ESTIMATION OF ADDITIVE, DOMINANCE AND HERITABILITY OF SOME EGG PRODUCTION TRAITS IN EGYPTIAN LOCAL STRAINS OF CHICKEN

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ABSTRACT: Egg production in poultry shows considerable individual variation over the laying period. Evaluation and selection of Egyptian local strain of chicken had been carried out. The aim of the present study was to estimate additive, dominance, heritability for some egg production traits and to determine the best strain based on multiple egg production traits. The four strains showed that Mandrah strain was ranked first, Doki-4 was ranked second, the strain Inshas was ranked third and El-Salam was ranked last in the performance of some egg production traits. The estimate additive genetic variance accounted a major part of the total genetic variance for sexual maturity, mature egg weight, early egg weight, number of eggs at 90 d of laying, egg mass at 90 d of laying and body weight at sexual maturity. The estimates of dominance genetic variance in these traits was relatively negative and low. The estimated heritability was almost 0.4 for all egg production traits studied. The present results showed clearly that Mandrah local strains of chicken may considered the fitting strains that play an important role in improving egg production.

Key words: Additive, Dominance, Heritability, Egg production, Egyptian local strain.
INTRODUCTION
One of the important protein resources is poultry protein (meat and eggs). Most of the Egyptian consumers still prefer eggs from local strains. The productivity of the local strains is genetically low. Studying egg production and its related traits such as age and body weight at sexual maturity, rate of laying and clutch size attracted the attention of many researcher when they found that there were wide variation in these traits between different breeds and/or strains of chickens (EL-Labban et al., 1991; Iraqi et al., 2007). Many investigators showed that more genetic gain could be obtained in egg production when using individual recording (Ezzeldin and Mostageer, 1984; Hanafi and EL-Labban, 1984). The heritability estimates help us to predict the effect of selection on any of performance traits and to select a suitable breeding and selection method in population. Many investigators reported that there were a lot of variations in egg production traits according to the differences of the genetic make-up (Khalil et al., 2004; Nugriartingsih et al., 2004; Chih-Feng Chen et al., 2007). Several reports have been discussed the relative importance of additive and non-additive variations upon productive traits (Khalil et al., 1999; Iraqi et al., 2000; Nawar and Bahie El-Deen, 2000 and Iraqi, 2002) they reported that the Egyptian strains of chicken had high additive and non-additive genetic variations appeared among them. Although, Fairfull and Gowe, 1990; Wei et al., 1991a,b; Gengler et al., 1997; Palucci et al., 2007 and Norris et al., 2010 reported that non additive effects have a substantial contribution to variation of economic traits. Mixed model equation was used to estimation genetic parameters and genetic evaluation including matrices of additive genetic and dominance relationships (Henderson, 1976; Boldman et al., 1993; Gilmour et al., 2000). The BLUP is an effective way of ranking and selecting animals given measurements on multiple traits of their own performance and information of their relatives (Xie and Xu, 1996). The aim of the present study was to estimate additive, dominance, heritability for egg production traits and to determine the best strain based on multiple egg production traits. These information's helps breeders to employ suitable breeding program for improvement.

MATERIALS AND METHODS
The present experiment had been carried out at Sakka Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt.

Experimental Stock and Design: Data used in the present study were extracted from a flock of Mandrah, Doki-4, El-Salam and Inshas hens. Measurements were recorded on 105, 110, 105 and 105 laying hens in the four strains, respectively. The individual egg production was recorded daily from start of lay to 5 months of production. The pullets were fed a commercial layer ration (16.5 % CP and 2750 Kcal) and received 16 hr day light. The eggs were recorded and weighed daily through the experimental period.

Studied traits: The traits which construct the phenotypic variance-covariance matrices are: Egg production traits were studied, age at sexual maturity (SM), body weight at sexual maturity (BWSM), number of eggs at 1st 90 d of laying (EN90), average egg weight at sexual maturity (EW1), mature egg weight (EW2) and egg mass throughout the 1st 90 d of laying (EM).

