Journal of Livestock Science and Technologies, 2013, 1 (2): 34-38 http://lst.uk.ac.ir

Estimation of genetic parameters for productive and reproductive traits in Esfahan native chickens

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Abstract The main aim of this research was to estimate the genetic and phenotypic parameters for productive and reproductive traits of Esfahan native chickens. Traits included body weights at hatch (BW1), 8 weeks of age (BW8), 12 weeks of age (BW12), and at sexual maturity (WSM)], age at sex maturity (ASM), egg number (EN), average egg weight (AEW) in the first 12 weeks of production, and egg production intensity (Eint). Data were collected over 13 generations (during 1998 to 2011) at the breeding center of Esfahan native chickens in Iran. Genetic parameters were estimated by a (bi)-univariate animal model using the restricted maximum likelihood (REML) procedure. Heritability estimates for body weight at different ages varied from 0.14±0.01 to 0.42±0.01. Estimated heritability for reproductive traits ranged from 0.12±0.01 for Eint to 0.36±0.01 for AEW. Estimates of heritability values were moderate but BW1 and AEW showed higher heritability values. Genetic correlation among body weight traits varied from 0.20±0.03 to 0.82±0.02. Fairly small negative Genetic correlation between body weight traits and egg traits (EN and Eint) was small (in the range of -0.22±0.05 to -0.03±0.03), while they showed positive and moderate genetic correlation with the average egg weight, ranging from 0.11±0.04 to 0.39±0.02. There was a low negative genetic correlation (-0.09±0.02) between egg number and egg weight. Therefore, during simultaneous selection for growth and egg production, probable reduction in egg production due to low reduction in egg number may be compared by increases in egg weight.

Keywords: heritability, animal model, economic traits, genetic correlation, native chicken

Received: 21 May. 2013, *accepted:* 13 Sep. 2013, *published online:* 17 Oct. 2013

Introduction

Breeding programs and genetic gain have important effects on genetic composition of commercial chickens but the question has risen as what the genetic diversity of pure commercial line would be in the future (Muir et al., 2008). Muir et al. (2008) showed that 50% or more of the genetic diversity in ancestral breeds was absent in a commercial pure line that, resulted from a high number of non-corporate breeds. This indicates the importance of native chickens for the future needs for genetic diversity. Indigenous chickens, despite their low growth rate and egg production, are generally superior in terms of disease resistance and performance under poor nutritions and high environmental temperatures compared to commercial strains reared under village system (Horst, 1989). During the past decades, importation of exotic breeds has increased the risk of native chicken extinction in Iran (Ghazikhani shad et al., 2007). Propagation and extension of Iranian indigenous chickens, in the framework of a national scheme, started in 1984 in several regions of Iran (Esfahan, Mazandaran, Fars, Azerbaijan, Yazd, and Khorasan). Iranian indigenous chickens are meat-egg type birds. Breeding of native fowl is important for small farmers to produce more income (Emamgholi Begli et al., 2010). Kianimanesh (2002) showed that age at sexual maturity, egg number, egg weight and body weight at 8 weeks of age were the most important traits for improving economic efficiency of Iranian native fowl. Several studies have reported on the estimates of (co)-variance components and genetic parameters for productive and reproductive traits in indigenous chickens from several regions in Iran (Kamali et al., 2007; Emamgholi Begli et al., 2010; Dana et al., 2011; Niknafs et al., 2012) but no comprehensive work on the genetic and phenotypic parameter estimation has been published for Esfahan native chicken. Therefore, the (co)-variance components and genetic and phenotypic parameters and correlation of several productive and reproductive traits were estimated in these chickens over 13 consecutive generations. The traits studies included body weights at hatch (BW1), 8 weeks of age (BW8), 12 weeks of age (BW12), and at sexual maturity (WSM)], age at sex maturity (ASM), egg number (EN), average egg weight (AEW) in the first 12 weeks of production, and egg production intensity (Eint).

Materials and methods

Esfahan province is situated in the center of Iran at latitude of 32° 39' 35" N and longitude of 51° 40' 17" E. The province has a dry and hot climate with an average temperature of 40°C and humidity of about 25% in the summer. Production of native chickens is economical in their environment, because of their adaptation to dry and high temperature conditions in Esfahan. The Native Chicken Breeding Center of Esfahan was established with two main objectives, concentrating on genetic conservation and improvement. At first, the base population was generated from native chickens, collected from far the rural areas based on their phenotypic properties, with the first generation created by random mating within the base population. Chickens were selected as the parents of the subsequent generations in two steps. Initially, the birds were selected based on BW12 after 20 weeks of age, and individual egg production was recorded for 12 weeks. Subsequently, the hens were selected based on their ASM, WSM, EN and EW, and the roosters were selected based on the performance of their sisters. Some 40% of the hens and 5% of the roosters were produced the next generation; 800 hens and 100 roosters, respectively. Data were recorded data on each individual The data file consisted of animal, sire, dam number, generation, hatch number and sex (for BW8 trait), and the number of days in production as a covariate for EN.

Statistical analysis

For the preparation of data file the visual Fox pro 9.0 software and for pedigree information pedigree software version 1.01 were used. Statistical description of the traits is summarized in Table 1.

