Journal of Kerbala for Agricultural Sciences Issue (4), Volume (12), (2025)

Heritability, genetic and phenotypic correlation of carcass characteristics in local and commercial chickens

Mohammed S. Abdullah *, Sharihan J. Majeed

Animal Production and Health Department, Agricultural Engineering Sciences College, University Salahaddin -Erbil, Iraq
***Corresponding author e-mail: mohammed.abdullah@su.edu.krd**
https://doi.org/10.59658/jkas.v12i4.5118

Received: June. 27, 2025

Accepted: Aug. 13, 2025

Published: Dec. 25, 2025

Abstract

The purpose of study is to compare the carcass characteristics and estimation of genetic parameters of two genotypes of chicks. The study was carried out, at the Kani-Graw private field – Erbil City. Two genotypes of chickens were selected which were widely raised in the region, Super-Harco commercial and local chickens. During the peak of production, each genotype was distributed to five groups, with each group including one wing-banded rooster (known sire) with five hens (dams). Three hundred fertile eggs of two genotypes were collected. 235 Day old chicks were hatched from fertile eggs, each genotype was considered as first generation to evaluate the estimate genetic parameters for carcass characteristics at 12 weeks. The results cleared that significant differences (P≤0.05) between the two genotypes, commercial chicks showed higher significant in body weight, carcass weight breast, thigh, wing and live with lower gizzard and heart than local chicks. on the other hand, no significant variation was observed in dressing percentage between two genotypes. In relation to effect of sex, as it described that the males were more significantly (P ≤ 0. 05) recorded on all carcass traits except of dressing percentage and thigh weight. In relation to genetic parameters for carcass traits, the results showed that estimated heritability of body weight at 12 weeks, dressing percentage, heart, gizzard and liver weight were low to moderate and ranged from (0.13-0.44) and (0.14- 0.53) respectively for commercial and local chicks. The genetic and phenotypic correlation estimates among body weight and carcass characteristics (dressing percentage, heart, gizzard and liver) illustrated a close relationship between these traits. Positive genetic and phenotypic correlations were found between above mention traits from (0.18 -0.52), (0.22-0.74) and (0.09 –0.35), (0.14-0.49) respectively for commercial and local chicks

Keywords: genotypes, carcass, heritability, genetic parameters.

Introduction

Poultry has long been recognized as a primary source of animal protein [1]. Iraqi boasts a diverse array of chickens, including indigenous types, which are noted for their robust resistance to a range of diseases and their ability to thrive under extreme environmental and nutritional conditions [2]. Local chicken meat gained acceptance among customers in many nations because of its particular flavour and texture, especially in that it contains less fat. [3]. The breeding program needs to include the estimates of genetic parameters such as heritability, genetic and phenotypic correlations to observe the target population. These estimates are very important to a reliable breeding plan [4]. Heritability estimates for carcass traits were reported to be medium-high [5]. Prior research has demonstrated that selection based on breast area measurements across the length and width, coupled with BW, led to a genetic gain of 277% per generation [6]. Consequently, the dearth of data on genetic variance components and genetic parameters has constrained genetic advancement. In this regard, heritability estimates for Body Weight and Carcass Traits in chickens have ranged from moderate to high [5,7,8,9]. The objectives of the study were to estimate heritability and genetic and phenotypic correlations for carcass characteristics. in local and commercial chicks.

Materials and Methods

This experiment was conducted at Kani-Graw Private Field, which is 22 kilometers outside of Erbil City, during the period from 26 Sept. 2025 till 8 Feb 2025. Two genotypes of chickens were selected which were widely raised in the region, Super-Harco commercial and local chickens. During the peak of production (24-25 weeks) each genotype was distributed to five groups; each group includes one rooster with five hens. Three hundred fertile eggs of two genotypes were collected. The percentage of hatchability was 74%. 235 Day old chicks were hatched from eggs, each genotype was considered as first generation to evaluate the productive performance of the offspring produced by these two breeds. The chicks were divided into 10 cages of equal dimensions (120 cm length, 60 cm wide, and 70 cm high) at a rate of 20 birds per cage. The floor was covered with shaving wood 5 cm thick, and 100 chicks of each breed were numbered for the purpose of monitoring the studied traits of the chicks individually.

