肉質重視の改良が黒毛和種雌牛の体測定値及び繁殖牛に及ぼす影響

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Effects of Improvement for Carcass Quality on the Body Measurements and Reproductivity of Japanese Black Cows

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Summary

Since the end of the 1970's, Wagyu producers in southern Kyushu have made efforts in order to improve not only carcass quantity but also carcass quality, introducing a number of AI sires which were produced in another districts that had a hight opinion on carcass quality. A study was conducted to examine effects of such an effort for carcass improvement on the body measurement and reproductivity of a local Japanese Black herd. The records of body measurements and reproductive traits of 1,189 dam-cows and daughter-cows were collected from Miyazaki Livestock Improvement Association. All the cows produced more than two calves. Breeding values of cow for carcass traits were predicted from another data-set using an animal model BLUP method.

Daughter-cows were superior significantly to dam-cows in predicted breeding values for both carcass weight and beef marbling standard (BMS). When effects of AI sire and age at registration were considered, least-squares means of daughter-cows for body measurements except withers height were smaller than those of dam-cows, respectively. And each difference was small one. There was no singnificant difference in withers height, age at first calving and calving interval, respectively, between dam- and daughter-cows. It may be said, therefore, that no bad effect of a promotion for carcass improvement was found on body measurements and reproductivity in a local Wagyu herd.

Key words: Japanese Black herd, carcass improvement, dam- and daughter-cows, body measurements, reproductivity.

Introduction

Since 1962, when the goal of Wagyu cattle improvement as modern beef cattle was determined officially, the Japanese Black, a representative breed of Wagyu cattle, has been improved in order to adopt to the Japanese beef markets. Recent research studies on the genetic trend based on the predicted breeding values of carcass traits have proved that Japanese Black has a great success in improving both quantitative and qualitative traits of carcass during past a quarter of the century[6,7]. In southern Kyushu, since the end of the 1970's,Wagyu producers have made efforts in order to improve not only carcass quantity but also carcass quality, introducing a number of AI sires which were produced in another districts (including

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Hyogo and Shimane prefectures) that had a high opinion on carcass quality.

On the other hand, a most striking feature of the breeding structure of a local Wagyu cattle herd is that female breeding stocks belong to the individual cow-calf operators or farmers, and that a couple of generations overlap each other in a breeding herd. Therefore, few research works have been reported on the genetic change or improvement per generation of economical traits, though several research studies have been made on the population structure of local Wagyu cattle herds[5,8].

The purpose of the present study was to clear the genetic changes in body measurements at registration and reproductive performance in a local breeding herd of Wagyu cow through the process of improvement effort for the beef cattle which adopt to Japanese beef market.

Materials and Methods

The records on body measurement at registration and reproductive performance of 1,189 pairs of Japanese Black dam-cows and their daughters-cows were collected from several Wagyu Improvement Unions in Miyazaki prefecture. The traits on body measurements included body weight, withers height, chest girth, chest depth, rump length and thurl width. Age at registration of the cows ranged from 16 to 33 months. Reproductive performance included age at first calving, first calving interval and average calving interval. The records of carcass traits including carcass weight and marbling score were collected from Japan Agriculture Cooperation of Miyakonojo.

The records of pedigree of a total 2,378 registered cows were collected in order to calculate inbreeding coefficient by the use of WRIGHT' s formula[11]. Breeding values for carcass traits were predicted by the animal model using indirect algorithm developed by SCHAEFFER and KENNEDY[9]. The model included shipped year, sex and fattening farm as fixed effects and linear regression of inbreeding coefficient and age at shipping, and quadratic regression of age at shipping .

All the registered cows were screened and selected by the following restrictions; (1) the dam-cows were born in 1973 to 1983; (2) the daughter-cows which were registered and kept in the population as first successor to their dam-cows; (3) all the cows of which each calving interval was more than 275 days and less than 845 days.

