ESTIMATION OF GENETIC PARAMETERS AND BREEDING VALUE OF SEXUAL AND EGG PRODUCTION TRAITS IN IRAQI LOCAL CHICKENS

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ABSTRACT

This study was conducted to estimate (Co) variance components of a sexual and egg production traits in Iraqi brown local chickens. Data on 2234 pedigreed hens for successive six generations of selection for high egg production during the first 24 weeks of laying were used. Data of first egg weight (FEWT), body weight at sexual maturity (BWSM), age at sexual maturity (ASM), egg number (EN), egg weight (EW) and egg mass (EM) were recorded individually. The univariate and bivariate animal models under Average Information Restricted Maximum Likelihood (AI-REML) were applied to estimate the variance component and the BLUP breeding values. The average of the traits mentioned above was 35.7g, 1489.59g, 149.31d, 109.32 egg/hen, 44.80g and 4887.72g respectively. Heritability estimates based on individual animal model was 0.17, 0.42, 0.39, 0.40, 0.68 and 0.40 for the traits mentioned above respectively. The genetic and phenotypic correlations between sexual traits (ASM, BWSM, and FEWT) showed moderate and positive values. Genetic correlation between sexual traits (ASM, BWSM, and FEWT) with EN and EM was negative. Genetic correlations between (EN and EW), (EN and EM) and (EW and EM) were -0.105,0.902 and 0.337 respectively. Genetic correlations between ASM with EW were negative while BWSM and FEWT with EW were Positive. Average breeding values across generation tend to be positive in productive traits but it was negative in sexual traits. In conclusion, a good performance and reliable estimation of genetic parameters and BLUP breeding value shown in the current study could be revealed that Iraqi brown local chickens have a good genetic potential for egg production traits and respond well to selection for increasing egg production traits.

Keywords: genetic parameters, local chickens, egg production, sexual maturity traits.

تقدير المعلمات الوراثية والقيم التربوية لصفات النضج الجنسي وانتاج البيض في الدجاج المحلي البني العراقي

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المستخلص

اجريت هذه الدراسة لتقدير مكونات التباين والقيم التربوية للصفات الجنسية وصفات انتاج البيض للدجاج المحلي العراقي بني اللون. تم استخدام بيانات 2234 دجاجة منسبة ولستة أجيال متعاقبة من الانتخاب لزيادة إنتاج البيض لأول 24 اسبوع من وضع البيض. وسُجلت بيانات وزن أول بيضة ووزن الجسم عند النضج الجنسي وعمر النضج الجنسي وعدد البيض ومعدل وزن البيض وكتلة البيض بشكل فردي. تم تطبيق انموذج الحيوان أحادي المتغير وثنائي المتغير وفق متوسط الاحتمالية المقيدة للمعلومات لتقدير مكونات التباين والقيم التربوية. بلغ متوسط الصفات المذكورة اعلاه 35.7غم و1489.59غم و149.31يوم و109.32 بيضة/دجاجة و44.8 غم و4887.72 غم على التوالي. وكانت تقديرات المكافيء الوراثي على أساس إنموذج الحيوان 0.17، 0.42، 0.39، 0.40، 0.68 و 0.40 للصفات المذكورة أعلاه على التوالي. واظهرت الارتباطات الوراثية والمظهرية بين صفات النضج الجنسي (وزن أول بيضة ووزن الجسم عند النضج الجنسي وعمر النضج الجنسي) قيماً معتدلة وإيجابية. وكان الارتباط الوراثي بين صفات النضج الجنسي و(عدد البيض، كتلة البيض) سالبًا، وبلغت الارتباطات الوراثية بين (عدد البيض ووزن البيض) و (عدد البيض وكتلة البيض) و (وزن البيض وكتلة البيض) 0.902 و 0.105− و 0.337 على التوالي. كانت الارتباطات الوراثية بين وزن البيض وعمر النضج الجنسي سلبية بينما كانت موجبة مع وزن اول بيضة ووزن الجسم عند النضج الجنسي. تميل القيمة التربوية عبر الأجيال إلى الإيجابية في الصفات الإنتاجية ولكنها كانت سلبية في الصفات الجنسية. يمكن الاستنتاج بان الأداء الجيد والتقدير الموثوق للمعايير الجينية والقيمة التربوية BLUP الموضحة في الدراسة الحالية أن الدجاج المحلي البني العراقي لديه إمكانات وراثية جيدة لصفات إنتاج البيض ويستجيب بشكل جيد للانتخاب لزيادة صفات إنتاج البيض.

