Egypt. Poult. Sci. Vol (36) (IV): (949-956) (2016) (1664)

Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: 1110-5623 (Print) – 2090-0570 (On line)

ESTIMATION OF ADDITIVE, DOMINANCE AND HERITABILITY OF SOME EGG PRODUCTION TRAITS IN EGYPTIAN LOCAL STRAINS OF CHICKEN

R.Sh, Abou El-Ghar and Ragaa E. Abd El-Karim

Anim. Prod. Rese. Inst., ARC, Minis. of Agric., Egypt.

Corresponding author: Reda.Abouelghar@GMail.com

Received:28/08/2016 Accepted: 02/09/2016

ABSTRACT: Egg production in poultry shows considerable individual variation over the laying period. Evaluation and selection of Egyptian local strain of chicken had been carried out. The aim of the present study was to estimate additive, dominance, heritability for some egg production traits and to determine the best strain based on multiple egg production traits. The four strains showed that Mandrah strain was ranked first, Doki-4 was ranked second, the strain Inshas was ranked third and El-Salam was ranked last in the performance of some egg production traits. The estimate additive genetic variance accounted a major part of the total genetic variance for sexual maturity, mature egg weight, early egg weight, number of eggs at 90 d of laying, egg mass at 90 d of laying and body weight at sexual maturity. The estimates of dominance genetic variance in these traits was relatively negative and low. The estimated heritability was almost 0.4 for all egg production traits studied. The present results showed clearly that Mandrah local strains of chicken may considered the fitting strains that play an important role in improving egg production.

Key words: Additive, Dominance, Heritability, Egg production, Egyptian local strain.

INTRODUCTION

One of the important protein resources is poultry protein (meat and eggs). Most of the Egyptian consumers still prefer eggs from local strains. The productivity of the local strains is genetically low. Studying egg production and its related traits such as age and body weight at sexual maturity, rate of laying and clutch size attracted the attention of many researcher when they found that there were wide variation in these traits between different breeds and/or strains of chickens (EL-Labban et al., 1991; Iraqi et al., 2007). Many investigators showed that more genetic gain could be obtained in egg production when using individual recording (Ezzeldin and Mostageer, 1984; Hanafi and EL-Labban, 1984). The heritability estimates help us to predict the effect of selection on any of performance traits and to select a suitable breeding and selection method in population. Many investigators reported that there were a lot of variations in egg production traits according to the differences of the genetic make-up (Khalil et al., 2004; Nurgiartiningsih et al., 2004; Chih-Feng Chen et al., 2007). Several reports have been discussed the relative importance of additive and non-additive variations upon productive traits (Khalil et al., 1999; Iraqi et al., 2000; Nawar and Bahie El-Deen, 2000 and Iraqi, 2002) they reported that the Egyptian strains of chicken had high additive and non-additive genetic variations appeared among them. Although, Fairfull and Gowe, 1990; Wei et al., 1991a,b; Gengler et al., 1997; Palucci et al., 2007 and Norris et al., 2010 reported that non additive effects have a substantial contribution to variation of economic traits. Mixed model equation was used to estimation genetic parameters and genetic evaluation including matrices of additive genetic and dominance relationships (Henderson, 1976; Boldman et al., 1993; Gilmour et al., 2000). The BLUP is an effective way of ranking and selecting animals given measurements on multiple Under this model the means and variances matrices re assumed to be as follows: traits of their own performance and information of their relatives (Xie and Xu, 1996). The aim of the present study was to estimate additive, dominance, heritability for egg production traits and to determine the best strain based on multiple egg production traits. These information's helps breeders to employ suitable breeding program for improvement.

MATERIALS AND METHODS

The present experiment had been carried out at Sakka Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt.

