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Genetic parameters for carcass traits of field progeny and their relations with feed efficiency traits of their sire population for Japanese Black cattle

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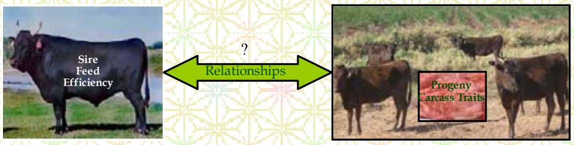
Carcass value, in Japanese beef market, is determined on the basis of meat quality, especially, degree of marbling. Individual bulls have large genetic influences in Japanese Black population because more than 90% of the progeny are produced by AI. The opportunity to improve production efficiency through exploitation of genetic variation in feed efficiency traits is dependent not only on the existence of genetic variation in young cattle but also on its genetic relationship with their progeny traits.



We estimated the genetic parameters for carcass traits of field progeny along with their genetic relationships with feed efficiency traits of their sire population, and examined the benefits of selecting feed efficiency traits in respects of biological point of view.

Data: The data were collected from 1971-2004 in Japan on 740 Japanese Black bulls (sire population) at the Okayama Animal Industry Centre, and on 1,774 of their field progeny (1,281 steers and 493 heifers) at 19 feedlot operations. Pedigrees of the recorded bulls were traced back to three generations and, including the tested animals, totaled 8,938.

Sire population: The bull calves were collected from designated farms within the age limits of 6–7 months and body weight 200–300 kg. Each year, 20–30 bull calves were selected on the basis of heavier body weight for performance test for 112 days from approximately 200 bulls. The residual feed intake (RFI) was calculated from the residual of phenotypic (RFI_{phe}) and genetic (RFI_{gen}) regression from the multivariate analyses of feed intake (FI) on metabolic weight (MWT) and daily gain (DG).

Field progeny: Calves produced from the mating between tested bulls and ordinary cows are fattened and slaughtered at the age between 663 to 965 days. Traits studied were carcass weight (CWT), rib eye area (REA), subcutaneous fat (SFT), yield estimate (YEM), marbling score (MSR), meat quality grade (MQG), meat color (MCL) and meat texture (MTX). The REA and SFT were measured at the 6th - 7th rib section (Figure 1). Grid approximation was used for REA measurement. The MSR was measured in 12 categories, with number 5.0 being the highest (from 0.0 to 3.0 with intervals of 0.33, and 4.0, 5.0). The YEM, MQG, MCL and MTX were obtained according to the meat grading standards of Japan. MCL was evaluated by beef color standard prepared as from light to dark color for 1 to 7 standards, respectively. MTX was evaluated by visual appraisal and they are classified into five grades from number 1 (course) to 5 (fine).

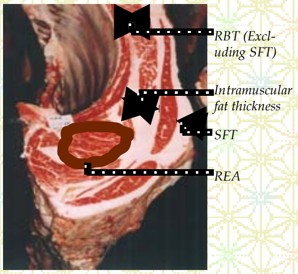


Figure 1 *Sixth - seventh rib section of carcass*

Statistical analysis: The covariances and h^2 were estimated by the REML method with the VCE program. The statistical model used in the analysis was:

$$Y_{ij}=F_{ij}+a_{ij}+e_{ij}; \text{ with } F_{ij}=CH_i+b(A_{ij}-A)$$

where Y_{ij}=phenotypic value of an animal; a_{ij}=genetic effect of an animal; e_{ij}=random residual; CH_i=fixed effect of i^{th} cohort; b=linear regression coefficient of the observation on age; A_{ij}=age of j^{th} animals in i^{th} cohort; A=mean age of animals. The covariances for all the traits were estimated by two-trait model.

