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CORRELATED RESPONSE FOR EGG QUALITY TRAITS AFTER THREE GENERATIONS OF SELECTION FOR EGG NUMBER IN BENHA CHICKENS

El-Attrouny, M.M.[1], Iraqi, M.M.[1], Khalil, M.H.[1] and El-Moghazy, Gihan M.[2]

[1]Dep.of Anim. Prod., Fac.of Agric. at Moshtohor, Benha Uni., Egypt.

[2]Regional Centre for Food and Feed, Agri.Res. Center, Egypt.

Corresponding author: Iraqi, M.M Email: mahmoud.iraqi@fagr.bu.edu.eg

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ABSTRACT: The current study investigated the effect of selection for increased egg number during the 1st 90 days of laying on egg quality traits over four generations in Benha chickens. A total of 18 cockerels and 180 pullets were selected according to their BLUP values for egg number at the first 90 days of laying from Benha base population (control). Data of 4242 eggs produced by 756 pedigreed hens fathered by 69 sires and mothered 484 dams from four generations (base and three selected generations) were used to estimate heritability, genetic and phenotypic correlations for egg quality traits (Egg weight (EW), Albumen weight (AW),Yolk weight (YW), Shell weight (SW), Haugh unit (HU), Egg shape index (ESI), Albumen index (AI), Yolk index (YI) and Egg shell thickness (EST)). The selection effects, correlated responses and the genetic and phenotypic trends for egg quality traits across generations were quantified or clarified applying the updated approach of the animal model program of BLUPF90. Heritability estimates were moderate or low for all traits (h^2 = 0.05 to 0.47). Also, genetic correlations for EW was closely positively genetically correlated with AW, YW, SW, with magnitudes of 0.99, 0.57, 0.69, respectively. The three selected generations were superior (P <0.05) in most egg quality traits than the base generation and the contrasts among estimates of these generations were significant (P<0.05). The phenotypic and genetic trend increased for all egg quality traits. While genetic trend decreased for AW. The accumulative correlated selection responses were 1.18 g for EW, 0.31g for SW, 5.27 for HU, and 0.06 mm for EST. Conclusion, these findings stated superiorities of selected generations indicating selection for egg number during the first 90 days of laying in Benha chickens was associated with an improvement in egg quality traits.

Keywords: selection, egg quality traits, genetic and phenotypic trends, correlated responses.

INTRODUCTION

Egg quality is one of the most important requirements of today's market to guarantee the integrity of the egg and to reduce the numbers of eggs lost on the way to the consumer. According to Harms *et al*. (1996), approximately 6 to 8% of the total egg production is not usable or marketable due to the poor quality of shells. Hunton (1995) observed major financial losses during routine handling and transport from producer to retail outlets. Therefore, eggshell stability traits play a major role because only eggs with an intact shell are considered salable. Thus, if egg quality, and specifically, eggshell stability, is guaranteed, the layer industry could increase the number of salable eggs produced by each hen housed.

Genetic selection helps to continuously improve the laying performance, efficiency, livability, and adaptability of the birds to different environments as well as egg quality (Preisinger and Flock, 2000). For this purpose, more than 30 different traits are included in the selection index of the laying hen breeding programs. All traits are closely monitored and their relations to each other are considered, making it possible for a balanced genetic progress and improvements in different traits even when they are negatively correlated with each other. Estimations of genetic parameters for different egg quality traits have been reported in literature(Dunn *et al*., 2005; Icken *et al.*, 2006; Flock *et al*., 2007; El-Attrouny and Iraqi, 2021). According to Dunn *et al.* (2005) and Flock *et al*. (2007), heritabilities (h^2) are ranged from 0.52 to 0.64 for EW and vary from h^2 = 0.33 to 0.53 for Kdyn in brown and white egg layers. Egg weight (EW) is a major criterion in determining the market price system, and according to Flock *et al.* (2007), EW is easily adaptable to the requirements of the market thanks to its high heritability. The main objectives of the present study were: 1) Estimate the genetic parameters and BLUP estimates across three generations of selection for egg quality traits, 2) Effect of selection quantify and comparing the generation contrasts, 3) clarify the phenotypic and genetic trends across generations, and 4) Estimate the correlated responses in egg quality over the three generations of selection in Benha chickens.

MATERIALS AND METHODS

Breeding plane and management:

A selection experiment was carried out at the Poultry Research Farm, Department of Animal Production, Faculty of Agriculture, Benha University, Egypt during the period from 2011 and terminated in 2015. A synthesized line of chickens, Benha line (Bl) was used in this study. This line has been developed from crossing Golden Montazah with White Leghorns chickens and using the BLUP estimates to select the birds for three generations (Iraqi *et al.*, 2013).

