GENETIC AND NON GENETIC PARAMETERS FOR BODY WEIGHTS OF TWO IRAQI LOCAL CHICKNS

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ABSTRACT

This study aimed to investigate the genetic parameters for body weights of White and Black local chickens. The experiment conducted at College of Agric., Salahaddien Univ. during the period from Sept. 2016 until April 2018. 520 fertile eggs were taken from Agri. Res. Center, Ministry of Agric., Baghdad. Hatched chicks considered as parents (G0), and distributed randomly in to ten families. Resulted eggs from each family were collected during the peak of production for each generation to produce chicks of the next generation (G1 and G2). Body weights of resulted chicks were recorded at 1-day old and weekly till maturity. SAS program used to analyze the body weights (BW) and body weight gains (BWG) at different ages. The model includes genetic groups and generations for traits before sexing and the effect of sex added for the traits after sexing. Variance component of random effects estimated by REML and tested for positive definiteness to develop reliable estimates. Repeatability for body weights estimated. BW of chicks at 1 day, 4, 8, 9, 10, 16 and 17 week were 31.02, 292.47, 679.29, 794.58, 892.82, 1362.53 and 1252.17 g, and BWG at (1-4, 4-8, 9-10 and10-16) weeks were 261.45, 386.82, 98.24, and 469.51 g, respectively. The chicks of black group significantly excelled the white group in their weight at 1 day, 4, 8, 16 and 17, as well at ages 1-4 and 10-16 weeks. The effect of generation on BW of chicks at all ages and BWG at 1-4, 4-8 weeks was highly significant and (P<0.05) during 9-10 and 10-16 weeks. Males surpassed females significantly (p<0.01) in their BW at 9, 10 and 16 weeks and in their BWG during 9-10 and 10-16 weeks. Estimates of heritability were 0.42, 0.61, 0.76, 0.71, 0.43, 0.51, and 0.70 and of repeatability were 0.29, 0.26, 0.22, 0.38, 0.41, 0.74, and 0.78 for BW at 1 day, 4, 8, 9, 10, 16 and 17 weeks respectively. Higher (0.78) and lower (0.14) genetic correlations were recorded between BW at 8 weeks with each of BW at 10 and 17 weeks respectively. While the phenotypic correlations ranged between 0.04 (among BW at 1 day with weight at 9 weeks) and 0.58 (among BW 16 with 17 weeks).

Key words: growth traits, chicks, heritability, repeatability, genetic correlation.

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مجلة العلوم الزراعية العراقية -2020 :51(1):323-332 هرمز وعبد الله

