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GENETIC EVALUATION FOR GLUTATHIONE PEROXIDASE AND PRODUCTIVE PERFORMANCE TRAITS OF CHICKENS

By

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Abstract: *Prior to study, 17 breeds or strains were screened according to their performance, then ten genotypes of them were chosen to meet all levels of production based on their glutathione peroxidase (GSH-Px) at 56 days of age and two genotypes were chosen showing the highest Rhode Island Red (RIR) and the lowest enzyme activities (Gimmizah).A crossbreeding experiment was carried out between two genotypes of chickens namely RIR as standard foreign breeds and Gimmizah as developed strains. Two crosses were made: RIR x Gimmizah and its reciprocal cross (Gimmizah x RIR dams) to study crossing effects on variance components of the studied traits with an approach to potence ratio. The studied traits were GSH-Px , body weight (BW) at one, 28, 56, 84,112 days of age, 5% and peak of egg production., egg production related traits (age at sexual maturity, ASM, egg number, EN, rate of lay, RL, egg weight, EW and egg mass, EM)and fitness traits.*

Samples were taken at previous mentioned ages. Results showed that RIR had higher GSH-Px$_{28}$, GSH-Px$_{56,}$ GSH-Px$_{84}$, BW$_{84}$, BW$_{5\%}$, EN$_{180}$, EM$_{90}$ and EM$_{180}$ than other genotypes. Whereas, Gimmizah had higher GSH-Px$_{1,}$ GSH-Px$_{5\%,}$ EN$_{90,}$ hatchablity% and mortality than other groups . RIR x Gimmizah and its reciprocal had lower GSH-Px$_{56}$, GSH-Px$_{84,}$ EN$_{90}$, EN$_{180}$, EM$_{90}$, EM$_{180}$ hatchability and mortality% than their parents.

Estimates of direct additive effect were positive and significant for GSH-Px$_{56}$ and GSH-Px$_{84}$, BW$_{5\%}$, ASM, EN$_{90}$, EN$_{180}$, egg weight (EW), EM$_{90}$ and EM$_{180}$. However, a significantly negative direct additive for GSH-Px$_{1}$ and GSH-Px$_{5\%}$ and BW$_{112}$ were found. All estimates of maternal effects were negative and significant for GSH-Px$_{28}$ and GSH-Px$_{5\%}$, EN$_{90}$, EN$_{180}$, EW, EM$_{90}$, EM$_{180}$. Similar trend of negative maternal effect was found for each of fertility, hatchability, except BW$_{112}$. Estimates of heterotic effect *were significant for most studied traits. Heterosis was negative and significant for each of GSH-Px$_{1}$, GSH-Px$_{28}$, GSH-Px$_{56}$, GSH-Px$_{84}$ and GSH-Px$_{5\%}$, BW$_{84}$, EN$_{90}$, EN$_{180}$, EM$_{90}$, EM$_{180}$, fertility, hatchability and mortality. On the other hand, heterosis% was positive and significant for each of BW$_{1}$, BW$_{112}$, ASM and EW. Estimates of PR showed that over-dominance for the dominant high parent (RIR) of GSH-Px$_{5\%}$, BW$_{56}$, EN$_{90}$, RL, EW, fertility, hatchability, mortality. There were over-dominance effects for the low parent (Gimmizah) of GSH-Px$_{28}$, GSH-Px$_{56}$, GSH-Px$_{84}$ and GSH-Px$_{Peak}$, BW$_{1}$, BW$_{84}$, BW$_{peak}$, ASM, EN$_{180}$, EM$_{180}$, abnormal chicks%.*

In conclusion, RIR was favored as a sire for for GSH-Px$_{56}$,GSH-Px$_{84}$, BW$_{5\%}$, and most egg production- related traits studied than Gim.

INTRODUCTION

Antioxidants play an important role in maintaining bird health, productivity and reproductive characteristics against free radicals which are formed as a natural consequence of the body normal metabolic activities and as part of the immune systems strategy for destroying invading microorganisms because of the detrimental effects of free radicals and toxic products of their metabolism on various metabolic processes (**Chance *et al*., 1979)**. Animals produce free radicals by-product of metabolism that can potentially damage or destroy biological molecules in cells. In this way, free radicals alter tissue proteins and lipids, causing cell damage and death **(Özturk-ürek *et al*., 2001).** Therefore, it is worthy to study antioxidants and their relationships with performance traits throughout animal life.

In general, an integrated antioxidant system has been described in avian tissues **(Surai, 2002)** and it has been suggested that the cells first and second lines of antioxidant defense is based on the activity of glutathione peroxidase (GSH-Px)**.**

The exploitation of genetically diverse stocks for improving economic traits, is one of the approaches in the breeding programs of chickens. Crossing procedures usually lead to better economic performance due to the hybrid vigor to obtain different degrees of heterosis for the goodness and welfare of man by directing the additive and non-additive effects of genes to better performance of the different traits (**Hoffmann, 2005**).

