Egypt. Poult. Sci. Vol. (40) (II): (525-535)(2020) (2005-1100)

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

ANALYSIS OF HETEROTIC COMPONENTS IN A CROSS BRED BETWEEN TWO EGYPTIAN LOCAL CHICKEN STRAINS

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Received: 17/05/2020 Accepted: 17 /06/2020

ABSTRACT: This study was conducted at the Poultry Research Unit (EL-Bostan farm), Department of Animal and Poultry Production, Faculty of Agriculture, Damanhour University. The point of the work were to estimate direct heterosis maternal effect and direct additive effect of growth and reproduction traits in the local chicken strain Sinai (SI) through crossing with Alexandria (AL) strain raised under Egyptian environmental conditions. Percentage heterosis estimates for body weight were the highest at 8 weeks of age (30.17%) and declined at 12 weeks of age (9.9%). Estimates of direct heterosis for egg production trait were associated with significant negative heterosis. Percentage heterosis was 37.56% for age at sexual maturity (ASM) and 40.34% for egg mass. Maternal effect on body weight at different ages was significant. Body weights of chickens from Alexandria line mothers were significantly superior to those from Sinai line mother. Maternal effect of egg production traits was significant on ASM, egg number through 90 day and egg mass. In conclusion, our results suggest that crossbreeding by mating of Alexandria sires with Sinai dams is recommended to improve egg production trait, while mating of Sinai sires with Alexandria dams is recommended to improve growth traits.

Key words: Cross breeding - direct additive effect- maternal additive effect- local chicken.

INTRODUCTION

In Egypt, there are many strains of local chicken and the local chicken provides the pool of genetic diversity in Egypt. Set up of Breeding programs for Egyptian local chicken will be difficult due to the competition with commercial breeding companies that have access to technology advantages and economy scale (Hoffmann, 2005). Cross-breeding in chicken is a tool to produce superior crosses to improve growth traits, egg production traits and fitness traits. Cross-breeding uses pure or line breeding with local strain to improve production and reproduction traits by using complementary traits. Heterosis in chicken caused by dominance and epistasis effect. Heterosis resulting from epistasis is hardly predictable because of the number and type of interaction that are usually unknown and the dominance effect.

Cross breeding improves the heterozygosis of epistasis and dominance genes because of the heterosis which is important in the adverse environmental condition. Crossbreeding of strains is considered an effective method for the production of commercial stocks with hybrid vigor in the poultry industry to take the advantage of hybrid vigor. The cross-breeding approach normally involves a two-way cross between a commercial breed and an improved local breed, aiming to combine better production traits capacity with the adaptability to hard environments.

In Egypt, the results of most cross-breeding experiments showed the presence of considerable heterotic effects on egg production traits (Iraqi *et al.,* 2007, 2012; 2010; Hanafi and Iraqi, 2001; Saadey *et al.,* 2008). The point of this study were to improve egg production trait and growth traits in local chicken strain Sinai by crossing with local strain Alexandria and to estimate crossbreeding parameters related to egg production traits and growth trait.

MATERIALS AND METHODS

Birds, housing, and feed:

The study was conducted at the Poultry Research Unit (El- Bostan farm), Department of Animal and Poultry Production, Faculty of Agriculture, Damanhour University. The experiments aimed to improve performance and reproduction traits in local chicken strain Sinai (SI) through crossing with Alexandria strain (AL) raised under Egyptian environmental conditions. Sinai chickens were originally obtained from the desert area of North and West Sinai Governorates. The Sinai breed probably is originated from the natural cross between some foreign breeds with the local chickens reared in Sinai Governorates **(**Gebriel *et al.,* 2018). The Alexandria strain was developed from a diallel crossing between four breeds (Fayoumi, White Leghorn, Rhode Island Red and Barred Plymouth Rocks) concluded by (Kosba, 1966). Hens of each strain were classified into two groups, first one was mated with cocks from the same strain, the second was mated with cocks from the other strain. Pedigreed and fertilized eggs were collected from each mating daily for one week and incubated in a commercial hatcher. Three hatches were used in this study. All chicks were identified by wing bands at day of hatch to save their genetic groups. Chicks were moved in the brooders floor start by temperature 32 °C during the first week of age and decreased by 2-3 °C each week thereafter. All birds were housed in the same room and have similar management and environmental conditions through the whole experimental period. Females were moved to individual laying cages (20×45×40 cm) at 18 weeks of age. All chicks were fed *ad libitum* with diet containing 20% crude protein and 2.9 kcal metabolizable energy/kg feed until 7 weeks of age after that birds received a diet containing 18% crude protein and 2.8 kcal metabolizable energy/kg feed until 18 weeks of age. During the egg production period, hens received a diet containing 16% crude protein, 2.75 kcal metabolizable energy/kg feed, 3.5% calcium, and 0.5% available phosphors. The lighting period was decreased to 8-10 h a day at 8-18 weeks of age and increased to 16 h per day during the laying period.

