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Estimation Of Genetic Parameters For Body Weight From Birth To 10 Years Old In Nellore Females

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ABSTRACT: Two-trait analyzes were performed for body weight from birth to 10 years old in Nellore females using yearling weight (W550) as anchor trait. Heritability estimates for birth weight, weaning weight and W550 were 0.46±0.06, 0.10±0.04 and 0.30±0.05, respectively. Heritability estimates for weights from two to 10 years old had medium to high magnitude and varied at different points throughout the ages, from 0.29±0.10 to 0.56±0.16 for eight and 10 years of age, respectively. Genetic correlations between body weights and yearling weight (W550) were high and, as expected, higher when closer to W550. Based on heritability estimates, it is possible to infer that selection based on growth traits at any age can promote genetic gains in body weight even in mature age. Correlations estimates indicate that selection will lead to significant increases in weight from birth to mature ages.
Keywords: beef cattle; correlation; growth traits; mature weight

Introduction

Body weights and weight gains are traits of easy mensuration, have moderate heritability, result in significant genetic gains over the generations and are directly related to final product (meat).This makes these traits the main criteria when the selection goal is to maximize the production efficiency in beef cattle herds. However, selection for weights can lead to higher mature weights, as a positive genetic correlations result, causing increases on nutrient requirements, under penalty of reproductive efficiency loss.

Studying the selection effects for yearling weight in Nellore cattle, Mercadante et al. (2003) reported 1% of genetic change per year on the average trait under direct selection and found no significant effects on cows reproductive traits. However, Cyrillo et al. (2010), evaluating the same herd adding two selection generations, found negative effect on parturition rate, indicating the need of mature weight inclusion as selection criteria. Studies involving matrices weights are uncommon, once most breeding programs in Brazil evaluate the animals until two years old, ceasing the data collection at this age.

The knowledge of genetic parameters involved in growth from birth to mature age can support the maximization of genetic progress for economic interest traits. Thus, the objective of this study was to estimate heritabilities and genetic correlations of body weight from birth to 10 years of age in female Nellore cattle.

Materials and Methods

Records of Nellore females from Beef Cattle Breeding Program of Instituto de Zootecnia, located at Sertãozinho city, São Paulo State/Brazil, were utilized.

The program started in 1976, having one control line (NeC) and two selection lines (NeS and NeT), with the objective of evaluate the selection effects within herds, involving beef cattle economic components as growth, reproduction and carcass quality (Mercadante et al. (2003). Selection was based on the maximum differential in the selected lines and null differential in control line, considering adjusted weight at 378 days of age in males, obtained in feeding performance test, and adjusted weight at 550 days of age in females, maintained under pasture conditions. For contemporary group's creation births were concentrated from September to November, and calves weaning were performed at, on average, 210 days of age. Weights measurements were taken at birth, at weaning and at 3 to 5 months intervals after weaning until heifers reach 550 days of age. Females that remained for breeding had weight measurements taken at beginning and end of breeding season (November to February), calving and calves weaning. Weight measurements taken at the breeding season beginning were considered indicative of cow's weight between 2 and 10 years of age.

The original database had 13,531 weight records, from 4,240 Nellore calves, 3,945 heifers and 2,603 cows born between 1981 and 2013. For consistency and descriptive data analysis Kolmogorov-Smirnov (n> 2000) test was performed using the SAS 9.3 (SAS Institute, 2011). Variances and covariances estimates were obtained by restricted maximum likelihood method, using WOMBAT program (Meyer, 2007).

Two-trait analyzes were performed for birth weight (BiW), weaning weight (W210), yearling weight (W550) and cow weights measured from 2 to 10 years of age (MW2, MW3, MW4, MW5, MW6, MW7, MW8, MW9, and MW10), using W550 as anchor trait. The model of analysis included the random effects: direct additive genetic, maternal additive genetic, and maternal permanent

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environment, and the fixed effects: contemporary group (year of birth from1981 to 2013 and selection lines NeC, NeS and NeT), month of birth (September, October and November) and linear and quadratic effects of animal and dams ages. Covariance between direct and maternal effects was equal to zero. The pedigree file contained 9,529 individuals. Animals with records were sons of 321 bulls and 2,164 cows.