In many developing countries, the local gene pool still provides the basis for improving the poultry sector. The genetic resource base of the indigenous chickens could form the basis for genetic improvement and diversification to produce breeds adapted to local conditions. However, breeding programs for local chicken will be difficult to set-up because of the competition with commercial breeding companies which have advantages to technology and economics at large scale.

This work aimed to estimate direct additive, maternal additive, heterotic effects as well as potence ratio for the studied traits in crossbreeding experiment involving RIR and Gimmizah chickens.

MATERIALS AND METHODS

This study was conducted at El-Takamoly Poultry Project at Al-Azab which belongs to Fayoum Governorate during the period from June 2007 to February 2009. Two genotypes were chosen showing the highest (Rhode Island Red, RIR) and the lowest enzyme activities (Gimmizah).

A crossbreeding experiment was carried out between two genotypes of chickens namely RIR as a standard foreign breed and Gimmizah as a developed strain. Two crosses were made: RIR x Gimmizah and its reciprocal cross (Gimmizah x RIR) to study crossing effects on variance components of the studied traits with an approach to potence ratio. All mixed-sex chicks of the chosen genotypes were brooded on floor. All populations were maintained under similar environmental conditions. Birds were subjected to continuous light for the first week of age and then photoperiod was reduced to 16 hours of light/day. Management practices were kept uniform as possible throughout the experimental period.

From hatch to eight weeks of age, all chicks had free access *(ad libitum*) to starter diet containing 18.93% CP and 2797.1 K cal of ME/Kg. From nine weeks to the 18 weeks of age, a grower diet containing 15.05% CP, 2716.7 K cal of ME / Kg ,1.01% calcium and 0.46% available phosphorous was supplied. From 19 weeks to the 22 weeks of age, a pre-layer diet containing 18.05% CP, 2830.0 K cal of ME / Kg,1.74% calcium and 0.47% available phosphorous was supplied. From 23 weeks to the 62 weeks of age, a layer diet containing 16.07% CP, 2789.0 K cal of ME/Kg diet, 3.22% calcium and 0.42% available phosphorous according to **NRC (1994)** was used**.** During the laying period, all females received the same restricted feed (as 105g/bird for native strains and 120g /bird for developed strains) and fresh clean water was adequately supplied.

Egg production-related traits:

Age at sexual maturity (ASM, days) recorded in days at 5% egg production for each flock. Egg number (EN, egg) and egg mass (EM, g) produced during certain periods (90 and 180 days) of egg production were recorded. EM was calculated by multiplying EN by average egg weight

(EW). Rate of lay (RL, %) during the period from the first egg up to 180 days of egg production was calculated. Mortality%, fertility and hatchability were calculated.

Blood samples:

Four hundred and eighty blood samples were collected from the four genotypes (RIR , Gimmizah , RIR x Gimmizah and Gimmizah x RIR) and ten samples for each sex per each genotype were collected. Samples were taken at one,28,56,84 days of age, at 5% and at peak of egg production. Blood samples were collected at the same time from the wing vein of males and females into tubes containing 200 µL (0.2 mol/L) EDTA as anticoagulant The red cell stroma removed by centrifuging (4000 rpm x 10 minutes at 4°C). The resulted clarified supernate was collected for use in the assay. The sample was freezed at -70°C before use or stored on ice if will be assayed the same day. RBCs supernate samples were assayed for GSH-Px using UV method**.**

Statistical analysis:

Data were subjected to one-way analysis of variance to test genotype effect for tested groups using the following model**:**

$$Y_{ij} = \mu + G_i + e_{ij}$$

where:

Yij: observed value in ith genotype of the jth individual, **µ:** common mean, G_i : genotype effect and e_{ij} **:** residual error

Estimation of crossbreeding components

Estimates of direct additive effects, maternal additive effects and direct heterosis for all traits were calculated using the **Software Package CBE (Wolf, 1996)**. Estimates of each component were calculated according to **Dickerson (1969** and **1973)** as follows:

Direct additive effects:

½ [(RIR x RIR – GIMMIZAH x GIMMIZAH) – (GIMMIZAH x RIR – RIR x GIMMIZAH)].

Maternal additive effects:

½ [(**GIMMIZAH x RIR** – **RIR x GIMMIZAH**)].

Direct heterosis:

½ [(RIR x GIMMIZAH + GIMMIZAH x RIR) – (RIR x RIR + GIMMIZAH x GIMMIZAH)]

Heterosis:

Heterosis was calculated as the difference between the cross and mid-parent means. Reciprocal effect is the difference between the crosses of two parental breeds in which their roles as male or female parents are reversed.

Potence ratio (PR):

PR based on the mid-parents (MP) were determined according to equations given by **Griffing (1950)** as follows:

$$PR = \frac{F_1 - MP}{\frac{1}{2}(P_1 - P_2)}$$

where:

F_1 = mean of crosses | **MP** = mid-parents

P_1 = mean of the first parent | P_2 = mean of the second parent

PR was used to interpret the degree of dominance of one parent on the other, since the mean of F_1 crosses were very close to the mean of the dominant parent. **Mather and Jinks (1982)** reported that when PR values were around zero,-1< PR< +1, equal +1 or -1 and -1 > PR >+1, these values mean that the degrees of dominance were : no dominance, partial dominance, complete dominance and over dominance for the (dominant) high parent of the traits, respectively. The corresponding negative values of PR mean no dominance, partial dominance, complete dominance and over dominance for the low parent of the traits studied.

