Breeding Values for Carcass Traits at Calf Markets as Determinant of Feeding Length in Japanese Black Cattle: an Exploratory Study

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ABSTRACT : Japanese Black cattle (Wagyu) are fed for a long period to produce high quality beef, however, extended feeding often causes inefficiency and greater environmental load mainly derived from their manure. The objectives of this study were to analyze changes in feeding length by listing breeding values (BVs) at calf markets and the relationships between BVs and carcass characteristics of 4,052 Japanese Black cattle, and to examine the feasibility of optimizing feeding length by referring to listed BVs. BV classes A, B, and C were defined based on BVs of cows in Shimane Prefecture as follows: an upper quarter of BVs was classified as A, a second quarter as B, and under the average as C. For cattle sold at calf markets in the first term of 1996, just before the start of BV listing, the feeding length of cattle with class B BVs for the beef marbling standard (BMS) was longer ($p>0.05$) than that of class A cattle. However, in the second term of 1996, just after the start of BV listing, the feeding length of class B cattle became shorter ($p<0.001$) than that of class A cattle. Then, the feeding lengths of both classes showed no significant differences. Feeding lengths of both class A and B BVs for carcass weight (CW) changed similarly to the corresponding BV classes for BMS. The analysis of the relationships among the listed BV classes and the actual carcass characteristics showed that class A cattle had a higher ($p<0.001$) BMS than class B cattle, and that the higher-class cattle had a heavier CW ($p<0.05$). On the basis of previous reports, the cattle, particularly those with lower genetic marbling ability, seem to only increase marbling at markedly low efficiency for a few months before slaughter. Therefore, the finding that carcass characteristics corresponded to their class of BVs suggests that an optimum feeding length based on listed BVs not only increases the efficiency of beef production, but also reduces the environmental load. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 5 : 635-638)***

Key Words : Feeding Length, Breeding Value, Beef Marbling Standard, Carcass Weight, Beef Cattle, Japanese Black Cattle

INTRODUCTION

Japanese Black cattle, called Wagyu, are fed for a long period in the Japanese beef production system in order to produce high quality beef. However, producers tend to extend the feeding period because they expect to obtain better meat quality, which often causes inefficiency and additional manure excretion. Since the environmental problem of manure is becoming serious in a small country such as Japan, it is important to determine the optimum feeding length to sustain sufficient production of high quality beef to meet the Japanese demand. Recently, several feeding studies aimed at shortening the feeding length to around 22 months of age have been reported (Sakawaki et al., 2000; Inoue et al., 2000), although the average slaughter age of Shimane herds has been reported as about 28 months (Kitamura et al., 1999).

Feeding length is now mainly determined by the experience of each farmer. Although beef marbling, which has a great influence on the price of beef, tends to increase during the later stages of fattening, the additional feed and labor during the extended feeding period are in vain unless a sufficient price increase can be expected due to the large individual variation in genetic ability. In Shimane Prefecture, Japan, listing of the expected breeding values (BVs) for carcass traits at calf markets started in November 1996. Informing farmers of BVs, which provide important genetic information regarding carcass traits, is expected to optimize feeding length, during which the largest environmental load occurs in the livestock industry. Therefore, changes in the feeding length affected by listing BVs and relationships between BVs and actual carcass measurements were analyzed, and the feasibility of optimizing feeding length referring to listed BVs was examined.

MATERIALS AND METHODS

The records from 4,052 Japanese Black cattle which had both calf and carcass market records were used from Shimane Prefecture. The cattle were marketed as calves after November 1995, and were slaughtered by September 2000. The records from twins, F1, injured cattle, and cattle which exceeded three times the standard feeding length deviation were excluded. BVs for carcass traits, beef marbling standard (BMS) and carcass weight (CW), were estimated using BLUP under an animal model. The mixed

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Table 1. Least squares means and standard errors for feeding length (days)