الكلمات المفتاحية: معالم وراثية، دجاج محلي: انتاج البيض، صفات النضج الجنسي.

Received:22 /2/2023, Accepted:3/5/2023, Published:30 June.

INTRODUCTION

Bodyweight (BW) and egg production (EP) traits are most important economic traits for farmers at rural level and producers at commercial level. In the commercial level, efforts were succeeded to produce birds with higher body weight -meat-type chickens- and higher egg output- egg-type chickens in a certain period of their lives. Local chickens have many unique features related to disease resistance and harsh environment adaptation (5, 6, 26, 22, 27). Despite their posing favorable alleles, the exotic breeds extended in many developing countries and may increase the risk of extinction of local races (33). In rural villages level, local chickens are still reared for providing fresh eggs and/or hobbies for fanciers. Local small-scale or large-scale production had never been established because the economic traits in local chickens are still greatly far from commercial breeds. Recently, in some areas of the world, much attention was paid to indigenous chickens as meat or layer strains that can provide the organic product to consumers (20, 14). The development of the special chicken egg or meat strains may be the first important step in enhancing small-scale production. The poultry Research Station at the Office of Agricultural Research located in the west of Baghdad re-inhabited the Iraqi local chickens (ILC) in 2008 to conserve and improve it. Iraqi indigenous chickens characterize as egg-type in the viewpoint of Iraqi researchers (3, 27) or dual-purpose in a native community where some people like to consume native chickens in festivals and religious events. Egg production in ILC, with a low level of management and rearing system under rural conditions, is very low. Egg production is still a most important unique trait in layer selection programs (37). However, the existence of national projects concerned with the development of local chicken breeds through the selection and crossbreeding to increase the economic returns of small-scale production, rural or backyard chickens is essential for poultry production. In this context, some previous local studies found that one breeds (brown) of the IIC has a good genetic potential for egg production traits in females (1, 4, 18) and BW in males (2). These results give a piece of clear positive evidence to develop special egg- or meat-type chickens through a selective breeding program. The present work was initiated in 2014 to improve the egg output of Iraqi brown local chickens. Egg production in chickens is affected by many genetic and non-genetic factors. Therefore, the values of heritability and correlations for egg production with the other sexual and production traits are gives the wide picture for economical traits trajectory. Estimation of (Co) variance components was a priority for any breeding plan for determining appropriate animal evaluation methods (21). The estimation of genetic parameters is crucial for any genetic program (6, 22, 16, 29). Despite some sporadic studies (17, 11) no comprehensive work relevant to genetic and phenotypic parameters estimation has yet to be published for Iraqi native chicken. On the other hand, genetic parameters are liable to change in a population under continuous selection (7). Therefore, as the aim of the current study, we used phenotypic information from 6 consecutive generations of Iraqi brown indigenous chickens to estimate heritabilities and correlations of the recorded traits as well as estimation breeding values to detect the genetic merits of individuals over 6 generations of selection.

MATERIALS AND METHODS

Study site and population: This study was carried out in Poultry Research Station at the Office of Agricultural Research /Ministry of Agriculture was used. The poultry farm is located at Longitude 33˚, 312,313'E and Latitude 44˚, 202,868'N. The birds of the current population were sires and dams of six generation select individually for high egg production. Data on 2234 Iraqi local hens represent six generations from third to eight generations were tested to estimate genetic parameters. The native poultry breed improvement program was initiated in 2008 at the Poultry Research Station (PRS) in Baghdad, Iraq. The initial parent stock of 15 cocks and 150 hens were selected randomly from base population raised in PRS. Each cock was mated to ten hens. Fertile eggs of two hatches were collected for two weeks and hatched in the incubator belonged the PRS. Birds in the base population were selected based on brown breed characteristics, including many morphological features such the type of comb, face color, eyes, beak, skin, tail, shank, body plumage, neck, and saddle plumage.