Studied traits :

Body weight of chicks at hatch (BW0), 4 weeks (BW4) ,8 weeks (BW8) and 12 weeks (BW12) of age was recorded individually to the nearest 0.1 gm. Body weight gain from 4 -8 weeks(BWG4-8), 8-12 weeks (BWG8-12) and 4-12 weeks (BWG4-12) was calculated.

Egg production traits:

Age at sexual maturity (ASM), which is the period from hatching to the day of laying the first egg, was recorded in days for each female. The duration of laying the first 10 eggs (P10), which is the number of days for each female needed to give its first 10 eggs, and the mean egg weight (MP10) were determined. The number (EN90) and mean weight (MEN90) of eggs were determinate for each female during the first 90 days of laying. Egg mass (EM) was also determined for each female, which is the total egg weight during the first 90 days of laying.

Estimation of cross breeding component:

Heterosis percentage (H%) was calculated according to the following equation:

H% = (Fi – (mid parents)/mid parents) × 100

Where:

Fi is the average of certain crosses and mid-parent is the average of the two appropriate parental lines.

Statistical analysis:

The statistical analyses of the data were conducted by using the international software program **(SAS, 2009).** Data of individual body weights and Body weight gain were analyzed using the following linear model:

$Y_{ikl} = \mu + G_i + H_k + GH_{ik} + e_{ikl}$

Where:

Y_{ikl} = the observation on the iklth chicken; μ = overall mean; G_i = fixed effect of ith genetic group; H_k = fixed effect of kth hatch; GH_{ik} = interactions between main effects; and e_{ikl} = random error.

Data of individual egg production traits of females were analyzed using the previous linear model.

Crossbreeding effects (direct additive, direct heterosis and maternal additive) on growth and egg production traits were estimated according to Dickerson (1992). Such genetic model permits deriving a select set of linear contrasts, i.e. direct additive effect. direct heterotic effect and maternal additive effect were estimated as follows.

Pure lines difference:

$(G^i_M + G^m_M) - (G^i_E + G^m_E) = (AL\times AL) - (SI\times SI)$

Direct heterosis effect (units):

$H^I_{MXE} = (AL\times SI + SI\times AL) - (AL\times AL + SI\times SI)$

Maternal additive effect (i.e. reciprocal crosses differences):

$(G^m_M - G^m_E) = (SI\times AL) - (AL\times SI)$

Direct additive effect (i.e. line group of sire differences):

$(G^i_M + G^i_e) = (AL\times AL) + (AL\times SI) - (SI\times SI) + (SI\times AL)$

Where $G^i + G^m$ represent direct additive and maternal additive effects, respectively of the subscript genetic group.

RESULTS AND DISCUSSION

Table 1 shows means, standard deviation (SD), and coefficient of variations (CV %) of the growth traits and egg production traits. The bird's body weight means at 0, 4, 8 and 12 weeks of age were 35.3 gm, 226.1 gm, 560.2 gm and 924.6 gm, respectively. The daily weight gain from 4-8 weeks was 11.4 gm, from 8-13 weeks was 13.8 gm and from 4-12 weeks of age was 12.6 gm.

Egg production traits, mean age at sexual maturity (ASM) was 149.9 days, period of first ten eggs (P10) was 17.4 days, mean weight of the first ten eggs (MP10) was 42.3 gm, egg production through 90 days after sexual maturity (EN90) was 38.6 eggs, mean egg weight during the first 90 days after sextual maturity (MEN90) was 46.3 gm and the egg mass (EM) was 1792.9 gm.

CV of body weight at different ages ranged from 9.6 to 22.3% with no clear trend. Estimates of CV of ASM, EN90, EM and P10 were 13.1%, 28.6%, 33.2% and 32.3%, respectively. CV for the daily body weight gains from 4-8, 8-12 and 4-12 weeks were 37.5%, 36.7% and 23.04% respectively.

