

Study for Some Body Weight and Egg Traits in Domyati and Khaki-Campbell Ducks

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Abstract: The duck industry makes an important contribution to the availability of animal protein sources in Egypt, little known about the genetic parameters, particularly the heritability and genetic correlations of body weight and egg production in ducks. Body weight is the most essential feature for genetic improvement due to its ease of selection, high heredity, and large impact on meat production costs. The target of this study was to evaluate and explain genetic parameters such as the heritability, the genetic and phenotypic correlations, and sire breeding value in Domyati (local) and Khaki-Campbell (foreign) ducks in order to improve body weight and egg traits. A total of 160 (80 Domyati and 80 Khaki-Campbell ducks utilized to measure body weight at 16 and 20 weeks g), as well as 7000 eggs (2500 Domyati and 4500 Khaki-Campbell) to measure egg traits (the egg number, egg weight, and egg mass are all measured throughout the first 90 days of laying). In Domyati and Khaki-Campbell ducks, the heritability estimated for body weight was moderate to high, ranged from 0.35 to 0.40, and 0.21 to 0.30 for egg production. The genetic correlations among body weight and egg traits were all positive and had high values, also among BW16 and BW20 were stronger (0.90); (0.99). So the genetic improvement in BW16 could be followed by an increase in BW20 weeks. It concluded that, the relatively high value of genetic heritability for body weights and egg traits in Domyati and Khaki-Campbell ducks, indicates that it is possible to genetically increase body weight and egg traits through selection and subsequently inbreeding to divide the herd into groups that are selected among themselves to keep their sons.

Keywords: Domyati and Khaki-Campbell Ducks; Body Weight, Egg Production; Heritability; Genetic and Phenotypic Correlations; Sire Breeding Value

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1. Introduction

Little is known about the genetic factors that influence body weight and egg mass in ducks, including heritability and genetic correlations. Body weight is the most important trait for genetic improvement because of its ease of selection, high heritability, and significant impact on meat production costs. Ducks were individually selected for body weight at eight weeks of age, as individual selection is beneficial for increasing highly heritable traits [1]. Commercially relevant features like as egg traits are among the duck selection criteria. The availability of information demonstrating an animal's superiority, referred to as breeding value, is the first step in the selection process [2]. To build a precise breeding programmer in a population. Genetic parameters should be examined in each group since genetic parameters such as heritability and genetic correlation are commonly utilized as the foundation for selection methods [3]. Duck production is one of the branches of poultry production that supplies protein, eggs, and fatty liver. Furthermore, they have natural immunity to certain chicken infectious diseases including as Newcastle, Mark's, and Leucosis. The majority of Egyptian consumers still favor local duck breeds. Many breeders have spent their money in egg production farms during the last two

decades. Several workers realized that by crossing with foreign breeds or using selection techniques, egg traits for indigenous breeds may be enhanced.

The target of this study was to evaluate and explain genetic parameters such as the heritability, the genetic and phenotypic correlations, and sire breeding value in Domyati (local) and Khaki-Campbell (foreign) ducks in order to improve body weight and egg traits.

2. Materials and Methods

2.1. Data and animals

The trial took place in Egypt's El-Serw Waterfowl Research Station, which of the Animal Production Research Institute of the Agricultural Research Center. The trial was prolonged for two years.

Birds: A total of 160 (80 Domyati (local) and 80 Khaki-Campbell (foreign)) breeds were utilized to measure body weight (at 16 and 20 weeks g), as well as 7000 eggs (2500 Domyati and 4500 Khaki-Campbell) to measure egg traits (the egg number, egg weight, and egg mass are all measured throughout the first 90 days of laying).