Environment and feeding: Birds of this study were reared in floor semi-closed house equipped with brooding heaters, feeders, waters, and a lighting system. The wood shaving was bedded on the house floor. The temperature and relative humidity were controlled as much as possible to achieve a proper environmental condition for each age in the house. Feed and water were offered freely. Five diets were introduced to chicks from hatch to the production phase. The starter diet (20% CP and 2900 Kcal/kg feed ME) from hatch to 4 weeks, the grower diet (17% CP and 2750 Kcal/kg feed ME) from 4 to 10 weeks, the developer diet (16% CP and 2750 Kcal/kg feed ME) from 10 to 16 weeks, pre-layer (16% CP and 2750 Kcal/kg feed ME) from 17 weeks to 5% egg production and layer diets (17% CP and 2800 Kcal/kg feed ME) from 5% to the end of experiment were fed on mash or crumble form. The compositions of the diets have not appeared in the separate table because changes in ingredients have happened across generations. All birds provided with light regimen with dark and light program according to their age. Birds were vaccinated against Marek disease, ND, IBD, fowl pox, and AE.

Data: Data used in this study represent six years of hatch (from 2016 to 2022). Parents of offspring were known for each bird, and six generations of pedigree were available for all birds with records. The overall number of animals in the pedigree file was 2480. The number of animals after pruning was 2450. The 216 animals without records were excluded from analysis Therefore, pedigree records of the remaining 2234 hens were tested. Hens without record for entire production cycle were excluded from analysis. Died birds were also excluded from analysis.

Traits studied: Six most important traits were measured on hens for 6 successive consecutive generations. These traits were age at sexual maturity (ASM), first egg weight (FEWT), body weight at sexual maturity (BWSM), Egg number (EN), average egg weights (EW), and egg mass (EM). EN and EW were recorded individually on a daily basis and data were summarized for overall cumulative periods (from starting lay to 43 weeks of age).

Statistical analyses: The SAS program (31) was used to calculate descriptive statistics and to identify significant fixed effects for each trait in a model. Statistical analysis shown a significant effect of generation, hatch and season on all traits therefore all three fixed effects were included in the model to estimate genetic parameters. Means were separated by using Duncan's multiple range and multiple F tests.

Genetic parameters: Genetic parameters were estimated using restricted maximum likelihood methods by fitting an animal model based on equation

$$\mathbf{Y} = \mathbf{Xb}+\mathbf{Zu}+\mathbf{e}$$

Where: **Y** = observation's vector of the trait; **b** = vector of fixed effects (hatch within year, generation, and season); **u**, is the vectors of direct additive genetic effect and **e** = vector of random residual effect; **X and**, **Z** are incidence matrices relating records to the fixed and direct additive genetic effect. The variance components for the random effects were de-noted as

var (u) = $\mathbf{A}\sigma^2 a$ and, var (e) = $\mathbf{I}\sigma^2 e$

where **A** is a numerator relationship matrix. The heritabilities and correlations for all traits were estimated using univariate and bivariate analysis, respectively using the WOMBAT software package (15). Breeding values for each animal in the pedigree were determined by using BLUP option in the Wombat software. BLUP based on mixed model equation (MME) under animal model of WOMBAT software package (15) were constructed in the matrix form written as

$$\begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z + \lambda A^{-1} \end{bmatrix} \begin{bmatrix} b \\ a \end{bmatrix} = \begin{bmatrix} X'y \\ Z'y \end{bmatrix}$$

Where y, X and Z were mentioned before in model equation above. $\lambda = \sigma^2 e/\sigma^2 a = (1-h^2)/h^2$ with $h^2 = \sigma^2 a/(\sigma^2 a + \sigma^2 e)$ in narrow sense and $\sigma^2 a$ is a random genetic variance; $\sigma^2 e$ is a residual error variance. A^{-1} is an inverse of the numerator relationship matrix of individuals in the pedigree.

