

GENETIC EVALUATION OF GROWTH TRAITS IN DOKKI-4 CHICKENS

M.H. Khalil¹, M. Hanafi¹, A.E.F. El-Labban² and M.M. Iraqi¹

1) Department of Animal Production, Faculty of Agriculture, University of Zagazig, Banha Branch, Qulyoubia Governorate, Egypt 2) Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt

SUMMARY

Growth traits of 4057 Dokki-4 chicks (as a synthetic native breed) produced by 35 sires in three consecutive hatches were evaluated. Body weight (BW) at hatch and biweekly thereafter up to 12 weeks as well as absolute gain (AG) and relative growth rate (RG) at intervals of between 0-4, 4-8 and 8-12 weeks of age were analysed separately using the mixed model procedures. Coefficients of variation (CV) for growth traits are tended generally to increase as the chick advanced in age. The differences due to sires and dams for all growth traits at different ages were highly significant ($P < 0.01$ or $P < 0.001$). Small percentages of variation (V%) due to sire effects on BW (2.4%), AG (2.7%) and RG (2.7%) were obtained.

Heritability estimates from sire component (h^2_s) for all growth traits were generally low and ranged from 0.065 to 0.153, while estimates from maternal half-sibs (h^2_d) ranged from 0.553 to 1.079 for BW, from 0.510 to 0.685 for AG and from 0.343 to 0.602 for RG. The estimates of heritability based on full-sibs (h^2_{s+d}) for growth traits at different age intervals were moderate or high which ranged between 0.312 to 0.606 for BW, 0.317 to 0.386 for AG and between 0.227 to 0.360 for RG. All estimates of phenotypic (r_p), genetic (r_g) and environmental (r_e) correlation among BW and AG were

positive and of moderate or high magnitude, and tended to decrease in value as the differences between the two ages get larger. Expected estimates of annual direct genetic progress based on paternal half-sib (PHS) for BW selected for hatch-, 4-, 8- and 12-week weight are 0.1, 3.0, 3.2 and 4.2 grams per chick per generation, respectively. The corresponding estimates based on full-sibs (FS) were 0.8, 5.0, 11.9 and 22.6 grams in the same order. Selection for 4-week body weight have been generally associated with a moderate or high rate of expected correlated response in growth traits at subsequent ages.

Keywords: Dokki-4 chickens, growth traits and genetic parameters

INTRODUCTION

In the last ten years, poultry industry in Egypt and chicken, in particular, depends mainly on some foreign breeds while local breeds are neglected. Although our local breeds (Fayoumi, White Baladi, Dandarawi, Dokki-4, ..etc) are more adapted for the Egyptian environmental conditions, they did not subject to intensive genetic improvement studies. Dokki-4 chickens, for instance, could be easily sexed at hatching (auto-sexing) and it is characterized by white skin and shanks. It has specific weight and gain as well as it has high feed conversion (El-Itriby and Sayed, 1966; Abd El-Gawad, 1969). It has also superior meat qualities compared to other local breeds such as Fayoumi and White Baladi. Moreover, its meat has an acceptable taste for the majority of the Egyptian consumers (Abd El-Gawad, 1969). Thus, these reviewed estimates on Dokki-4 could be an advantage for encouraging the poultry breeders in Egypt to utilize this breed in meat production. It is worthy, therefore, for the chicken breeders in Egypt to give more effort in carrying out selection programmes on this breed in order to enhance its rate of growth.

The available genetic information concerning the inheritance of growth traits in broilers of our local breeds (or correlations among them) is little. The purpose of the present study was to quantify the average genetic, phenotypic and environmental variation and

covariation of growth traits in Dokki-4 chicks and to assess the direct and correlated response expected from selection.

MATERIAL AND METHODS

Experimental work and data

This work was carried out on Dokki-4 chickens raised in the Poultry Research farm at Inshas (Sharkia Governorate), Animal Production Research Institute, Ministry of Agriculture, Egypt. This synthetic native breed was developed from the crossing of Fayoumi males (native breed) and Banded Plymouth Rock females (exotic breed) for four consecutive generations of selection (El-Itriby and Sayed, 1966). The experimental work was carried out for three consecutive hatches in the period from March 1979 to June 1980. A total number of 4057 chicks were produced by 35 sires in the three hatches. All chicks of one-day old were wing-banded and reared in floor brooder, then transferred to the rearing houses. Chicks were fed during rearing and growing periods on ration containing 20.4% and 16% crude protein, 3.2% and 3.9% crude fiber, 3.7% and 4.3% fat and 2997 metabolizable energy Kcal/kg, respectively. All birds had the same managerial and climatic conditions and they were treated and medicated similarly throughout the experimental period.

Data of individual body weight at hatch and biweekly thereafter up to 12 weeks of age were collected. Absolute gain (AG) and relative growth rate (RG) between 0-4, 4-8 and 8-12 weeks were computed.

Statistical analysis

Individual chick's body weight (at one day, 2, 4, 6, 8, 10 and 12 weeks of age) and AG and RG (at intervals of 0-4, 4-8 and 8-12 weeks) were analysed separately by fitting the following mixed model (Harvey, 1987):

$$Y_{ijklm} = \mu + S_i + D_{ij} + A_k + B_l + AB_{(kl)} + e_{ijklm}$$

Where Y_{ijklm} = the observation on the $ijklm$ th individual; μ = the overall mean; S_i = random effect of the i th sire; D_{ij} = random effect of the j th dam mated to the i th sire; A_k = fixed effect of k th hatch; B_l = fixed effect of l th sex; $AB_{(kl)}$ = the

interaction between k^{th} hatch and l^{th} sex; and e_{ijklm} = random deviation of m^{th} chick of ij^{th} dam.

According to Harvey (1987), the decimal percentage of genetic variance in sire (i.e. σ_s^2) = the decimal percentage of the additive genetic variance in dams within sire = 0.25, i.e. $\sigma_s^2 = \sigma_{D:S}^2 = 0.25$, and the decimal percentage of additive genetic variance within dams $\sigma_e^2 = 0.5$. Estimates of σ_s^2 , $\sigma_{D:S}^2$ and σ_e^2 components of variances and covariances were computed according to Method 3 of Henderson (Henderson, 1984). Estimates of heritability and their standard errors were calculated according to LSMLMW of Harvey (1987). The genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations between any two growth traits were calculated using the formulae described by Harvey (1987). These correlations were estimated on the basis of paternal half sibs (PHS), maternal half sibs (MHS) and full-sibs (FS). The expected direct (E_G) and correlated (CR) response of selection were calculated according to Falconer (1989).

