GENETIC IMPROVEMENT OF DISEASE RESISTANCE TO JAPANESE *THEILERIOSIS* WITH PHYSIOLOGICAL INDICATORS

M. Fukasawa[1], T. Kikuchi [2], S. Konashi[2], H. Shinohara[1], A. Nishida[1] and T. Yamagishi[1]

[1] Graduate school of Agricultural Science, Tohoku University, Sendai, Japan, 981-8555
[2] Sotoyama Beef Cattle and Grassland Management Research Section, Animal Industry Research Institute, Iwate Agricultural Research Center, Tamayama-mura, Japan, 028-2711

INTRODUCTION

Japanese *Theileriosis*, caused by hemoparasite *Theileria orientalis sergenti*, is one of the most serious diseases in Japan. As the pathogenicity is not strong, *T. orientalis sergenti* is a benign *Theileria*. The disease is found mainly in grazing cattle, and infected calves show anemia and growth retardation. Additionally, drug treatment is costly and labor-consuming. It has been required the genetic improvement of resistance to Japanese *Theileriosis* (Minami, 1989). The objects of our study are : 1) to discuss the feasibility of genetic improvement in disease resistance to Japanese *Theileriosis* and 2) to discuss the use of plasma lipid components information as physiological indicators for genetic improvement of disease resistance to Japanese *Theileriosis*.

MATERIALS AND METHODS

Data Collection. Data was obtained from calves in Koishikawa pasture, Sotoyama laboratory, Iwate Prefecutural Institute of Animal Industry, from 1996 to 2000. Records on 419 Japanese shorthorn calves were used in the analyses. Packed cell volume (PCV) at pre-grazing (PrePCV), minimum PCV during grazing (MinPCV) and daily gain (DG), concentrations of plasma phospholipids (PrePL) and total cholesterol (PreTC) at May were collected. PrePCV, MinPCV and DG were collected from 198, 393 and 380 calves from 1996 to 2000, respectively. PL and TC were collected from 180 and 191 calves from 1998 to 2000, respectively.

Estimation of Variance Components. Genetic (co) variance was estimated by VCE4.0 (Groeneveld and Garcia, 1999) with multiple traits animal model including the five traits. Sex, farm, grazing herd of calves and year were assigned as fixed effects. All measurements of each trait were adjusted for age at start of grazing with linear regression of measurements on age at start of grazing.

Selection Indices. Using estimated (co) variances, several selection indices to realize each relative desired gain (Yamada *et al*., 1974) were set up with two selection criteria groups ; (A) contains PrePCV, MinPCV and DG, these traits now we can easily obtain, and (B) contains (A) and PrePL and PreTC as physiological indicators. Detail of each selection index was shown in table 1.
INDEX I : for improving DG only.
INDEX II : for improving MinPCV and DG with no restriction.
INDEX III : for improving MinPCV and DG with restriction of no change in PrePCV.

INDEX IV : for improving MinPCV and DG without direct information of MinPCV.
INDEX V : for improving MinPCV and DG with information that could get before grazing.

Table 1. The details of five selection indices

	Index No.	PrePCV (%)	MinPCV (%)	DG (kg/day)	PrePL (mg/dl)	PreTC (mg/dl)
Selection Criterion	I	× [A]	×	○	×	×
	II	○	○	○	△	△
	III	○	○	○	△	△
	IV	○	×	○	△	△
	V	○	×	○	△	△
Desired Gain	I	×	+ 3.31	+ 0.12	×	×
	II	×	+ 3.31	+ 0.12	×	×
	III	0	+ 3.31	+ 0.12	×	×
	IV	×	+ 3.31	+ 0.12	×	×
	V	0	+ 3.31	+ 0.12	×	×

[A] ○ This trait was included in both criteria group. △ included in group B.
× not included."

RESULTS AND DISCUSSION

Genetic parameter. Estimated genetic parameters are shown in table 2. MinPCV has lower heritability than that reported by Trail *et al.* (1991). And MinPCV has positive phenotypic correlation with DG, however, it has a negative genetic correlation with DG. Physiological indicators (PrePL and PreTC) have moderate or low heritability, and there are high positive genetic correlations with MinPCV, respectively. In dairy cattle improvement, Land *et al.* (1983) suggested that whether the physiological indicator for genetic improvement was useful or not depend on the genetic relationship between indicator and object, repeatability of indicator and simplicity with which it might be measured. In this study, both lipid components were not particularly difficult to measure. Fukasawa *et al.* (2001) suggested that plasma lipids components played important role in control of anemia development. And both components had strongly positive genetic correlation with MinPCV. Therefore, PL and TC would be suitable as physiological indicator for anemia tolerance caused by *T. orientalis sergenti* infection.

Table 2. Estimated genetic parameters of the five traits [A]

	PrePCV	MinPCV	DG	PrePL	PreTC
PrePCV	0.52 ± 0.10	0.35 ± 0.21	0.77 ± 0.09	-0.17 ± 0.21	0.23 ± 0.35
MinPCV	-0.09	0.15 ± 0.07	-0.09 ± 0.17	0.87 ± 0.13	0.64 ± 0.23
DG	0.04	0.25	0.64 ± 0.06	0.23 ± 0.24	-0.33 ± 0.32
PrePL	0.07	-0.07	-0.09	0.31 ± 0.10	0.20 ± 0.39
PreTC	0.20	-0.14	-0.09	0.60	0.09 ± 0.05

[A] Heritabilities (± s.e.) on the diagonal, phenotypic and genetic correlations (± s.e.) below and above the diagonal, respectively

Selection index. The predicted selection response of each trait and the number of generation to

reach the each goal by repeated selection based on the each index is shown in this table 3.
Index I, for improving DG only, population would reduce their anemia tolerance by correlated response. Using PCV and DG data, anemia tolerance and DG could be improved simultaneously (INDEX II-A, III-A and IV-A). The application of physiological indicator for selection would enhance the accuracy of selection (Woolliams and Smith, 1988 ; Davis and Simmen, 2000). In this report, more efficient improvement would realize by introduce physiological indicators into selection indices. (INDEX II-B, III-B and IV-B)
When individuals had not direct information of objective trait, the accuracy of selection would be low. However, in genetic improvement of disease resistance, it is difficult and inefficient to get direct information of disease resistance. The result of INDEX V indicated that effective selection might be possible by the application of physiological indicators before and/or without *T. orientalis sergenti* infection.

Table 3. The predicted selection response in each trait and the number of generation to reach the each goal by repeated selection based on the each index

Index No.	Criterion Group	PrePCV (%)	MinPCV (%)	DG (kg/day)	PrePL (mg/dl)	TC (mg/dl)	Number of acherved generation
I		(1.77) [A]	(- 0.09)	0.09	(2.53)	(- 2.51)	1.34
II	A	(1.43)	0.65	0.02	(2.21)	(3.48)	5.09
	B	(0.76)	0.92	0.03	(7.91)	(2.52)	3.61
III	A	0	0.13	0.00	(4.88)	(- 0.24)	24.80
	B	0	0.95	0.03	(9.16)	(- 0.67)	3.48
IV	A	(0.99)	0.34	0.01	(- 0.27)	(2.63)	9.88
	B	(- 0.10)	0.67	0.02	(7.95)	(0.84)	4.96
V		0	0.66	0.02	(7.52)	(1.11)	4.98

[A] Each figure in parenthesis represents correlated response.

Simultaneous improvement in anemia tolerance and productivity s thought to be feasible. However, such an improvement would be inefficient without physiological indicators. PrePL and PreTC would be suggested sufficiently useful indicators for genetic improvement of anemia tolerance.

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