The reciprocal cross effect between local and commercial chickens on growth performance and estimating some genetic parameters

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Abstract

This study was carried out in private field Kani Graw – Erbil city during the periods from 1/8/2021 to 20/11/2021 by using two genotypes 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) . body weight among genotypes, general combining ability (GCA) and specific combing ability (SCA), heterotic effect percent (H%), and direct additive effect (DAE) for body weight in two genotypes and their crosses were investigated regarding the bodyweightat aching, 4, 8 and 12 weeks . GCA and SCA were also used to estimate breeding value (BV) and genetic value (GVFM) for two parents and their crosses.Bodyweight (BW) was measured and analyzed at 4, 8, and 12 weeks of age using full diallel analysis. The results indicated that there were significant differences (P< 0.01) among genetic groups in body weight (BW) at all stages of age. The K ×H genotype recorded the highest value in body weight at age 12 weeks. , general combining ability effects indicated that additive genetic variance was important in determining BW and revealed the superiority of the HH genotype in these traits. This genotype, therefore, may be used as one of the parents if its improvement is sought through crossbreeding. Specific combining ability was significant for BW at all ages, except at hatching, Heterosis estimates showed that crossing between Kurdish males and Super Harco females at all stages of age gave the highest heterotic effects for BW. On the other hand, both cross and reciprocal were positive values for BW at 4 and 8 weeks of age. The HH genotype had the highest value of direct additive effect (DAE) at 12 weeks of age. Both the HH and KK genotypes had negative DAE values at hatching and the HH genotype had positive breeding values for BW ,while the KK genotype had a negative value. The cross had an intermediate breeding value of body weight at the same age .In addition, the genetic value of K×H had the highest value in body weight at 8 and 12 weeks of age.

Keywords: body weight, combining ability, heterosis, additive variance, breeding and genetic values.

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Introduction

Iraqi Local chickens have adapted to the native climatic conditions and resistance to the endemic diseases, but are recognized for their low production efficiency compared to commercial chickens. (3C). Kurdish local chickens are Iraqi local chickens that differ from each other in terms of the color of their feathers, earlobe color, the shape of their comb, the color of their eggshell, and other characteristics. In addition differences in their quantitative traits, such as their body weight, feed consumption, egg production, egg size, and weight, and other characteristics local chickens differ from commercial chickens in the price of their production, such as eggs and meat which almost triples that of commercial chickens (11). The reason for the high price is that they are relatively rare and people tend to find the meat and eggs of local chickens more delicious than the meat and eggs produced by commercial chickens. The increasing demand for human consumption of meat and eggs in Iraq requires a program to improve local chickens to meet the requirements. It could be used in crossbreeding plans to improve their productivity.

The most effective breeding program for determining inferences about gene activities involved in the inheritance of a characteristic is the diallel cross. Knowledge of the nature and size of genetic diversity aids in enhancement by allowing superior nicking genetic groups/groups to be determined. (27). Various researchers have demonstrated the importance of various combining ability effects in poultry (13). Crossing local chickens with commercial lines due to increased chicken growth traits. Because local chicken breeds had high non-additive genetic variance, most of these studies indicated that crossing local breeds with commercial chickens resulted in heterotic effects (28). This would motivate breeders to enhance local chickens by crossbreeding.

Crossbreeding programs are commonly used in commercial hen breeding systems to exploit heterosis (7). Heterosis (hybrid vigor) refers to how a crossbred performs in one or more attributes compared to the average performance of the two parents.

The purpose of this study was to help improve the productivity of local chickens by improving their body weight trait through a crossbreeding program between Kurdish local chickens and super Harco commercial chickens

.Materials and Methods:

This study was carried out in the private field Kani Graw- Erbil city from the periods of 1/8/2021 until 20/11/2021. 240 chicks were obtained from a diallel cross of Kurdish local and Super Harco commercial chickens (HH), which were weighed weekly from hatching up to 12 weeks of age. The local chickens were collected from different villages around Erbil city, while the commercial breed was obtained from the same field and was imported from Hungary. It was widely bred as a dual-purpose bird. The chicks appeared to be in good health, having been vaccinated against the most common diseases (according to the veterinarian's instructions). The feeding system and lighting program were used according to Super-Harco guidance.