Experimental Stock and Design: Data used in the present study were extracted from a flock of Mandrah, Doki-4, El-Salam and Inshas hens. Measurements were recorded on 105, 110, 105 and 105 laying hens in the four strains, respectively. The individual egg production was recorded daily from start of lay to 5 months of production. The pullets were fed a commercial layer ration (16.5 % CP and 2750 Kcal) and received 16 hr day light. The eggs were recorded and weighed daily through the experimental period.

Studied traits: The traits which construct the phenotypic variance-covariance matrices are: Egg production traits were studied, age at sexual maturity (SM), body weight at sexual maturity (BWSM), number of eggs at 1^{st} 90 d of laying (EN90), average egg weight at sexual maturity (EW1), mature egg weight (EW2) and egg mass throughout the 1^{st} 90 d of laying (EM),

Statistical Analysis: The data were set up to Mixed Model Equations for the estimation of variance components according to Olsen et al. (2006).

The model in matrix notations was:

$$Y = Xb + Zu + e$$

Where: Y is the vector of observations, b and u are the vectors of fixed and random effects, with their respective incidence matrices X and Z, and e a vector of random environmental effects.

$$E\begin{vmatrix} Y \\ a \\ d \\ e \end{vmatrix} = \begin{vmatrix} Xb \\ 0 \\ 0 \\ 0 \end{vmatrix}$$

$$V\begin{vmatrix} Y \\ a \\ d \\ e \end{vmatrix} = \begin{vmatrix} V_{dom} & Z'A_{\sigma^2 a} & Z'D_{\sigma^2 d} & I_{\sigma^2 e} \\ AZ'_{\sigma^2 a} & A_{\sigma^2 a} & 0 & 0 \\ DZ'_{\sigma^2 d} & 0 & D_{\sigma^2 d} & 0 \\ I_{\sigma^2 e} & 0 & 0 & I\sigma^2 e \end{vmatrix}$$

Where: $V_{dom} = z\,(A\sigma^2 a + D\sigma^2 d)\,z' + I\sigma^2 e$, $\sigma^2 d$ is the dominance genetic variance; A and D are the additive and dominance animal relationship matrices, $\sigma^2 e$ is the random environmental variance and I is an identity matrix.

Heritability was computed according to Boldman et al. (1995). $h^2 = \sigma^2 A / (\sigma^2 A + \sigma^2 e)$

Where: h^2 is the heritability, $\sigma^2 A$ is the additive genetic variance, $\sigma^2 e$ is the random environmental variance.

The best linear unbiased prediction solutions for fixed and random effects by solving the usual Mixed Model Equations given by (Henderson, 1975; 1984)

λ is the ratio $\sigma^2 e/\sigma^2 u$

The (Co) variance estimates were obtained with REML individual animal model using the

$$\begin{vmatrix} X`X & X`X`Y \\ Z`X & Z`Z+\lambda A^{-1} \end{vmatrix} \begin{vmatrix} \hat{b} \\ \hat{u} \end{vmatrix} = \begin{vmatrix} Z \\ Z`Y \end{vmatrix}$$

DEREML software (Meyer, 1989).

RESULTS AND DISCUTIONS

Performance of the strains: Performance of the four strains were given in Table 1, shows that Mandrah strain was ranked first in the performance of some egg production traits were 181 d, 1398 g, 39 g, 25 egg, 40 g and 1015 g, for sexual maturity (SM), body weight at sexual maturity (BWSM), early egg weight at sexual maturity (EW1), number of eggs at 90 d of laying (EN90), average egg weight at maturity (EW2) and egg mass (EM), respectively. Also as seen in Table 1, that Doki-4 strain had 186 d for (SM), 1337 g for (BWSM), 37 g for (EW1), 26 (EN90), 38 g for (EW2) and 987 g foe (EM), so Doki-4 was ranked second. Moreover, the strain Inshas was ranked third, since it showed 187 d for (SM), 1427 g for (BWSM), 39 g for (EW1), 24 egg for (EN90), 40 g for (EW2) and 947 g for (EM). Table 1, showed the strain El-Salam was ranked last, it showed 185 d for (SM), 1387 g for (BWSM), 40 g for (EW1), 18 egg foe (EN90), 42 g for (EW2) and 754 g for (EM), respectively. These results showed clearly that Mandrah local strains of chicken was considered to be fitting strains that play an important role in improving egg production traits. The results were agreed with findings of (Kosba and Abd El-Halim, 2008 for egg number and egg mass at 90 d of production.

