EFFECT OF INBREEDING ON CARCASS TRAITS IN HIGHLY INBRED BEEF CATTLE

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SUMMARY

Inbreeding depressions on carcass traits were estimated in beef cattle. The 4,099 records on fattened steers were obtained from the Hyogo Prefectural Record of Performance Program for the Japanese Black Cattle. Carcass records for marbling standard(BMS), carcass weight, rib-eye area, rib thickness and subcutaneous fat thickness were analyzed by best linear unbiased prediction method with animal model. Average inbreeding coefficients of steers and their dams were 9.86% and 7.57%, respectively. The regression coefficients of carcass weight and subcutaneous fat thickness on inbreeding percentage were –.22kg/% or .6% of one phenotypic standard deviation and -.06mm/% or .9%, respectively. On the other hand, the coefficient of BMS was positive though it was very small.

INTRODUCTION

The main breed of beef cattle in Japan is Japanese Black Cattle, consisting of 660 thousand females and 1,500 males dispersed in Japan. They were separated into more than twenty sub–populations by prefectures. However, the genetic contribution of two sub–populations (Hyogo and Tottori) to the whole population is 67.1% (Nomura and Sasaki,1986). Since the Hyogo sub–population has been maintained as a closed population at a small population size consisting only 17 thousand heads, an average inbreeding coefficient has been increasing (Moriya et al., 1994). The objectives of this study were to estimate the levels of inbreeding and inbreeding depression on carcass traits from the records of fattened steers in Hyogo Prefecture.

MATERIALS AND METHODS

A total of 4,099 records on fattened steers slaughtered from 1988 through 1991 were obtained from the Hyogo Prefectural Record of Performance Program for the Japanese Black Cattle, as shown by year and carcass market in Table 1.

Table 1. Fattened steer records used for the present research collected at two markets in different years

Carcass	Year				
Market	1988	1989	1990	1991	Sum
Kobe	511	492	515	437	1,955
Kakogawa	362	472	560	750	2,144
Sum	873	964	1,075	1,187	4,099

Inbreeding coefficients, originally devised by Wright (1922), were computed for the steers. Tracing pedigree back to the 6^{th} generations, all the relationships among both males and females were used to compute inbreeding coefficients for the 4,099 steers.

Using the obtained inbreeding coefficients, our analyses were done by tow steps. Firstly, carcass records for marbling standard (BMS), carcass weight, rib–eye area, rib thickness and subcutaneous fat thickness were analyzed by best linear unbiased prediction method (Henderson, 1973) with the animal model:

$$y_{i(jkl)} = a_i + M_j + N_k + F_l + p_1(P_i - \bar{P}) + p_2(P_i - \bar{P})^2 + a_1(A_i - \bar{A}) + a_2(A_i - \bar{A})^2 + c(C_i - \bar{C}) + e_i,$$

where,

$y_{i(jkl)}$: a record on a steer,

a_i : random effect, *i.e.*, breeding value of the i^{th} steer $(0, \mathbf{A}\sigma_a^2)$ where $\mathbf{A}$ is the numerator relationship matrix among steers,

M_j : fixed effect of the j^{th} carcass market,

N_k : fixed effect of the k^{th} year,

F_l : fixed effect of the l^{th} fattening farm,

p_1 *and* p_2 : linear and quadratic partial regression of the $y_{i(jkl)}$ on fattening period of a particular steer,

P_i *and* $\bar{P}$: continuous variable for the fattening period and its average, respectively,

a_1 *and* a_2 : linear and quadratic partial regression of the $y_{i(jkl)}$ on slaughter age of a particular steer,

A_i *and* $\bar{A}$: continuous variable for the slaughter age and its average, respectively,

c : linear partial regression of the $y_{i(jkl)}$ on inbreeding coefficient of a particular steer,

C_i *and* $\bar{C}$: continuous variable for the inbreeding coefficient and its average, respectively and

e_i : a random residual effect associated with a particular record.

Secondly, the model was alternated by including the inbreeding coefficient as five classifying variables shown in Tables 2 and 3. The computations were done with MTDFREML program (Boldman et al.,1993).

RESULTS

As expected, the inbreeding coefficient of the steers of Hyogo sub–population was high as shown in Table 2. Steers with inbreeding coefficient higher than 9% were more than 50% of the total. Average inbreeding coefficients of the steers and their dams were 9.86% and 7.57%, respectively.

Table 2. Classification of steers by inbreeding coefficient

Class of inbreeding, %					Frequency Heads	%
0	<	f	≤	3.125	124	3.3
3.125	<	f	≤	9	1,915	46.7
9	<	f	≤	15	1,481	36.1
15	<	f	≤	24	539	13.2
24	<	f			40	1.0

In general inbreeding adversely affects phenotypic performance. Since this influence may not be negligible, we include the effect of inbreeding in the statistical model. The regression coefficients of carcass weight and subcutaneous fat thickness on inbreeding percentage were -.22kg/% or .6% of one phenotypic standard deviation and -.06mm/% or .9%, respectively. Both values were low comparing milk yield in dairy cattle –26kg/% or 2.4% and –9.84kg/% reported by Casanova *et al.*, 1992 and Miglior *et al.*, 1992, respectively, and –2kg/% for mature weight in beef cattle reported by McCurley *et al.*, 1984). On the other hand, the regression coefficient of BMS was positive though it was very small.

Using the alternative model which included the inbreeding coefficient as classifying variables, the same data were reanalyzed. The results are shown in Table 3. Only in case of BMS, the differences among means of inbreeding classes were significant($P<0.05$). The solutions of all inbreeding classes higher than 3.125% were significantly larger than that of almost noninbred class ($0 < f \leq 3.125$).

Table 3. Solutions for carcass traits by class of inbreeding

Class of inbreeding, %					BLUE: BMS*	Carcass weight(kg)	Rib–eye area (cm^2)	Rib thickness (mm)	Subcutaneous fat thickness(mm)
0	<	f	≤	3.125	0.00^a	0.00	0.00	0.00	0.00
3.125	<	f	≤	9	0.64^b	4.00	0.97	1.20	-1.00
9	<	f	≤	15	0.60^b	3.24	1.10	1.11	-1.32
15	<	f	≤	24	0.64^b	1.18	0.99	1.15	-1.71
24	<	f			$0.63^{a,b}$	-1.07	1.58	0.20	-1.68

a,b: Means within the same column without a common letter in their superscripts differ ($P < .05$).

*: Marbling was divided into 12 grades (1–12) showing continuous change of the degree of marbling.

BLUE: The solution of the first class of inbreeding ($0 < f \leq 3.125$) was set to zero. Then, the other BLUE was expressed as the deviation from it.

DISCUSSION

It is generally accepted that traits with high heritability are little affected by inbreeding depression. Although the effects of inbreeding on various productive traits have been reported for beef cattle (Burrow, 1993), dairy cattle (Sachdeva *et al.* , 1983) and sheep (Lamberson and Thomas, 1984), the effect on carcass traits in beef cattle has not been reported as far as we know. We found in steers that inbreeding had a slightly positive effect on BMS rather than negative in the sub–population of the Japanese Black Cattle in Hyogo prefecture which has been closed for long period except for a very few case and in which an intensive inbreeding had been conducted to establish lines so called "TSURU". It is also generally accepted that inbreeding depression weakens survival and reproduction. Such depression usually appears in livestock production as depression in economic traits. The positive effect of inbreeding on BMS, therefore, may indicate that the BMS is a trait not advantageous to animal's survival or reproduction, although it is an important economic trait pursued strongly by Japanese producers.

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