Correlated Response of Immune Traits with Selection for morbid state of Mycoplasma Pneumonia of Swine in Landrace Pigs

K. Suzuki[1], T. Okamura[1], W. Onodera[1], T. Tayama[1], H. Kadowaki[2], T. Shibata[2], E. Suzuki[2], H. Uenishi[3], T. Hayashi[3], and T. Awata[3]

Introduction

The most important disease affecting domestic pig production system is a compound respiratory tract disease arising from the mixed infection of the pathogenic microbe as symbolized by porcine respiratory disease complex（PRDC）. Although vaccinations, drug administering, preventive sanitation, and making SPF are available as disease control method, these are not necessarily optimal strategies. Breeding for disease resistance must also be considered as an important choice. This breeding method exposes the pig to bacillus, and enables selection of animals with high resistance ability. Miyagi Prefecture Animal Industry Experiment Station did the selection for the morbidity of lungs of full sibs in Landrace pigs. The lung lesion was significantly decreased as a result of selection done at the fifth generation. The purpose of this report is to estimate the correlated genetic parameters and the breeding value of peripheral the blood immunity, and to investigate the relation between mycoplasma pneumonia resistance and immunity.

Material and methods

Selection method: Landrace pigs used in this experiment were of a line selected for five generations at the Miyagi Prefecture Animal Industry Experiment Station from 2002-2008. Selection criteria traits were daily gain from 30 kg to 105 kg body weight (DG), backfat thickness (BF) at 105 kg body weight measured using ultrasound technology, and the morbid change of mycoplasma pneumonia of swine (MPS) measured on slaughtered sib pigs. The aggregate breeding values were calculated by multiplying the relative economic weights to the estimated breeding value of each trait; then selection was executed. Relative economic weights of selection traits were calculated from the relative desired gain. The average population size and the number of litters of each generation were shown in Table 1. Gilts farrowed only once and boars were retained for use during 4-6 wk breeding period. Thereby, a new generation was obtained each year. Pigs were weaned at 4 wk. At 7 wk, 1-2 male piglets (total 50 piglets) and

[1]Graduate School of Agricultural Science, Tohoku University, Sendai, Japan, 981-8555
[2]Miyagi Prefectural Animal Industry Experiment Station, Iwadeyama, Miyagi prefecture, Japan, 989-6445
[3]Division of Animal Sciences, National Institute of Agrobiological Sciences, Tsukuba 305-8602, Japan

2-4 female piglets (total 100 piglets) from each litter were selected as boar and gilt candidates based on body weight at 7 wk. At the same time, about 120 piglets comprising mainly boars and sometimes gilts from each litter were selected for investigation of the state of morbidity of the lungs in each generation. This first stage of selection was conducted within litters. For each pig blood was collected at the first stage of selection at 7 wk. Boars for full sib test were subsequently castrated. Blood samples were also collected from candidate boars and gilts and from full sibs at 105 kg body weight. Pigs were provided *ad libitum* access to a commercial diet during the testing periods. Boars were reared individually in performance testing pens. Gilts and barrows were reared in growing pens with group feeding.

Table 1: Number of pigs performance tested

Generation	Selected Parents		No. of performance tested					
			Candidate		Slaughter pig A		Slaughter pig B	
	Sires	Dams	Boars	Gilts	Barrows	Gilts	Barrows	Gilts
1	13	50(33)[1)]	33	57	40	7	44	33
2	13	44(40)	50	113	40	6	53	42
3	13	48(37)	50	113	32	15	45	34
4	15	47(40)	49	106	34	8	48	30
5	15	43(35)	46	103	34	11	44	29
Mean	14	46(37)	45.6	98.4	36	9.4	46.8	33.6
Total	71	232(194)	228	492	180	47	234	168
Sum		303		720		227		402

1) Parentheses show actually breeding population size

Measurement of Immune traits: When the animals reached 70 kg body weight, the first immunization was practiced with approximately 10^8/ml of sheep red blood cells (SRBC). The second immunization was given 1 week later. Blood samples were collected when body weight reached 105 kg. Phagocyte activity (PA) in the peripheral blood using a chemiluminescence detector, white blood cell number (WBC) and the ratio of granular leukocyte to lymph cell (GLR) were measured. The remaining whole blood sample was centrifuged and the separated plasma was used for measuring the complement alternative pathway activity (CAPA). Specific antibody productions (AP) to SRBC (IgG), IgG titer of *Mycoplasma hyopneumoniae* (MPIGG) were also measured. The morbid changes caused by atrophic rhinitis (AR) in two full-brothers of the candidates were graded on a scale from 1 to 5 according to the degree of atrophy in nasal concha when they were slaughtered at 105 kg of body weight. The areas (cm^2) of the morbid changes by MPS in the full-brothers were measured at the same time.

Statistical Analyses: The genetic parameters were estimated using VCE4.25 (Neumaier and Groeneveld, 1998) with models of generation and sex as fixed effects and random effects of individual additive genetic effect and error. Five generations of pedigree information of 1,937 animals with data of 599 ancestors born before the three generation (total 1,348 animals) were included in this analysis. At 7wk, a common environmental effect was incorporated in the model as a random effect.

Results and discussion

Genetic parameter estimates

The heritabilities of AR and MPS were estimated, respectively as 0.33 and 0.09 (table2、table3). These values are almost equal to the estimate that Kikuchi et al reported for the Duroc breeds (Kikuchi et al., 2002). The negative genetic correlations of PA at 7 wk and 105 kg BW with MPS (-0.68 and -0.37) were significantly different from zero but that of NIGA with MPS (-0.44) was not significant. This result shows that the animals with high phagocyte activity have a low morbid state. At 105 kg BW, GLR had significantly high negative correlation with MPS (-0.62). At the same time, positive genetic correlation of COR, CAPA, and MPIGG with MPS (0.48, 0.65, 0.45, respectively) were also significantly different from zero. Furthermore, high negative genetic correlation of GLR and SIGA with AR (-0.50 and -0.49) were significantly different from zero. Because no reports on genetic correlation of immune traits with morbid state of MPS and AR have published, further research on genetic relation between them is necessary.