2.2. The statistical analysis

Data analyze using a multi-trait animal model for the body weight and egg traits using the MTDFREML program [4]. The following general model was used to conduct the analyses.

$$y = Xb + Zs + e.$$

Where y is the vector of observation; X is the incidence matrix of fixed effects; b is the vector of fixed effects of month (12 levels); Z is the incidence matrix corresponding to the random effect of sire (s) and e = Vector of random errors. The heritability was calculated using the sire random effect ($h^2_s = 4 \sigma^2_s / \sigma^2_p$), where σ^2_s and σ^2_p are the variances related to the sire random effect and phenotype, respectively.

3. Results and Discussion

3.1. Means

Table 1 shows the means, standard deviations, and coefficients of variability for body weight and egg traits in Domyati and Khaki-Campbell ducks. To phenotypically describe the population utilized. According to these findings, the Khaki campbell ducks clearly outperformed the Domyati ducks in terms of body weight and egg traits. This could be owing to Khaki campbell ducks good genetic makeup and the fact that it is more acclimated to the environmental circumstances in Egypt than the Domyati duck. So, the Khaki-Campbell ducks must be taken in the improvement programs, either by crossing or selection. The coefficients of variation in body weights were very low for both Domyati and Campbell duck, while CV% for egg production was moderate. These results were in the range of reported by [5] used Brown Tsaiya ducks that weighed 1,270 g at 16 weeks of age and 1,407 g at 40 weeks of age. According to [6] the weights of Domyati at 4, 8, 12, and 16 weeks of age were 435.2, 1227.3, 1663.1, and 1752.8 g. He also reported that the body weight of Domyati ducklings had decreased after 14 weeks of age. This could be due to Domyati ducklings' slower growth rate as a local breed, especially at maturity under Egyptian circumstances. [7], who recorded Domyati eggs weighing 56.7 and 62.7 g at 25 and 32 weeks of age, respectively; he also noted that the egg mass of Domyati ducks aged 20-32 weeks was 815.75 g/duck. [8], who found a 30-40% increase in Khaki-Campbell and Domyati ducks between 10 and 22 weeks of age. During the 22-30, 30-38, 38-46, and 22-46

weeks of age, Domyati has more eggs than Khaki-Campbell. During the same time periods, he noticed that Khaki-Campbell had higher egg weight and egg mass/duck than Domyati. [9], who revealed that Domyati had higher equivalent weights of 1070.2, 1657.5, 2132.8, 2572.8, and 2975.9 g. Throughout the 0-2, 2-4, 4-6, 6-8, 8-10, and 10-12 weeks of laying in Domyati, the egg/duck ratio was 6.72, 6.83, 7.54, 7.75, 5.52, and 0.73. [10] found Domyati eggs weighing 61.2, 61.7, 61.5, 61.6, 62.9, and 62.8 g throughout the intervals 0-2, 2-4, 4-6, 6-8, 8-10, and 10-12 weeks of laying, and egg mass was 27.47, 28.11, 30.96, 31.85, 23.15, and 3.05. [11], who noticed 4.7, 14.7, and 10.7 egg/duck in Domyati between the ages of 20-24, 24-28, and 28-32 weeks; he also observed that Domyati eggs weighed 58.8, 62.4, and 67.1 g in the same intervals; and Khaki-Campbell had larger egg mass/duck (1721.0, 2948.0, 2720.0, and 7313.0 g) than Domyati during (1687.0, 2797.0, 2567.0, and 6897.0 g). [12] reported that body weight of Khaki-Campbell ducks was significantly heavier up to 20 weeks of age than Domyati, Khaki-Campbell weighed 593.01, 1338.69, 2067.44, 2309.20, and 2359.01 g, at 4, 8, 12, 16, and 20 weeks of age, Domyati weighed 463.22, 1237.97, 1707.91, 1806.95, and 1799.59 g in the same intervals respectively, also during the 24-36 week period, Khaki-Campbell produced 59.76 eggs while Domyati produced 37.42 eggs, also during their 90-day laying period, Khaki-Campbell ducks laid 25% more eggs than Domyati ducks, also during 0-2, 2-4, 4-6, 6-8, 8-10, and 10-12 weeks of laying, egg/duck was 4.51, 7.29, 8.08, 8.21, 6.31, and 3.02 in Domyati, respectively, he also observed that egg weight for Khaki-Campbell ducks was 72.69 g, as well as Khaki-Campbell eggs had a significantly larger egg mass/day than Domyati eggs. [13], who found that the live body weight of Muscovy ducks at marketing age was 3097g. [1], who found that duck body weights increased by more than 100 g between 110 days (1,269 g) and 300 days (1,381 g), egg weight increased from 65.0 g to 67.0 g, and the average number of eggs laid up to 300 days was 161 g. Ducks laid their first egg on average at 109.5 days of age, with a very low coefficient of variation (1.7 percent). [14], who noted that with, Pkein ducks had the highest coefficients of variation (12.14 percent) and the mean body weight was 2496 g at 42 days. [15], who found that an Alabio duck's mean body weight at 16 weeks of age was 1291.33 g, which was similar to the Mojosari duck's 1299.0 g. However, the Alabio duck's mean body weight at first egg was 1612.40 g, which was greater than the Mojosari duck's 1544 g.

