Association of carcass quality traits, genetic and management factors on scrotal circumference development in yearling Angus bulls

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Abstract

The objective of this study was to estimate the association among various carcass traits, genetic and management factors on scrotal circumference development in yearling Angus bulls. Data obtained from Angus bulls (N=1374) were retrospectively evaluated. Pearson correlation coefficient analysis was performed to estimate the linear relationship between the variables. The mean (± SEM) scrotal circumference (SC), body weight, and carcass traits were different among age groups, locations, years and expected progeny difference (EPD) groups (P<0.05). For yearling bulls, positive correlations were observed between the following: body weight and SC (r=0.11; P=0.0001), age (d) and SC (r=0.22; P=0.0001), SC-EPD and adjusted yearling SC (r=0.50; P=0.0001), 240 d SC and yearling SC (r=0.42; P=0.0001), SC and adjusted yearling rump fat (r=0.07; P=0.008), SC and adjusted yearling rib fat (r=0.12; P=0.0001), SC and adjusted yearling rib eye area (r=0.13; P=0.0001), SC and adjusted yearling percent intramuscular fat (r=0.06; P=0.05). Bull average daily weight gain during the trial period was positively correlated with growth differences in SC during the same period (r=0.13; P=0.0001). The SC growth per day was higher for bulls completing the trial period at < 1 year of age compared to those > 1 yr, and higher SC EPD values were associated with more SC growth during the trial period. In summary, the current study shows significant but moderate to poor positive associations among yearling bull SC and various growth and carcass quality traits, so we conclude that the best method to increase SC in Angus bulls would be by independent bull selection based on the sire SC-EPD trait.

Keywords: Sire, progeny, scrotal circumference, carcass trait, EPD

Introduction

Proper bull selection is the most rapid way to change the genetic component of a cattle herd. Selecting bulls that are genetically superior through National Cattle Evaluation programs can double the genetic change compared to within herd selection.[1] However, reproductive traits also must be considered in genetic improvement even though their heritability is low.[2-4]

The most important single determining factor for bulls attaining satisfactory potential breeder status is larger SC, accounting for 66 to 72% of failures to achieve satisfactory breeding soundness status.[4] Scrotal circumference has been found to be positively correlated with growth and reproductive traits. Several studies have found moderate to high genetic correlations between SC and growth traits.[5-7] Bourdon and Brinks suggested that positive genetic correlations between scrotal circumference and growth traits also inherently affects fertility in females.[6] Thus, the selection of bulls with larger SC and higher growth rates may improve reproductive efficiency in female offspring.

Beef seedstock breeders have available EPDs for carcass traits including rib eye muscle area and subcutaneous fat thickness at the rib and rump for use as selection criteria. These data are collected from real-time ultrasound scanning of yearling bulls and heifers in seedstock herds. Producers also use SC-EPD as a selection criterion. Determination of the effectiveness of using different traits for selection is a complex problem. Factors affecting decisions about selection criteria include use for sire, dam, or individual selection, potential number of animals measured and the intensity of selection possible, relationship with other desirable effects and age at measurement. The producers' perception is that selection for carcass traits, especially less external fat and bigger rib eye area results in smaller SC.

The objective of this study was to estimate the association among various carcass traits, genetic and management factors on SC development in yearling Angus bulls.

Materials and methods

Multiple farm source Angus bulls (N = 1374) were brought to Virginia Beef Cattle Improvement Association-sponsored bull test stations at two locations (location 1 and location 2) in Virginia, for a four month evaluation period. Data from bulls entered in the test stations from 2002 to 2006 were retrospectively evaluated.