المعالم الوراثية وغير الوراثية لأوزان الجسم في خطين من الأفراخ المحلية العراقية

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المستخلص

يهدف البحث الى دراسة المعالم الوراثية لأوزان جسم خطين (الأبيض والأسود) من الدجاج المحلي. أجريت التجربة في كلية الزراعة – جامعة صلاح الدين خلال الفترة من أيلول 2016 ولغاية نيسان 2018. أخذت 520 بيضة مخصبة من الدجاج المحلي من مركز البحوث الزراعية – وزارة الزراعة – بغداد. تم أعتبار الأفراخ الناتجة من الفقس وبعمر يوم واحد كآباء (G0) وتم توزيعها عشوائيا الى 10 عوائل. تم جمع البيض الناتج من كل عائلة خلال فترة قمة الانتاج لكل جيل لأنتاج أفراخ الجيل التالي (G1 and G2). تم تسجيل أوزان جسم الأفراخ بعمر يوم واحد وبعده أسبوعيا لغاية النضج الجنسي. استخدم البرنامج SAS لتحليل صفات أوزان الجسم والزيادات الوزنية في أعمار مختلفة. تضمن الإنموذج تأثير المجموعة الوراثية والجيل لجميع الصفات قبل التجنيس وتم اضافة تأثير الجنس للصفات بعد التجنيس. تم تنفيذ طريقة تعظيم الاحتمالات المقيدة لتقدير مكونات التباين للتأثيرات العشوائية وتم فحصا وفق اختبار الموجب المحدد للحصول على تقديرات ضمن الحدود المقبولة، وتم تقدير المعامل التكراري لصفات أوزان الجسم. بلغ معدل وزن جسم الأفراخ عند عمر 1 يوم، 4، 8، 9، 10، 16 و 17 أسبوع 31.02، 292.47، 679.29، 794.58، 892.82، 1362.53 و 1252.17 غم كما بلغت الزيادة الوزنية للفترات (1–4، 4–8، 9–10، و 10–16) أسبوع 261.45، 386.82، 98.24، و 469.51 غم على التوالي. تفوقت الأفراخ المحلية السوداء معنويا في أوزانها عند عمر 1 يوم، 4، 8، 16 و 17 أسبوع وكذلك للفترات 1–4 و 4–8 أسبوع. تبين أن تأثير الجيل في أوزان جسم الأفراخ عند جميع الأعمار وكذلك في الزيادة الوزنية للفترات 1–4 و 4–8 أسبوع كان عالي المعنوية ومعنوي عند مستوى (P<0.05) للفترات 9–10، و 10–16 أسبوع. تفوقت الذكور معنويا (P <0.01) في أوزان جسمها عند عمر 9، 10 و 16 أسبوع وكذلك في زيادتها الوزنية للفترات للفترات 9–10، و 10–16 أسبوع. بلغت تقديرات المكافئ الوراثي 0.42، 0.61، 0.76، 0.71، 0.43، 0.51 و 0.70 على التوالي ، وبنفس الترتيب بلغت تقديرات المعامل التكراري 0.29، 0.26، 0.22، 0.38، 0.41، 0.74 و 0.78 لوزن جسم الأفراخ عند عمر 1 يوم، 4، 8، 9، 10، 16 و 17 أسبوع. تم تسجيل أعلى (0.78) وأقل (0.14) إرتباط وراثي بين وزن الجسم عند عمر 8 وكل من وزن الجسم عند عمر 10 و 17 أسبوع على التوالي. بينما تراوح الارتباط المظهري بين 0.04 (بين وزن الجسم عند عمر 1 يوم و 9 أسبوع) و 0.58 (بين وزن الجسم عند عمر 16 و 17 أسبوع).

الكلمات الدالة: صفات النمو ، افراخ الدجاج ، المكافئ الوراثي ، المعامل التكراري، الأرتباط الوراثي

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INTRODUCTION

The Iraqi indigenous chickens have the advantage of being well adapted to the local environmental conditions. Another advantage of the Iraqi indigenous chickens claimed by the consumers is the good taste and flavor of both eggs and meat as compared to commercial chickens (8). Earlier researchers reported that the main problem of indigenous chickens in the tropics is that they are poor producer of egg and meat comparing with other exotic breeds and commercial strains, anyway they are characterized by their well-adapted to the tropics, resistant to poor management, feed shortages and tolerate to some of the most common diseases and parasites. The aggregation of local gene pool of Iraqi chickens was adopted from two Iraqi institutions: the Scientific Research Council in 1986 and IPA Agricultural research center in 1992-2003. In the last decade, at Ainkawa Research Station, Animal Production Department, Directorate of Agricultural Research–Erbil, Ministry of Agriculture, also a project was conducted on local chickens in collaboration with advisors from Animal Resource Department, College of Agricultural - University of Salahaddin. The project includes selecting the individuals according to their color and bred them separately for several generations (22). Body weight is defined as a function of framework or size of the animal and its condition which considered as the main factor influencing egg size. Variation in body weight within a flock can be attributed to genetic variation and environmental factors affecting the individuals (12). Similar to other economically important traits, the growth and fitness traits of chickens are controlled by multiple genes, so understanding the genetic control of growth in chickens will provide an opportunity for genetic enhancement of production performance and physiology (16). Earlier reports showed that the indigenous fowl possesses great potentials for genetic improvement through breeding programs such as selection and or cross breeding (1, and 31).
The aim of this study is to analyze genetic and non-genetic factors affecting body weights of two Iraqi local chickens (white and black), and to estimate the genetic parameters using an accurate method to be able to improve their productivity by breeding beside the suitable management.

