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Estimation of direct and maternal genetic effect on weaning weight and average daily gain to wean in Japanese Black cattle

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ABSTRACT: There are comparatively few studies dealing with parameter estimates for growth traits particularly in weaning weight and average daily gain to wean for Japanese Black cattle. Variance and covariance components were estimated using two-trait restricted maximum likelihood (REML) procedure under animal models. Direct and maternal variances of weaning weight and weaning daily gain were 116.309±27.562 kg and 0.005±0.0016 kg; 66.485±13.203 kg and 0.005±0.00094, respectively. Phenotypic variances of weaning weight and weaning daily gain were 316.509 kg and 0.021 kg, respectively. Genetic covariances between direct and maternal of weaning weight and weaning daily gain were 7.625±16.479 kg, and 0.0005±0.0010 kg. Direct heritabilities were 0.367±0.071 for weaning weight and 0.250±0.066 for weaning daily gain, respectively. Maternal heritabilities for those traits were lower than direct heritabilities for all traits.
Key word: weaning weight; weaning daily gain; Japanese Black cattle

Introduction

The primary breeding objective for Japanese Black cattle is carcass characteristic including marbling. Japanese Black cattle are famous for the high marbling score of their beef. Genetics studies for carcass traits are numerous for this breed (Mukai, 1994; Kitamura et al, 1999; Uchida et al, 2001). However, there are comparatively few studies dealing with parameter estimates for growth traits (Shimida et al, 1995; Mukai et al, 2000) particularly in weaning weight and average daily gain to wean. In mammals, growth is influenced by the genes of the individual for growth, by the environment provided by the dam, both pre- and postnatal, what are known as maternal effects, and other environmental effects. In beef cattle, maternal effects are important for growth traits until weaning although significant effects remain thereafter that have been identified for later weights, and differences between breeds have also been found (Mackinnon et al. 1991; Meyer 1992; Robinson and O'Rourke 1992; Meyer at al.1993; Eller et al. 1995). Maternal effects must be considered when carrying out genetic evaluations of early growth traits, in addition to direct genetic effect. Albuquerque and Meyer (2001) concluded that direct heritability estimates were low to moderate, varying from 0.11 to 0.28 for weights from birth to 600 days of age in Nelore cattle. Further they stated that the importance of maternal genetic effects on weights started to decrease close to weaning (180-210 days). Estimates of genetic parameters for weaning weight and average daily gain to weaning are scare in Japanese Black cattle. These genetic parameters reflect to what extent and how genetic changes in weight gain can be achieved by selection. The objective of this paper was to estimate direct and maternal genetic effect on weaning weight and average daily gain to wean in Japanese Black cattle as based on selection program.

Materials and Methods

Data. The initial data set comprised 9,482 weaning weight and average daily gain records on 4,741 Japanese Black calves. These data were collected from 1994 to 2009 in a farm located in Shiroshi city, Miyagi prefecture, Japan. This farm has an operational genetic improvement program that considers growth, marbling score, fertility, and maternal ability traits. Calves are weighed at birth and subsequently at monthly intervals. They are weaned at approximately 6 mo of age. Calves are given free access to concentrate mixed with chopped rice straw by weight. The concentrate comprised 20% ground barely, 35% ground yellow corn, 20% wheat bran, 17% defatted rice bran, 6% soybean meal, 1% NaCl, and 1% calcium carbonate (as-fed basis). In addition, roughage (in the form of green forage, silage, or hay) and water are supplied ad libitum. A unique number assigned by the Wagyu Registry Association, which maintain pedigree records, identifies animals. Information available is animal name and number, parental identifications, and date and place of birth. Traits included in this study were weaning weight and average daily gain to wean. Some missing value of weaning weight and average daily gain to wean were excluded from the data set. Animals that did not have any information of parental were also excluded from the data set. The edited data set included 8342 of weaning weight and average daily gain to wean from 4,171 calves, offspring of 61 sires, and 841 dams. Calves were born year round. All animals had records for birth weight. All calves and dams had their parents identified. There were overlapping sires and dams used every year.