Table 1. The body weight and egg traits (Mean \pm SD); of Domyati and Khaki-Campbell ducks, as well as.

Traits	Mean	SD	CV%
<u>Domyati duck</u>			
Body weight at 16 weeks (g)	1684.0	23.7	1.4
Body weight at 20 weeks (g)	1667.3	21.9	1.3
Body weight at first egg (g)	1639.8	16.9	1.0
Number of egg	50.2	12.2	24.2
Egg weight (g)	61.4	6.5	10.7
Egg Mass (g)	3181.5	752.2	23.6
<u>Khaki-Campbell duck</u>			
Body weight at 16 weeks (g)	2148.0	15.9	0.74
Body weight at 20 weeks (g)	2218.0	15.9	0.72
Body weight at first egg (g)	2171.7	14.2	0.65
Number of egg	53.9	10.1	18.8
Egg weight (g)	64.3	3.4	5.3
Egg Mass (g)	3187.4	754.4	23.7

3.2. Heritability

Tables 2 and 3 indicate heritability estimates for body weight and egg traits based on a multi-trait animal model. The heritability estimate for body weights was moderate to relatively high, ranged from 0.35 to 0.40, and also the heritability estimate for egg traits was moderate to relatively high, ranged from 0.21 to 30 in Domyati and Khaki-Campbell ducks, according to these calculations. The relatively high value of genetic heritability indicates that it is possible to genetically increase body weight and egg traits through selection and subsequently inbreeding to divide the herd into groups that are selected among themselves to keep their sons. My results are similar to those reported by [5], who found that heritability values for Brown Tsaiya ducks at 16 and 40 weeks of age were 0.47 for both body weights. [16], who discovered higher values in Pekin ducks, with heritability for the number of eggs laid ranging from 0.23 to 0.32. as well as [17], who obtained moderate heritability values of 0.33, 0.33, 0.35, 0.16, 0.43, and 0.50 for egg weight at 40 weeks/body weight at 40 weeks, egg weight at 40 weeks, egg weight at 30 weeks, body weight at 20 weeks, and body weight at 40 weeks. [18], who found that with, Pekin ducks, the heritability of body weight at 7 weeks are 0.53. Thus according [1], the heritability of egg weights was high and ranged from 0.43 to 0.61, intermediate for number of eggs laid ranged from 0.38 to 0.43, and low for age at first egg 0.13. In addition, body weight heritability values ranged from low to high, ranged from 0.345 for body weight at 110 days to 0.540 for body weight at 300 days. [15], reported that the body weight heritability levels at Alabio ducks 0.63 and Mojosari ducks 0.88 had the maximum age at 16 weeks. The Alabio duck's heritability for body weight at first egg was 0.55, while the Mojosari duck's heritability was 0.44, according to duck Mojosari, estimates of heritability for egg number from months 1-3 and 1-6 range from 0.30 to 0.46. The Alabio duck showed a high egg number heritability (0.62) from month one to month twelve, while the Mojosari duck had a moderate egg number heritability (0.46). In Pekin ducks, [14] showed that body weight at 42 days had the highest heritability of 0.48. [19] noted that the estimated heritability of body weight at 21 days (0.29) and body weight at 42 days (0.48) were relatively high; thus, they could be improved by direct phenotypic selection in Pekin ducks. In contrast, at 10 and 18 weeks of age, [20] found that heritability estimates of body weights for Muscovy ducks were 0.07 and 0.10, respectively. [12] found that body weight at 0, 4, and 8 weeks of age had a low heritability (ranging from 0.014 to 0.175), with heritability slightly greater in Khaki-Campbell ducks than in Domyati ducks. Heritability estimates for body weight at 12, 16, and 20, sexual maturity, 20%, and 50% laying production were from 0.325 to 0.449 in Khaki-Campbell and 0.302 to 0.431 in Domyati weights, respectively.

