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Genetic parameter estimates for feed efficiency and dry matter intake and their association with growth and carcass traits in Nellore cattle

M.H.A. Santana [a,*], G.A. Oliveira Junior [a], R.C. Gomes [b], S.L. Silva [a], P.R. Leme [a], T.R. Stella [a], E.C. Mattos [a], P. Rossi Junior [c], F.S. Baldi [d], J.P. Eler [a], J.B.S. Ferraz [a]

[a] Faculdade de Zootecnia e Engenharia de Alimentos-USP, Av. Duque de Caxias Norte, 225, Pirassununga, SP 13635-900, Brazil
[b] Empresa Brasileira de Pesquisa Agropecuária, CNPGC/EMBRAPA, BR 262 km 4, 79002-970 Campo Grande, MS, Brazil
[c] Universidade Federal do Paraná-SCA/UFPR, Rua dos Funcionários, 1550, Curitiba, PR, 80035-050, Brazil
[d] Faculdade de Ciências Agrárias e Veterinárias, UNESP-Univ Estadual Paulista, Jaboticabal, São Paulo 14884-900, Brazil

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ABSTRACT

This study estimated genetic parameters and (co)variance components for dry matter intake (DMI), average daily gain (ADG), feed conversion rate (FCR), residual feed intake (RFI), residual body weight gain (RWG) and residual intake and body weight gain (RIG) in Nellore cattle. We also estimated the genetic and phenotypic correlations between these traits with growth and carcass traits. We used data on feed efficiency of 1038 Nellore males (*Bos indicus*), being 147 castrated and 891 young bulls. The animals were progenies of 176 sires and 779 dams, composing a relationship matrix of 3521 animals. The (co) variance components and genetic parameters were estimated by GIBBS2F90 software, using the Bayesian approach. The heritability estimates for DMI, RFI and RIG were 0.40, 0.38 and 0.54, respectively. The genetic correlations between all feed efficiency and carcass traits were low. The traits analyzed showed enough genetic variability and heritability, thus the inclusion of feed efficiency in animal breeding programs of Nellore cattle is feasible. The RIG showed higher heritability and a selection for feed efficiency does not have a negative effect on carcass traits.

1. Introduction

In recent years, feed intake and feed efficiency in beef cattle have received great importance. Estimates of genetic parameters and genetic correlations for feed efficiency have been widely obtained in Bos taurus animals (known as taurine) and crossbreeds, and residual feed intake is already used as selection criterion in some taurine breeds (Arthur et al., 2005). Genetic parameter estimates for these traits are scarce in Bos indicus breeds under tropical conditions. Barwick et al. (2009) estimated genetic parameters for feed efficiency in Brahman cattle and recently, Grion et al. (2014) reported genetic parameters for feed efficiency traits and their correlations with growth traits in Nellore cattle.

The knowledge of these parameters and their correlations is critical for future studies on genetic selection based on feed efficiency and feed intake. It is also useful to define selection criteria for Bos indicus cattle breeding

* Corresponding author. Tel.: +55 19 3565 4105; fax: +55 19 3565 4107.
E-mail addresses: miguel-has@hotmail.com (M.H.A. Santana), gersonjr@gmail.com (G.A. Oliveira Junior), rodrigo.gomes@embrapa.br, gomes_rc@hotmail.com (R.C. Gomes), sauloluz@usp.br (S.L. Silva), prleme@usp.br (P.R. Leme), tigostella@hotmail.com (T.R. Stella), limattos@usp.br (E.C. Mattos), parossi@ufpr.br (P. Rossi Junior), fernandobaldiuy@gmail.com (F.S. Baldi), joapeler@usp.br (J.P. Eler), jbferraz@usp.br (J.B.S. Ferraz).

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programs. This study estimates genetic parameters and (co)variance components for dry matter intake (DMI), average daily gain (ADG), feed conversion rate (FCR), residual feed intake (RFI), residual body weight gain (RWG) and residual intake and body weight gain (RIG) in Nellore cattle. We also estimated the genetic and phenotypic correlations between these traits with growth and carcass traits.

