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# Study on the Genetic Correlations of Body Weights and the Growth Rates from 2- to 8-weeks of Age in Broiler Chicken

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# Broiler 成長段階別 體重에 對한 遺傳相關과 性別 成長率에 關한 研究

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## 摘　要

本 研究는 서울大學校 農科大學 實驗牧場에서 飼育되었던 Broiler 種鷄 3 系統에 대하여 二面交雜을 實施하고 여기에서 作出된 9個 交配組合의 資料를 利用하였다. 總 32首의 父家系와 209首의 母家系에서 生產된 1,109首의 암·수탉을 供試하여 얻어진 結果는 다음과 같다.

1. 交配組合, 集區, 性別에 對한 分散分析은 모두 高度의 有意性 ($P < 0.01$)이 認定되었다.

2. 父母 結合分散成分에 의한 遺傳力은 2,4,6 및 8週齡 體重에서 各各 0.32, 0.31, 0.35 및 0.29로 推定되었다.

3. 2,4,6 및 8週齡의 體重에 對한 相關分析에서 2週齡과 8週齡에서는 0.72의 遺傳相關과 0.35의 낮은 表現型相關을 보였으며, 4週齡과 8週齡에서는 0.91 및 0.61의 遺傳相關과 表現型相關을 보였다. 또한 6週齡과 8週齡에서 0.94의 높은 遺傳相關 및 0.78의 表現型相關이 推定된 結果 broiler 種鷄 交雜試驗에 있어서 4週齡 및 6週齡 體重을 利用하여 8週齡 體重에 대한 早期判定의 可能性을 보였다.

4. 2週齡부터 8週齡까지 broiler 成長을 多項回歸에 適合시킨 結果 全體平均에 의한 것이 $W = -141.13 + 30.575D + 0.161D^2$ (단 $14 \leq D \leq 56$), 암컷은 $W = -228.42 + 29.886D + 0.126D^2$ (단, $14 \leq D \leq 56$), 수컷은 $W = -257.14 + 31.474D + 0.202D^2$ (단, $14 \leq D \leq 56$)으로 推定되었다 (W: body weight, D: days of age). 이들 모두 $R^2$가 0.99 이상 高度의 適合度를 보였으며, 2週齡時 8.36 g의 암수 體重差異에서 週齡이 經過함에 따라 68.08 g (4週齡), 169.99 g (6週齡), 293.19 g (8週齡)의 性에 의한 差異가 크게 나타났다.

따라서 암수 混合飼育時에는 性에 대한 效果가 적은 系統의 組合으로 選拔이 考慮되어야 하며, 또한 出荷時 體重에 따라 分離飼育하는 것이 바람직하다.


## I. Introduction

The genetic relationship between traits measured on 4-, 6-, and 8-week old broiler chickens is useful to poultry breeders because it provides information for selection of broiler breeders at early age.

Peeler et al. (1954) obtained an estimate of 0.79 for the genetic correlation between body weight (6 to 12 weeks of age) and mature weight (24 to 36 weeks of age) in the broiler population. Pym and Nicholls

(1979) gave genetic correlations of 0.82 and 0.94 from sire and dam variance components between 5- and 9- week body weights. Noah Aman et al. (1983) reported 0.58 for the genetic correlation between 6- week old live weight and 7- week old live weight. From anyone of these studies one could not investigate genetic correlations among biweekly body weights over time periods from 2- to 8- weeks of age.

The objective of these studies were to determine the genetic correlations of live weights among 2-, 4-, 6-, and 8- week old broilers, and to investigate the growth rates for male and female in mixed-sex population.

## II. Materials and Methods

Table 1. The combinations of 3×3 diallel crosses and the number of progeny in each combination

| Line of sire | Line of dam A | Line of dam B | Line of dam C |
|---|---|---|---|
| A | A $\frac{(4,8)}{74}$ | D $\frac{(4,8)}{156}$ | E $\frac{(4,8)}{148}$ |
| B | G $\frac{(4,8)}{131}$ | B $\frac{(4,8)}{119}$ | H $\frac{(4,8)}{151}$ |
| C | I $\frac{(3,8)}{119}$ | K $\frac{(3,8)}{120}$ | C $\frac{(3,8)}{127}$ |

Upper figures in the parentheses are the numbers of sires and dams per sire respectively.
Under figures are the numbers of progeny for each combination type.

A population of progeny from diallel crosses of broiler breeder strains which were reared in 3- tier cages from october 20 to december 15, 1980, at the College of Agriculture, Seoul National University, were used in this study. The mating combinations and the number of sires and dams per sire were presented on Table 1. The experimental layout was the randomized block by blocking the 3 tiers.

From the population a total of 1,109 broilers from 32 sires and 209 dams with unequal size per cell were finally used.

Feed and water were available ad libitum. Other feeding and management system progressed according to the broiler feeding program.