MATERIALS AND METHODS

This Experiment conducted at Gardarash field–Animal resources Department during the period from 9 Sept. 2016 until 9 April 2018. 520 fertile eggs of two local line chickens (White and Black) were taken from Agriculture Research Center-Ministry of Agriculture-Baghdad. The percentage of hatchability was 73%. Day old chicks hatched from eggs on 9 Sept. 2016 of each line were considered as parents (G0), and distributed randomly in to ten families. At sex maturity, each family contains one male and six females. Eggs resulted from each family belongs to each line were collected during the peak of production (23-24 week) for each generation to produce chicks of the next generation. The chicks produced from eggs hatched on 27 March 2017 considered as the first generation (G1), and chicks produced from eggs hatched on 9 Oct. 2017considered as the second generation (G2). The resulted chicks from hatching of both lines were kept in replicates as families and their body weights recorded at 1-day of their age and weekly till maturity (producing 5% of eggs in the flock) by a sensitive scale to the nearest 0.1 g. Also their weekly body weight gains calculated. The accumulative body weight of chicks at 4, 8, 9, 10, 16, 17 (maturity) weeks were recorded and body weight gain were calculated at the periods 1-4, 4-8, 9-10 and 10-16 weeks of age. After 8 weeks of age, males were isolated from females. The chicks bred in a clean well ventilated hall and belonged to ordinary management. All chicks were given Newcastle vaccines, antibiotics, minerals and vitamins as needed.
General Linear Model (GLM) within the statistical program SAS (34) was used to analyze the studied traits including body weights and body weight gains at different ages. The model includes the effect of genetic groups and generations for the traits before sexing and the effect of sex was added to the model for the traits after sexing. Scheffe's test within the SAS (34) was conducted to diagnosing the significant differences between the least square means of the levels of each

factor. Restricted Maximum Likelihood-REML (29) method used to estimate the variance component of random effects. The mixed model includes the effect of sire as well the above fixed effects. Variance-covariance (VCV) matrices were built from random effects (sire and error) and tested for positive definiteness, in order to develop reliable estimates and VCV used for genetic parameters should be within the allowable range (21). Repeatabilities for body weights were also estimated.

RESULTS AND DISCUSSION

Body Weight of Chicks:

The overall mean of chicks body weights at 1 day, 4, 8, 9, 10 and 16 weeks were 31.02±0.08, 292.47±1.02, 679.29±1.93, 794.58±5.90, 892.82±9.01 and 1362.53±10.98 g, respectively (Tables 1 and 2).

Genetic Group:

It appears from tables (1 and 2) that the chicks of local black group (L2) excelled chicks of local white group (L1) in their age at 1 day (31.59±0.08 vs. 30.45±0.06), 4 (299.43±0.81 vs. 285.51±0.80), 8 (688.83± 2.44 vs. 669.75±2.49) and 16 weeks (1397.17 ± 3.83 vs. 1327.49 ± 3.62) g. The differences between the two genetic groups were significant ($p<0.01$) at the above ages which could be due to their initial body weight at 1-day old, where L2 had higher body weights than L1, as well could be due to larger egg size of L2 comparing with those of L1 (23), while the differences in their body weights at 9 and 10 weeks of age were not significant, and were (795.38± 3.27 vs. 793.78±3.19) and (891.41± 4.74 vs. 894.24± 4.41) g respectively. The indigenous chickens in Kurdistan were bred by selection. Studies conducted by Hermiz et al. (22) and Hermiz and Ibrahim (24) using three local genetic lines and their crossing with Isa Brown and found that genetic lines have a significant effect on body weight of chicks at different ages. Several researchers revealed to the significant differences in the body weight of male and female chicks at different ages using pure or cross breeds, strains or lines (17, 20, and 42). While in Iraq, Ali (8) revealed to a non-significant differences between three broiler hybrids (Lohman, Ross and Hubbard) in their body weights at different ages.