Factors Affecting Some Egg Production Traits: The differences between replicates and genotypes were presented in Table 2, revealed that all egg production traits studied were statistically significantly differ ($P<0.01$) in between genotypes. The differences between replicates were significant for sexual maturity (SM) and highly significant for body weight at sexual maturity (BWSM) and highly significant for egg number at 90 d, of laying (EN90). In addition, Mandrah strain had highly significant differences for (SM), (BWSM) and (EN90), respectively. Unlike, early egg weight at sexual maturity (EW1), average egg weight at maturity (EW2) and egg mass at the first 90 d, of laying (EM) were insignificant differences. Doki-4 had highly significant differences for (SM) and (EN90) while, (EW2) was significant differences. Unlike, (BWSM), (EW1) and (EM) were insignificant differences. El-Salam had highly significant differences for (BWSM) and the other traits were insignificant differences. Inshas was highly significant differences for (EW1) and (EW2) and the other traits were insignificant differences. These findings of variations for egg production traits may be attributed to adaptability to the environment and genetic variations among and within breeds (Cole, 1972; Fredeen, 1972 and Okon, 2008).

Genetic Variance Components And Heritability Estimates: The estimates of additive σ^2A, dominance σ^2d, random environmental σ^2e variations and heritability estimates h^2 for some egg production traits were presented in Table 3, it pointed out that additive genetic variance (σ^2A) accounted a major part of the total genetic variance for (SM) 23657618393, (EW2) 61635109, (EW1) 45019734, (EN90) 2640192.8, (EM) 8.6553 and (BWSM) 8.0462. The estimates of dominance genetic variance (σ^2d) in these traits was relatively negative and low -3784934159, -9850664, -7146878.3, -402912.9, -1.33028 and 1.2715, respectively. These results indicate that additive genetic variance may be a common in the inheritance of these trait. This conclusion dealt with those cited by (Abou El-Ghar and Abdou, 2004 and Abou El-Ghar, 2005). The observed estimates of random environmental variation (σ^2e) were -85870517.2, -229250, -193661.8, -6.1017 and -3.77827, respectively. The same findings was cited by (Shebl et al., 1990 and Zaky, 2005). The heritability estimates for egg production traits were presented in Table 3, it showed that h^2 estimated were 0.4 for all egg production traits studied. The results were agreed with findings reported by (Quadeer et al., 1977; Venktramaiah et al., 1986; Wei et al., 1991a,b and Sang and Tae-Jun, 2005).

Table (1): Means and s.d of egg production traits and ranking the strains performance

			Trait			
	SM	**BWSM**	**EW1**	**EN90**	**EW2**	**EM**
Mandrah	181+17.9	1389+149	39+5.5	25+12.3	40+2.3	1015+509
Doki-4	186+18.2	1337+128	37+5.1	26+13.5	38+3.4	987+483
Inshas	187+14.3	1427+185	39+4.1	24+10.8	40+4.3	947+381
El-Salam	185+15.1	1387+179	40+5.6	18+11.5	42+3.6	754+532

SM = sexual maturity, BWSM = body weight at sexual maturity, EW1 = early egg weight at the first 90 d., of laying, EN90 = egg number at 90 d., of laying, EW2 = average egg weight at maturity, EM = egg mass at the first 90 d., of laying.

