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GENETIC ANALYSES OF GENERATION MEANS FOR A CROSS BETWEEN TWO LOCAL BREEDS OF CHICKENS:

III- INHERITANCE OF EGG QUALITY IN F3 AND BACKCROSS GENERATIONS

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Abstract: *External and internal egg quality traits are the primary selection objectives of breeders to maximize the return of saleable eggs. In order to help for developing an effective improvement program for egg quality traits, performances of F_3 and backcrosses generations derived from crossing Gimmizah with Bandarah developed strains were used to estimate the components of genetic variability of egg quality traits in this experiment. The current results revealed that the differences between genetic groups were highly significant for all traits studied. Also the variations between F3 and Backcrosses were highly significant differences for egg weight, shell weight, yolk weight, albumin weight and yolk index, while shell thickness, egg shape index and Haugh unit were not significantly differ in the same trend. Moreover, the results revealed that most of egg quality characteristics had negative estimates of additive σ^2A and dominance σ^2d genetic variations. This may be due either to presence of many deleterious recessive genes were expressed largely or because of the very little genetic variation between the parental strains in egg quality traits. The average degree of dominance ($\bar{h}$) was varied from no dominance in shell weight to complete dominance of the low parent in yolk index and complete dominance of the high parent in albumin weight and egg weight, to over dominance of the low parents in Haugh unit and over dominance of the high parents in shell thickness, egg shape index and yolk weight, respectively.*

INTRODUCTION

Locally developed strains of chicken Gimmizah and Bandarah gained more appreciation among the rural areas due to their well adaptation to harsh environments and their high value of safety and healthy protein source. Basically, they are a dual purpose strains so, the eggs and meat quality are the most important factors for its popularization, although the production of such strains has not been achieved up to their maximum genetic potential. Because of egg quality is more importance price contributing factor in table and hatching eggs Stadelman (1977). Different internal and external egg quality characteristics are high importance in analyzing egg quality (Silversides and Scott, 2001). The most important external egg-quality characteristics are shell strength, which decreases with the age of the hen advancing. Concerning egg weight, the objective is to select towards an intermediate optimum which helps to maximize the percentage of eggs in the preferred weight range and good hatch. Shell color is also receiving attention, especially in brown-egg stocks, in response to consumer preferences of dark brown eggs. Traditional internal quality characteristics are albumen height and incidence of blood and meat spots which are to be minimized, while the important factors in measuring freshness of the eggs are thick albumen and air cell. Selection for higher yolk percentage and dry matter increased with increasing use of eggs for further processing. Several interrelationships are apparent between egg size, chick weight, chick growth, hatchability and consumer's acceptability (Wilson, 1991). The successful production of good quality of eggs need several factors should be considered i.e., breed, strain, variety, temperature, relative humidity, rearing practices and season (Sauter et.al. 1954 and Washburn 1990). Egg weight and proportion of albumen, yolk and shell were varied significantly between the strains of hens (Pandey et.al., 1986). Inherited differences between strains of White Leghorn in egg weight and shape index have been reported by Arafa et.al. (1982) and Carter and Jones (1970), respectively. Eisen and Bohren (1963) found it possible to list albumin quality as quantitative genetic traits. The proportion of albumin had high heritability and is controlled by additive multiple factors (Scheinberg et al., 1953). Eggs produced by the strain selected for live body weight were larger with proportionately more shell weight than the strains selected for growth rate and breast meat, respectively, whereas yolk and albumen did not differ by strain (Joseph and Moran, 2005). Nwachukwu et.al., (2006) reported that the reciprocal crosses Normal Local chicken x Exotic Broiler Breeder stock, Naked Neck x Exotic Broiler Breeder stock and Frizzle chicken x Exotic Broiler Breeder stock had significantly heavier egg weight at first egg, while shell thickness and yolk weight were not significantly differ ($p>0.05$) in all genetic groups, but Yolk index, Albumen weight and Hough Unit were significantly higher for the reciprocal crosses. Most of breeding programs put little selection pressure on shell quality possibly because of risk of diverting selection pressure away from egg production and egg weight (Hunton, 1982). Moreover, it is difficult to select for these traits within line because of there were very little variations among the hens within a line. In order to explore the genetic mechanism which controls the various affecting the performance of these strains and examine how best to model the trait for the purpose of genetic evaluation and selection for improvement, generation means analysis were used to study the performances of F_3 and backcrosses derived from crossing Gimmizah with Bandarah parental strains. The motive of this study was to estimate the components of genetic variability of egg quality traits that may help for developing the effective improvement programs.