Table 2. Shows the heritability estimates (on diagonals), the genetic correlations and their standard error (above diagonals) and phenotypic correlations (below diagonal), of body weight and egg traits in Domyati ducks.

Traits	BW16	BW20	BWF1	NE	EW	EM
Body weight at 16 weeks ,g (BW16)	0.37 ± 0.004	0.90 ± 0.002	0.79 ± 0.011	0.52±0.090	0.57 ± 0.088	0.50 ± 0.019
Body weight at 20 weeks, g (BW20)	0.93 ± 0.001	0.40 ± 0.04	0.78 ± 0.016	0.57±0.084	0.50 ± 0.089	0.58 ± 0.013
Body weight at first egg, g (BWF1)	0.80 ± 0.006	0.840 ± 0.004	0.37 ± 0.04	0.57±0.088	0.52 ± 0.102	0.50 ± 0.019
Number of egg (NE)	0.85 ± 0.009	0.88 ± 0.008	0.88 ± 0.007	0.24 ± 0.09	0.69 ± 0.141	0.82 ± 0.065
Egg weight, g (EW)	0.88 ± 0.008	0.83 ± 0.010	0.85 ± 0.010	0.92 ± 0.009	0.21 ± 0.08	0.72 ± 0.048
Egg Mass, g (EM)	0.83 ± 0.001	0.88 ± 0.001	0.83 ± 0.001	0.94 ± 0.007	0.90 ± 0.006	0.30 ± 0.08

3.3. Genetic correlations

Due to linkage and pleiotropy, the amount and direction of correlated responses play a critical role in designing effective breeding strategies for increased productivity, especially among positively correlated features [21]. For Domyati and Khaki-Campbell ducks, the genetic correlations between body weight and egg traits were all positive and had high values, the correlations between BW16 and BW20 were high (0.90), (0.99). So the genetic improvement in BW16 may be followed by a rise in BW20 weeks (Table 2&3). As well as genetic correlations between BW20 and both BWF1; NE; EW and EM were higher for Khaki-Campbell ducks (0.92; 0.82; 0.82 and 0.82). That is, an improvement in BW20 is followed by an improvement in both BWF1; NE; EW and EM. These results are similar to those found by [17] discovered that egg production traits and egg weight at 40 weeks /body weight at 40 weeks were relatively negatively correlated, while body weight traits were substantially genetically correlated (0.988) and positively correlated with egg weights. All other variables were negatively correlated with egg production traits except body weight at 40 weeks and egg weight at 30 weeks and egg weight at 40 weeks (0.979) and were strongly genetically correlated (0.948). [22], who found that there were little genetic links between reproductive traits and weights (0.036). The body weight of a male mule duck at 6 weeks of age is the most closely related feature. [1], who found that the number of eggs laid was genetically correlated with body weight (+0.54), but not with the age of first egg or egg weight. Egg weight and body weight traits were shown to have strong positive correlations. He suggested that depending on his observations, an efficient selection technique may be used to improve the pure Shan Ma duck line's egg production. [15], who found a high genetic correlation ranged from 0.80 to 0.99 among the egg number from months 1 to 12 (EN 12) and the egg number from months 1-3 (EN 3) and 1-6 (EN 6). EN12 had a negative genetic link to body weight and the age of the first egg (between -0.81 and -0.21). This finding suggests that EN3 could be used as a selection criterion to improve EN12 in Alabio and Mojosari ducks.