A total of 18 cockerels and 180 pullets were selected according to their BLUP estimates for egg number during the first 90 days of egg production from Benha line base population. Data of 4242 egg collected on 756 hens produced by 69 sires and 484 dams from four generations (base and three selected generations). Egg number (EN) was recorded for each hen by counting the number of eggs laid during the first 90 days after sexual maturity. Each selected cock was mated with 10 selected hens and housed separately in breeding pen to produce the first generation of selection (G_1), consequently selection was practiced further for two generations to produce the 2nd (G_2) and 3rd (G_3) generations of selection. The pedigreed eggs from each individual breeding pen for the three selection generations (G_1, G_2 and G_3) were collected daily for 15 days and then incubated (El-Attrouny *et al*., 2019). The structures of data collected from all generations are presented in Table 1.

Upon hatch, chicks produced from all generations were wing - banded and reared in floor brooder, then transferred to the floor pens. Chicks produced from all generations were fed *ad libitum* during growing (from hatch up to 8 weeks of age), rearing (from 8-20 weeks of age) and laying (more than 20 weeks of age)periods on diets containing 21% protein and 2950 kcal/kg, 18% protein and 2850 kcal/kg, and 16% protein and 2700 kcal/kg, respectively. The feed requirements were supplied according to NRC (1994). All the birds were treated and medicated similarly throughout the experimental period.

Data and model of analysis

Records on 4242 eggs from different generations were collected to study egg quality traits. Which were egg weight (EW), albumen weight (AW), yolk weight (YW), shell weight (SW), Haugh unit (HU), egg shape index (ESI), albumen index (AI), yolk index (YI)and shell thickness (EST).

Multi-trait animal model (in matrix notation) used to analyze egg quality traits **(**as characters of the hen) was as follows:

$y = Xb + Z_a u_a + Z_p u_p + e$

Where: y= n×1 vector of observation of the hen, n = number of records; X= design matrix of order n×p, which is related to the fixed effects of generation (four levels), month-year (12 levels); b= p×1 vector of the fixed effects of generation and month-year Z_a= the incidence matrix relating records to the additive genetic effect of the hen; u_a= the vector of random additive genetic of the hen; Z_p= the incidence matrix relating records to random permanent environmental effect of the hen; u_p= the vector of random permanent environmental effect of the hen; and e= n×1 vector of random residual effects, NID (0, σ^2e).

Heritability estimates of egg quality traits were computed as: $h^2{}_a = \frac{\sigma^2{}_a}{\sigma^2{}_a + \sigma^2{}_p + \sigma^2{}_e}$

Where: s_a^2, s_p^2 and s_e^2 are variances due to the effects of direct additive genetic, permanent environment and random error, respectively.The genetic (r_g) and phenotypic (r_p) correlations between egg quality traits were also estimated.

The BLUP were estimated using BLUPF90 Fortran program (Misztal *et al.,* 2014). Bird solutions are computed from the pedigree file, one bird at a time (for both birds with and without records, i.e. hens, sires and dams). These BLUP estimates were calculated based on the theory of Kennedy (1989).

The estimated (co) variances were used to estimate the fixed and the random effects by solving the corresponding mixed model equations using the BLUPF90 software (Misztal *et al.,* 2014). The estimates of the error (co) variance matrix were also obtained. Estimates of the differences between the four generations of selection were obtained by generalized least-squares analysis using the BLUPF90 software.

The phenotypic trend was measured as the regression of least squares estimates on generation number, while the genetic trend was measured by regressing the BLUP estimates on generation number. As stated before, the BLUP estimates of the birds with and without records were estimated using the BLUPF90 program (Misztal *et al.*, 2014).

The correlated selection response (CR_Y) in each trait (Y) was calculated using the following equation of Falconar and Meckay (1996): $CR_Y= (i_X) (h_X) (h_Y) (r_{GXY}) (\sigma_{PY})$; where: i_X is the selection intensity assuming to be one for comparison only, h_X and h_Y are the square roots of heritability estimates of the X and Y traits, respectively, r_{GXY} is the genetic correlation between the two traits and σ_{PY} is the standard deviation of phenotypic value of trait Y.

