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Effect of a reciprocal cross between local and commercial chickens on hatchability and estimating some genetic parameters

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ABSTRACT

This study was carried out at Kani Graw field –around Erbil city during the breeding season 2021 by using two genetic groups of chickens, Kurdish local chickens (KK) and Super Harco commercial dual purpose chickens (HH), which were reciprocally mated to produce four combinations (HH , KK ,HK and KH) to estimate crossbreeding effects, general combining ability (GCA) and specific combining ability (SCA), heterotic effect percent (H%), and direct additive effect (DAE) for hatching traits in pure chickens and their crosses. Furthermore, GCA and SCA were also used to estimate breeding value (BV) and genetic value (GVFM) for two parents and their crosses. The results indicated that significant differences among genetic groups in fertility percentage (F%) and chick weight (CW) however did not observe any significant differences in egg weight (EW) , hatchability of total eggs percentage (HTE%) and embryonic dead rate (ED%). However there were no significant difference between H×K cross and it's reciprocal K ×H in EW, HTE% , F% and ED% traits, furthermore, the reciprocal crosses(K×H) had recorded statistically the highest values for HTE%, F% and CW compared to the other genotypes, the KK genotype was recorded positive values of GCA for EW , HTE% , F% and ED% traits.. the reciprocal crosses (K × H) was recorded the positive and high estimates of SCA for HTE % , F % and ED % traits while, H x K had the highest positive estimates for EW trait compared to the other genotypes. percentages of Heterotic (H %) for the H x K cross and K x H reciprocal were recorded positive values of HTE% ,F% and ED% traits were found. On the other hand both cross and reciprocal were negative value for CW . The KK genotype had significant and positive values of direct additive effect (DAE) for F% and ED % traits. Both of the HH and KK genotypes had negative value of DAE for CW trait, KK strain and H× K cross had the highest expected breeding values for HTE% and F % traits. both of HH , KK and H×K genotypes had the negative breeding values for EW and CW, while, K×H reciprocal had the highest values of HTE% , F% and ED % traits. In addition , genetic value of KS had the highest value in H% , F% and ED% .

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INTRODUCTION

Fertility and Hatchability estimations include the combination of the ova and sperm cells that results in the development and hatching of a live chick at the end of the incubation period. In poultry, fertility indicates the proportion of fertile eggs incubated, whilst hatchability belongs to the percentage of fertile eggs that hatch. The percentage hatchability of the total number of chicks to be hatched is influenced by the estimation of egg fertility. Fertility and hatchability are essential indicators in measuring the economic efficiency of parent populations since they are both indicators of a bird's genetic and reproductive fitness. (Ahmedin and Mangistu, 2016).

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Iraqi Local chickens are recognized by their adaptation, resistance to common disease in the region, and poor productivity when compared to commercial chickens. The raising demand of human consumption for meat and egg in Iraq requires plan to improve local chickens to meet the requirements. (Abdullah, 2020) Kurdish local chickens is an Iraqi local chickens and to their environmental condition, it could be used in the crossbreeding plans to enhance their productivity. The genetic resource base of the indigenous chickens could form the basis for genetic improvement and diversification programs to produce breeds adapted to local conditions (Saadey et al, 2008). Diallel cross is one of the breeding methods that is used to test the combination ability of pure lines. Cross-crossing is mainly used to estimate the genetic components of quantitative traits and also to estimate the combination ability of various lines which inbred, and to provide information about the breed which is used in cross-breeding and selection programs, this due to increase in the frequency of crosses. Heterozygous genotypes in the population and low frequency of homologous genotypes (Siwendu et al., 2012). Cross-crossing is also used in poultry farming for the purpose of forming a broad genetic base and producing a new generation of lines that superior breeds through cross-breeding between different breeds. (Saaddey, 2008), it is considered an important way to increase production and obtaining the hybrid vigor. (Youssef et al., 2008). Several researchers (Abou El-Ghar et al., 2003) revealed that the estimated dominant effect is large for egg production traits, whereas others believe that the additive effect is significantly greater than the dominant effect. Many studies found that general combining ability (additive genetic effects) was significant and high value, but specific combining ability (non-additive effects) which include dominance and epistasis (Mohamed et al., 2005; Aly et al., 2005; Amin, 2007). the purpose of current study is to estimate crossbreeding effects, general combining ability (GCA) and specific combining ability (SCA), percentage of heterotic effect (H%), and, direct additive effect (DAE), breeding value (BV) and genetic value (GVFM) for egg hatching traits in Kurdish local chickens with Super Harco commercial chickens and their crosses.

