World Academy of Science, Engineering and Technology
International Journal of Nutrition and Food Engineering
Vol:7, No:10, 2013

Improving Production Traits for El-Salam and Mandarah Chicken Strains by Crossing II-Estimation of Crossbreeding Effects on Egg Production and Egg Quality Traits

Ayman E. Taha, Fawzy A. Abd El-Ghany

Abstract**—**A crossbreeding experiment was carried out between two Egyptian strains of chickens namely Mandarah (MM) and El-Salam (SS). The two purebred strains and their reciprocal crosses (MS and SM) were used to estimate the effect of crossing on egg laying and egg quality parameters, direct additive and maternal additive effects as well as heterosis and direct heterosis percentages for studied traits. Results revealed that SM cross recorded the highest significant averages for most of egg production traits including body weight at sexual maturity (BW1), egg numbers at first 90 days, 42 weeks and 65 weeks of age (EN1, EN2 and EN3; respectively), egg weight at 90 days, 42 weeks of age (EW1 and EW2), egg mass at 90 days, 42 weeks and 65 weeks of age (EM1, EM2 and EM3; respectively), feed conversion ratio to egg production at 90 days , 42 weeks and 65 weeks of age (FCR1, FCR2 and FCR3; respectively), fertility and commercial hatchability percentages. Moreover, SM line reached the age sexual maturity (ASM) and period to the first ten eggs (Pf10 egg) at earlier age than other lines. On the other hand, crossing did not well improve egg quality parameters. Estimates and percentages of direct additive effect (GI) were negative for most of the studied traits except for EN1, EN2, EN3, FCR3, fertility, scientific and commercial hatchability percentages that were positive. But Estimates and percentages of maternal heterosis (Gm) were positive for all the studied traits of egg production, except for BW2, BW3, ASM, Pf10, FCR1, FCR2, FCR3 and scientific hatchability that were negative. Also, positive estimates and percentages of heterosis were recorded for most of egg production and egg quality traits. It was concluded that using of SS strain as a sire line and MM strain as a dam line resulting in best new commercial egg line (SM) which is of great concern for poultry breeder in Egypt.

Keywords**—**Mandarahand El-Salam chickens, Crossing, Egg production, Egg quality, Crossbreeding components.

I. Introduction

BREEDING programs play a major role in increasing the performance of chickens. The most important aspect in developing a new line of chicken is to include differences between breeds for productive traits. Egg production is a complex metric trait and the study of egg production and its related traits such as age and body weight at sexual maturity are of great concern by many authors who found wide variations in these traits among different lines, breeds and strains of chickens [1].

Crossbreeding improves the heterozygosis of non-additive genes causing the heterosis, which is important in the adverse environmental conditions. In fact, crossing constitute one of the tools for the exploitation of the genetic variation, hybrid vigour and maternal effects by combination of the different important characteristics of each breed [2], [3]. The analysis of difference between productive performances of crossbreds helps in identifying the best possible combinations of hybrid vigour according to the desired objectives [4]. Additionally, crossings between the adapted local chicken and exotic standard breeds would allow exploiting the rusticity of first and the productive performances of the later at a time in tropical environment to produce adapted and more productive genetic types, moreover, hybrid vigor is considered to be an important tool for producing several strains of chickens.

Results of most crossbreeding experiments that carried out in Egypt showed that crossing between local breeds or strains of chickens with other local ones was generally associated with an existence of considerable heterotic effects on egg quality [5]-[7]. Conversely, [8] found that crossbreeding had no advantageous heterotic effect on egg quality.

Egg quality characters monitoring is important mainly in terms of production economy. External and internal egg quality traits of the breeds affect the future generations and their performance [9]. Moreover, genotype significantly affects egg shape index, yolk and albumen quality and yolk index [10], [11] and affects egg weight and eggshell traits [12] whereas, [13] reported no significant effects of genotype on eggshell percentage and thickness. Crossbreeding tended to increase eggshell quality [14], in addition, the average of egg shape of crossbreds was higher than that of purebreds [15]. Additionally, heterotic effects among egg quality parameters were studied by many authors [12], [16], [17].

The main objectives of this work were to analyze the improvement of egg production traits in local chicken strains through crossing and to estimate most of genetic effects related to these traits.

II. Materials and Methods

Two developed local chicken strains were used in this study. Mandarah strain (MM), it has been developed from

Ayman E. Taha is with the Department of Animal Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, Alexandria University, Behira, Rashid, 22758 Edfina, Egypt (e-mail: ayman_soma2007@ yahoo.com).

Fawzy A. Abd El-Ghany is with the Animal Production Research Institute, ARC, Ministry of Agriculture, Egypt.

cross between Alexandria males and inbred Dokki-4 females for four generations [18], and El-Salam (SS), A new strain established from a cross between Nichols males and Maamourah females using system of breeding and selected for meat production [19].