Six hens were selected at random for each genotype and mated with one rooster. 360 fertile eggs from Kurdish local chickens with super Harco commercial chickens and their crosses were obtained which grouped by their breeds and crossbreds. The chicks were separated after hatching based on the breeds and crossbreds four genetic groups H x H, K x K, H x K, and K x H were obtained. The hatched chicks were wing banded until six weeks old han leg banded. The chicks were weighed using a sensitive electronic balance with a sensitivity of 1 gm at 1 day, 4, 8, and 12 weeks of age.

Studied Parameters:

The following crossbreeding parameters for theweight of chicks were estimated according to Falconer(12) and Williams, *et al*.(2002).

General Combining Ability (GCA): for HH and KK were calculated as the following formula GCAi = (Σxi / n-μ)

GCAi= the GCA for lines (HH and KK Genotypes) , yi = The offspring body weights with one parents or two parents i, and μ = overall mean forbodyweight which was estimated from diallel crosses (2 ×2) (24).

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

Specific Combining Ability (SCA): This value of SCA for the crosses were computed following Odeh *et al*. (24) procedure.

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

Heterosis (H %): was calculated, according to the following equation: (Williams et al ., 2002).

H % = {F1-[(MP] / [(MP)] x 100}

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

Direct additive effect (DAE) for pure lines: (5A).

DE for (HH) =1/2[(HH) + (HK)] –1/3 [(HH)

+ (KK) + (KH)

DE for (KK) =1/2[(KK) + (KH)] – 1/3

[(KK) + (HH) + (HK)]

Breeding values and Genetic values:

The breeding value for pure lines was calculated, according to the following formula (6B).

BV (HH) = 2GC (HH).

The estimated breeding value of any cross between two parents is the total of the GCA for both sexes (males and females). BVFM= GCAF + GCAM

Genetic Value (GV): The GCA for pure breeds and the SCA of the same cross are expressed by the genetic value of a cross, which was computed, using this formula: (18).

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

Statistical Analysis

The effect of breed on body weight was examined using the completely randomized

design of the Statistical Analysis System software program's general linear model (GLM) program (29). For significant means, Duncan's multiple range test was used. The model used was as follows:

$Yij = \mu + Gi + eij$

Where

Yij = the bodyweight of chicks in i the genotypes,

μ = the overall mean,

Gi= the effect of the ith genotypes,

eij = effect of random error.

Results and Discussion:

The results showed that there was a significant difference ($P<0.01$) between two genotypes H×H, K×K and H×K, K×H crosses in body weight at hatching which the commercial chickens HH had the highest value for bodyweight followed by KK and then HK and KH, In addition, there was a significant difference ($P \leq 0.05$) between pure lines, HH, KK and crosses HK, KH at four weeks of age which the KH genotype recorded the highest value for bodyweight followed by HH, HK and KK amounted 345.32, 338, 289.1 and 237 gm respectively, whereas at the eighth week the HH line was greater in body weight than KH, HK and KK amounted 976,948,833 and703 gm, respectively. Moreover, commercial chickens (HH) surpassed the local chickens (KK) and their crossbreds (HK) in body weight at twelve weeks while KH recorded the highest value in body weight, and then followed in the order of HH, KH, and KK amounted to 1433,1414,1235 and 1087gm respectively. The difference among them was also significant. However, from the fourth week, The KH cross began to exceed the other crosses, and the crosses' supremacy extended until the twelve-week. We conclude that the KH starts at lower weights in the early ages, then the weight increases. The KH had the highest weights in the 4, 8, and 12 weeks of age and it was concluded that the hybrid breeds KH were better than pure breeds and HK crosses in the final weights (Table 1).

Several researchers stated that there were significant variations among genotypes, lines, and crossbreds in body weight traits, according to Abdulla (1). He used a diallel cross between Ross 308 and Cobb500 broiler breeders, he found that there were significant variations among genotypes at different weeks of age. These variations were due to genetic makeup. Moreover, Amin *et al.* (4) used a diallel cross between Sasso meat type and Gimmizah local chickens. They found highly significant differences ($P<0.001$) between pure lines and crosses and also indicated that SS chicks recorded the highest value in body weight at 4 and 12 weeks. For crosses, chicks of the S×G cross were greater in body weight than their reciprocal G×S, Also, significant differences ($P<0.001$) in body weight among genotypes have been indicated by many researchers (3C,15, 2B and 26).

Table-1: Means ±S.E of body weight at different ages by different lines.

