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Genetic analysis of calf market weight and carcass traits in Japanese Black cattle[1]

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ABSTRACT: Heritabilities of and genetic correlations between additive direct and maternal genetic effects for calf market weight, and additive direct genetic effects for carcass traits, were estimated for Japanese Black cattle by REML procedures under 2-trait animal models. Data were collected from calf and carcass markets in Hyogo and Tottori prefectures and analyzed separately by prefecture. Calf market weight was measured on 42,745 and 23,566 calves in Hyogo and Tottori, respectively. Only the fattening animals with calf market weight were extracted from the carcass database and used for estimation. The carcass traits analyzed were carcass weight, ribeye area, rib thickness, subcutaneous fat thickness, yield estimate, beef marbling score, and 4 meat characters (color, brightness, firmness, and texture). Direct and maternal heritabilities for calf market weight were estimated to be 0.22 and 0.07 in Hyogo, and 0.37 and 0.15 in Tottori, respectively. The estimates of heritabilities for carcass traits were moderate to high in both prefectures. The estimates of direct-maternal genetic correlations for calf market weight were positive (0.17) in Hyogo and negative (–0.63) in Tottori. The direct effect for calf market weight was positively correlated with the direct effect for carcass weight (0.87 and 0.56 in Hyogo and Tottori, respectively) but negatively correlated with the direct effect for beef marbling score (–0.10 in both prefectures). The estimates of genetic correlations between the maternal effect for calf market weight and the direct effects for carcass traits varied from –0.13 to 0.34 in Hyogo and from –0.14 to 0.15 in Tottori. Because direct and maternal genetic effects for early growth traits can be evaluated from calf market weight data in the production system of Japanese Black cattle, this information should be incorporated into selection and mating schemes of the breed.

Key words: beef cattle, direct genetic effect, genetic correlation, genetic variance, heritability, maternal effect

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INTRODUCTION

In recent decades, carcass traits of Japanese Black cattle have been improved through genetic evaluation with BLUP under an animal model using field carcass records from fattening farms. In contrast, no selection has been applied for maternal ability of the breed, even though the milking and nursing abilities are insufficient for calves to grow adequately, and thus, beef production in Japan cannot survive without milk replacers and starters. Improvement of maternal ability contributes to greater beef productivity through less labor and enhanced immunity. However, estimation of maternal effects may be difficult because many calves receive milk replacer and starter shortly after birth.

Calves of Japanese Black cattle are weighed and traded at calf markets between 8 and 10 mo of age. Previous studies on calf market weight of Japanese Black cattle suggest the possibility of estimation of the maternal effect for early growth (Shimada et al., 1995; Kitamura et al., 1999; Mukai et al., 2000). Mukai et al. (2000) indicated that there were considerable differences among 3 prefectures in (co)variance components and genetic correlations between direct and maternal effects for early growth traits. For simultaneous improvement of maternal ability and carcass traits, genetic relationships among these traits are necessary. However, relatively little is known about these genetic relationships (Mohiuddin, 1993; Koots et al., 1994; Splan et al., 2002).

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The objective of this study was to estimate genetic relationships between direct and maternal effects for calf market weight and direct effects for carcass traits in Japanese Black cattle using field data collected in 2 prefectures.

MATERIALS AND METHODS

Animal Care and Use Committee approval was not obtained for this study because the data were obtained from existing databases, as described below.

Data

Data were collected from calf and carcass markets in Hyogo and Tottori prefectures and analyzed separately by prefecture. For calf market weight, birth year ranged from 1994 to 2002 in Hyogo and from 1988 to 2000 in Tottori. Records of twins and calves produced by embryo transfer were omitted. Only fattening animals with calf market weight were extracted from the carcass database and used for parameter estimation. These cattle were slaughtered from 1997 to 2003 in Hyogo and from 1991 to 2004 in Tottori.

The carcass traits analyzed were carcass weight (**CW**), ribeye area (**RA**), rib thickness (**RT**), subcutaneous fat thickness (**SF**), yield estimate (**YE**), beef marbling score (**MS**), meat color (**MC**), meat brightness (**MB**), meat firmness (**MF**), and meat texture (**MT**). All carcass traits were measured by official graders of the Japan Meat Grading Association according to the carcass grading standards (JMGA, 1988). Carcass traits except CW and YE are evaluated at the sixth to seventh rib section, and YE is calculated using CW, RA, RT, and SF as an indicator of salable meat proportion. The MS is a subjective measure of the degree of marbling, especially in the ribeye, and is categorized into 12 grades (from 0 to 3 with intervals of 0.33, and 4 and 5) according to the Beef Marbling Standard. Greater numbers indicate more marbling. The MC is evaluated using a 7-point Beef Color Standard (1 = bright, 7 = dark). Five-point scales are used to quantify MB (1 = very dull, 5 = very shiny), MF (1 = very loose, 5 = very firm), and MT (1 = very coarse, 5 = very fine).