RESULTS AND DISCUSSI

Descriptive statistics: Average FEWT, BWSM, ASM, EN, EW, and EM are presented in Table (1). Hens reached ASM at 149.31

days of age, with an average BWSM of 1489.59g and FEWT of 35.7g. The average EW was 44.80 g, the average EN was 109.32 eggs per hen and the average EM was 4887.72 g for the first 24 weeks of the laying period. The variation (SD and CV%) between birds in these six traits was noticed where some birds exhibited better performance than others, but in general more numbers of hens achieved reasonable performance. In tow strains of Iraqi local chickens EN recorded for 24 weeks of laying, BWSM, EW and daily EM in two strains of Iraqi local chickens was about 81.97 eggs per hen, 1252.17 g, 48.15 g, and 22.59 g respectively (17, 11). In five strains of Korean native chickens, The FEWT, BWSM, ASM, and EN for 39 weeks of age, and EW at 39 weeks of age ranged from 30.64-33.24 g, 1398.02-1583.37 g, 147.36-152.84 d, 84.49-89.75 egg per hen, and 47.90-50.76 g, respectively (30). In Iranian native hens, Kamali et al (13) found higher ASM (174.2 d), lower EN (53.26 egg), and comparable EW (43.86g). Also in Ethiopian native chickens, ASM and EN were 190 d and 33.64 eggs per hen respectively (6). In Thai native chickens, ASM, BWSM, FEWT, and EN were 196 d, 2050 g, 37 g, and 54 eggs per hen respectively (36) which reflect on egg number produce from hens reached maturity at delayed age. Higher performance in Iraqi brown local chickens compared to local chickens in Asia and Africa is a result of the selection of birds with high egg production and with ideal age at sexual maturity on the one hand and introduced ideal environmental conditions as possible on other hand. In this regard, many researchers (34, 32) proposed that selecting hens with less age at sexual maturity would increase egg production.

Table 1. Mean, standard deviation, minimum, maximum, and coefficient of variability (CV%) of sexual and production traits of Iraqi brown local chickens

Trait[1]	Records (n)	Mean	SD	Minimum	Maximum	CV%
FEWT (g)	2234	35.70	5.83	20.00	68.40	16.34
BWSM (g0	2234	1489.59	198.87	900.00	2845.00	13.35
ASM (day)	2234	149.31	13.49	109.00	198.00	9.03
EN (egg/hen)	2234	109.32	21.71	3.00	156.00	19.86
EW (g)	2234	44.80	3.14	30.31	59.05	7.400
EM (g)	2234	4897.54	973.48	120.40	7356.40	19.92

[1]: FEWT is first age weight; BWSM is body weight at sexual maturity; ASM is age at sexual maturity EN is egg number per hen; EW is average egg weight; EM is egg mass (=EN*EW).

Effect of non-genetic factors

The effect of generation, hatch, and season on sexual and productive traits are shown in Table (2). Egg production varied between generations. The higher FEWT and BWSM shown in the second generation compared to other generations may be due to hens attending maturity at greater age (163.2 d). The cumulative EN from the onset of lay to 43 weeks of age varied between generations where the highest EN was recorded in the six-generation compared to the first generation (112.45 vs 104.85 egg/hen). EW achieved better values in the second generation (47.60g) while the lowest was recorded in the third to the sixth generations (ca 43.5g). EW increased with age-progressive. The variation in sexual and productive traits across generations was also shown previously (28, 24, 10). The hatch effect had a significant effect on BWSM, ASM, EN, EW and EM. Hens hatched first achieved better performance compared to the second hatch. The second hatch is routinely raised in the same house as the first hatch and many environmental conditions such as temperature, humidity, and lighting regime could affect negatively performance (24). The effect of season was significant on FEWT, BWSM, ASM, EN, and EW. Birds hatched in the spring season achieved higher FEWT, BWSM, EW, and greater days to reach maturity. The overall EN for the hens hatched in the spring season was significantly lower than their counterparts hatched in the other season times. Birds hatching in the winter season achieved higher EN than in other seasons. Whereas, the scenario was the opposite for the overall average EW where the lowest values were recorded in the winter season. The variations between seasons with respect to the seasons were reported previously (19, 35).