Effect	N	Least squares means and standard errors	
		BMS[1]	CW[2]
Sex		***	***
Steer	3,360	612.7± 2.2	613.2±2.2
Heifer	692	621.2±2.7	621.7±2.7
Calf market		***	***
Chuo	3,492	609.3±1.3	609.7±1.2
Chubu	300	597.6±2.7	598.3±2.6
Seibu	226	620.6±3.0	620.7±3.0
Oki	34	640.4±7.3	641.0±7.3
BV class for BMS			-
A	892	618.0±2.5	-
B	244	613.5±3.4	-
Non-classified	2916	619.3±2.1	-
BV class for CW		-	-
A	423	-	618.1±2.9
B	442	-	617.3±2.9
C	271	-	614.9±3.3
Non-classified	2916	-	619.4±2.1
Calf market time		***	***
2nd 95	541	611.4±3.2	611.7±3.3
1st 96	591	622.8±3.3	619.9±3.1
2nd 96	650	618.4±3.7	623.8±3.4
1st 97	716	627.1±3.3	628.4±3.1
2nd 97	791	610.0±3.3	607.3±3.3
1st 98	763	612.1±3.0	613.4±2.9
BV class×calf market time		***	***

*** $p<0.001$

[1,2] Feeding length analyzed with model containing the effect of BV class for BMS and CW, respectively.

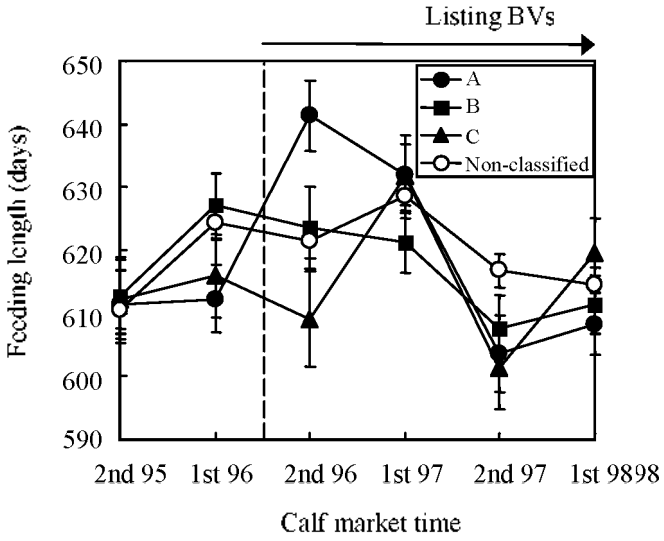

Figure 2. Changes in cattle feeding length with each class of breeding values (BVs) for carcass weight (CW) marketed as calves at different times before and after start of BV listing. A, B and C class denotes the upper quarter, a second quarter and under the average of BVs, respectively. The error bars indicate standard errors.

model included additive genetic effects and residual error as random effects. Fixed effects included were sex, market year, market place and feeding place. In addition, slaughter age as the linear and quadratic partial regression, and the inbreeding coefficient as the linear partial regression were considered in the model. Although BVs were not listed at calf markets until October 1996, they were calculated using the same method. BV classes A, B, and C were defined based on BVs of cows in the prefecture: the upper quarter of BVs was classified as A, a second quarter as B, and under the average as C. However, BVs of many cattle were still unknown, and approximately 70% of cattle were not classified. If a BV for BMS was C, BVs for all traits were not listed. Data were analyzed using a General Linear Models procedure (SAS, 1990). Feeding length was defined as the period between the calf market date and the slaughter date, and was analyzed using a model that contained the fixed effects of sex, calf market, BV class, calf market time, and BV class×calf market time interaction. Calf market time, i.e., when calves were marketed, was classified into six classes, with May to October as the first term, and November to the following April as the second term in each year. Carcass characteristics were analyzed using a model that contained sex, slaughter year, and BV class as the fixed effects, and linear regression on feeding length. The statistical significance of the results was analyzed by the least significant difference (LSD) test.