Table 1 *h^2 (on diagonal) for and genetic (above diagonal) and phenotypic (below diagonal) correlations among carcass traits*

Traits	CWT	REA	SFT	YEM	MSR	MQG	MCL	MTX
CWT	**0.70 ±0.07**	0.37±0.10	0.21±0.11	-0.14±0.10	0.09±0.11	0.07±0.12	0.03±0.13	0.10±0.13
REA	0.29	**0.47 ±0.06**	0.25±0.12	0.84±0.04	0.63±0.07	0.58±0.09	-0.36±0.13	0.57±0.09
SFT	0.17	-0.01	**0.34 ±0.06**	-0.64±0.08	0.02±0.13	0.02±0.14	-0.11±0.16	0.18±0.14
YEM	-0.07	0.71	-0.56	**0.45 ±0.05**	0.62±0.09	0.48±0.10	-0.24±0.12	0.40±0.12
MSR	0.20	0.44	0.03	0.35	**0.33 ±0.06**	0.88±0.07	-0.67±0.10	0.86±0.02
MQG	0.22	0.39	0.04	0.31	0.80	**0.35 ±0.06**	-0.71±0.08	0.85±0.02
MCL	-0.05	-0.20	-0.08	-0.17	-0.34	-0.36	**0.15 ±0.03**	-0.82±0.07
MTX	0.19	0.38	0.09	0.30	0.74	0.79	-0.46	**0.25±0.6**

- The h^2 was high for CWT, while for all the other traits were moderate, except for MCL and MTX, which were low.
- Estimated negative r_g and r_p between YEM and SFT can be implemented into genetic evaluation system for reducing undesirable SFT using high yielding rates.

Table 2 *Genetic correlations between carcass traits of progeny and feed efficiency traits of their sire population*

Traits	CWT	REA	MSR	YEM	MQG	SFT	MCL	MTX
RFI_{phe}	-0.60±0.32	-0.42±0.33	-0.62±0.29	-0.03±0.27	-0.31±0.32	0.30±0.27	-0.27±0.37	-0.54±0.31
RFI_{gen}	-0.53±0.23	-0.45±0.29	-0.50±0.31	-0.02±0.30	-0.26±0.23	0.27±0.20	-0.28±0.27	-0.43±0.38
FCR	-0.41±0.36	-0.18±0.34	-0.54±0.32	-0.23±0.32	-0.43±0.24	0.11±0.39	-0.59±0.27	-0.42±0.30

- The r_g of RFI (RFI_{phe} and RFI_{gen}) of sires with CWT and REA of their progeny were favorably negative.
- The estimated negative r_g between RFI and MSR is considered a favorable indication for the possibility of simultaneous improvement of beef marbling and efficiency of feed
- CWT of progeny favorably negatively correlated with all the studied feed efficiency traits of their sires but was more strongly (higher absolute values) correlated with RFI than with FCR.

Table 3 *Correlated responses in carcass traits of progeny to selection against feed efficiency traits of their sire population*

Traits	CWT	REA	MSR	YEM	MQG	SFT	MCL	MTX
RFI_{phe}	10.55	0.98	0.48	0.01	0.06	-0.35	0.02	0.08
RFI_{gen}	9.51	1.08	0.40	0.01	0.05	-0.32	0.02	0.07
FCR	5.70	0.33	0.33	007	0.07	-0.10	0.03	0.05

Correlated responses after one generation of selection with selection intensity equal to -1.00

- Correlated responses in carcass traits of progeny over selection against RFI_{phe} were similar to those for RFI_{gen}, with a slightly greater increase in CWT.
- No responses in YEM and MCL and weak correlated responses in MQG and MTX of progeny were found over selection against feed efficiency traits (RFI or FCR) of sires.

Conclusion

The h^2 for CWT was high and for most of the other carcass traits were moderate. The RFI correlated more favorably with CWT and MSR than those for FCR with these traits. The correlated responses in CWT and MSR of progeny were higher to selection against RFI than those to selection against FCR, suggesting that selection against RFI might be preferred over selection against FCR in sire population for getting higher correlated responses in carcass traits of their progeny.