MATERIALS AND METHODS

The present experiment had been carried out at El-Sabahiah Poultry Research Station, Animal Production Research Institute, Agriculture Research Center.

Experimental Design:

The two parental lines Gimmizah and Bandarah were crossed to produce F_1 crossbreds. Random mating of F_1 crossbreds used to form the F_2 generation. All F_3 progeny derived from intercrossing the F_2 families. At the same time the males of F_2 generation were randomly chosen and backcrossed with females of the two parental strains Gimmizah and Bandarah to produce F_2 backcross generations i.e. F_2 x Gimmizah (BC_1) and F_2 x Bandarah (BC_2). Three genetic groups i.e. F3, BC_1 and BC_2. Each group was randomly divided into 5 replicates they were kept in family pins each contains 12 layer hens. At the age of 42 weeks, a total number of 150 eggs were collected randomly from the three genetic groups 50 eggs for each genetic group to evaluate various external and internal egg quality traits. All managerial practices were similar as possible as throughout the experiment.

The Studied Traits:

Firstly the external characters like egg weight (EW) and egg diameter were recorded. Thereafter the eggs were broken and the other traits like shell weight (Sh.W), shell thickness (Sh.Th) including shell membranes was measured using a micrometer at three locations on the egg i.e. air cell, equator and sharp end, albumin weight (Al.W), yolk weight (Y.W), were recorded using standard procedure. Egg Shape Index % (E.Sh.I) Carter and Jones (1970), Yolk index % (Y.I) Funk (1948) and Haugh Unit score (HU) Haugh (1937) were calculated.

Statistical Analysis:

The data of egg quality traits, which derived from F3 and backcross generations were analyzed using analysis of variance appropriate for Complete Randomized Block Design with 5 Replicates. All percentages were first converted to arcsine transformation prior to statistical analysis. Partitioning of variance into its components and estimates of the components of genetic variance (σ^2A and σ^2d) were done by using the method of (Kearsey and Jinks, 1968).

The degree of dominance ($\hat{h}$) was estimated according to equations given by (Griffing, 1950). $(\hat{h}) = (\sigma^2d / \sigma^2A)^{0.5}$

σ^2A = additive mean square, σ^2d = dominance mean square.

RESULTS AND DISCUTIONS

***External egg quality traits*:**

It is obvious in Table (1) that the backcross that had Gimmizah dame (BC_1) had the heaviest egg weight and shell weight 51 and 6.6 g., compared with F_3 generation which ranked second (50 and 5.9 g.) and BC_2 which had Bandarah dame 46 and 5.6 g., respectively. The previous results were in agreement with those reported by Joseph and Moran, (2005) they showed that selection for live body weight of chicken can result in increased egg size with more proportionately shell weight. The contrasts are shown for shell thickness and egg shape index, where F_3 generation being the best among all genetic groups (35 mm., and 75 %, respectively). Whereas, shell thickness being similar in BC_1 and BC_2 31 mm., also F_3 generation had the same percentage of egg shape index as BC_2 75 %. It could be concluded that shell thickness decreased significantly as the breeder age advance. The same conclusion was reported by (Rayan et.al., 2010). Table (2) revealed that all the external egg quality traits were highly significant differences ($P<0.01$) in all genetic groups (genotypes), while the backcrosses were statistically differ significantly ($P<0.01$) for egg weight and shell weight, but did not differ significantly for shell thickness and egg shape index. The same trend was found within F_3 generation and the variation between F_3 generation and backcrosses for shell thickness and egg shape index. The genetic differences between strains for egg weight were reported by Carter and Jones (1970) and Arafa et al. (1982), also Nwachukwu et.al. (2006) found that shell thickness was not significantly differing among different genetic groups of chicken. Estimates of additive and dominance variations for external egg quality traits in F3 and backcross presented in Table 3, reflected negatively low estimate of additive genetic variations σ^2A (-3.1 and -0.92) and dominance variations σ^2d (-2.66 and -0.15) for egg weight and shell weight, respectively. These results suggested that the genetic variation for this trait was largely unexpressed or may be the environmental effects were large and masked observable genetic variation. The same conclusion was reported by (Cannings et al., 1978). The estimated degree of dominance ($\hat{h}$) 0.9 and 0.4 for egg weight and shell weight showed that the dominance was ranged from no dominance to complete dominance for shell weight and egg weight, respectively. Also Table 3, pointed out that dominance genetic variance σ^2d accounted a major part of the total genetic variance for shell thickness 0.002 and egg shape index 45.8, since the estimates of additive variance σ^2A in these traits were relatively low 0.001 and 16.7, respectively. The former results indicate that dominance genetic variance may be a common in the inheritance of these traits. Moreover, the degrees of dominance ($\hat{h}$) were the same 1.6 for these traits. this means that over-dominance is present in the inheritance of shell thickness and egg shape index. The same findings were found by (Abou El-Ghar et al., 2009).