The records of body measurements and reproductive traits were statistically analyzed[10] to determine genetic change between dam and daughter. Generational change (Δ Ge) was determined by subtracting the phenotypic mean of dam-cows from that of daughter-cows[2], that is, $\Delta Ge = \bar{P}_{daughter} - \bar{P}_{dam}$.

A least squares analysis of variance for body measurement was done by using the HARVEY method's[3]. The data set was obtained from one part of the same data set included the records of 857 pairs of dam- and daughter-cows which were progenies of 32 sires. The statistical model used included generation (dam and daughter) as fixed effect, sire as random effect and age at measurement(registration) as linear regression.

Results and Discussion

Age between dam- and daughter-cows

As described in the previous section, each material daughter-cow was the first successor to dam-cow in the herd. It is determined by a chance whether a dam-cow will produce a female calf or male calf at calving, and whether the born female calf will be brought up to be a succsessor of dam-cow or not. In the case on the present study, as shown in Table 1, it was at 1.9 to 15 years of age when a dam-cow had her first successor in breeding herd. The mean value was 5.03 years of age. In a breeding herd of Japanese Black cow, in which number of successor per dam-cow is relatively small, the average interval between birth date of dam- and daughter-cow may be defined as generation interval. Therefore, the interval of 5.03 year is naturally smaller than the generation interval of 5.78 to 5.88 years which reported by NOMURA and SASAKI[8] and that of 6.98 to 8.23 years by MUKAI et al.[5].

Table 1. Age of dam-cows when she had her suc cessor daughters for the first time in the herd

Age of dam-cow (yares old)	No. of dam-cow	Cumulative (%)
1	9	0.76
2	252	21.95
3	227	41.02
4	162	54.67
5	176	69.47
6	112	78.89
7	78	85.45
8	64	90.83
9	45	94.62
10	25	96.72
11	16	98.07
12	13	99.16
13	8	99.83
14	1	99.92
15	1	100.00

Change in inbreeding coefficient

Average inbreeding coefficients were 0.011 with a range of 0 to 0.259 for dam-cows and 0.029 with a range of 0 to 0.207 for daughter-cows, respectively. A slight increase of 0.018 was observed in inbreeding coefficient per generation. As shown in

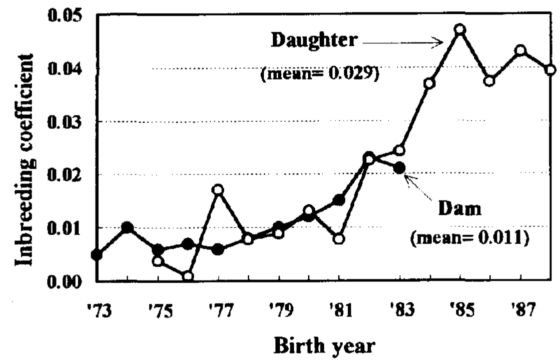

Fig. 1. Changes in average inbreeding coefficients of dam-daughter pairs by birth year

Fig.1, mean value of inbreeding coefficient by birth year for dam-cows tended not to change until 1977, and after that it tended to increase gradually yearly until 1983. On the contrary, average inbreeding coefficient for daughter-cows increased from 1982 to 1985, and it kept a level approximately of 0.04 thereafter. The fact seems to suggest that intentional mating was made in order to increase inbreeding coefficient of progeny. In the 1980's, a great demand took place among Japanese Black producers for the AI sires with high transmitting ability of marbling instead of daily gain. And the demand for the semen straws of specific AI sires was growing year by year. In fact the number of AI sire used decreased from 119 heads for dam-cows to 55 heads for daughter-cows. The fact may be one of the reason why there was a slight increase of 0.018 in inbreeding coefficient per generation. Average value of inbreeding coefficient of 0.029 for daughter-cows in the present study was lower than of 0.128 for Japanese Black cows in Hyogo prefecture where a completely closed breeding system had been carried for more than 80 years[5]. The fact may also suggest that any systematic breeding project had not been carried in Miyazaki prefecture until early 1980's.