Bull management

Bulls entering the test stations were managed under the auspices of the Virginia Beef Cattle Improvement Association. Weaning age and age at arrival at the test station varied among farms. Bulls born August through November were designated as senior bulls (9.0 to 11 months of age), whereas bulls born January through March were designated as junior bulls (6.5 to 8.5 months of age). At location 1, senior bulls arrived in July, and junior bulls in November. At location 2, both senior and junior bulls arrived in October. At arrival, senior and junior bulls were divided into two pens of 50 to 70 bulls based on age, weight, and breed at both locations. Each bull had negative brucellosis and tuberculosis tests or was from a certified and accredited herd, and negative anaplasmosis and persistently infected bovine viral diarrhea virus tests. On arrival, bulls were weighed, vaccinated for infectious bovine rhinotracheitis, parainfluenza type 3 virus, bovine viral diarrhea virus, bovine respiratory syncytial virus, seven species of Clostridia, and Pasteurella and were dewormed. All bulls were subjected to examination of the scrotum and its contents and measurement of SC. Bulls with significant abnormalities were rejected from the test.

Bulls were fed a transition ration for a period of 14 d, at which time they received at ration formulated to achieve daily weight gain of 3.75 pounds (72% total digestible nutrients, 13.5% crude protein) when offered ad libitum. At location 1, the ration was composed of primarily corn silage, dry corn, and soybean meal. Similar feedstuffs were offered at location 2 from 2002 through 2004. In 2005, a commercial dry feed consisting of corn gluten feed, wheat midds, cottonseed hull pellets, peanut hulls, soy hulls, dry distillers' grains was utilized. All diets included an ionophore.

Bulls were maintained at the bull test stations for a test period of 112 to 133 days. At the end of the test period, bulls were weighed and subjected to reproductive examination procedures including SC measurement and extension of the penis either manually or by stimulation with an electroejaculator and transrectal examination to assess the internal reproductive organs.

Pre-slaughter carcass characteristics were measured by a Beef Improvement Federation certified technician with an ultrasound scanner using a 3.5 MHz, 17.2 cm linear array transducer (Aloka 500V; Corometrics Medical Systems, Wallingford, CT). Measurements were taken when the average age of the bull group was approximately one year and measurements were adjusted to yearling values. Bulls were measured for rib fat thickness between the twelfth and thirteenth ribs over the longissimus muscle, for rib eye area over longissimus muscle area between the twelfth and thirteenth rib and for the rump fat thickness at the P8 site (P8 site is located over the gluteus muscle on the rump, at the intersection of a line through the pin bone parallel to the chine and its perpendicular through the third sacral crest). Predictions of percent intramuscular fat were made on images collected from a longitudinal scan of the longissimus muscle made longitudinally over eleventh to the thirteenth rib and analyzed with software developed by Iowa State University.[8]

Expected progeny differences for individual bulls tested and their sires were obtained from the American Angus Association (http://www.angus.org/registeredangus/index.html). The variables of interest were bull's age, weight, average daily weight gain, SC, adjusted 240 day SC, adjusted yearling SC, bull and sire SC EPD, adjusted yearling ultrasound rib fat, adjusted yearling ultrasound rib eye area, adjusted yearling ultrasound percent intramuscular fat.

Statistical analyses

Data were analyzed with a statistical software program (SAS Version 9.1 for Windows, SAS Institute, Cary, NC). Pearson correlation coefficient analysis and univariate regression analysis was performed to estimate the linear relationship between the SC and carcass quality variables. Mean (±SEM) daily SC and carcass traits among age groups (junior vs. senior bulls), test stations (1 vs. 2), years (2002-03, 2003-04, 2004-05, 2005-06) and EPD groups were determined and the differences in the mean were analyzed using General Linear Model.

Results

Mean (± SEM) SC, body weight, and carcass traits in yearling Angus bulls are shown in the Table. The yearling SC and daily SC growth were different among age group, years and SC-EPD (P<0.05), but not different between the test stations (P>0.1). Average daily gain was different among test stations, years, age groups and average daily gain (ADG)-EPD (P<0.05). The carcass traits were significantly different with the exception that the yearling rump fat thickness was not significantly different among stations and age groups.