The nonlinear equation for growth rate from 2 wks to 8 wks was:

$$W = a + bD + cD^2$$

where D; chick age in days,

W: live weight in grams,

For the genetic analysis Least-squares by Harvey(1966) were used to correct for cross effect, block effect, and sex effect. The model was:

$$Y_{ijkl} = \mu + CR_i + BL_j + SE_k + e_{ijkl}$$

where Y(ijkl) is observation of individual; $\mu$, population mean; CR, cross effect; BL, block effect; SE, sex effect; e(ijkl), random error assumed to be NID(O, $\sigma^2$).

The method of estimating heritability was by variance component analysis. The linear model of nested classification with full sib progeny within dams within sires (King and Henderson, 1954b) was:

$$Y_{ijk} = \mu + S_i + D_{ij} + e_{ijk}$$

where Y(ijk) is observation of the k-th progeny from the j-th dam and i-th sire; $\mu$, population mean; S(i), effect of the i-th sire; D(ij), effect of the j-th dam mated to the i-th sire; e(ijk), effect of the k-th progeny within the j-th dam and i-th sire, assumed to be NID(O, $\sigma^2$).

Genetic correlation from combined sire and dam component of variance and covariance was estimated as COV(gi.gj)/$\sqrt{Vgi.Vgj}$, where COV(gi.gj) is genetic covariance between traits i-th and j-th: Vgi, Vgj is genetic variance for i-th, j-th trait (Backer, 1975).

## Ⅲ. Results and Discussion

Least-squares means and standard errors for body weights and their analysis of variance, which was performed using a fixed model in which cross, block, and sex were regarded as fixed effects and error as a random effect, were presented in Table 2 and Table 3 respectively. The live body weights of crosses had ranges 208.25-235.18 g, 684.76-788.39, 1254.64-1404.52, and 1892.49-2068.01 for the 2wks, 4wks, 6wks, and 8wks respectively. Least squares mean differences of body weights between male and female were 8.36, 68.08, 169.99, and 293.19 g for the 2 wks, 4 wks, 6 wks and 8 wks respectively. At all ages males were heavier than females. From the analysis of variance all of the effects cross, block, and sex were shown highly significant at 1% level for the each biweekly body weights. As for the block effect, it was considered that tiers of cage gave some influence

Table 2. Least-square means and standard errors for body weights for each crosses, blocks and sexes

(unit : gr)

| Items | | 2 wks | 4 wks | 6 wks | 8 wks |
|---|---|---|---|---|---|
| Cross | A | 215.96 ± 2.36 | 725.96 ± 8.08 | 1352.31 ± 13.39 | 2068.01 ± 18.78 |
| | B | 226.40 ± 1.71 | 717.34 ± 5.85 | 1355.61 ± 9.70 | 2052.31 ± 13.61 |
| | C | 209.03 ± 1.74 | 684.76 ± 5.95 | 1296.06 ± 9.86 | 1910.46 ± 13.83 |
| | D | 228.64 ± 1.85 | 765.83 ± 6.32 | 1371.98 ± 10.48 | 2027.70 ± 14.71 |
| | E | 235.18 ± 1.90 | 783.98 ± 6.48 | 1390.33 ± 10.74 | 2051.08 ± 15.08 |
| | G | 216.78 ± 1.71 | 719.57 ± 5.84 | 1302.98 ± 9.67 | 1898.36 ± 13.57 |
| | H | 217.03 ± 1.90 | 767.28 ± 6.48 | 1348.38 ± 10.74 | 1997.74 ± 15.07 |
| | I | 228.24 ± 1.95 | 788.39 ± 6.67 | 1404.52 ± 11.06 | 2039.83 ± 15.52 |
| | K | 208.25 ± 5.37 | 717.27 ± 18.37 | 1254.64 ± 30.45 | 1892.49 ± 42.72 |
| Block | 1 | 222.06 ± 0.93 | 756.67 ± 3.16 | 1371.48 ± 5.24 | 2015.09 ± 7.36 |
| | 2 | 222.35 ± 0.93 | 747.75 ± 3.19 | 1347.54 ± 5.29 | 1994.54 ± 7.43 |
| | 3 | 217.43 ± 1.32 | 717.37 ± 4.50 | 1306.59 ± 7.45 | 1968.70 ± 10.45 |
| Female | | 216.43 ± 0.66 | 706.56 ± 2.27 | 1256.87 ± 3.76 | 1846.52 ± 5.28 |
| Male | | 224.79 ± 0.66 | 774.64 ± 2.27 | 1426.86 ± 3.76 | 2139.71 ± 5.28 |

Table 3. Analysis of variance

| S. V. | D. F. | MS | | | |
|---|---|---|---|---|---|
| | | 2 wks | 4 wks | 6 wks | 8 wks |
| Cross | 8 | 10833.95 | 168111.38 | 280740.56 | 647579.75 |
| Block | 2 | 2778.84 | 155777.72 | 396938.00 | 208103.75 |
| Sex | 1 | 19035.13 | 1262486.25 | 7872575.00 | 23418048.00 |
| Error | 1097 | 480.77 | 5617.77 | 15430.48 | 30374.62 |

All effects are significant at 1% level in each biweekly body weight.

