Genetic Parameter Estimates for Backfat Thickness at Three Different Sites and Growth Rate in Swine

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ABSTRACT : The purpose of this study was to estimate the genetic parameters for backfat thickness at shoulder, mid back and loin and days to 90 kg using a derivative-free REML procedure. Data were collected from 6,146 boars and gilts of purebred Durocs, Landraces and Large Whites performance tested at breeding farms of National Agricultural Cooperatives Federation in Korea from 1998 to 2001. Estimated heritability for backfat measurements at shoulder, mid-back and loin and an average of those backfat measurements were 0.14, 0.32, 0.22 and 0.25 in Durocs, 0.34, 0.50, 0.42 and 0.46 in Landraces and 0.33, 0.52, 0.43 and 0.49 in Large Whites. Heritabilities of backfat measurements estimated were hightest in mid-back and lowest at shoulder. Phenotypic variances of backfat measurements estimated were largest at shoulder and smallest at mid-back. Estimated heritabilities for days to 90 kg were 0.37 in Durocs, 0.42 in Landraces and 0.54 in Large Whites. Genetic correlations among backfat measurements at shoulder, mid-back and loin and an average of those backfat measurements estimated were positive and very high. Genetic correlations of days to 90 kg with the backfat measurements estimated were -0.19 ~ -0.30 in Durocs, -0.04 ~ -0.17 in Landraces and -0.10 ~ -0.13 in Large Whites. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 3 : 305-308)***

Key Words : Swine, Genetic Parameters, Backfat Thickness, Growth Rate

INTRODUCTION

Backfat thickness and growth rate are the traits that have an important influence on the profit from swine farming and they can be the major criteria in selection of breeding stock for genetic improvement of swine in some breeds or lines (Christian, 1994).

For the measurement of fatness in live hogs, backfat thickness was commonly measured at 3 different sites, shoulder, mid-back and loin, or above the point of the elbow, the last rib and the stifle joint and an average of those backfat measurements was used for the genetic evaluation of breeding stock (NSIF, 1987). The purposes of this study were to estimate the heritabilities of backfat measurements at shoulder, mid-back and loin and average of those backfat measurements and days to 90 kg and genetic and phenotypic correlations among the traits and to obtain information useful for devising the effective breeding plan for the genetic improvement of backfat thickness in 3 major breeds of swine. Heritability estimates for the backfat thickness at a specific site can be used for predicting the response expected from selection for the backfat thickness at the specific site. Genetic correlations among the traits can be of value for predicting the correlated responses expected from selection in other traits that are genetically correlated with.

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MATERIALS AND METHODS

The data for this study were collected from 6,146 boars and gilts of purebred Durocs, Landraces and Large Whites performance-tested at breeding farms of National Agricultural Cooperatives Federation in Chonnam, Korea from 1998 to 2001. Table 1 shows the number of animals by breed, sex, parity and final weight. The traits examined in this study included days to 90 kg, backfat thickness measured at 3 different sites and an average of those backfat measurements. Days to 90 kg was measured as the age in day at the body weight of 90 kg. Backfat thickness was measured for each animal using A-mode ultrasound machine at shoulder, mid-back and loin when the animal finished the performance test. Backfat thicknesses at shoulder, mid-back and loin were measured at a position directly above the point of the elbow, last rib and last lumbar vertebra locations, taken 5 cm off the midline on one sides of the pig.

The following animal model was used to estimate the genetic parameters for each breed.

$$y=X\beta+Z\mu+e$$

where, y is a vector of observations, β is a vector of fixed effects (sex, year of birth, month of birth, parity, final weight), μ is a vector of random additive genetic effects, X and Z are known incidence matrices relating observations to the respective fixed and random effects and e is a vector of random residual effects. Months of birth were spread over 12 months of a year and year of birth was from 1998 to 2001. Final weights were classified into 5 different groups.