A. Breeding Plan and Management

Total numbers of 540 pullets of four genetic groups [150 Mandarah (MM), 150 El-Salam (SS), 120 Mandarah x El-Salam (MS) and 120 El-Salam x Mandarah (SM)] were obtained from crossing experiment between Mandarah and El-Salam strains. Numbers of cocks and hens during laying period are listed in Table I.

TABLE I
NUMBERS OF COCKS AND HENS DURING LAYING PERIOD OF FOUR DIFFERENT GENETIC GROUPS

Line	Numbers	
	Cocks	Hens
Mandarah (MM)	15	150
El-Salam (SS)	15	150
MS	12	120
SM	12	120
Total	54	540

Pullets were transferred from rearing houses at 20 wks. of age to the laying house containing individual laying cages and received 16 hrs. day light. Pullets were fed during laying periods on diet containing 16% crude protein.

B. Data and Studied Traits

1. Data of Egg Production Traits for Each Hen Were Daily Recorded during the First Year of Production

Traits of egg production were:

Body weight at sexual maturity (BW1), body weight at 90 day of laying (BW2), body weight at 65 weeks of age (BW3), age at sexual maturity (ASM), period for first ten eggs (Pf10 eggs), egg number at first 90 days of production (EN1), egg number at 42 wks. of age (EN2), egg number at 65 wks. of age (EN3), average egg weight at first 90 days of production (EW1), average egg weight at 42 wks. of age (EW2), average egg weight at 65 wks. of age (EW3), egg mass at first 90 days of production (EM1), egg mass at 42 weeks of age (EM2), egg mass at 65 wks. of age (EM3), feed conversion at first 90 days of production (FCR1), feed conversion at 42 wks. of age (FCR2), feed conversion at 65 wks. of age (FCR3), fertility (F%), scientific hatchability and commercial hatchability.

2. Egg Quality Characters

External egg quality traits: Egg weight (EW), specific gravity (ESG), shell percentage (Sh.%), shell thickness (E.Sh.Th) and egg shape index (E.Sh.I).

Internal egg quality traits: Albumen percentage (Alb %), yolk percentage (Y %), yolk index (Y.I), haugh unit (HU).

C. Statistical Analysis

Data collected were analyzed by analysis of variance (ANOVA) using SAS program [20] to assess the significant differences between different lines.

D. Estimation of Crossbreeding Components

Estimates of each component were calculated according to [21] as follows:

1. Direct additive effect (G^I): [(MM - SS) - (SM - MS)]
2. Maternal breed additive (G^m): (SM - MS)
3. Direct heterosis: (H^i): [(MS + SM) - (MM + SS)]
4. Heterosis percentage (H %) was calculated according to the following equation.

$$H\ \% = \{[F1 - (\text{Mid parents})] / \text{Mid parents}\} \times 100$$

where: F1 is the average of a certain cross and Mid-parent is the average of the two appropriate parental lines.

III. RESULTS AND DISCUSSION

A. Actual Means

1. Egg Production

Means presented in Table II showed that cross of El-Salam x Mandarah (SM) recorded the best significant averages for BW1 (1524.25g), reaching sexual maturity at earlier ages than other lines (163.14 days), the shortest period for first ten eggs (15.69 days), the highest averages for egg numbers at EN1, EN2 and EN3 (44.82, 97.23 and 186.49; respectively), the highest average for egg mass at EM1, EM2 and EM3 (2150.73, 5090.19 and 9735.28g; respectively). Also, SM cross recorded the best feed conversion in comparison with other lines at FCR1, FCR2 and FCR3 (4.45, 3.43 and 4.27; respectively). Moreover, the highest fertility percentage was recorded for SM cross (91.58%) as well as the highest percentages for commercial hatchability also recorded by SM cross (82.19%). On the other hand, MS cross recorded higher scientific hatchability percentage (90.10%) than other lines.

The superiority of strain crosses over the pure strains in most of productive and egg production traits were confirmed by several reports [6], [22]-[24]. Both of MS and SM cross decreased the age sexual maturity (ASM) and the period produce the first 10 eggs compared to the pure pullets. These results agreed with those found by [24]-[28].