RESULTS AND DISCUSSION

Actual means and variations:

The actual means for egg components, ESI and EST in Benha chickens were estimated and illustrated in Table 2. The means for EW, AW, YW and SW were 48.3, 27.6, 14.6 and 6.1 g, respectively. El-Garhy (2004) found that the means for EW, AW, YW, SW and EST were 43, 24, 13.4, 5.6 g and 0.31 mm in chickens. Khawja *et al*. (2013) found that the actual means of EW, AW and YW were 43.4, 22 and 14 g in Fayoumi chickens. Khalil *et al*. (2013) showed that the averages of EW, AW, YW and SW were 44.0, 24.2, 14.4 and 5.5 g, respectively in Golden Montazah chickens. Taha and Abd El-Ghany (2013) reported that means of EW in Mandarah and EL-Salam strains were 50.6 and 52.5 g, respectively. The actual means of HU, ESI, AI, YI and EST 90.6, 78.4, 8.0, 44.0 % and 0.33 mm, respectively (Table 2).The shell thickness means was 0.33 mm. Abd El-Latif (2001) reported that the means for HU was 69.2 and 68.4 in Dandarawi and Golden Montazah chicken, respectively. Iraqi (2002) reported that the means of ESI, AI and YI were 77.5, 11.3 and 47.83 %, respectively in Mandara chickens, while they were 77.2, 47.5 and 86.6 % for the same traits in Matrouh chickens, respectively.

The percentages of variation ranged from 9.8 to 28.6 % for egg component traits and from 0.11 to 0.21 % for shape index traits (Table 2) and the variation for shell thickness was 0.12 %. Olawumi and Ogunlade (2008) found that the percentage of variation ranged from 7.8 to 9.8 % for egg components and from 3.7 to 9.0 % for shape index traits and 12.6 % for EST in Brown layer breeds. Olawumi and Jobin (2013) reported that the percentages of variation were 9.6, 22.1, 33.0, 11.4, 7.3, 7.8 and 5.4 % for EW, AW, YW, SW, EST, HU, ESI, respectively in Rhode Island White chickens.

Variance components and heritability:

Estimates of additive (σ^2_a), permanent (σ^2_{PE}) and residual (σ^2_e) variances for egg quality traits are given in Table (3). The estimates of σ^2_a were low and intermediate for egg components traits (ranged from 0.75 to 16.1g) compared to shape index trait (ranged from 0.07 to 1.7 %) and EST (2.1 mm). These results indicate that egg components traits had high additive genetic variance comparable to shape indexes and shell thickness traits. Therefore, improving egg components traits by selection could be possible. These estimates of additive genetic variance are agreed with Iraqi (2002) using an animal model, while they are disagreed with those reported by Abou El-Ghar *et al.*(2011) and El-Attrouny (2011).

Egg components traits had intermediate estimate of h^2, ranging from 0.17 to 0.47 for egg components, 0.06 and 0.25 for shape indexes and 0.23 for shell thickness (Table 3).It seems that egg components are largely influenced by genes of additive effect and thus these traits could be improved by selection. Based on multi-trait animal model, Iraqi (2002) found that heritability estimates were 0.67, 0.50, 0.30 and 0.25 for EW, AW, YW and SW, respectively in Mandarah and Matrouh chickens. Zhang *et al*. (2005) found that estimates of h^2 for EW, AW, YW, SW, HU and ESI in brown-egg dwarf layers were 0.63, 0.59, 0.45, 0.64, 0.41 and 0.34, respectively. Dasari *et al.* (2013) reported that the estimates of h^2 ranged from 0.12 to 0.32 for egg components, from 0.10 to 0.23 for shape indexes, from 0.27 to 0.41for shell thickens in different strains of White Leghorns. On the other hand, Younis *et al*. (2014) found that estimates of h^2 for ESI, AI, AI, HU and EST were 0.39, 0.29, 0.46, 0.18 and 0.21, respectively in Dokki_4 chickens. Ashour *et al*. (2015) found that estimate of h^2 for ESI, AI, YI, EST and HU were 0.45, 0.36, 0.18, 0.07 and 0.15, respectively in El-Salam chickens. Also, Rath *et al. (*2015) reported that the estimates of h^2 for egg components ranged from 0.14 to 0.57, from 0.40 to 0.59 for shape indexes and 0.44 for shell thickness in White Leghorn.

Genetic and phenotypic correlation

Estimated of r_G were positive and closely correlated between EW & AW (0.99), EW & YW (0.57) and EW & SW (0.69) are presented in Table (4). It seems that pullets giving high egg weight could have higher albumin, yolk and shell weights. Also, positive r_G between AW&AI (0.59) and YW&YI (0.61) were recorded. Hanafi and El-Labban (1990) found that highly positive genetic correlation between EW & AW (0.69) and EW&SW (0.52) in Dokki-4 chickens. Zhang *et al*. (2005) found that r_G recorded among EW and each of AW, YW, SW ranged from 0.67 to 0.97 in brown-egg layer. El-Attrouny (2011) found that highly positive r_G among EW and each of AW (0.80), YW (0.70) and SW (0.53) in Golden Montazah and White Leghorn and their crosses.

