CORRELATED RESPONSES IN DAILY PROTEIN, FAT DEPOSITION AND PROTEIN CONVERSION RATIO TO INDEX SELECTION FOR DAILY GAIN, BACKFAT THICKNESS AND EYE MUSCLE AREA IN LANDRACE PIGS

K. Suzuki, S. Nishida and S. Ujiie

Miyagi Prefectural Animal Industry Experiment Station,
Iwadeyama-cho, Miyagi Prefecture, 989-64
Japan

SUMMARY

Correlated responses in chemical body composition, daily fat and protein deposition, protein conversion ratio from a line of Landrace pigs selected for daily gain, backfat thickness and eye muscle area were studied in 139 male pigs and correlations between these traits were estimated. Daily gain, daily feed intake and daily protein deposition increased by 21.82g/day, 0.05kg/day and 2.4g/day, respectively, per generation. Backfat thickness decreased by −0.04cm per generation. But total feed intake, the conversion ratio of feed and protein, chemical body fat and protein percentage didn't change. Daily protein deposition was highly correlated with daily gain and feed conversion ratio. On the other hand, protein conversion ratio was highly correlated with feed conversion ratio, total feed intake and backfat thickness. To improve not only daily protein depositon but also protein conversion ratio, daily gain, backfat thickness and feed conversion (or total feed intake) should be considered as selection traits.

INTRODUCTION

In pig breeding objectives, growth rate and feed conversion ratio are important traits to decrease pig production costs. High growth rate means high daily lean or protein deposition within a certain time. Daily protein deposition is highly correlated with daily gain and with daily feed intake. Kanis(1988) pointed out the significance of daily feed intake in pig breeding. Protein conversion ratio (protein deposition/digested crude protein ×100) is as important trait as daily protein deposition. Considering the conversion ratio of feed (or protein) to lean, this trait should be considered. To investigate the possibility that protein cnoversion ratio is changed by selection, it must be important to estimate the genetic and phenotypic correlation between protein conversion ratio and production traits such as daily gain, backfat thickness and feed conversion ratio. The object of this study was to estimate the correlated responses in chemical body composition, daily fat and protein deposition, protein conversion ratio during six generations of index selection for daily gain, backfat thickness and eye muscle area and the correlation between these traits in a line of Landrace pigs.

MATERIALS AND METHODS

Six generations of index selection for daily gain, backfat thickness and eye muscle area were carried out. Pigs were tested from 30kg to 90kg of body weight. In each generation, 22~24 male pigs were housed in individual pens and slaughtered at 90kg of body weight. The feed intake of pigs offered the diet *ad libitum* was recorded. To estimate chemical body composition at the start of test of pigs slaughterd at 90kg body weight, fifteen male pigs were slaughterd at 3rd and 4th generation respectively. The empty gut, internal organs and right side of carcass were sealed in a plastic bag and stored at −30°C. The frozen carcass and empty gut and internal organs were ground in a

commercial butcher's mincer, mixed and subsampled for chemical analysis. The accmulation of fat and protein were estimated by comparative slaughter method. Genetic parameters were estimated using LSMLMW (Harvey, 1987).

RESULTS AND DISCUSSION

Generation means for production traits, chemical body composition and daily deposition of fat and protein are given in Table 1. Daily gain, daily feed intake, backfat thickness, daily protein deposition were significantly changed. But feed conversion ratio and protein conversion ratio were not improved. Also, chemical body fat and protein percentage did not change. It was suggested that the relocation of body fat from backfat to other sites. Because the backfat thickness measured by ultrasonic machine decreased but whole body fat percentage unchanged. In addition, it is necessary to measure backfat thickess which reflect exact estimation of body fat percentage.

Table 1. Least squares means for production traits, daily fat and protein deposition, protein conversion ratio and chemical body percentage.

Traits		Generation						b[1]
		1	2	3	4	5	6	
Daily gain	g/day	806	795	886	897	868	912	21.8**
Feed intake	kg	182	183	180	182	178	176	−1.2
Daily feed intake	kg/ day	2.38	2.31	2.55	2.60	2.47	2.60	0.05**
Feed conversion ratio		2.97	2.92	2.89	2.90	2.86	2.86	−0.02
Age at 90kg BW	days	151	157	148	143	149	142	−2.2
Backfat thickness	cm	2.08	1.74	1.93	1.79	1.78	1.77	−0.04*
Eye muscle area	cm^2	32.8	34.0	34.1	31.6	35.9	31.9	−0.04
Body fat percentage	%	23.7	20.9	22.5	22.8	22.2	24.7	0.27
Body protein percentage	%	16.8	17.2	17.1	16.9	17.2	16.4	−0.06
Daily protein depositon	g/day	122.2	122.8	133.5	134.0	132.5	133.2	2.4**
Daily fat deposition	g/day	203.4	175.5	207.7	212.9	200.0	237.3	7.3
Protein conversion ratio	%	39.5	40.7	40.2	39.6	41.2	39.4	0.001

1)Coefficent of regression on generation.
*P<0.05, **P<0.01

Table 2. shows the estimates of phenotypic and genetic correlations between daily fat and protein deposition, protein conversion ratio, chemical body fat and protein composition and production traits. Because of small sample, genetic correlations have large standard error. Daily gain and the age at 90kg body weight were almost same trait in quality and both traits were highly correlated with daily protein and fat deposition. Namely faster growing pigs was high in daily protein and fat deposition. As indicated by Kanis(1988), daily feed intake was highly related to body protein and fat percentage, daily fat deposition. Feed conversion ratio was favorably correlated with daily protein deposition and protein conversion ratio. Although the correlation between backfat thickness and daily protein deposition was near zero, backfat thickness was favorably correlated with protein conversion ratio and body protein, fat percentage. These

correlations suggest that genetically improved pigs in daily protein deposition may increase daily feed intake and daily gain. Also these pigs may be improved both in feed conversion ratio and protein conversion ratio. But the percentage of body fat and protein, backfat thickness may be unchanged.