Calf market and carcass datasets were integrated, and only the records from cow-calf production and fattening farms with at least 5 calf or carcass market records were used. Records were omitted if observations of each trait or ages (d), or both, at calf and carcass markets fell outside of the range of the mean ± 3 SD. Descriptive statistics of the traits analyzed after data editing are given in Table 1.

Table 1. Number of records and descriptive statistics (mean ± SD) of traits at calf and carcass markets

Item	Hyogo	Tottori
Calf market		
Number of records		
Steer	23,661	12,369
Female	19,084	11,197
Total	42,745	23,566
Age at calf market, d	278.0 ± 26.62	246.2 ± 28.86
Inbreeding coefficient, %	21.8 ± 4.40	6.9 ± 5.19
Trait		
Calf market weight, kg	242.6 ± 27.70	257.3 ± 33.55
Carcass market		
Number of records		
Steer	8,190	4,027
Female	645	746
Total	8,835	4,773
Age at carcass market, d	967.4 ± 46.11	859.1 ± 53.94
Inbreeding coefficient, %	21.7 ± 4.41	6.8 ± 5.05
Trait		
Carcass weight, kg	381.8 ± 40.33	449.5 ± 52.43
Ribeye area, cm^2	50.7 ± 6.84	47.8 ± 7.31
Rib thickness, cm	6.8 ± 0.74	7.4 ± 0.85
Subcutaneous fat thickness, cm	2.2 ± 0.61	2.7 ± 0.85
Yield estimate, %	73.8 ± 1.09	72.5 ± 1.26
Beef marbling score, 0 to 5	1.5 ± 0.63	1.3 ± 0.62
Meat color, 1 to 7	3.9 ± 0.68	3.7 ± 0.68
Meat brightness, 1 to 5	3.8 ± 0.80	3.6 ± 0.83
Meat firmness, 1 to 5	3.8 ± 0.84	3.5 ± 0.87
Meat texture, 1 to 5	4.0 ± 0.76	3.7 ± 0.79

Genetic Models

Under a 2-trait animal model, calf market weight was combined with the respective carcass traits. In the analytical model of calf market weight, sex (steer and female), the dam's parity (1, 2, ..., 15, and >15), the birth month, the month-year at market, and the calf market (in Hyogo) or area of calf market (in Tottori) were considered as fixed effects, and partial regressions of record on age (d) at calf market (linear and quadratic) and on inbreeding coefficient (linear) were included as covariates. As random effects, direct and maternal genetic effects, cow-calf production farms, and residuals were considered. Permanent environmental effects due to dams were not considered because approximately one-fourth of the dams in both prefectures had only one calf, and variances due to permanent environment were small in preliminary analyses. For carcass traits, sex (steer and female), year and month at carcass market, and carcass market were considered as fixed effects, and linear and quadratic partial regressions on age (d) at carcass market and linear partial regression on inbreeding coefficient were included as covariates. Direct genetic effect, fattening farms, and residuals were considered as random effects. Number of levels of each fixed and farm effect are shown in Table 2, and means of covariates are found in Table 1.

In matrix notation, the mixed linear models for calf market weight and carcass traits, respectively, can be represented as follows:

$$\mathbf{y}_1 = \mathbf{X}_1\beta_1 + \mathbf{Z}_{a1}\mathbf{a}_1 + \mathbf{Z}_{m1}\mathbf{m}_1 + \mathbf{Z}_{f1}\mathbf{f}_1 + \mathbf{e}_1,$$

and

$$\mathbf{y}_2 = \mathbf{X}_2\beta_2 + \mathbf{Z}_{a2}\mathbf{a}_2 + \mathbf{Z}_{f2}\mathbf{f}_2 + \mathbf{e}_2,$$

Table 2. Number of levels in fixed and farm effects, and number of animals analyzed