RESULTS

Arithmetic means ± S.D. of age and weight at calf market were 251.5±21.7 days and 273.7±23.6 kg, respectively, and those of slaughter age and feeding length were 851.9±47.3 days (27.98±1.55 months) and 608.4±42.3 days, respectively. The records of cattle classified as A, B, and non-classified on the basis of the BVs for BMS accounted for 22%, 6%, and 72% of all the records, respectively, and those classified A, B, C, and non-classified on the basis of the BVs for CW accounted for 10%, 11%, 7%, and 72%, respectively. Considering the cattle with estimated BVs, the numbers of cattle were almost the same in each BV class for CW. However, the number of class A cattle was larger than that of class B cattle for BMS.

Least squares means and standard errors for feeding length are presented in Table 1. All effects except BV class

were significant for feeding length ($p<0.001$), especially calf market and calf market time. There were differences of more than six weeks and more than two weeks among the feeding lengths of cattle sold at the different calf markets and at the different times, respectively. Figure 1 shows the effects of listing BVs for BMS on feeding length. For the cattle sold at calf markets in the first term of 1996, which was just before the start of listing BVs, the feeding length of class B cattle was longer than that of class A cattle ($p>0.05$). However, for the cattle sold at calf markets in the second term of 1996, just after the start of listing BVs, the feeding length of class B cattle became shorter by one month compared with that of class B cattle sold in the term just before, and was shorter ($p<0.001$) than that of class A cattle. And then, the feeding length of both classes of cattle showed no significant differences. In contrast, the feeding lengths of non-classified cattle were similar to the mean of those of class A and B cattle throughout the investigated period, and were little influenced by listing BVs. Figure 2 shows the effects of listing BVs for CW on feeding length. As in the case with BVs for BMS, among the cattle sold at calf markets in the second term of 1996, the feeding lengths of class B and C cattle were shorter ($p<0.05$ and $p<0.001$, respectively) than that of class A cattle, and thereafter those of every class cattle showed no significant differences.

The relationships between listed BV classes and actual carcass characteristics were analyzed. The least-squares analysis of variance for carcass traits showed that all effects were significant ($p<0.001$), except slaughter year on CW for carcass traits (Table 2). Figure 3 shows the BMS of carcasses derived from cattle of each BV class. Class A cattle had a higher ($p<0.001$) BMS than class B cattle, although non-classified cattle had the highest. The higher-class cattle had heavier ($p<0.05$) actual CW, except non-classified cattle (Figure 4).

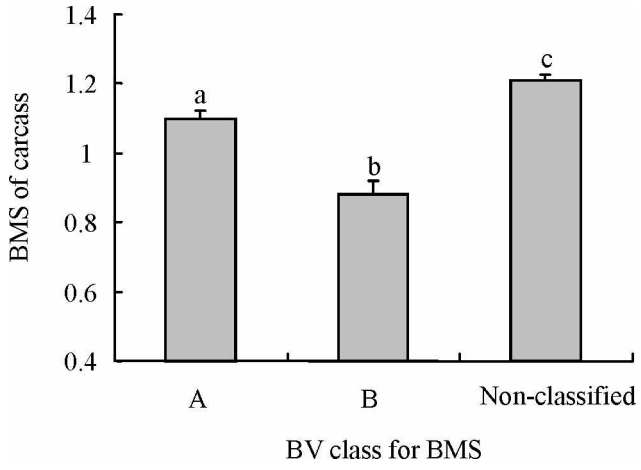

Figure 3. Beef marbling standard (BMS) of cattle carcasses with each class of breeding values (BVs) for BMS. The error bars indicate standard errors. Means with different letters differ significantly ($p<0.05$).