MATERIALS AND METHODS

This experiment was conducted at Kani Graw private field during the breeding season 2021. One local breed (Kurdish, KK) and one commercial chicken strains, Super Harco (HH) were used. The local strain was collected from different villages around Erbil city while the commercial breed was obtained from the same field which imported from Hungary, it was widely bred as dual purpose. The chicks appeared to be in good health, having been vaccinated against the most common diseases. (according to the veterinarian instructions). the feeding system and lighting programme were used according ISA –Brown guidance. The mating plan was done in 2 x 2 full diallel to produce four combinations among these genotypes had been done (2 pure lines and 2 crosses), which are KK, HH, KH and HK, each genotype include five families also each family contains one male and 7 females. at 30 weeks of ages 360 fertile eggs of Kurdish local chickens with Super Harco commercial chickens and their crosses were collected to measure egg hatch traits.

Hatch traits

collected eggs were cleaned and kept in a cool place at a temperature of 10°C and a relative humidity of 70%. The eggs were incubated for eighteen days at 37.5°C and 55 percent relative humidity before being transferred to a hatch at 37.2°C and 70 percent relative humidity. egg weight loss was measured, eggs from each pure lines and their crosses were numbered and weighted just before being placed in the incubator to measure the average weight. The fertility was computed as the number of fertile eggs as a percentage of the total number of eggs laid. The number of active chicks hatched as a percentage of total eggs was used to measure hatchability. After hatching, all eggs remained after hatching were broken to measure the embryonic dead as a proportion of egg sets.

Studied Parameters

The following crossbreeding parameters for egg hatch traits were estimated according to (Falconer, 1988 and Williams, et al. 2002).

General Combining Ability (GCA): for HH and KK were calculated as the following formula
 $GCA_i = (\sum x_i / n - \mu)$

CA_i= the GCA for lines (HH and KK Genotypes), y_i = trait for offspring from the pure breeds parents, i. n= No of all offspring and μ = overall mean for egg hatch traits which was estimated from diallel crosses (2 × 2).

y_i = trait for a offspring with one parents or two parents from pure breeds i, and μ = overall mean for taken trait estimated from all 2 × 2 diallel crosses. (Odeh et al., 2003).

The GCA for (H×H) computed as:- $GCA (H \times H) = \{1/3 * [(HH) + (H \times K) + (K \times H)] - 1/4 * [(HH) + (KK) + (H \times K) + (K \times H)]\}$

Specific Combining Ability (SCA): This values of SCA for the crosses were computed as

SCA for (H×K) = $\{[(H \times K) - 1/4 * [(HH) + (KK) + (H \times K) + (K \times H)]] - [(GCA \text{ for } HH + GCA \text{ for } KK)]\}$

Heterosis (H %): was calculated according to equation:

$$H \% = \{F1 - [(MP) / 2] \times 100\}$$

Where F1 = mean of the offspring and MP = mean of two parents

Direct additive effect (DAE) for pure lines

$$DE \text{ for } (HH) = 1/2[(HH) + (HK)] - 1/3 [(HH) + (KK) + (KH)]$$

$$DE \text{ for } (KK) = 1/2[(KK) + (KH)] - 1/3 [(KK) + (HH) + (HK)]$$

Breeding values (BV) and Genetic values (GV) :

Breeding value for pure lines was calculated according to the following formula

$$BV(HH) = 2GC(HH)$$

The estimated breeding value of any cross between two parents is the total of the GCA of the both sex (male and female) . BVFM= GCAF + GCAM

Genetic Value (GV): The GCA for pure breeds parents and the SCA of the same cross are expressed by the genetic value of a cross, which is computed using the formula:

$$GV(HK) = GCA(H) + GCA(K) + SCA(HK)$$

Statistical analyses

The completely randomized design was used to analyze data, the general linear model procedure of (SAS, 2005) also used for variation between the genotypes. Duncan's multiple range test (Duncan, 1955) used to compare among means.

Following a linear model was used to analyze the data:

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

Where

Y_{ij} = the observed data of the ijth egg hatch trait,

μ = the overall mean,

G_i = the effect of the ith genotype,

e_{ij} = the effect of random error.