RESULTS AND DISCUSSION

Means and variation

Means, standard deviations (SD) and coefficients of variation (CV) of body weight (BW), absolute gain (AG) and relative growth rate (RG) of Dokki-4 chickens are given in Table 1. These means fall within the range of means reported for the same breed by most Egyptian studies (e.g. Ayoub and Magraby, 1976). The reviewed means of the Egyptian studies (El-Itriby and Sayed, 1966; Abd El-Gawad, 1969; Ezzeldin, 1970; Ismail, 1980; Kosba and Eid, 1983; Sorour, 1984; Amer, 1990) on Fayoumi, White Baladi, Dandarawi, Rhode Island Red and White Leghorn have shown that body weight of these breeds at hatch, 2, 4, 6, 8 and 12 weeks of age had lower means than those obtained here for Dokki-4 chicks. However, RG was high (137.5%) at the early stages (0-4 weeks), then decreased gradually with the advancement of age which reached 52.8% during the period of 8-12 weeks. In general, means of RG for Dokki-4 chicks in this study were higher than those previously reported by Ezzeldin (1970) for Fayoumi and Dandarawi. Coefficients of variation (CV) for growth traits of Dokki-4 chickens tended generally to increase as the chick advanced in age (Table 1). An evidence for this trend in Dokki-4

chicks and for other local breeds was also given in most of the Egyptian studies (e.g. Ayoub and Magraby, 1976). Estimates of CV of the present study indicated also that variation in growth of Dokki-4 chicks was markedly lower during the earlier age intervals (0-4 weeks) than at the older age interval (8-12 weeks). This lower variability from 0-4 weeks may be due to the consequence of the expression of the combination of non-genetic maternal environment and the genetic factors (Falconer, 1989). High CV's at later ages may be due to that birds become less sensitive to the non-genetic maternal effect which decreases with advance of age, while the environmental effect increases with age (Gupta and Johar, 1975). Estimates of CV for growth traits reported here (Table 1) are relatively higher than those of other local breeds (e.g. Fayoumi, White Baladi, Alexandria and Mamourah).

Table 1. Means, standard deviations (SD) and coefficients of variation (CV) of uncorrected records for different growth traits of Dokki-4 chicks.

Trait	NO	Mean	SD	CV%
<u>BW (gm):</u>				
BW0	4057	31.6	3.0	9.5
BW2	3860	76.5	11.5	15.0
BW4	3663	174.1	29.0	16.6
BW6	3600	288.7	53.3	18.5
BW8	3470	429.1	71.3	16.6
BW10	3355	564.7	96.6	17.1
BW12	3262	741.1	135.9	18.3
<u>AG (gm):</u>				
AG0-4	3663	142.5	28.3	19.8
AG4-8	3470	254.1	57.8	22.8
AG8-12	3262	311.4	96.8	31.1
<u>RG (%):</u>				
RG0-4	3663	137.5	9.9	7.2
RG4-8	3470	83.8	12.2	14.6
RG8-12	3262	52.8	12.1	22.9

Genetic aspects and variance components

Results presented in Table 2 indicated that sire and dam effects on all growth traits of Dokki-4 chicks at different ages were significant ($P < 0.01$ or $P < 0.001$). In agreement with the present results, Sorour (1984) working on Dokki-4 and White Baladi chickens concluded that sire and dam effects on body weight at different ages were significant ($P < 0.05$ or $P < 0.01$). The significant sire and dam effects for growth traits suggest an important direct additive genetic effect on these traits at all ages studied. In addition, the highly significant dam effect on all growth traits indicates also an important maternal and dominance effects (non-additive genetic effects). The suggestion of possible important maternal effects upon all growth traits of Dokki-4 chickens would agree with other reports (El-Maghraby and Bakir, 1977). However, the expected influence of the dams on their chicks' weights is not only due to the genes transmitted by the dams to their offspring but also to the large non-genetic maternal environmental effects in the pre- and post-hatching period. In this respect, Saeki *et al.*, (1968) observed that chick's weight at hatching was highly significantly correlated with egg weight ($r = 0.853$). Chaudhary *et al.*, (1986) observed a significant maternal effect on body weights at different ages. They added also that, although maternal effects decreased in relative importance after 8 or 12 weeks of age, they were still present at 20 weeks of age.

Table 2. Estimates of variance components (σ^2) and percentages of variation (V%) for random effects affecting growth traits of Dokki-4 chicks.

Growth trait	Sire			Dam			Remainder		
	d.f.	$\sigma^2 S$	V%	d.f.	$\sigma^2 D$	V%	d.f.	$\sigma^2 e$	V%
BW:									
BW0	34	0.2	2.1***	863	2.1	25.5***	3154	6.1	72.4
BW2	34	4.2	3.3***	818	34.1	27.0***	3002	88.2	69.7
BW4	34	28.7	3.8***	812	107.6	14.3***	2811	615.1	81.9
BW6	34	43.0	1.8***	812	333.3	13.8***	2748	2036.0	84.4
BW8	34	101.7	2.6***	812	645.8	16.3***	2618	3224.7	81.2
BW10	34	112.7	1.6***	812	1254.5	18.1***	2503	5578.8	80.3
BW12	34	239.3	1.9***	812	2310.3	18.2***	2410	10180.6	80.0
AG:									
AG0-4	34	26.6	3.7***	812	92.4	12.8***	2811	605.9	83.6
AG4-8	34	60.1	2.2***	812	472.1	17.1***	2618	2224.9	80.7
AG8-12	34	164.9	2.3***	812	983.4	13.6***	2410	6094.5	84.2
RG:									
RG0-4	34	2.61	2.8***	812	8.13	8.6***	2811	83.93	88.7
RG4-8	34	4.25	2.9***	812	21.80	15.1***	2618	118.69	82.0
RG8-12	34	3.24	2.4***	812	14.40	10.9***	2410	115.03	86.7

The estimates of variance (σ^2) and percentages of variation (V%) showed that V% of sire, dam within sire and remainder components of variance are variable for different growth traits, (Table 2), i.e. inconsistent estimates for these traits were observed. Small V% due to sire effects on BW were obtained at all ages. However, large V% due to dam effects on BW were recorded at all ages comparable to those of sire. These large components of variance of dam effects may be due to the existence of large maternal effects and possibly due to dominance and other additive and non-additive gene interactions. In addition, the sire as well as the dam effects were large in early ages than those of later ages. Also, non-additive maternal effects were large at the early ages and decreased thereafter with the advancement of age.