Table(2): Significance of variations for some egg production traits

		Bet.Replicats	**S.O.V Bet.Genptype**	**Mandrah**	**Doki-4**	**El-Salam**	**Inshas**
d.f	417	4	3	104	109	104	104
Traits	M.S Error						
SM	219.15	*	**	**	**	NS	NS
BWSM	14702.4	**	**	**	NS	**	NS
EW1	29.3	NS	**	NS	NS	NS	**
EN90	122.4	**	**	**	**	NS	NS
EW2	10.2	NS	**	NS	*	NS	**
EM	320918.8	NS	**	NS	NS	NS	NS

SM = sexual maturity, BWSM = body weight at sexual maturity, EW1 = early egg weight at the first 90 d., of laying, EN90 = egg number at 90 d., of laying, EW2 = average egg weight at maturity, EM = egg mass at the first 90 d., of laying.

Table(3): Additive $\sigma^2 A$, dominance $\sigma^2 d$, random environmental $\sigma^2 e$ mean squares and heritability estimates h^2 for some egg production traits

Trait	**σ^2A**	**σ^2d**	**σ^2e**	**h^2**
SM	23657618393	-3784934159	-85870517.2	0.4
BWSM	8.0462	-1.2715	-3.77827	0.4
EW1	45019734	-7146878.3	-193661.8	0.4
EN90	2640192.8	-402912.9	-20042.4	0.4
EW2	61635109	-9850664	-229250	0.4
EM	8.6553	-1.33028	-6.1017	0.4

σ^2A = additive genetic variance, σ^2d = dominance genetic variance, σ^2e = random environmental variance, h^2= heritability estimates.

REFRENCES

Abou El-Ghar, R.Sh., 2005. Evaluation of genetic variance components based on the concept of generation means for some economic traits in chickens: absence of epistasis. Proc.2 Nd Conf. Anim. Prod. Res. Inst., Sakha, 27-29 Sep. 2005: 475-480.

Abou El-Ghar, R.Sh. and F.H. Abdou, 2004. Evaluation of genetic variance components based on the concept of generation means for some economic traits in chickens. Egypt. Poult. Sci. 24:687-699.

Boldman, K.G.; L.A. Kriese and L.D. van Vleckm, 1993. A manual for use MTDFREML. USDA-ARS, Clay Center, NE, USA.

Boldman, K.G.; Kriese L.A; van Vleck L.D.; Van Tassell C,P. and Kachman S.D., 1995. A manual for use of MTDFREML. A set of programs to obtain estimates of variances and covariances [DRAFT]. U.S. Department of Agricuture, Agricultural Research Service, USA.

Chih-Feng Chen; Yow-Ling Shiue; Cheng-Ju Yen; Pin-Chi Tang; Hui-Chiu Chang and Yen-Pai Lee, 2007. Laying traits and underlying transcripts, expressed in the hypothalamus and pituitary gland, that were associated with egg production variability in chickens. Available online.

Cole, D. J. A. 1972. Pig production. Proceedings of the Eighteenth Easter School in Agricultural Science. University of Nottingland, Sulton Boninghan, Lougborough, Leicestershire.

EL-Labban, A. F. M.; Hanafi, M. S. and Khalil, M. H. 1991. Genetic studies on egg production in Dokki-4 chicken. Annals of Agric. Sci. Moshtohor, 29 (3): 1081 – 1094.

Ezzeldin, Z. A. and Mostageer, A. 1984. Genetic and phenotypic correlation between the animal egg production and different part records in Fayoumi. Egypt. J. Anim. Prod., 24 (1-2): 69 – 78.

Fairfull, R. W. and R. S. Gowe., 1990. In: R. D. Crawford (Ed.) Poultry Breeding and Genetics. p 705. Elsevier, Amsterdam, The Netherlands.

Fredeen, H. T., 1972. Factors Influencing genetic gain. In: Cole, D. J. A. (eds.), Pig Production. Proceedings of the Eighteenth Easter School in Agricultural Science. University of Northingham, Leicestershire. Pp. 3 – 19.