Item	Hyogo	Tottori
Calf market weight		
Fixed effect		
Sex	2	2
Parity	16	16
Birth month	12	12
Year-month	80	97
Calf market	4	
Area of market		4
Cow-calf production farm	865	390
Carcass trait		
Fixed effect		
Sex	2	2
Year	7	13
Month	12	12
Carcass market	3	5
Fattening farm	152	112
Number of animals analyzed	65,885	36,565

where subscripts 1 and 2 represent calf market weight and carcass traits, respectively, and **y** is the vector of records, β is the vector of fixed effects, **a** and **m** are the vectors of direct and maternal genetic effects, **f** is the vector of farm effects, and **e** is the vector of residuals. $\mathbf{X}$, $\mathbf{Z_a}$, $\mathbf{Z_m}$, and $\mathbf{Z_f}$ denote the incidence matrices relating **y** to β, **a**, **m**, and **f**, respectively. For these models, assumed expectation and (co)variance structures are

$$E\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix},$$

and

$$\mathrm{Var}\begin{bmatrix} a_1 \\ a_2 \\ m_1 \\ f_1 \\ f_2 \\ e_1 \\ e_2 \end{bmatrix} =$$

$$\begin{bmatrix} A\sigma^2_{a1} & A\sigma_{a1a2} & A\sigma_{a1m1} & 0 & 0 & 0 & 0 \\ & A\sigma^2_{a2} & A\sigma_{a2m1} & 0 & 0 & 0 & 0 \\ & & A\sigma^2_{m1} & 0 & 0 & 0 & 0 \\ & & & I\sigma^2_{f1} & 0 & 0 & 0 \\ & & & & I\sigma^2_{f2} & 0 & 0 \\ & \text{Sym.} & & & & I\sigma^2_{e1} & I\sigma_{e1e2} \\ & & & & & & I\sigma^2_{e2} \end{bmatrix},$$

where σ^2_{ai}, σ^2_{mi}, σ^2_{fi}, and σ^2_{ei} stand for variances for additive direct genetic, maternal genetic, farm, and residual effects, respectively, for the ith trait, σ_{aiaj}, σ_{aimj}, and σ_{eiej} for direct genetic, direct-maternal genetic, and residual covariances between the ith and jth traits, respectively. **A** and **I** denote the additive relationship and identity matrices, respectively.

Pedigrees were traced back to animals born in 1960 using pedigree information from the Wagyu Registry Association, and all available ancestors were included in calculation of the additive relationship matrix. As a result, the numbers of ancestors without records were 23,140 and 12,999 in Hyogo and Tottori, respectively.

Estimation of Variance and Covariance Components

Variance and covariance components were iteratively estimated by REML procedures (Patterson and Thompson, 1971; Henderson, 1984) using an expectation maximization algorithm (Dempster et al., 1977). Convergence criteria were set as $(\| \mathbf{D}_{i+1} \| - \| \mathbf{D}_i \|)/\| \mathbf{D}_i \| < 1.0e^{-6}$, where $\| \|$ stands for the norm of matrix, and $\mathbf{D}_i$ for the matrix of genetic (co)variance, farm (co)variance, or residual (co)variance at the ith iteration. For convergence, all random effects were required to meet the above criteria simultaneously. Standard errors of estimates of direct and maternal heritabilities and genetic correlations were calculated by formulas of Falconer (1989), as implemented by Carnier et al. (2000).

RESULTS AND DISCUSSION

Animals produced in the Hyogo population have traditionally been characterized as having high meat quality with small body frame size, whereas those of the Tottori population are faster growing with large size. These assessments are well reflected in the descriptive statistics presented in Table 1. In Tottori, cattle were younger at both calf and carcass markets than in Hyogo. In contrast, MS was greater in Hyogo, even though SF was less. A large difference in inbreeding coefficients was found, reflecting differences in breeding history and mating systems between prefectures. Breeding stock in Hyogo has been maintained as an almost closed population (Honda et al., 2001). Although data in this study were collected from commercial populations, all calves in the Hyogo datasets were produced by AI sires from the Hyogo breeding population. On the other hand, in the dataset of Tottori, the calves were produced by AI sires from various prefectures. The proportion of progeny produced by AI sires from the Tottori population decreased from 98.4% in 1988 to 75.8% in 2000.