RESULTS AND DISCUSSION

Genotype effect:

Means presented in **tables 1 to 3** showed that each of GSH-Px , BW's, ASM, EN_{90}, EN_{180}, EW, EM_{90}, EM_{180}, hatchability% and $mortality_{1-365}$% were affected by different genotypes. There were significant differences for GSH-Px among genotypes from one day to peak of egg production RIR had higher $GSH\text{-}Px_{28}$, $GSH\text{-}Px_{56}$, $GSH\text{-}Px_{84}$ (**Table 1**), BW_{84}, $BW_{5\%}$ (**Table 2**), EN_{180}, EM_{90} and EM_{180} (**Table 3**) than other genotypes. Similarly, significant genotype effects for BW were reported by **Nawar *et al.* (2004), Aly and Abou El-Ella (2006), Amin (2007), Roshdy *et al.*(2007), Amin (2008 a and b)** and **Iraqi (2008).**

Whereas, Gimmizah had higher $GSH\text{-}Px_1$, $GSH\text{-}Px_{5\%}$ (**Table 1**), EN_{90}, hatchablity% and mortality (**Table 3**) than other groups . RIR x Gimmizah and its reciprocal had lower GSH-Px$_{56}$, GSH-Px$_{84}$(**Table 1**), EN_{90}, EN_{180}, EM_{90}, EM_{180}, hatchability and mortality% (**Table 3**) than their parents. **El-Soudany (2003)** and **Iraqi (2008)** found higher EN for some studied crosses than one or both parents. Similar trend for EM during different periods of egg production was shown by **El-Soudany (2003), Amin (2008a), Amin (2008b)** and **Iraqi (2002)**. The results of hatchability are in contradiction to those reported by **El-Soudany (2003), Amin (2008a)** that studied crosses had higher hatchability than their parents. Similar trend for mortality was shown by **Nawar and Abdou (1999)**. On the contrary, **Amin (2008a)** found that studied crosses had lower mortality than their parents.

Similarly, Gimmizah x RIR had lower GSH-Px$_{5\%}$ (**Table 1**) and BW_{84} (**Table 2**) than its parents. On the other hand, RIR x Gimmizah and its reciprocal had higher GSH-Px$_{Peak}$ (**Table 1**), BW_1 , BW_{112} (**Table 2**) and ASM (**Table 3**) than their parents. These results were in agreement with those reported by **Shaaban *et al*. (2008)** that the cross and its reciprocal had lower GSH-Px estimates than their parents. On the contrary, **Shaaban *et al*. (2004)** reported that the crosses had higher GSH-Px than one or both parents. The results of BW are in harmony with those reported by **(Amin) 2007** that some of the studied crosses showed lower BW than one of their parents. The results of ASM in this study are in contradiction to those reported by **El-Soudany (2003)**, **Amin (2008a)** and **Iraqi (2008)** that some of the studied crosses had earlier ASM than one or both parents. The RIR x Gimmizah cross had higher EW than their parents , this result is confirmed by those reported by **Iraqi (2002)**, **El-Soudany (2003), Amin (2008a)** and **Ghanem *et al.*(2008)** that some crosses studied had heavier EW than one or both parents

Parent difference:

Estimates of parent differences were significant for most studied traits except GSH-Px$_{28}$, GSH-Px $_{Peak}$ (**Table 1**), BW_1 , BW_{56}, BW_{84} and BW_{Peak} (**Table 2**). Whereas, estimates of parent differences were insignificant for egg production–related traits, fitness traits and abnormal chick but ASM, RL $_{ASM\text{-}180days}$ and EW were significant (**Table 3**) The RIR had higher GSH-Px$_{56}$, GSH-Px$_{84}$ (**Table 1**), $BW_{5\%}$ (**Table 2**), ASM and EW(**Table 3**) than Gimmizah. However, Gimmizah was significantly superior in GSH-Px$_1$, GSH-Px$_{5\%}$ (**Table 1**), BW_{28} and BW_{112} (**Table 2**) and had higher RL $_{ASM\text{-}180days}$ (**Table 3**) than RIR.

Cross difference :

Estimates of cross difference were significant for most studied traits indicating that the RIR x Gimmizah cross was significantly superior in GSH-Px$_{28}$, GSH-Px$_{5\%}$, GSH-Px$_{Peak}$ (**Table 1**) , BW_{84} , $BW_{5\%}$ (**Table 2**),

EN_{90}, EN_{180}, EW, EM_{90} and EM_{180}(**Table 3**) than Gimmizah x RIR cross . Generally, birds having higher BW at sexual maturity produced more eggs than those having relatively lower BW **(Mitra *et al*., 1976).** On the other hand, the Gimmizah x RIR cross was significantly superior than RIR x Gimmizah cross for $GSH\text{-}Px_1$, $GSH\text{-}Px_{56}$ and $GSH\text{-}Px_{84}$ (**Table 1**) , BW_{112} (**Table 2**) and abnormal chicks% (**Table 3**) than its reciprocal .