Table 2: Genetic parameter estimates of selection and immune traits measured at 7 wk of age

	h^2	se	PA	CAPA	WBC	GLR	COR	NIGA
DG	0.59	0.03	0.14	-0.02	-0.01	0.67	-0.26	0.31
BF	0.66	0.03	-0.35	0.19	-0.04	-0.22	-0.52	-0.13
MPS	0.09	0.03	-0.68	0.14	0.21	-0.14	0.00	-0.44
AR	0.33	0.03	-0.32	-0.27	-0.28	-0.22	-0.34	0.19
h^2			0.15	0.11	0.30	0.03	0.26	0.25
se			0.03	0.03	0.02	0.02	0.05	0.07

DG: Daily gain, BF: Backfat thickness, AR: Lesion of Atrophic Rhinitis, MPS: Mycoplasma Pneumonia of Swine, PA: Phagocyte activity, CAPA: Complement alternative pathway activity, WBC: White blood cell, GLR: granular leukocyte to lymph cell ratio, COR: Cortisol, NIGA: Nose IgA.

Table 3: Genetic parameter estimates of selection and immune traits measured at 105 kg BW

	h^2	se	COR	PA	CAPA	WBC	AP	GLR	MPIGG	SIGA
DG	0.59	0.03	0.28	0.19	-0.02	0.12	-0.22	0.30	0.13	-0.10
BF	0.66	0.03	0.03	-0.27	0.02	-0.02	-0.11	0.51	0.16	-0.08
MPS	0.09	0.03	0.48	-0.37	0.65	-0.29	-0.23	-0.62	0.45	-0.08
AR	0.33	0.03	0.08	-0.19	-0.35	-0.07	-0.18	-0.50	0.12	-0.49
COR	0.19	0.03	1.00	-0.24	-0.19	0.20	0.02	-0.21	-0.14	-0.50
h^2			0.19	0.17	0.08	0.23	0.18	0.06	0.56	0.10
se			0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.02

DG: Daily gain, BF: Backfat thickness, AR: Lesion of Atrophic Rhinitis, MPS: Mycoplasma Pneumonia of Swine, COR: Cortisol, PA: Phagocyte activity, CAPA: Complement alternative pathway activity, WBC: White blood cell, AP: Antibody production to SRBC, GLR: granular leukocyte to lymph cell ratio, SIGA: salivary IgA.

Genetic trends

The breeding value of DG standardized by sd increased and that of MPS decreased with selection (figure 1a). Of the immune traits at 7 wk of age, GLR and NIGA significantly increased (figure 1b). At 105kg BW, GLR and COR increased. Also, MPIGG and AP decreased with selection (figure 1c). These results suggest that the immune traits classified as natural immunity and mucosal immunity genetically correlated with morbid state of respiratory organ.

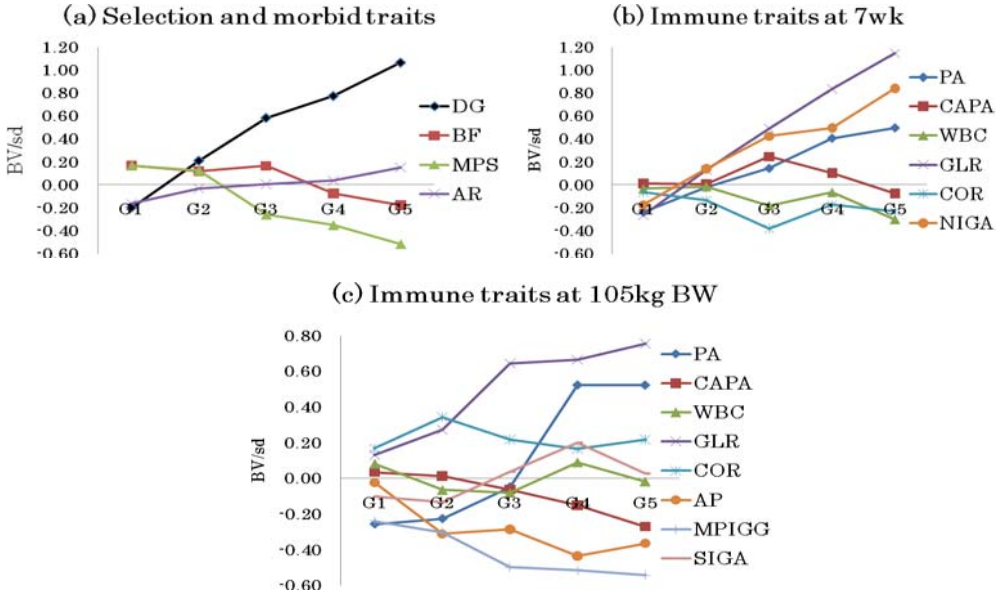

Figure 1 Genetic trends of selection traits (a), and correlated trends of immune traits measured at 7 wk of age (b) and at 105 kg of BW (c) (Refer to Tables 2 and 3 for the abbreviation).

Conclusion

Various immunities have changed as a correlated response of the selection of which the direct selection traits is the morbid state of MPS. The breeding value of natural immunity (GLR, PA) increased and humoral immunity (AP) decreased with selection. The result of this research is offering important information for the selection strategy of disease resistance.

References

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