Feeding System

Every chick from the same hatching batch had the same diet. A beginning meal comprising 20.5% crude protein and 2950 kcal/kg of metabolizable energy was given to each chicken to ensure that they met the nutritional requirements for Isa Brown from day one to four weeks of age. After four weeks, the hens were given grower feed that included 2850 kcal/kg of metabolizable energy and 19% crude protein until they were ten weeks old. The hens were fed grower feed with 16% crude protein and 2750 kcal/kg of metabolizable energy after ten to twelve weeks of age.

Dressing Percent

The dressing percentage was calculated for birds slaughtered at 12 weeks of age after taking measurements and weights for each bird. The dressing percentage was calculated for 20 birds from each genotype after cleaning and preparation according to the following equation [10].

Carcass percentage (%) = (Carcass weight (g))/ (Slaughter weight (g)) ×100

Heritability Estimation

The paternal half-sib ANOVA analysis approach was used to analyze the variance components that are used in heritability estimation. The heritability for carcass features and body weight, were estimated according to [11], via the following formulas:

$$h^2 = 4\sigma^2S/(\sigma^2S+\sigma^2W)$$

Where:

h^2_s = narrow sense heritability using paternal half-sib correlation,

σ^2S = variance component of the Sire,

σ^2W= variance component of progenies (error).

Estimation of phenotypic correlation and genetic correlation

The phenotypic correlation (r_P) between the observed values of any two traits, let's say X and Y, was calculated using Pearson formula. [11].

$$r_p = COVxy / sqrt(\sigma^2s(X)\ \sigma^2s(Y))$$

The Genetic correlation (r_G) was estimated as the correlation between additive genes governing any two traits and had estimated according to the following formula (from half-sib analysis), via sire variance and covariance components:

$$r_g = COV_W+COV_S /sqrt((\sigma^2w(X)+\sigma^2s(X))\ (\sigma^2w(Y)+\sigma^2s(Y)))$$

Where COV_S is covariance component of sire.

Statistical Analysis:

The statistical analysis of the researched traits was carried out utilizing a completely randomized design with the General Linear Model (GLM) method to estimate the mean square for each feature. The data were analyzed using the ready-made statistical software [12].

The means of each trait were compared using [13], multi-range test at 5% significance levels.

Results and Discussion

Carcass Characteristics

Table 1 illustrates the impact of genetic group and sex on several carcass characteristics in 12-week-old chicks. The details include live weight, carcass weight, dressing percentage, and the mass of specific body segments and internal organs. The findings regarding genotype revealed that local chicks had considerably greater live weight (1565 g) and carcass weight (1005 g) compared to commercial chicks (1360 g and 872 g, respectively), highlighting better growth performance ($P \leq 0.05$). In terms of dressing percentage, no notable difference was recorded between the genetic types, indicating that both types showed comparable efficiency in converting body weight into meat yield. Regarding body cuts, the local chicks displayed notably larger weights for thighs, breasts, wings, and backs when compared to commercial chicks, showcasing their better muscle development. On the other hand, local chicks had significantly heavier necks and hearts, gizzards and livers ($P \leq 0.05$). This could indicate genetic variations in organ development or physiological adaptations.

The results indicated that the effect of sex indicated that males were significantly heavier than females for both live weight (1503.12 g vs. 1254.28 g) and carcass weight (989 g vs. 808 g), confirming the common occurrence of sexual dimorphism in poultry ($P \leq 0.05$).

