Heritability and Repeatability of Ultrasound Predicted Percentage of Intramuscular Fat Measures in Angus Bulls and Heifers

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Summary

The present study included repeated ultrasound-predicted percentage of intramuscular fat (UPFAT) measures from 675 Angus bulls and heifers collected over a three-year period between 1998 and 2000. Each year cattle were scanned four to six times for UPFAT and other ultrasound traits, starting at a minimum age of 28 weeks. The objective of the current study was to estimate variance components, heritability, and repeatability of UPFAT in young bulls and heifers. Heritability of UPFAT ranged from 0.32 at 28 weeks of age to a maximum of 0.53 at 63 weeks. Repeatability of UPFAT increased from a minimum of 0.60 at ages 28 to 39 weeks to a maximum of 0.80 at ages 61 to 63 weeks. Heritability and repeatability of yearling UPFAT was 0.50 and 0.71, respectively. The present results showed an optimum heritability and repeatability of UPFAT measures around 52 weeks and through at least 63 weeks of age. This suggested that differences in UPFAT measures during this period also are good measures of differences in marbling genetic potential of Angus cattle.

Introduction

Most studies on ultrasound traits have been restricted to evaluation of mean differences between ultrasound and slaughter measurements. However, additional study is required to determine genetic parameter estimates for a wide range of ages and production systems.

National cattle evaluation programs use yearling UPFAT and other ultrasound-measured traits to compute animal expected progeny differences (EPD). Data for such evaluations come from bulls and developing heifers measured at about 365 and 395 days of age, respectively. The choice of these end-points is based on practical herd management and also to allow breeding cattle differentiate themselves genetically than earlier measurements. However, to maximize genetic response to selection, ultrasound data should be collected at the earliest possible time when individual animal phenotypic differences are best indicators of genetic ranking.

The objective of this study was to estimate variance components, heritability, and repeatability of serially measured UPFAT data in purebred Angus bulls and heifers.

Materials and Methods

Source of Data

Bulls and heifers in the present study came from the Iowa State University beef cattle breeding project. The project is designed to develop two lines of beef cattle for use as a research base to answer questions that influence genetic improvement of beef cattle. The two selection lines include a Quality line (Q-line) and a Retail line (R-line). Bulls in the Q-line are primarily selected for UPFAT EPD. Bulls in the R-line are selected primarily for ultrasound measured ribeye area (UREA) and percentage of retail product (PRP) EPD. In addition, bulls in both lines are required to meet birth weight EPD, fertility, and functional criteria.

The project was initiated in 1997 with the purchase of 285 spring1996-born, purebred registered Angus heifers. Heifers were purchased from two herds in Nebraska and three herds in South Dakota. The heifers were randomly assigned to the two selection lines. Both lines were managed under similar conditions at the Rhodes research and demonstration farm located in central Iowa. Each year, breeding took place in June and July, with calving the following spring.

After weaning, bull calves were fed a 1.3 Mcal NEg /kg diet to allow a mean weight gain of 1.5kg/day. Replacement heifers were fed a 1.1 Mcal NEg/kg diet to allow a mean daily weight gain of 0.70 to 1.1 kg /d.

Animals and Scanning Procedure

Serial ultrasound data were collected on progeny born at the Rhodes farm during the spring of 1998 to 2000. Each year the weaned bull and heifer calves were scanned four to six times for UPFAT and other ultrasound traits starting at minimum ages of 28 weeks, with an average interval of 4 to 6 weeks between scans. Bulls and heifers were scanned using an Aloka 500V real-time ultrasound machine, equipped with a 3.5-MHZ, 17.2 cm linear array transducer (Coromertics Medical Systems Inc., Wallingford, CT) and Classic Scanner-200, equipped with a 3.5-MHz, 18-cm transducer (Classic Ultrasound Equipment, Tequesta, FL).

Data Analysis

Six hundred seventy-five bulls and heifers. Ages at scanning time were expressed in weeks, resulting in 36 different ages ranging from 28 to 63 weeks.

Variance components were estimated by an average information REML algorithm using DXMRR (Meyer, 1998a). Model included fixed effects of contemporary group (birth year, sex, pen, and scan session), fixed Legendre polynomial of age at measurement (linear),

random animal genetic and permanent environmental effects, and an error term. Animal effect was fitted as a function of Legendre polynomial of age at measurement (linear). Measurement errors were assumed to be homogenous and independently distributed.

Results and Discussion

The general trends in mean UPFAT measures of bulls and heifers are shown in Figure 1. Mean UPFAT values showed nearly a linear increase with age for both sexes. Heifers started at 3.16% and consistently outranked bulls for all measurement ages. The mean yearling UPFAT of bulls and heifers were 3.97% (SD = 0.84%) and 4.84% (SD =1.35%), respectively. Except for extreme ages, CV values suggest a similar relative variability for both sexes across all ages.

The general trend in additive direct genetic, permanent environmental (PE), and phenotypic variance, are shown in Figure 2. All estimates increased with age at measurement. Both direct additive genetic and PE started the same and additve genetic variance increased as age at measurement increased from 28 to 63 weeks. However, PE variance estimates declined until an age of 40 weeks, followed by a gradual increase and eventually reaching 0.38 $\%^2$ at an age of 63 weeks. Phenotypic and additive genetic variances at 52 weeks of age were 0.94 and 0.47$\%^2$, respectively.

The relative contribution of variance components to the total phenotypic variance is shown in Figure 3. The error variance contributed up to 40% of the phenotypic variance between ages 28 to 38 weeks. However, PE contribution ranged from 19% to 28%. Generally, 60 to 70% of the variability in UPFAT of bulls and heifers between ages of 28 to 38 weeks was nongenetic.

