Effect of Selection of Japanese Quails for Rapid Growth on Immune Function

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This experiment was conducted to study the effect of selection for high four weeks body weight of Japanese quails on antibody titers against inactivated NDV vaccine. A total of 582 birds were used as a base population from which 40 sire families (half sib mating) with ratio 3:1 were selected to be parent for new generation, birds were weighed individually at four weeks of age. Birds of both sex had the highest body weights were selected to be the parents for three successive generations and vaccinated intramuscularly with inactivated NDV vaccine (blood samples were collected at 15, 21 and 28 days post vaccination. Heritability estimates of body weight were 0.48, 0.15 and 0.44 for generation 1, 2 and 3; respectively. Whereas the corresponding values for antibody titers against inactivated NDV were 0.48, 0.80 and 0.46 for generation 1, 2 and 3; respectively, 0.32, 0.21 and 0.08 and 0.45, 0.18 and 0.31; respectively. Significant correlations between body weight and antibody titers were found as -0.8 (21 days), -0.7 (15 days), -0.88 (21 days), for generation 1, 2 and 3; respectively.

It was concluded that improving of body weight by genetic selection lowers resistance to Newcastle disease.

1. INTRODUCTION:

Growth is a priority trait in poultry industry and most researchers tended to made selection for high body weight with the ignorance of traits that are negatively correlated with body weight. Japanese quails (Coturnix coturnix japonica) have been used widely as a pilot bird for poultry breeding and genetics of growth traits, because they are small, less expensive than chickens and turkeys, have a short generation interval and show genetic variation for growth traits in most populations (Wilson et al., 1961; Marks, 1990).

Selection experiments provide the framework for the study of the inheritance of complex traits, short-term experiments for example, can be used to estimate genetic variances and covariance, test their consistency from different sources of information, and estimate the magnitude of the initial rates of response to selection (Martinez et al., 2000).

Body weight in poultry is known to be moderately to highly heritable trait therefore the selection of heavier individuals should result in the genetic improvement of the trait (Oke et al., 2004).

However, the rapid growth is usually associated with fitness benefits. In commercial settings, fast-growing animals are usually more profitable. However, accelerated growth can also have detrimental effects, because it requires resources that cannot be spent on other vital traits. Similarly, although the benefit of an effective immune system is obvious, the wide spread susceptibility to disease suggests there may be downsides as well. This indicates that immune function also should be treated as a trait that needs to be optimized Evans, 2000; Zuk and Stoehr, 2002.

Brah et al., (2001); Khakkari et al., (2010); Mehrgardari (2013), found that response to selection increase with generation. Meanwhile Marks, 1978 indicated that changing the selection environment following long-term selection may be an effective technique to maximize total selection responses for 4-week body weight in quail after carrying out an experiment on 4 line of quail found that in the line 1 selected on an adequate 28% protein diet continued to respond to selection for 40 generations.

Heritability estimate exhibited decreasing trend form 0.39 in first generation to −0.01 in fourth generation of selection for high body weight at the age of 5 weeks in Japanese quails (Metodiev and Drbohlav 1998). Realized heritability for body weight at 35 day of age for H and L males in the 2nd generation was 0.43 and 0.35, while they were 0.50 and 0.55 for the H and L females. Body weight of the 2nd generation H and L females were 118.64 and
Realized heritability for 4-wk BW was 0.55, reflecting the accuracy of selection. However, the estimated heritability by using pedigree information was 0.26 (Khalkari et al., 2010). Most studies demonstrated an inverse relationship between growth rate and development of components of the avian immune system.

Correlation between body weight and immune response studied by Li et al., 2001 who carried out an experiment to study the influence of selection for increased 16-wk BW in turkeys on in vivo phagocytic activity, antibody responses to vaccines, and weight of the spleen and bursa of Fabricius by using two lines A line (F) of turkeys selected long term for increased 16-wk BW and random bred control (RBC). He suggested that long-term selection for increased 16-wk BW might have resulted in changes in the immune system, as indicated by changes in the relative weights of the spleen and bursa of Fabricius and phagocytic activity. The decreased phagocytic activity in the F line may be partially responsible for increased susceptibility to specific diseases in this line. However, there were no line differences in the antibody responses to Newcastle disease virus at 1, 2, 3, 4, 5, or 12 weeks after vaccination.

Parmentier et al. (1996) observed that there was a negative phenotypic correlation within lines between body weight at 17 weeks of age and antibody titers at one week after sensitization was found, but no further correlations between humoral responses and body weight or growth could be established.