Statistical Analysis: The data were set up to Mixed Model Equations for the estimation of variance components according to Olsen et al. (2006).

The model in matrix notations was:
\[ Y = Xb + Zu + e \]

Where: Y is the vector of observations, b and u are the vectors of fixed and random effects, with their respective incidence matrices X and Z, and e a vector of random environmental effects.
Additive, Dominance, Heritability, Egg production, Egyptian local strain

\[
E = \begin{bmatrix}
Y \\
a \\
d \\
e
\end{bmatrix} = \begin{bmatrix}
Xb \\
0 \\
0 \\
0
\end{bmatrix}
\]

\[
V = \begin{bmatrix}
Y \\
a \\
d \\
e
\end{bmatrix} = \begin{bmatrix}
V_{\text{dom}} \\
Z'A_{\sigma^2a} \\
Z'D_{\sigma^2d} \\
I_{\sigma^2e}
\end{bmatrix}
\]

Where: \( V_{\text{dom}} = z (A\sigma^2a + D\sigma^2d) z' + I\sigma^2e \), \( \sigma^2d \) is the dominance genetic variance; \( A \) and \( D \) are the additive and dominance animal relationship matrices, \( \sigma^2e \) is the random environmental variance and \( I \) is an identity matrix.

Heritability was computed according to Boldman et al. (1995).

\[
h^2 = \frac{\sigma^2A}{\sigma^2A + \sigma^2e}
\]

Where: \( h^2 \) is the heritability, \( \sigma^2A \) is the additive genetic variance, \( \sigma^2e \) is the random environmental variance.

The best linear unbiased prediction solutions for fixed and random effects by solving the usual Mixed Model Equations given by (Henderson, 1975; 1984). \( \lambda \) is the ratio \( \sigma^2e/\sigma^2u \)

The (Co) variance estimates were obtained with REML individual animal model using the DEREML software (Meyer, 1989).

RESULTS AND DISCUTIONS

Performance of the strains: Performance of the four strains were given in Table 1, shows that Mandrah strain was ranked first in the performance of some egg production traits were 181 d, 1398 g, 39 g, 25 egg, 40 g and 1015 g, for sexual maturity (SM), body weight at sexual maturity (BWSM), early egg weight at sexual maturity (EW1), number of eggs at 90 d of laying (EN90), average egg weight at maturity (EW2) and egg mass (EM), respectively. Also as seen in Table 1, that Doki-4 strain had 186 d for (SM), 1337 g for (BWSM), 37 g for (EW1), 26 (EN90), 38 g for (EW2) and 987 g foe (EM), so Doki-4 was ranked second. Moreover, the strain Inshas was ranked third, since it showed 187 d for (SM), 1427 g for (BWSM), 39 g for (EW1), 24 egg for (EN90), 40 g for (EW2) and 947 g for (EM). Table 1, showed the strain El-Salam was ranked last, it showed 185 d for (SM), 1387 g for (BWSM), 40 g for (EW1), 18 egg foe (EN90), 42 g for (EW2) and 754 g for (EM),
respectively. These results showed clearly that Mandrah local strains of chicken was considered to be fitting strains that play an important role in improving egg production traits. The results were agreed with findings of (Kosba and Abd El-Halim, 2008 for egg number and egg mass at 90 d of production. Factors Affecting Some Egg Production Traits: The differences between replicates and genotypes were presented in Table 2, revealed that all egg production traits studied were statistically significantly differ (P<0.01) in between genotypes. The differences between replicates were significant for sexual maturity (SM) and highly significant for body weight at sexual maturity (BWSM) and highly significant for egg number at 90 d, of laying (EN90). In addition, Mandrah strain had highly significant differences for (SM), (BWSM) and (EN90), respectively. Unlike, early egg weight at sexual maturity (EW1), average egg weight at maturity (EW2) and egg mass at the first 90 d, of laying (EM) were insignificant differences. Doki-4 had highly significant differences for (SM) and (EN90) while, (EW2) was significant differences. Unlike, (BWSM), (EW1) and (EM) were insignificant differences. El-Salam had highly significant differences for (BWSM) and the other traits were insignificant differences. Inshas was highly significant differences for (EW1) and (EW2) and the other traits were insignificant differences. These findings of variations for egg production traits may be attributed to adaptability to the environment and genetic variations among and within breeds (Cole, 1972; Fredeen, 1972 and Okon, 2008).