Similar trend of small estimates of V% due to sire for AG comparable to those of dam were estimated (Table 2). The non-additive maternal effect on AG reached 11.8%. From the previous results, it is clear that dam effects could be considered as the most important factor affecting growth traits at hatching and during the post-hatching period. This is true, since maternal and non-additive genetic effects are still present up to later ages which they reached 16.3% at 12 weeks of age.

In general, results given in Table 2 reveal that the dam at all ages had greater effect on the chick's growth trait than that of the sire. Similarly, Ezzeldin (1970), El-Maghraby and Bakir (1977), Shalash (1977), Sorour (1984) worked on different breeds of chickens reported that the dams' components of variance were higher than those of sire at all ages studied. From the biogenetical point of view, the dam component of variance in Dokki-4 chickens is probably overestimated here because additive genetic variance in the dam component may be greater than in the sire component since observations of most dams are spread over three hatches and therefore the dam component would include a part of the genetic trend over hatches. Also, the dam component of variance is expected to include variance due to maternal effects and a quarter of both the dominance and additive variance, besides all possible interactions of additive x additive, additive x dominance and dominance x dominance (Becker, 1984). Statistically, the upward bias in dam component of

variance may be a result of the existence of interaction between dams and other fixed effects included in the same model of analysis (Toelle *et al.* 1990) which results in an inflation in the dam component and thereby biasing the sire component downwards. In this respect, Ezzeldin (1970) reported that the removal of hatch as a factor allowed estimation of the sire genetic variance free of such bias. Moreover, possibility of an interaction between dam with month of hatch could exist which would bias the sire component downward (Ezzeldin, 1970; Toelle *et al.* 1990). In practice and according to the present and reviewed estimates of dam genetic variance, the statistical analysis for the growth traits in chickens which are pre-corrected for hatch and/or month of hatch, give an estimate free of such bias.

Heritability

Heritability of growth traits estimated from paternal half-sibs (h^2_s), maternal half-sibs (h^2_d) and full-sibs (h^2_{s+d}) are shown in Table 3. Lower estimates of h^2_s for all growth traits were obtained in this study; they ranged from 0.041 to 0.153 (Table 3). These estimates showed that there was insufficient scope for increasing the growth of Dokki-4 chickens by selection. The existence of related-dams or high relationship coefficients between dams and sires in the parent population of this study will lead to a downward bias in the estimates of heritability from the sire component (Hinkelmann, 1971). Also, these small estimates of h^2_s might be due to the large maternal effects, i.e. variation within the egg sizes of sires' and dams' daughters (hens) could have masked any additive genetic variance and consequently an increase in the non-additive genetic effects was expected. Sampling effect and non-randomness in the distribution of dams within sire groups could be added as other causes in this respect.

Small estimates of h^2_s and large estimates of h^2_d were observed (Table 3), e.g. h^2_d for BW and AG ranged from 0.553 to 1.079 and from 0.510 to 0.685, respectively, while estimates for RG ranged from 0.343 to 0.602. This may be due to that growth traits in Dokki-4 chickens were subjected to a large non-genetic maternal influence. It is also clear that maternal effects are of considerable importance in determining

phenotypic differences in the growth traits at different ages which bring the predominance of the h^2_D estimate over the h^2_S . Most estimates of h^2_D obtained by El-Hossari (1970), Ezzeldin (1970) and Ismail (1980) on Dokki-4 and Fayoumi chickens reported similar results. Growth characteristics from hatching time and up to 12 weeks of age were still give evidence of this maternal effect, probably due to correlation of growth of the chick with its egg weight. However, dam component of variance included all maternal additive genetic variance, covariance between direct and maternal additive and both maternal dominance and maternal environmental variances. These were not included in the sire component of variance and four times their contributions would lead to differences between paternal and maternal estimates of heritability. A suggestion of possible maternal effects upon growth traits of chickens at different ages would agree with other reports (El-Hossari, 1970; Ismail, 1980; Kumar and Acharya, 1980; Verma *et al.*, 1983).

Table 3. Estimates of heritability for growth traits of Dokki-4 chicks.

Trait	$h^2_S \pm SE$	$h^2_D \pm SE$	$h^2_{(S+D)} \pm SE$
BW:			
BW0	0.084±0.032	1.020±0.067	0.552±0.039
BW2	0.134±0.045	1.079±0.069	0.606±0.041
BW4	0.153±0.050	0.573±0.065	0.363±0.035
BW6	0.071±0.030	0.553±0.065	0.312±0.034
BW8	0.102±0.039	0.650±0.069	0.376±0.037
BW10	0.065±0.029	0.722±0.072	0.394±0.038
BW12	0.075±0.032	0.726±0.073	0.401±0.039
AG:			
AG0-4	0.147±0.049	0.510±0.064	0.328±0.034
AG4-8	0.087±0.035	0.685±0.069	0.386±0.037
AG8-12	0.091±0.037	0.543±0.071	0.317±0.036
RG:			
RG0-4	0.110±0.040	0.343±0.060	0.227±0.030
RG4-8	0.118±0.042	0.602±0.068	0.360±0.036
RG8-12	0.098±0.038	0.434±0.069	0.266±0.034

Several investigators (e.g. El-Hossari, 1970; El-Maghraby and Bakir, 1977; Kumar and Acharya, 1980; Stino et al. 1981; Kosba and Eid, 1983; Kumar et al. 1988; Abd Ellatif, 1989) stated that analyses of growth traits using covariances between sibs have resulted in negative estimates of h^2_s and numerous large estimates of h^2_D . Bias and/or sampling errors could be responsible for such unreliable estimates. Bias may be due to large maternal and dominance effects while sampling errors would arise from the small number of sires and dams used. Recently, Mayer et al., (1987) stated that relationships among parents could influence the interpretation of structural variance components in terms of causal components and of heritability, i.e. variance components and heritability estimates are overestimated as a result of the presence of relationships among dams. The same author therefore concluded that genetic relationship among dams within and between dam groups must be considered in the analysis.