Sacco et al., (1994) estimated the primary and secondary antibody responses of 671 turkeys of two genetic lines to Newcastle disease virus (NDV) and Pasteurella multocida vaccines RBC line and (F) line selected for increased 16-week body weight and found that Line F turkeys had significantly higher 9-week and 15-week serum antibody titers to NDV than line RBC2. However, line RBC2 had significantly higher serum antibody titers to P. multocida at 15 weeks of age than line F. So, this study aimed to evaluate the effect of selection of Japanese quails for rapid growth on immune function.

2. MATERIAL AND METHODS:
2.1. Quail families and vaccination:
This experiment was conducted at Animal Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, Alexandria University, in order to estimate genetic parameters of four week body weight of Japanese quail as a response to selection. Records of 160 animals with 40 sires and 120 dams were used for this purpose. A base population of 582 day old quail chicks was the start point. Chicks were wing banded and at the age of 4 weeks, each bird was weighed and only 40 males and 120 females having the highest body weight were vaccinated intramuscular with inactivated NDV vaccine and picked to be the parents of next generation.

At the age of five weeks, these birds were shifted to the breeding house and at the days of 15, 21 and 28 post vaccination blood samples were collected in centrifuge tube from wing vein to obtain serum for measuring antibody titer to inactivated NDV vaccine. Eggs were collected during this period and set in the incubators in order to obtain day-old chicks. This procedure was repeated for three generations.

2.2. Management and housing:
All the experimental birds were maintained in cages specially made for separate rearing and breeding. The eggs were collected daily, numbered according to their sire families and incubated weekly in a proportionate cabinet having separate arrangements for setting and hatching of eggs. After hatching the day old chicks were wing banded according to their sire families and then transferred to brooder house. Fresh and clean drinking water was provided. The growing chicks were fed broiler starter ration ad-libitum.

2.3. Statistical Model:
The analysis of variance for the obtained data was performed using SAS software using one way ANOVA test. The significance between the means was tested using Duncan's multiple range tests at the 0.05 level of significance. Following model was used for determination of average body weight of selected progeny in different generation:

\[ Y_{ij} = \mu + s_i + g_j + e_{ij} \]

where:
- \( Y_{ij} \): Average body weight of selected progeny
- \( \mu \): the population mean
- \( s_i \): effect of \( i \)th sire family
- \( g_j \): genetic effect of \( j \)th generation of selection
- \( e_{ij} \): Error term

Response of selection was calculated by:

\[ R = \text{average of } i+1^{\text{th}} \text{ generation} - \text{average of } i^{\text{th}} \text{ Generation} \]

Also, some genetic parameters was estimated as following: Heritability (narrow sense heritability) by variance components

\[ h^2 = \frac{4S/G}{h^2} \]

where:
- \( S \): sire variance and \( G \) total variance

Realized heritability = selection response

\[ = \text{average of } i+1^{\text{th}} \text{ generation} - \text{average of } i^{\text{th}} \text{ generation} \]
average of progeny − average of selected parents
Regression equation was calculated
Y^ = bx + a  (Chatterjee and Hadi, 2006)
Where:     Y^:   predicted values  of  dependent
variable                    b:  regression value
x:  independent  variable      a:  Y  intercept
Correlation values  were  calculated by
rxy= cov (X,Y) /σXσY

3. RESULTS AND DISCUSSION
3.1. Selection response

Responses to selection for 4week body weight after selection for three generations were
presented in Table 1. The mean of body weight of selected lines at the base, first and second
generation was 165, 172 and 195; respectively. The mean of body weight of selected birds at third
generation were 200. It was 52% of the cumulative genetic improvement.

Results showed that genetic improvement in body weight was 18, 12 and 22 for first, second and third
generations; respectively. Improvement of response to selection depends on selection intensity, selection accuracy
and genetic variance; and optimal response to selection is obtained by maximizing these factors,
but it is not simultaneously possible. In selection experimental, by increasing in alleles frequency for
traits under selection, genetic variation is decreased, hence inbreeding is inevitable. Short-term selection is
often performed with high selection intensity and usually genetic improvement is high. It should be
noted that the selection intensity is not the same in different generations.

This study showed that the response to selection for high body weight was consistent with
that noted by Khaldari et al., 2010 who found that 4-wk body weight increase with 9.6, 8.8, and 8.2 g in
generations 2, 3, and 4, respectively.

Mehrgardi (2013) observed that mean BW at 4 weeks of age in the base generation was 186.2
and 178.6 g for females and males. In the 3rd generation, the mean of 4-wk BW for male and
female birds was 214.5 and 208.1 in the HW line.

