

## Ear Type and Coat Color on Growth Performances of Crossbred Pigs

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**ABSTRACT** : Records from a total of 202 crossbred pigs were classified by their ear type and coat color to examine the presence of interrelationships with growth performances. Crossbred pigs were F2 generations of full sib family out of ten Landrace sows bred by 5 Korean domestic boars. Heavily drooped ear type was predominant, 195 out of 202 pigs over the other two types (1 straight and 6 slightly drooped). Coat colors were classified as four categories, all white, all black, dominant white or dominant black. Ratio among coat color categories did not fall within Mendelian principle of independence regarding two loci involved. There was dependency between ear type and coat color. However, due to rarity of ear types other than heavy drooped, dependency comes from distribution of those rare ear types. Three least squares models to test the effect of ear type and coat colors on growth performances were analyzed. First model analyzed effects on birth weight, body weight at 3 and 6 weeks and ADG's before weaning and between 3 and 5 weeks of age. This model included sex in addition to ear type and coat color. Second model analyzed postweaning growth traits (initial weight, final weight and ADG between these periods) upon initiation of performance testing. This model included effects of sex, test group and start age (as a covariate) in addition. Third model was fit for fasted weight before slaughter and included the effects of sex, test group and age at slaughter (as a covariate). The effects of sex and ear type were not significant source of variation for all traits. Test group was a significant source of variation for all the postweaning traits. Effect of coat color was not significant until the initiation of performance testing and became significant then after. Least squares means of dominantly black pigs were significantly lower than the other three coat colored pigs in final weight around 195 days of age and in ADG from the start of performance test and final weight measure. (*Asian-Aust. J. Anim. Sci.* 2002, Vol 15, No. 8 : 1178-1181)

**Key Words** : Crossbred, Ear Type, Coat Color, Growth

### INTRODUCTION

Swine breeders seeking genotypes with better growth and superiority in other economically important traits have developed efficient performance recording system in the field. The other approach were to detect genotypes of pigs for those performances according to typical and readily visible body shapes such as coat color, ear type, tail shape, leg soundness or overall body shapes. Coat color, especially, plays an importance concern for the packers for merchandising other than its relationship with performance. In the United States, colored pigs cost over \$1US per pig compared to white pigs preferred by the US consumers (Rothschild and Plastow, 1999). In Korea and maybe in several other Asian countries, consumers prefer colored pigs of domestic wild breeds.

There have been some researches on heredity of coat color and ear types early in 1960s (Legault, 1998). Recent molecular works have found two genes regulating the coat

color of pigs, a melanocortin receptor 1 (MC1R, Kijas et al., 1998) and a dominant white phenotype gene called KIT (Marklund et al., 1998).

Korean consumers for their taste and palatability favor Korean wild pigs. However, we still do not know much about difference in muscle and fat composition or other physiological mechanism to make it preferable.

The objective of this study was to identify the relationships between shape characteristics of crossbred pigs such as coat colors or ear types and growth performances.

### MATERIALS AND METHODS

#### Animals

The experiment was designed to develop genetic markers associated with quantitative trait loci (QTL) in swine. An F2 design with full sib family structure was applied. Five Korean domestic boars were selected from a line-bred population in the swine unit of National Livestock Research Institute (NLRI), Songhwan, Korea, selected for faster growth and carcass quality. Ten Landrace sows were selected also from a line-bred population in the swine unit of NLRI selected for reproductive performances as well as for faster growth.

Five boars were randomly assigned to ten Landrace sows to produce ten crossbred families (F1). One or two

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boars and two to six gilts within each F1 family were selected for full-sib mating to produce next generation (F2).

Pigs of F2 generation were performance test for growth and carcass measurement after the test. Pigs were weaned from three to five weeks of age. All the procedure including reproduction, growth and performance tests were performed at the swine unit of NLRI, Suwon, Korea. Data on growth performance were recorded from May to December in 2000.

We classified ear types in three categories - A, B, and C. Type 'A' represents light ear with prickly posture. 'B' is the ear with slight drooping towards the end (lop-ear). And 'C' represents heavy and drooped posture as in Landrace pigs.