Direct additive effects:

Estimates of direct additive effects indicated that some estimates were positive and highly significant for $GSH\text{-}Px_{56}$ and $GSH\text{-}Px_{84}$ being 204.88 and 269.66 respectively (**Table 4**) , $BW_{5\%}$ was significant being 193.75 as shown in **(Table 5**). However, ASM, EN_{90}, EN_{180},EW, EM_{90} and EM_{180} were highly significant being 2.00, 4.93, 10.45, 1.91, 342.86 and 677.14, respectively (**Table 6**). However, a highly significantly negative direct additive effects for $GSH\text{-}Px_1$ and $GSH\text{-}Px_{5\%}$ being -159.84 and -117.73 (**Table 4**) and BW_{112} ($P \leq 0.01$, -61.50, **Table 5**). The results of additive effects for BW_{112} in the present study are in accordance with those reported by **Aly and Abou El-Ella (2006)** also found that additive effect for BW_{112} was negative. **Nawar and Abdou (1999)** showed that additive effect% for BW at sexual maturity was positive when they crossed RIR sires to Fayoumi dam.

Similarly, the reported additive effect% of BW at sexual maturity was positive and highly significant for each of White Leghorn x Saudi chickens (**Khalil *et al.*, 2004)**, RIR (**Iraqi *et al*., 2007)** and Mandarah x Matroh **(Iraqi, 2008**), while it was negative in Fayoumi chickens as reported by **Iraqi *et al*. (2007)**. The results of additive effect for ASM in the present study are confirmed with those reported by **Nawar and Abdou (1999)** that additive effect% for ASM was positive. On the other hand, additive effect% was negatively influenced ASM as reported by **Khalil *et al*. (2004)**, **Iraqi *et al*. (2007)** for Fayoumi and WL breeds. The results for additive effect of EN in this study are in accordance with those reported by **Ghanem *et al.* (2008)** that additive effects were positive for EN during 84 and 247 days of production when crossed Matroh sires to Silver Montazah (SM) dams. Similarly, **Iraqi (2008)** showed that additive effects% were positive for EN during 84 and 210 days of production. Negative trend, was reported by **Ghanem *et al.* (2008)** for that trait during 84 and 247 days of production when they crossed Matroh x Inshas and Matroh x Mandarah.

The results for additive effect% of EW in this study are confirmed by those reported by **Nawar and Abdou (1999)** and **Iraqi (2002)** that additive effect% for EW were positive. Similar trend was obtained by

Ghanem *et al.*(2008) in the cross of Matroh x SM and Matroh x Mandarah for this trait. Similar positive trend for additive effect % of EM_{90} in the present study is confirmed by **Nawar and Abdou (1999)** and **Iraqi (2008)**.

Maternal additive effects

All estimates of maternal effects were negative and highly significant for $GSH\text{-}Px_{28}$ and $GSH\text{-}Px_{5\%}$ (-26.00 and -78.67**)** as shown in (**Table 4).** Also, EN_{90}, EN_{180}, EW, EM_{90}, EM_{180} were highly significant being -4.96, -10.09, -1.64, -336.82 and -671.86, respectively as shown in **(Table 6**). Similar trend of negative maternal effect was found for each of fertility (-1.78, P≤0.05), hatchability (P≤0.01,-1.94) as shown in **Table 6,** whereas the BW_{112} was 34.25 at P≤0.01(**Table 5**). **Aly and Abou El-Ella (2006)** reported similar trend of negative maternal effect for BW_{112}. The results of maternal effect% in the present study for ASM are in harmony with the negative maternal effect % of this trait reported by **Iraqi *et al.* (2007)** for Dand chickens. Conversely**, Khalil *et al*. (2004)** reported positive maternal effect% for ASM in the cross of WL x BB Saudi chickens. Also, **Iraqi (2008)** found insignificant positive maternal effect% for ASM.

Negative maternal effect% for both EN_{90} and EM_{90} in the present study are confirmed by those reported by **Iraqi (2008)** being-4.65% and -3.86. Similarly, **Nawar and Abdou (1999)** found that the maternal effect% for EW was negative when they crossed RIR sires and Fayoumi dams. On the other hand, **Iraqi (2002)** reported positive maternal effect% for EW. Similar positive trend of maternal effect for EW at 90 days of production was reported for Matroh x SM and Matroh x Inshas crosses by **Ghanem *et al.*(2008).** Similarly, **Nawar and Abdou (1999)** reported that maternal effect% for EM at 84 days of production and hatchability were positive whereas fertility was negative.