Table 3. Shows the heritability estimates (on diagonals), the genetic correlations and their standard error (above diagonals) and phenotypic correlations (below diagonal), for body weight and egg traits in Khaki-Campbell ducks.

Traits	BW16	BW20	BWF1	NE	EW	EM
Body weight at 16 weeks, g (BW16)	0.36 ± 0.02	0.99±0.010	0.71 ± 0.014	0.71 ± 0.028	0.70±0.055	0.87 ± 0.005
Body weight at 20 weeks, g (BW20)	0.99 ± 0.003	0.35 ± 0.03	0.92 ± 0.004	0.82 ± 0.018	0.82±0.036	0.82 ± 0.007
Body weight at first egg, g (BWF1)	0.90 ± 0.003	0.94 ± 0.001	0.40 ± 0.03	0.78 ± 0.022	0.77±0.047	0.78 ± 0.009
Number of egg (NE)	0.89 ± 0.004	0.93 ± 0.003	0.91 ± 0.004	0.29 ± 0.09	0.72±0.119	0.82 ± 0.059
Egg weight, g (EW)	0.93 ± 0.007	0.92 ± 0.005	0.90 ± 0.007	0.91 ± 0.012	0.24 ± 0.10	0.72 ± 0.048
Egg Mass, g (EM)	0.94 ± 0.001	0.92 ± 0.001	0.91 ± 0.001	0.94 ± 0.006	0.90 ± 0.006	0.30 ± 0.07

3.4. Phenotypic correlations

Body weight and egg traits had strong phenotypic correlations, with values ranged from 0.80 to 0.99 for Domyati and Khaki-Campbell ducks (Table 2 & 3). These results correspond to those of [12] noted that the day-old body weight was significantly correlated with weight at 4, 8, and 12 weeks of age in both breeds (0.8, 0.8, and 0.6 in Khaki-Campbell and 0.8, 0.5, and 0.7 in Domyati, respectively). Furthermore, body weight

at 4 weeks was phenotypically associated with weight at 8 or 12 weeks in both breeds (0.6 to 0.8), and the phenotypic correlation between weight at 16 weeks and other weights at 20, sexual maturity, and 20% and 50% laying production was quite strong in both breeds (except sexual maturity in Domyati ducks). [1] indicated that as the duck grew older, phenotypic correlation among egg weights for two successive ages increased, with values of + 0.36 between egg weight of the 10 first egg and egg weight at 210 day, + 0.56 between egg weight at 210 day and egg weight at 280 day, and + 0.72 between egg weight at 280 day and egg weight at 300 day. In terms of the quantity of eggs laid, phenotypic correlations increased from + 0.75 between number of egg at 210 day and number of egg at 280 day to + 0.97 between number of egg at 280 day and number of egg at 300 day. [19] in Pekin ducks, phenotypic relationships between body weight at 42 days, body weight at 21 days, daily body weight gain, daily feed intake, and meal feed intake were shown to be significantly positive.

3.5. Sire breeding value

The rate of improvement in the principal trait of selection is determined by the estimated breeding value. Any genetic improvement initiative in livestock and poultry must start with population variability. The response to selection in the primary as well as other correlated qualities of economic value determines genetic progress. For developing breeding programmes for genetic enhancement of desirable traits in chicken, a thorough understanding of the genetic basis, gene activity, and environmental effect is required. The population size, gene frequency, mutation, allelic fixation, random drift, and physiological constraints all influence the trait's selection response [23]. As well as individuals' phenotypic value can be determined directly; however, breeding values define their impact on future generations; so, breeding value must be evaluated.