Coat colors were classified into four categories depending on the coverage of black or white colors over the body. For simplicity, we adopted the notation used for genotyping two loci model. 'W' represents white body color and 'B' represents black body color. Therefore, 'WW' represents pigs with all white coat and 'BB' represents pigs with all black coat. And 'Bw' represents coat that is mostly black with some white spots. Likewise, 'bW' represents coat that is mostly white with some black spots.

Growth performances were recorded three time before the beginning of performance test, twice during the test and finally at slaughter after fasting. Growth traits analyzed were birth weight (BW), weight at three weeks of age (W3wk, on day measurement), ADG from birth to 3 weeks (PWADG), weight at five weeks of age (W5wk, on day measurement), ADG from 3 to 5 weeks of age (ADG35wk), weight at the beginning of performance test (STWT, average age: 85±6.24 days), final weight (FW, average age: 195±12.34 days), ADG during the test (ADGT), and fasting weight before slaughter (FSW, average slaughter age: 216±4.92 days). All the weights and growth rates used were without pre-adjustment for sex or age because of large variation in growth patterns.

**Statistical analyses**

Three linear covariance models were constructed. Each model deals with effects of sexes (male, female), ear types (A, B, C) and coat colors (WW, bW, Bw, BB) on early growth performances (model 1), growth during performance test (model 2) and at slaughter (model 3) as follows.

Model 1: For traits prior to performance test, a multivariate linear effect model

$$Y_{ijkl} = \mu + \text{sex}_i + \text{coat color}_j + \text{ear type}_k + e_{ijkl}$$

Where,  $Y_{ijkl}$  = BW, W3wk, W5wk, PWADG, ADG35wk

Model 2: For traits during performance test, a multivariate linear covariance model

$$Y_{ijklm} = \mu + \text{sex}_i + \text{test group}_j + \text{coat color}_k + \text{ear type}_l + \beta x_m + e_{ijklm}$$

Where,  $Y_{ijklm}$  = STWT, FW, ADGT.

$\beta$  = regression coefficient of dependent variables on age at the beginning of the test.

And  $x_m$  = a covariate of age at the start of the test in days.

Model 3: For fasting weight at slaughter, a univariate linear covariance model

$$Y_{ijklm} = \mu + \text{sex}_i + \text{test group}_j + \text{coat color}_k + \text{ear type}_l + \beta x_m + e_{ijklm}$$

Where,  $Y_{ijklm}$  = FSW.

$\beta$  = regression coefficient of dependent variables on age at slaughter.

And  $x_m$  = a covariate of age at slaughter in days.

Analysis of variance for all three models was performed with generalized linear model (GLM) procedure of SAS (1990). Chi-square test and Fisher's exact test for the test of independence between ear type and coat color categorization were performed by frequency test procedure of SAS (1990).

**RESULTS AND DISCUSSION**

Frequencies of ear type and coat color categories are shown in table 1. Goodness of fit test for the hypothesis of independent assortment of genes affecting coat color under the assumption of two loci model was significant ( $p < 0.01$ ). Chi-square value was 44.53, which means that coat color is not affected by Mendelian segregation or possibly is affected by other genes. Two loci assumption with epistatic effect between two genes was not a positive hypothesis either.

Null hypothesis for the test of independence between coat color and ear type was accepted (table 1). Two tailed

**Table 1.** Number of pigs with each coat color and ear type<sup>1</sup>

Ear type <sup>2</sup>	Coat color <sup>1</sup>				Total
	WW	bW	Bw	BB	
A	0	0	1	0	1
B	2	1	1	2	6
C	60	81	17	37	195
Total <sup>3</sup>	62	82	19	39	202

<sup>1</sup> WW=All white, bW=Mostly white with some black spots, Bw=Mostly black with some white spots, BB=All black.

<sup>2</sup> A=Prickly ear, B=Lop ear, C=Drooped ear.

<sup>3</sup> p-value of Goodness-of-Fit Test (H0:WW:bW:Bw:BB=1:1:1:1) = 1.16E-9.

<sup>4</sup> p-value from Fisher's Exact Test (two-tailed) for independence between coat color and ear type=0.132.