RESULTS AND DISCUSSION

The results showed that no significant differences between the two pure breeds, H × K, and K × H crosses in egg weight, hatchability of total eggs percentage (HTE %) and embryonic dead rate (ED%), eggs laid by both of H×K and K×H chickens were recorded the minimum values for the same traits, also recorded highest values for (HTE %), on the other hand the genotypes significantly effect on fertility percentage (F %) and chick weight at one day, Table (1). The pure line HH was recorded the highest values of chick weight (CW) and minimum of embryonic dead rate (36.17 g and 3.17%) respectively when compared to the other genotypes. While HH was recorded the lowest values for fertility % (75.4%) and hatchability (74.98%). Also indicated that significant differences among the HH genotype and both of its reciprocal crosses with KK genotype, Moreover the results indicated that reciprocal of K × H had the highest means for fertility and hatchability of total eggs percentages compared to the pure genotypes. Many researchers were indicated to get higher fertility rate than their parental pure genotypes (Gad et al., 1991). Significant variations among genotypes, lines and crossbreds in

hatchability traits were reported by Eltohamy et al, 2018 they reported significant difference among pure lines and its crosses in fertility % and chick weights at One day. also (Abdullah ,2007; Abdullah, 2020 ;Hermiz and Abdullah ,2020) reported that significant differences among genetic groups in chick weight ,one the other hand Amin, 2014 he found that none- significant variations among the three pure genotypes and crosses for embryonic dead rate trait. However Mohammed and Hani (2019) reported that significant differences between two lines of Iraqi local chickens in egg weight.

Table (1): Means and SE of egg hatching traits by genotypes

Genotypes	Traits				
	Egg weight (gm)	Hatchability %	Fertility %	Embryonic dead %	Chicks weight(gm)
HH	50.9a $\pm$ 1.33	74.98b $\pm$ 2.06	75.40b $\pm$ 1.94	3.17a $\pm$ 1.59	36.78a $\pm$ 0.81
KK	51.77a $\pm$ 0.75	79.99ab $\pm$ 6.67	92.38a $\pm$ 0.95	10.67a $\pm$ 4.67	34.45b $\pm$ 0.54
HK	50.4 a $\pm$ 1.04	82.37a $\pm$ 1.12	86.54 a $\pm$ 0.96	4.17 a $\pm$ 2.08	31.55 c $\pm$ 0.51
KH	49.95a $\pm$ 0.99	82.54a $\pm$ 1.84	87.89a $\pm$ 4.68	7.40a $\pm$ 2.3	32.78c $\pm$ 0.41
Overall mean	50.75 $\pm$ 0.54	79.97 $\pm$ 1.81	85.55 $\pm$ 2.19	6.35 $\pm$ 1.53	33.89 $\pm$ 0.36

HH=Super Harco $\times$ Super Harco, KK = Kurdish $\times$ Kurdish, HK= Super Harco male $\times$ Kurdish female, KH= Kurdish male $\times$ Super Harco female ,
different letters within a column for genotypes show significantly differences ($p \leq 0.05$).

General combing ability (GCA) and specific combing ability (SCA) for hatch traits

The GCA and SCA for hatch traits are existed in Table (2). The KK genotype recorded the positive and high values of GCA for EW , HTE% , F% and ED ,their data were (0.05 , 1.66 , 3.38 and 1.06) respectively ,however in chick weight was negative value , while HH genotype recorded the lowest negative values of GCA for mention above traits , The estimates of SCA showed that no significant differences between H $\times$ K cross and K $\times$ H reciprocal cross except in F% and EM% , on the other hand K $\times$ H reciprocal cross was recorded the highest positive value for HTE% , F% and ED traits , Amin (2014) found that The GCA and SCA for hatch traits , The MM genotype recorded the maximum values and positive which had significant effect of GCA for HFE% and HTE% traits, but SS genotype recorded the minimum values of GCA which was negative and significant .

Specific and reciprocal heterosis for hatch traits

Results of Table (2) indicated that K $\times$ H reciprocal cross recorded the highest value and positive of heterosis (H%) for F% (4.90%) and ED% (44.11%) while H* K cross had the highest value for HTE% (7.1%) and recorded positive value for egg weight (0.581%).on the other hand both specific heterosis and reciprocal were recorded negative value for chick weight. Same results were reported by Hossari and Dorgham (2000) they indicated positive heterotic effects on hatchability. Furthermore , Amin (2008) indicated that in turkeys (BW) cross was recorded the higher value for fertility , hatchability, embryonic dead rate of heterotic effect than the (WB) reciprocal cross , in addition, crossing improved early embryonic dead rate for crosses and reciprocal crosses . Moreover, Soliman et al ,(2020) used a crossbreeding program between local chickens (Alexandria) and commercial chickens (Lohman White) they indicated that positive value and none significant heterosis for egg weight .