Results and Discussion

Body weight records distribution, means, standard deviations and coefficient of variation in each age were presented in Figure 1. The records number of cows having two to 10 years of age decreased due to the culling of animals with morphological or reproductive problems. In addition, the mean body weight increased continuously until eight years of age, ranging from 29 to 461 kg, with slight decrease after this period. Corresponding standard deviations showed a similar trend and the coefficient of variation decreased with age, indicating the variation within each age is not linearly related to the mean.

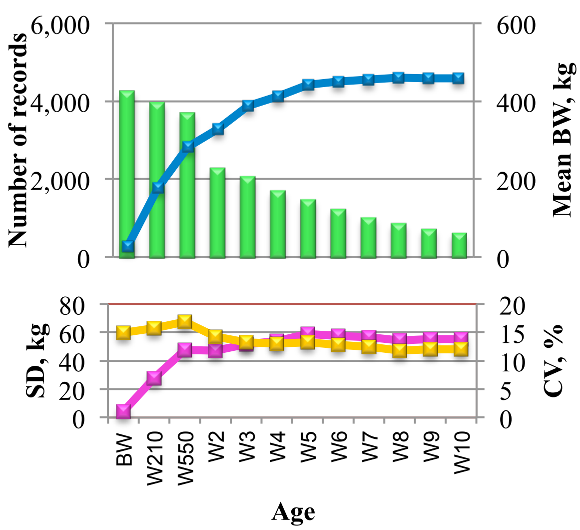

Figure 1. Records distribution (green bars), mean body weight (blue line), standard deviation (orange line) and coefficient of variation (pink line) according to age.

Additive direct variance estimates showed increasing trends up to four years of age, stability up to seven years and strong oscillation in the final ages (Table 1). Costa et al. (2011), studying the mature weight in Angus animals reported high growth rates of direct additive variances up to 4 years of age, with apparent stability after this age. Maternal additive and maternal permanent environment variances estimates were higher in initial ages up to W550 and erratic after this age. Phenotypic variances were crescent up to 5 years of age, with variations after this age. Estimates of residual variance also increased up to 4 years of age, but remained stable after this period.

Table 1. Estimates of additive direct (σ^2_a, kg^2) additive maternal (σ^2_m, kg^2), maternal permanent environment (σ^2_{ep}), residual (σ^2_r, kg^2) and phenotypic (σ^2_p, kg^2) variances according to age.

Trait[1]	σ^2_a	σ^2_m	σ^2_{ep}	σ^2_p	σ^2_r
BiW	6.3	0.69	0.62	13.85	6.41
W210	50.3	53.1	136.5	551.4	295.3
W550	226.8	7.1	80.4	741.1	368.6
W2	297.4	6.49	33.3	735.1	390.0
W3	550.5	7.55	35.9	1395.4	395.8
W4	753.1	22.5	5.14	1770.6	407.4
W5	698.7	65.3	23.1	1994.0	402.8
W6	712.3	34.3	36.4	1863.6	406.5
W7	690.3	58.7	0.27	2146.2	405.2
W8	583.3	74.6	0.47	1957.1	406.0
W9	935.0	66.5	13.2	2131.2	408.0
W10	1033.2	40.0	0.01	1829.6	407.3

[1]BiW = birth weight, W210 = weaning weight, W550 = yearling weight; MW2, MW3, MW4, MW5, MW6, MW7, MW8, MW9, and MW10 = body weights measured from 2 to 10 years of age.