The dressing percentage did not display significant differences between the sex suggesting that both males and females converted their live weight into carcass weight at similar rates. In the analysis of body cuts and organs, males had notably higher weights in breast, back, neck, heart, gizzard, and liver compared to females. Although males had higher thigh and wing weights on average, only the breast and internal organs consistently showed significant differences ($P \leq 0.05$). Additionally, females had lower organ weights overall, which is commonly observed due to variations in growth rate and physiological maturity. These findings agree with those presented [14], who noted that the analysis of carcass cut proportions by genotype indicated that the SS genotype outperformed the WW genotype, which was similarly reflected in the crossbreds. The SS genotype had significantly ($P \leq 0.05$) higher measurements compared to the WW genotype. According to [15], there was a significant difference ($P \leq 0.05$) between the Black Iraqi line and White line chicks in terms of carcass weight, dressing percentage, and carcass parts. Furthermore, the white line was more significantly ($P \leq 0.05$) found on the gizzard, thighs, neck, and carcass compared to the black line. Although [16], who mentioned that breed significantly ($P<0.05$) influences on carcass weight and percentage of carcass cuts. Also, [17], they stated that the genotype of the hybrid (Ross 308 and Cobb500) and sex had significant impact on dressing percentage and weight carcass. Also, the males are the superior of the carcass weight and dressing percentage than female. On the other hand, there were none no significant differences in the dressing percentage of the carcass parts when compared Ross308 and Hubbard strains at 42 days [18]. Another researcher [19], which reported no significant variations in live weight and carcass characteristics between two genotypes of heavier strains at 18 weeks, Furthermore [20], reported that genotypes had no significant differences in dressing percentage and percentage of parts of carcass, additionally [21], indicated that no significant differences between Iranian and indigenous chickens bred in the same management in term of carcass characteristics.

Table (1): Means ± S.E. and mean square for the genotypes and Sex affecting carcass characteristics at 12 weeks.

Traits	Live Weight	Carcass Weight /g	Dress-ing%	Thigh/g	Breast/g	Wings/g	Back/g	Neck/g	Heart/g	Giz-zard/g	Liver/g
Overall	1462.50 ± 42.84	938.4 ±34.45	64.12 ± 1.17	277 ± 10.70	225.33 ± 9.17	127.167 ± 4.61	170.667 ± 6.38	45.500 ± 2.99	11.50 ± 0.49	40.333 ± 1.32	36 ± 2.24
Genotypes											
Local Chicks	1565 a ± 72.039	1005 a ± 63.334	64.21 a ± 2.333	290 a ± 18.528	240.66 a ± 17.229	137 a b±7.488	182.33 a± 9.915	53 a± 5.318	14 a ±0.655	43.66 a± 1.260	39.66 a± 4.125
Exotic Chicks	1360 b ± 17.829	872 b ± 17.538	64.044 a ± 0.525	264 b ± 4.884	210 b± 1.464	118 b± 2.330	160 b ± 7.319	38 b ± 1.069	9 b ± 0.535	37 b± 2.171	33 a± 1.813
Sex											
Sex	**Live Weight**	**Carcass Weight /g**	**Dress-ing%**	**Thigh/g.**	**Breast/g.**	**Wings**	**Back**	**Neck**	**Heart**	**Giz-zard**	**Liver**
Females	1254.286 b± 73.684	808.929 b ± 61.669	64.50 a± 2.133	245 a ± 19.344	193.21 b ± 17.608	112.50 a± 6.457	138.571 b ± 9.951	42.143 b ± 4.050	10.929 b ± 0.569	35.929 b ± 1.588	29.643 b ± 3.686
Males	1503.125 a ± 25.815	989.063 a ± 21.131	65.172 a± 1.194	282 a ± 10.368	235.625 a ± 4.054	115.625 a ± 6.768	176.250 a ± 5.449	59.813 a ± 3.564	13.875 a ± 0.625	52.063 a ± 1.138	43.250 a ± 1.963

Different letters in the same column indicate significant differences between the lines and sex at a significance level of (P≤0.05).

