COMPARISON OF THE CHARACTERISTICS OF MARBLING AND THE BMS No. USING THE IMAGE ANALYSIS TRAITS OF INTRAMUSCULAR FAT AND NEW FINENESS INDEX IN JAPANESE BLACK CATTLE AND CROSSBREED JAPANESE BLACK × HOLSTEIN

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Abstract – In this study, we compared the characteristics of marbling of Japanese Black (JB) and crossbred (F1) Japanese Black × Holstein, using the image analysis traits; intramuscular fat ratio (IMF %) and the new fineness index (NFI). Data for this study were 18,225 carcass images of JB and 8,333 carcass images of F1. To investigate the distribution of JB and F1 of Beef Marbling Standard Number (BMS No.), a matrix was created with the vertical axis showing NFI and the horizontal axis showing IMF %. For JB both IMF % and NFI respectively were located in a higher position on the matrix when compared to F1. In addition, the means of BMS No. for both IMF % and NFI were calculated and a matrix was created for each breed. Carcasses grading BMS No. 5 or higher showed a higher NFI with a higher proportion of JB represented compared to F1. Furthermore when comparing carcasses with the same IMF%, individual's with higher NFI had increased BMS No. The results of this study revealed that the characteristics of marbling utilizing image analysis traits could contribute to meat improvement in both JB and F1.

Key Words – Carcass grading. Image analysis. Matrix.

I. INTRODUCTION

In Japan, Wagyu, Holstein, and crossbred of Japanese Black × Holstein are the major beef cattle breeds. Approximately one million beef cattle are slaughtered in Japan per year (Japan Meat Grading Association, 2015) [1]. Four distinct breeds make up Wagyu cattle in Japan including Japanese Black (JB), Japanese Brown, Japanese Shorthorn and Japanese Polled. JB account for a very large percentage (approximately 93%) among the total numbers of Wagyu in Japan. The JB breed is well known for its propensity to produce abundant marbling with very fine marbling particle size and in addition meat displaying excellent sensory properties. One of the primary roles of F1 production is to reduce dystocia of Holstein cows run on dairy farms. The resultant, F1 calves are purchased and fattened by fattening farmers. The meat quality of F1 is far superior when compared to Holstein.

Recently, image analysis technology to accurately evaluate a variety of meat products has been developed, delivering detailed and objective analysis values [4], [6], [8]. Various studies on the marbling of JB using these image analysis traits have been reported, but there is little research documenting marbling performance of F1 using image analysis traits. This study compares BMS No. to intramuscular fat ratio (IMF %) which shows the area of marbling in *longissimus thoracis* muscle and new fineness index (NFI) which shows the degree of fine marbling particles in *longissimus thoracis* muscle (Kuchida. et al. 2012) [2]. We have created an individual matrix for both the JB and F1 breeds respectively that maps both the frequency and the average value of BMS No. with relation to both NFI and IMF %.

II. MATERIALS AND METHODS

Carcass data was collected from the Hokkaido carcass market between 2005 and 2013. The number of records of JB and F1 was 18,225 (steer 12,785, heifer 5,440) and 8,333 (steer 4,626, heifer 3,707), respectively. Carcasses were evaluated by official graders of the Japan Meat Grading Association (JMGA). The image analysis traits

were calculated from images taken at the level of the 6th and 7th rib section using dedicated software developed by Kuchida et al. (2006) [3]. In this study, we used the image analysis traits of intramuscular fat ratio (IMF %) and the new fineness index (NFI) reported by Kuchida et al. (2012) [2] in order to evaluate the characteristics of beef marbling in detail and objectively. A contour graph detailing the percentage of frequency of BMS No. was created for each breed which compared the inputs of IMF % and NFI. In addition an individual matrix of means of BMS No. comparing the inputs of NFI (vertical axis) and IMF% (horizontal axis) was created for each breed (JB and F1).

Table 1. Descriptive statistics of carcass grading traits and image analysis traits for steers of Japanese Black (JB) and crossbred (F1) of JB × Holstein

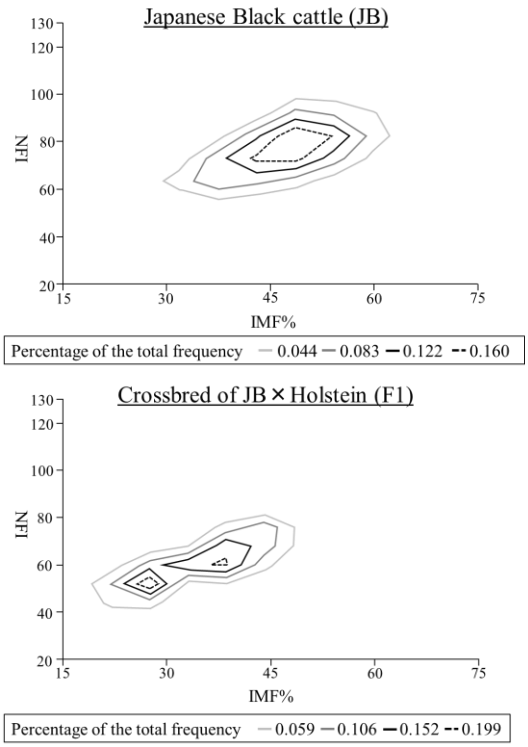
	JB (n=12,785)				F1 (n=4,626)		
Trait	mean	±	SD		mean	±	SD
Slaughter age (months)	28.54	±	1.83	**	25.73	±	4.21
Carcass grading trait							
Carcass weight (kg)	465.87	±	54.47	**	480.11	±	51.58
Rib eye area (cm^2)	57.70	±	8.48	**	52.08	±	7.20
Rib thickness (cm)	7.73	±	0.90	**	7.17	±	0.95
Subcutaneous fat thickness (cm)	2.26	±	0.66	**	2.48	±	0.72
Yield estimate	74.22	±	1.34	**	70.69	±	1.16
Beef marbling standard	5.73	±	2.15	**	3.41	±	1.16
Image analysis trait							
Intramuscular fat ratio (%)	47.29	±	8.45	**	35.74	±	7.94
New fineness index	76.88	±	10.72	**	61.75	±	10.18