Estimates of r_p presented in Table (4), the r_G were positive and highly correlated between EW & AW, EW & YW and EW&SW; being 0.85, 0.63 and 0.54, respectively, while the correlations between AW&AI (0.02) and YW & YI (-0.26) were low and negative in Benha chickens. Udoh *et al. (*2012*)* indicted that correlations between EW & AW were positive and ranged from 0.68 to 0.79 and from 0.56 to 0.77 between EW & YW in three Nigerian chickens. Dasari *et al.* (2013) found that the estimates of r_P between EW&AW ranged from 0.20 to 0.76, from 0.89 to 0.96 between EW&YW, from -0.30 to 0.20 between AW & AI and from -0.07 to 0.21 between YW & YI in White Leghorn chickens.

Selection effect and generation contrasts

Estimates of the three generations of selection obtained by generalized least squares using BLUPF90 were superior (P <0.05) for most egg quality traits than the base generation (Table 5). Based on BLUPF90, the contrasts among estimates of these generations were significant (P<0.05). The third generation showed superiority in most egg quality traits compared to the average of the first and second generations. These results agree with Aly *et al.* (2010a), Abou El-Ghar *et al.* (2011), Khalil *et al*. (2013), Shalan *et al.* (2012) and Rayan *et al*. (2013). These superiorities indicted that selection for egg number during the first 90 days of laying in Benha chickens was associated with improvement in egg component, ESI and EST traits. Shalan *et al*. (2012) found that EW was 42.3, 45.0 and 47.9 g for the base, 1st and 2nd generations in Baheij selected line and 40.3, 42.9 and 44.0 g for the base, 1st and 2nd generations in Baheij control line. Younis *et al*. (2014) reported that the averages of EST in Dokki-4 chickens for the base, first and second generations were 0.38, 0.35 and 0.35 mm for the selected line and 0.37, 0.35 and 0.34 mm for the control line, respectively.

The phenotypic and genetic trends across generations:

The phenotypic trends for egg quality traits across the generations are presented in Figure 1. The initial phenotypic values were 48, 26.8, 14.6 and 6.0 g for EW, AW, YW and SW, respectively. While reached 48, 27.4, 14.6 and 6.0 g in the first generation, 48.5, 27.7, 14.6 and 6.1g in the second generation and 48.9, 28, 28.1, 14.6 and 6.2 g in the third generation, respectively; indicating that egg components were improved by selection. These results fall within the ranges of 42.1 to 52.5 g for EW, from 13.9 to 16.19 g for YW and from 21.6 to 30 for AW as cited in literature (Aly *et al.*, 2010b; Shalan *et al.,* 2012; Alipanah *et al*., 2013; Taha and Abd El-Ghany, 2013; Khalil *et al.*, 2013; Younis *et al.*, 2014).Phenotypic values of ESI, AI and YI were 76, 7.0 and 42 % in the base generation, respectively (Figure 1). While the phenotypic values were 76.9, 8.0 and 43.0 % in the first generation, 77.4, 8.0 and 44 % in the second generation and 77.9, 9.0 and 45.1% in the third generation, respectively. These results agree with shalan et al. (2012), Khalil et al. (2013) and Taha and Abd El-Ghany (2013).The initial phenotypic value for haugh unit was 87 in the base generation, while reached 89, 92 and 94 in the first, second and third generation, respectively (Figure 1). These results fall within the ranges showed by Abd El-Latif (2001), Iraqi (2002) and Khalil et al. (2013). The phenotypic value for shell thickness initiated at 0.30 mm in the base generation, then increasing slightly till reached 0.31, 0.33 and 0.35 mm in the first, second and third generation, respectively (Figure 1). These trends agree with Samak (2001) and Khalil *et al.* (2013).

The genetic trends across the generations for egg quality traits are presented in Figure 2. The initial BLUP for EW, AW, YW and SW were 0.1, 0.43, -0.19 and 0.09 g in the base generation, while reached 0.4, 0.36, 0.05 and 0.11 g in the first generation, 0.7, 0.30, 0.08 and 0.12 g in the second generation and finally reached 1.0, 0.24, 0.22 and 0.13 g in the third generation, respectively. The BLUP estimates initiated with 0.46, -0.02 and 0.04 % for ESI, AI and EST in the base generation (Figure 2), while reached 0.81, 0.03 and 0.20 % in the first generation, 1.16, 0.07 and 0.35 % in the second generation and 1.52, 0.12 and 0.05 in the third generation, respectively.