No consistent trend for estimates of h^2_s was observed for different growth traits (Table 3). In this respect, the average of the reviewed estimates for h^2_s for BW at different ages were generally higher at older ages than at younger ages (Ezzeldin, 1970; Ismail, 1980; Kumar and Acharya, 1980; Kosba and Eid, 1983). Gupta and Johar (1975), Sabri (1979), Stino et al., (1981) and Tripathy et al., (1984) reported that h^2_s for BW of chicks were the highest for weight at hatch, declined to the lowest values at 4 and/or 6 weeks of age and increased again for weights at 8 weeks or older.

The estimates of h^2_{s+D} for growth traits at different age intervals were moderate or high (Table 3). The estimates ranged between 0.312 to 0.606, 0.317 to 0.386 and 0.227 to 0.360 for BW, AG and RG, respectively. These results confirm the fact that maternal effects on the chick tend to be very high during the early stages of growth, decreasing thereafter gradually during the later ages. Estimates of h^2_{s+D} reported here were higher than the corresponding estimates reported by Ismail (1980) for Dokki-4 and by EL-Hossari (1970) and Ezzeldin (1970) for Fayoumi chickens. El-Maghraby and Bakir (1977) with Dokki-4 chickens found that estimates of h^2_{s+D} for BW had a wide variation and this was expected due to the small number of sires they used in their analysis (8 sires). Since

the number of degrees of freedom for sires was fairly small, estimates based on the full-sib correlation are consequently subjected to large sampling errors. However, estimates of h^2_{S+D} represent variation among full sibs caused by additive direct, additive maternal, non-genetic maternal and non-maternal common environmental effects. Accordingly, differences between the present and reviewed estimates could be attributed to differences in one or more of these components.

In general, estimates of h^2_S , h^2_D and h^2_{S+D} reported herein for BW were higher than those previously reported by the Egyptian investigators (Abd El-Gawad, 1970; Ayoub and Magraby, 1976; El-Maghraby and Bakir, 1977). Sabri (1979) and Kosba and Eid (1983) derived higher corresponding estimates for other local breeds.

Correlation

Estimates of genetic (r_G), phenotypic (r_p) and environmental (r_E) correlations are shown in Table 4.

Phenotypic correlation (r_p)

All estimates of r_p among BW and AG at different ages were positive and of moderate or high magnitude (Table 4), and tended to decrease relatively in their values as the differences between the two ages get larger. Most estimates of r_p among RG traits and with BW or AG were mainly positive and of moderate or high magnitude, while some estimates were negative and variable in size according to the age interval (Table 4). In agreement with the present results, most estimates in the literature (El-Hossari, 1971; Abd El-Gawad and El-Ibiary, 1972; Kumar and Acharya, 1980; Gill and Varma, 1983; Stino *et al.*, 1983; Asuquo and Nwosu, 1987) showed that estimates of r_p among growth traits of chicken at different ages were positive and generally high. In practice, these positive and generally moderate or high r_p among growth traits at different ages give management and culling decisions considerable advantage.

Genetic correlation (r_G)

Estimates of r_G (PHS, MHS and FS) obtained here show that these estimates tended to decrease in value as the differences between the two ages get larger. Similar findings were reported by Kumar and Acharya (1980), Gill

and Varma (1983) and Tripathy *et al.*, (1984). Estimates of r_G based on sire (r_S), dam (r_D) and sire + dam (r_{S+D}) components of variance and covariance among different weights (Table 4) showed also that most of these associations were positive and similar in sign to the corresponding estimates of r_P . Also, the $r_{G's}$ (PHS, MHS and FS) among BW's and/or AG's showed that most of these relationships were positive (Table 4). The negative estimates of r_G (PHS, MHS and FS) among some growth traits (e.g. BW at hatching and RG) were unexpected (Table 5). Similarly, Ezzeldin (1970) and El-Hossari (1971) reported that some estimates of r_G among BW and RG of Fayoumi chicks were negative and generally low (especially those in the later age intervals). The same authors stated that birds which showed faster RG at later age intervals were high in weight at earlier ages and consequently negative estimates of correlation were obtained. Sampling errors may be another cause of these unexpected estimates.

Table 4. Estimates of genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations among growth traits at different ages.