Heterotic effects:

Estimates of heterotic effects were significant for most studied traits. Heterosis was negative and significant for each of $GSH\text{-}Px_1$, $GSH\text{-}Px_{28}$, $GSH\text{-}Px_{56}$, $GSH\text{-}Px_{84}$ and $GSH\text{-}Px_{5\%}$, $BW_{84,}$ EN_{90}, EN_{180}, EM_{90}, EM_{180}, fertility, hatchability and mortality (-127.26,-425.40, -563.53, -651.76, -656.62 in **Table 4** , -120.72 in **Table 5**, -12.17, -24.71, - 430.31, -865.42, -6.10, -7.38 and -0.79 at P≤0.01, respectively in **Table 6**). On the other hand, heterosis% was positive and significant for each of BW_1, BW_{112}, ASM and EW (2.88 and 91.50 in **Table 5**, 12.99 and 3.04 at P≤0.01 in **Table 6**). Several authors reported that heterosis% was positive for BW_1 (**Aly and Abou El-Ella, 2006** and **Amin, 2007**), BW_{84} days of age (**Aly and Abou El-Ella, 2006** and **Amin, 2007**), BW_{112} days of age (**El-Soudany,**

2003 and **Amin, 2007**), ASM (**Amin, 2008a**), EW (**El-Soudany, 2003 and Amin, 2008b**), EN (**El-Soudany, 2003 and Iraqi, 2008**), EM (**El-Soudany, 2003** and **Iraqi, 2008**). On the other hand, many investigators reported that heterosis% was negative for BW_1 and BW_{112} (**Aly and Abou El-Ella, 2006**), **ASM (El-Soudany, 2003**) EW (**El-Soudany, 2003** and **Ghanem *et al.*, 2008**), EN (**Ghanem *et al.*, 2008**), fertility, hatchability (**El-Soudany, 2003, Aly and El-Sahn, 2006** and **Amin, 2008a**), mortality (**Amin, 2007** and **2008b**). When offspring are considered to be better, or more fit for survival than their parents, positive heterotic effects in the first generation may have resulted from two possible causes : Firstly, direct individual heterosis which resulted from uniting pairs of somatic genes (**Sheridan, 1981**) and secondly the intra or inter allelic interactions **(Dickerson, 1992).**

Potence ratio:

Estimates of PR are presented in **Tables from 4 to 6** indicated that these estimates ranging from -161.83 to 304.25. Estimates of PR showed that over-dominance were shown for the dominant high parent (RIR) of GSH-$Px_{5\%}$, BW_{56}, EN_{90}, RL, EW, fertility, hatchability, mortality being 3.34 (**Table 4)**, 2.08 (**Table 5)**, 304.25, 87.81, 11.26, 22.18, 13.92 and 158, respectively **(Table 6)**. Similar trend of over-dominance PR for BW_{56} of Gimmizah x Bandarah was reported by **Aly *et al.*(2005)** for Kosmos x GM and Mandarah x Kosmos crosses **(Amin, 2007)**. However, **Amin (2007)** reported partial to over-dominance for the low parent of the same trait for Kosmos x Mandarah, Mandarah x GM, GM x Kosmos and GM x Mandarah crosses.

There were over-dominance effects for the low parent (Gimmizah) of GSH-Px_{28}, GSH-Px_{56}, GSH-Px_{84} and GSH-Px_{Peak}, BW_1, BW_{84}, BW_{peak}, ASM, EN_{180}, EM_{180}, abnormal chicks%, (-22.90, -2.44, -2.24,-4.69 in **Table 4**,-4.97,-3.71 , -51.00 in **Table 5**, -23.50,-68.67, -161.83 and -2.93 in **Table 6**, respectively). Similar trends of over-dominance for the low parent for both $BW_1$of Mandarah x GM, GM x Kosmos and GM x Mandarah crosses and BW_{84} of Kosmos x GM, Mandarah x GM and Mandarah x Kosmos crosses were reported by **Amin (2007)**. However, there was over-dominance for BW_1 for the Gimmizah x Bandarah cross **(Aly *et al.*, 2005)**. Partial dominance for RIR parent was shown in GSH-Px_1, BW_{28} and $BW_{5\%}$ being 0.95 in **Table 4**, 0.46 and 0.62 in **Table 5**, respectively. Similar trend of partial dominance for the high parent for BW_{28} of Gimmizah x Bandarah cross (**Aly *et al.*, 2005)** and Kosmos x GM cross was reported by **Amin (2007)**. On the other hand, there were partial dominance of BW_{28} for the low parent of Bandarah x Gimmizah cross (**Aly *et al.*, 2005)**, for Mandarah x Kosmos and GM x Kosmos crosses as reported by **Amin (2007)**. There were no dominance in BW_{112}.

In conclusion, RIR was favored as a sire for for GSH-Px_{56} ,GSH-Px_{84}, $BW_{5\%}$, and most egg production- related traits studied than Gim.

