed bunks and one GrowSafe™ water trough. Adjustable head gates allowed only one animal to drink or feed per bunk at a time. When an animal inserts its head into the bunk or trough, its RFID tag is automatically read by GrowSafe™ hardware. The data acquired is sent wirelessly to a data acquisition centers located throughout the barn. The data is then compiled and sent using spread spectrum technology to a GrowSafe™ software enabled computer in a nearby location. Accuracy of the GrowSafe™ system was checked prior to and after the study using known weights. Feed intake data obtained at the NFREC FE facility has been used in a recent publication by Elzo et al. (2009).

Twelve different breeds and crosses were included in the data set. Sire breeds used included Angus (AN), Brangus (BN), and Charolais (CH). Maternal breeds included BN, AN, Hereford x Angus (HFAN), Romosinuano (RS), Romosinuano x Angus (RA), Simmental (SM), Brangus x Hereford (BH,) and Simmental x Angus (SMAN). The resulting breeds and crosses were; ANBN (n=26), BN (n=58), BNHFAN (n=1), BNRS (n=18), BNRA (n=1), CHAN (n=8), CHBH (n=1), CHBN (n=15), CHRS (n=15), CHSM (n=1) and CHSMAN (n=2). Average starting BW was 276 ±87 kg and age was 7 to 9 month at the start of the study. Cattle were assigned to pens of 16 to 18 head per pen. Pen assignment was as even as possible by genetic background and BW; two pens were of bulls and steers; and six were of heifers and steers.

Cattle were allowed *ad libitum* access to a total mixed ration feed throughout the day with feed troughs being replenished twice daily at approximately 0800 and 1500 hr for the duration of the study. The diet was composed of whole dry corn (380 g/kg of total mixed diet), soybean hulls (181 g/kg), cottonseed hulls (136 g/kg), corn gluten feed (180 g/kg), chopped grass hay (100g/kg, “Beefmaker 60” mineral mix (Flint River Mills, Brainbridge, GA, USA; 20g/kg), and calcium carbonate (10 g/kg). Diet crude protein was 143 g/kg, net energy for maintenance was 1.55 mcal/kg, net energy of gain was 1.00 mcal/kg and Na was 1.2g/kg. Water was available *ad libitum*.

Following a two week adjustment period, all cattle were weighed weekly (n=13). Total weekly feed and water intakes per animal were determined for each of the 13 wk. Weekly average daily gain (ADG) and gain: feed (G: F) were calculated. Because feed and water intakes are expected to vary with BW, water and feed intake were adjusted by dividing kg of intake by kg of metabolic BW (MBW). Metabolic BW was calculated using the following equation: MBW = ((start BW, kg + end BW, kg) / 2) $^{0.75}$. For the determination of the effect of breed/cross, only those groups with eight or more animals were used. Ambient temperature was recorded by the Florida Automated Weather Network from the substation in Marianna.

Data were analyzed using SAS version 9.0 (SAS Inst., Inc., Cary, NC). The experimental unit was individual animal, rather than pen, as GrowSafe™ allows for individual measurements to be recorded. Variables measured included water intake (WI), feed intake (FI), WI adjusted for M BW, FI adjusted for MBW, ADG, and G:F. PROC MEANS was used to determine mean WI, FI, WI/ kg metabolic BW (WMB), FI/ kg metabolic BW (FMB), ADG, and G:F for each breed/cross group and again for each gender. PROC GLM and Tukey’s PDIFF were then used to separate significantly different means at the alpha = 0.05 level. PROC CORR was used to detect correlations that existed between variables. PROC REG, using a repeated measures model where week (time) was the repeated measure, was used to detect the linear relationships between variables.

3. Results

Mean WI was 29.98 L ± 8.56 L/head/d. When adjusted for MBW, cattle drank an average of 0.38 L ± 0.11 L/ kg of MBW. Mean FI was 9.73 Kg ± 2.01 kg/ d. or 0.13 kg of feed/ kg of MBW. The cattle gained an average of 1.41 kg ± 1.03 kg/d of BW and G:F averaged 0.14 kg ± 0.11kg BW gain/ kg FI. The average daily temperature was 15.0 ºC ± 3.5 and remained within the thermal neutral zone (5 to 20 ºC) for the duration of the study. Temperature during the study had no influence (P > 0.05) or feed or water intake. Water present in the feed was not included in the amount of WI/d.

Charolais x Angus cattle drank more (P<0.05) water compared to all other breeds and crosses (Table 1). The ANBN, BN, and CHBN cattle had similar (P> 0.05) WI. These breed/cross groups consumed less water (P< 0.05) compared to the CHAN cattle and had a greater WI than either BNRS or CHRS cattle (P< 0.05). The BNRS cattle drank less than the non Romosinuano crosses but drank more than CHRS cattle (P< 0.05). The CHRS cattle had the lowest gross WI when compared to all other breed/cross groups (P< 0.05)

When intake was adjusted for MBW, CHAN cattle drank more water than all other breed combinations (P< 0.05; Table 1). The ANBN cattle drank more water per unit of MBW than all other breeds/crosses except CHAN (P< 0.05). The CHBN, BN, and CHRS were similar (P>0.05) in adjusted WI drinking less than CHAN and BNAN cattle (P< 0.05). The BNRS cattle had the lowest intake per unit of MBW, but the average intake was not different (P >0.05) from average intakes of the

BN and CHRS groups. Bulls, heifers, and steers were all similar in both gross and adjusted WI ($P > 0.05$; means not shown).