Genetic trend of carcass traits for dam- and daughter-cows

In order to confirm where any genetic improvement was obtained or not as beef cattle during the period, the mean values of PBV and genetic trend for carcass weight (CWT) and marbling trait (BMS) were calculated. As shown in Table 2, the mean values of PBV for CWT and BMS were 1.5968 kg and -0.0091 for dam-cows, and were 4.2118 kg and 0.0544 for daughter-cows, respectively, when the year of genetic base was 1975. The genetic changes for both traits were not so much though they were significant statistically. It is because that in those day selection and preservation of replacement animal were carried based on the type conformation and the phenotypic mean values of performance or progeny test of AI sires, and that no genetic evaluation for carcass traits were made on any replacement heifers and cows. It may be also said that in those days Japanese Black producers were more interested in increasing age and weight at slaughter than in selecting AI sire with a higher transmitting abiliy of marbling in order to improve carcass quality. Considering the maximal values of 46.088 kg and 42.7168 kg for CWT, and those of 1.3237 and 1.0116 for BMS of dam- and daughter-cows, respectively, there might be a great possibility of genetic improvement per generation if an appropriate selection and mating based on the information of the PBV would be put into practice.

Figure 2 shows genetic trend of average PBV for CWT and BMS of dam- and daughter-cows by birth year of dam cow. The average PBV of daughter-cows for CWT tended to be larger than that of the dam-cows. The PBV of daughter-cows of which dam-cows were born after 1977

Table 2. Predicted breeding values (PBV) for carcass weight (CWT) and coded beef marbling standard (BMS) of dam- and daughter-cows[1)]

Traits	Dam				Daughter				Difference[2)]	
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
CWT(kg)	1.5968	11.6427	-37.6011	46.0880	4.2118	12.2260	-34.2958	42.7168	2.6150**	10.7990
BMS(unit)	-0.0091	0.2405	-0.7481	1.3237	0.0544	0.2768	-0.8580	1.0116	0.0635**	0.2569

[1)]1,189 dam-daughter pairs.
[2)]Daughters PBV−dams PBV for traits.
SD : standard deviation, **$P<0.01$.

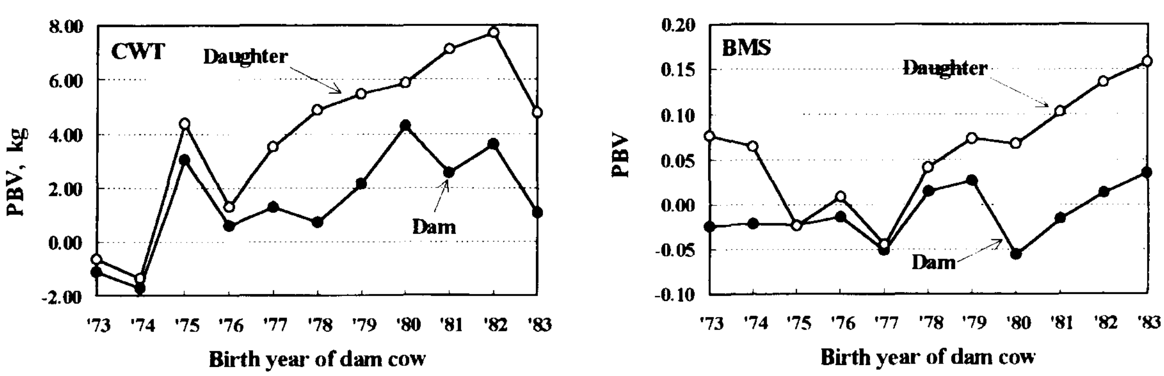

Fig. 2. Changes in average predicted breeding values (PBV) for carcass weight (CWT) and code beef marbling standard (BMS) of dam-daughter pairs by birth year of dam cow