Higher body weight in selected birds were also reported in other studies as well Collins and Abplanalp, 1968; Anthony et al., 1986; Siegel, 1987 and Khaldari et al., 2010.

3.2. Heritability of body weight:

Heritability for particular trait can take different values according to population, environmental condition surrounding the animal and calculation method (Falconer, 1960). Also, differences in heritability may be due to method of estimation, population genetic structure, environmental effects and sampling error from small data set or sample size (Prado-Gonzalez et al., 2003).

Heritability and realized heritability of body weight obtained from sire variance component are
showed in Table 2. Heritability estimate in the base population was high (0.51) also found to be high in the first and third generation and was 0.48 and 0.44 respectively; While it was medium estimate in generation two (0.15). In the control line, heritability estimate ranged from 0.27 to 0.41 with an average estimate 0.34.

Realized heritability is calculated as ratio of selection response to selection differential. The results showed that realized heritability for four weeks body weight after selection for three generations was 0.72, 0.85 and 0.88 for first, second and third generations, respectively (Table 2) with an average estimate of 0.82. Realized heritability increased with generation and this may be due to greater response to selection.

The present realized heritability for four weeks body weight after selection for three generations are in agreement with the results of other researchers (Momoh et al. 2014) But differed from the results reported by Marks, 1996 and Narayan et al., 1996.

<p>| Table 1: Population means, selected mean, selection differential and response to selection across three generation (gram) |
|-------------------------------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Generation</th>
<th>Population Mean</th>
<th>Selected Means</th>
<th>Selection differential</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>140</td>
<td>165</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>One</td>
<td>158</td>
<td>172</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Two</td>
<td>170</td>
<td>195</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>Three</td>
<td>192</td>
<td>200</td>
<td>8</td>
<td>-</td>
</tr>
</tbody>
</table>
3.3. Genetic correlation between four weeks body weight and antibody titer against inactivated Newcastle disease virus vaccine:

Genetic correlation between four weeks body weight and antibody titer against inactivated Newcastle disease virus vaccine found to be moderate to low at 15 day post vaccination while it was very high at day 21 and 28 post vaccination also found to be over estimate at generation 2 at day 21 and 28 post vaccination.

Table 2: Heritability estimates of body weight at 4-weeks body weight from sire variance component and realized heritability across three generation of selection.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Heritability by variance component</th>
<th>Realized heritability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SL</td>
<td>RBCL</td>
</tr>
<tr>
<td>One</td>
<td>0.48</td>
<td>0.27</td>
</tr>
<tr>
<td>Two</td>
<td>0.15</td>
<td>0.36</td>
</tr>
<tr>
<td>Three</td>
<td>0.44</td>
<td>0.41</td>
</tr>
<tr>
<td>Overall average</td>
<td>0.36</td>
<td>0.35</td>
</tr>
</tbody>
</table>

SL = selected line RBCL = random bred control line

The present results indicated that selection for high body weight adversely affect immune response to inactivated NDV vaccine similar results were obtained by Brommer, 2004; Soler et al., 2003; Swain and Johri, 2000; Tsiagbe et al., 1987 whom observed that there was a negative correlation between body weight and immune response to different pathogen.

The present results stand in contrast to the many studies that have measured immune function at the end of chick development and found that chicks in better body condition are better able to respond to immune challenges.

Table 3: Genetic correlations between four weeks body weight and immune response during three generations of selection.

<table>
<thead>
<tr>
<th>Period post vaccination (days)</th>
<th>15</th>
<th>21</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four weeks Body eight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generation 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antibody titer</td>
<td>-0.1</td>
<td>-0.8</td>
<td>-0.79</td>
</tr>
<tr>
<td>Generation 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.7</td>
<td>-1.4</td>
<td>OE</td>
</tr>
<tr>
<td>Generation 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.05</td>
<td>-0.88</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

Figure 1: Antibody titer against INDV vaccines 2, 3 and 4 week post vaccination the first generation of selection for high 4 week body weight.
Figure 2: Antibody titer against INDV vaccine 2, 3 and 4 week post vaccination across the second generation of selection for high 4 week body weight.

Figure 3: Antibody titer against INDV vaccine 2, 3 and 4 week Post Vaccination across the third generation of selection for high 4 week body weight.

4. CONCLUSION
Selection of Japanese quails for rapid growth unintentionally resulted in reduction in immune function.

5. ACKNOWLEDGEMENT
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6. REFERENCES