Genetic parameters for the body weight, dressing percentage, heart, gizzard and liver of commercial chicks at 12 weeks

Table (2) presented results that elucidated the primary genetic parameters heritability values (on the diagonal), genetic correlations (above the diagonal), and phenotypic correlations (below the diagonal)—for body weight, dressing percentage, heart, gizzard, and liver weights in commercial chicks at 12 weeks of age.

The Heritability Estimates (Diagonal) indicated that these values are predominantly moderate to low, suggesting substantial contributions from environmental factors to trait variability. Gizzard weight (0.44) and body weight (0.41) exhibited the highest heritability, indicating a greater opportunity for genetic enhancement. Conversely, liver weight (0.13) revealed very low heritability, signifying a strong influence from environmental factors or physiological variability. Other traits, including heart weight (0.34) and dressing percentage (0.33), also showed moderate heritability, making them viable but slower candidates for selection. In addition, the Genetic Correlations (Above the Diagonal) showed that most genetic correlations were positive, indicating how traits may react concurrently under selection. Body weight is positively genetically correlated with dressing percentage (0.67) – suggesting that selecting for heavier birds could enhance carcass yield. It also correlates positively with liver (0.42) and gizzard (0.34) weights, indicating a collective genetic influence on body composition. Dressing percentage presents strong genetic associations with liver weight (0.58) and gizzard (0.47), suggesting improvements in carcass yield may also affect internal organ development. On the other hand, genetic correlations involving heart weight are relatively weaker, ranging from 0.18 to 0.35, indicating a more independent genetic control.

Moreover, the Phenotypic Correlations (Below the Diagonal) usually exhibit positive values but are notably lower than genetic correlations. The strongest phenotypic correlations exist between body weight and dressing percentage (0.31), and between gizzard and liver weight (0.52) – indicating a close linkage in observed expression. Liver weight demonstrates low phenotypic correlations with the majority of traits, consistent with its low heritability and possibly high individual variation. These findings conclude that body weight and gizzard weight are the most heritable traits and, in conjunction with dressing percentage, represent attractive targets for selection in commercial poultry breeding. This information serves as a foundation for balanced breeding strategies aimed at enhancing growth performance while upholding carcass and organ quality across commercial poultry populations. Comparable genetic correlation estimates for these traits were reported by [22], showing correlation ranges from 0.12 between BW0 and liver to 0.68 between BW16 and leg. [23], were conducted study to estimate Genetic parameters of body weight, carcass, and internal organs traits they revealed that the low value of heritability estimated in body weight, dressing percentage, heart weight and back weight their range was (0.13–0.21) compared to the other traits which ranged from medium to high (0.31–0.69). Estimates of the genetic and phenotypic correlation between dressing percentage and BW22 were low. Dressing percentage also had low phenotypic correlations with thigh weight. The genetic and phenotypic correlations had positive medium to high with other traits. Moderate to strong positive genetic and phenotypic correlations of body weight with carcass traits of chicken have also been reported by [8,24]. In addition, it appears that selection based on body weight may improve some of the carcass weight given the medium to moderate positive genetic correlation estimates between growth, carcass, and internal organ traits of local and commercial chicks.

Table (2): Genetic parameters for the body weight, dressing percentage, heart, gizzard and liver of commercial chicks at 12 weeks.

Traits	Body weight /g	Dressing %	Heart/g	Gizzard/ g	Liver / g
Body weight / g	0.41	0.67	0.18	0.34	0.42
Dressing %	0.31	0.33	0.26	0.47	0.58
Heart / g	0.17	0.35	0.34	0.28	0.24
Gizzard / g	0.21	0.16	0.19	0.44	0.52
Liver /g.	0.19	0.18	0.26	0.09	0.13

The values on, above, and below the diagonal are estimates of heritability, genetic and phenotypic correlations between traits, respectively

Genetic parameters for the body weight, dressing percentage, heart, gizzard and liver of local chicks at 12 weeks.