For yearling bulls, positive correlations were observed between the following: body weight and SC (r=0.11; P=0.0001), age (d) and SC (r=0.22; P=0.0001), SC-EPD and adjusted yearling SC (r^2=0.25; P=0.0001), 240 d SC and yearling SC (r=0.42; P=0.0001), SC and adjusted yearling rump fat (r=0.07; P=0.008), SC and adjusted yearling rib fat (r=0.12; P=0.0001), SC and adjusted yearling rib eye area (r=0.13; P=0.0001), SC and adjusted yearling percent intramuscular fat (r=0.06; P=0.05). Bull ADG during the trial period was positively correlated with growth differences in SC during the same period (r=0.13; P=0.0001).

Discussion

In the current study associations among carcass quality traits, genetic, and management factors on SC development in yearling Angus bulls were studied. In general, positive associations among the variables of interest were observed.

Scrotal circumference was positively correlated to age and body weight and has been shown to be associated with height,[6] weight,[9] age[10] and age of the dam.[6,11] Selection for any growth traits may increase SC. However in young bulls all these factors are confounded with weight.

Reported heritability estimates for yearling SC are moderate to high.[5-7,12-15] In the current study, the SC growth during the trial period was higher in junior bulls than in senior bulls (Table 1). The SC growth also increased with an increase in the SC-EPD scores. It seems logical that sires' and progeny's SC-EPD would be correlated since the sires' SC-EPD is included in the calculation of the sons' SC-EPD. In fact, since the progeny SC-EPD often did not have their own SC measurement nor any progeny data included in the calculation, most of the data contributing to calculation of the progeny (yearling bulls in this study) SC-EPD are from pedigree sources. However, dam effects are also included in this calculation so that this analysis allows an assessment of the mating decisions made by the breeders of these bulls. This positive correlation suggests that breeders are not simply cancelling a negative SC-EPD in the dams' pedigrees with positive SC-EPD from sires. Rather, this finding documents that continued progress in selection for larger SC is probably occurring.

In the present study, factors such as age groups, and year of the trial affected SC growth during the trial period. Results indicated that the junior bulls had higher SC growth and average daily gain than senior bulls during the trial period. Differences in ADG were observed between the test stations. However, there were no differences in SC growth between test stations. The trial during 2002-2003 resulted in higher SC growth but lower ADG compared to subsequent years.

Correlations among SC and adjusted yearling rump fat (r^2=0.02; P=0.0001), SC and adjusted yearling rib fat (r^2=0.02; P=0.0001), SC and adjusted yearling rib eye area (r^2=0.02; P=0.0001), SC and adjusted yearling percent intramuscular fat (r^2=0.003; P=0.05) were low. It is possible that these factors are confounded with growth traits.

These data would suggest that the selection for growth and carcass traits that is currently being used in Angus breeding decisions does not counter the selection for increased SC. It should be noted that correlations between yearling SC and other growth and carcass traits were positive indicating that selection for yearling SC is not adversely affecting carcass traits in the Angus breed.

The main objective of the cow-calf segment of the beef industry is production of calves. Changes in body composition potentially affect the production of calves by decreased calf survival and increased pubertal age and postpartum interval. Leaner breeds tend to be associated with these factors.[16,17] It seems possible to change age at puberty either by direct selection or by selection based on SC in bulls.[18] Selection for direct and maternal calving ease or smaller birth weights likely decreases calving difficulty.[19] Bennett and Gregory concluded that larger SC was correlated with decreased maternal calving difficulty and increased 200 d weight.[20] Therefore, cows of leaner genotypes may need to be selected for improved reproductive ability. Selection for reproduction could be achieved alternatively by terminal crossing to partially disassociate the slaughter animals from the cow's genotype.[17] The positive associations between growth and carcass characteristics and SC described in this study suggest that successful selection for all of these traits is occurring.

Determination of the effectiveness of using different traits for selection is a complex problem. Factors affecting decisions about selection criteria include use for sire, dam, or individual selection, potential number of animals measured and the intensity of selection possible, relationship with other desirable effects and age at measurement.