Traits correlated	PHS		MHS		FS		
	$r_S \pm SE$	r_E	$r_D \pm SE$	r_E	$r_{S+D} \pm SE$	r_E	r_P
W0 and BW4	0.51+0.18	0.19	0.56+0.06	1.22	0.54+0.06	-0.05	0.22
BW8	-0.06+0.25	0.15	0.29+0.07	0.77	0.25+0.07	0.03	0.13
BW12	0.46+0.23	0.13	0.36+0.07	1.21	0.36+0.06	-0.04	0.15
BW4 and BW8	0.66+0.13	0.56	0.54+0.06	0.63	0.56+0.05	0.58	0.57
BW12	0.87+0.09	0.43	0.58+0.06	0.22	0.62+0.05	0.37	0.47
BW8 and BW12	0.56+0.18	0.68	0.80+0.04	0.34	0.78+0.03	0.59	0.67
BW0 and AG0-4	0.45+0.20	0.08	0.45+0.07	1.12	0.43+0.06	-0.14	0.12
AG4-8	-0.42+0.23	0.09	0.06+0.07	0.04	0.02+0.07	0.07	0.05
AG8-12	0.62+0.20	0.06	0.30+0.08	0.73	0.32+0.07	-0.07	0.10
BW4 and AG0-4	1.00+0.00	0.99	0.99+0.00	1.00	0.99+0.00	1.00	0.99
AG4-8	0.20+0.23	0.17	0.17+0.09	0.18	0.17+0.08	0.17	0.17
AG8-12	0.62+0.17	0.15	0.43+0.09	-0.12	0.46+0.07	0.07	0.20
BW8 and AG0-4	0.69+0.13	0.55	0.54+0.07	0.62	0.56+0.05	0.57	0.57
AG4-8	0.87+0.06	0.91	0.92+0.01	0.88	0.91+0.01	0.90	0.91
AG8-12	-0.03+0.25	0.16	0.40+0.09	-0.26	0.35+0.07	0.04	0.15
BW12 and AG0-4	0.87+0.10	0.42	0.58+0.06	0.26	0.61+0.05	0.37	0.46
AG4-8	0.11+0.26	0.59	0.67+0.05	0.29	0.62+0.05	0.52	0.56
AG8-12	0.81+0.09	0.84	0.87+0.02	0.82	0.86+0.02	0.83	0.84
BW0 and RG0-4	0.18+0.24	-0.35	-0.23+0.10	0.69	-0.17+0.08	-0.41	-0.30
RG4-8	-0.75+0.17	-0.04	-0.32+0.08	-0.99	-0.36+0.07	0.10	-0.11
RG8-12	0.58+0.21	-0.02	0.13+0.09	0.31	0.17+0.08	-0.07	0.03
BW4 and RG0-4	0.94+0.03	0.82	0.67+0.05	1.02	0.73+0.04	0.90	0.84
RG4-8	-0.63+0.19	-0.50	-0.47+0.12	-0.59	-0.50+0.09	-0.53	-0.52
RG8-12	0.27+0.23	-0.15	0.08+0.10	-0.31	0.11+0.09	-0.20	-0.10
BW8 and RG0-4	0.72+0.13	0.42	0.35+0.09	0.59	0.42+0.07	0.47	0.45
RG4-8	0.18+0.22	0.42	0.49+0.07	0.23	0.44+0.06	0.36	0.39
RG8-12	-0.48+0.24	-0.36	-0.22+0.16	-0.59	-0.25+0.09	-0.43	-0.37
BW12 and RG0-4	0.88+0.11	0.30	0.36+0.09	0.39	0.43+0.07	0.32	0.35
RG4-8	-0.58+0.19	0.24	0.20+0.08	0.08	0.10+0.08	0.19	0.16
RG8-12	0.46+0.20	0.44	0.41+0.08	0.53	0.41+0.07	0.46	0.44

Table 4. Cont.

Traits correlated	PHS		MHS		FS		r_p
	$r_s \pm SE$	r_E	$r_D \pm SE$	r_E	$r_{s+D} \pm SE$	r_E	
AG0-4 and AG4-8	0.24+0.22	0.16	0.17+0.09	0.18	0.18+0.08	0.17	0.17
AG8-12	0.60+0.17	0.15	0.41+0.09	-0.08	0.44+0.07	0.07	0.20
AG4-8 and AG8-12	-0.46+0.22	0.12	0.27+0.09	-0.25	0.18+0.08	0.01	0.07
AG0-4 and RG0-4	0.96+0.02	0.87	0.75+0.04	1.00	0.80+0.03	0.92	0.88
RG4-8	-0.59+0.19	-0.50	-0.46+0.13	-0.59	-0.48+0.09	-0.53	-0.52
RG8-12	0.23+0.23	-0.15	0.07+0.11	-0.28	0.10+0.09	-0.19	-0.10
AG4-8 and RG0-4	0.32+0.23	0.09	0.12+0.11	0.12	0.15+0.09	0.09	0.11
RG4-8	0.64+0.14	0.75	0.79+0.04	0.65	0.77+0.03	0.72	0.74
RG8-12	-0.78+0.21	-0.35	-0.30+0.12	-0.54	-0.36+0.09	-0.41	-0.39
AG8-12 and RG0-4	0.58+0.19	0.09	0.23+0.11	0.07	0.29+0.09	0.09	0.14
RG4-8	-0.82+0.15	0.01	-0.06+0.10	-0.12	-0.18+0.08	-0.03	-0.08
RG8-12	0.89+0.05	0.85	0.80+0.04	0.91	0.82+0.03	0.87	0.85
RG0-4 and RG4-8	-0.48+0.22	-0.48	-0.30+0.15	-0.67	-0.33+0.10	-0.54	-0.48
RG8-12	0.19+0.24	-0.13	-0.02+0.13	-0.15	0.02+0.10	-0.14	-0.10
RG4-8 and RG8-12	-0.79+0.17	-0.22	-0.34+0.12	-0.22	-0.42+0.09	-0.22	-0.28

+ r_s = correlations from paternal half-sibs; r_D = correlations from maternal half-sibs; r_{s+D} = correlations from full-sibs.

Correlations given in Table 4 indicate that the r_s among growth traits at different ages were generally higher than the r_p and r_E . This may be due to that genes which influence growth traits are more persistent in their effects than the environmental factors which they are more temporary in nature. Similar trend was reported by some workers who working on different breeds of chickens (e.g. El-Hossari, 1971; Kumar and Acharya, 1980; Stino *et al.* 1983). Therefore, it could be safely to conclude, on the basis of estimates of r_G in the present and other reviewed studies, that growth traits of chickens at earlier ages may be effective in selection. Consequently, correlated improvement in growth traits at later ages (through indirect selection) may be quite possible. The estimates of r_s among growth traits at different ages were high and indicated that the genetic factors of all growth traits studied were closely additively related. They also indicated that measures before the age of 12 weeks could be good indications of the genetic value for growth traits at that age. Estimates of r_s among different growth traits

reported for local breeds (e.g. Dokki-4, Fayoumi and Baladi White) by some Egyptian investigators (El-Hossari, 1971; Abd El-Gawad and El-Ibiary, 1972; Sorour, 1984) fall within the range of those estimates obtained in the present study. This may be due to that our local breeds were not subjected to any intensive programme of selection. This gives an encouragement for the chicken breeders in Egypt to improve the growth rate of their Dokki-4 chicks through indirect selection.

Table 5. Expected direct (underlined) and correlated response based on paternal half-sib per generation from single-trait selection* for different growth traits.