Direct additive effect

Results of table (2) showed that KK genotype was recorded the highest values and significant for F% and ED% ,their data were (5.36 and 3.03)% respectively and had highest positive value for THE% ,but it was recorded negative value for egg weight and chick weight , while HH genotype was significantly the lowest values of direct additive effect for the mentioned above traits except egg weight . In addition , the HH and KK strains had the negative value for chick weight their data were (-0.60 and -0.63) respectively On the other hand, El-Delebshani et al. (2013) obtained negative values of direct additive effect for fertility and HTE

%. Furthermore, Khalil et al. (2004) recorded higher values of direct additive effects of White Leghorn when used as sired chickens than Baladi Saudi-sired hens. Taha and Abd El-Ghany (2013) indicated that (El-Salam x Mandarah) cross had positive direct additive effect for fertility %, and HTE%, also, Soliman et al., 2020 found significant negative values of direct additive effect for egg weight.

Breeding values for pure line (2GCA)

Results of table (2) showed that KK strain had the highest BV for HTE%, F% and ED% their data were (3.33, 6.77 and 2.12) respectively while HH strain recorded the lowest values for mentioned above estimates. Also both pure strains and cross were recorded negative value for egg weight and chick weight. In addition, the cross had the intermediate breeding value for the aforementioned estimates.

Genetic values

Results of table (2) showed that K x H reciprocal cross had the highest value for HTE%, F% and ED% traits, but both of cross and reciprocal cross achieved the negative values for chick weight traits. The estimations of genetic values showed that the progeny of K x H reciprocal cross recorded best performance than those of H x K cross for the former traits. The supremacy of KK as best sires in crossbreeding programs including HH genotype would be useful for enhancing most of hatch traits.

Table (2): Crossbreeding genetic estimates ($\pm$ standard error) for egg hatch traits

Genotypes	Egg weight	Hatchability %	Fertility %	Embryonic dead %	Chicks weight
GGA					
HH	-0.25b $\pm$ 0.09	-0.01b $\pm$ 0.008	-2.28b $\pm$ 0.48	-1.44b $\pm$ 0.47	-0.29a $\pm$ 0.11
KK	0.05a $\pm$ 0.03	1.66a $\pm$ 0.36	3.38a $\pm$ 0.32	1.06a $\pm$ 0.29	-0.78 a $\pm$ 0.12
SCA					
HK	0.615a $\pm$ 0.25	0.74a $\pm$ 0.38	-0.12b $\pm$ 0.03	-1.81 b $\pm$ 0.14	-1.06a $\pm$ 0.42
KH	-0.83a $\pm$ 0.22	0.91 a $\pm$ 0.29	1.23a $\pm$ 0.31	1.43 a $\pm$ 0.95	-0.01a $\pm$ 0.009
Heterosis %					
Specific Heterosis	0.581a $\pm$ 0.28	7.1a $\pm$ 1.90	3.18 a $\pm$ 0.8	7.32 b $\pm$ 1.44	-10.20a $\pm$ 1.92
Reciprocal Heterosis	-2.460a $\pm$ 0.96	6.91a $\pm$ 1.74	4.90a $\pm$ 2.54	44.11 a $\pm$ 5.32	-8.45a $\pm$ 1.57
Direct additive effect					
HH	0.28a $\pm$ 0.09	-0.50b $\pm$ 0.09	-4.25b $\pm$ 1.29	-3.41 b $\pm$ 1.13	-0.60a $\pm$ 0.29
KK	-0.5a $\pm$ 0.06	2.15a $\pm$ 0.98	5.36a $\pm$ 2.33	3.03 a $\pm$ 0.82	-0.63a $\pm$ 0.22
Breeding values					
HH	-0.51a $\pm$ 0.05	-0.01a $\pm$ 0.006	-4.55c $\pm$ 0.95	-2.88 b $\pm$ 2.83	-0.58 a $\pm$ 0.32
KK	-0.22a $\pm$ 0.03	3.33a $\pm$ 0.91	6.77a $\pm$ 1.03	2.12 a $\pm$ 0.41	-1.56a $\pm$ 0.66
HK	-0.268a $\pm$ 0.03	1.66a $\pm$ 0.78	1.11b $\pm$ 0.77	-0.38 b $\pm$ 0.16	-1.07a $\pm$ 0.29
Genetic values					
HK	0.40 a $\pm$ 0.09	2.4a $\pm$ 0.33	0.98a $\pm$ 0.144	-2.18a $\pm$ 0.27	-2.13a $\pm$ 0.64
KH	-1.35 a $\pm$ 0.83	2.57a $\pm$ 0.76	2.34a $\pm$ 1.03	1.05 a $\pm$ 0.20	-1.34a $\pm$ 0.44

means in the same column with different superscripts differ significantly ($P < 0.05$)

