4-P33

CARCASS TRAITS AND MICROSATELLITE DISTRIBUTIONS IN OFFSPRING OF SIRES FROM THREE GEOGRAPHICAL REGIONS OF JAPAN

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Background:
The various regions and prefectures of Japan are known to produce Japanese Black cattle differing in conformation and carcass quality (Namikawa, 1984). This resulted from the use of a small number of founding cows within each region in the early 1800s. Additionally, there were regional differences in the breeds of cattle used for crossbreeding after the Meiji Restoration in 1868. We proposed that we could demonstrate regional differences in microsatellite allele sizes and frequencies that would support our contention of a genetic basis for differences among production regions in carcass traits.

Objectives:
The objective of this study was to demonstrate: 1) differences in carcass characteristics in offspring from bulls of the Hyogo, Shimane, and Tottori regions; and 2) differences in microsatellite allelic frequency and across regions. The latter finding would provide evidence for a genetic basis for the differences in carcass traits in the different production regions.

Methods:
Semen was obtained from 6 sires, 3 sires, and 1 sire from the Hyogo, Shimane, and Tottori regions, respectively. Therefore, the Tottori regional effects must be considered single sire effects. Cows and heifers were bred by artificial insemination. There were 44, 35, and 19 offspring from the Hyogo, Shimane, and Tottori sires, respectively. The calves were between 170 and 272 days of age, and weighed between 164 and 307 kg, at the beginning of the finishing phase. The steer and heifer calves were fed for various periods of time (from 253 to 948 days) to achieve a wide variation in intramuscular lipid content. The production system has been described in detail previously (Zembayashi et al., 1995). All cattle were fed a concentrate ration consisting of 25% flaked corn, 20% steam rolled barley, 10% wheat bran, 15% powder enriched wheat bran, 10% gluten feed, 10% barley bran, 8% rice bran, and 0.02% mineral additives.

Samples of *M. longissimus thoracis* and *M. longissimus dorsi* were obtained from chilled carcasses for the analysis of lipid content. Samples were vacuum packed and stored at –20°C until analyzed. Fatty acid composition of intramuscular neutral lipids of the 6th rib section of the *M. longissimus thoracis* was measured as described previously (Zembayashi et al., 1995). Samples of the DNA were analyzed by PE AgGen, Inc. (Salt Lake City, Utah, USA) for 11microsatellites. The microsatellites were BM1824 (Bta1), BM2113 (Bta2), ETH10 (Bta5), ETH225 (Bta9), ETH3 (Bta 19), TGLA122 (Bta21), TGLA126 (Bta20), TGLA227 (Bta18), TGLA53 (Bta16), and INRA 23 and SPS115 (bovine chromosomal assignments unknown). Microsatellite analysis and scoring were essentially as described by Taylor et al. 1998). Data were analyzed by analysis of covariance by the SuperAnova program (Abacus Concepts, Inc., Berkeley, CA). For carcass data, region was the main effect and days on feed was the covariate. When treatment effects were significant ($p < 0.05$), means were separated by the Fisher's Protected LSD method which was contained in the same software program. Microsatellite allele frequencies were compared across regions by analysis of variance by the SuperAnova program.

Results and discussion:
Cattle produced from sires from the Hyogo, Shimane, and Tottori regions significantly differed in days on feed, due to differences in average daily gain (Table 1). By design, there was no difference in slaughter weight. Carcasses of cattle from the Shimane sires had more muscle than Hyogo cattle. Hyogo and Shimane cattle consistently contained more fat in the various depots than Tottori cattle, although there were no differences across regions in the MUFA:SFA ratio (Table 1).

We previously reported that Japanese Black cattle from the Kagoshima, Miyazaki, and Gunma regions of Japan differed significantly in the MUFA:SFA ratios of their muscle and adipose tissues (Sturdivant et al., 1992). This indicted either production or genetic differences across these production regions. We demonstrated differing allele frequencies of *Taq*I restriction fragment length polymorphisms for the stearoyl coenzyme A gene for the Hyogo, Shimane, and Tottori regions (Wilson et al., 1993), suggesting genetic differences among these populations of Japanese Black cattle. Further support for this supposition is provided by our microsatellite analyses (Table 2). Analyses for three of the 11 microsatellites are provided. All microsatellite alleles were in Hardy-Weinberg equilibrium when data were pooled across regions. However, ETH3 and TGLA122 for the Tottori cattle were not in Hardy-Weinberg equilibrium. This may in part be due to use of the sire on successive generations. There were apparent differences in allele frequencies, especially in the Tottori cattle (Table 2).

Conclusions:
We have provided evidence for differences in the genetic base of sires from three separate production regions of Japan. These differences may be responsible for the observed differences in carcass characteristics for this population of Hyogo, Shimane, and Tottori cattle.

Pertinent literature:
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Data:

Table 1. Growth and carcass characteristics of cattle produced from sires from the Hyogo, Shimane, and Tottori production regions.

	Region			
Trait	Hyogo	Shimane	Tottori	Pooled SEM
Production traits				
Days on feed	553.3^{a}	443.3^{b}	422.6^{c}	20.5
Average daily gain, g	657^{c}	773^{b}	844^{a}	23
Slaughter weight, kg	542.4	554.3	562.7	14.6
Composition traits				
Total muscle, kg	91.5^{b}	96.2^{a}	94.1^{ab}	2.6
Total subcutaneous fat, kg	17.1	15.2	17.2	1.0
Total intermuscular fat, kg	27.9	25.3	26.8	1.2
Kidney fat, g	429^{a}	436^{a}	416^{b}	13
12th rib fat, g	12.1^{a}	11.3^{a}	9.6^{b}	0.6
2nd loin fat, g	14.5^{a}	13.9^{a}	10.6^{b}	0.7
5th loin fat, g	17.8^{a}	16.0^{ab}	12.8^{b}	0.8
MUFA:SFA	1.93	1.47	1.72	0.07

Production traits were analyzed by analysis of variance, whereas composition traits were analyzed by analysis of covariance, with days on feed as the covariate. 6th, 9th, and 12th rib fat, and 2nd and 5th loin fat are ether extractable lipids. MUFA:SFA = the monounsaturated:saturated fatty acid ratio. Means within rows with common superscripts are not different (P > 0.05).

Table 2. Microsatellite allele frequencies for cattle produced from sires from the Hyogo, Shimane, and Tottori regions.

	Allele					
Microsatellite/region	A	B	C	D	E	F
BM1824/Hyogo	0.07^{b}	0.36^{a}	0.14^{b}	0.4^{a}		
BM1824/Shimane	0.14^{b}	0.42^{a}	0.42^{a}	0^{b}		
BM1824/Tottori*	0.86^{a}	0.04^{b}	0^{c}	0.09^{b}		
ETH3/Hyogo	0.01	0.71^{a}	0.06^{b}	0.01	0.19^{b}	0.01
ETH3/Shimane	0	0.42^{b}	0.24^{a}	0	0.33^{ab}	0
ETH3/Tottori	0	0.22^{c}	0.27^{a}	0	0.50^{a}	0
TGLA122/Hyogo	0.01	0.24^{b}	0.01	0.01	0.67^{a}	0.04
TGLA122/Shimane	0.04	0.34^{b}	0	0.04	0.58^{a}	0
TGLA122/Tottori	0	0.63^{a}	0	0	0.33^{b}	0.03

*Not in Hardy/Weinberg equlibrium. Means within a column with common superscripts are not different (P > 0.05).