Generation: The effect of generation on body weights of chicks at all ages was highly significant (Tables 1 and 2). The chicks of the 1st generation excelled the others in their body weights at 1 day (32.19±0.08 g) at 8 weeks (687.74±3.06 g) and at 16 weeks (1374.95±20.04 g), while the chicks of the 2nd generation excelled the others in their body weights at 4, 9 and 10 weeks of age and were (304.11±0.99, 803.36±4.48 and 915.88±15.89 g respectively) which mean that there were an improvement comparing with the parents (G0). The performance of birds in the later generations as obtained in this study also reflect the cumulative effects of realized genetic gain as a result of positive responses to selection of superior males in their body weights and superior females in their egg weights in earlier generations. Similar results were found earlier by several authors. Faruque and Bhuiyan (17) reported a highest ($p<0.001$) body weights in the third generation (G3) compared to other generations in all ages (8, 12, 16 weeks) using local Bangladesh chickens genotypes (Naked neck, Hilly and Non-descript Desh). Ashour et al. (11) studied the live body weights of males and females in both selected and control Egyptian local lines (EL-Salam strain) over three successive generations and revealed that all body weights were increased by generations. The selected line had higher body weight than control line. Ramadan et al., (30) reported that after eight generations of selection for increasing six week live body weight the selected line weighted 35% more than the control line.

Sex: It can be shown from table (2) that males surpassed females in their body weights at 9, 10 and 16 weeks by 167.38, 256.51 and 323.24 g respectively and the differences between the two sexes were significant ($p<0.01$) and this could be due to the effect of male growth hormones (36). Several studies conducted at several countries indicated that males were generally superior in their body weights at different ages to females using different pure or crossed breeds or strains (5, 14, 23, and 60). Singh and Nordoskog (37) claimed that many avian species, like chickens, showed marked dimorphism in body weight with males being substantially heavier than females which could be due to the effect of male growth hormones, and this superiority as well of their ability to dominate while feeding and hormonal differences resulting in faster deposition of muscles in males than in female birds (4).

Body Weight Gains of Chicks:

Overall mean of chicks body weight gains at (1-4, 4-8, 9-10 and10-16) weeks were 261.45±0.99, 386.82±1.75, 98.24±4.64, and 469.51±5.32 g, respectively (Tables 3, 4).

Genetic Group:

It is revealed from Tables (3 and 4) that local black chickens have higher body weight gain than white chickens at ages 1-4 (267.84±1.29 vs. 255.06±1.28) and 10-16 weeks (505.76±5.20 vs. 433.25±5.03) g and the differences were highly significant (p<0.01). The difference in growth rate of different breeds of chickens could be attributed to interplay of multiple genes which improved through genetic selection (14). Whereas the differences between the chicks of both genetic groups at ages 4-8 and 9-10 weeks were not significant and body weight gains of black and white chicks were (389.40±2.36 vs. 384.24±2.38) and (96.03±5.60 vs. 100.46±5.56) g respectively (Table 3 and 4). Earlier studies investigated the differences between genotypes, breeds or strains of chicks and revealed to significant differences in their body weight gains at different periods of ages (17 and 26). Halima et al. (20) compared seven Ethiopia indigenous chicken lines and revealed that significant (P<0.05) differences in final weight gain within the indigenous and between the indigenous and RIR chicken lines at 22 week. Also in Kurdistan Region of Iraq, Hermiz et al. (22) and Hermiz and Ibrahim (24) showed that the differences between genetic lines were significant on all of weekly body weight gains of chicks.

Generation:

The differences between body weight gains of chicks belongs to different generations were significant (P<0.01) during the periods 1-4, 4-8 weeks, and (P<0.05) during 9-10 and 10-16 weeks (Tables 3 and 4). The highest body weight gains were recorded for the 2nd, 1st, 2nd and 1st generation during the periods 1-4, 4-8, 9-10 and 10-16 weeks and were 273.72±0.94, 392.06±3.01, 112.51±6.59, and 485.75±10.36 g respectively. Similar results were found by Faruque and Bhuiyan (17), they observed that significantly highest daily gains were observed in G3 generation compared to other generations G0, G1, G2 in all stages (0-8), (0-12) and (0-12) weeks in local Bangladesh chickens (Non-descript Desh, Hilly and Naked neck).

Sex: Males were significantly (P<0.01) heavier than females in their body weight gains during the periods 9-10 (142.81± 6.08 vs. 53.68±4.04) and 10-16 weeks (502.88±6.85 vs. 436.14±6.93) g (Table 4). Similar results were noticed by other, the research conducted in Egypt by Taha et al. (40) using three Canadian dual purpose strains (Shaver A, B and C) and two Egyptian strains (Salam and Mandarah), the sex effect showed that the males of all strains recorded higher significant weight gain than females during weeks 4, 6, 8, 10 and 12 of age, while females recorded higher weight gain during week 2 of age for all strains. Also in Nigeria, Faruque and Bhuiyan (17) reported significant differences (p<0.05) between males and females in their body weight gains at ages 0-8, 0-12 and 0-16 weeks and were (8.5, 7.0), (10.7, 8.1) and (11.4, 8.27) g/day, respectively.