Table 1. Number of animals by breed, sex, parity and final weight

Breed	No.	Sex	No.	Parity	No.	Final wt (kg)	No.
Duroc	1,102	Boar	3,599	1	1,078	≤88	471
Landrace	1,995	Gilt	2,547	2	1,220	88-93	958
Large White	3,049			3	1,191	93-98	1,148
				4	914	98-103	1,006
				5	635	≥103	2,563
				6	457		
				7	299		
				8	215		
				≥9	137		
Total	6,146		6,146		6,146		6,146

Table 2. Least squares means of the traits for breed and the standard errors

Breed	Backfat thickness (mm)				Days to 90 kg (day)
	Shoulder	Mid-back	Loin	Average	
Duroc	$18.70^a \pm 0.13$	$11.54^a \pm 0.09$	$13.92^a \pm 0.12$	$14.72^a \pm 0.10$	$153.3^c \pm 0.36$
Landrace	$17.85^b \pm 0.11$	$10.88^b \pm 0.07$	$13.60^b \pm 0.10$	$14.11^b \pm 0.09$	$155.4^b \pm 0.30$
Large White	$17.78^b \pm 0.10$	$10.48^c \pm 0.07$	$13.41^c \pm 0.09$	$13.89^c \pm 0.08$	$156.7^a \pm 0.27$

[a, b, c] Means with different superscripts in a column differ significantly ($p<0.05$).

Table 3. Estimated heritabilities and phenotypic variances of backfat thickness and days to 90 kg

Item[a]	Breed	Backfat thickness				Days to 90 kg
		Shoulder	Mid-back	Loin	Average	
h^2	Duroc	0.14	0.32	0.22	0.25	0.37
	Landrace	0.34	0.50	0.42	0.46	0.42
	Large White	0.33	0.52	0.43	0.49	0.54
σ_p^2	Duroc	11.73	4.96	7.39	5.99	76.3
	Landrace	12.12	5.87	9.75	7.30	96.5
	Large White	14.28	6.15	11.42	7.47	107.6

[a] h^2=heritability, σ_p^2=phenotypic variance.

Derivative-free REML procedure was employed to estimate the components of variance and covariance using the MTDFREML programs (Boldman et al., 1995). The convergence criterion was 10^{-10} of simplex variance. For the analysis of the data with the animal model, pedigree was traced back up to 4 generations. The numbers of sires and dams in the pedigree files were 56 and 286 in Durocs, 72 and 387 in Landraces and 79 and 712 in Large Whites.

To estimate the breed mean for each trait, the least squares analysis was performed with the data pooled over the three breeds based on the linear model which includes the overall mean and the effects of breed, sex, year of birth, month of birth, parity, final weight and random residuals.

RESULTS AND DISCUSSION

Breed mean

Least squares means of the traits for breed and the standard errors are given in Table 2.

Durocs had a significantly lower age at 90 kg than Landraces or Large Whites. The lower age at 90 kg in Durocs as compared with other breeds corresponded with the reports of Young et al. (1976), McLaren et al. (1987), and Christian (1994).

Backfat thicknesses at shoulder, mid-back and loin and an average of those backfat measurements were significantly thicker in Durocs than in Landraces or Large Whites. The result that the Durocs had more thickness of backfat than Landraces or Large Whites was in agreement with the reports of Miller et al. (1979) and Park and Lee (1995).

Heritability

Estimated heritabilities and phenotypic variances of backfat thickness and days to 90 kg are given in Table 3.

The heritability estimates for backfat thickness were highest in the measurements at mid-back, followed in rank by the measurements at loin and were lowest in the measurements at shoulder. The heritabilities for backfat thickness at mid-back estimated were slightly higher than the estimates for an average of 3 backfat measurements. Since the heritabilities for backfat thickness at shoulder estimated were lower than the estimates at mid-back or at loin, selection for backfat thickness at shoulder is expected to be less effective than selection for backfat thickness at mid-back or at loin. The heritabilities of 0.46 and 0.49 estimated for an average of the 3 backfat measurements in Landraces and Large Whites were in agreement with the reports of McPhee et al. (1979), Bereskin (1986), Van Diepen and Kennedy (1989), Li and Kennedy (1994).