Table 2. Least squares means and standard errors for carcass characteristics

Effect	N	Least squares means and standard errors	
		BMS	CW (kg)
Sex		***	***
Steer	3,360	1.19±0.02	439.0±1.1
Heifer	692	0.94±0.03	403.5±2.0
Slaughter year		***	
1997	565	1.28±0.03	423.7±2.2
1998	1,224	1.19±0.02	418.5±1.6
1999	1,524	0.97±0.02	420.1±1.6
2000	739	0.83±0.03	422.7±1.9
BV class for BMS		***	-
BV class for CW		-	***
Feeding length		***	***

*** $p<0.001$

DISCUSSION

Since the feeding length of beef cattle in Japan is quite long, the average slaughter age is about 28 months, whereas most of cattle are slaughtered under 18 months of age in the USA (Blakely and Bade, 1994), and between 22 and 24 months of age in Korea (Jung, 1998; Lee et al., 2000). To reduce environmental load, it is important to study the optimum feeding length for Japanese Black cattle since, as we reported, shortening the feeding length to 26 months of age actually reduced environmental loads such as global warming and eutrophication as well as manure excretion (Ogino et al., 2002). In this study, analysis of feeding length revealed that cattle feeders adjusted the feeding length according to classes of BVs just after the start of BV listing at calf markets, however, they have not done so since then. This seems to have been caused by many cattle feeders expecting higher-class cattle to produce high quality meat, especially with marbling, as well as attempting to win beef cattle judging contests. Specifically, it seems they fattened their cattle for longer periods to win the contests, however, the expected results were not always obtained, and they therefore ceased to feed their cattle for longer periods. At around 28 months cattle increase their weight very slowly, and it is desirable that fattening be finished earlier for the sake of feed efficiency. Nonetheless, Japanese beef farmers feed their cattle for such a long period because they expect the longer feeding makes more marbling, which has had a great influence on the price of beef. Japanese consumers prefer tender, juicy and well-marbled beef, especially for domestic beef, and there is enough demand for it despite the relatively high price. However, marbling reportedly increases linearly from 12 months of age until 20

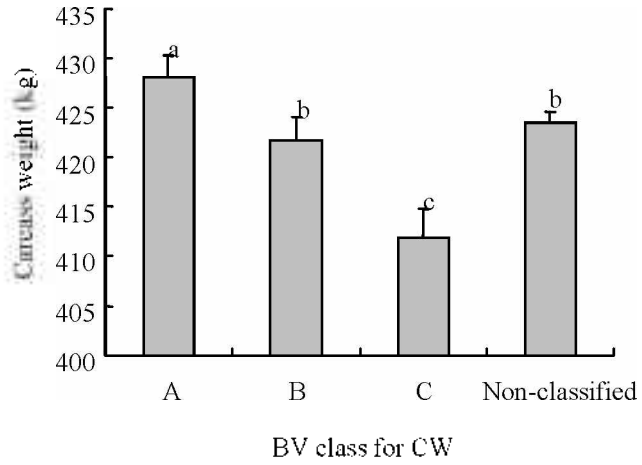

Figure 4. Weight of cattle carcasses with each class of breeding values (BVs) for carcass weight (CW). The error bars indicate standard errors. Means with different letters differ significantly ($p<0.05$).

or 24 months of age (Tsuchiya et al., 1967; Fukuhara et al., 1968; Yamazaki, 1981). Based on these reports, cattle aged around 28 months seem to increase marbling only at low efficiency, particularly those with lower genetic marbling ability. Therefore, the finding that carcass characteristics corresponded to their class of BVs suggests that an optimum feeding length based on listed BVs not only increases the efficiency of beef production, but also reduces environmental load. However, it has to be taken into account that the optimum feeding length might differ among different frame size lines due to differences in growth characteristics. Furthermore, increasing the percentage of cattle with estimated BVs by collecting more data about carcass characteristics is important, because BVs of many cattle were not estimated or not listed in the data used in this study. In addition, analysis of records in other regions of Japan where BVs are listed at calf markets is necessary.

Environmental problems in animal production, especially the treatment of animal waste, are emerging, and are crucial for the "survival" of the livestock industry in Japan. It is important to reduce the environmental load from animal production using the knowledge obtained in various research areas such as BV, originally an index for animal genetic performance, which was used in this study.

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