Gengler, N.; VanVleck L.D.; MacNeil M.D.; Misztal I. and Pariacote F.A., 1997. Influence of dominance relationships on the estimation of dominance variance with sire-dam subclass effects. Journal of Animal Science 75: 2885–2891.

Gilmour A.R.; Cullis B.R.; Welham S.J. and Thompson R., 2000. ASREML reference manual. Harpedden, UK, IACR-Rothamsted Experimental Station

Hanafi, M. S. and EL-Labban. A. F. M. 1984. On estimating genetic parameters of partial egg production records and other related traits in pullets of Dokki-4 chickens produced from triallel mating. Egypt. J. Anim. Prod., 24 (1-2): 51 – 67.

Henderson, C. R., 1975. Best Linear unbiased estimation and prediction under a selection model. Biometrics 31:423-447.

Henderson C.R., 1976. A simple method of computing the inverse of a numerator relationship matrix used for prediction of breeding values. Biometrics, vol. 32, 69–79.

Henderson, C. R., 1984. Applications of Linear Models in Animal Breeding. Univ. Guelph Press, Guelph, Ontario, Canada.

Iraqi M. M., El-Labban A. F. M. and Khalil M. H., 2000. Estimation of breeding values and their accuracies using multivariates animal model analysis for growth traits in three local strains of chickens. Egyptian Poultry Science, 20 (4) : 981-1002.

Iraqi, M. M. 2002. Genetic evaluation for egg quality traits in crossbreeding experiment involving Mandarah and Matrouh chickens using Animal Model. Egypt. Poult. Sci. Vol. 22 (Ш) Sept.: 711 – 726.

Iraqi, M. M.; Afifi, E. A.; EL-Labban, A. M. and Afram, M. 2007. Heterotic and genetic components in 4x4 diallel mating experiment for egg production traits in chickens. 4th World Poult. Conf. 27 – 30 March 2007, Sharm EL-Sheikh, Egypt.

Khalil, M.K; Hermes I.M. and Al-Homidan A.H., 1999. Estimation of heterotic components for growth and livability traits in a crossbreeding experiment of Saudi chickens with White Leghorn. Egyptian Poultry Science 19(3): 491-507.

Khalil, M. K.; AL-Homidan, A. H. and Hermes, I. H. 2004. Crossbreeding components in age at first egg and egg production for crossing Saudi chickens with white Leghorn. Livestock Res. for Rural Development. 16 (1).

Kosba, M.A. and H.A.H. Abd El-Halim, 2008. Evaluation of the Egyption local strains of chickens. Egypt poult. Sci. Vol. (28): 1239-1251.

Meyer, K., 1989. Restricted maximum likelihood to estimate variance components for animal models with several random effects using a derivative-free algorithm. Genet. Sel. Evol. 21:317.

Nawar, M. E. and Bahie EL- Deen 2000. A comparative study of some economical traits of seven genotypes of chickens under intensive production system. Egypt. Poult. Sci. Vol. 20 (IV) Dec.: 1031 – 1045.

Norris, D.; Varona L.; Ngambi J.W.; Visser D.P.and Mbajiorgu C.A., 2010. Estimation of the additive and dominance variances in SA Duroc pigs. Livestock Science 131: 144–147.

Nurgiartiningsih, V. M. A.; Mielenze, N.; Preisinger, R. and Schmutz, M., 2004. Estimation of genetic parameters based on individual and group mean records in laying hens. Br. Poult. Sci. 45, 5: 604 – 610.

Shebl, M.K.; M.A Ali; Magda M. Balat and T.H. Tag El-Din, 1990. Evaluation of combining ability for some body size traits and feathering in a diallel cross of chickens. Egypt. Poult. Sci. 10:159-177.

Okon, B., 2008. Sow Litter Variability and Performance of Piglets from Birth to 24 weeks in Ibadan, Nigeria. Doctor of Philosophy Thesis, University of Ibadan, Ibadan, Nigeria. P. 229.