Genetic Variance Components And Heritability Estimates: The estimates of additive σ²A, dominance σ²d, random environmental σ²e variations and heritability estimates h² for some egg production traits were presented in Table 3, it pointed out that additive genetic variance (σ²A) accounted a major part of the total genetic variance for (SM) 23657618393, (EW2) 61635109, (EW1) 45019734, (EN90) 2640192.8, (EM) 8.6553 and (BWSM) 8.0462. The estimates of dominance genetic variance (σ²d) in these traits was relatively negative and low -3784934159, -9850664, -7146878.3, -402912.9, -1.33028 and 1.2715, respectively. These results indicate that additive genetic variance may be a common in the inheritance of these trait. This conclusion dealt with those cited by (Abou El-Ghar and Abdou, 2004 and Abou El-Ghar, 2005). The observed estimates of random environmental variation (σ²e) were -85870517.2, -229250, -193661.8, -6.1017 and -3.77827, respectively. The same findings was cited by (Shebl et al., 1990 and Zaky, 2005). The heritability estimates for egg production traits were presented in Table 3, it showed that h² estimated were 0.4 for all egg production traits studied. The results were agreed with findings reported by (Quadeer et al., 1977; Venktramaiah et al., 1986; Wei et al., 1991a,b and Sang and Tae-Jun, 2005).

**Table (1):** Means and s.d of egg production traits and ranking the strains performance

<table>
<thead>
<tr>
<th>Trait</th>
<th>SM</th>
<th>BWSM</th>
<th>EW1</th>
<th>EN90</th>
<th>EW2</th>
<th>EM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandrah</td>
<td>181+17.9</td>
<td>1389+149</td>
<td>39+5.5</td>
<td>25+12.3</td>
<td>40+2.3</td>
<td>1015+509</td>
</tr>
<tr>
<td>Doki-4</td>
<td>186+18.2</td>
<td>1337+128</td>
<td>37+5.1</td>
<td>26+13.5</td>
<td>38+3.4</td>
<td>987+483</td>
</tr>
<tr>
<td>Inshas</td>
<td>187+14.3</td>
<td>1427+185</td>
<td>39+4.1</td>
<td>24+10.8</td>
<td>40+4.3</td>
<td>947+381</td>
</tr>
<tr>
<td>El-Salam</td>
<td>185+15.1</td>
<td>1387+179</td>
<td>40+5.6</td>
<td>18+11.5</td>
<td>42+3.6</td>
<td>754+532</td>
</tr>
</tbody>
</table>

SM = sexual maturity, BWSM = body weight at sexual maturity, EW1 = early egg weight at the first 90 d., of laying, EN90 = egg number at 90 d., of laying, EW2 = average egg weight at maturity, EM = egg mass at the first 90 d., of laying.
### Table 2: Significance of variations for some egg production traits

<table>
<thead>
<tr>
<th>d.f</th>
<th>Traits</th>
<th>S.O.V</th>
<th>Mandra</th>
<th>Doki-4</th>
<th>El-Salam</th>
<th>Insha-s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bet.Replicats</td>
<td>Bet.Genotypes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
<td>104</td>
<td>109</td>
<td>104</td>
</tr>
<tr>
<td>417</td>
<td>SM</td>
<td>219.15</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>14702.4</td>
<td>BWS M</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>NS</td>
<td>**</td>
</tr>
<tr>
<td>29.3</td>
<td>EW1</td>
<td>NS</td>
<td>**</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>122.4</td>
<td>EN90</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>NS</td>
<td>**</td>
</tr>
<tr>
<td>10.2</td>
<td>EW2</td>
<td>NS</td>
<td>**</td>
<td>NS</td>
<td>*</td>
<td>NS</td>
</tr>
<tr>
<td>320918.8</td>
<td>EM</td>
<td>NS</td>
<td>**</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