Fisher's Exact Test was performed instead of chi-square test because most of the pigs had 'C (drooped-ear)' type ears and 'A' or 'B' types were hardly ever seen.

Table 2 shows the results of the analyses of variance from three models. Effects of sex, coat color or ear type were all non-significant for early growth traits with Model 1 except for the effect of ear type in ADG from 3 to 5 weeks of age. Gain for this age interval was the greatest of the pigs with lop ears ('B' type) followed by 'C' and 'A' types in order. However, 'A' type was found in only one pig and 'B' type was found in only six pigs (see table 1), which makes unsure about the validity of significant difference. Least squares mean for the gain of 'A' type was unexpectedly low (0.03 kg/day) compared with that of 'B' (0.25 kg/day) or 'C' (0.17 kg/day) type. The number of observations of 'A' type pigs might explain this.

Effect of coat color became significant for the traits of late growth around 6 to 7 months of age (table 2, model 2) while the effect of sex or ear type remained non-significant. In model 2 and model 3 (for fasting weight at slaughter), test group assigned through performance test was a significant source of variation for all traits in the models.

Least squares means of each trait for sexes and for coat color categories are summarized in table 3. Sex effects were not significant for all traits studied. Pigs with 'bW', 'WW' or 'BB' coat colors, however, grew faster than pigs with 'Bw' color pattern in the traits (FW, ADGT) after the start of the test ( $p < 0.05$ ). Pigs with 'bW' color pattern had heavier fasting weight at slaughter than pigs with 'Bw' pattern ( $p < 0.01$ ). However, any other significant differences were not found between pigs of 'bW' and pigs of 'BB' or 'WW', or between pigs of 'Bw' and pigs of 'BB' or 'WW'.

Partial correlation coefficients of residuals are

calculated in table 4 for the traits in model 1 and in table 5 for the traits in model 2. The highest correlation (0.98) was found between body weight at 3 weeks (W3wk) and pre-weaning daily gain (PWADG) in model 1. Correlations of birth weight with weights at 3 or 5 weeks and with pre-weaning or earlier growth rate were low, which represent the genetic as well as environmental difference between placental growth and individual growth involving milking ability of dams in earlier growth of piglets. Relatively high correlations between body weight at 5 weeks of age and growth rate up to 3 weeks (PWADG) and from 3 to 5 weeks (ADG35wk) suggest that body weight at 5 weeks comprise growth of individuals as well as growth rate due to milking ability of dams while suckling. However, there was zero correlation between growth rates of pre- and post-weaning, which implies that two growth rate traits explain different biological backgrounds. Pre- and post-weaning growth owe to individual growth potential while maternal contribution to individual growth plays a great role for suckling piglets. Some higher correlation coefficient between body weight at 5 weeks and weight gain from 3 to 5 weeks than coefficient between weights at 5 weeks with pre-weaning ADG explains this.

High correlation coefficients between final weight upon termination of performance testing and weight gain through testing (table 5). Correlations between starting weight upon initiation of performance testing and final weight or weight gain were medium or low. This implies that the body weight at the start of the test do not show full growth potential of individual pigs.

We may conclude that the coat color was a significant source of variation after individual growth performances are expressed. However, the genetic and environmental

**Table 2.** p-values from analyses of variance for growth traits in crossbred (F2) pigs

Trait <sup>1</sup>	Sex	Coat Color	Ear Type	Test Group	Age <sup>2</sup>	$\beta$ <sup>3</sup>
----- Model 1 -----						
BW	0.693	0.763	0.977	-	-	-
W3wk	0.440	0.492	0.991	-	-	-
W5wk	0.597	0.170	0.099	-	-	-
PWADG	0.385	0.548	0.995	-	-	-
ADG35wk	0.161	0.299	0.010	-	-	-
----- Model 2 -----						
STWT	0.720	0.222	0.241	0.000	0.000	0.479
FW	0.274	0.004	0.630	0.000	0.000	1.171
ADGT	0.106	0.007	0.827	0.009	0.000	7.95E-3
----- Model 3 -----						
FSW	0.948	0.052	0.462	0.017	0.001	0.691

<sup>1</sup> BW=Birth weight, W3wk=Weight at 3 weeks, W5wk=Weight at 5 weeks, PWADG=ADG from birth to 3 weeks of age, ADG35wk=ADG from 3 to 5 weeks of age, STWT=Starting weight upon performance test, FW=Final weight, ADGT=ADG from STWT to FW, FSW=Fasting weight at slaughter.

