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Ultrasonic Measurement of the Subcutaneous Fat Thickness in Crossbred Steers of Brahman Sire×Japanese Black, Japanese Shorthorn and Holstein Dams

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Summary

The subcutaneous fat thickness (SFT) was investigated in live bodies and carcass of crossbred steers of Brahman (Z) sire×Japanese Black (B), Japanese Shorthorn (N) and Holstein (H) dams, and straightbred steers of B and N. Thirty-five steers (5 ZB, 6 ZN, 2 ZH, 12 BB and 10 NN) were fed according to the seasonal pasturing system for a two-year period. SFT in live bodies was measured twice, in the 8th month of fattening and at the time of marketing, at six positions (four upper positions : 1～4 UP and two lower positions : 1～2LW) on both sides of the body using an A-mode ultrasonic device.

SFT in the four upper positions of BB and NN showed consistent values of 7.6 mm and 9.6 mm, respectively. On the other hand, SFT at 2-UP of ZB (9.1 mm) and at 3-UP of ZN (11.3 mm) were the highest values among the four upper positions within the same mating group. The lowest SFT value among mating groups was found in ZH for all measurement positions except 1-UP. SFT value in the 2 lower positions(1-LW and 2-LW) of BB (8.5 mm, 10.7 mm, respectively) were almost the same as those of ZB (8.5 mm, 10.7 mm), while those of ZN (8.5 mm, 11.6 mm) were thinner than those of NN (11.2 mm, 12.3 mm). The daily deposition of subcutaneous fat (DDSF) in BB and NN was higher at both 2-UP and 3-UP (17.4～35.8 μm/day), while in ZB and ZN, DDSF was high at 1-UP. For the two lower positions, the DDSF in ZN was higher than that in other mating group.

The results of this study revealed that the crossing of Brahman sire with dams of Japanese Black and Japanese Shorthorn is effective for reducing subcutaneous fat.
Key words : Brahman, Wagyu, subcutaneous fat, ultrasonic measurement

Crossbreeding of the Brahman, which is a representative breed of *Bos indicus*, with *Bos Taurus* is known to improve the growth performance (1). However, Yamagishi *et al.* (2) reported that under pasturing conditions, higher growth performances were obtained in crossbreds of Brahman with Japanese Black and Japanese Shorthorn than from corresponding straightbreds. They also pointed out that introducing germ plasm of the Brahman breed to Japanese beef breeds was effective for increasing the growth potential of calves in the more temperate northeastern area of Japan. Differences in the deposition of subcutaneous fat among beef breeds was also reported by Marshall (3). However, there has been no comparison of subcutaneous fat thickness in Japanese beef breeds (crossbreds of Brahman with Japanese Black and with Japanese Shorthorn).

Therefore, in the present study, we investigated the degree of subcutaneous fat deposition in the live bodies of crossbreds of Brahman sire × Japanese Black, Japanese Shorthorn and Holstein dams using an ultrasonic measurement device, and compared the results with those of corresponding straightbreds fattened under the same conditions. A further objective was to estimate the effect of crossbreeding with Brahman on the deposition of subcutaneous fat.

Materials and methods

Mizuma *et al.* (1) imported the one sire semen of Brahman (Z) from the Wacol artificial insemination center in Queensland, Australia in February, 1985 for academic research. The semen was artificially inseminated into Japanese Black (B), Japanese Shorthorn (N) and Holstein (H) females kekt in the Experimental Farm of the Faculty of Agriculture, Tohoku University. The animals used in the present study were five ZB, six ZN, two ZH, twelve BB and ten NN steers. The 35 steers were fed according to the seasonal pasturing system for a two-year period. Fattening was started from 20～28 months old. The steers were individually fattened in stanchions by concentrated feed given twice daily and *ad libium* feeding of roughage. The concentrate was a formula feed for fattening, and the roughage consisted of silage and rice straw for the first two months, and only rice straw for the remainder of the fattening period.