Among purebred lines Mandarah strain (MM) was favored over El-Salam strain (SS) in most of the studied traits including ASM, Pf10, EN1,EN2, EN3, EM1,EM2, EM3, FCR1, FCR2, FCR3, fertility, scientific and commercial hatchability percentages (168.31 days,18.32 days, 40.96 eggs, 90.79 eggs, 177.40 eggs, 1931.08g, 4538.36g, 9055.90g, 5.00, 3.94, 4.70, 89.88%, 87.31% and 78.45; respectively), while SS strain recorded the lowest averages for most of the studied traits in comparison with other lines. The superiority MM over SS strain in egg production traits may be due to their genetic makeup. All hatching traits in this study were in agreement with those reported by [29] for Mandarah strain. Also, higher fertility and hatchability percentages for MM over SS were reported by [30] but SS strain was better in body weight and egg weights (BW1, BW2, BW3, EW1, EW2, and EW3) 1519.86, 1712.53, 1956.66, 48.34, 51.93 and 52.30g, respectively, differences between purebred strains also recorded by [7], [26], [28], [31]-[34].

Generally, it could be concluded that using of SM cross was higher than the reciprocal one MS for most the studied traits during all experimental periods. Thus one would recommend the poultry breeders in Egypt to use the SM cross as egg production type chickens.

2. Egg Quality

Effect of genotypes and their crosses on external and internal egg quality characters are listed in Table III.

Results showed that crossing did not well improve egg quality parameters except for egg weight, where SM cross showed the highest significant egg weight than other lines (53.10g.), also SM had higher non-significant increase in shell percentage (9.74%), but MS cross showed the higher increase in egg shape index (77.18%), on the other hand, Mandarah pure line recorded the best shell thickness (38.10mm), higher specific gravity (1.11), yolk percentage (34.10%) and the best haugh unit that indicated best egg albumen and quality. Moreover, El-Salam strain recorded the best values for albumen percentage (61.10%). On the other hand, non-significant differences were recorded for yolk index among pure and crossbred lines.

Differences between egg weights for different genotypes were also recorded by [11], [27]. Moreover, [10] confirmed significant breed effects on egg quality character. Also, [8], [35] recorded significant differences between purebreds and their crossbreds in egg specific gravity, but disagreed with [5] who found non-significant breed effects on egg weight and egg shell index, Also disagreed with [25] who reported that mating of Gimmizah hens with Matrouh males improved eggshell quality characters. Our results confirmed that comparing egg quality parameters as shell weight, albumen weight and yolk weight must be expressed in relative values in order to make comparison between different genotypes but many researcher dealt with absolute weights for these parameters as [10], [11], [25], [27], [32] who reported that egg weight values are more appropriate in determining the shell quality.

B. Direct Additive Effect (G^I)

Estimates of direct additive effect (G^I) given in Table IV indicated that most of G^I were negative for most of the studied traits of egg production and ranged from low (-390.6 for EM3) to (-0.22 for fertility), except for (EN1, EN2, EN3, FCR3, scientific and commercial hatchability %) that were positive and ranged from low 0.09 for FCR3 to high 6.42 for EN2. Percentages of (G^i) were (-6.25, -1.99, -1.67, -1.00, -18.74, 4.34, 6.98, 0.46, -4.91, -6.84, -4.76, -0.51, -0.13, -4.28, -10.33, -6.10, 1.74, 0.24, 4.19 and 4.49%) for BW1, BW2, BW3, ASM, Pf10, EN1, EN2, EN3, EW1, EW2, EW3, EM1, EM2, EM3, FCR1, FCR2, FCR3, fertility %, scientific hatchability and commercial hatchability; respectively. Results obtained by [6] recorded that percentages of G^I were 37.4% for BWSM, –12.5% for EN90D, 15.07% for EM90D and 23.6% for total egg mass when crossed R.I.R sires to Fayoumi dams. Moreover, [36] found that percentages of G^I were negative (-1.9%) for ASM but positive for BWSM (36.4%) and for total egg number (26.5%) in the cross of White Leghorn x Baldi Saudi.

Generally, Estimates of G^I in the present study showed that Mandarah hens sired by El-Salam cocks were superior in most egg production traits when compared with El-Salam hens that sired by Mandarah cocks (Table II). Results agreed with [6] who found that pullets sired by RIR were superior in egg weight than pullets sired by Fayoumi chickens.

Direct additive effect (G^I) for egg quality are listed in Table V, it was positive for most egg characteristics as E.Sh.I (1.99), shell thickness (2.93mm), specific gravity (0.03), Y% (4.76%), Y.I (0.05), and HU (4.64). However, negative estimates were recorded for EW, shell % and Alb. %. Results obtained by [8], [37] recorded a significant effect of G^I on egg weight and shell thickness when crossed two chicken lines. Percentages of G^I were (-7.12, 2.59, -8.72, 7.75, 2.71, -6.79, 14.62, 0.11 and 5.40) for EW, E.Sh.I, shell%, E.Sh.Th, ESG, Alb. %, Y%, Y.I and HU; respectively. Estimates of direct additive effect (G^I) showed that crossing not affect greatly egg quality traits except for EW, shell% and Alb% for SM cross line. Results confirmed by those obtained by [6] who found that pullets sired by Rhode Island Red were superior in egg weight than pullets sired by Fayoumi. Moreover, [10] reported that MA-sired hens were superior in most egg quality traits compared to MN-sired hens.