Estimated genetic parameters for calf market weight are shown in Table 3. Variance components and heritability estimates for calf market weight are expressed as the average of 10 estimates obtained from 2-trait analyses with 10 carcass traits. Ranges of standard errors of individual direct heritability, maternal heritability, and genetic correlation between direct and maternal genetic effects from ten 2-trait analyses were from 0.03 to 0.04, 0.01 to 0.02, and 0.04 to 0.10, respectively. Mukai et al. (2000) reported estimates of direct

Table 3. Average ± empirical SD of estimates of variance components and genetic parameters for calf market weight from ten 2-trait analyses

Parameter[1]	Hyogo	Tottori
σ^2_a	105.33 ± 6.47	314.26 ± 7.79
σ^2_m	32.07 ± 3.45	122.85 ± 2.69
σ_{am}	9.90 ± 2.37	−124.74 ± 4.83
σ^2_f	77.69 ± 0.74	145.96 ± 0.54
σ^2_e	258.14 ± 3.31	385.86 ± 3.87
h^2_a	0.22 ± 0.01	0.37 ± 0.01
h^2_m	0.07 ± 0.01	0.15 ± 0.00
r_{am}	0.17 ± 0.05	−0.63 ± 0.01
p_f	0.16 ± 0.00	0.17 ± 0.00

[1]σ^2_a = direct genetic variance; σ^2_m = maternal genetic variance; σ_{am} = genetic covariance between direct and maternal genetic effects; σ^2_f = variance due to cow-calf production farm; σ^2_e = temporary environmental variance; h^2_a = direct heritability; h^2_m = maternal heritability; r_{am} = genetic correlation between direct and maternal genetic effects; and p_f = proportion of phenotypic variance due to cow-calf production farm.

heritability for calf market weight of Japanese Black cattle to be 0.25, 0.30, and 0.27 using field data from the Iwate, Gifu, and Kagoshima prefectures, respectively. The estimates in this study were similar to those reported estimates.

Although the estimates of maternal heritability (0.07 and 0.15) were lower than the estimates of direct heritability in both prefectures, maternal effects can be evaluated based on weight at calf market. The estimate in Tottori fell into the range from 0.10 to 0.18 found by Mukai et al. (2000). The estimate in Hyogo was lower than that in Tottori but similar to the estimate of 0.06 reported by Kitamura et al. (1999) using calf market weights of Japanese Black cattle in the Shimane prefecture.

Genetic correlations between direct effect and maternal effect were positive (0.17) in Hyogo and highly negative (−0.63) in Tottori. The estimates for calf market weight of Japanese Black cattle were also reported to be positive by Mukai et al. (2000) and Kitamura et al. (1999) and were consistent with our estimate in Hyogo. However, in Tottori, there was an antagonistic relationship between direct and maternal genetic effects. Shimada et al. (1995) analyzed body weights from birth to 6 mo in Japanese Black cattle from the National Agricultural Experimental Station and reported consistent negative direct-maternal genetic correlations (−0.70 to −0.32). Estimates of direct-maternal genetic correlations may be influenced by a negative dam-offspring environmental correlation (Koch, 1972; Baker, 1980), often known as fatty udder syndrome. However, in Japan, calves from poor milking cows are given more milk replacer and starter than calves from high milking cows (i.e., nutritional condition of calves from different cows tends to be similar and independent of milking ability in Japan). In such a case, dam-offspring covariance is expected to be small. Other possible reasons for negative estimates of direct-maternal genetic correlations may be additional variation between sires or sire × year interaction effects (Robinson 1996a,b; Meyer 1997). Robinson (1996b) stated that additional variation between sires might result from the importation of superior genetic material. As described earlier, because migration of breeding stock from other populations into Tottori tended to increase and changes in production systems may have occurred in Tottori, additional variation between sires or sire × year interaction effects are likely to have exaggerated the negative correlation in these data.

Fractions of phenotypic variance due to cow-calf production farm were estimated to be 16 and 17% in Hyogo and Tottori, respectively. It is expected that the feeding and management systems of individual caw-calf operators have a large effect on early growth of calf because the farmers try to enhance early growth to increase value at calf market.

Estimates of heritability for carcass traits, fractions of phenotypic variance due to fattening farm, and genetic correlations with direct and maternal effects for calf market weight are shown in Table 4. Estimates of heritability for carcass traits were moderate to high, ranging from 0.31 to 0.61 in Hyogo and from 0.32 to 0.53 in Tottori. Considerable genetic variation that can be utilized for genetic improvement seems to remain in both prefectures. Mukai et al. (1995) analyzed genetic relationships between growth traits measured during performance testing at a test station and carcass traits collected from field data in the Kagoshima prefecture. They reported estimates of heritability for carcass traits to be moderate (0.39) to high (0.55), similar in magnitude to our estimates. Variances attributable to fattening farm ranged from 2 to 14%. Generally, variance due to farm was not as large as genetic causes of variation.