Body Weight at Maturity:

Body weight at sex maturity for all chickens was 1252.17±5.09 g (Table 5). This finding lay within the range noticed earlier by several investigators in different breeds of chickens (5, and 10). Previously, Soller et al. (38) investigated the minimum weight for onset of sexual maturity in chickens and suggested that the age at first egg is highly correlated with body weight. Barbato (13) reported that body weight, generally, has been shown to be highly responsive to selection in chickens such that genetic improvement for growth has resulted in increasing egg weight and age at first egg/sexual maturity.

Genetic Group:

It was found that the local black chickens have highest body weight at sex maturity (1291.85±4.03 g) comparing with local white (1212.50±4.09 g) and the differences were highly significant (Table 5) due to genetic variation. Several researchers conducted their studies using Iraqi local chicken and they revealed that their body weights at sexual maturity ranged between 1290 to 1391 g and were significantly lighter than Leghorn and

New Hampshire at the same age (3, and 9). Also, other studies revealed to significant differences using different breeds or strains in their weight at maturity (5, 17, and 39).

Generation:

It appears that the chicks belongs to the 1st and 2nd generations have significantly ($P<0.01$) higher body weight at sex maturity than those of parents and were (1261.53±5.62, 1263.81±5.78, and 1231.17±6.08) g respectively (Table 5). Earlier studies conducted to improve the age and weight at maturity by application of selection for several generations. They revealed that the body weight at first egg for all generations over both sexes in the selected population in the second generation was higher than earlier generations (27 and 41). Also, Ashour et al. (11) and Faruque and Bhuiyan (17) recorded a significant increase in the body weight at sex maturity of selected and control over three successive generations.

Heritability Estimates of Body Weights of Chicks:

Estimates of heritability for body weights of chicks at different ages are presented in Table (6) and being 0.42, 0.61, 0.76, 0.71, 0.43, 0.51, and 0.70 for body weight at 1 day, 4, 8, 9, 10, 16 weeks and at maturity respectively. These findings indicated that the heredity of body weight traits ranged between 42%-76% and the rest could be controlled by environment. Also earlier studies using different breeds in several countries mentioned that values for growth traits – body weight, body weight gain and linear body measurements – from various studies using various variance components (sire, dam, sire + dam) and mating designs indicate that growth traits have mostly moderate to high heritabilities (11, 18, 19, 32, and 41), and hence the selection of heavier individuals in a population should result in genetic improvement of the trait. Also, Ashour et al. (11) estimated the heritability for body weight at 12 week of age in El-Salam chicken strain and was 0.67. In Iraq, Al-Rawi (7) estimated the heritability for the same trait in barred local chickens from sire, dam and sire + dam components of variance and were (0.32, 0.38, 0.35) and (0.29, 0.45, 0.37) in first and second generation respectively.

Repeatability Estimates of Body Weights of Chicks:

Estimates of repeatability obtained from this study were 0.29, 0.26, 0.22, 0.38, 0.41, 0.74, and 0.78 for body weights of chickens at 1 day, 4, 8, 9, 10, 16 weeks as well at maturity respectively (Table 6). Repeatability of body weights estimated in this study were higher than that reported earlier by Ojedapo (28) who reveals that the repeatability of body weight at 8 weeks was 0.312 in Marshall broiler. While Sanda et al. (32) reported higher estimates of repeatability for body weight of three types of meat chickens (Arbor Acre, Marshall and Ross) at ages 4, 6, 8 and 10 weeks and were (0.74, 0.72, 0.7), (0.8, 0.79, 0.83), (0.86, 0.81, 0.81) and (0.83, 0.84, 0.88) respectively. So when the estimates were high, culling poor performers on the basis of a single record will be effective in improving flock performance. Also could be used to predict the number of successive records required to maximize prediction of performance capacity of an individual (25).

