Livestock Science 137 (2011) 231–237

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Genetic parameters and response to selection for post-weaning weight gain, visual scores and carcass traits in Hereford and Hereford × Nellore cattle

Fábio Luiz Buranelo Toral [a,*], Vanerlei Mozaquatro Roso [b], Cláudio Vieira de Araújo [c], João Cruz Reis Filho [d]

[a] Department of Animal Science, College of Veterinary Medicine, Federal University of Minas Gerais, Belo Horizonte/MG, Brazil
[b] Gensys Consultores S/C, Porto Alegre/RS, Brazil
[c] Federal University of Mato Grosso, Sinop/MT, Brazil
[d] Ministry of Agriculture, Livestock and Food Supply, Viçosa/MG, Brazil

ARTICLE INFO

Article history:
Received 26 March 2010
Received in revised form 17 November 2010
Accepted 18 November 2010

Keywords:
Correlation
Genetic evaluation
Heritability
Ultrasound

ABSTRACT

The objective of this study was to estimate heritability, correlations and response to selection for post-weaning average daily weight gain (ADG), visual scores of conformation (C), precocity (P) and muscling (M), longissimus muscle area (LMA), and backfat thickness (BFT) measured by ultrasound in Brazilian Hereford and Hereford × Nellore cattle. The components of (co)variance were estimated by the Bayesian method in two-trait analysis. The posterior means (± standard deviation) of heritability for ADG (0.164 ± 0.013), C (0.152 ± 0.014), P (0.194 ± 0.015), M (0.198 ± 0.015), LMA (0.232 ± 0.047) and BFT (0.136 ± 0.037) and their corresponding phenotypic standard deviation (standard deviation of posterior density) of 0.076 (0.0003) kg/day, 0.803 (0.003), 0.869 (0.005), 0.883 (0.007), 5.491 (0.069) cm^2 and 0.761 (0.009) mm support the utilization of these traits as criteria for selection, as long as the selection is done based on predicted breeding values. The genetic correlations (± standard deviation) between M and LMA (0.483 ± 0.098) and between P and BFT (0.403 ± 0.108) were favorable and indicate that part of the genes with additive effect on the visual scores also influenced the traits measured by ultrasound. The genetic correlations between M and P (0.814 ± 0.025) and between LMA and BFT (0.286 ± 0.200) suggest that the selection of animals with more developed muscle mass does not necessarily result in animals with less fat cover.

1. Introduction

Brazil has the largest commercial cattle herd and is also the largest exporter of beef in the world (USDA-FAS, United States Department of Agriculture – Foreign Agricultural Service, 2009). Animal breeding programs and production of genetically superior animals certainly contribute to the country achieving this position. However, to maintain such a position, the components of the production network need to continue developing stock aimed at increasing production and final product quality with improved profitability of livestock.

In this context, the post-weaning average daily weight gain (ADG) is a trait economically important to the production system of beef because it is related to the time necessary for the animal to reach slaughter point, and it expresses the genetic potential of the animal itself. However, ADG by itself may not be sufficient as a trait indicative of carcass quality.

Carcass weight, the percentage of marketable cuts and meat tenderness are traits directly related to the quality and value of the carcass (Field, 2007). Since the measurements of these traits imply the slaughter of the animal, selection to improve the quality of the carcass can be made based on the results of progeny testing and analysis on molecular markers or on indicative traits measured in the live animal, such as visual scores and traits measured by ultrasound.

* Corresponding author. Department of Animal Science, College of Veterinary Medicine, Federal University of Minas Gerais (DZOO/EV/UFMG). Avenida Antônio Carlos, 6627, Caixa Postal 567, CEP 31270-901. Belo Horizonte/MG, Brazil. Tel.: +55 31 3409 2180; fax: +55 31 3409 2168.
E-mail address: flbtoral@ufmg.br (F.L.B. Toral).

1871-1413/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.livsci.2010.11.013

The percentage of muscle, fat, bone and marketable cuts and the carcass value have phenotypic correlations that are moderate to high (0.4 to 0.8) with the visual scores and other traits measured by ultrasound in the live animal (Conroy et al, 2010). This suggests that the visual scores and the traits measured through ultrasound could be used as alternatives for selection to improve carcass quality.

In Brazil, some beef cattle breeding programs have performed visual evaluations for conformation (C), precocity (P) and muscling (M) since the 1970s. Evaluations for longissimus muscle area (LMA) and backfat thickness (BFT) measured with ultrasound began in the 1990s and gained momentum from 2000 on, with the adoption of this technique in several beef breeding programs.