Olsen, K. M., D. J. Garrick and R. M. Enns, 2006. Predicting breeding values and accuracies from group in comparison to individual observations. J. Anim. Sci., 84:88-92.

Palucci, V.; Schaeffer L.R.; Miglior F. and Osborne V., 2007. Non-additive genetic effects for fertility traits in Canadian Holstein cattle. Genetics Selection Evolution 39: 181–193.

Quadeer, M. A., J. V. Craig, K. E. Kemp and A. D. Dayton, 1977. Selection for egg mass in different social environments.2- Estimation of parameters in selected populations. Poult. Sci., 56:1536-1549.

Sang-Min, L. and Tae-Jun, L., 2005. Effects of Dietary Protein and Energy Levels on growth and Lipid Composition of juvenile Snail. Journal of Shellfish Research.

Venktramaiah, A., V. Ayyagari and D. Choudhuri, 1986. Selection response for part period egg number and egg mass in chickens- a comparison. Theor. Appl. Genet., 72:129-134.

Wei, M.; H.A.M. van der Steen; J.H.J. van der Werf and E.W. Brascamp, 1991a. Relationship between purebred and crossbred parameters. I. Variances and Covariances under the one-locus model. J. Anim. Breed. Genet. 108:253.

Wei, M.; J.H.J. van der Werf and E. W. Brascamp, 1991b. Relationship between purebred and crossbred parameters 11. Genetic correlation between purebred and crossbred performance under the model with two loci. J. Anim. Breed. Genet. 108:262.

Xie, C. and S. Xu, 1996. Best linear unbiased prediction under selection. J. Genet.& Breed. 50:287-294.

Zaky, H.I., 2005. Genetic effects in crossbreeding and estimate of genetic components in crossbred chickens of Fayoumi and Rhode Island Red. Egypt. Poult. Sci. 25 (IV): 1085-1101.

الملخص العربي

تقدير التباين الوراثي المضيف وتباين السيادة والمكافئ الوراثي لبعض صفات إنتاج البيض في السلالات المصرية من الدجاج المحلى

رضا شعبان أبو الغار و رجاء السيد عبد الكريم

معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – وزارة الزراعة – مصر

إنتاج البيض قي الدجاج تظهر فيه اختلافات فردية معقولة أثناء فترة إنتاج البيض. ولتقييم وانتخاب للسلالات المحلية من الدجاج تم بهدف تقدير التباين الوراثي المضيف وتباين السيادة والمكافئ الوراثي لبعض صفات إنتاج البيض وكذا تحديد أفضل سلالة في إنتاج البيض على أساس معرفة العديد من صفات إنتاج البيض. وجد ترتيب إنتاجية السلالات المحلية كالتالي سلالة المندرة في المرتبة الأولي وسلالة دقي-4 في المرتبة الثانية وسلالة إنشاص في المرتبة الثالثة وسلالة السلام في المرتبة الأخيرة وذلك لبعض صفات إنتاج البيض. قدر التباين الوراثي المضيف على أنه يمثل الجزء الأكبر من التباين الوراثي بالنسبة لصفات العمر عند النضج الجنسي ووزن البيضة عند تمام النضج ووزن البيضة عند النضج الجنسي وعدد البيض عند 90 يوم من الإنتاج وكتلة البيض عند 90 يوم من الإنتاج ووزن الجسم عند النضج الجنسي. وبلغت تقديرات التباين السيادي قيما سالبة ومنخفضة بالنسبة لهده الصفات. كما بلغت تقديرات المكافئ الوراثي 0.4 بالنسبة لصفات إنتاج البيض المدروسة.. أوضحت النتائج السابقة أن سلالة المندرة تعتبر مؤهلة من كل السلالات المحلية لتلعب دورا في تحسن إنتاج البيض.