tended to be larger remarkably than those of their dam-cows. The fact seems to suggest that the genetic improvement of CWT may depend mainly on the progenies of dam-cows which were born after 1977. The average PBV for BMS of the daughter-cows of which dam-cows were born after 1980 were superior to those of their dam-cows. One of the reason why the PBV value of daughter after 1980 was superior stably to that of dam seems to be a widely use of the specific AI sires with high transmitting ability concerning marbling trait, for in those day no selection and preservation were carried as described above. In Miyazaki prefecture, the prediction of breeding value of cow was initiated in the early 1990's. Therefore, the PBV level of marbling trait will be expected to increase greatly in the next generation, that is, grand-daughter and grand grand-daughter generations of the present population.

Generational changes in body weight and other measurements

Comparison of mean values. Body weight and other body measurements of all material animals were measured at registration, respectively. The frequency distribution of age at registration for the daughter-cows agreed almost completely with that for dam-cows, as shown in Fig. 3. Therefore, comparisons of the mean values of body weight and other body measurements between dam- and daughter-cows were made without adjustment for age at registration. The mean and standard deviation values for body weight and other body measurements of dam-daughter pairs were presented in Table 3. The mean value for body weight of daughter-cow was smaller significantly by 3.6kg than that of dam-cow, while that for withers

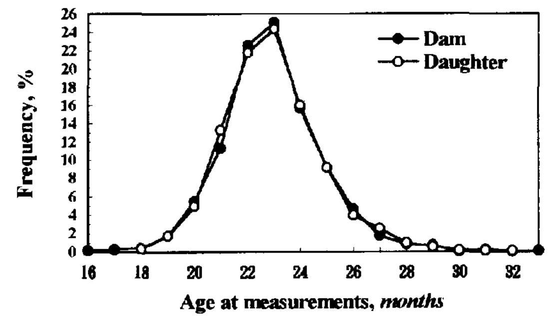

Fig. 3. Frequency distribution of age at measurement for body measurements of dam-daughter pairs

height of daughter-cow was superior significantly($P<0.01$)by 0.7 cm to that of dam-cow. The fact that a negative gain was obtained in body weight in spite of a positive gain in withers height seems to be a very interesting phenomenon.

A negative change of 0.6 cm was found in chest girth while a positive improvement of 0.2 cm in chest depth. These values were statistically significant. A negative change in chest girth seems to reflect the negative gain in body weight, because chest girth is well known to have a close relationship with body weight. No genetic improvement was found in rump length and thurl width. It is worthy to note that the value of standard deviation for body weight, withers height, chest girth and chest depth became smaller as generation advanced.

Effect of generation. It is well-known that sire has significant effect on body measurements. Therefore, generation effect on body measurement should be discussed, if possible, considering sire effect in addition to age effect. So, a least squares analysis was conducted using a statistical model which included sire effect and regression to age at measurement(registra tion). The results are shown in Table 4 and Table 5. Generation had highly significant effect on body weight, chest girth, chest depth, rump length and thurl width,

Table 3. Mean and standard deviation values (SD) of body weight and body measurements of 1,166 dam-daughter pairs

Body Measurements[1)]	Dam		Daughter		Difference[2)]	
	Mean	SD	Mean	SD	Mean	SD
BW(kg)	508.6	44.2	505.0	38.6	-3.6*	54.9
WH(cm)	127.5	2.8	128.2	2.4	0.7**	3.3
CG(cm)	193.4	7.4	192.8	6.7	-0.6*	9.4
CD(cm)	68.0	2.3	68.2	2.0	0.2*	2.9
RL(cm)	51.3	1.8	51.2	1.9	-0.1[NS]	2.4
TW(cm)	46.7	2.0	46.7	2.1	0.0[NS]	2.8

1)BW: body wegiht, WH: withers height, CG: chest girth, CD: chest depth, RL: rump length, and TW: thurl width.
2)Daughter phenotypic value - dam phenotypic value.
**P < 0.01, *P < 0.05, NS: not significant.