The results shown in table (3) revealed that the Genetic Parameters for Carcass and Organ Traits in Local Chicks at 12 Weeks demonstrated that the Genetic and Phenotypic Parameters in Local Chicks, such as heritability (found on the diagonal), genetic correlations (noted above the diagonal), and phenotypic correlations (noted below the diagonal) for body weight, dressing percentage, heart, gizzard, and liver weight in local chicks at 12 weeks of age.

Heritability Estimates (found on the diagonal) indicated that most traits have moderate heritability values, suggesting a good opportunity for genetic advancements through selective breeding. The heritability for Body weight (0. 44) and gizzard weight (0. 53) is the highest, showing that these traits are significantly shaped by genetics. In contrast, the dressing percentage (0. 39) and heart weight (0. 29) also display moderate levels of heritability. Conversely, the liver weight (0. 14) reveals low heritability, indicating that environmental or non-genetic aspects may play a larger role. The genetic Correlations (noted above the diagonal) indicated that body weight has a strong positive genetic correlation with dressing percentage (0. 74), suggesting that heavier birds often have better carcass yields. Moreover, liver weight (0. 52) and gizzard weight (0. 41) also show that there is shared genetic influence on growth and organ size, while the dressing percentage strongly correlates with gizzard (0. 59) and liver (0. 69) weights, implying that selecting for these internal organs might enhance carcass traits. Additionally, heart weight exhibits moderate genetic correlations with other attributes, indicating that it may have a more independent genetic effect.

The Phenotypic Correlations (listed below the diagonal) demonstrated that these correlations are generally positive, although they are lower than genetic correlations. The strongest phenotypic ties occur between body weight and dressing percentage (0. 49) as well as between gizzard and liver weights (0. 56). These findings imply that these traits often increase together when looked at in real measurements, even if they are not fully governed by genetics. These results indicate that local chicks display moderate heritability for important traits such as body weight, gizzard weight, and dressing percentage, showcasing their potential for genetic enhancement. The strong genetic links between body weight and carcass indicators imply that selecting for weight gain might also bring improvements in dressing percentage and organ development. However, the low heritability of liver weight suggests it may not respond much to selection pressures. Such findings are essential for developing breeding strategies that contribute to better growth and carcass standards in local poultry varieties.

The estimates of genetic and phenotypic correlations among body weight, and carcass traits showed that there is a notable genetic link between carcass percentage and body weight traits. It was noted that an increase in the percentage of carcass was linked to an increase in body weight, indicating that as body weight rises, some results of the percentage of carcass [22]. Also, [25], found a strong positive genetic correlation (r = 0. 95) between body weight at 38 days and carcass weight in broilers. Similarly [26], confirmed a high genetic correlation value of 0. 85. This indicates that utilizing body weight as a selection factor could enhance the carcass percentage, potentially boosting profit from these types.

Most traits showed high positive genetic and phenotypic correlations, with the exception of dressing percentage and BW22, which showed moderate values of genetic and phenotypic correlation. Additionally, head weight showed weak phenotypic relationships with live weight and gizzard weight. When selection is focused on increasing BW22, estimates of the genetic connection between BW22 with dressed weight, breast weight, thigh weight, wing weight and drumstick weight were positive and strong, indicating that these traits could lead to indirect genetic gains. Also, estimates of the genetic connection between BW22 and dressed weight, breast weight, thigh weight, wing weight and drumstick weight were positive and strong, indicating that these traits could lead to indirect genetic gains. [23].

Table (3): Genetic parameters for the body weight, dressing percentage, heart, gizzard and liver of local chicks at 12 weeks.