Heritability estimation: The estimations of heritabilities for FEWT, BWSM, ASM, EN, EW, and EM are shown in table 3. The additive genetic variance was low in FEWT but high for the other five traits. Higher additive genetic variance revealed that this trait may improve through selection. The heritability of FEWT and BWSM in the current study (0.17±0.04 and 0.42±0.05 respectively) are similar to the estimation reported by Niknafs et al. (20) and Tongsiri et al. (36), but higher than the value (0.12 and 0.24) reported by Shadparvar and Enayati (34) in Iranian Mazandaran native chickens. Estimate heritability for ASM was in line with values obtained by Niknafs et al. (20) and Shadparvar and Enayati (34), and but lower than the value (0.49) estimated by Kamali et al (13) in Fars native chickens, and in Azerbaijan native chickens with a value 0.43 (12) and higher than the value (0.06) recorded in Ethiopian Horro chickens (6) and in Thai native chickens (36). However, in five strains of Korean native chickens, the heritability of ASM ranged from 0.12 to 0.32 (30). The heritability of egg number recorded in the present work exceeded values (h^2= 0.24-0.37) reported by Snag et al. (30), values (h^2= 0.24-0.35) reported by Dana et al. (6), value (h^2= 0.15) reported by Shadparvar and Enayati (34) and value (h^2= 0.17) reported by Niknafs et al. (20). But it was in the range with the value (h^2= 0.40) found by Kamali et al. (13). For EW the heritability estimated in the current study was higher than reported by Niknafs et al. (20) and in line with the value (h^2= 0.64) of Kamali et al. (13). The heritability estimated in the current work exceeded the value (h^2= 0.16) reported by Niknafs et al. (20). The higher values of heritability of productive traits revealed that the improvement of entire performance through selection is possible and could be a strategy to improve annual egg production traits in Iraqi local chickens.

Genetic and phenotypic correlations

Genetic and phenotypic correlations between studied traits are shown in Table (4). Genetic correlations estimated between sexual traits were positive. The genetic correlations between FEWT and BWSM, ASM and EW were moderate to high positive with values 0.473, 0.345, and 0.856 respectively. The BWSM had a positive correlation with ASM and EW with values of 0.430, and 0.515 respectively. On the other hand, EN was negatively correlated with all traits except with EM ranging from -0.093 to -0.528 which indicates that selection for higher EN would have reduced FEWT, BWSM, ASM, and EW. Phenotypic correlations were shown the same trend as genetic correlations but in lower magnitude. The phenotypic correlations between FEWT and BWSM, ASM and EW were moderately positive with values 0.247, 0.249, and 0.470 respectively. The BWSM had a positive correlation with ASM and EW with values of 0.360, and 0.371 respectively. A high positive phenotypic correlation between EN and EM close to the unity with the value of 0.941. A high and negative genetic correlation between EN and ASM shown in the current study (rg = -0.403) was also shown in study of Kamali et al. (13), Niknafs et al. (20), Firozjah et al. (8), Haunshi et al. (9) and Jafarnejad et al. (12) who they found the same relationship between these traits in Iranian and Indian local chickens but in higher magnitude (-0.63 or greater). In this contest, increasing of maturation age result a decreasing in EN of hens through entire of production cycle. A high positive genetic correlation between EN and EM (0.902) and between FEWT and EW (0.856) shown in the current work are in range with previous work (20). The high positive relationship between these traits is a good indicator for selection on one side for increasing egg production to get benefit to increase egg mass in laying chickens that reflect on improvement the feed conversion efficiency and increasing profit for producers.