Internal egg quality traits:

It appears from Tables 1, that BC_1 had significantly heaviest albumin weight 28 g., followed by F_3 27 then BC_2 25 g. The most desirable yolk weights were achieved by the two genotypes BC_1 and F_3 17 g., while the lowest yolk weight was achieved by BC_2 16 g. The same trend was found for Haugh Unit percentage, where BC_2 have the lowest percent 95 compared with BC_1 and F_3 generations 97 and 97 %, respectively. Contrarily, the estimate of yolk index in BC1 was larger than both BC_2 and F_3 generations 46 vs. 45 and 45, respectively. The same findings for these traits were reported by (Abou El-Ghar et al., 2009). There were significant differences ($P<0.01$) among all genetic groups for albumin weight, yolk weight, yolk index and Haugh Unit traits, also significant differences ($P<0.01$) were shown for these traits except for Haugh Unit concerning the variations between F_3 and backcrosses, which were in significant (Table 2). The same findings were reported by (Pandey et al., 1986; Joseph and Moran, 2005; Nwachukwu et.al., 2006; Abou El-Ghar et al., 2009 and Nawar, 2009). It could be seen from Table, 3 that negative estimates of σ^2A -2.91 and σ^2d -3.39 for albumin weight indicated that the genes with negative effects were present with high frequencies in the inheritance of albumin weight. The same conclusion was reported by (Cannings et al., 1978). The same findings of σ^2A -0.03 and σ^2d -1.58 were found for yolk weight. Contrarily, dominance seems to be the major source of variation for yolk index and Haugh Unit (0.0015 and 236.8), while negative estimates of additive variance were found for these traits -0.0017 and -26.9, respectively. Such results together with the values of the degrees of dominance ($\hat{h}$) 7.4, -2.9, 1.1

and - 0.9, suggested that over dominance to the high parent and to the low parent was present in the inheritance of both yolk weight and Haugh Unit, respectively. While complete dominance was found in the inheritance of albumin weight and yolk index, respectively. These results disagreed with those reported by (Scheinberg et al., 1953 and Abou El-Ghar et al., 2009).

CONCLUSION

Generally, results of the current study showed that most of these traits had negative estimates of additive σ^2A and dominance σ^2d genetic variations, this may be due to the effects attributed to the maternal strains on egg quality traits were minimal and/or many recessive genes were expressed what reduces the observable genetic variations in egg quality traits.

Table (1) Means and s.d of some egg quality traits from F3 and backcross generations

Genotypes	No.	Traits							
		E.W	Sh.W	Sh.Th	E.Sh.I %	Al.W	Y.W	Y.I%	H.U
F3	50	50±4.6	5.9±0.7	35±0.04	75±4.1	27±4.1	17±1.5	45±3.9	97±14.4
BC1	50	51±39	6.6±0.9	31±0.03	74±3.1	28±4.4	17±1.3	46±5.6	97±9.6
BC2	50	46±26	5.6±0.7	31±0.04	75±5.2	25±2.8	16±1.6	45±3.6	95±9.3
Total Backcrosses	100	51±4.1	6.6±0.9	31±0.04	74±4.3	28±3.8	17±1.6	46±4.7	97±9.4

E.W = egg weight, Al.W = albumin weight, Y.W = yolk weight, Sh.W= egg shell weight, Sh.Th = shell thickness.
E.Sh.I = egg shape index, Y.I = yolk index, HU = Haugh units, BC1 = backcross 1, BC2 = Backcrosses 2, F3 = 3rd generation.