2. Material and methods

2.1. Animals and facilities

We used data on feed efficiency of 1038 Nellore males (Bos indicus), being 147 castrated and 891 young bulls. The animals were progenies of 176 sires and 779 dams. The pedigree contained 3521 animals. The analyses were performed at the Animal Breeding and Biotechnology Group of University of São Paulo, Pirassununga City, Brazil. The data were obtained from a compilation of 13 experiments to investigate feed efficiency conducted in Brazil, where 10 studies were conducted in the southeastern region (Gomes et al., 2012, 2013; Alexandre et al., 2014; Cancian et al., 2014), two in the central-western and one in the southern region (Santana et al., 2012, 2013). The data were combined in order to increase the number of records and the pedigree was connected through common sires in the experiments.

The animals were kept in three types of feedlot systems with 430 animals in individual pens, 212 in Calan Gates and 396 in GrowSafe. The last two feedlot types were equipped with automatic gates that allowed to measure the animals individually in the feedlots. At the beginning of the experiment, the animals had an initial average age of 517 ± 169 days old and weight of 366 ± 59 kg. The experiments were conducted between 2007 and 2013.

2.2. Experimental diet and management

Before starting the experiments, the animals underwent a period of 21 days for adaptation to the installations, to the management system and to the diet. We carried out bulky collections of concentrates and leftovers for periodic evaluations of dry matter (DM) content. The diet was offered twice a day by means of total mixed ration.

2.3. Data collection

The period of data collection was different for each experiment varying from 70–90 d, and the animals were weighed every 21 d. The average daily gain (ADG) was calculated based on these weighing procedures, represented the angular coefficient of linear regression of body weights by the days of experiments.

Additionally, during the assessment period, the dry matter intake (DMI) for each animal was measured daily subtracting the quantity of food supplied by the amount of leftovers. The feed efficiency traits (FCR, RFI, RWG and RIG) were calculated based on the data of DMI. The FCR was calculated as the ratio of DMI/ADG, while the RFI and the RWG represent the residues (ε_1 and ε_2) of regression equations that estimated DMI and ADG, respectively (Koch et al., 1963). The models for estimating these traits were:

$$DMI = \beta_0 + \beta_1 ADG + \beta_2 MBW^{0.75} + \beta_3 SC + \beta_4 CG + \varepsilon_1$$

$$ADG = \beta_0 + \beta_1 DMI + \beta_2 MBW^{0.75} + \beta_3 SC + \beta_4 CG + \varepsilon_2$$

Being the parameters (β) estimated on PROC MIXED procedure of the SAS software and *MBW* the mid body weight. The sexual condition (*SC*) and the contemporary group (*CG*) were included in the model to estimate RFI and RWG. The equation used to calculate RIG was:

$$RIG = RWG - RFI$$

At the beginning and end of each experiment, the animals were submitted to carcass evaluation by ultrasonography (Aloka SSD500 with 3.5 MHz transducer) conducted by a certified technician from the Ultrasound Guidelines Council, following the methodology described in the guide of Beef Improvement Federation (Beef Improvement Federation, 2002). We evaluated the rib eye area (REA), back fat thickness (BFT), and rump fat thickness (RFT).

The REA and BFT were measured between the 12th and 13th ribs, across from the muscle longissimus lumborum. The RFT was measured at the intersection of the muscles gluteus medius and biceps femoris, located between the ileum and ischium. The REA_g, BFT_g and RFT_g gains during the experiment were estimated by calculating the difference between the final and initial REA, BFT, and RFT values.

The systematic environmental effects to be included in the contemporary groups (CG) were chosen based on the significant level ($P < 0.001$) of a mixed model using the PROC MIXED procedure of SAS. The CG were formed considering the different feedlot facilities (individual pens, Calan Gate or GrowSafe systems) and farms where the animals were reared. The sexual condition (SC, steers and young bulls) was included as a covariate in the statistical models. Records exceeding three standard deviations above and below the mean of the CG were excluded from the genetic analysis.

2.4. Statistic analysis

The animal age at the beginning of the experiment was considered a covariate for the fixed effect of CG. The additive genetic effect was considered a random effect in the model. The model can be represented in general matrix as:

$$y = X\beta + Za + \varepsilon$$

where: y is the vector of the dependent variable (phenotypic variable); β is the vector of fixed effects; a is a vector of additive genetic random effects; ε=residual effect vector; X and Z are the matrices of incidence relating to β and a with a dependent variable y. The genetic parameters and (co)variance components were estimated through the Bayesian inference, applying an animal model, using the GIBBS2F90 software (Misztal et al., 2002). The uniform a priori distribution was defined for fixed effects (β). Gaussian and inverted Wishart distributions