** ($P < 0.01$)

III. RESULTS AND DISCUSSION

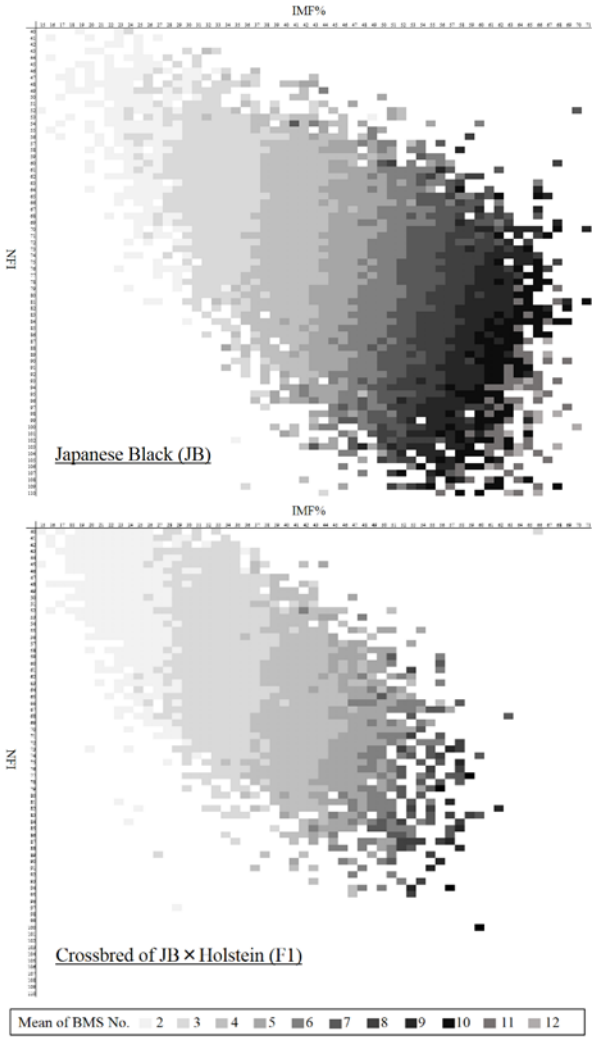
Descriptive statistics of carcass grading traits and image analysis traits for steers of JB and F1 are detailed in Table 1. Although carcass weight and subcutaneous fat thickness of JB were significantly lower than F1 ($P < 0.01$), slaughter age, rib eye area, rib thickness, yield estimate, beef marbling standard (BMS No.), intramuscular fat ratio (IMF %), and new fineness index (NFI) of JB were significantly higher than F1 ($P < 0.01$). Slaughter age and carcass weight of JB were 28.54 month and 465.87 kg, respectively. In contrast, slaughter age and carcass weight of F1 were 25.73 month and 480.11 kg, respectively. This results indicated that F1 showed a predisposition to earlier maturing and fattening than JB. Carcass weight of JB (465.87 kg) was heavier than that reported by Nakahashi et al. (2012) [5], although there were no differences in the other traits of JB or any of the traits of F1. IMF % and NFI of JB were significantly higher when compared to that of F1. This indicated that the degree of intramuscular fat deposition of JB was much higher than F1 and also there were many more fine marbling particles in *longissimus thoracis* muscle of JB compared to F1.

Fig 1. Contour graph of percentage of the total frequency for JB and F1



The contour graph of percentage of the total frequency for JB and F1 is shown in Fig 1. When comparing JB and F1, JB has higher IMF % and NFI measurements than F1. These results revealed that JB had both more marbling and finer marbling than F1.

Fig 2. Matrix of means of BMS No. for JB and F1



The matrix of mean of BMS No. for JB and F1 is shown in Fig 2. The range of IMF % from BMS No. 2 to 4 is similar for both breeds. This result indicates that the evaluation for beef marbling by the JMGA grader has been assessed accurately regardless of the breed. In carcasses graded BMS No. 5 or higher, the number of JB with high NFI was greater than that of F1. Furthermore when comparing carcasses with the same IMF%, individual's with higher NFI had increased BMS No. This was due to the fact that the smaller marbling particle size could be evaluated accurately. In a previous study, Takeo et al. (2016) [7] reported that carcasses which display many fine marbling particles result in a higher carcass unit price. Thus, by instituting a breeding program with genetic selection for increased NFI a resultant increase in both meat quality and carcass value could be expected.

This method using image analysis could be objectively evaluated the characteristics of beef marbling in detail.

IV. CONCLUSION

The results of this study revealed the differences and characteristics of the degree of marbling for the JB and F1 breeds. By using JB Sires with high breeding values for both IMF % and NFI, breeding programs will result in improvement of BMS No. of resultant JB and F1 carcasses respectively. With meat quality improvement, the carcass unit price would be increased, resulting in an expected increase in revenue growth and profitability for fattening farmers.

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