Statistical analysis. Traits of interest in this study were weaning weight and average daily gain from birth to weaning. Variance and covariance components were estimated using two-trait restricted maximum likelihood (REML) procedure under animal models (Paterson and Thompson, 1971). In the analytical model, year, month, sex and dam's parity were considered as fixed effects, whereas animal and wean age were as random effects. Year was classified into 16 levels, month was divided by 12 levels,

sex was into two levels and parity was into 11 levels. Pedigree was traced back to animals born in 1994 and all relatives appeared were included in calculating an additive relationship matrix.

Result and Discussion

Concerning the traits used in the study, the highest and the lowest figures for the traits were 30 kg and 175 kg for weaning weight and 0.1 kg and 1.2 kg for weaning daily gain, respectively. Coefficient of variation (CV) was 20% for weaning weight and 24% for weaning daily gain.

Table 1. Estimates of (co)variance components and genetic parameters from two-traits model for individual weaning weight and weaning daily gain

Parameter[a]	Weaning weight	Weaning daily gain
σ^2_a	116.309±27.562	0.005±0.0016
σ^2_m	66.485±13.203	0.005±0.00094
σ_{am}	7.625±16.479[b]	0.0005±0.0010[b]
σ^2_e	118.464±13.871	0.010±0.0009
σ^2_p	316.509	0.021
h^2_a	0.367±0.071	0.250±0.066
h^2_m	0.210±0.033	0.251±0.033
r_{am}	0.087±0.200[b]	0.0865±0.199[b]

[a]σ^2_a = direct variance; σ^2_m = maternal variance; σ_{am} = covariance between direct and maternal effects; σ^2_e = environmental variance; σ^2_p = phenotypic variance; h^2_a = direct heritability; h^2_m = maternal heritability; r_{am} = correlation between direct and genetic effect
[b]Standard error estimate>1.0

The (co)variance components, direct and maternal heritabilities were estimated for weaning weight and weaning daily gain of Japanese Black cattle in Japan environmental condition. Direct and maternal variances of weaning weight and weaning daily gain were 116.309±27.562 kg and 0.005±0.0016 kg for direct variance, and 66.485±13.203 kg and 0.005±0.00094 for maternal variances, respectively (Table 1). Environmental variances of weaning weight and weaning daily gain were 118.464±13.871 kg and 0.005±0.00094, respectively, which are higher than direct and maternal variances for all characters. Genetic variances were influenced by differences in data number (structure analyzed), genetic analysis method, connectedness (relationship among cattle groups) and research time (Mohiudin, 1993; Clement et al., 2001). Phenotypic variances of weaning weight and weaning daily gain were 316.509 kg and 0.021 kg, respectively. Meyer (2001; 2005) reported greater phenotypic variances estimates using random regression models for body weight at 250 d of age for Australian cattle and 820 d of age for Angus cattle, respectively. Using random regression models to analyze body weight of Angus, Hereford, and F1 females from 2 to 8 yr of age, Arango et al (2004) also reported variance estimates which are increasing with age, but estimates at older ages were different from those obtained using standard 2-trait models. Boligon et al (2009) reported that phenotypic variances increased until a certain age 2 000 d of age, and smaller differences were observed thereafter. Genetic covariances between direct and maternal of weaning weight and weaning daily gain were 7.625±16.479 kg, and 0.0005±0.0010[b] kg. Highly of standard deviation was due to highly variation of data base both for weaning weight and weaning daily gain. Direct heritabilities (h^2_a) were estimated to be 0.367±0.071 for weaning weight and 0.250±0.066 for weaning daily gain, respectively. Maternal heritabilities for those traits were lower than direct heritabilities for all traits. Meyer (1992) pointed out the importance of introducing common environmental effects into the mathematical model and reported the h^2 estimate for weaning weight which was 0.26 in Hereford cattle reduced to 0.10 by including the common environmental effects in the model. Kitamura et al (1999) reported that both calf market and carcass weights of Japanese Black cattle were influenced by maternal genetic effects.

Conclusion

Results suggest that (co)variances and heritabilities of maternal were lower than those of direct. The estimates of genetic parameters obtained in this study indicated that if genetic improvement through selection for weaning weight and weaning daily gain of Japanese black cattle is desired, substantial genetic progress can be achieved.

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