The subcutaneous fat thickness (SFT) of the live body was measured at six different positions on both right and left sides by an ultrasonic measurement device (fig. 1). The ultrasonic machine was an A-mode Model SM-90 with a 2.25 MHz transducer, manufactured by Tokyo Keiki Co., Ltd.. Ultrasonic measurements were performed twice: once during 8th month (average of 229 days) of fattening, and once at the time of marketing. The method of measurement used in the present study was the same as that of Nagamine *et al.* (4). The mean of the measurements on the right and left sides at each of the six positions was used as value of the SFT at that position, as the results of studies by Nagamine *et al.* (4), and Robinson *et al.* (5), as well as our own pre-analysis showed that there were

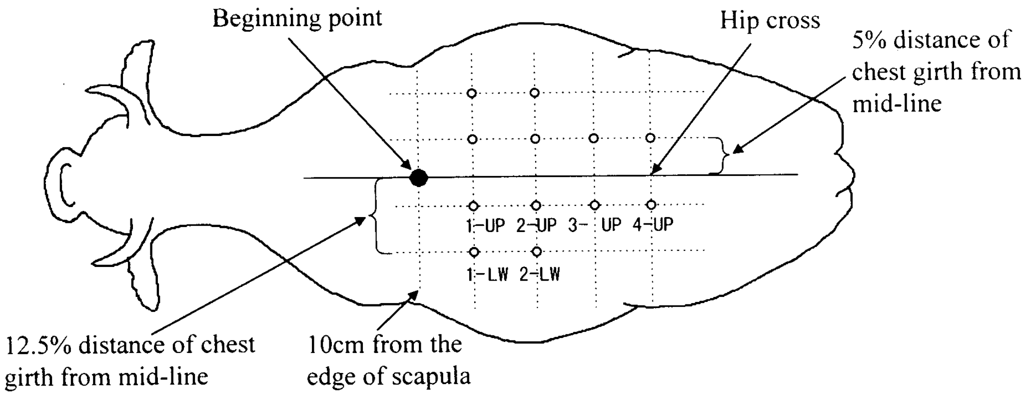

FIG. 1. The measured positions (○) of subcutaneous fat thickness by ultrasonography method (Nagamine *et al.*)

no differences between right and left-side SFT values.

One-way analysis of variance and Duncan's multiple range test were performed on the SFT data obtained in the 8th month of fattening, as this was a narrower range of age for each mating group. The mating group was treated as a fixed effect in the analysis of variance. Statistical analysis was also performed on the daily deposition of subcutaneous fat (the quotient of the amount of deposition divided by the number of days from the 8th month of fattening to the time of marketing) to investigate the degree of the fat deposition in the final stage of fattening for each mating group. Similar analysis was also performed on the SFT of carcasses, SFT data for carcasses were obtained from carcass grading. The GLM procedure of SAS (6) was used for the statistical analysis.

Results and discussion

The least square means and standard errors of live body weight and SFT by ultrasonic measurement in the 8th month of fattening for each mating group are shown in Table 1. The live body weight of crossbred groups tended to be heavier than that of the corresponding straightbred groups. Yamagishi *et al.* (2) reported that the growth of Brahman-sired crossbred calves was significantly faster than that of corresponding straightbred calves. The results of the present study also showed that there was a higher growth performance of Brahman crossbreds compared with straightbreds during the fattening period.

SFT at the four upper positions in BB and NN showed consistent values from 1-UP to 4-UP of 7.6 mm and 9.6 mm, respectively. On the other hand, 2-UP of ZB and 3-UP of ZN were the thickest in the same mating group among the four upper positions. The thinnest subcutaneous fat among the mating groups was found in ZH at all measurement positions except 1-UP.