Table 2. Effect of generation, hatch and season on sexual and productive traits for Iraqi brown local chickens (mean ± standard error)

Factor	Record, n	Trait FEWT	BWSM	ASM	EN	EW	EM
Generation							
1	289	36.10±0.30[bc]	1472.44±11.79[c]	148.67±0.61[c]	104.87±1.62[b]	45.23±0.18[c]	4752.23±74.54[b]
2	220	39.47±0.33[a]	1574.73±15.93[a]	163.20±0.99[a]	101.98±1.32[b]	47.60±0.22[a]	4832.67±60.92[b]
3	401	36.50±0.28[b]	1509.72± 9.97[b]	151.13±0.63[b]	111.17±0.83[a]	46.10±0.15[b]	5116.64±38.53[a]
4	433	34.15±0.28[e]	1490.21± 9.47[bc]	145.84±0.51[d]	111.16±1.19[a]	43.85±0.15[d]	4869.80±53.55[b]
5	577	34.91±0.22[de]	1458.58± 7.16[c]	149.11±0.59[c]	109.98±0.75[a]	43.95±0.11[d]	4824.05±34.06[b]
6	314	35.30±0.39[cd]	1476.16±11.19[c]	142.96±0.62[e]	112.45±1.21[a]	43.64±0.19[d]	4900.36±53.89[a]
Hatch							
1	1185	35.95±0.17	1497.79±5.45[a]	148.07±0.38[b]	111.94±0.63[a]	45.11±0.10[a]	5037.80±27.79[a]
2	1049	35.42±0.18	1482.34±6.50[b]	150.71±0.43[a]	106.36±0.66[b]	44.44±0.10[b]	4718.19±29.79[b]
Season							
Winter	1519	35.05±0.15[c]	1479.08± 4.85[b]	148.20±0.33[b]	110.94±0.52[a]	44.36±0.08[c]	4914.11± 23.40
Spring	220	39.47±0.33[a]	1574.73±15.93[a]	163.21±0.99[a]	101.98±1.33[c]	47.60±0.22[a]	4832.67± 60.92
Summer	169	36.07±0.39[b]	1442.59±14.16[c]	149.23±0.73[b]	108.35±2.24[ab]	45.15±0.25[b]	4909.24±103.59
Autumn	326	36.02±0.35[b]	1505.48±11.48[b]	145.11±0.62[c]	107.23±1.33[b]	44.76±0.18[b]	4790.78± 58.70
Source of variation		**Level of significance**					
Generation		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Hatch		0.1164	0.0345	<.0001	<.0001	<.0001	<.0001
Season		0.0542	<.0001	<.0001	0.0011	<.0001	0.1685

[a-e] Mean within same column for within same factor with no common superscripts differ significantly (P<0.05).
[1]: FEWT is first age weight, BWSM is body weight at sexual maturity, ASM is age at sexual maturity EN is egg number per hen, EW is average egg weight
EM is egg mass (=EN*EW).

Table 3. variance component and heritability of sexual and productive traits of Iraqi brown local chickens

TRAIT[1]	Record (n)	Animal(n)	Sire (n)	Dam (n)	σ^2a	σ^2e	σ^2p	h^2	±se
FEWT	2234	2450	152	849	5.57	26.48	32.05	0.17	0.04
BWSM	2234	2450	152	849	16451.6	22668.9	39120.5	0.42	0.05
ASM	2234	2450	152	849	61.03	94.85	155.88	0.39	0.05
EN	2234	2450	152	849	189.7	286.39	476.09	0.40	0.05
EW	2234	2450	152	849	6.61	3.16	9.77	0.68	0.04
EM	2234	2450	152	849	386652	576898	963550	0.40	0.05

[1]FEWT is first age weight; BWSM is body weight at sexual maturity; ASM is age at sexual maturity EN is egg number per hen; EW is average egg weight; EM is egg mass (=EN*EW).