C. Maternal Breed Additive (G^m)

Estimates of maternal heterosis (G^m) given in Table IV indicated that most of G^m were positive and ranged from low (1.07 for commercial hatchability %) to high (546.1g. for EM3) in magnitude for all the studied traits of egg production, except for BW2, BW3, ASM, Pf10, FCR1, FCR2, FCR3 and scientific hatchability that were negative ranged from low (-0.17 for FCR2) to high (-62.92 for BW2). Percentages of G^m were 2.11, -3.73, -0.90, -2.06, -5.57, 3.63, 4.79, 3.69, 2.31, 2.87, 2.21, 6.11, 8.46, 6.04, -4.42, -4.28, -5.32, 1.74, -0.33 and 1.39 for BW1, BW2, BW3, ASM, Pf10, EN1, EN2, EN3, EW1, EW2, EW3, EM1, EM2, EM3, FCr1, FCR2, FCR3, fertility %, scientific hatchability and commercial hatchability %; respectively. These results reflects the importance and magnitude of maternal heterosis effects on egg production traits where maternal breed additive (G^m) improved egg production (number and weight and egg mass) and improved ASM, Pf10 egg, feed conversion ratio and scientific hatchability when used Mandarah hens as a dam line. Results obtained by [6] showed negative maternal genetic effects for traits of ASM (-1.9%), BWSM (-4.36%) and WFE (-6.8%), while they were positive for traits of EN90D (6.88%), EM90D (0.15%) and TEM (5.3%), when crossed R.I.R sires and Fayoumi dams. Results agreed with those obtained by [36] who found that percentages of maternal heterosis were negative for ASM but positive for egg number at 90 days and annual egg production when crossed Baladi Saudi with White Leghorn chickens. Moreover, [1] reported negative effects of maternal ability on ASM and total egg production. But [28] showed that maternal heterosis (G^m) were positive and high significant for most of the traits studied.

Estimates of G^m for egg quality traits (Table V) showed low maternal effects for most of egg quality traits where low negative for E.Sh.I, E.Sh.Th., Alb. % and HU and also low positive maternal effects were recorded for shell%, ESG, Y% and Y.I but high positive for egg weight (1.73) indicating that maternal effects not improved well egg quality traits except for egg weight. Percentage of G^m was 4.06% for egg weight when crossed Fayoumi with Rhode Island Red [6].Also, [37] recorded 0.57 % (G^m) percentage for egg weight and 0.30% for shell thickness. Moreover, [10] recorded that percentage of G^m was positive for egg weight, albumen weight but negative for E.Sh.W and HU, when crossed MN with MA chickens.

D.Heterosis

Estimates of H^I presented in Table IV were of excellent indicator of how well crossing improved egg production traits.

Positive heterosis estimates were recorded for most productive traits as BW1, BW3, EN1, EN2, EN3, EW2, EM1, EM2, EM3, fertility, scientific and commercial hatchability percentages and negative for ASM (-12.03), Pf10 (-8.55) FCR1 (-1.60), FCR2 (-1.25) and FCR3 (-0.78). Heterosis percentages were 1.26, -1.90, 3.78, -3.52, -20.84, 12.15, 11.29, 5.47, -0.62, 0.80, -0.07, 11.43, 12.61, 5.39, -14.91, -15.10, -8.15, 2.03, 5.09 and 7.26 % for BW1, BW2, BW3, ASM, Pf10, EN1, EN2, EN3, EW1, EW2, EW3, EM1, EM2, EM3, FCR1, FCR2, FCR3, fertility %, scientific hatchability and commercial hatchability; respectively.

Estimates of H^I and heterosis percentages confirmed that crossing between MM and SS strain improved most of egg production traits as ASM, Pf10, EN, EM, FCR, fertility and hatchability. These results agreed with those obtained by [1], [36], [37], they showed that the negative percentages of H^I ranged between -11.33 and -0.14% for ASM. Also, [1], [6], [25] and [38] who found positive percentages of H^I ranged from 0.4 to 12.8% for BWSM. Moreover, [26] recorded positive H^I for all productive traits except for ASM, WFE, PF10E, and EMF10E. Also, similar results obtained by many authors [1], [6], [7], [26], [37], [39]. In addition, [28] found that estimates of direct heterosis (H^I)were positive for all traits and ranged from 43.81% for PF10E to 36.15%for EN90D and heterosis Percentages of fertility, scientific and commercial hatchability were 4.09,10.18 and 14.52 %; respectively.