Genotypes	Body weights(gm)			
	Hatch	4weeks	8 weeks	12 weeks
HH	36.78 a ± 0.81	338 a ± 17.42	976 a ± 20.39	1414 a ±39.69
KK	34.45 b ± 0.54	237.5 c ± 26.78	703 c ± 38.43	1087.5 c ±44.34
HK	31.55 c ± 0.51	289.1 b ± 12.44	833 b ± 23.73	1235 b ±33.72
KH	32.78 c ± 0.41	345.32 a ± 18.54	948 ab ± 29.75	1433.25 a ±31.75
Overall mean	33.89 ± 0.36	302.33 ± 14.48	865 ± 18.57	1289 ± 63.44

HH=Super Harco × Super Harco, KK =Kurdish × Kurdish, HK= Super Harco male × Kurdish female, KH= Kurdish male × Super Harco female,

Different letters within a column for genotypes show significant differences ($p \leq 0.05$).

General combining abilities (GCA) and specific combining abilities (SCA):

The GCA and SCA for body weight at hatching, 4, 8, and 12 weeks are presented in Table (2). Both the genotypes HH and KK were recorded negative values at hatching. On the other hand, The HH line had the highest value of GCA for body weight at 4, 8, 12 weeks compared to GCA for the KK genotype. These results indicated that the HH line is better than Kurdish local chickens.

For improving body weight at different ages. Also, GCA showed the importance of the effects of super Harco commercial chickens on body weight at different ages. The GCA values for purebreds HH and KK aid in the selection of the best combinations for using heterosis.

The estimates of SCA for both crosses (HK and KH) which means the effect of non-additive genetic components, the results SCA estimate showed significant differences ($P<0.05$) between H×K cross and K×H reciprocal cross in body weight at various ages. The cross of K×H recorded the highest value at hatch, 4, 8, 12 weeks of age compared to the H×K cross. However, results may be due to the hybrid vigor in the K×H cross.

Differences in body weight between breeds show a better opportunity to select among them to improve body weight. Significant GCA of BW was found by Razuki and AL-Shaheen (26) they indicated that GCA of BW in commercial breeds was positive and significant at different ages, The GCA and SCA for body weights were also reported by Amin (6B) that GCA of BW in males of both genotype SS and II was positive and significant at different ages. The MM genotype recorded negative and significant GCA. The SS genotype recorded the highest value GCA while the MM genotype recorded the minimum value and negative of GCA for bodyweight trait .in addition the S×I genotype had the highest

value for SCA followed by I x S at different ages, according to Tyasi et al.,(2019) used diallel cross among three local chickens which are Potchefstroom Koekoek (P), Venda (V) and Ovambo (O) and produced nine genotypes. GCA and SCA were found to be significant (P ≤0. 05) for bodyweight from hatch to 10 weeks of age. Although positive effects of GCA were obtained by the P breed as well as the positive value of SCA by the P x V crossbreed. Many researchers reported that general and specific combining abilities are very important for improving body weight at different ages. (22, 5A, 6B, 27, 9, 26 and 21),

Specific and reciprocal Heterosis for bodyweight trait: Results of Table (2) indicated that K ×H reciprocal cross had the highest value, positive and significant of heterosis estimates (H %) for body weight at 4, 8, and 12 weeks of ages, their data were 2.60, 3.18 7.32 and 20.21, 13.12, 15.51 % respectively for cross and reciprocal cross . on the other hand, H% for both the H ×K cross and K ×H reciprocal cross was negative at hatching but reciprocal cross K ×H was better than the H ×K cross at the same age. These results show that the K×H reciprocal cross was better than the H×K cross for bodyweight at different.

Several researchers gave different estimates of heterotic effects on body weights at different ages (17, 27, and A6). They reported that positive and high H% estimate for BW at different ages, also, Nwenya *et al*. (23) recorded positive heterosis for bodyweight after mating Frizzled feather breed and Naked neck nevertheless Hanafi and Iraqi (14) showed no significant effect of erotic on body weight at 8 weeks of age. Razuki and AL-Shaheen (26) used crossing be even Brown line and New Hampshire and New Hampshire x White Leghorn they found crosses had the highest positive heterosis, according to Khalil *et al*., (20) achieved full diallel cross among four Egyptian indigenous chickens Heterosis estimates showed that mating among Fayoumi males and Matrouh females at earlier ages also among Matrouh males and Golden Montazah females at 8 weeks of age recorded the highest values of heterotic effects for body weight. in a study by Keambou *et al*. (19), used crossing between the exotic Hubbard strain with the indigenous chicken due to improving live weight in HL and LH genetic groups, Although Saadey *et al.* (27) reported that hybrids obtained from mating between Sinai and White Leghorn had higher and positive heterosis at different ages except at 4 and 12 weeks of age,