Table 4. Estimated genetic and phenotypic correlations among backfat thickness at shoulder, mid-back and loin, an average of those backfat measurements and days to 90 kg

Traits involved[a]		Genetic correlation[b]			Phenotypic correlation		
Trait 1	Trait 2	D	L	LW	D	L	LW
BFS	BFM	0.68	0.75	0.73	0.53	0.69	0.67
BFS	BFL	0.71	0.84	0.82	0.60	0.77	0.74
BFS	BFA	0.90	0.93	0.82	0.84	0.90	0.90
BFS	DAY	-0.19	-0.04	-0.10	-0.21	-0.27	-0.33
BFM	BFL	0.82	0.82	0.81	0.78	0.83	0.80
BFM	BFA	0.90	0.90	0.93	0.86	0.90	0.88
BFM	DAY	-0.30	-0.17	-0.13	-0.29	-0.22	-0.29
BFL	BFA	0.89	0.95	0.92	0.91	0.95	0.94
BFL	DAY	-0.23	-0.15	-0.11	-0.25	-0.20	-0.29
BFA	DAY	-0.26	-0.12	-0.13	-0.28	-0.25	-0.33

[a] BFS=backfat thickness at shoulder, BFM=backfat thickness at mid-back, BFL=backfat thickness at loin, BFA=average of BFS, BFM and BFL, DAY=days to 90 kg. [b] D=Duroc, L=Landrace, LW=Large White.

Cameron and Curran (1995), Culbertson et al. (1998) and Chens et al. (2002). Higher estimates of heritability for backfat thickness were reported by Swinger et al. (1979), Bereskin (1987), Bryner et al. (1992), Mrode and Kennedy (1993) and Hicks et al. (1999) and lower estimate was obtained by Johnson et al. (1999).

Estimated heritabilities for backfat thickness at the 3 different sites and for an average of the 3 backfat measurements in Landraces were similar to the heritability estimates for backfat thickness in Large Whites. However, the heritability estimates for backfat thickness in Durocs were lower than the estimates in Landraces or Large Whites.

The phenotypic variances of backfat thickness estimated were largest in the measurements at shoulder and were smallest in the measurements at mid-back in all of the 3 breeds. The phenotypic variances of backfat thickness measured at loin were intermediate between the measurements at shoulder and at mid-back.

The heritability estimates for days to 90 kg obtained in this study corresponded with the results of Swinger et al. (1979), Kennedy et al. (1985) and Kim et al. (1996), but were higher than the estimates of Bereskin (1987), Keele et al. (1988) and Van Diepen and Kennedy (1989). The heritability estimates for days to 90 kg reported by Hutchens et al. (1981) and Song et al. (2002) were higher than the estimates obtained in this study.

Genetic and phenotypic correlations

Estimated genetic and phenotypic correlations among backfat thickness at shoulder, mid-back and loin and average of those backfat measurements and days to 90 kg are given in Table 4.

The genetic correlations among the backfat measurements at the 3 different sites estimated were very high in all 3 breeds. The phenotypic correlations among the backfat measurements at the 3 different sites estimated were slightly lower than the genetic correlations. The genetic correlations of an average of the backfat measurements at the 3 different sites with one of the 3 backfat measurements estimated were highly positive in all 3 breeds.

Among the 3 genetic correlations involving the backfat measurements at shoulder, mid-back and loin, the genetic correlation between the backfat measurements at shoulder and mid-back was the lowest in all 3 breeds. The phenotypic correlation between the backfat measurements at shoulder and mid-back was also the lowest in all 3 breeds among the 3 phenotypic correlations involving the backfat measurements at the 3 different sites.

Days to 90 kg was negatively correlated phenotypically with the backfat measurements at shoulder, mid-back and loin. The estimated genetic correlations of days to 90 kg with the backfat measurements at shoulder, mid-back and loin were also negative, with the range of -0.19 ~ -0.30 in Durocs, -0.04 ~ -0.17 in Landraces and -0.10 ~ -0.13 in Large Whites. The genetic correlations between days to 90 kg and backfat thickness estimated in this study were in unfavourable direction for the genetic improvement when the objective of breeding for the breed is the increased growth rate and reduced backfat. However, the genetic correlations between days to 90 kg and backfat thickness observed were not high. The genetic and phenotypic correlations between days to 90 kg and backfat thickness estimated were in agreement with the reports of Swiger et al. (1979), Lo et al. (1992) and Kennedy (1994).

IMPLICATIONS

Heritability for backfat thickness at shoulder estimated was lower than the estimates for backfat thickness at mid-back or loin, indicating that backfat measurement at shoulder is less reliable as an indicator of breeding value for the trait. Highly positive genetic correlations among backfat measurements at shoulder, mid-back and loin suggest that selection for backfat thickness at mid-back or loin is expected to bring the correlated responses in backfat thickness at other sites as well as the direct response.

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