Correlated selection responses

Selection for improving egg number at 90 day increasing EW after three selected generations since the correlated response for EW was 0.44, 0.25 and 0.49 g in the 1st, 2nd and 3rd generation, respectively and 1.18 g as accumulative response (Table 6). The correlated response for AW was 0.11, 0.26 and 0.50 g in the 1st, 2nd and 3rd generation, respectively and 0.87 g with accumulative response, while the YW was 0.38, 0.32 and 0.08 g, in 1st,2nd and 3rd generation, respectively and 0.78 g with accumulative response and the SW was 0.02, 0.27 and 0.02 g in the 1st, 2nd and 3rd generation, respectively with a ccumulative response of 0.31g ; these results indicated that the genes that affect the egg number at 90 days are the same genes affecting EW. These results are in agreed with those obtained by Cavero *et al*. (2001) and Shalan *et al*. (2012). Response in HU was -1.11, 5.64 and 0.74 in the 1st, 2nd and 3rd generation of selection, respectively and 5.27 as accumulative response. The improvement in the HU in the three generations may be due to the increasing in EW and AI values. The correlated response to selection for ESI was -0.42, 2.12 and 0.13 % in the 1st, 2nd and 3rd generation, respectively and 1.83 % with accumulative response. Response in AI was 0.47, -1.55 and 2.45% in the 1st, 2nd and 3rd generation, respectively with accumulative response of 1.37 %). These results may be due to that increasing EW after three generations of selection was associated with improvement in egg components. Yolk index was 0.24, 0.75 and 0.96 % in the 1st, 2nd and 3rd generation, respectively with accumulative response of 1.95%. This result in accordance with Younis *et al*. (2014). The responses in EST were 0.04, 0.01 and 0.01mm in the 1st, 2nd and 3rd generations, respectively and of 0.06 as a cumulative response. Similar trend was observed by Younis *et al*. (2014) and Shalan *et al*. (2012).

CONCLUSIONS

1) The high estimates of BLUP for egg quality traits in the control and selected generations indicate that improvement of egg quality traits in Benha chickens could be achieved through more generations of selection for egg number during the 1st 90 days of laying

2) Superiorities in the selected generations indicated that selection for egg number during the first 90 days of laying in Benha chickens was associated with an improvement in egg quality traits

3) The genetic trends were slightly positive for most traits indicating that the selection program was performed correctly.

Table (1): Numbers (No.) sires, dams, pullets and eggs used.

Generation	No. of sires	No. of dams	No. of Pullets	No. of eggs used
Base (control) population	17	113	180	603
1st generation of selection	18	119	180	1476
2nd generation of selection	17	117	180	897
3rd generation of selection	17	135	216	1266
TOTAL	69	484	756	4242

Table (2): Actual means, standard deviations (SD), and percentages of variation (V%) for egg quality traits in Benha chickens.

Trait	Symbol	Mean	SD	V%
Egg weight (g)	EW	48.3	4.7	9.8
Albumen weight (g)	AW	27.6	3.4	12.5
Yolk weight (g)	YW	14.6	2.0	13.9
Shell weight (g)	SW	6.1	0.85	13.9
Haugh unit	HU	90.6	26.0	28.6
Egg shape index (%)	ESI	78.4	0.17	0.21
Albumen index (%)	AI	8.0	0.02	0.24
Yolk index (%)	YI	44.0	0.05	0.11
Egg shell thickness (mm)	EST	0.33	0.04	0.12

Table (3): Estimates of additive genetic (σ^2_a), permanent environment (σ^2_{PE}), uncontrolled environment (σ^2_E) and phenotypic (σ^2_p) variances along with heritability estimates (h^2±**SE**) for egg quality traits in Benha chickens.

Trait	σ^2 **a**	σ^2 **PE**	σ^2 **E**	σ^2 **P**	**h^2 ± SE**
EW (g)	16.1	8.4	9.5	34	0.47±0.02
AW (g)	11	6.4	9.7	27.1	0.40±0.02
YW (g)	1.1	0.97	1.0	3.0	0.36±0.02
SW (g)	0.75	2.1	1.6	4.4	0.17±0.02
HU	4.5	25.1	44.3	74	0.06±0.02
ESI (%)	1.7	2.2	2.9	6.9	0.25±0.01
AI (%)	0.6	1.8	2.7	5.1	0.11±0.01
YI (%)	0.07	0.5	0.84	1.4	0.05±0.01
EST (mm)	2.1	2.8	4.2	9.1	0.23±0.01

Table (4): Estimates of genetic (r_G), and phenotypic (r_P) correlations among some egg quality traits in Benha chickens.