Gross WI was related to ADG, but was not correlated with G: F (Table 2). Cattle that consumed greater quantities of water gained more BW overall ($P<0.05$), but were not necessarily more or less feed efficient than cattle who consumed less water. When adjusted for MBW, WI was positively correlated with FI, FI per unit of MBW, and ADG. There was no relationship between WI per unit of MBW and G: F (Table 2).

When WI adjusted for MBW was regressed with ADG, a weak ($r^2=0.005$) linear relationship was evident ($P<0.001$). Average daily gain exhibited a slight linear relation to gross WI ($r^2=0.009$). The strongest linear relationships existed between FI and WI ($r^2 = 0.13$) and WI adjusted for MBW ($r^2=0.084$).

4. Discussion

The NRC (1996) estimates beef cattle WI using information from a review by Winchester and Morris (1956) and utilizes animal BW and ambient temperature. The average WI observed during our study was within the range of 25 to 35 L/head/d predicted by Winchester and Morris (1956). The agreement of our study with that of Winchester and Morris was somewhat surprising as data used in their calculations were mostly from studies of individual animals that were of short duration. This is contrary to studies mentioned in the introduction (Da Haer and Mercks, 1992; Nielsen et al., 1995; Guiroy et al., 2001; Beatty et al., 2006) that housing animals individually may alter feeding and drinking behaviors. Our results, in contrast, were from a rather large population of individuals reared in groups and for a relatively long duration.

Average WI in our study, however, was 28% less than what would have been predicted using the WI predication equation of Hicks et al. (1988). The Hicks et al. equation was designed to be used for growing/finishing beef cattle reared under feedlot conditions. The difference may have been due to the differences in facilities and management practices that exist between feedlot cattle maintained in open dry lots and the cattle in our study that were housed in an open-sided, concrete-floored barn.

The relationship of WI to FI and ADG was expected and has been documented previously (Winchester and Morris, 1956; Paquay et al., 1970; Little and Shaw, 1978; Murphy et al., 1983; Holter and Urban, 1992; Beede and Collier, 1986; NRC, 1996). The relationship of WI with G: F is not as well known – and we observed no relationship of WI and feed efficiency. In a preliminary study with growing Angus bulls, Hansen et al. (2007) noted that more feed efficient bulls drank less water per unit of BW gain than less feed efficient bulls. An explanation for the difference between the two studies is not apparent. This previous study, like ours, used the GrowSafe™ system. However, Hansen et al. (2007) utilized a homogenous population of cattle with high growth potential while our research was with a heterogeneous group of mixed breeds and crossbred cattle, and calves of mixed gender.

Cattle from tropically adapted cattle breed types (Romosinuano and Brahman) consumed less water in our study than British or Continental influenced cattle even when adjusted for MBW. This observation agrees with previous studies comparing *Bos indicus* cattle to *Bos taurus* cattle (Winchester and Morris, 1956; Phillips, 1960; Coiditz et al., 1972; Beatty et al, 2006). However, we are not aware of studies of comparing heat adapted *Bos taurus* cattle (Romosinuano) to normal *Bos taurus* cattle.

Gender was found not to influence water intake. The animals used, however, were young growing cattle not near maturity to exhibit lean tissue mass differences. Additional, only a small number of bulls were used in the comparison.

5. Conclusions

Individual water consumption was measured using a continuous data acquisition system in a large number of growing beef cattle with different breed composition and gender that were reared in groups. Consumption averaged 29.98 ± 8.56 L/ d for cattle weighing between 200 and 400 kg and gaining at a rate of 1.41 kg/ d. Water intake was positively correlated with average daily gain and feed intake, but had no relationship to feed efficiency.

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Table 1

Influence of breed composition on water intake (WI) of growing beef cattle

Breed Composition	Gross WI, L/head/d	WI/kg metabolic BW, L/head/d
Charolais X Angus	42.8[a]	0.58[a]
Angus X Brangus	30.8[b]	0.42[b]
Brangus	30.8[b]	0.32[c,d]
Charolais X Brangus	29.7[b]	0.38[c,b]
Brangus X Romosinuano	24.1[c]	0.28[d]
Charolais X Romosinuano	20.7[d]	0.32[c,d]

[a,b,c,d] Means in the same column with a different superscript differ ($P<0.05$).

Table 2

Significance (P-values) of relationship of variables[a]

	FI	FMB	WI	WMB	ADG	GF
FI		<0.001	<0.001	<0.001	<0.001	0.027
FMB	<0.001		<0.001	<0.001	<0.001	0.001
WI	<0.001	<0.001		<0.001	0.001	0.568
WMB	<0.001	<0.001	<0.001		0.016	0.756
ADG	<0.001	<0.001	0.001	0.016		<0.001
GF	<0.001	0.001	0.568	0.756	<0.001	

[a]FI = feed intake, FMB = feed intake adjusted for metabolic BW, WI = water intake, WMB = water intake adjusted for metabolic BW (MBW at mid trial), ADG = average daily gain, and GF = gain to feed ratio.