Least-squares means and comparisons among pure lines for body weight at different ages are given in Table (2). Alexandria pure strain (AL×AL) was heavier than Sinai pure strain (SI×SI) in body weight at 0, 4, 8 and 12 weeks of age. There was high statistical significance between the two pure strains. The genetic groups contrasted evidenced that AL strain was superior in body weight at different ages. On the other hand, the least-squares means of daily weight gain from 4-8, 8-12 and 4-12 weeks of age, which are shown in Table (3), indicate that the AL×AL strain was highly significantly different from SI×SI strain. The SI×SI strain had superior performance in egg production traits; it was better in ASM, P10, EN90 and EM than AL×AL strain Table(4).

Direct additive effect:

Table 2 shows the direct additive effect (G^i) and their percentages for growth traits. Results indicate that G^i was significant ($p\leq 0.05$) for body weight at 8 weeks of age. Sinai-sired chicken strain was significantly superior in body weight at eight weeks than Alexandria-sired chicken strain. At 12 weeks of age, direct genetics effects were also pronounced in favor of Sinai sires. For daily weight gain from 4-8 weeks of age, Alexandria-sired cross was highly significantly different from Sinai-sired cross ($p\leq 0.0001$) Table(3).

For egg production traits reported in Table(4), Alexandria and Sinai-sired crosses were significantly different in ASM ($p\leq 0.0001$), P10 ($p\leq 0.0001$), MP10 ($p\leq 0.0001$), EN90 ($p\leq 0.0001$), MEN90 ($p\leq 0.0001$) and EM ($p\leq 0.0001$). Sire line effects were of considerable importance in the variation of mast egg production traits. Alexandria-sired line was superior in P10, EN90 and EM90. ASM was in favor of Sinai-sired line. Such favorable effects lead to conclude that Alexandria line could be used as a sire line to improve P10, EN90 and EM traits. In contrast, Sinai line could be used as a sire line to improve ASM.

Heterotic effects:

Direct heterosis contrast values are given in Table (2) and indicate the heterotic effects on body weight at different ages. Percentage of heterosis estimates for body weight was high at 8 weeks of age (30.17%) and declined to 9.9% at 12 weeks of age. Estimates of heterosis contrast were statically significant for BW0 ($p \leq 0.0001$), BW4 ($p \leq 0.0001$), BW8 ($p \leq 0.0001$) and BW12 ($p \leq 0.0001$). Percentages of heterosis estimates for daily weight gain are shown in Table (3) and the percentage ranged from 41.07% to 9.06%. Heterosis contrast was statistically significant for DG 4-8, DG 8-12 ($p \leq 0.0001$) and DG 4-12 ($p \leq 0.05$). The magnitude for heterosis decreased across age of body weight and daily weight gain. These results may be an encouraging factor for the poultry breeders in Egypt to cross these two native strains to get hybrid vigor in growth traits. Iraqi *et al*., (2002) reported that crossing between local breeds (Mandarah and Matrouh) have positive heterosis ranged from 32.87% to 41.82% for body weight at different ages. Percentages of H^i recorded by most of previous studies were higher than those obtained in the present study. This result may be due to non-additive genetic effects in the two local strains (Iraqi *et al.,* 2000and 2002). Estimates of direct heterosis for egg production traits are presented in Table 4. These estimates indicated that crossing between Alexandria and Sinai chickens was associated with significant negative heterosis effects on egg production traits. Percentage heterosis estimates for egg production traits were high for ASM (37.56%) and EM (40.34%) and declined to 16.34% for EN90. In conclusion, crossing between Alexandria and Sinai was associated with improvement in egg production traits, while it caused unfavorable effects in body weight and daily weight gain.

Maternal additive effects:

Maternal line effect (expressed as the differences between reciprocal crosses) on body weight at different ages was statistically significant, with Alexandria line-mothered chickens superior to those Sinai line-mothered ones (Table 2). Therefore, it may be effective to use Alexandria chicken strain as a line of dams in crossbreeding programs for producing chickens with heavy weights and increased weight gains. The same results were obtained by Hanafi and Iraqi (2001) and Saadey *et al*. (2008), who found that, the crossing between Sinai and White Leghorn breed showed the best maternal effect through six crosses used in their studies. Therefore, the recommendation using the White Leghorn as a dam breed in crossbreeding programs with local chicken strain. Also, significant differences in body weight among purebred and crossbred chickens were obtained by many investigators (Razuki and AL-Shaheen, 2011; Abou EL-Ghar *et al*., 2012; Amin *et al*., 2013, 2017and Lalev *et al*., 2014).