Traits correlated	r_G	r_P
EW & AW	0.99±0.01	0.85±0.17
EW & YW	0.57±0.11	0.63±0.14
EW & SW	0.69±0.13	0.54±0.16
AW&AI	0.59±0.10	0.02±0.08
YW&YI	0.61±0. 11	-0.26±0.13

Table (5): generalized Least-square means for egg quality traits in different generations along with all possible generation contrasts and their standard errors (± SE) in Benha chickens.

Generations	EW (g)	AW (g)	SW (g)	HU	ESI (%)	STH (mm)
Base generation (G_0)	47.4±0.19^c	27.3±0.14^b	6.0±0.03^b	88.5±1.05^b	76.7±0.007^b	0.27±0.01^b
1stgeneration (G1)	48.1±0.12^b	27.3±0.09^b	5.9±0.02^b	87.3±0.64^b	76.3±0.005^b	0.32±0.01^c
2nd generation (G2)	48.3±0.15^b	27.5±0.11^b	6.2±0.02^a	92.9±0.86^a	78.9±0.006^a	0.33±0.01^a
3rd generation (G3)	49.1±0.13^a	28.1±0.10^a	6.2±0.02^a	93.8±0.72^a	79.1±0.005^a	0.34±0.01^a
G_0VS G_1	-0.7±0.22*	0.0±0.0	0.1±0.04	1.2±1.40	0.4±0.009	0.05±0.01-
G_0VS G_2	-0.9±0.24*	-0.2±0.18	-0.2±0.04*	-4.4±1.36*	-2.2±0.009*	-0.0±0.03*
G_0VS G_3	-1.7±0.23*	-0.8±0.17*	-0.2±0.04*	-5.3±1.27*	-2.4±0.009*	-0.01±0.003*
G_1VS G_2	-0.2±0.02	-0.3±0.14	-0.3±0.03*	-5.6±1.09*	-2.6±0.008*	-0.01±0.002*
G_1VS G_3	-1.0±0.18*	-0.8±0.13*	-0.3±0.03*	-6.5±0.99*	-2.8±0.007*	-0.02±0.002
G_2VS G_3	-0.8±0.20*	-0.6±0.15*	0.0±0.0	-0.9±1.12	-0.2±0.008	-0.01±0.002

a, b, c, d Means with the same letters within each trait are not significantly different ($P<0.05$).

* Generation effect significantly different from 0, $\alpha = 0.05$.

Table (6): Realized correlated response for unselected egg components traits in Benha chickens through three generations of selection.

Traits	Correlated selection response as a result of selection for egg number during the 1st 90 day of laying (EN90D)			
	1st generation	2nd generation	3rd generation	cumulative
EW (g)	0.44	0.25	0.49	1.18
AW (g)	0.11	0.26	0.50	0.87
YW (g)	0.38	0.32	0.08	0.78
SW (g)	0.02	0.27	0.02	0.31
HU	-1.11	5.64	0.74	5.27
ESI (%)	-0.42	2.12	0.13	1.83
AI (%)	0.47	-1.55	2.45	1.37
YI (%)	0.24	0.75	0.96	1.95
EST (mm)	0.04	0.01	0.01	0.06

Figure (1): The phenotypic trend for egg quality traits in Benha chickens across the selected generations.