Regarding Estimates of heterosis (H^I) for egg quality traits (Table V), results revealed low positive heterosis estimates and percentages for all egg quality traits except Y% (-1.2 and -1.89%; respectively). These results indicating that improvement in egg quality traits by crossing were not obvious and of not concern. Positive heterosis percentages for egg quality traits were recorded by [5]-[8], [37] and [10] who found that estimates of heterosis were positive for most egg components and shape indexes as well as for ESG; while, they were negative for Yolk weight, egg shell weight and shell thickness.

TABLE II
MEANS ± STANDARD ERRORS FOR SOME PRODUCTIVE TRAITS OF FOUR GENETIC GROUPS IN CROSSING EXPERIMENT BETWEEN MANDARAH AND EL-SALAM STRAINS

Traits	Mandarah (MM)	El-Salam (SS)	(MS)	(SM)
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
BW 1 (gm)	1459.33 ±4.50c	1519.86 ±4.12a	1492.50 ±3.90b	1524.25 ±4.93a
BW 2 (gm)	1617.00 ±3.37c	1712.53 ±4.96a	1664.58 ±5.44b	1601.67 ±4.66d
BW 3gm)	1906.00 ±7.88c	1956.66 ±6.71b	2013.33 ±9.71a	1995.41 ±9.86a
ASM (days)	168.31 ±0.99b	173.50 ±0.93a	166.65 ±1.07b	163.14 ±0.79c
Pf10 egg (day)	18.32 ±0.30b	22.71 ±0.56a	16.79 ±0.16c	15.69 ±0.17d
EN 1	40.96 ±0.33c	37.66 ±0.59d	43.35 ±0.42b	44.82 ±0.42a
EN2	90.79 ±1.20c	80.22 ±0.91d	93.08 ±0.78b	97.23 ±0.84a
EN3	177.40 ±2.13b	170.11 ±1.59c	180.03 ±2.32b	186.49 ±1.23a
EW1	47.13 ±0.12c	48.34 ±0.14a	46.89 ±0.10c	47.99 ±0.01b
EW2	49.96 ±0.08c	51.93 ±0.11a	50.62 ±0.12b	52.09 ±0.11a
EW3	51.01 ±0.06b	52.30 ±0.08a	51.05 ±0.06b	52.19 ±0.10a
EM 1	1931.08 ±16.90c	1823.27 ±30.44d	2032.85 ±20.74b	2150.73 ±20.34a
EM 2	4538.36 ±51.93c	4168.40 ±49.47d	4714.30 ±43.56b	5090.19 ±44.55a
EM 3	9055.90 ±108.58b	8900.42 ±87.12b	9189.20 ±188.88b	9735.28 ±69.97a
FCR1	5.00 ±0.04b	5.73 ±0.10a	4.68 ±0.05c	4.45 ±0.03d
FCR2	3.94 ±0.06b	4.34 ±0.05a	3.60 ±0.03c	3.43 ±0.02d
FCR3	4.70 ±0.07b	4.87 ±0.04a	4.52 ±0.07c	4.27 ±0.03d
Fertility %	89.88 ±0.37b	88.11 ±0.45c	90.03 ±0.37b	91.58 ±0.43a
Scientific hatchability	87.31 ±0.56b	83.88 ±0.54c	90.10 ±0.32a	89.81 ±0.42a
Commercial hatchability	78.45 ±0.59b	73.79 ±0.52c	81.11 ±0.44a	82.19 ±0.47a

BW 1 (g.)	Body weight at sexual maturity
BW 2 (g.)	Body weight at first 90 days of laying
BW 3 (g.)	Body weight at 65 weeks of age
ASM	Age at sexual maturity (days)
Pf10 egg	Period for first ten eggs (days)
EN 1	Egg number at first 90 days of production
EN2	Egg number at 42 weeks (g.)
EN3	Egg number at 65week of age (g.)
EW1	Egg weight at first 90 days of laying (g.)
EW2	Egg weight at 42 weeks (g.)
EW3	Egg weight at 65 week of age (g.)
EM 1	Egg mass at first 90 days of production (g.)
EM 2	Egg mass at 42 weeks (g.)
EM 3	Egg mass at 65 week of age (g.)
FCR1	Feed conversion at first 90 days of production (g.)
FCR2	Feed conversion at 42 weeks (g.)
FCR3	Feed conversion at 65 weeks of age (g.)

IV. Conclusion

It was concluded that; concerning purebred lines, MM strain recorded the highest records than SS strain for most of egg production traits and this may be due to their genetic makeup. While, SM cross showed the best records for most of egg production traits, thus the use of El-Salam strain as a sire line and Mandarah strain as a dam line is of a great concern for poultry breeder as a new egg production line in Egypt.

