Session 10. 68

Estimation of genetic parameters for yield and marbling traits using a random regression model on slaughter age in Japanese Black cattle

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Introduction and Objective

- The slaughter age of Japanese Black cattle in Japan ranges from about 25 to 35 mo of age (average is 29).
- Genetic effects on the meat yield and meat quality might vary depending on the slaughter age.

The objective of this study was to estimate genetic parameters for yield and marbling traits using a random regression model on slaughter age.

Materials and Methods

Data

- The Data were **7,359** Japanese Black cattle at carcass market in Hokkaido, Japan during Apr/00-Mar/07
- The number of pedigree records was **27,015**.
- Digital images of the 6-7th cross section were taken by two photography equipments.

Traits analyzed

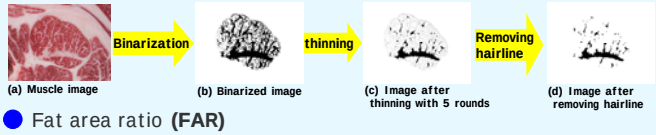
- Yield traits were carcass weight (CW), ribeye area (REA) and rib thickness (RT) by grader.
- Marbling traits were marbling score (MS) by grader, fat area ratio (FAR) and overall coarseness of marbling (OCM) by image analysis.

Statistical model

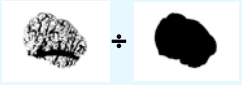
- Fixed effects
  Date at carcass market (146 levels), sex of animal (2 levels) and slaughter age (11 levels).
- Random effects
  Fattening farm (203 levels) and additive genetic effects with random regression on slaughter age (25,26…34 and 35) using **second-order Legendre polynomials**, heterogeneous residual variances (25-27, 28, 29, 30, 31 and 32-35).

Using Gibbs3f90 program (200,000 rounds and 50,000 burn-in)

Procedure for image analysis



- Fat area ratio **(FAR)**



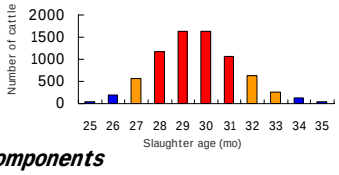
Pixels of image (b) ÷ Muscle area×100

- Overall coarseness of marbling **(OCM)**

Pixels of image (d) ÷ Pixels of image (b)×100

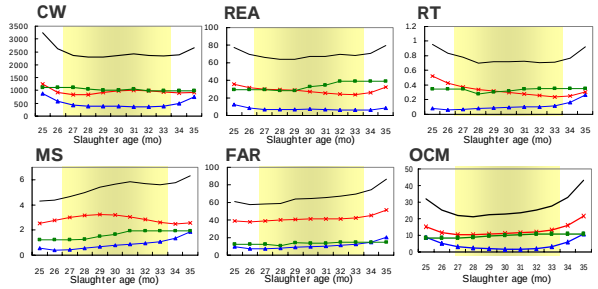
Results and Conclusions

Distribution of data

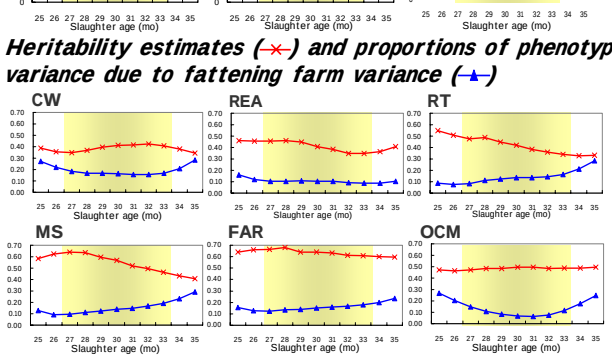


Variance components

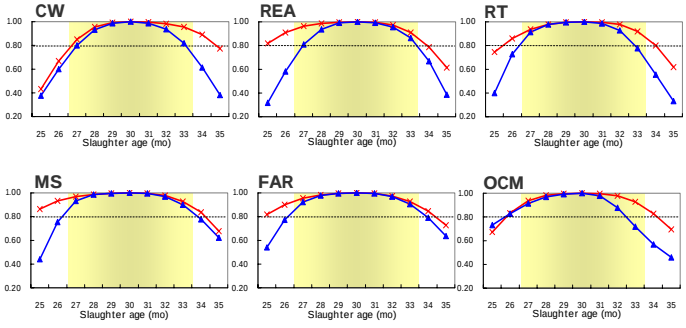
additive genetic variance ─×─, fattening farm variance ─▲─,
residual variance ─■─, phenotypic variance ──



Heritability estimates (─×─) and proportions of phenotypic variance due to fattening farm variance (─▲─)



Genetic (─×─) and fattening farm (─▲─) correlations between 29 mo and other slaughter ages



Conclusions

- Heritability estimates for RT and MS decreased and proportions of phenotypic variance due to fattening farm variance for those traits increased as age increases.

  Environmental influence strengthens with age.

- In any traits, genetic correlations among 27-33 were 0.80 or higher.

  Genetic relationship in range of general slaughter age was very strong.

A P P E N D I X

Carcass data

The carcass data were collected from Japanese Black steers shipped between April, 2000 and March, 2007 to a meat processing plant in Hokkaido, Japan. This data set was edited so that a minimum of 3 animals were included in each of the following subclasses: date at carcass market, slaughter age in months, fattening farm and sire. The final number of animals was 7,359. There were 146 subclasses for dates at carcass market, 11 subclasses for slaughter age (25, 26, ...35 mo), and 203 for fattening farm.