In summary, the current study shows significantly positive but moderate to poor strength of associations among yearling bull SC and various growth and carcass quality traits. This study suggests that the best method to increase SC in Angus bulls would be by independent bull selection based on the sire SC-EPD trait.

Acknowledgement

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Table. Mean (± SEM) scrotal circumference, body weight, and carcass traits in yearling Angus bulls raised in test stations between 6.5 and 8.5 (junior bulls; n = 832) or 9 to 11 months of age (senior bulls; n = 542).

	Yearling SC (cm)	Daily SC growth (cm/d)*	Yearling weight (kg)	ADG (kg/d)*	Yearling % IMF	Yearling rib eye area	Yearling rump fat thickness
Location							
Station 1	34.8±0.9[a]	0.070±0.001[a]	1208.3±9.7[a]	3.68±0.092[a]	3.28±0.06[a]	12.27±0.83[a]	0.32±0.08[a]
Station 2	34.6±0.7[a]	0.073±0.003[a]	1295.8±12.5[b]	3.52±0.108[b]	3.34±0.09[a]	12.76±0.79[b]	0.32±0.01[a]
Year							
2002-03	35.1±0.7[c]	0.040±0.007[c]	1180.9±7.8[c]	3.10±0.084[c]	2.95±0.10[c]	11.78±0.92[c]	0.28±0.04[c]
2003-04	34.3±0.4[d]	0.035±0.011[d]	1245.3±8.3[d]	3.72±0.097[d]	3.30±0.09[d]	12.33±0.67[d]	0.31±0.06[cd]
2004-05	34.3±0.5[d]	0.036±0.010[d]	1284.9±6.5[e]	4.00±0.114[e]	3.50±0.05[d]	13.14±0.93[e]	0.34±0.07[de]
2005-06	35.0±0.9[c]	0.034±0.012[d]	1297.0±11.2[f]	3.57±0.102[df]	3.49±0.03[d]	12.82±0.89[e]	0.35±0.02[e]
Age							
Junior	30.2±0.6[a]	0.081±0.004[a]	1044.4±12.5[a]	3.81±0.107[a]	3.02±0.06[a]	11.06±0.78[a]	0.28±0.06[a]
Senior	31.5±0.6[b]	0.050±0.007[b]	1181.5±15.6[b]	3.19±0.116[b]	2.86±0.04[b]	11.19±0.59[a]	0.29±0.06[a]
Sire SC-EPD							
<- 0.5	33.6±0.8[g]	0.049±0.009[g]	998.2±9.1[g]	2.78±0.098[g]	3.05±0.05[g]	11.92±0.70[g]	0.27±0.06[g]
≥-0.5 to 0	33.9±0.4[g]	0.054±0.006[g]	1144.5±8.9[h]	3.01±0.089[h]	2.98±0.03[g]	12.14±0.56[g]	0.28±0.04[gh]
≥ 0 to 0.5	34.6±0.9[h]	0.067±0.008[h]	1160.4±10.4[i]	3.30±0.084[h]	3.68±0.07[h]	13.39±0.81[h]	0.31±0.01[hi]
≥ 0.5 to 1	34.8±0.7[h]	0.088±0.008[h]	1197.4±8.2[j]	3.67±0.104[i]	4.87±0.06[i]	13.68±0.66[h]	0.33±0.08[i]
≥1	35.8±0.5[i]	0.106±0.011[i]	1247.4±7.6[k]	3.86±0.134[i]	6.26±0.04[j]	14.24±0.86[h]	0.34±0.08[i]

*During test period of 112 to 133 days.

[a,b]Lines with different superscripts differ (P < 0.05); location effect and/ or age effect.

[c,d,e,f] Lines with different superscripts differ (P < 0.05); year effect.

[g,h,i,j,k]Lines with different superscripts differ (P < 0.05); sire SC-EPD effect