Table (3) Heterosis percentages from mid parent (MP) and high parent (HP) for some egg production traits

Crosses		Traits								
		ASM	BW	EN1	EW1	EN2	EW2	EN3	EW3	EM
Single Crosses	H%(MP)	5.4	-0.02	-21	-0.8	6	-17.0	19	-1.3	15.4
	H%(HP)	19.3	-8.9	-33	-14.3	-10	-12.9	-3	-11.9	-15.3
MnxLB	H%(MP)	8.5	-0.6	-16	-6.7	-5	-5.4	6	-3.9	0.2
	H%(HP)	19.2	-8.1	-29	-16.3	-17	-13.7	-11	-11.8	-21.9
SMxLB	H%(MP)	8.6	-4.1	-32	-2.4	8	-4.1	18	-4.5	11.1
	H%(HP)	19.4	-9.7	-38	-12.4	-2	-12.0	4	-12.0	-8.6
3-way Crosses	H%(MP)	-11.5	-6.1	53	-3.3	19	-1.5	18	-2.6	14.7
	H%(HP)	-0.1	-11.6	19	-12.5	17	-10.0	15	-10.3	3.1
MnxSMxLB	H%(MP)	-8.0	-5.6	30	-2.4	17	-2.1	19	-4.5	12.7
	H%(HP)	0.8	-9.4	12	-10.4	7	-8.8	12	-10.1	0.3
SMxMnxLB	H%(MP)	-9.7	-9.4	56	-9.1	17	-5.5	16	-4.9	10.6
	H%(HP)	-1.0	-13.8	26	-14.7	16	-11.2	19	-10.6	5.8

ASM = age at sexual maturity, BW = Body weight at sexual maturity, EN1 = Egg number at the 1st 90 d. of laying, EW1 = Egg weight at the 1st 90 d. of laying, EN2 = Egg number at 240 d. of laying, EW2 = Egg weight at 240 d. of laying, EN3 = Egg number at 52 wks. of laying, EW3 = Egg weight at 52 wks. of laying, EM = Egg mass at 52 wks. of laying, LB = the commercial laying hens Lohman Brown, Mn = Mandarah strain, SM = Silver Montazah strain, S.C = single 3-way = 3-way crosses, (MP) = mid parent, (HP)= high parent (LB), H% = Heterosis percentages

Table 2. Means ± SE for BW, parent and cross differences at different ages.

Trait	RIR	Gimmizah	RIRx Gimmizah	Gimmizah x RIR	Parent difference	Cross difference
BW_1	**31.99±1.08^b**	**33.15±0.66^{ab}**	**35.36±0.83^a**	**35.55±0.79^a**	**-1.16^{NS}**	**-0.19 ^{NS}**
BW_{28}	**247.5±6.76^a**	**277.5±11.17^a**	**256.3±8.60^a**	**255.05±8.4^a**	**-30.00***	**1.25 ^{NS}**
BW_{56}	**615±22.40^a**	**657.5±17.50^a**	**597.65±26.10^a**	**586.35±32.14^a**	**-42.5 ^{NS}**	**11.30 ^{NS}**
BW_{84}	**1125±49.02^a**	**1060±36.75^{ab}**	**996.95±47.25^{ab}**	**946.6±49.89^b**	**650 ^{NS}**	**50.35***
BW_{112}	**1417±1.99^d**	**1471.5±1.50^c**	**1501.5±1.50^b**	**1570±1.06^a**	**-54.50****	**-68.50****
$BW_{5\%}$	**1942.5±89.64^a**	**1630±59.67^b**	**1920±102.09^a**	**1845±88.37^{ab}**	**312.5****	**75.00***
BW_{Peak}	**2108.75±90.18^a**	**2107.5±99.73^a**	**2060±90.34^a**	**2092.5±85.28^a**	**1.25 ^{NS}**	**32.50 ^{NS}**

Means having different superscripts within each row are significantly different (P≤0.05).
NS: Not significant,*: Significant at P≤0.05, **: Significant at P≤0.01 and ***: Significant at P≤0.001

Table 3. Means ± SE for egg production–related traits, fitness traits and abnormal chick of the tested genotypes

Trait	RIR	Gimmizah	RIRx Gimmizah	Gimmizah x RIR	Parent difference	Cross difference
ASM, day	**126.00±0.49^{c}**	**122.00±0.49^{b}**	**137.00±0.49^{a}**	**137.00±0.49^{a}**	**4.00***	**0.00^{NS}**
EN_{90}, egg	**58.37±0.25^{a}**	**58.45±0.22^{a}**	**51.21±0.10^{b}**	**41.27±0.13^{c}**	**-0.08^{NS}**	**10.00****
EN_{180}, egg	**116.72±0.36^{a}**	**116.00±0.25^{a}**	**101.73±0.37^{b}**	**81.55±0.28^{c}**	**0.72^{NS}**	**20.18***
RL% $_{ASM-180days}$	**65.25±7.45^{a}**	**65.56±4.25^{a}**	**57.47±8.03^{a}**	**46.15±11.34^{a}**	**-0.31***	**11.32^{NS}**
EW, gm	**48.24±0.85^{b}**	**47.70±0.85^{b}**	**52.65±0.74^{a}**	**49.37±0.74^{b}**	**0.46****	**3.28****
EM_{90}, gm	**2818.57±0.28^{a}**	**2806.5±0.25^{b}**	**2719.05±0.1^{c}**	**2045.40±0.20^{d}**	**12.07^{NS}**	**673.65*****
EM_{180}, gm	**5639.60±0.30^{a}**	**5628.90±0.45^{b}**	**5440.60±0.30^{c}**	**4096.87±0.44^{d}**	**10.70^{NS}**	**1343.73*****
Fertility%	**89.82±2.13^{a}**	**90.37±2.98^{a}**	**85.77±1.44^{a}**	**82.22±0.8^{a}**	**-0.55^{NS}**	**3.55^{NS}**
Hatchability%	**85.9±1.86^{a}**	**86.96±3.11^{a}**	**80.99±1.45^{ab}**	**77.11±0.44^{b}**	**-1.06^{NS}**	**3.88^{NS}**
$Mortality_{1-365}$ %	**0.79±0.25^{a}**	**0.80±0.25^{a}**	**0.004±0.02^{b}**	**0.005±0.003^{b}**	**-0.01^{NS}**	**-0.002^{NS}**
Abnormal chicks%	**1.81±0.7^{a}**	**1.43±0.61^{a}**	**1.00±0.58^{a}**	**1.33±0.77^{a}**	**0.38^{NS}**	**-0.33***