SM = sexual maturity, BWSM = body weight at sexual maturity, EW1 = early egg weight at the first 90 d., of laying, EN90 = egg number at 90 d., of laying, EW2 = average egg weight at maturity, EM = egg mass at the first 90 d., of laying.

### Table 3: Additive $\sigma^2A$, dominance $\sigma^2d$, random environmental $\sigma^2e$ mean squares and heritability estimates $h^2$ for some egg production traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>$\sigma^2A$</th>
<th>$\sigma^2d$</th>
<th>$\sigma^2e$</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>23657618393</td>
<td>-3784934159</td>
<td>-85870517.2</td>
<td>0.4</td>
</tr>
<tr>
<td>BWSM</td>
<td>8.0462</td>
<td>-1.2715</td>
<td>-3.77827</td>
<td>0.4</td>
</tr>
<tr>
<td>EW1</td>
<td>45019734</td>
<td>-7146878.3</td>
<td>-193661.8</td>
<td>0.4</td>
</tr>
<tr>
<td>EN90</td>
<td>2640192.8</td>
<td>-402912.9</td>
<td>-20042.4</td>
<td>0.4</td>
</tr>
<tr>
<td>EW2</td>
<td>61635109</td>
<td>-9850664</td>
<td>-229250</td>
<td>0.4</td>
</tr>
<tr>
<td>EM</td>
<td>8.6553</td>
<td>-1.33028</td>
<td>-6.1017</td>
<td>0.4</td>
</tr>
</tbody>
</table>

$\sigma^2A$ = additive genetic variance, $\sigma^2d$ = dominance genetic variance, $\sigma^2e$ = random environmental variance, $h^2$ = heritability estimates.
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الملخص العربي

تقدير التباين الوراثي المضضيف وتباعن السيادة والمكافئ الوراثي لبعض صفات إنتاج البيض في السلالات المصرية من الناحية المحلية

رضا شعبان أبو الغار و رجاء السيد عبد الكريم

معهد بحوث الحيوان – مركز البحوث الزراعية – وزارة الزراعة – مصر

إنتاج البيض في الدجاج يظهر فيه اختلافات فردية معقولة أثناء فترة إنتاج البيض. لتقدير وتقييم واختيار السلالات المحلية من الدجاج تم اعتماد تقدير التباين الوراثي المضضيف وتباعن السيادة والمكافئ الوراثي لبعض صفات إنتاج البيض وكذا تحديد أفضل سلالة في إنتاج البيض على أساس معرفة عدد صفات إنتاج البيض. وجد ترتيب إنتاجية السلالات المحلية كالتالي سلالة المندرة في المرتبة الأولى وسلالة دقي-4 في المرتبة الثانية وسلالة إنشاص في المرتبة الثالثة وسلالة السلام في المرتبة الأخيرة وذلك لبعض صفات إنتاج البيض. قدر التباين الوراثي المضضيف على أنه يمثل الجزء الأكبر من التباين الوراثي بالنسبة لصفات العمر عند النضج الجنسي وزن البيضة عند تمام النضج ووزن البيضة عند النضج الجنسي وعدد البيض عند 90 يوم من الإنتاج ووزن البيضة عند النضج الجنسي. وبلغت تقديرات التباين السائدية فيهما سالبة ومنخفضة بالنسبة لهذه الصفات. كما بلغت تقديرات المكافئ الوراثي 0.4 بالنسبة لصفات إنتاج البيض المدروسة. أوضح النتائج السابقة أن سلالة المندرة تعتبر مؤهلة من كل السلالات المحلية لتلعب دوراً في تحسين إنتاج البيض.