Traits	Body weight /g	Dressing %	Heart/g	Gizzard/ g	Liver / g
Body weight / g	0.44	0.74	0.22	0.41	0.52
Dressing %	0.49	0.39	0.34	0.59	0.69
Heart / g	0.27	0.24	0.29	0.32	0.38
Gizzard / g	0.26	0.14	0.24	0.53	0.56
Liver /g	0.25	0.17	0.21	0.14	0.14

The values on, above, and below the diagonal are estimates of heritability, genetic and phenotypic correlations between traits, respectively

The genetic estimations of carcass traits may provide useful information in determining a successful breeding strategy. Incorporating body weight as selection criteria in breeding programs will significantly increase the carcass percentage, and potentially improve the production benefit of the strains. Owing to positive genetic associations between body weight and carcass traits, assessing body weight at a young age may be a fair and reliable predictor of carcass traits in future selection program.

References

1) Randazzo, B., Zarantoniello, M., Cardinaletti, G., Cerri, R., Giorgini, E., Belloni, A., Contò, M., Tibaldi, E., & Olivotto, I. (2021). *Hermetia illucens* and poultry by-product meals as alternatives to plant protein sources in gilthead seabream (*Sparus aurata*) diet: A multidisciplinary study on fish gut status. *Animals, 11*(3), 677. https://doi.org/10.3390/ani11030677
2) Abdullah, M. S. (2020). *Estimation of some genetic parameters for body weight and egg production traits of two Iraqi chicken lines* (Doctoral dissertation). Salahaddin University–Erbil, College of Agricultural Engineering Sciences.
3) Wattanachant, S., Benjakul, S., & Ledward, D. A. (2004). Composition, color, and texture of Thai indigenous and broiler chicken muscles. *Poultry Science, 83*, 123–128.
4) Gaya, L. D. G., Mourão, G. B., Ferraz, J. B. S., Mattos, E. C. D., Costa, A. M., Michelan Filho, T., Rosa, A. F., Felício, A. M., & Eler, J. P. (2011). Estimates of heritability and genetic correlations for meat quality traits in broilers. *Scientia Agricola, 68*(6), 620–625. https://doi.org/10.1590/S0103-90162011000600002
5) Chabault, M., Baéza, E., Gigaud, V., Chartrin, P., Chapuis, H., Boulay, M., Arnould, C., D'Abbadie, F., Berri, C., & Le Bihan-Duval, E. (2012). Analysis of a slow-growing line reveals wide genetic variability of carcass and meat quality-related traits. *BMC Genetics, 13*(1), Article 90.
6) Saxena, V. K., & Kolluri, G. (2018). Selection methods in poultry breeding: From genetics to genomics. In *Application of genetics and genomics in poultry science* (pp. 19–32). IntechOpen. https://doi.org/10.5772/intechopen.77966
7) Abd El-Karim, R., & Ashour, A. F. (2014). Effect of selection for body weight on body measurements and carcass traits in El-Salam strain of chicken in Egypt. *Journal of Animal and Poultry Production, Mansoura University, 5*, 459–471. https://doi.org/10.21608/jappmu.2014.70609
8) Bungsrisawat, P., Tumwasorn, S., Loongyai, W., Nakthong, S., & Sopannarath, P. (2018). Genetic parameters of some carcass and meat quality traits in Betong chicken (KU line). *Agriculture and Natural Resources, 52*(3), 274–279. https://doi.org/10.1016/j.anres.2018.09.010
9) Ullengala, R., Prince, L. L., Paswan, C., Haunshi, S., & Chatterjee, R. (2020). Variance component analysis of growth and production traits in Vanaraja male

line chicken using animal model. *Asian-Australasian Journal of Animal Sciences, 34*(4), 471–481. https://doi.org/10.5713/ajas.19.0826

10) Ibrahim, K. I. (2000). *Poultry feed* (2nd ed.). Ministry of Higher Education and Scientific Research, University of Mosul.

11) Falconer, D. S. (1989). *Introduction to quantitative genetics* (3rd ed.). Longman.

12) SAS Institute Inc. (2004). SAS user's guide (Version 9.1). SAS Institute Inc.

13) Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11, 1–42. https://doi.org/10.2307/3001478

14) Dzungwe, J. T., Tozo, K., & Chrysostome, C. (2022). Growth performance, mortality, and carcass yield evaluation of pure and reciprocal crosses between Sasso and Wassache chickens. Tropical Animal Health and Production, 54(5), Article 298. https://doi.org/10.1007/s11250-022-03272-x

15) Abdullah, M. S., Al-Dabbagh, A. S., Ahmed, B. H., & Sulaiman, B. F. (2025). Comparative study of production performance and meat quality of two different local chicks. [Journal name not specified]. https://doi.org/10.58928/ku24.16212

16) Tudorache, M., Custura, I., Gheorghe, A., Habeanu, M., Lefter, N. A., Pogurschi, E. N., & Popa, D. C. (2022). Effects of genotype and diet on performance, carcass traits, and blood profiles of slow-growing chicks obtained by crosses of local breed with commercial genotype. Agriculture, 12(11), 1906. https://doi.org/10.3390/agriculture12111906

17) Gafar, E. G., Abdo, S. G., Mahrous, M. Y., & Kamal, M. A. (2022). Effect of strain and sex on productive performance and carcass traits in some broiler chickens. Archives of Agriculture Sciences Journal, 5(1), 77–87. https://doi.org/10.21608/aasj.2022.233391

18) Abdullah, M. S. (2014). Effect of different periods of feed withdrawal before slaughtering in two broiler strains on meat quality. Journal of Tikrit University for Agricultural Sciences, 14(2).

19) Motsepe, R., Mabelebele, M., Norris, D., Brown, D., & Ginindza, J. N. M. (2016). Carcass and meat quality characteristics of South African indigenous chickens. Indian Journal of Animal Research, 50(4), 580–587. https://doi.org/10.18805/ijar

20) Nolte, T., Jansen, S., Weigend, S., Moerlein, D., Halle, I., Link, W., Hummel, J., Simianer, H., & Sharifi, A. R. (2020). Growth performance of local chicken breeds. Animals, 10(4), 702. https://doi.org/10.3390/ani10040702

21) Mohammed, M. S., & Ameen, Q. A. A. (2023). Comparative study among local chicken and two strains for some performance traits. Anbar Journal of Agricultural Sciences, 21(2), 330–342.

22) Venturini, G. C., Cruz, V. A. R., Rosa, J. O., Baldi, F., El Faro, L., Ledur, M. C., Peixoto, J. O., & Munari, D. P. (2014). Genetic and phenotypic parameters of carcass and organ traits of broiler chickens. Genetics and Molecular Research, 13.

23) Kanlisi, R. A., Amuzu-Aweh, E. N., Naazie, A., Otsyina, H. R., Kelly, T. R., Gallardo, R. A., Lamont, S. J., Zhou, H., Dekkers, J. C. M., & Kayang, B. B. (2024). Genetic architecture of body weight, carcass, and internal organ traits of Ghanaian local chickens. Frontiers in Genetics, 15, Article 1297034. https://doi.org/10.3389/fgene.2024.1297034

24) El-Attrouny, M. M., Iraqi, M. M., & Mohamed, S. A.-H. (2021). Estimation of genetic parameters for body weight, body dimension, and carcass traits in four Egyptian chicken strains. Journal of World's Poultry Research, 11(2), 230–240. https://doi.org/10.36380/jwpr.2021.28

25) Peertile, S. F., Zampar, A., Petrini, J., Gaya, L. D., Rovadoscki, G. A., Ramírez-Díaz, J., Ferraz, J. B., Michelan Filho, T., & Mourão, G. B. (2014). Correlated responses and genetic parameters for performance and carcass traits in a broiler line. Revista Brasileira de Saúde e Produção Animal, 15(4), 1006–1016. https://doi.org/10.1590/S1519-99402014000400008

26) Xu, T. S., Liu, X. L., Huang, W., & Hou, S. S. (2011). Estimates of genetic parameters for body weight and carcass composition in Pekin ducks. Journal of Animal and Veterinary Advances, 10, 23–28.