The minimum and maximum estimates of sire breeding values (SBV) in Domyati ducks are higher than in Khaki-Campbell ducks, (Table 4). Furthermore, the range between the minimum and maximum sire breeding values for the same attributes in Domyati ducks is greater than in Khaki-Campbell ducks. The range of sire breeding value estimates between the minimum and maximum values forms the basis for any planned selection strategy to increase economic features and introduce the potential of making the best culling decision and picking the best ducks. These results were in the range of reported by [14] found in Pekin ducks, the generational average breeding value of body weight at 42 days grew to 349.45 g over a 10-generation period. [19], who found that during the selection, the average breeding value of body weight at 21 days increased by 8 g, while improvements in body weight at 42 days and FI were 20 g and 40 g, respectively, in Pekin ducks. [24], who observed a growing trend in the average breeding value of egg mass during a 40-week period utilizing Dahlem Red chickens, with a genetic gain of 1.87 eggs each generation. There was no inbreeding and the breeding value for primary and linked traits exhibited linear trends in the intended direction.

Table 4. Sire breeding values (SBV), accuracy and Range for body weights and egg traits of Domyati and Khaki-Campbell ducks.

Traits	Minimum			Maximum			Range
	SBV	S.E	Accuracy	SBV	S.E	Accuracy	
<u>Domyati ducks</u>							
Body weight at 16 weeks (g)	-38.09	0.36	0.80	47.67	0.36	0.80	85.76
Body weight at 20 weeks (g)	-222.34	0.42	0.90	292.00	0.42	0.90	514.34
Body weight at first egg (g)	-166.78	0.28	0.89	120.59.	0.28	0.89	287.37
Number of egg	-4.49	0.34	0.86	5.96	0.34	0.86	10.45
Egg weight (g)	-3.32	0.36	0.82	5.69	0.36	0.82	9.01
Egg Mass (g)	-392.70	0.19	0.94	498.30	0.19	0.94	891.00
<u>Khaki-Campbell ducks</u>							
Body weight at 16 weeks (g)	-15.36	0.41	0.90	14.19	0.41	0.90	29.55
Body weight at 20 weeks (g)	-11.79	0.41	0.80	10.14	0.41	0.80	21.93
Body weight at first egg (g)	-15.13	0.43	0.82	21.36	0.43	0.82	36.49
Number of egg	-5.03	0.39	0.76	3.08	0.39	0.76	8.11
Egg weight (g)	-3.02	0.38	0.76	5.77	0.38	0.76	8.79
Egg Mass (g)	-117.30	0.37	0.73	185.71	0.37	0.73	303.01

4. Conclusion

The relatively high value of genetic heritability for body weights and egg traits in Domyati and Khaki-Campbell ducks, indicates that it is possible to genetically increase body weight and egg traits through selection and subsequently inbreeding to divide the herd into groups that are selected among themselves to keep their sons. For Domyati and Khaki-Campbell ducks, genetic correlations between body weights and egg traits variables were all positive and had high values; the correlations between BW16 and BW20 were strong correlations (0.90). (0.99). Then the increase in BW16 weeks could be followed by a rise in BW20 weeks as a result of the genetic improvement. By based on the present results, breeders possible to improve body weight and egg production. And create successful genetic selection strategies for Domyati and Khaki-Campbell ducks.

Declarations

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Conflict of interest: There is no conflicts of interest declared by the authors.

Ethics approval and consent to participate: The Animal Production Research Institute agreed to conduct research on ducks at their El-Serw Waterfowl Research Station.

Data availability: The writing author declares database availability and sends a request to the related writers for any query. We ask that you contact the author for access to and consultation of supplemental information (databases).

Author contribution: Wael A. H. Ali collated the data, Mahmoud G. Gharib performed statistical analysis of the data, and Amira S. El-Deghadi prepared and reviewed the research. The final manuscript was read and approved by all contributors.

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