A comparison of SFT between BB and ZB at each measurement position

TABLE 1. *The Least Square Means and Standard Errors for Subcutaneous Fat Thickness by Ultrasonic Measurement in the 8th Month of Fattening for Five Mating Groups*

Mating group	n	Body weight (kg)	1-UP (mm)	2-UP (mm)	3-UP (mm)	4-UP (mm)	1-LW (mm)	2-LW (mm)
BB	12	554.6 $\pm 14.8^{c}$	7.3 $\pm 0.5^{ab}$	7.4 $\pm 0.5^{ab}$	7.8 $\pm 0.4^{bc}$	7.5 $\pm 0.6^{ac}$	8.5 $\pm 0.7^{a}$	10.7 $\pm 0.5^{ab}$
NN	10	610.5 $\pm 16.2^{bc}$	9.5 $\pm 0.6^{a}$	9.3 $\pm 0.5^{a}$	9.6 $\pm 0.4^{ab}$	10.1 $\pm 0.7^{a}$	11.2 $\pm 0.7^{a}$	12.3 $\pm 0.5^{a}$
ZB	5	631.4 $\pm 22.9^{ab}$	5.8 $\pm 0.8^{b}$	9.1 $\pm 0.8^{b}$	8.4 $\pm 0.6^{b}$	7.5 $\pm 0.9^{ab}$	8.5 $\pm 1.0^{a}$	10.7 $\pm 0.8^{ab}$
ZN	6	667.3 $\pm 20.9^{ab}$	6.6 $\pm 0.7^{b}$	9.5 $\pm 0.7^{a}$	11.3 $\pm 0.6^{a}$	7.8 $\pm 0.8^{ab}$	8.5 $\pm 0.9^{a}$	11.6 $\pm 0.7^{a}$
ZH	2	695.0 $\pm 36.2^{a}$	6.8 $\pm 1.3^{b}$	5.8 $\pm 1.2^{b}$	6.3 $\pm 1.0^{c}$	6.8 $\pm 1.5^{b}$	8.3 $\pm 1.6^{a}$	8.6 $\pm 1.2^{b}$

a, b, c : Means in each column with different superscripts are significantly different ($p < 0.05$).
BB : Japanese Black, NN : Japanese Shorthorn, ZB : Brahman♂ × BB♀, ZN : Brahman♂ × NN♀, ZH : Brahman♂ × Holstein♀

showed that BB was thicker than ZB at 1-UP, while the opposite trend was found at the other three upper positions. The averages of the 4 upper positions of BB (7.5 mm) and ZB (7.7 mm) were near value. SFT at the two lower positions was also the same between BB and ZB. The average of SFT per live body weight at the six positions in ZB (0.013 mm/kg) was lower than that in BB (0.015mm/kg).

SFT in ZN tended to be thicker than that in NN at 1-UP and 4-UP from a comparison between NN and ZN at the four upper positions. The average of the four upper positions in NN (9.6 mm) was significantly larger than that in ZN (8.8 mm). Similarly, the SFT at the two lower positions in NN was slightly larger than that in ZN. As the live body weight of NN was less than that of ZN, crossbreds of Brahman and Japanese Shorthorn may be expected to have less subcutaneous fat per live body weight (NN : 0.017 mm/kg, ZN : 0.014 mm/kg) than straightbreds.

Nagamine *et al.* (4) reported that ultrasonic measurements of SFT at the four upper positions were constant for the steers used in progeny testing of Japanese Shorthorn. Their finding agrees with the result of this study for BB and NN. Their finding that the SFT of 2-LW was about 20% larger than that of 1-LW also coincided with the results of the present study.

It is known that heterosis, due to the non-additve action of genes, is larger in traits having low or moderate heritability. Moderate heritabilities ($h^2 = 0.42 \sim 0.63$) were estimated for SFT by Nagamine *et al.* (4). Marshall (3) investigated the relationships between heritability and heterosis using various kinds of crossbreads. It can be inferred that SFT has a stronger heterotic effect than the other carcass traits, because carcass traits have relatively high heritabilities. Thus, the crossing of Brahman with Japanese Black and Japanese Shorthorn would be effective for reducing the deposition of subcutaneous fat.

