鶏の免疫応答能選抜に対する相関反応としての産卵形質

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Egg Production Traits as Correlated Responses to the Selection for Immune Responses in Chickens

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Egg production traits such as egg production, egg weight, egg shell thickness, albumen height and Haugh unit were compared between high responder (HR) and low responder (LR) lines of chickens which were selected for immune responses to rabbit serum albumin over five generations. These traits were also compared between B^9/B^9 and B^{11}/B^{11} genotypes of the major histocompatibility B complex in HR line, since B^9 and B^{11} alleles were segregated in the line, but B^{11} allele was fixed in LR line. From observations on egg production over 173 days, B^{11}/B^{11} chickens produced significantly more eggs than B^9/B^9 chickens, whereas difference between the lines within B^{11}/B^{11} genotype was small and not significant. Egg weight of LR line was a little heavier than that of HR line. Albumen height of HR line was a little higher than that of LR line. Egg shell thickness of LR line was larger than that of HR line. Haugh unit of LR line was larger than those of HR line. Associations of all the traits except egg production with B genotypes were not observed.

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Key words : immune response, egg production traits, correlated response to selection, MHC, chickens

Introduction

It has been reported that the major histocompatibility B complex genes as well as the other polygenic immune response genes played significant roles on immune responses in chickens. (BALCAROVA *et al.*, 1974 ; GÜNTHER *et al.*, 1975 ; PALLADINO *et al.*, 1977 ; PEVZNER *et al.*, 1981). To clarify the association of B gene and polygenes on immune responses, we started selections for high and low immune responses to rabbit serum albumin in a base population of chickens which had the same genotype B^9/B^{11} in 1982, and established high responder line (HR) and low responder line (LR) over five generations of selections (OKABAYASHI and OKADA, 1989). At present, it is not well known whether the immune response genes influence or not on economic traits, especially egg production traits in chickens.

In the present study, we compared egg production traits as egg production, egg weight, egg shell thickness, albumen height and Haugh unit between the lines of chickens selected for high and low immune responses to rabbit serum albumin.

Materials and Methods

HR and LR lines of White Leghorn chickens, which were selected for high and low

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immune responses to rabbit serum albumin over five generations (OKABAYASHI and OKADA, 1989), were used in this study. These lines of chickens were kept as closed populations after the fifth generation of the selections. B^9/B^9 and B^{11}/B^{11} genotypes of chickens were obtained by $B^9/B^9 \times B^9/B^9$ and $B^{11}/B^{11} \times B^{11}/B^{11}$ matings in HR line, because B^9 and B^{11} alleles were segregated only in HR line, but B^{11} allele was fixed in LR line. Nomenclatures of B alleles followed in OKADA and MCDERMID (1970).

Egg production was expressed as the total number produced over 173 days from 272 to 445 days of age. Data of chickens which died or became serious sickness in the periods were excluded in the present study.

Egg weight, albumen height, egg shell thickness and Haugh unit were taken as the averages of the data obtained in succeeding seven days from 388 to 394 days of age. Albumen height, egg shell thickness and Haugh unit were measured with the exclusive instruments (Fujihira Kogyo Inc., Tokyo).

All data of egg production trait measurements were analyzed by ANOVA and Tukey's method of SYSTAT (LELAND, 1989).

Results

Averages of egg production, egg weight, albumen height, egg shell thickness and Haugh unit of the lines of chickens selected for high and low immune responses are given in Table 1. The difference of egg productions produced over 173 days from 272 to 445 days of age between HR line and LR line was small, but the difference between the B genotypes in HR line was more greater than the line difference. B^{11}/B^{11} chickens produced more eggs than B^9/B^9 chickens. The difference was statistically significant ($P<0.05$). Egg weight of LR line was larger than that of HR line. The difference between LR line and HR (B^9/B^9) line was statistically significant ($P<0.05$). Egg shell

Table 1. Measurements of egg production traits in the lines of chickens selected for immune responses

Traits	HR lime		LR line
	B^9 / B^9	B^{11} / B^{11}	B^{11} / B^{11}
Egg production	117.54±25.69 *a	131.50±9.34^b	129.36±32.86^{ab}
Egg weight (g)	48.27±3.10^a	48.41±3.83^{ab}	49.94±2.41^b
Egg shell thickness (1/100 mm)	32.58±2.29^{ab}	31.66±2.57^a	33.47±1.99^b
Albumen height (mm)	5.51±0.86^b	5.40±0.78^{ab}	4.95±0.74^a
Haugh unit	76.78±6.44^b	75.96±5.82^b	71.60±5.79^a
Number of birds investigated	35	18	22