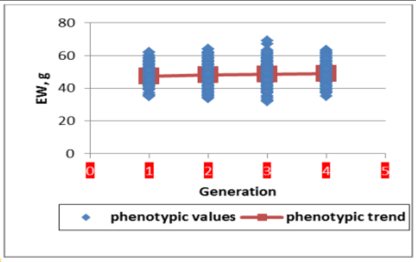

Fig. 1-A

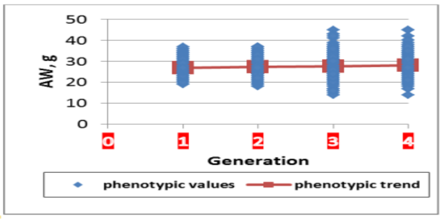

Fig. 1-B

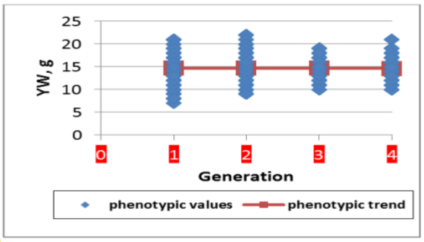

Fig. 1-C

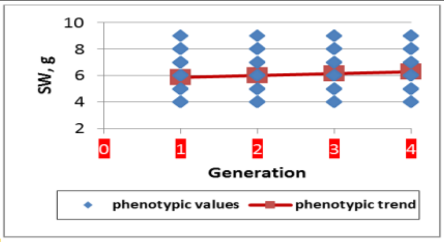

Fig. 1-D

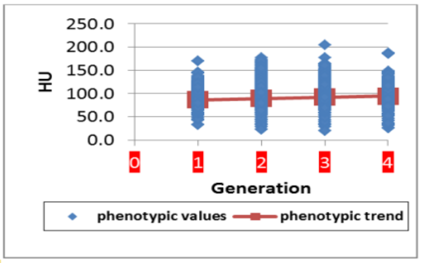

Fig. 1-E

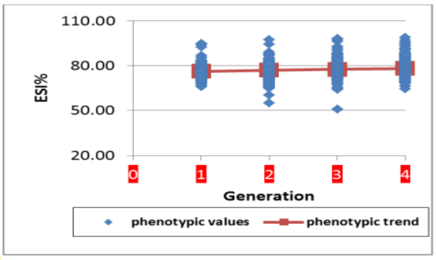

Fig. 1-G

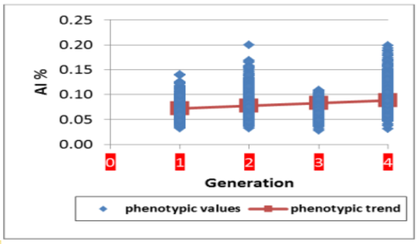

Fig. 1-H

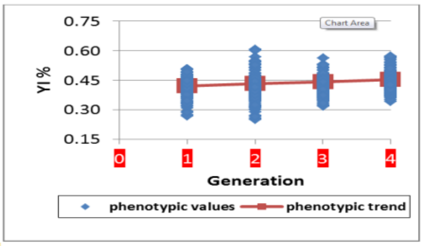

Fig. 1-I

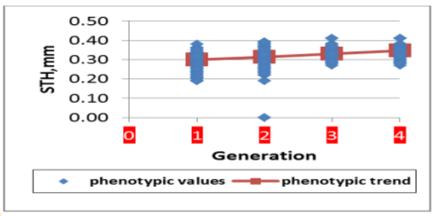

Fig. 1-J

Where : 1= control population, 2 = first selected generation, 3 = second selected generation, 4 = third selected generation

Figure (2): Genetic trend for egg quality traits in Benha chickens across the selected generations.