Heritability estimates for birth weight had high magnitude (0.46±0.06) (Table 2), above the values 0.21 and 0.33 reported by Nobre et al. (2003), for the same trait, comparing estimates from random regression and multiple traits models. Albuquerque & El Faro (2008), comparing two-trait analyzes Legendre polynomial function and parametric correlation functions found heritability between 0.31 to 0.33 for birth weight. For W210, heritability estimates were low for direct (0.10±0.04) and maternal (0.09±0.04) and moderate for maternal permanent environmental (0.24±0.04). Albuquerque & El Faro (2008) and Boligon et al. (2009) found values between 0.15 and 0.33 for direct heritability in the different analyzes for weight at 205 days of age for Nellore cattle. Heritability estimates for yearling weight (W550) had medium magnitude (0.30±0.05) (Table 2). Literature reports for W550 heritability mostly of high magnitude. Berzatto et al. (2004) reported estimate of 0.72 for the same trait in two-trait analysis with longevity of Nellore cattle. High heritability was also observed by Yokoo et al. (2007) who reported value 0.40 and Boligon et al. (2009) that obtained, for yearling weight, estimate of 0.34. Heritability estimates for weights from two to 10 years old, described in Table 2, had medium to high magnitude and varied at different points throughout the ages, from 0.29±0.10 to 0.56±0.16 for eight and 10 years of age, respectively. Based on heritability estimates, it is possible to infer that selection based on growth traits at any age can promote genetic gains in body weight even in mature age.

Table 2. Direct (h^2) and maternal (h_m^2) heritability estimates, maternal permanent environment variances estimates as a proportion of phenotypic variances according to age (h_{ep}^2) and genetic (r_G) and phenotypic (r_P) correlation between W550 and body weight at different ages.

Trait[1]	h^2	h_m^2	h_{ep}^2	r_G	r_P
BiW	0.46±0.06	0.05±0.03	0.04±0.02	0.48	0.36
W210	0.10±0.04	0.09±0,04	0.24±0.04	0.98	0.78
W550	0.30±0.05	0.00±0.02	0.13±0.02	-	0.74
W2	0.40±0.06	0.009±0.02	0.04±0.02	0.96	0.89
W3	0.39±0.07	0.005±0.03	0.03±0.03	0.92	0.68
W4	0.42±0.08	0.01±0.03	0.003±0.03	0.71	0.63
W5	0.35±0.08	0.03±0.04	0.01±0.04	0.64	0.59
W6	0.38±0.09	0.02±0.04	0.02±0.04	0.61	0.61
W7	0.32±0.08	0.03±0.04	0.00±0.04	0.67	0.67
W8	0.29±0.10	0.04±0.07	0.00±0.06	0.5	0.57
W9	0.44±0.13	0.09±0.08	0.006±0.08	0.54	0.59
W10	0.56±0.16	0.02±0.09	0.00±0.10	0.57	0.52

[1] BiW = birth weight, W210 = weaning weight, W550 = yearling weight; MW2, MW3, MW4, MW5, MW6, MW7, MW8, MW9, and MW10 = body weights measured from 2 to 10 years of age.

Genetic correlations between body weights and yearling weight (W550) were moderate to high and, as expected, higher when closer to W550 (Table 2). Results obtained in this study differ from those found by Boligon et al. (2009), with Nellore, although both studies show moderate to high genetic correlations, with values of 0.66 for W550 and MW5, 0.85 between W550 and MW2, and 0.69 between W550 and MW3. Costa et al. (2011), studding growth traits in Angus, reported genetic correlation of 0.84 ± 0.14 between W210 and Y550 and from 0.77 ± 0.08 to 0.85 ± 0.07 between YW and mature weights up to 5 years old. Correlations estimates obtained in this study indicated that selection will lead to significant increases in weight from birth to adulthood, however, increase in birth weight and after four years of age, occurs more slowly relative to weights included from weaning to three years old.

Conclusion

Selection based on growth traits at any age can promote genetic gains in body weight even in mature age. Correlations estimates indicate that selection will lead to significant increases in weight from birth to adulthood, however, increase in birth weight and after four years of age, occurs more slowly relative to weights included from weaning to three years old.

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