The daily deposition of subcutaneous fat (DDSF) at each position for each mating group is shown in Table 2. The DDSF in BB and NN were high at 2-UP and 3-UP, high at all four upper positions in ZH. However, in ZB and ZN, DDSF was high at 1-UP. The difference might be caused by the paucity of fat that was found at 1-UP in ZB and ZN in the 8th month of fattening (Table 1).

TABLE 2. *Least Square Means and Standard Errors for the Daily Gain of Body Weight and Daily Deposition of Subcutaneous Fat by Ultrasonic Measurement from the 8th Month of Fattening to the Time of Marketing for Five Mating Groups*

Mating group	n	DG (Kg/day)	1-UP (μm/day)	2-UP (μm/day)	3-UP (μm/day)	4-UP (μm/day)	1-LW (μm/day)	1-LW (μm/day)
BB[1)]	12	0.55 $\pm 0.12^{ab}$	1.1 $\pm 14.5^{ab}$	17.4 $\pm 12.2^{b}$	20.7 $\pm 8.0^{bc}$	10.7 $\pm 17.3^{a}$	12.6 $\pm 11.9^{a}$	15.6 $\pm 9.4^{bc}$
NN	-10	0.27 $\pm 0.13^{b}$	−37.6 $\pm 15.8^{b}$	33.4 $\pm 13.4^{ab}$	35.8 $\pm 8.7^{ab}$	−6.2 $\pm 18.9^{a}$	11.4 $\pm 13.0^{a}$	43.4 $\pm 10.3^{ab}$
ZB	5	0.82 $\pm 0.21^{ab}$	3.2 $\pm 25.0^{ab}$	−10.8 $\pm 21.2^{b}$	−6.5 $\pm 13.8^{c}$	−15.4 $\pm 29.9^{a}$	4.5 $\pm 20.6^{a}$	−11.5 $\pm 16.3^{c}$
ZN	6	0.92 $\pm 0.17^{a}$	62.1 $\pm 20.4^{a}$	45.5 $\pm 17.3^{ab}$	12.7 $\pm 11.3^{bc}$	29.8 $\pm 24.5^{a}$	63.5 $\pm 16.8^{a}$	43.3 $\pm 13.3^{ab}$
ZH	2	0.62 $\pm 0.30^{ab}$	25.8 $\pm 35.4^{ab}$	92.5 $\pm 30.0^{a}$	69.4 $\pm 19.5^{a}$	42.1 $\pm 42.3^{a}$	3.0 $\pm 29.1^{a}$	8.1 $\pm 23.0^{a}$

a, b, c : Means in each column with different superscripts are significantly different ($p < 0.05$).
1) : See Table 1.

TABLE 3. *The Least Square Means and Standard Errors for Subcutaneous Fat Thickness, Carcass Weight and the Fattening Period at the Time of Slaughter for Five Mating Groups*

Mating group	n	Fat thickness[1)] (mm)	Carcass weight (kg)	Fattening period (day)
BB[2)]	12	13.8 ± 0.8^{a}	373.0 ± 7.8^{b}	365.3 ± 9.0^{a}
NN	10	13.8 ± 0.9^{a}	387.8 ± 8.5^{ab}	321.9 ± 9.8^{b}
ZB	5	9.4 ± 1.3^{b}	389.9 ± 12.0^{ab}	296.8 ± 15.6^{bc}
ZN	6	8.6 ± 1.2^{b}	422.7 ± 11.0^{a}	260.0 ± 12.7^{c}
ZH	2	8.0 ± 2.1^{b}	403.5 ± 19.0^{ab}	268.0 ± 22.0^{c}

a, b, c : Means in each column with different superscripts are significantly different ($p < 0.05$).
1) : subcutaneous fat thickness of carcass (6-7th rib cross section)
2) : See Table 1

The DDSF at 2-LW was conspicuously higher than that at 1-LW in NN and ZH, but in ZN, DDSF was lower at 2-LW than at 1-LW. The differences in DDSF between 1-UP and 1-LW, and between 2-UP and 2-LW were examined to try to determine the cause. A pair of values at 1-UP and 1-LW was resembling as well as that at 2-UP and 2-LW. Therefore, the deposition of subcutaneous fat were going to cross-sectionally progress to live body under the fattening condition of this study.