Means having different superscripts within each row are significantly different ($P \le 0.05$).
NS: Not significant,*: Significant at $P \le 0.05$, **: Significant at $P \le 0.01$ and ***: Significant at $P \le 0.001$

Table 4. Estimates of direct additive, maternal additive, heterotic effects and PR for GSH-Px at different ages

Trait	Additive effects ±Sd RIR♂ xGimmizah♀	Maternal effects ±Sd	Heterotic effects ± Sd	PR
$GSH\text{-}Px_1$	$-159.84 \pm 17.78^{**}$	27.04 ± 15.21^{NS}	$-127.26 \pm 17.78^{**}$	0.95
$GSH\text{-}Px_{28}$	44.58 ± 27.07^{NS}	$-26.00 \pm 8.19^{**}$	$-425.40 \pm 27.07^{**}$	-22.9
$GSH\text{-}Px_{56}$	$204.88 \pm 29.60^{**}$	25.88 ± 23.67^{NS}	$-563.53 \pm 29.60^{**}$	-2.44
$GSH\text{-}Px_{84}$	$269.66 \pm 38.59^{**}$	21.46 ± 13.26^{NS}	$-651.76 \pm 38.59^{**}$	-2.24
$GSH\text{-}Px_{5\%}$	$-117.73 \pm 37.09^{**}$	$-78.67 \pm 21.74^{**}$	$-656.62 \pm 37.09^{**}$	3.34
$GSH\text{-}Px_{Peak}$	-21.15 ± 70.73^{NS}	-2.72 ± 40.78^{NS}	111.88 ± 70.73^{NS}	-4.69

NS: Not significant,*: Significant at P≤0.05, **: Significant at P≤0.01 and ***: Significant at P≤0.001

Table 5. Estimates of direct additive, maternal additive, heterotic effects and PR for BW at different ages

Trait	Additive effects ±Sd RIR♂ xGimmizah♀	Maternal effects ±Sd	Heterotic effects ±Sd	PR
BW_1	-0.68 ± 0.85^{NS}	0.09 ± 0.57^{NS}	$2.88 \pm 0.85^{**}$	-4.97
BW_{28}	-14.36 ± 8.87^{NS}	-0.62 ± 6.01^{NS}	-6.82 ± 8.87^{NS}	0.46
BW_{56}	-15.6 ± 25.16^{NS}	-5.65 ± 20.76^{NS}	-44.24 ± 25.16^{NS}	2.08
BW_{84}	57.67 ± 46.03^{NS}	-25.17 ± 34.35^{NS}	$-120.72 \pm 46.03^{**}$	-3.71
BW_{112}	$-61.50 \pm 1.54^{**}$	$34.25 \pm 0.92^{**}$	$91.50 \pm 1.55^{**}$	0.00
$BW_{5\%}$	$193.75 \pm 86.35^{*}$	-37.5 ± 67.51^{NS}	96.25 ± 86.35^{NS}	0.62
BW_{Peak}	-15.62 ± 91.53^{NS}	16.25 ± 62.11^{NS}	-31.87 ± 91.53^{NS}	-51.00

NS: Not significant,*: Significant at P≤0.05, **: Significant at P≤0.01 and ***: Significant at P≤0.001

Table 6. Estimates of direct additive, maternal additive, heterotic effects and PR egg production-related and fitness traits