Criteria of selection	Item†	Response in different growth traits per generation									
		BW0	BW4	BW8	BW12	AG0-4	AG4-8	AG8-12	RG0-4	RG4-8	RG8-12
BW:											
BW0	a	0.12	0.79	-0.18	2.06	0.67	-0.94	2.31	0.08	-0.45	0.30
	b	0.39	0.45	-0.04	0.28	0.47	-0.37	0.74	0.06	-0.54	0.57
BW4	a	0.08	2.97	2.60	5.26	2.02	0.61	3.11	0.59	-0.51	0.19
	b	0.27	1.71	0.61	0.71	1.42	0.34	1.00	0.43	-0.61	0.36
BW8	a	-0.01	1.13	3.21	2.76	1.14	2.15	-0.12	0.37	0.12	-0.28
	b	-0.03	0.65	0.75	0.37	0.80	0.85	-0.04	0.27	0.14	-0.52
BW12	a	0.05	1.28	1.54	4.23	1.23	0.23	2.85	0.39	-0.33	0.23
	b	0.17	0.73	0.36	0.57	0.86	0.09	0.91	0.28	-0.39	0.43
AG:											
AG0-4	a	0.07	2.06	2.66	5.15	1.98	0.71	2.95	0.59	-0.47	0.16
	b	0.23	1.18	0.62	0.70	1.39	0.28	0.95	0.43	-0.56	0.30
AG4-8	a	-0.05	0.32	2.58	0.50	0.37	2.28	-1.74	0.15	0.39	-0.42
	b	-0.17	0.18	0.60	0.07	0.26	0.90	-0.56	0.11	0.47	-0.79
AG8-12	a	0.08	1.00	-0.09	3.78	0.93	-1.08	3.87	0.28	-0.51	0.48
	b	0.25	0.58	-0.02	0.51	0.66	-0.42	1.24	0.21	-0.61	0.92
RG0-4	a	0.03	1.67	2.40	4.51	1.64	0.82	2.47	0.54	0.33	0.11
	b	0.08	0.96	0.5	0.61	1.15	0.35	0.79	0.39	0.39	0.22
RG4-8	a	-0.11	-1.16	0.62	-3.08	-1.05	1.70	-3.62	-0.27	0.71	-0.49
	b	-0.34	-0.67	0.15	-0.42	-0.73	0.67	-1.16	-0.19	0.85	-0.93
RG8-12	a	0.08	0.45	-1.51	2.23	0.37	-1.89	3.58	0.10	0.51	0.56
	b	0.24	0.26	-0.35	0.30	0.26	-0.74	1.15	0.07	0.61	1.07

* Selection intensity equals 1.0 for estimated response.

† Where a=response in actual units of measurements and b= response (a) per generation as expressed as a percent of the overall mean of the trait.

Most estimates of r_D among growth traits of different ages were generally positive and relatively large or moderate (Table 4). These estimates represent

the similarity among pair-mates (maternal half-sibs) caused by additive maternal, non-additive maternal and non-genetic maternal effects. However, estimates of r_D among growth traits obtained here were lower than those estimates reported by El-Hossari (1971), Abd El-Gawad and El-Ibiary (1972) and Sabri (1979) on Fayoumi chicks and Sorour (1984) on Baladi White chicks.

The estimates of r_S reported here were higher than the corresponding estimates of r_D (Table 4). This might be due to the non-randomness in choosing the mates for sires or the tendency of sires to produce most of their offspring at certain period, i.e. non-randomness in the distribution of offspring of sires in the different hatches. The downward bias in the estimates of r_D while r_S showed upward bias, may also arise from two circumstances. Firstly, it can be due to the correction of the data for some possible maternal environmental factors such as hatch, i.e. egg size (as a character of the dam) differed from one hatch to another and consequently including the effects of hatch and dam in the same mixed model will lead to a reduction in the dam component of variances and covariances. Secondly, the bias can also be caused by selection (i.e. bias resulting from using the data of chicks surviving to the latest weight at 12 weeks of age).

The estimates of r_{S+D} among different growth traits were generally positive and moderate or high in magnitudes (Table 4). These r_{S+D} of the present study were generally fall within the range of those estimates cited by Ezzeldin (1970), Abd El-Gawad and El-Ibiary (1972), Sabri (1979), Stino et al. (1983) and Sorour (1984) for Fayoumi and Baladi White chickens. However, r_G estimated from full-sibs for growth traits represents the likeness among maternal half-sibs caused by additive direct, additive maternal, non-genetic maternal and non-maternal common environmental effects. Variation in estimates of r_{S+D} in the present and reviewed studies may be due to variation in one or more of these previous components.

Environmental correlation (r_E)

The estimates of r_E (PHS, MHS and FS) among growth traits of Dokki-4 chickens showed that most of these relationships were positive and generally moderate or high (Table 4). Similar findings were reported by

El-Hossari (1971), Abd El-Gawad and El-Ibiary (1972) and Sorour (1984). Estimates of r_E reported herein (PHS, MHS and FS) for different growth traits indicated that the magnitude of the coefficients decreased as the chick advanced in age.

In some cases, estimates of r_G and r_E are different in magnitude, or even in sign, while in other cases the two correlations are of the same sign and not very different in magnitude, and this is the more usual situation in the present study. A large difference, and particularly a difference in sign, shows that genetic and environmental sources of variation affect the characters through different physiological mechanism (Falconer, 1989).

Prediction of response to selection

The expected direct and correlated responses per generation from single-trait selection for weight of Dokki-4 chick are presented in Table 5 for estimates based on PHS and in Table 6 for estimates based on FS. One standard deviation of selection differential was assumed for estimated responses. Values for response are given in actual units of measurements and as percentage of mean per generation, i.e. the relative efficiency of correlated response as compared to direct response. In general, predicted response due to selection tended to decrease in value as differences between the two ages get larger (Tables 5&6). Therefore, growth traits at earlier ages could be improved somewhat more rapidly if selection was based on 4-week weight or during the first four weeks of age.