TABLE III
MEANS OF EGG QUALITY TRAITS IN PUREBREDS AND THEIR RECIPROCAL CROSSES IN CHICKENS

Parameter	Genotype			
	MM	SS	MS	SM
Egg weight (gm)	50.60 ±0.13d	52.50 ±0.27b	51.37 ±0.19c	53.10 ±0.18a
Egg shape index (%)	76.50 ±0.21b	75.34 ±0.21c	77.18 ±0.27a	76.35 ±0.24b
Egg shell (%)	9.05 ±0.06b	9.65 ±0.08a	9.53 ±0.09a	9.74 ±0.08a
Egg shell thickness (mm)	38.10 ±0.17a	35.18 ±0.15c	37.47 ±0.18b	37.46 ±0.16b
E. Specific gravity	1.11 ±0.00a	1.08 ±0.00c	1.10 ±0.00ab	1.10 ±0.00b
Albumen (%)	56.85 ±0.30c	61.10 ±0.24a	59.44 ±0.28b	59.14 ±0.25b
Yolk (%)	34.10 ±0.18a	29.25 ±0.20c	31.03 ±0.24b	31.12 ±0.21b
Yolk index (%)	44.36 ±0.25a	44.29 ±0.22a	45.00 ±0.28a	45.02 ±0.28a
Haugh Unit	86.77 ±0.32a	82.65 ±0.40c	85.17 ±0.30b	84.65 ±0.28b

Means within the same row bearing different letters are significantly differed at ($P<0.05$)

TABLE IV
ESTIMATES OF DIRECT ADDITIVE (G^i), MATERNAL ADDITIVE (G^M), DIRECT HETEROSIS (H^I) AND THEIR PERCENTAGES (%) FOR EGG PRODUCTION TRAITS

Trait	Direct additive (G^i)		Maternal additive (G^m)		Heterosis (H^I)	
	Estimate	%	Estimate	%	Estimate	%
BW 1	-92.28	-6.25	31.75	2.11	37.55	1.26
BW 2	-32.62	-1.99	-62.92	-3.73	-63.28	-1.90
BW 3	-32.75	-1.67	-17.92	-0.90	146.08	3.78
ASM	-1.69	-1.00	-3.51	-2.06	-12.03	-3.52
Pf10	-3.29	-18.74	-1.10	-5.57	-8.55	-20.84
EN 1	1.82	4.34	1.48	3.63	9.55	12.15
EN2	6.42	6.98	4.15	4.79	19.30	11.29
EN3	0.83	0.46	6.46	3.69	19.01	5.47
EW1	-2.31	-4.91	1.10	2.31	-0.60	-0.62
EW2	-3.43	-6.84	1.47	2.87	0.82	0.80
EW3	-2.43	-4.76	1.14	2.21	-0.07	-0.07
EM1	-10.07	-0.51	117.9	6.11	429.2	11.43
EM2	-5.94	-0.13	375.9	8.46	1097.7	12.61
EM3	-390.6	-4.28	546.1	6.04	968.2	5.39
FCR1	-0.49	-10.33	-0.24	-4.42	-1.59	-14.91
FCR2	-0.24	-6.10	-0.17	-4.28	-1.26	-15.10
FCR3	0.09	1.74	-0.26	-5.32	-0.77	-8.15
Fertility	-0.22	0.24	1.55	1.74	3.62	2.03
Scient. Hatch.	3.72	4.19	-0.29	-0.33	8.72	5.09
Comm. hatch.	3.58	4.49	1.07	1.39	11.06	7.26

Traits as defined in TABLE II

TABLE V
ESTIMATES OF DIRECT ADDITIVE EFFECT (G^i), MATERNAL EFFECTS (G^M), DIRECT HETEROSIS (H^I) AND THEIR PERCENTAGES FOR EGG QUALITY TRAITS

Trait	Direct additive (G^i)		Maternal additive (G^m)		Heterosis (H^I)	
	Estimate	%	Estimate	%	Estimate	%
Egg weight	-3.63	-7.12	1.73	3.33	1.37	1.33
Egg shape index	1.99	2.59	-0.83	-1.09	1.69	1.11
Shell (%)	-0.81	-8.72	0.21	2.19	0.57	3.05
shell thickness	2.93	7.75	-0.01	-0.03	1.65	2.25
Specific gravity	0.03	2.71	0.00	0.00	0.01	0.46
Albumen (%)	-3.95	-6.79	-0.3	-0.50	0.63	0.53
Yolk (%)	4.76	14.62	0.09	0.30	-1.2	-1.89
Yolk index (%)	0.05	0.11	0.02	0.04	1.37	1.55
Haugh unit	4.64	5.40	-0.52	-0.62	0.4	0.24