Table 4. Least squares analysis of variance for body measurements

Source of variayion	d.f.	Mean squares					
		BW(kg)	WH(cm)	CG(cm)	CD(cm)	RL(cm)	TW(cm)
Generation	1	42673.71**	19.49[NS]	854.42**	33.95**	84.35**	71.68**
Sire	31	4291.75**	20.13**	122.18**	15.23**	16.43**	18.59**
Regression:							
Age(linear)	1	1182.14[NS]	8.77[NS]	2.74[NS]	10.82[NS]	5.86[NS]	11.42[NS]
Error	1680	1464.07	5.85	43.52	4.21	3.22	3.72

BW: body weight, WH: withers height, CG: chest girth, CD: chest depth, RL: rump length, and TW: thurl width, d.f. : degree of freedom.
** P < 0.01, NS: not significant.

Table 5. Least-squares mean (LSM) and standard error (SE) for body measurements of dam and daughter

Body Measurements[1)]	Dam	Daughter
	LSM±SE	LSM±SE
BW(kg)	508.6±2.2[a]	502.2±2.3[b]
WH(cm)	127.9±0.1[a]	127.6±0.1[a]
CG(cm)	194.1±0.4[a]	192.3±0.4[b]
CD(cm)	68.2±0.1[a]	67.9±0.1[b]
RL(cm)	51.5±0.1[a]	50.9±0.1[b]
TW(cm)	47.0±0.1[a]	46.5±0.1[b]

BW: body weight, WH: withers height, CG: chest girth, CD: chest depth, RL: rump length, and TW: thurl width.
Values with different superscripts in the same row are significantly different (P<0.05).

respectively, while it did not affect significantly on withers height. All the values of least squares mean for daughter generation were smaller than those for dam generation, respectively. Effect of sire on all the body measurements were highly significant and linear regression to age at measurement was not significant in all traits. The results shown in Table 4 suggested that disagreement between the results in Table 3 and those in Table 5 may be due to sire effect.

Changes in age at first calving and calving interval

The mean values of age at first calving were 26.4 months for dam-cows and 26.3 months for daughter-cows as presented in Table 6. There was no significant difference between two generations. The mean values were larger as compared with the recent of 25.9 months for Miyazaki prefecture which reported by BACO *et al* [1)].

The mean values of first calving interval and average calving interval were 399.5 days and 398.2 days for dam-cows, and 402.6 days and 406.0 days for daughter-cows, respectively. There were negative but non-significant changes of 3.1 days and 7.8 days, respectively The figures of average calving interval almost agreed with those reported by other research workers[4)]. Considering efficiency of lifetime produc-

Table 6. Mean and standard deviation (SD) values of age at first calving and calving interval of dam-daughter pairs

Item	No. of pairs	Dam		Daughter	
		Mean	SD	Mean	SD
Age at first calving (months):	1,189	26.4	3.5	26.3	3.5
Calving interval (days):					
1st[1)]	1,121	399.5	81.9	402.6	84.3
Average[2)]	1,121	398.2	51.1	406.0	52.5

[1)] Interval between 1^{st} and 2^{nd} calving.
[2)] Average of mean value of the interval calving for each cow by maximal 7^{th} calving.

tion, more efforts should be done to improving calving interval.

From the results described above, it may be concluded that no genetical changes in both body size and reproductive performance in a local Wagyu herd, resulting from the improvement efforts for beef cattle, though significant differences are found in body weight and body measurements except withers height between dam and daughter generations. It is also suggested that no improvement was found in age at first calving and calving interval. A further study should be made in the future on the genetic gain or improvement in economical traits of Japanese Black herd in the period when selection and preservation of replacement animals are carried based on predicted breeding value.