The theoretical estimates of maximum annual rate of direct genetic progress as percentages of mean per generation (based on PHS) for BW selected for hatch-, 2-, 4-, 6-, 8-, 10- and 12-week weight are 0.4, 1.0, 1.7, 0.6, 0.6, 0.5 and 0.6%, respectively (Table 5). These results showed that the expected direct response for BW at earlier ages (4-week weight) did not give sufficient scope for the improvement of BW of Dokki-4 chicks through direct selection. On the other hand, the corresponding estimates of direct genetic gain based on FS (Table 5) are relevant to an average of 10.5% as a percentage of the overall mean for different weights. Estimates of direct response obtained in the present study were generally within the range of those estimates

cited by Ezzeldin (1970) and El-Maghraby and Bakir (1977) who worked on different breeds of chickens. The theoretical estimates of maximum annual rate (as a percentage of the overall mean) of direct genetic progress (based on PHS) for other growth traits of AG and RG (at intervals of 0-4, 4-8 and 8-12 weeks of age) averaged 2.5 and -0.6%, respectively. The corresponding estimates based on FS averaged 3.8 and 3.1% in the same order. These results indicated that the direct selection based on families of FS for growth traits at earlier ages (0-4 weeks of age) give greater improvement in growth traits of chickens than indirect selection (Ezzeldin, 1970, El-Maghraby and Bakir, 1977).

Table 6. Expected direct (underlined> and correlated response based on full-sib per generation from single-trait selection* for different growth traits.

Criteria of selection	Item ⁺	Response in different growth traits per generation									
		BW0	BW4	BW8	BW12	AG0-4	AG4-8	AG8-12	RG0-4	RG4-8	RG8-12
BW:											
BW0	a	0.80	3.31	3.59	9.56	2.46	0.24	5.70	-0.29	-0.97	0.38
	b	2.53	1.90	0.84	1.29	1.73	0.10	1.83	-0.21	-1.15	0.71
BW4	a	0.35	4.98	6.52	13.35	4.60	1.67	6.64	1.02	-1.09	0.20
	b	1.11	2.85	1.52	1.80	3.23	0.66	2.13	0.74	-1.30	0.37
BW8	a	0.17	2.84	11.85	17.09	2.65	9.10	5.14	0.60	0.97	-0.46
	b	0.52	1.63	2.76	2.31	1.86	3.58	1.65	0.44	1.16	-0.86
BW12	a	0.25	3.25	9.54	22.62	2.98	6.40	13.05	0.63	0.23	0.77
	b	0.78	1.86	2.22	3.05	2.09	2.52	4.19	0.46	0.27	1.46
AG:											
AG0-4	a	0.27	4.68	6.20	12.48	4.42	1.68	6.04	1.06	-0.99	0.17
	b	0.84	2.68	1.44	1.68	3.10	0.66	1.94	0.77	-1.18	0.32
AG4-8	a	0.01	0.87	10.93	13.76	0.86	10.13	2.68	0.22	1.73	-0.66
	b	0.04	0.50	2.55	1.86	0.61	3.99	0.86	0.16	2.06	-1.26
AG8-12	a	0.19	2.14	3.81	17.30	1.91	1.65	13.49	0.38	-0.37	1.37
	b	0.61	1.23	0.89	2.33	1.34	0.65	4.33	0.28	-0.44	2.60
RG:											
RG0-4	a	-0.09	2.87	3.87	7.32	2.94	1.17	3.31	1.10	-0.57	0.03
	b	-0.28	1.65	0.90	0.99	2.06	0.46	1.06	0.80	-0.68	0.05
RG4-8	a	-0.23	-2.48	5.10	2.14	-2.22	7.54	-2.59	-0.46	2.17	-0.75
	b	-0.73	-1.42	1.19	0.29	-1.56	2.97	-0.83	-0.33	2.59	-1.42
RG8-12	a	0.09	0.47	-2.30	7.55	0.40	-3.03	10.13	0.02	-0.78	3.06
	b	0.30	0.27	-0.54	1.02	0.28	-1.19	3.25	0.02	-0.93	5.81

* Selection intensity equals 1.0 for estimated response.

+ Where a= response in actual units of measurements and b= response (a) per generation as expressed as a percent of the overall mean of the trait.

Selection for 4-week weight has been generally associated with a moderate or high rate of expected correlated response in BW at subsequent ages (Table 6). These findings indicated that the theoretical maximum rate of direct genetic progress in Dokki-4 chicken stock selected solely for 4-week weight would be almost 124% (correlated relative to direct) as effective as direct selection of improving 12-week weight. In addition, Table 6 shows that the relative efficiency of improving 12-week weight and the other growth traits as a correlated trait is greater for 4-week weight than for 8-week weight or 10-week weight. If selection is to be applied for 12-week weight at an early age on the basis of increased 4-week weight, the maternal effect involved can be avoided by practising within family selection, or selection among groups of full-sib progeny. On the other hand, selection for 12-week weight would cause growth traits at earlier ages to increase. Consequently, selection for 12-week weight would be 43% (correlated relative to direct) as effective as direct selection for improving 4-week weight in Dokki-4 chickens. However, these results reflect the direction and magnitude of genetic correlations between growth traits of different ages studied, i.e. due to their part-whole genetic relationship. Also, selection for other growth traits (e.g. AG and RG) at 0-4 weeks of age has been generally associated with a moderate rate of expected correlated response in growth traits at subsequent age intervals (Tables 5 & 6). The relative efficiency of improving growth traits at 8-12 weeks of age, as a correlated trait, is greater for 0-4 weeks of age than for 4-8 weeks of age.

Selection for BW4 based on PHS would cause a correlated increase of 5.3 gm, 3.1 gm and 0.2% in BW12, AG8-12 and RG8-12, respectively (Tables 5 & 6). Similarly, selection for BW4 based on FS were 13.3 gm, 6.6 gm and 0.2% in the same order (Table 6). Selection for AG0-4 based on PHS would cause a correlated increase of 5.1 gm, 2.9 gm and 0.2% in BW12, AG8-12 and RG8-12, respectively (Table 5), while the corresponding estimates based on FS were 12.5 gm, 6.0 gm and 0.2% in the same order (Table 6). Selection for RG0-4 based on PHS would result a correlated increase of 4.5 gm, 2.5 gm and 0.1% in BW12, AG8-12 and RG8-12, respectively (Table 5), while the corresponding estimates based on FS were

7.3 gm, 3.3 gm and 0.03% in the same order (Table 6).