Maternal line effects for egg production traits in the present study are shown in Table (4). These effects were significant for ASM, P10, EN90 and EM, but were non-significant for MP10 and MEN90 traits. Least-squares means of the present study showed that using Sinai as a dam line gave an advantage in terms of higher EN90, EM and P10 eggs indicating significant maternal effects. The same results were obtained by(Nawar and Bahei-EL-Deen 2000; EL-Soudany *et al.*, 2003 and Ghanem *et al.,* 2012).

IN CONCLUSION, our results suggest that crossbreeding by mating of Alexandria sires with Sinai dams is recommended to improve egg production trait, while mating of Sinai sires with Alexandria dams is recommended to improve growth traits.

Table (1): Overall means, standard deviation (SD), coefficients of variations (CV%) of body weight and body weight gain.

Trait	**Mean**	**SD**	**CV**
0- body weight, BW0	35.3	3.4	9.6
4- week body weight, BW4	226.1	46.6	20.6
8- week body weight, BW8	560.2	125.2	22.3
12- week body weight, BW12	924.6	172.2	18.6
Body weight gain (g / day)			
Body weight gain 4-8 week, BWG 4-8	11.4	4.3	37.5
Body weight gain8-12 week, BWG 8-12	13.8	5.1	36.7
Body weight gain 4-12 week, BWG 4-12	12.6	2.9	23.04
Egg production traits			
Age at sexual mating (day), ASM	149.9	19.6	13.1
The first 10 egg production (day), P10	17.4	5.6	32.3
Mean of egg production for 10 eggs(g),MP10	42.3	4.7	11.1
Egg number at 90 day (egg), EN90	38.6	11.0	28.6
Mean of egg number at 90 day (g), MEN	46.3	6.1	13.2
Egg Mass (g), EM	1792.9	595.0	33.2

Table (2): Least-squares means (±SE) for strain group as well as heterosis (H^i), maternal additive effect (G^m) and direct additive effect (G^i) of body weight.

Item	**No**	**BW0**	**BW4**	**BW8**	**BW12**
R^2 of model		0.130	0.028	0.090	0.020
Mating type					
AL*AL	49	38.4±0.4	249.3± 5.9	667.9±18.2	995.8±28.8
SI*SI	293	35.8±0.2	225.7± 2.7	586.6± 6.4	926.1±9.8
SI*AL	304	35.6±0.2	229.9±2.7	548.7±7.5	935.6±10.1
AL*SI	217	33.5±0.2	215.9±3.0	516.4±7.8	891.1±10.7
Significant	***	***	***	***	***
Pure lines difference		2.60***±0.48	23. 6***±7.10	81.23***±18.45	69.72**±26.35
Heterosis contrast H^i AL*SI (units)		-5.03***± 0.56	-29.23***±8.19	-189.34***±21.29	-95.2**±30.40
Percentage		13.5	12.3	30.17	9.9
Maternal additive effect (G^m AL-G^{m}SI)		2.15***±0.28	13.97**±4.09	32.31**±10.62	44.48*±15.17
Direct Additive effect (G^{I}AL-G^{I}SI)		0.451^{ns} ±0.56	9.66 ^{ns} ±8.19	48.92*±21.29	25.23^{ns}±30.40

ns= non-significant, *= p≤ 0.05 ,**= p≤ 0.001,***= p≤ 0.0001

Table (3): Least-squares means (±SE) for strain group as well as heterosis (H^i), maternal additive effect (G^m) and direct additive effect (G^i) of daily gain of body weight.

Item	No	BWG 4-8	BWG 8- 12	BWG 4-12
R^2 of model		0.084	0.0255	0.011
Mating type				
AL*AL	49	14.9± 0.5	11.7±0.7	13.3±0.50
SI*SI	293	12.9±0.2	12.1±0.3	12.5±0.2
SI*AL	304	11.4±0.2	13.8±0.3	12.6±0.2
AL*SI	217	10.7±0.2	13.4±0.3	12.1±0.2
Significant		***	***	*
Pure line different		2.05±0.57***	-0.411 ± 0.75^{ns}	0.82 ± 0.44^{ns}
Heterosis contrast H^i AL*SI (units)		$-5.71^{***}\pm0.66$	$3.36^{***}\pm0.87$	$-1.17^{*}\pm0.50$
Percenta		41.07	28.23	9.06
Maternal additives effect(G^mAL-G^mSI)		$0.65^{*}\pm0.33$	$0.43^{ns}\pm0.43$	$-0.54^{*}\pm0.25$
Direct additive effect(G^iAL-G^iSI)		$1.40^{*}\pm0.66$	$-0.84^{ns}\pm0.87$	$0.27^{ns}\pm0.50$

ns= non-significant, *= p≤ 0.05 ,**= p≤ 0.001,***= p≤ 0.0001

Table (4): Least-squares means (±SE) for strain group as well as heterosis (H^i), maternal additive effect (G^m) and direct additive effect (G^i) of egg production traits.