Absolute values of estimates of genetic correlations in Hyogo were generally larger than those in Tottori. Direct genetic variance for calf market weight in Hyogo was estimated to be approximately one-third of that in Tottori (Table 3). This might contribute to the larger genetic correlations in Hyogo. Estimates of genetic correlations between direct effects for calf market weight and CW were highly positive in Hyogo (0.87) and Tottori (0.56). Mukai et al. (1995) also found that CW was highly correlated with weights during performance testing (0.87 to 0.95). Estimates of genetic correlations between maternal effect for calf market weight and direct effect for CW were also positive in both prefectures but lower than the corresponding direct-direct genetic correlations. Few literature estimates are available regarding genetic correlations between maternal genetic effects for early growth traits and direct effects for carcass traits. Using a multiple-trait animal model, Splan et al. (2002) estimated the genetic correlations between direct and maternal genetic effects for weaning weight and direct effects for carcass traits in crossbred

Table 4. Estimates of variance components, heritabilities, and proportion of phenotypic variance caused by farm effect for carcass traits and genetic correlations with calf market weight from 2-trait analysis

	Parameter[1]						
Trait	σ_a^2	σ_f^2	σ_e^2	$h_a^2 \pm SE$	p_f	$r_{aa} \pm SE$	$r_{am} \pm SE$
Hyogo							
Carcass weight	727.07	225.59	674.51	0.45 ± 0.07	0.14	0.87 ± 0.03	0.32 ± 0.10
Ribeye area	29.90	1.86	17.59	0.61 ± 0.09	0.04	0.45 ± 0.08	–0.06 ± 0.11
Rib thickness	0.25	0.05	0.29	0.43 ± 0.07	0.09	0.43 ± 0.09	0.34 ± 0.10
Subcutaneous fat thickness	0.21	0.03	0.16	0.52 ± 0.08	0.07	0.07 ± 0.11	0.26 ± 0.10
Yield estimate	0.79	0.06	0.49	0.59 ± 0.09	0.04	0.16 ± 0.10	–0.13 ± 0.10
Beef marbling score	0.27	0.04	0.13	0.61 ± 0.09	0.09	–0.10 ± 0.10	0.26 ± 0.10
Meat color	0.15	0.02	0.32	0.31 ± 0.05	0.03	0.17 ± 0.11	–0.13 ± 0.11
Meat brightness	0.39	0.05	0.26	0.56 ± 0.08	0.08	–0.04 ± 0.10	0.16 ± 0.10
Meat firmness	0.40	0.06	0.32	0.51 ± 0.08	0.08	–0.05 ± 0.11	0.24 ± 0.10
Meat texture	0.30	0.05	0.27	0.48 ± 0.08	0.08	–0.03 ± 0.11	0.21 ± 0.10
Tottori							
Carcass weight	918.62	210.45	1,262.22	0.38 ± 0.05	0.09	0.56 ± 0.05	0.12 ± 0.08
Ribeye area	24.86	1.62	25.74	0.48 ± 0.06	0.03	0.18 ± 0.07	–0.08 ± 0.08
Rib thickness	0.26	0.06	0.42	0.36 ± 0.05	0.08	0.15 ± 0.08	0.07 ± 0.09
Subcutaneous fat thickness	0.31	0.04	0.34	0.44 ± 0.06	0.06	–0.08 ± 0.07	0.15 ± 0.08
Yield estimate	0.90	0.07	0.73	0.53 ± 0.07	0.04	0.00 ± 0.07	–0.14 ± 0.08
Beef marbling score	0.20	0.03	0.18	0.49 ± 0.06	0.07	–0.10 ± 0.07	0.09 ± 0.08
Meat color	0.14	0.01	0.29	0.32 ± 0.05	0.02	0.07 ± 0.08	–0.14 ± 0.09
Meat brightness	0.33	0.07	0.32	0.46 ± 0.06	0.09	–0.11 ± 0.07	0.06 ± 0.08
Meat firmness	0.38	0.06	0.35	0.48 ± 0.06	0.08	–0.10 ± 0.07	0.09 ± 0.08
Meat texture	0.28	0.04	0.32	0.43 ± 0.06	0.07	–0.09 ± 0.08	0.05 ± 0.08