Genetic (r_g) and Phenotypic (r_p) Correlations between body weights at different ages were positive and listed in Table (6). Higher (0.78) and lower (0.14) genetic correlations were recorded between body weight of chicks at 8 weeks with each of body weight at 10 and 17 weeks respectively. While the phenotypic correlations ranged between 0.04 (among body weight of chicks at 1 day with weight at 9 weeks) and 0.58 (among body weigh 16 weeks with 17 weeks). Earlier studies were also conducted to estimate the genetic and phenotypic correlations between body weights at different ages. Sang et al. (33) reported that genetic correlation ranged from 0.84 to 0.97 between body weight at first egg and body weight at age of 270 days in five Korean native chickens. Dana et al. (15) found that the phenotypic correlation between body weights at different ages were positive and decrease in general as the time interval between weights increase. While genetic correlation between body weights were positive and increase in general as the time interval between weights increase. Shadparvar and Enayati (35) reported that the genetic correlations between body weights at different ages varied from 0.04 to 0.46. Firozjah and

Zare (19) revealed that the estimated genetic correlations between body weights at different ages of Iranian Mazandaran native chickens ranged between 0.32 and 0.94. Such selection tends to have increased the gene frequency of the favored genes, which in the course of recombination were probably transmitted together as linked genes and translated to the maximum performance observed in the selected line. Adebambo et al. (2) reported that genetic improvement for one trait could result in improvement for the other trait as correlated response. Pleitropic action of gene can be implicated here.

It can be concluded that Black chicken will be suitable for meat purposes. Fixed effects need to be adjusted before estimating genetic parameters. Genetic gain by generation on the basis of weekly body weight will be effective for both lines. Positive and high estimates of genetic parameters at early ages indicate that selection of chickens depending on their early body weights will improve their weights at later ages.

Table 1. Least Square Means ± S.E. and mean square for the factors affecting body weight (g) of local chicks at the first three ages:

Factors	d.f. or No.	Body weight 1 day of age (g) Mean square or Means ± S.E.	Body weight 4-weeks age (g) Mean square or Means ± S.E.	Body weight 8-weeks age (g) Mean square or Means ± S.E.
Overall mean	240	31.02±0.08	292.47±1.02	679.29±1.93
Genetic Group:	1	78.204 **	11620.42 **	21845.65 **
Local White (L1)	120	30.45 ± 0.06 b	285.51 ± 0.80 b	669.75 ± 2.49 b
Local Black (L2)	120	31.59 ± 0.08 a	299.43 ± 0.81 a	688.83 ± 2.44 a
Generation:	2	82.777 **	14671.84 **	6941.63 **
Parents	80	30.46 ± 0.08 b	277.61 ± 0.95 c	669.30 ± 3.05 b
1st Generation	80	32.19 ± 0.08 a	295.68 ± 0.98 b	687.74 ± 3.06 a
2nd Generation	80	30.40 ± 0.08 b	304.11 ± 0.99 a	680.82 ± 3.06 a
Residual	236	0.451	78.09	748.93

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe's test.
**** P<0.01**

Table 2. Least Square Means ± S.E. and mean square for the factors affecting body weight (g) of local chicks at three ages after sexing:

Factors	d.f. or No.	Body weight 9-weeks age (g) Mean square or Means ± S.E.	Body weight 10-weeks age (g) Mean square or Means ± S.E.	Body weight 16-weeks age (g) Mean square or Means ± S.E.
Overall mean	240	794.58±5.90	892.82±9.01	1362.33±10.98
Genetic Group	1	152.37	482.23	291319.54 **
Local White (L1)	120	793.78 ±3.19 a	894.24 ± 4.41 a	1327.49 ± 3.62 b
Local Black (L2)	120	795.38 ±3.27 a	891.41 ± 4.74 a	1397.17 ± 3.83 a
Generation	2	8170.33 **	36888.11 **	27769.98 **
Parents	80	783.53 ± 4.57 b	873.39 ± 5.44 b	1340.93 ± 3.25 b
1st Generation	80	796.84 ± 4.59 a	889.20 ± 5.31 b	1374.95 ± 3.54 a
2nd Generation	80	803.36 ± 4.48 a	915.88 ± 5.39 a	1371.10 ± 3.73 a
Sex	1	1680986.3 **	3947863.5 **	6269297.99 **
Male	120	878.27 ± 3.96 a	1021.08 ±5.69 a	1523.95 ± 4.59 a
Female	120	710.89 ± 2.57 b	764.57 ±4.15 b	1200.71 ± 4.92 b
Residual	235	1283.77	2703.39	1276.28