On the other hand, improved pigs in protein conversion ratio may be thin in backfat thickness and have less fat and more protein. They were favorable in daily protein deposition. But daily gain and age at 90kg body weight will not be improved. Furthermore, daily feed intake will decrease. Selection for feed conversion ratio or lean tissue conversion ratio resulted in decline in daily feed intake (Webb 1989).

Table 2. Phenotypic and genetic correlations from sire componets of variance and covariance between daily protein, fat accumul protein conversion efficiency and production traits.

	Daily deposition(g/day)		PCR[1]	Empty body percentage	
	Protein	Fat		Protein	Fat
Daily gain	0.76±0.18	0.74±0.17	0.09±0.38	−0.37±0.40	0.41±0.32
	0.80	0.73	0.08	−0.36	0.32
Feed intake	−0.57±0.61	0.20±0.39	−0.81±0.61	−0.50±0.41	0.50±0.32
	−0.52	0.03	−0.70	−0.23	0.36
Daily feed intake	0.26±0.41	0.99±0.07	−0.60±0.51	−0.86±0.52	0.92±0.15
	0.45	0.84	−0.47	−0.61	0.63
Age at 90kg BW	−0.89±0.71	−0.70±0.55	−0.26±0.40	0.31±0.33	−0.32±0.43
	−0.68	−0.66	−0.06	0.35	−0.31
Feed conversion	−0.70±0.54	0.17±0.33	−0.81±0.50	−0.48±0.35	0.52±0.26
ratio	−0.62	0.04	−0.79	−0.30	0.40
Backfat thickness	0.01±0.38	0.95±0.1	−0.77±0.42	−0.81±0.39	1.05±0.07
	−0.01	0.67	−0.54	−0.59	0.72
Eye msucle area	UE[2]	UE	UE	UE	UE
	0.09	−0.19	0.28	0.20	−0.27

Upper row: Genetic correlatin±S.E., Lower row: Phenotypic correlation
1)PCR:Protein Conversion Ratio. 2)UE:Unestimated

Table 3 shows correlated responses in daily protein, fat deposition, protein conversion ratio and body composition to single-trait selection for production traits. Althogh daily gain is unfavourable in fat deposition, this traits is important. Because this trait is highly related to daily protein deposition and easily measured. But, selection for daily gain results in increase in fat and decrease in protein percentage. And so, in addition to daily gain, backfat thickness should be included into selection trait. By including backfat thickness, body fat deposition will be suppressed and protein conversion ratio may be increased. However, in our index selection experiment included daily gain, backfat thickness and eye muscle area, both empty body fat percentage and protein conversion ratio were unchanged. One of these reasons is the relative weight for daily gain and backfat thickness in selection index. Another resaon is the position of backfat thickness measured. In our experiment, backfat thickness was measured at the site of 2cm off the dorsal midline of 1/2 body length by using ultrasonic instruments . Another locations

that can be predicted more exactly carcass composition (lean and fat) should be selected. Moreover, to improve protein conversion ratio, feed conversion ratio is important. Because the feed conversion ratio is a ratio, this trait is difficult to improve (Cleveland and Shinckel, 1988). Therefore, as a replace of feed conversion ratio, total feed intake should be considered as a selection trait. Total feed intake is correlated highly with feed conversion ratio. Because a denominator(gain) is almost constant, it is natural conclusion that total feed intake of numerator becomes a varied primary factor.

Table 3. Correlated responses to single-trait selection in protein, fat deposition, protein conversion ratio and chemical body composition in pi

Select on:	Direction	Daily deposition Protein	Daily deposition Fat	PCR	Carcass composition(%) Protein	Carcass composition(%) Fat
Daily gain	↑	○○	××	△	×	×
Feed intake	↓	○	△	○○	○	○
Daily feed intake	↑	○	××	××	××	××
Age at 90kg BW	↓	○○	××	△	×	×
Feed conversion	↓	○○	△	○○	○	○
Backfat thickness	↓	△	○○	○○	○○	○○
Eye muscle area	↑	△	△	△	△	△

"○" = favourable, "△" = unchangable and "×" = unfavourable response to selection.

From above mentioned, the index selection incorporated daily gain, backfat thickness and total feed intake may be effective to improve both daily protein deposition and protein conversion ratio.

REFERENCES

CLEVELAND, E.R. and SHINCKEL, A.P. (1988) Pig News and Information, 9:137-141.

HARVEY, W. R. (1987) User's Guide for LSMLMW. PC-1 Version.

KANIS,E. (1988) Animal Production, 46 : 111-122.

WEBB,A.J. (1989) The voluntary food intake of pigs. British Societyof Animal Production Occasional Publication No13. 41-50.