A comparison between BB and ZB showed that SFT was larger at all positions in ZB except for 1-UP, at which DDSF was lower in BB than in ZB. ZN showed a relatively high DDSF at all positions, except for 3-UP, in comparison with NN.

SFT measurements from the carcass, carcass weight and the fattening period are shown in Table 3. Carcass grading data were analyzed by Fukuhara *et al.* (7) for the Japanese Black, and Kuchida and Yamagishi (8) for the Japanese short-horn. The means of SFT, carcass weight and fattening period were 26 mm, 410 kg and 562 days, respectively for the Japanese Black, and 19 mm, 355 kg and 426 days, respectively for the Japanese Shorthorn. Harada (9) measured SFT in the Japanese Black by ultrasonography from the 12th month of fattening, and reported a linear accumulation of subcutaneous fat during that period. Thus, the lower SFT values in BB and NN in the present study may be attributable to the short fattening period.

The SFT values of ZB and ZN carcass were significantly lower than those of corresponding straightbreds. Marshall (3) reported that the deposition of subcutaneous fat in crossbreds sired by the Brahman was slightly less than that in crossbreds sired by the Angus and Hereford. The results of SFT in the present study agree with those of Marshall, even though different breeds were used.

As mentioned above, the SFT in BB was similar to that in ZB in the 8th month of fattening, while the SFT of the carcass was lower in ZB than in BB. This might be due to the lower DDSF in ZB than in BB. Although the DDSF in ZN (12.7～63.5 μm/day) after 8 months of fattening was higher than that in NN (-37.6～43.4 μm/day), SFT at the time of slaughter in ZN was lower than that in NN. This may be due to the thicker subcutaneous fat in NN (9.3～12.3 mm) than in ZN (6.6～11.6 mm) in the 8th month of fattening.

The results of this study reveal that the crossing of Brahman with Japanese Black and Japanese Shorthorn is effective for reducing SFT.

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References

1) Mizuma, Y., Yamagishi, T., Yamaki, K., Shinohara, H., Ohta, M., Nihei, A., Takahashi, H., Abe, A., Ito, I., Masaki, J., Katsuno, M., Horiguchi, M., Tsuda, T., Sasaki, Y., Hoshino, T., and Adachi, S., *Bull. Exp. Farm Tohoku Univ.*, **3**, 133 (1987) (in Japanese with English summary)

2) Yamagishi, T., Suzuki, E., Ohta, M., Shinohara, H., Yamaki, K., and Mizuma, Y., *Jpn. J. Zootech. Sci.*, **61**, 876(1990) (in Japanese with English summary)

3) Marshall, D.M., *J. Anim. Sci.*, **72**, 2745 (1994)

4) Nagamine, Y., Hayashi, T., Sato, H., Nishida, A., and Komatsu, S., *Jpn. J. Zootech. Sci.*, **59**, 335 (1988)

5) Robinson, D.L., McDonald, C.A, Hammond, K., and Turner, J.W., *J. Anim. Sci.*, **70**, 1667 (1992)

6) SAS Institute inc. "*SAS user's guide : Statistics*", SAS Institute Inc. Cary, NC., p. 113 (1982)

7) Fukuhara, R., Moriya, K., and Harada, H., *Jpn. J. Zootech, Sci.*, **60**, 1128 (1989) (in Japanese with English summary)

8) Kuchida, K., and Yamagishi, T., *Anim. Scdi. Technol. (Jpn.)*, **63**, 840 (1992) (in Japanese with English summary)

9) Harada, H., *Bull. Fac. Agr. Miyazaki Univ.*, **29**, 1 (1982) (in Japanese with English summary)