* Mean±Standard deviation
There is significant difference at 5% level between means with different superscript letters in each horizontal line.

thickness of LR line was larger than that of HR line. The difference between LR line and HR (B^{11}/B^{11}) line was statistically significant ($P<0.05$). Albumen height of LR line was smaller than that of HR line. The difference between LR line and HR (B^{9}/B^{9}) line was statistically significant ($P<0.05$). Haugh unit of LR line was smaller than those of HR line which involved B^{9}/B^{9} and B^{11}/B^{11} chickens. The differences between LR line and HR (B^{9}/B^{9} and B^{11}/B^{11}) line were statistically significant ($P<0.05$). Significant association of *B* locus genotypes with the traits examined in this study was not observed with the exception of egg production.

Discussion

The present study showed that egg productions between B^{9}/B^{9} and B^{11}/B^{11} genotypes were significantly different, but not between the HR and LR lines within B^{11}/B^{11} genotypes. SIEGEL *et al.* (1982) reported that HA line of chickens selected for high immune responses to sheep erythrocytes had significantly lower egg production rates (hen day basis) than LA line selected for low responses to the antigen. Later they showed from analyses on serological identified *B* alleles at the 13th generation of selection that a frequency of B^{21} allele in HA line was 0.99 and a frequency of B^{13} allele in LA line was 0.98 (MARTIN *et al.*, 1990). The line difference of egg production rates showed by SIEGEL *et al.*, (1982) is considered to be primarily brought by divergencies of *B* alleles between the selected lines. It is suggested that divergencies of *B* alleles brought by the selections for immune responses to natural antigens cause the differences of egg production, but polygenic immune response genes except *B* locus genes do not influence the egg production.

The present study showed that LR line produced significantly heavier eggs with thicker shells than HR line. It is suggested that the polygenes except *B* genes which control the immune response affect egg weight and egg shell thickness in chickens. But SIEGEL *et al.*, (1982) showed no significant differences in egg weights between the HA and LA lines. The inconsistency of results in the present study and SIEGEL *et al.* (1982) may depend on the disparity of antigens used in selection experiments. There is a report which shows an association of *B* locus with egg weight in chickens (KIM *et al.*, 1989). More detail investigations will be necessary to clear the association of *B* locus with egg weight.

In the present study, the line differences of albumen height and Haugh unit were observed. Similar results were reported by SIEGEL *et al.* (1982), although the line differences in their study were not always the same to those of the present study because their line differences also involved divergencies of *B* alleles.

Considering whole genetic control involving *B* locus, it is assumed that selections for immune responses in chickens brought significant differences of egg production, egg weight, egg shell thickness, albumen height and Haugh unit as the correlated response between the high and low selected lines. Further, it has been demonstrated that tumor incidence of Marek's disease in HR line was lower than that in LR line (YAMAMOTO *et al.*, 1991). More considerations on the relationships between the immune response gene and production traits should be paid in the breeding programs for disease

resistance in poultry.

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鶏の免疫応答能選抜に対する相関反応としての産卵形質

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鶏の免疫応答能についてそれぞれ高低の2方向に選抜したHR系ならびにLR系の間で産卵数，卵重，卵殻厚，卵白高，ハウユニットなどの産卵形質について差があるか否かを分析した。なお，LR系においては主要組織適合座位であるB座位の遺伝子はB^{11}に固定されているが，HR系ではB^{9}とB^{11}とが分離しているので，*HR*系内ではB^{9}/B^{9}およびB^{11}/B^{11}の間でもそれらの形質について比較を行なった。産卵数については，系統差は見られなかったがB座位遺伝子型との関連性が観察された。即ち，B^{9}/B^{9}の産卵数はB^{11}/B^{11}のそれより有意に少なかった。卵重については，LR系の方がHR系に比べて若干大きく，特にHR系のB^{9}/B^{9}との差は統計的にも5%水準で有意であった。卵殻厚については，LR系はHR系に比べて厚く，特にB^{11}/B^{11}との差は統計的にも有意であった（$P<0.05$）。卵白高については，LR系はHR系に比べて低く，とくにB^{9}/B^{9}との差は5%水準で有意であった。ハウユニットについては，LR系はHR系に比べて有意に小さかった（$P<0.05$）。産卵数を除いた形質ではB座位との関連性は見られなかった。

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キーワード：免疫応答，産卵形質，相関反応，MHC，鶏