Heritability of UPFAT ranged from 0.32 estimate at 28 weeks of age to a maximum of 0.53 at 63 weeks. Heritability of UPFAT at 52 weeks of age was 0.50. Repeatability of UPFAT measures increased from a minimum of 0.60 at ages 28 to 39 weeks to a maximum of 0.80 at ages 61 to 63 weeks. Repeatability of yearling UPFAT measures was estimated at 0.71.

Currently UPFAT scans for breeding bulls are taken at about one year of age and for developing heifers at 395 days of age. These end-points have been chosen from a practical herd management standpoint, and also because they allow animals to differentiate themselves genetically more than younger age scans. Present results indicate that heritability and repeatability of UPFAT measures are also at their optimum at around 52 weeks and through at least 63 weeks of age. This suggests that differences in UPFAT measures during this period are good measures of differences in marbling genetic potential of Angus cattle. However, it is unknown if this is true for other breeds of beef cattle.

Figure 4 shows the general trend of genetic correlations. Correlations with yearling measurements were positive and generally increased as the gap between ages decreased. Genetic correlation estimates suggest that selecting for UPFAT as early as 28 weeks of age would increase yearling UPFAT. However, genetic correlations with yearling UPFAT of 0.90 and above were attained starting at 35 to 36 weeks of age.

Implications

Heritability and repeatability of UPFAT in young Angus cattle are at their optimum at around 52 weeks and through at least 63 weeks of age. Therefore, as currently practiced, yearling bull and 13 to 14 months old heifer ultrasound measures from good quality images can be used to evaluate the compositional genetic potential of next generation parents in Angus cattle. However, as a large proportion of the phenotypic variance at earlier ages is non-genetic, selection at these ages may slow genetic progress.

Figure 1. Means and CV of ultrasound-predicted percentage of intramuscular fat measures in purebred Angus bulls and heifers.

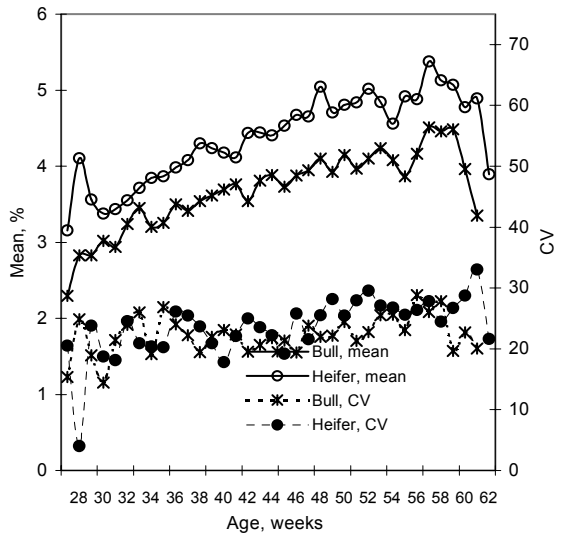

Figure 2. Trends in variance component estimates for ultrasound-predicted percentage of intramuscular fat measures in purebred Angus bulls and heifers.

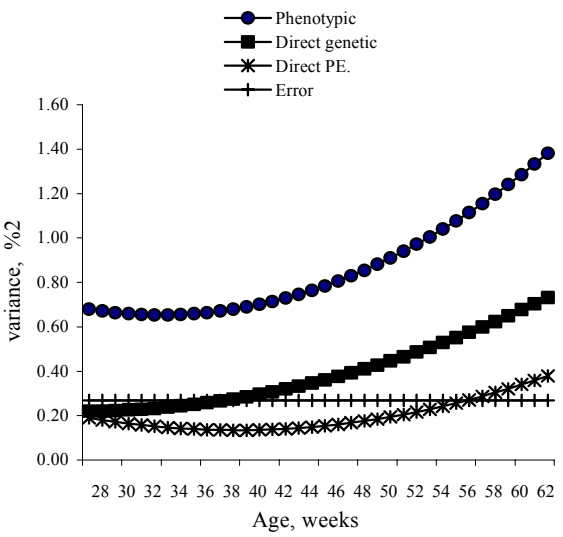

Figure 3. Ratios of variances for ultrasound-predicted percentage of intramuscular fat measures in purebred Angus bulls and heifers.

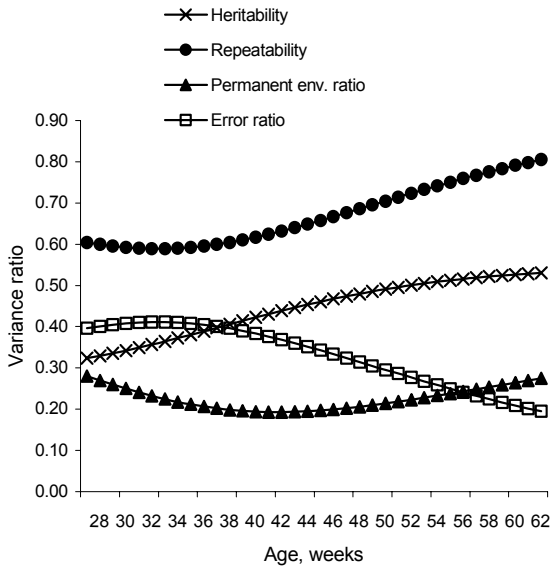

Figure 4. Genetic correlations between yearling ultrasound-predicted percentage of intramuscular fat data and measurements made at other ages.