Trait	Additive effects ±Sd RIR♂ xGimmizah♀	Maternal effects ±Sd	Heterotic effects ± Sd	PR
ASM	$2.00 \pm 0.49^{**}$	$-0.1E^5 \pm 0.35^{NS}$	$12.99 \pm 0.49^{**}$	-23.50
EN_{90}	$4.93 \pm 0.43^{**}$	$-4.96 \pm 0.28^{**}$	$-12.17 \pm 0.43^{**}$	304.25
EN_{180}	$10.45 \pm 1.57^{**}$	$-10.09 \pm 1.16^{**}$	$-24.71 \pm 1.57^{**}$	-68.67
$RL\%_{ASM\text{-}180\ day}$	5.51 ± 8.16^{NS}	-5.66 ± 6.95^{NS}	-13.59 ± 8.16^{NS}	87.81
EW	$1.91 \pm 0.76^{**}$	$-1.64 \pm 0.47^{**}$	$3.04 \pm 0.76^{**}$	11.26
EM_{90}	$342.86 \pm 9.68^{**}$	$-336.82 \pm 3.37^{**}$	$-430.31 \pm 9.68^{**}$	-0.66
EM_{180}	$677.14 \pm 4.73^{**}$	$-671.86 \pm 4.16^{**}$	$-865.42 \pm 4.73^{**}$	-161.83
Fertility%	1.50 ± 2.01^{NS}	$-1.78 \pm 0.82^{*}$	$-6.1 \pm 2.01^{**}$	22.18
Hatchability%	1.41 ± 1.96^{NS}	$-1.94 \pm 0.75^{**}$	$-7.38 \pm 1.96^{**}$	13.92
$Mortality_{1\text{-}364days}\%$	0.004 ± 0.18^{NS}	0.0009 ± 0.01^{NS}	$-0.79 \pm 0.18^{**}$	158
Abnormal chicks%	0.02 ± 0.67^{NS}	0.17 ± 0.48^{NS}	-0.46 ± 0.67^{NS}	-2.93

NS: Not significant,*: Significant at P≤0.05, **: Significant at P≤0.01 and ***: Significant at P≤0.001

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الملخص العربى

قبيل الدراسة تم مسح 17 نوع و سلالة تبعا لأدائها الانتاجى كدراسة تمهيدية. وتم بعدئذ اختيار عشرة تراكيب وراثية تبعا لإنتاجيتها و نشاط انزيم الجلوتاثيون بيروكسيديز (GSH-Px) فى كرات الدم الحمراء و وزن الجسم . تم إختيار التركيبين الوراثيين اللذين اظهرا أعلى(الرود ايلند الأحمر) و أقل (الجميزة) نشاط لإنزيم GSH-Px. تم عمل خلط بين الرود ايلند الأحمر و الجميزة و الخلط العكسى لهما لدراسة تأثير الخلط على مكونات التباين للصفات المدروسة كسبيل لمعرفة قوة النفاذية على الصفات المدروسة وهى نشاط انزيم الجلوتاثيون بيروكسيديز ووزن الجسم عند أعمار يوم ، 28 ، 56 ،84 يوم، عند 5% وقمة انتاج البيض والصفات المرتبطة بانتاج البيض وصفات المواءمة.

كانت قيم التأثيرات الاضافية المباشرة موجبة ومعنوية لصفان نشاط الانزيم عند 56 ، 84 يوم ، وزن الجسم عند 5% من انتاج البيض والعمر عند النضج الجنسى وعدد البيض خلال 90 و180 يوم ووزن البيضة وكتلة البيض عند 90 و180 يوم . ولكنها كانت عالية المعنوية وسالبة لنشاط الانزيم عند عمر يوم ، 5% من انتاج البيض، وزن الجسم عند 112 يوم. كانت التأثيرات الاضافية الأميه كلها سالبة وعالية المعنوية لنشاط الانزيم عند عمر 28 يوم وعند 5% من انتاج البيض وعدد البيض خلال 90 و 180 يوم ووزن البيضة وكتلة البيض عند 90 و180 يوم وكذلك نسبتى الخصوبة والفقس. كانت قيم قوة الهجين معنوية لمعظم الصفات المدروسة وكانت سالبة ومعنوية لصفات نشاط الانزيم فى الأعمار يوم، 28 ،56 ، 84 ،و عند 5% من الانتاج وكذلك وزن الجسم عندعمر 84 وعدد البيض خلال 90 و 180 يوم و كتلة البيض عند 180 يوم ونسب كل من الخصوبة والفقس والنفوق . على الجانب الاخر كانت موجبة وعالية المعنوية لوزن الجسم عند عمر يوم و 112 يوم والعمر عند النضج الجنسى ووزن البيضة.

قوة النفاذية أظهرت سيادة فائقة للأب (الرود ايلند الأحمر) لنشاط الانزيم عند 5% من انتاج البيض،وزن الجسم عند عمر 56 يوم وعدد البيض خلال 90 يوم و نسبة انتاج البيض ووزن البيضة ونسب كل من الخصوبة والفقس و النفوق.وجدت سيادة فائقة للأب (الجميزة) لنشاط الانزيم عند الأعمار 28 ،56 ،84، قمة انتاج البيض، وزن الجسم عند عمر يوم ، 84 وعند قمة انتاج البيض و العمر عند النضج الجنسى وعدد البيض خلال 180 يوم وكتلة البيض عند 180 يوم و كذلك نسبة الكتاكيت المشوهة. وجد عدم سيادة لصف وزن الجسم عند عمر 112 يوم.

نخلص من هذا الى ان الرود ايلند الأحمر كأب كان الأفضل بالنسبة لصفات نشاط الإنزيم عند عمر 56 يوم وعند 84 يوم وزن الجسم عند 5% من إنتاج البيض وكذلك في معظم الصفات المتعلقة بإنتاج البيض المدروسة عن الجميزة.