Direct additive effect: The results of table (2) revealed that the HH genotype had the highest values and significance for body weight at 4 and 8 weeks their data were 6.61, 3.22 and 29.83,-12.51 respectively whereas the KK genotype had the highest positive value for body weight at 12 weeks compared to the HH genotypes their data were 12.32, 14.75. However**,** both HH and KK genotypes had the negative value of direct additive effect at hatching weight. Radwan and Mahrous (25) indicated that the value of direct additive effects of body weight was negative for the Fayoumi line at all stages of the experiment. The direct additive effect of Fayoumi was negative and lower than that of both the RIR and the Sinai one. On the other hand, (16, 17, and 21) recorded positive effects of additive genes on body weight, although EL-Tahawy, (10) showed the direct additive effect was significant (p≤ 0.05) for

body weight at 8 weeks of age. The Sinai-sired chicken recorded the highest values at 8 and 12 weeks of age compared to the Alexandria-sired chicken genotype.

Breeding values for a pure line (2GCA), Results of the table (2) showed that The HH genotype had the highest and most significant body weight at 4, 8, and 12 weeks of age; their data were 43.31, 108.33, and 136.58 respectively, while the KK strain had the lowest values of body weight at the same ages, nevertheless both pure strains and cross were recorded negative value for chick weight at hatching in addition, the cross had the intermediate breeding value for the bodyweight at the same ages.

Genetic values: Results from the table (2) showed that the KxH reciprocal cross had the highest value and was significant for body weight at 8 and 12 weeks of age, but both the cross and the reciprocal cross achieved negative values for chick weight traits at hatching and 4 weeks of age. Also showed that genetic values for the KH reciprocal cross performed better than those of the HK cross for chick weight. The superiority of KK as the best sire in crossbreeding programs, including the HH genotype, would be useful for improving the bodyweight of chicks.

Table-2: Crossbreeding genetic estimates (±standard error) for body weights .

Genotypes	Hatch	BW4	BW8	BW12
		GGA		
HH	-0.29a ± 0.11	21.65a±1.97	54.16a ± 5.48	68.29a ± 3.47
KK	-0.78 a± 0.12	-11.84b±2.58	-36.83b ± 3.32	-40.54a± 2.29
SCA				
HK	-23.19 b ± 4.42	-47.83b±4.39	-0.12b ± 0.03	-85.12 b± 7.14
KH	33.01a ± 5.38	65.16a ±7.68	1.23a ± 0.31	112.87a± 8.95
		Heterosis %		
Specific Heterosis	-10.20a ± 1.92	2.60b±0.89	3.18 a± 0.8	7.32 b± 1.44
Reciprocal Heterosis	-8.45a ± 1.57	20.21a±5.87	13.12 aa ± 2.54	15.51 a±35.32
		Direct additive effect		
HH	-0.60a ± 0.29	6.61 a ± 2.09	29.83 a ± 1.29	13.32a ± 1.13
KK	-0.63a ± 0.22	3.22a ± 0.98	-12.51b ± 2.33	14.75 a± 0.82

		Breeding values		
HH	-0.58 a± 0.32	43.31a ± 1.06	108.33a ± 6.95	136.58a± 2.83
KK	-1.56a ± 0.66	-23.68c ± 1.91	-73.34c ± 4.03	-81.09c± 30.41
HK	-1.07a ± 0.29	9.81b ± 0.78	9.17b ± 0.77	27.78 b± 3.16
		Genetic values		
HK	-2.13a ± 0.64	-13.37 b ± 1.64	-30.51b± 2.33	-57.37b± 3.27
KH	-1.34a ± 0.44	-42.85a ± 5.44	82.53a ± 5.76	140.63a± 8.20

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

Conclusions:

Crossing between Kurdish sires (local chicken) and Super Harco am (Hungary commercial chickens) resulted in improvement of body weight at different ages significantly when compared to the pure mating of Kurdish local chickens or the cross (H×K). Thus, it could be recommended that use the sire of Kurdish as a parent in crossbreeding programs to enhance the growth traits of local breeds which are used as sire parents and utilize hybrid vigor of body weight at hatching, 4,8 and 12 weeks of age.

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