Table 4. Genetic (above diagonal) and phenotypic (below diagonal) correlations ± standard error between studied traits of Iraqi brown local chickens

Trait[1]	FEWT	BWSM	ASM	EN	EW	EM
FEWT		0.473±0.106	0.345±0.116	-0.528±0.114	0.856±0.057	-0.080±0.134
BWSM	0.247± 0.021		0.430±0.080	-0.411±0.088	0.515±0.062	-0.121±0.098
ASM	0.249±0.021	0.360±0.021		-0.403±0.088	-0.087±0.104	-0.321±0.093
EN	-0.153±0.023	-0.251±0.023	-0.363±0.021		-0.105±0.084	0.902±0.017
EW	0.470±0.018	0.371±0.022	0.038±0.024	-0.093±0.026		0.337±0.075
EM	0.007±0.023	-0.110±0.024	-0.304±0.022	0.941±0.003	0.241±0.024	

1: FEWT is first age weight; BWSM is body weight at sexual maturity; ASM is age at sexual maturity EN is egg number per hen; EW is average egg weight; EM is egg mass (=EN*EW).

Breeding value estimate

Estimated breeding value (BV), accuracy, number of positive and negative animals, maximum, and minimum values of six studied traits are presented in table 5. The negative BV of sexual traits (FEWT, BWSM, and ASM) were shown and positive BV was recorded in productive traits (EN, EW, and EM). The accuracy was higher and the number of animals with positive BV values exceeded the number of animals with negative values of BV. The results achieved in the current study revealed that the flock of the study was progressing in the correct and desired direction. The negative BV of BWSM and ASM were accepted due to the reduction of these traits could reflect a reduction in feed due to low maintenance requirements and higher egg output as a result of increasing production cycle. The negative BV of FEWT was a low magnitude and could not be a big problem to affect negative adversely on mean egg weights through the laying period since EW had a positive BV. This conclusion was reliable since EN, EW, and EM achieved positive BV. It is also necessary to see that the higher values of the accuracy of breeding values (BV), and the higher number of negative or positive BV, depending on a trait, had higher robustness to select birds with high breeding values in order to increase genetic improvement in the population. Many researchers have shown that the desired trend of BV with higher accuracy will increase the annual gain in the population (23, 25, 24). The positive or the negative values of BV is depending on which trait. Sexual maturity traits especially age at first egg and body weight at first age need to be negative values in order to get higher egg output with a better feed conversion ratio. On other hand, the positive values for BV in productive traits refer to the population responding well to the selection for desired traits.

Table 5. Breeding Value, accuracy, number of animals with positive and negative values of BV, and maximum and minimum values of BV of studied traits estimated

Trait[1]	Average BV	Accuracy	Positive animals(n)	Negative animals(n)	Maximum	Minimum
FEWT	-0.197	0.764	1002	1394	12.961	-7.011
BWSM	-7.391	0.764	1081	1315	553.799	-306.174
ASM	-0.732	0.764	1056	1340	23.814	-21.482
EN	4.577	0.764	1702	694	38.492	-49.768
EW	0.251	0.768	1315	1081	6.597	-6.605
EM	194.510	0.768	1703	693	1623.593	-2134.98

[1]: FEWT is first age weight; BWSM is body weight at sexual maturity; ASM is age at sexual maturity EN is egg number per hen; EW is average egg weight; EM is egg mass (=EN*EW).

Conclusion

Based on the current results with respect to performance, genetic parameter estimation, and BLUP breeding value, the Iraqi brown local chickens have a good genetic potential for egg production traits and respond well to selection for increasing egg number. Higher values of heritability with lower standard errors indicate that they improved through selection and still have a large additive genetic variation that could continue to be improved for egg production, egg weight, or egg mass traits. The positive genetic correlations between sexual traits and egg weight indicate that higher first egg weight, body weight at sexual maturity, and delay maturation age increases the average egg weight. The negative correlation between egg number and age at sexual maturity indicates that birds that reached sexual maturity at an earlier age produced more eggs than their counterparts who reached maturity at a delayed age.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

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