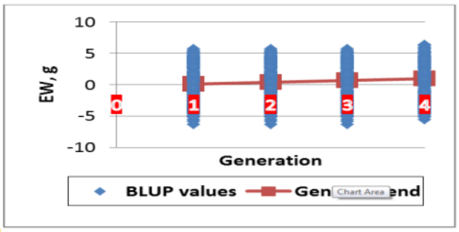

Fig. 2-A

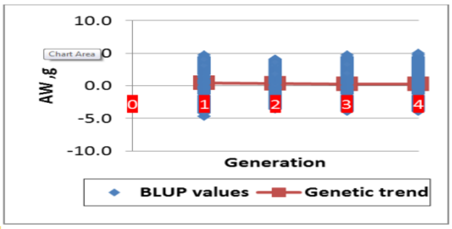

Fig. 2-B

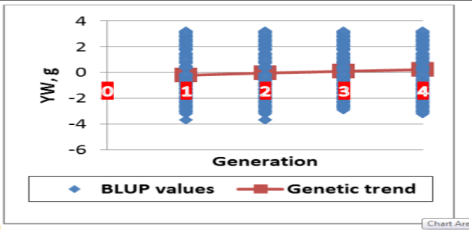

Fig. 2-C

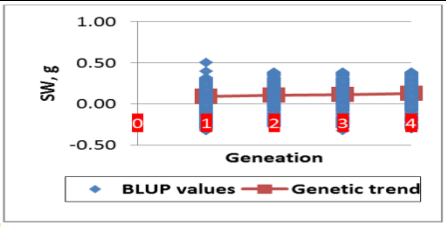

Fig. 2-D

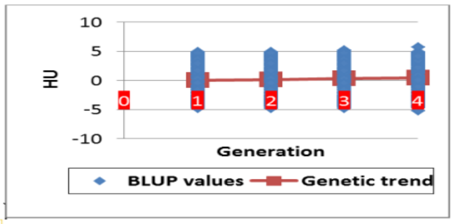

Fig. 2-E

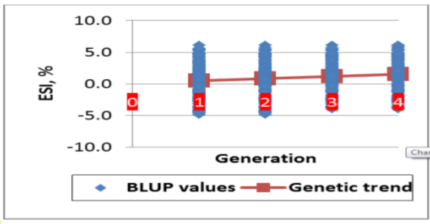

Fig. 2-G

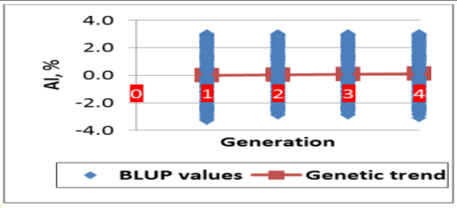

Fig. 2-H

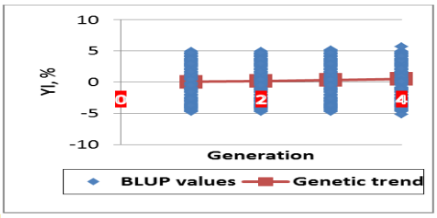

Fig. 2-I

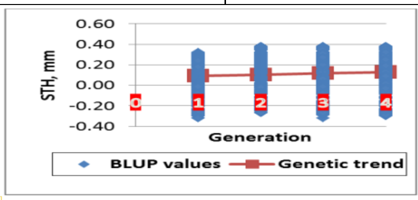

Fig. 2-J

Where : 1= control population 2 = first selected generation, 3 =second selected generation, 4 = third selected generation

selection, egg quality traits, genetic and phenotypic trends, correlated responses.

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الملخص العربى

الاستجابه المرتبطه لصفات جوده البيض بعد ثلاث اجيال من الانتخاب لعدد البيض فى دجاج بنها

محمود مصطفى الاطرونى[١]، محمود مغربى عراقى[١] ، ماهر حسب النبى خليل[١] ، جيهان محمد المغازى[٢]

[١]قسم الإنتاج الحيوانى كلية الزراعة بمشتهر – جامعة بنها - مصر
[٢]المركز الإقليمى للأغذية والاعلاف – مركز البحوث الزراعية – مصر

هدفت الدراسة الحالية علي دراسة تأثير الإنتخاب لزيادة عدد البيض خلال ال ٩٠ يوم الاولى من الوضع علي صفات جودة البيض خلال أربعة اجيال فى دجاج بنها. تم إنتخاب ١٨ ديك و١٨٠ دجاجه طبقا لقيم أحسن متنبئ خطى غير متحيز BLUP لصفة عدد البيض عند اول ٩٠ يوم من الإنتاج من جيل الاساس (الكنترول) .تم جمع عدد 4242 بيضة ناتجه من ٧٥٦ دجاجة ناتجة من ٦٩ ذكر و ٤٨٤ أم للأربع أجيال (جيل اساسي وثلاث اجيال إنتخابية) لتقدير المكافئ الوراثى – الإرتباط الوراثى والمظهرى وقيم أحسن متنبئ خطى غير متحيزBLUP لصفات جودة البيضة (وزن البيضة ، وزن البياض ، وزن الصفار ، وزن القشرة ، وحدات هــــو ، دليل شكل البيضة ، دليل البياض، دليل الصفار وسمك القشرة). تم تقدير أوتوضيح أثر الإنتخاب والإستجابة المرتبطه عبر الاجيال والإتجاهات الوراثية والمظهرية لصفات جودة البيض فى دجاج بنها بإستخدام نموذج الحيوان المعروف بإسم BLUPF90 Program . كانت تقديرات المكافئ الوراثى قيما متوسطة او منخفضة لصفات جودة البيض حيث كانت بين ٠.٠٥ الي ٠.٤٧ . ايضا أظهرت الإرتباطات الوراثية قيم موجبة بين صفة وزن البيض وكلاً من وزن البياض ، وزن الصفار ووزن القشرة حيث كانت ٠.٩٩ ، ٠.٥٧ ، ٠.٦٩ على التوالى.. أظهرت الأجيال الثلاثة الإنتخابية تفوقا لمعظم صفات جودة البيض عن جيل الأساس وكانت الفروق معنوية عند مستوى معنوية (P<0.05). كما أظهرت التضادات المستقلة Contrasts بين الإجيال المختلفة اختلافاً معنوياً .أظهر الإتجاهات المظهرية والوراثية إزدياداً لمعظم صفات جودة البيض . بينما انخفض لصفة وزن البياض . فى القيم المظهرية .أظهرت الإستجابة الإنتخابية المحققة والمصاحبة بعد ثلاث أجيال إنتخابية زيادة تراكمية لكلاً من الصفات التالية: وزن البيضة (١.١٨ جرام) ، وزن القشرة (٠.٣١ جرام) ، وحدات هو (٥.٢٧) وسمك القشرة (٠.٠٦ ملليمتر) على التوالى. الخلاصة ، تشير هذه النتائج إلى أن تفوق الأجيال المنتخبة يشير إلى أن انتخاب عدد البيض خلال التسعين يومًا الأولى من الوضع في دجاج بنها كان مرتبطًا بتحسن صفات جودة البيض.