Traits as defined in TABLE III

References

[1] M. M. Iraqi, E. A. Afifi, A. M. El-Labban and M. Afram ‘‘Heterotic and genetic components in 4x4 diallel mating experiment for egg production traits in chickens,’’ 4th World Poultry Conference 27 - 30 March 2007, Sharm El-Sheikh, Egypt.
[2] R. L. Willham, and E.Pollak ‘‘Heterosis and crossbreeding,’’ Dairy Sci. 1985, (68): 2411–2417.
[3] M. S. Hanafi and M. M. Iraqi ‘‘Evaluation of purebreds, heterosis, combining abilities, maternal and sex-linked effects for some productive and reproductive traits in chickens,’’ 2nd international Conference on Animal Production and Health in Semi-Arid Areas, 4-6 September, El-Arish-North-Sinai, Egypt, 2001, 545-555. Egypt.
[4] D. M. Mekki, I. A. Yousif, M. K. Abdel Rahman, J. Wang and H. H. Musa, ‘‘Growth performance of indigenous X exotic crosses of chicken and evaluation of general and specific combining ability under Sudan condition,’’ Int. J. Poult. Sci. 2005, (4): 468-471.
[5] Z. A. Ezzeldin and A. F. El-Labban ‘‘Egg weight and egg characteristics of purebred and crossbred chickens. Third Egypt British conference on Animal, Fish and poultry production Alexandria,’’ 7-10 October, 1989, 983-992.
[6] M. E. Nawar and F. H. Abdou ‘‘Analysis of heterotic gene action and maternal effects in crossbred Fayoumi chickens,’’ Egypt. Poult. Sci. 1999, (10): 671-689.
[7] M. E. Nawar and M. Bahie El-Deen‘‘A comparative study of some economical traits of seven genotypes of chickens under intensive production system,’’ Egypt. Poult. Sci. 2000, (20): 1031-1045.
[8] M.A. Kosba‘‘Hetrosis and phenotypic correlation for shank length, body weight and egg production traits in Alexandria strain and their crosses with Fayoumi chickens,’’ Alex. J. Agric. Res. 1978, (26): 29-41.
[9] M. A. Islam, S. M. Bulbuli, G. Seeland and A. B. Islam ‘‘Egg quality of different chicken genotypes in summer and winter,’’ Pak. J. Bid. Sci. 2001, (4): 1411-1414.
[10] M. M. Iraqi ‘‘Genetic evaluation for egg quality traits in crossbreeding experiment involving Mandarah and Matrouh chickens using animal model,’’ Egypt. Poult. Sci. 2002, (22): 711-726.
[11] K. M. YousriaAfifi, O. M. Aly and Nazla Y. Abou El-Ella. ‘‘Effect of crossing on the performance of local chicken strain. 4- Effect of strain and laying age on egg quality characteristics,’’ Egypt. Poult. Sci. 2010, (30): 1171-1188.
[12] L. Zita, E. Tumova and L. Stolc‘‘Effect of genotype, age and their interaction on egg quality in Brown-egg laying hens,’’ Actavet, Brno, 2009, (78): 85-91.
[13] H.Basmacioglu and M. Ergul‘‘Research on the factors affecting cholesterol content and some other characteristics of eggs in laying hens – the effect of genotype and rearing system,’’ Turk. J. Vet. Anim. Sci., 2005, (29), 157–164.
[14] A. I. El-Turky, Y. M. Kader, N. Z. Mohana, L. Gohar and I. F. Sayed‘‘Certain factor affecting rate of weight loss in incubated eggs,’’ Agric. Res. Rev. Cairo. 1981, (59):29-44.
[15] A. A. El-Srwy ‘‘Studies in poultry production. Effect of crossing on fertility, hatchability and egg quality of Dandarawy chickens,’’ 1980, M.Sc. Thesis. Fac. of Agric. Univ. of Mansoura, Egypt.