CONCLUSION

(1) Results of the present and reviewed studies indicated that Dokki-4 chicken has heavier body weight (BW) and higher rate of gains than other local breeds. Since, it is characterized by an acceptable taste for the majority of the Egyptian consumers (Abd El-Gawad, 1969), it is safe, therefore, to conclude that Dokki-4 chicks may be considered as a meat-type chickens in Egypt. Moreover, utilization of this breed in programmes of meat production in Egypt is recommended.

(2) High coefficients of variation (CV) for most growth traits of Dokki-4 as compared to other local breeds may encourage the poultry breeders in Egypt to improve the growth of this breed through phenotypic selection.

(3) The highly significant effects of sires and dams on all growth traits of Dokki-4 chickens indicated that the direct additive genetic effects on these traits are important and this leads to state that improvement of these traits by selection may be possible. The highly significant dam effect on all growth traits indicates the existence of an important nonadditive maternal and dominance effects which indicate also that marketing of meat broilers is recommended at the age in which maternal effects are becoming small or insignificant (e.g. at 12 weeks of age).

(4) Low estimates of heritability from paternal half-sibs and overestimates of heritability from maternal half-sibs may be resulted from the existence of related-dams or high relationship coefficients between dams and sires in the parent population of the present study. Therefore, the genetic relationship among dams within and between dam groups should be considered in estimation of heritability. Future research is needed to investigate the biometrical aspects of this relationship in the estimation of heritability.

(5) The estimates of correlations obtained here amongst different growth traits were favorable in terms of the objectives of mass selection for increased growth at different ages. High and positive genetic and phenotypic correlations lead also to state that growth traits at earlier ages could be used for selection. Moreover, these estimates are pertinent in constructing efficient

selection indices to improve the growth traits in Dokki-4 chickens.

(6) In respect to the moderate additive genetic variance and the high genetic correlations, it is clear that selection for most growth traits has very much to offer for the Egyptian commercial chicken breeding at the farm level. Even so, Further research is needed to identify the direct and correlated responses due to selection for these growth traits in different herds and in several locations.

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التقييم الوراثي لصفات النمو في دجاج دقي ٤

ماهر حسب النبي^١ - محمد حنفي سيد^١ - محمود عبد الفتاح اللبان^٢ -
محمود مغربي عراقي^١

١- كلية الزراعة بمشتهر - جامعة الزقازيق -مشتهر - قليوبية ٢- معهد
بحوث الإنتاج الحيواني - وزارة الزراعة

اجريت هذه الدراسة لتقييم صفات النمو على عدد ٤٠٥٧ كتكوت دقي ٤ (كسلالة محلية) نتجت من ٥٣ أب في ثلاث تفرخات متتالية. تم التقييم الوراثي باستخدام بيانات أوزان الجسم (المقاسة عند عمر الفقس وعلى فترات اسبوعين حتى ١٢ أسبوع) وكذا لصفات النمو الأخرى مثل الزيادة المطلقة في الوزن ومعدل النمو النسبي (في الفترات من عمر الفقس حتى ٤ اسابيع، من ٤ حتى ٨ اسابيع ومن ٨ حتى ١٢ اسبوع) وذلك باستخدام النماذج المختلطة للتحليل الاحصائي.

تلخصت النتائج المتحصل عليها فيما يلي:-

- ١- كانت معاملات الاختلاف المظهرى لصفات النمو تتجه للزيادة تدريجيا بتقدم عمر الكناكيت .
- ٢- كانت الاختلافات الراجعة لتاثيرات كل من الآباء والأمهات عاليه المعنويه (عند مستوى ٠,٠١ او ٠,٠٠١) لكل صفات النمو فى الأعمار المختلفه. كانت نسبة التباين الراجعة لتاثير الآباء على صفات وزن الجسم (٢,٤٪) والزيادة المطلقة فى الوزن (٢,٧٪) صغيره ولكن بدرجة ملموسه.
- ٣- وجد انه لا يوجد إتجاه ثابت لقيم المكافئ الوراثى المقدر من أنصاف الأشقه الأبويه لكل صفات النمو المدروسه. ولكن لو حظ ان المكافئ الوراثى المقدر من الآباء لصفات النمو منخفض القيمة حيث تراوحت القيم بين ٠,٠٤١ الى ٠,١٥٤ بينما تراوحت القيم المقدره من أنصاف الأشقه الأميه بين ٠,٥٥٣ الى ١,٠٧٩ لوزن الجسم ، وبين ٠,٥١١ الى ٠,٧١٧ للزيادة المطلقة فى وزن الجسم ، وبين ٠,٣٤٣ الى ٠,٦٠٦ لمعدل النمو النسبى. كانت قيم المكافئ الوراثى لصفات

النمو المقدره من مكون الأخوه الأشقه متوسطه او مرتفعه القيمه وذلك فى الأعمار المختلفه حيث تراوحت القيم بين ٠,٣١٢ الى ٠,٦٠٦ لوزن الجسم ، وبين ٠,٣١٧ الى ٠,٣٩٥ للزيادة المطلقة فى وزن الجسم وبين ٠,٢٢٧ الى ٠,٣٦٠ لمعدل النمو النسبى .

٤- كانت قيم الارتباطات المظهرية وكذا كل من الارتباطات الوراثيه والبيئيه المقدره من مكونات أنصاف الأشقه الأبويه وأنصاف الأشقه الأميه والأشقه الكامله موجبہ ومتوسطہ أو عاليه القيمه وذلك بين صفات وزن الجسم والزيادة المطلقه فى الوزن ، كما كانت القيم تتجه للإخفاض فى قيمها كلما زادت الفروق بين العمرين .

٥- كانت القيم المتوقعه للإستجابہ للإنتخاب المباشر المقدره على اساس أنصاف الأشقه الأبويه عند عمر الفقس، ٤، ٨، ١٢ اسبوع هى ٠,١٢، ٣، ٢,٣، ٢,٤، ٢,٤ جراما لكل كتكوت عن كل جيل من الإنتخاب لوزن الجسم على التوالى . كما كانت التقديرات المماثلہ المقدره على أساس الأشقه الكامله هى ٠,٠، ٠,٠، ٠,٠، ١١,٩، ٢٢,٦ جراما بنفس الترتيب . صاحب الإنتخاب لوزن الجسم عند عمر ٤ اسابيع معدلا متوسطا او عاليا من الإستجابہ الغير مباشره فى الأوزان التى

ثلت ذلك .