Knowledge of genetic parameters and expected response to the selection for ADG, visual scores and carcass traits is fundamental to the design of animal breeding programs focusing on the quality of the carcasses produced in Brazil. Such information is useful for defining the most adequate selection criteria and predicting genetic values of the candidates for selection. The objective of this study was to estimate genetic parameters and selection response for the post-weaning average daily weight gain, visual scores and carcass traits evaluated through ultrasound in Brazilian Hereford and Hereford × Nellore cattle.

2. Materials and methods

Information regarding the performance of Hereford and Hereford × Nellore cattle participants in the Conexão Delta G breeding program was used to estimate (co)variances for the variables: post-weaning average daily weight gain (ADG, kg/day), visual scores of conformation (C), precocity (P) and muscling (M) and longissimus muscle area (LMA, cm^2) and backfat thickness (BFT, mm) obtained through ultrasound.

The visual scores were utilized as alternatives to estimate the amount of meat on the carcass by length, body depth and muscle development, characterizing the conformation (C) measurement. Precocity (P) measurement represents the ability of the animal to display the lowest acceptable degree of finishing with a low body weight. The development of muscle mass determined the scores for muscling (M). The visual scores were assigned by livestock technicians, in which each contemporary group was assessed by a single technician, and on a scale of 1 to 5, where five represents the highest level of trait expression. The LMA and the BFT were measured with the use of ultrasound and specific software equipment in the region between the 12th and 13th ribs.

Only the data from animals with known pedigree and members of the post-weaning contemporary groups with at least three observations were considered. For ADG, C, P and M, the post-weaning contemporary groups were formed by animals of the same contemporary group at weaning, raised on the same farm and part of the management post-weaning group, of the same sex and weighed on the same Julian date. The contemporary group at weaning was formed by animals of the same sex, born and weaned on the same farm and in the same year, raised in the same management group and weighed on the same Julian date at weaning. For LMA and BFT, the management group between the time of post-weaning weighing and evaluation by ultrasound, and the Julian date of ultrasound were also included in the formation of the post-weaning contemporary groups. Table 1 provides a summary of the data structure studied in this work.

The database was composed of data from 47,563 animals belonging to Hereford (Her), 3/4Her, 11/16Her, 5/8Her, 9/16Her, 1/2Her, 3/8Her and 1/4Her genetic groups. Table 2 lists the numbers according to the genetic group of the animal.

The animals were born from 1974 to 2006 on 47 Brazilian ranches located between latitudes 14° S and 31.5°S, in the following states: RS, PR (South region), SP (Southeast region), MS, MT, GO (Central-West region) and BA (Northeast region). However, measurements by ultrasound were only taken on animals born from 1998 to 2005 on 22 ranches located between latitudes 21°S and 31.5°S, in the states of RS, PR, SP and MS.

The ages of the animals on the days of the measurements ranged between 370 and 670 days. The average ± standard deviation of the ages in assessing ADG, C, P and M was 505 ± 78 days, and for the assessments by ultrasound it was 541 ± 58 days.

Under the matrix form, the general model considered in the analysis of two traits simultaneously was

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \times \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \times \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

in which: y_i, is a vector with the observations of trait i; β_i, is a vector with the "fixed" effect solutions (contemporary groups, month of birth, annual class of dam age at birth, linear effect of the animal composition (expected percent of Hereford genes in the calf), linear effect of the dam composition (expected percent of Hereford genes in the dam), and the linear effect of the age of the animal at the time of measurement); a_i is a vector with solutions of the random direct genetic additive effects; e_i, is a vector with the solutions of random residual effects; and X_i, and Z_i are incidence matrices that relate y_i with β_i and a_i, respectively.

Table 1
Number of observations and pedigree structure for each trait[a].

	ADG	C	P	M	LMA	BFT
Animals with records	45,773	47,253	41,589	41,402	4375	4363
Sires with progeny	1077	1078	988	975	294	294
Sires with progeny and personal data	263	261	258	257	36	36
Dams with progeny	34,092	34,881	31,443	31,310	3596	3587
Dams with progeny and personal data	4805	5082	3769	3733	199	195
Animals in the relationship matrix	80,867	80,867	80,867	80,867	80,867	80,867

[a] ADG, post-weaning average daily weight gain; C, conformation; P, precocity; M, muscling; LMA, longissimus muscle area; BFT, backfat thickness.