[1] σ_a^2 = direct genetic variance; σ_f^2 = variance due to fattening farm; σ_e^2 = temporary environmental variance; h_a^2 = direct heritability; p_f = proportion of phenotypic variance due to fattening farm; r_{aa} = genetic correlation between direct genetic effects for calf market weight and carcass trait; and r_{am} = genetic correlation between maternal effect for calf market weight and direct effect for carcass trait.

cattle. They also reported large positive genetic correlations of direct effects for carcass weight with direct and maternal effects for weaning weight (0.70 and 0.61, respectively). Both RA and RT had positive genetic correlations with direct effects for calf market weight, but lower genetic correlations with maternal effects. However, estimates of genetic correlations of SF with direct and maternal effects for calf market weight were near zero and positive, respectively, in both prefectures.

Genetic correlations of MS with direct effects for calf market weight were estimated to be negative (–0.10) in both prefectures, whereas the correlations with maternal effects for calf market weight were 0.26 in Hyogo and 0.09 in Tottori. Mukai et al. (1995) also reported negative estimates of genetic correlations between direct effects for early weights and MS (–0.10 to –0.04), which are similar to our estimates. Splan et al. (2002) also reported a negative estimate of genetic correlation between direct effect for weaning weight and MS (–0.12) and a positive correlation between maternal effect for weaning weight and direct effect for MS (0.28). The magnitude of their estimates of genetic correlations was similar to those of this study. The positive genetic relationship between maternal effects for calf market weight and direct effects for MS is favorable from the viewpoint of improvement for both effects.

In Japan, consumers generally prefer meat color intermediate between bright and dark, corresponding to categories 3 or 4. In these data, one-half of the records for MC fell into category 4 in both prefectures. However, MC was found to be heritable and had genetic relationships with direct and maternal effects for calf market weight, except with the direct effect in Tottori. Although the magnitude of the relationships was small, attention should be paid to correlated response for MC with selection on direct and maternal effects for calf market weight.

For MB, MF, and MT, estimates of genetic correlations with calf market weight were similar to those involving MS in both prefectures. Hence, direct-direct genetic correlations and direct-maternal genetic correlations were low and positive in Hyogo, and were low negative and near zero in Tottori, respectively. This is not unexpected, as in the preliminary analyses, estimated genetic correlations among MS, MB, MF, and MT were very high, ranging from 0.93 to 1.00 in both prefectures. This may suggest that selection on calf market weight does not cause detrimental indirect effects on the meat characters, and, in addition, selection for MS would be expected to improve almost all meat qualities simultaneously in both prefectures.

Improved maternal ability is important to increase overall beef productivity, but records for estimating milking and nursing abilities are generally not available for beef cows because milk yield is not usually measured. In this study, it became clear that variances and covariances for such maternal effects could be estimated through calf market weight at about 8 to 10 mo of age. Because almost all calves are weighed at calf market, estimation of direct and maternal effects can be useful for evaluating maternal ability. Genetic parameters for calf market weight were different between Hyogo and Tottori, possibly due to differences in respective breeding and production systems. Therefore, genetic parameters for calf market weight should be estimated in each population under consideration. Furthermore, a negative direct-maternal genetic correlation for calf weight was estimated in Tottori. As a result, a breeding system should be planned carefully. Nomura and Shimada (1998) conducted a simulation study under negative direct-maternal correlation (–0.70) based on the genetic parameters for weight at 6 mo reported by Shimada et al. (1995). They demonstrated that an approach to mate selection as proposed by Toro and Silio (1992) was efficient in improving direct effects, while restricting maternal effects to zero change. Such an approach may be well suited for simultaneous selection in the Tottori population.

Direct and maternal effects for calf market weight were genetically correlated with carcass traits. Selection for increased direct genetic value for calf market weight would improve the traits concerning meat quantity. However, selection for direct genetic value for calf market weight would slightly decrease MS, whereas selection for maternal genetic value would result in increased MS. Thus, information obtainable from genetic evaluation of calf market weight should be considered in making breeding decisions, such as selection of breeding stock and mating schemes of AI sires with breeding cows.

IMPLICATIONS

Maternal ability should be estimated using early growth traits of calves because milk yield is not usually measured in beef cows. All calves sold at market are weighed in Japan. However, the data for calf market weight have not been used for breeding purposes thus far. Although further research would be required, the current study estimated the genetic effects on calf market weight and showed some possibility to use the data for genetic improvement of maternal effects.

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