Yield traits

The yield traits considered in this study were carcass weight (CW), ribeye area (REA) and rib thickness (RT). The REA was measured using the grid method. The RT was the distance between pleural membranes and the outside of *M. latissimus dorsi* in the center of the rib. These traits were measured by an expert grader.

Marbling traits

The marbling traits considered were fat area ratio (FAR), overall coarseness of marbling particles (OCM) calculated by image analysis, and beef marbling score (MS) which was evaluated by an expert grader. Detailed methods of calculation are shown bellow.

Digital images of the carcass cross section were taken between the 6th and 7th ribs by two types of photographing equipment (**A** and **B**). **A** was set a 2 mega pixels digital camera (1cm = 60 pixels) used between April, 2000 and November, 2004. **B** was set a 12 mega pixels digital camera (1cm = 100 pixels) used between December, 2004 and March, 2007. A flowchart of image analysis traits is illustrated in Figure 1, and details of these traits are as follows.

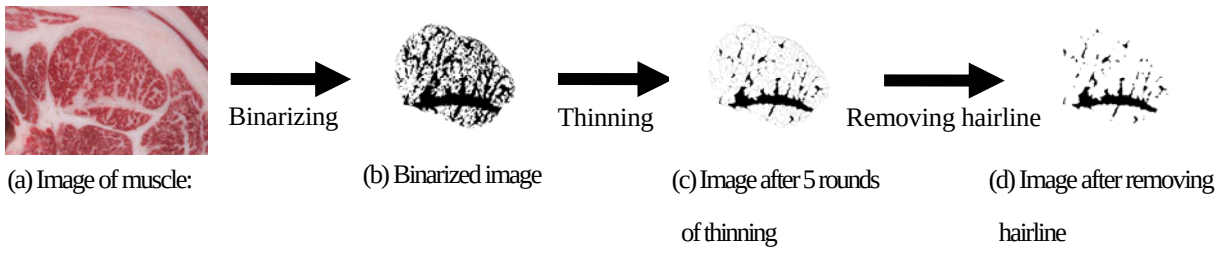


Figure 1. Detailed flow of image analysis to calculate coarseness of marbling particles.

FAR: ribeye with a border line (Figure 1-a) were binarized as lean and fat using the image analysis program. FAR was calculated by dividing all pixels of the fat image (Figure 1-b) by ribeye area.

OCM: The binarized image (Figure 1-b) was thinned with 5 rounds (Figure 1-c), and the hairlines were removed (Figure 1-d) using the image analysis program. OCM was calculated by dividing all pixels of fat from thinning image without the hairline (Figure 1-d) by all pixels of fat image (Figure 1-b). A high OCM value indicates a muscle involving many rough marbling particles. OCM in **B** equipment was timed 0.6 to equal the value in **A** equipments.

Table 1. Descriptive statistics of the data set

Traits	Mean±SD
Slaughter age, mo	29.6±1.8
Yield traits	
CW, kg	435.1±54.7
REA, cm^2	56.6±8.0
RT, cm	7.6±0.9
Marbling traits	
MS, 1 to 12	5.4±2.3
FAR, %	40.5±8.3
OCM	20.3±4.7

Table 2. Eigenvalues of additive genetic and fattening farm covariance matrices for each trait

	Additive genetic variance						Fattening farm variance					
	First	(%)[a]	second	(%)	Third	(%)	First	(%)	second	(%)	Third	(%)
Yeild traits												
CW	794.154	(84.5)	117.407	(12.5)	28.466	(3.0)	330.533	(72.7)	75.822	(16.7)	48.142	(10.6)
REA	25.174	(90.1)	1.931	(6.9)	0.821	(2.9)	5.304	(75.0)	1.155	(16.3)	0.618	(8.7)
RT	0.284	(89.2)	0.020	(6.3)	0.014	(4.5)	0.080	(77.2)	0.018	(17.6)	0.005	(5.2)
Marbling traits												
MS	2.636	(91.3)	0.217	(7.5)	0.035	(1.2)	0.725	(87.8)	0.073	(8.9)	0.027	(3.3)
FAR	37.04	(89.7)	3.525	(8.5)	0.724	(1.8)	9.084	(87.5)	0.807	(7.8)	0.489	(4.7)
OCM	11.275	(90.1)	0.741	(5.9)	0.499	(4.0)	2.924	(82.3)	0.495	(13.9)	0.132	(3.7)

[a] Percentage of the total eigenvalue.

Table 3. Estimates of additive genetic (co)variance from quadratic random regression model

	Additive genetic variance			Fattening farm variance		
	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
CW						
Intercept	787.900			330.130		
Linear	32.379	103.690		-9.446	75.573	
Quadratic	-57.643	-36.394	48.437	3.701	-4.166	48.793
REA						
Intercept	25.061			5.261		
Linear	-1.567	1.785		-0.189	1.087	
Quadratic	-0.403	0.492	1.080	-0.407	-0.170	0.729
RT						
Intercept	0.280			0.078		
Linear	-0.031	0.024		0.012	0.012	
Quadratic	-0.002	-0.000	0.014	-0.002	0.006	0.013
MS						
Intercept	2.611			0.690		
Linear	-0.095	0.213		0.151	0.070	
Quadratic	-0.227	0.046	0.063	-0.008	0.016	0.065
FAR						
Intercept	36.966			8.899		
Linear	0.759	3.448		1.244	0.750	
Quadratic	-1.444	0.473	0.875	0.007	0.138	0.731
OCM						
Intercept	11.214			2.682		
Linear	0.705	0.567		-0.049	0.375	
Quadratic	0.381	0.095	0.733	0.767	0.164	0.495