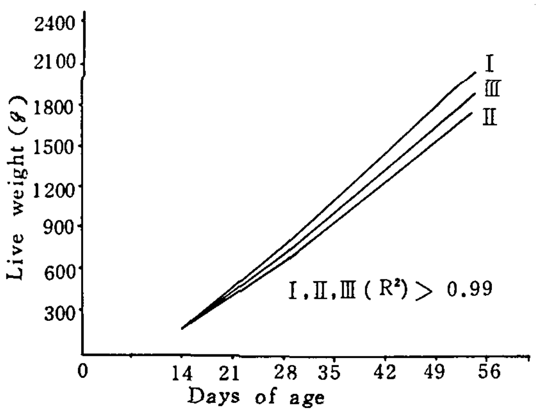
Table 4. Genetic correlation coefficients estimated from combined genetic variance and covariance components and phenotypic correlation coefficients estimated from phenotypic variance and covariance components

| Item | 2 wks | 4 wks | 6 wks | 8 wks |
|---|---|---|---|---|
| 2 wks | 0.32 | 0.84 | 0.73 | 0.72 |
| 4 wks | 0.64 | 0.31 | 0.93 | 0.91 |
| 6 wks | 0.49 | ⁻0.77 | 0.35 | 0.94 |
| 8 wks | 0.35 | 0.61 | 0.78 | 0.29 |

Above diagonal : genetic correlation coefficients
On diagonal: heritability estimates
Below diagonal: phenotypic correlation coefficients

on the broiler body weight.

The heritabilities, genetic and phenotypic correlations were presented on the Table 4. Heritability estimates derived from combined variance and covariance components were 0.32, 0.31, 0.35 and 0.29 for the 2 wks, 4 wks, 6 wks and 8 wks body weights respectively. These estimates agreed closely with the estimates reported by Peeler et al. (1954). The genetic correlation coefficients were 0.91 between 4 wks and 8 wks, 0.94 between 6 wks and 8 wks body weights. These estimates were agreed closely with those found by Pym and Nicholls (1979) between 7- and 9- weeks body weights but high estimates compared to those of Noah Aman (1983). The genetic correlation coefficients obtained in these experiments indicate the possibility of using 4- and 6-week old broiler in selection program designed to improve 8- week body weights.




I : $W = -257.14 + 31.474D + 0.202D^2$

II : $W = -228.42 + 29.886D + 0.126D^2$

III : $W = -241.13 + 30.575D + 0.161D^2$

Fig. 1. Typical growth rate for male (I), female (II) and mixed-sexed (III) broiler chickens from 14 days to 56 days of age.

Broiler growth types from 2 wks to 8 wks of age were shown in Fig.1. When fitting the 2wks, 4 wks, 6 wks and 8 wks mean body weights to the nonlinear equations for male and female respectively they showed differences in growth rates for both linear and quadratic terms. At all ages males grew at a faster rate than females. These models were not allowed for the extrapolations except from 2 wks to 8 wks. Even though both sexes showed closely equal body weights at 2wks of age, they manifested great difference about 300 g at 8 wks of age. As for the point af peak gain, this model could not give explanation but Tzeng et al. (1981) reported that the age of peak gain per day in male broiler chickens were 44 days. Because of their rapid growth rate, it might be profitable to raise male broiler to the roaster weight. For the female as the other half of hatch population there might be some feasibility of marketing as broiler purpose at early age in mixed sex population. For the other alternative as suggested by Hulan et al. (1982) is to rear together and to market male and female separately under several stage feeding program. From the point of competition for feed and other effects of interactions between male and female it might be economical to raise male and female broilers separately for the marketing weights. On the other hand it may be more profitable to select the combination of lines which has little sex effect.

## IV. Summary


This study was carried out to estimate genetic correlations among broiler body weights for the selection of broiler breeders at early age, and to investigate the difference of growth rates between male and female in mixed-sex population of broiler from 2 wks to 8 wks of age.

A total of 1109 records were used in this study. the heritability estimates from combined variance components for 2-, 4-, 6- and 8- weeks body weights were 0.32, 0.31, 0.35 and 0.29 respectively. Genetic correlations were 0.91 between 4wks and 8wks body weights, 0.94 between 6wks and 8wks body

weights. Records obtained on 4 wks and 8 wks might be useful in a selection program to improve traits in 8 wks broiler weight. Growth rates of male and female from non-linear equations from 2 wks to 8 wks were shown differently in both linear and quadratic terms. Even though both sexes showed closely equal body weights at 2 wks of age, they manifested great difference about 300 g at 8 wks of age. At all ages males were havier, grew at a faster than than female. From this result it might be profitable either to select the combination of lines which has little sex effect or to rear male and female broiler separately up to the marketing body weights.

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