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe's test.
**** P<0.01**

Table 3. Least Square Means ± S.E. and mean square for the factors affecting body weight gains (g) of local chicks at the first two ages:

Factors	d.f. or No.	Body weight gain 1-4 weeks of age (g) Mean square or Means ± S.E.	Body weight gain 4-8 weeks of age (g) Mean square or Means ± S.E.
Overall mean	240	261.45±0.99	386.82±1.75
Genetic Group	1	9792.04 **	1600.38
Local White (L1)	120	255.06 ± 0.78 b	384.24 ± 2.38 a
Local Black (L2)	120	267.84 ± 0.81 a	389.40 ± 2.36 a
Generation	2	14371.14 **	6142.22 **
Parents	80	247.14 ± 0.97 c	391.70 ± 2.95 a
1st Generation	80	263.49 ± 0.93 b	392.06 ± 3.01 a
2nd Generation	80	273.72 ± 0.94 a	376.71 ± 2.92 b
Residual	236	78.799	683.09

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe's test.
**** P<0.01**

Table 4. Least Square Means ± S.E. and mean square for the factors affecting body weight gains (g) of local chicks after sexing:

Factors	d.f. or No.	Body weight gain 9-10 weeks of age (g) Mean square or Means ± S.E.	Body weight gain 10-16 weeks of age (g) Mean square or Means ± S.E.
Overall mean	240	98.24 ± 4.64	469.51 ± 5.32
Genetic Group	1	1176.74	315506.96 **
Local White (L1)	120	100.46 ± 5.56 a	433.25 ± 5.03 b
Local Black (L2)	120	96.03 ± 5.60 a	505.76 ± 5.20 a
Generation	2	12344.57 *	18863.28 *
Parents	80	89.85 ± 6.78 b	467.54 ± 7.68 ab
1st Generation	80	92.36 ± 6.58 b	485.75 ± 7.36 a
2nd Generation	80	112.51 ± 6.59 a	455.23 ± 7.25 b
Sex	1	476633.91 **	267228.29 **
Male	120	142.81 ± 6.08 a	502.88 ± 6.85 a
Female	120	53.68 ± 4.04 b	436.14 ± 6.93 b
Residual	235	3128.08	4259.69

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe's test.
**** P<0.01 * P<0.05**

Table 5. Least Square Means ± S.E. and mean square for the factors affecting body weight (g) of local chicks at sex maturity:

Factors	d.f. or No.	Body weight (g) of chicks at sex maturity Mean square or Means ± S.E.
Overall mean	120	1252.17 ± 5.09
Genetic Group	1	13281.52 **
Local White (L1)	60	1212.50 ± 4.09 b
Local Black (L2)	60	1291.85 ± 4.03 a
Generation	2	188902.99 **
Parents	40	1231.17 ± 6.08 b
1st Generation	40	1261.53 ± 5.62 a
2nd Generation	40	1263.81 ± 5.78 a
Residual	236	1332.80

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe's test.
**** P<0.01**

Table 6. Genetic parameters for the body weights of local chicks at several ages (from 1 day till the sex maturity

Body Weights at Age:	1-day	4-week	8-week	9-week	10-week	16-week	17-week
1-day	0.42	0.48	0.33	0.41	0.31	0.31	0.45
4-week	0.06	0.61	0.35	0.40	0.27	0.47	0.38
8-week	0.07	0.27	0.76	0.63	0.78	0.28	0.14
9-week	0.04	0.14	0.15	0.71	0.57	0.65	0.61
10-week	0.10	0.10	0.13	0.24	0.43	0.45	0.40
16-week	0.06	0.06	0.14	0.21	0.13	0.51	0.64
17-week (Maturity)	0.07	0.06	0.13	0.15	0.19	0.58	0.70
Repeatability	0.29	0.26	0.22	0.38	0.41	0.74	0.78

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

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