CONCLUSIONS

This study showed that genotypes have statistically significant on fertility percentage and chick weight except of egg weight, hatchability percentage and embryonic dead traits, based on the analysis of general combing ability Kurdish local chickens had a highest value for all traits except chick weight, in relation to direct additive effects, it could be concluded that the local chicken (KK) was the best sire strain for improving fertility. However, for egg weight the commercial chickens was better than others. positive heterosis percentages were obtained for HTE%, F% and ED% except chick weight. Regarding direct additive effect, also. Regarding

genetic value reciprocal cross (K×H) had a highest value for THE% , F% and ED% , the local chicken (KK) could be used as strain of sire to enhance egg hatch traits .

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تأثير التضريب التبادلي بين دجاج المحلي و دجاج التجاري و تقدير بعض المعالم الوراثية لصفات الفقس

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الخلاصة

أجريت هذه الدراسة في حقل كاني كراو باستخدام نوعين من الدجاج هما الدجاج المحلي الكردي (KK) ودجاج سوبر هاركو التجاري ثنائي الغرض (HH) ، في نظام خلط تبادلي لإنتاج أربع مجموعات (KK ، HK ، KH و HH) لتقدير تأثيرات التهجين ، والقابلية توافق العامة (GCA) وقابلية توافق الخاصة (SCA) ، وقوة الهجين (H%) ، والتأثير التجمعي المباشر (DAE) لصفات الفقس في الدجاج النقي والخلط. علاوة على ذلك ، تم استخدام GCA و SCA أيضًا لتقدير قيمة التربية (BV) والقيمة الوراثية (GVFM) للاباء وتهجينهما. أشارت النتائج إلى وجود فروق معنوية بين المجموعات الوراثية في نسبة الخصوبة (F%) ووزن افراخ (CW) ومع ذلك لم تلاحظ أي فروق معنوية في وزن البيض (EW) ونسبة الفقس لعدد البيض (THE%) ونسبة هلاكات الجنينية (ED%). ومع ذلك ، لم يكن هناك فرق كبير بين الخلط $K \times H$ و $K \times K$ في H و EW و HTE و F% و ED% ، علاوة على ذلك ، عطلت الخلط $(K \times H)$ أعلى قيم لصفات HTE ، F% و CW مقارنة بالتركيبات الوراثية الأخرى ، و عطلت دجاج الكردي KK قيم موجبة لـ GCA لصفات EW و HTE و F% و ED%. وايضا تم تسجيل الخلط $(K \times H)$ التقديرات الموجبة والعالية لـ SCA لصفات HTE و F% و ED% بينما كان الخلط $H \times K$ أعلى التقديرات الموجبة لصفات المذكورة سابقا مقارنة بالتركيبات الوراثية الأخرى. تم حصول على قوة الهجين (H%) لتركيبات الوراثية $H \times K$ و $K \times K$ وكان قيم موجبة لصفات HTE و F% و ED% من ناحية أخرى ، كان كلا من الخلط سجلا قيمة سالبة لـ CW. وعطت التركيب الوراثي KK قيم معنوية وموجبة للتأثير التجمعي المباشر (DAE) لصفات F% و ED%. كانت لكلا من التركيبات الوراثية HH و KK قيمة سالبة لـ DAE لصفة CW ، وكان لتركيب $K \times K$ و $H \times K$ أعلى قيم التربية لصفات HTE و F%. بينما كان لكل من التركيبات الوراثية HH و KK و HK قيم تربوية سالبة لـ EW و CW ، مع ذلك عطلت الخلط $K \times H$ أعلى قيم التربية لصفات HTE و F% ، بالإضافة إلى ذلك ، كانت القيمة الوراثية لخلط $K \times H$ أعلى قيمة في H% و F% و ED%.

الكلمات المفتاحية:
الصفات الفقس ، قابلية التوافق العامة و الخاصة ، قوة الهجين ، تأثير التجمعي ، قيمة التربية ، قيمة الوراثية