[16] C. Hartmann, K. Johansson, E. Strandberg and M. Wilhelmson. “One-generation divergent selection on large and small yolk proportions in a white Leghorn Line,” Br. Poult. Sci. 2000, (41): 280-286.
[17] L. C. Zhang, Z. H. Ning, G. Y. Xu, Z. C. Hou and N. Yang “Heritabilities and genetic and phenotypic correlation of egg quality traits in Brown-egg Dwarf layers,’’Poult Sci. 2005, (84): 1209-1213.
[18] E. M. Abd EI-Gawad ‘‘The "Mandarah" a new breed of chickens,’’ Egypt. Poult. Sci. 1981, (1): 16-22.
[19] E. M. Abd-El-Gawad, M. M. Ali, N. Y. Abou El-Ella, M. M. Balatandand K. M. Omran “El-Salam A new breed of chickens,” Agric. Res. Rev. Cairo, 1983, (61): 147-157.
[20] SAS “*User’s Guide Statistics*,”2004, SAS Institute INC., Cary, NC, USA.
[21] G. E. Dickerson ‘‘Manual for evaluation of selection theory in poultry,’’ Genet. Today. 1992, (3): 747-761.
[22] M. A. Mandour, G. A. Abd-allah and M. M. Sharaf ‘‘Effect of crossbreeding in some carcass traits of native and standard breeds of chickens,’’Egypt. Poult. Sci. 1996, 16 (1): 171-185.
[23] A. A. Mohamed ‘‘Effect of diallel crosses on poultry performance,’’ 2003, M. Sci. Thesis Fac. Of Agric. Alex. University, Egypt.
[24] E. M. Amin ‘‘Effect of crossing between native and a commercial chicken strain on egg production traits,’’Egypt. Poult. Sci. 2008, 28 (1): 27-349.
[25] S. M. El-Soudany, E. F. Abde-Hamid, M. M. Fathi and M. F. Amer “Effect of crossbreeding between two developed local strains of chickens on laying performance,” Egypt. Poult. Sci. 2003, 23 (II): 409-419.
[26] M. M. Iraqi ‘‘Estimation of cross breeding effects for egg production traits in crossbreeding experiment involving two local strains of chickens,’’ Egypt. Poult. Sci. 2008, (28):876-882.
[27] R. S. Abou El-Ghar, H. M. Shalan, H. H. Ghanem and O. M. Aly‘‘Egg quality characteristics from some developed strains of chickens and their crosses,’’ Egypt. Poult. Sci. 2009, (29): 1173-1186.
[28] M. M Iraqi, M. H. Khalil and M. M. El-Attrouny‘‘Estimation of crossbreeding parameters for egg production traits in crossing Golden Montazah with White Leghorn chicken,’’ Livestock Research Rural Development. 2012, 24 (4), http://www.lrrd.org/lrrd24/4/iraq24055.htm
[29] O. M. Aly, H. H. Ghanem, Y. K. Afifi, N. Y. Abou El-Ella and M. M. Balat ‘‘Selection for improving egg production in Mandarah chickens. 4-Direct and correlated response for some economic traits for four generations of selection,’’ Egypt. Poult. Sci. 2010, (30): 137-156.
[30] M. A. Kosba and H. A. H, Abd El-Halim ‘‘Evaluation of the Egyptian local strains of chickens,’’ Egypt. Poult. Sci. 2008, (28): 1239-1251.
[31] W. S. El-Tahawy‘‘Genetically improvement of some productive and reproductive traits in local chicken,’’2000, M. Sc. Thesis. Fac. of Agric., Alex. Univ., Egypt.
[32] A. F. M. El-Labban‘‘Genetic Study of egg laying performance in four locally developed strains of chickens,’’ Journal of Agriculture Science Mansoura University 2000, 25 (6) 3187 - 3195.
[33] M. G. El-sisy ‘‘Estimation of genetic and phenotypic parameters for some productive traits in poultry,’’ 2001, Ph. D. Thesis. Fac. Of Agric. At Moshtohor, Zagazig Univ. Egypt.
[34] H. H. Ghanem, O. M. Aly and R. S. Abou El-Ghar‘‘Matrouh as a common parent in crossing with some local strains of chickens: II-Heteriosis, additive and maternal effects on some egg production traits,’’ Egypt. Poult. Sci. 2008, (28): 205-221.
[35] M. S. Hanafi ‘‘Egg characteristics as affected by egg weight in New Hampshire and White Leghorn chickens,’’Egypt, J. Anim. Prod. 1981, (21): 135-153.
[36] M. K. Khalil, A. H. Al-Homidan and I. H. Hermes ‘‘Crossbreeding components in age at first egg and egg production for crossing Saudi chickens with White Leghorn,’’Livestock Research for Rural Development 2004,http://www.lrrd.org/lrrd16/1/khal161.htm
[37] A. Bordas, P. Merat, and F. Minviele‘‘Heterosis in egg- laying lines under divergent selection for residual feed consumption,’’Poult. Sci. 1996, (75):20- 24.
[38] H. A. Hassan ‘‘Estimation of heterosis and predicated breeding values for traits of egg production in chickens using Multi-trit Animal Model,’’ 2008, M.Sc. Thesis, Faculty of Agriculture. Banha Univ.
[39] R. W.Fairfull and R. S. Gowe, In: R. D. Crawford (Ed.) ‘‘*Poultry Breeding and Genetics*,’’ 1990, p 705. Elsevier, Amsterdam, The Netherlands.