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References

1) Baco, S., Fukuhara, R., Ishida, T. and Harada, H. : Improvement of reproductive performance of Wagyu cows in Japan. Proceeding of the 7th AAAP Animal Science in Bali, Indonesia, 107-108 (1994).
2) Falconer, D.S. : Introduction to quantitative genetics. Oliver and Boyd LTD. Edinburgh and London. (1964).
3) Harvey, W.R. : User's guide for LSMLMW and MIXMDL. Mixed model least-squares and maximum likelihood computer program. Ohio State Univ., Columbus. (1990).
4) Moriya, K., Fukuhara, R., Ishikawa, Y., Harada, Y. and Harada, H. : Analysis of field records on the reproductive traits of Japanese Black cows. *Anim. Sci. Technol.(Jpn.)*, 62(4):357-361 (1991).
5) Mukai, F., Tsuji, S., Fukazawa, K., Ohtagaki, S. and Nanbu, Y. : History and population structure of a closed strain of Japanese Black cattle. *J. Anim. Breed. Genet.*, 106 : 254-264 (1989).
6) Mukai, F. : Genetic evaluation and se lection methods for carcass traits in Japanese Black cattle. *Anim. Sci. Technol.(Jpn.)*, 65(9): 890-905 (1994).
7) Namikawa, K. : Wagyu. 2nd ed. Wagyu Registry Association. Kyoto. (1992).
8) Nomura, T. and Sasaki, Y. : Breeding structure based on age pattern of sires and dams and on the diversity of sires of the registered Japanese Black bull and heifers. *Jpn. J. Zootech. Sci.*, 57(4)

: 305-309 (1986).

9) SCHAEFFER, L.R. and KENNEDY, B.W. : Computing solution to mixed model equation. In Proc. 3rd World Congr. Genet. Appl. Livest. Prod. (G.E. Dickerson and R.K. Johnson,eds.) Agric. Commun., Univ. Nebraska, Nebraska, XII : 382-393 (1986).

10) STEEL, R.G.D. and TORRIE, J.H. : Principles and procedures of statistics. McGraw-HillBook Co., Inc. New York, Toronto, London. (1960).

11) WRIGHT, S : Mendelian analysis of pure breeds of livestock. I. The measurement of inbreeding and relationship. *J. Heredity*, 14 : 339-348 (1923).

肉質重視の改良が黒毛和種雌牛の体測定値及び繁殖牛に及ぼす影響

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要　約

1970年代の後半以降，南九州の代表的な和牛生産地帯では，体型や繁殖性よりも脂肪交雑に代表される肉質を重視した改良を意図し，肉質に関して優れていると評価されていた兵庫系（但馬系）や島根系の種雄牛を導入し，繁殖雌牛の産肉性の向上を図ってきた。本研究は，このような改良過程が地方の繁殖牛群の体型や繁殖性にどのような影響を与えているかを検討するため，母娘の関係にある黒毛和種登録雌牛の体測定値及び繁殖成績を用いて世代当たり変化量を計算しようとしたものである。材料としては宮崎県のM和牛改良組合で1973年から1983年の間に生まれ，２産以上している黒毛和種登録雌牛とその第一後継娘牛の組1189組，計2378頭の登録検査時の体重と体測定値，初産月齢，分娩間隔及び産子の枝肉重量と脂肪交雑基準値（BMS)の記録を使用した.

分析の結果，娘牛の枝肉重量とBMS の育種価予測値は，母牛よりそれぞれ有意に高く，肉質改良の効果が認められた．これに関連して，母数効果として父牛を，回帰として登録検査時の月齢を分析モデルに取り込んだ場合には，娘牛の体重，胸囲，胸深，尻長及びかん幅は母牛より有意に小さくなったが，母娘間の差は小さなものであった。また，和牛の発育指標として広く利用されてきた体高では母娘間に有意な差は認められなかった．初産月齢及び初産と第２産の間の分娩間隔も，それぞれ母娘間には有意な差は認められなかった．以上の結果，肉質を重視した改良過程は，当該繁殖雌牛群の体測定値や繁殖性に対してはとくに悪影響を及ぼすことはないようであった.

キーワード：黒毛和種登録雌牛，肉質改良，母娘牛，体測定値，繁殖性

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