Table (2) Mean squares of some egg quality traits from F3 and backcross generations

S.O.V	d.f	Traits							
		E.W	Sh.W	Sh.Th	E.Sh.I	Al.W	Y.W	Y.I	H.U
Bet. Rep.	4	2.39^{NS}	1.07*	0.03^{NS}	22.8^{NS}	3.95^{NS}	1.71^{NS}	0.006*	415.9**
Bet. Genotypes	2	1039**	30.2**	8.67**	1005**	473**	186**	0.067**	5456.7**
Bet. Backcrosses	1	561**	24.5**	0.001^{NS}	35^{NS}	136**	47**	0.001^{NS}	115^{NS}
Within F3	49	22**	0.48^{NS}	0.001^{NS}	1.3^{NS}	16.9^{NS}	2^{NS}	0.002^{NS}	208**
F3 vs. Backcross	1	283.5**	9.29**	0.51^{NS}	15.7^{NS}	93.3**	67.8**	0.020**	36.0^{NS}
Error	243	12	0.42	0.06	13	12.5	2	0.002	74

E.W = egg weight, Al.W = albumin weight, Y.W = yolk weight, Sh.W= egg shell weight, Sh.Th = shell thickness, E.Sh.I = egg shape index,
Y.I = yolk index, HU = Haugh units, BC1 = backcross 1, BC2 = Backcrosses 2, F3 = 3rd generation.

Table (3) Components of genetic variation for some egg quality traits

Traits	σ^2A	σ^2d	$\hat{h}$
Egg Weight	-3.1	-2.66	0.9
Shell Weight	-0.92	-0.15	0.4
Shell Thickness	0.001	0.002	1.6
Egg Shape Index	16.7	45.8	1.6
Albumin Weight	-2.91	-3.39	1.1
Yolk Weight	-0.03	-1.58	7.4
Yolk Index	-0.0017	0.0015	-0.9
Haugh Units	-26.9	236.8	-2.9

σ^2A = additive genetic variance, σ^2d = dominance variance, $\hat{h}$ = the degree of dominance, F3= 3rd generation, BC= backcrosses.

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الملخص العربي

تحليلات وراثية لمتوسطات الأجيال في الخلط بين سلالتين من الدجاج المحلي
III – وراثة صفات جودة البيض فى الجيل الثالث والهجن الرجعية

رضا شعبان أبو الغار

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الإنتخاب لصفات جودة البيضة الخارجية والداخلية أصبح هدفا للمربين بهدف زيادة عائدات بيع البيض وفى محاولة لعمل برنامج تحسين وراثي لصفات جودة البيضة تم حساب مكونات التباين الوراثي لصفات جودة البيض عن طريق استخدام بيانات الجيل الثالث والهجن الرجعية الناتجة عن خلط سلالتي الجميزة والبندرة. اوضحت النتائج ان الإختلافات بين التراكيب الوراثية كانت عالية المعنوية بالنسبة الى كل الصفات المدروسة كما كانت الفروق بين الجيل الثالث والهجن الرجعية عالية المعنوية بالنسبة الى صفات وزن البيضة ، وزن القشرة ، وزن الصفار ، وزن البياض و دليل الصفار فى حين ان الإختلافات بين الجيل الثالث والهجن الرجعية كانت غير معنوية وذلك بالنسبة الى صفات سمك القشرة ، دليل شكل البيضة ووحدات هوف علاوة على أن نتائج هذه الدراسة أوضحت أن معظم صفات جودة البيض أظهرت قيم سالبة لكل من التباين الوراثي التجميعي والتباين السيادي وهذا ربما يرجع الى إما لوجود العديد من الجينات المتنحية ذات التاثير السالب التي عبرت عن نفسها بصورة كبيرة أو ربما يكون ذلك راجعا الى قلة التباين الوراثى بين سلالتى الاباء الجميزة والبندرة. ولقد إختلفت تقديرات درجة السيادة من إنعدام للسيادة فى صفة وزن القشرة الى سيادة تامه للأب الأقل فى صفة دليل الصفار وسيادة تامة للأب الأعلى فى صفات وزن الألبيومين ووزن البيضة ثم الى سيادة فائقة للاب الاقل فى صفة وحدات هاوف ثم الى سيادة فائقة للأب الأعلى فى صفات سمك القشرة ودليل شكل البيضة ووزن الصفار على التوالي.