<sup>2</sup> p-values for the regression of traits on age at the start of performance test (model 2) or on age at slaughter (model 3).

<sup>3</sup> Regression coefficients of traits on age in each model (kg/day).

**Table 3.** Least squares means and standard errors of each trait by sexes and by coat colors

Trait <sup>1</sup>	Sex		Coat Color <sup>2</sup>			
	Male	Female	WW	bW	Bw	BB
BW	1.24±0.07	1.23±0.07	1.24±0.07	1.26±0.07	1.21±0.07	1.23±0.07
W3wk	4.77±0.37	4.88±0.36	4.94±0.39	4.94±0.39	4.73±0.39	4.68±0.40
W5wk	7.02±0.58	6.90±0.56	7.10±0.60	7.34±0.60	6.70±0.60	6.71±0.61
PWADG	0.17±0.02	0.17±0.02	0.18±0.02	0.17±0.02	0.17±0.02	0.16±0.02
ADG35wk	0.16±0.03	0.14±0.03	0.15±0.03	0.17±0.03	0.14±0.03	0.14±0.03
STWT	24.13±1.90	23.87±1.84	24.04±1.95	25.28±2.00	22.73±1.97	23.96±2.00
FW	81.49±4.59	83.38±4.45	83.68 <sup>A</sup> ±4.72	86.95 <sup>A</sup> ±4.76	74.73 <sup>B</sup> ±4.77	84.39 <sup>A</sup> ±4.85
ADGT	0.54±0.03	0.56±0.03	0.56 <sup>A</sup> ±0.03	0.57 <sup>A</sup> ±0.03	0.49 <sup>B</sup> ±0.03	0.56 <sup>A</sup> ±0.04
FSW	83.88±5.04	83.76±4.90	83.92 <sup>AB</sup> ±5.20	87.97 <sup>A</sup> ±5.23	78.35 <sup>B</sup> ±5.24	85.03 <sup>AB</sup> ±5.33

<sup>1</sup> BW=Birth weight, W3wk=Weight at 3 weeks, W5wk=Weight at 5 weeks, PWADG=ADG from birth to 3 weeks of age, ADG35wk=ADG from 3 to 5 weeks of age, STWT=Starting weight upon performance test, FW=Final weight, ADGT=ADG from STWT to FW, FSW=Fasting weight at slaughter.

<sup>2</sup> WW=All white, bW=Mostly white with some black spots, Bw=Mostly black with some white spots, BB=All black.

<sup>A,B</sup> Means by coat colors with different superscripts differ significantly ( $p < 0.05$ ) within trait.

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**Table 4.** Partial correlation coefficients between residuals of each trait from Model 1

Trait <sup>1</sup>	W3wk	W5wk	PWADG	ADG35wk
BW	0.23	0.32	0.04	0.23
W3wk	1	0.68	0.98	0.05
W5wk	symmetric	1	0.64	0.76
PWADG		1	0.01	

<sup>1</sup> BW=Birth weight, W3wk=Weight at 3 weeks, W5wk=Weight at 5 weeks, PWADG=ADG from birth to 3 weeks of age, ADG35wk=ADG from 3 to 5 weeks of age.

**Table 5.** Partial correlation coefficients between residuals of each trait from model 2

Trait <sup>1</sup>	FW	ADGT
STWT	0.63	0.29
FW	1	0.91

<sup>1</sup> STWT=starting weight upon performance test, FW=final weight, ADGT=ADG from STWT to FW, FSW=fasting weight at slaughter.

relationship of coat color with growth performances should be examined in more detail. Growth rates of pre-weaning, post-weaning for earlier growth and later growth exerts different physiological history such that those growth traits as well as body weights at different growth stages should be understood with different biological models.