Item	No	ASM	P10	MP10	EN90	MEN90	EM
R^2 of model		0.462	0.2188	0.235	0.185	0.23	0.174
Mating type							
AL*AL	52	170.2±1.9	19.3±0.9	46.7±0.6	34.5±1.8	51.5±0.8	1770.9±101.5
SI*SI	190	154.6±0.9	16.1±0.3	42.5±0.4	41.6±0.8	47.1±0.5	1960.9±42.4
SI*AL	50	126.6±2.8	23.2± 1.1	39.2±0.3	28.6±1.1	42.4±0.3	1221.9±52.1
AL*SI	62	137.2±2.0	15.4±0.4	40.0±0.2	41.1±0.7	42.7±0.3	1757.2±35.6
Significant		***	***	***	***	***	***
Pure line different		15.66±2.2***	3.288±0.7***	4.18±0.6***	-7.19±1.5***	4.42±0.8***	-189.98±84.9*
Heterosis contrast H^i AL*SI (units)		-61.0±3.5***	3.14±1.2**	-10.0±1.01***	-6.22±2.4**	-13.47±1.3***	-752.7±133.7***
percentage		37.56	17.74	22.4	16.34	27.32	40.34
Maternal additives effect(G^mAL-G^mSI)		10.66±2.7***	-7.77±0.9***	0.78±0.7 ^{ns}	12.42±1.8***	0.30±1.02^{ns}	535.31±103.2***
Direct additive effect(G^iAL-G^iSI)		5.00±3.5^{ns}	11.06±1.2***	3.39±1.01***	-19.62±2.4***	4.11±1.3*	-725.29±133.7***

ns= non-significant, *= p≤ 0.05 ,**= p≤ 0.001,***= p≤ 0.0001

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الملخص العربي

تحليل مكونات قوه الخليط في الخلط ما بين سلالتين من الدجاج المحلي المصري

وليد صلاح الطحاوي

قسم الانتاج الحيوانى والداجنى - كليه الزراعه- جامعه دمنهور

أجريت هذه الدراسة في وحدة بحوث الدواجن (بمزرعة البستان) ، بقسم الانتاج الحيوانى والداجنى ، كلية الزراعة ، جامعة دمنهور. كان الهدف من االدراسه هو تقدير التأثير الاموى وتقدير قوه الهجين لصفات النمو وصفات انتاج البيض للخليط الناتج من تزاوج سلاله دجاج سينا المحلي مع سلاله الاسكندراني المحلية تحت الظروف البيئيه المصريه. كانت النسبه المئويه لقوه الخليط لصفه وزن الجسم عند عمر 8 اسابيع مرتفعه بنسبه 30.17 % ثم انخفضت الي 9.9 % عند عمر 12 اسبوع .قوه الخليط لصفات انتاج البيض كان لها تاثير معنوي سلبي. النسبه المئويه لقوه الخليط لصفه عمر البلوغ الجنسى كانت 37.56٪ و 40.34٪ لصفه كتلة البيض. التاثير الاموي لصفه وزن الجسم كان ذو تاثير معنوي في مراحل العمر المختلفه. كانت أوزان الجسم للكتاكيت الناتجه من أمهات سلاله الاسكندرانى مرتفعه في الوزن بشكل معنوي كبير عن اوزان الكتاكيت الناتجه من أمهات سلاله سينا.التاثير الاموى لصفات انتاج البيض كان معنويا لصفه عمر البلوغ الجنسى وعدد البيض خلال اول 90 يوم من البلوغ وكذلك صفه كتله البيض.

الخلاصه : يوصى باستخدام سلالة الإسكندراني كخط امهات في برامج التهجين لإنتاج كتاكيت ذات وزن جسم مرتفع وزياده وزن الجسم المكتسب. لتحسين صفات انتاج البيض تستخدم سلاله سينا كخط امهات وسلاله الاسكندرانى كخط اباء.