Table 1. Pedigree information of Esfahan native chicken

Category	Number
All birds	60487
Inbred animals	39766
Sirs in total	1189
Dams in total	6117
Animals with progeny	7306
Animals without progeny	53181
Base animals	785
Non- base animals	59702

Because of missing observations, the number of observations differed between traits. The GLM procedure of SAS software (SAS Institute, 2003) was used to test the significance of the fixed effects. Genetic analyses were done by using (BLUP f90) family Misztal (1999). (Co)-variance components and genetic parameters were estimated by univariate (1) procedure and correlation between traits by bivariate (2) animal model. The models used for the analyses were:

$$y = Xb + Za + e \quad (1)$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \quad (2)$$

where, for trait i (i=1); $\boldsymbol{y_i}$ = vector of observations; $\boldsymbol{b_i}$ =vector of fixed effects of generation, sex, and hatch; $\boldsymbol{a_i}$ = vector of random direct genetic effects; $\boldsymbol{e_i}$ = vector of random residual effects; and $\boldsymbol{X_i}$ and $\boldsymbol{Z_i}$ are incidence matrices relating the observation to the respective fixed and direct genetic effects.

Results

Pedigree information of Esfahan native chickens is shown in Table 1, and statistical description (number of recorded animal, means, standard deviation and CV %) in Table 2.

Heritability estimates

Estimated heritability of productive and reproductive traits and their correlation are shown in Table 3. The estimated heritability for body weight at different ages varied from 0.14 to 0.42. Low estimated heritability values were obtained for traits BW8 and BW12 and high values for BW1 and WSM. A heritability value of 0.36 was obtained for AEW. The heritability estimates for egg traits varied from 0.12 for Eint to 0.16 for EN. However, BW1 among growth traits and AEW among egg traits were more heritable than other traits studied.

Correlations within and among growth and egg production traits

Genetic and phenotypic correlations among studied traits are presented in Table 3. In general, genetic correlations among body weight traits were rather high and positive. Genetic correlations among growth traits ranged from 0.20 to 0.82. The traits BW1 and BW8 were highly correlated genetically (0.82). The phenotypic correlation between BW1 and BW8 was 0.17. The environmental correlation between body weight traits ranged from 0.05 to 0.56. There was a low negative genetic correlation between body weight traits and egg traits (EN and Eint), while body weight traits showed

Table 2. Descriptive statistics for the traits in Esfahan native chickens

Trait	N	Mean	SD	CV%
Bw0	52034	37.75	3.57	9.47
BW8	46310	820.82	181.96	21.13
BW12	42201	1461.37	287.35	19.66
WSM	15269	1875.60	211.10	11.25
ASM	15380	179.26	17.23	9.61
EN	14456	48	13.69	20.43
AEW	14341	49.49	4.12	8.33
Eint	14456	75.36	16.011	21.24

BW1, BW8, and BW12: body weight at birth, 8 and 12 weeks of age , respectively, WSM : age at sexual maturity, ASM: age at first egg, EN: egg number, AEW: average egg weight at 28, 30 and 32 weeks of age, Eint: egg production intensity [= (egg number/days of recording) × 100]

positive and moderate genetic correlation with average egg weight traits, ranging from 0.11 to 0.39. A negative genetic correlation (-0.20) was observed between age at ASM and EN. Average egg weight and egg number were negatively correlated genetically. The genetic correlation coefficient values ranged from -0.03 (AEW with Eint) to -0.09 (AEW with EN), however, environmental correlation coefficients for these traits were positive and high, ranging from 0.78 to 0.91.

Discussion

Phenotypic means

The mean birth weight of Esfahan native chicken was higher than that of the local Venda (Norris and Ngambi, 2006), Mazandaran (Niknafs et al., 2012), and Horro Chicken of Ethiopia (Dana et al., 2011). The calculated values for BW8 and BW12 were lower than in Fars native (Ghazikhani Shad et al., 2007), Horro (Da na et al., 2011), Mazandaran (Niknafs et al., 2012) chickens. Age at sexual maturity in Esfahan native chickens was rather higher than that reported in Mazandaran (Niknafs et al., 2012) and Yazd (Emamgholi Begli et al., 2011) native chickens. Phenotypic means of egg weight in the present study was in the range of values reported previously (Ghazikhani Shad et al., 2007; Lwelamira et al., 2009; Niknafs et al., 2012). The mean egg number was higher than for other breeds in Iran (Ghazikhani et al., 2007; Emamgholi Begli et al., 2011; and Niknafs et al., 2012). The phenotypic differences may be due to breed diversity, long-term selection in Esfahan native birds (13 generations) and different environmental conditions.

Heritability

Heritability estimates for most growth and egg traits, except BW1 and AEW, were in general moderate. Estimated heritability for BW1 was higher than the estimated value by Norris and Ngambi (2006) and Dana et al. (2011). The higher estimation in our study could have resulted from excluding the maternal and permanent environmental effects in our model. The estimated values for other BW traits (BW8, BW12, and WSM) were close to the lower range reported previously (Ghazikhani Shad et al., 2007; Kamali et al., 2007; Niknafs et al., 2012; Dana et al 2011). Age at first egg in our study seemed to be less heritable than in two other (Yazd and Mazandaran) Iranian indigenous chickens (Emamgholi Begli et al., 2011; Niknafs et al. 2012). Most estimated values for egg number in previous studies are higher than those obtained in ours study (Francesch et al., 1977; Sabri et al., 1999; Kamali et al., 2007; Dana et al., 2011; Niknafs et al 2012). Our heritability estimate for AEW was 0.36 , which is higher than the heritability value reported in the literature (Emamgholi et al., 2010; Niknafs et al., 2012) for Yazd and Mazandaran native chickens, and lower than the study by Kamali et al. (2007) in Fars native chickens. A review of previous studies showed that the direct additive genetic variance, and consequently direct heritability, increased with age for egg number Ledure et al. (2000), and the additive genetic variation for egg number increased with age (Engstrom et al., 1992; Ledure et al., 2003). Change in heritability over generations may result from expression of different genes during the production cycle. The estimated values for BW traits in our research were in the range of values reported by others (Dana et al., 2011; Niknafs et al., 2012). Heritability estimates for some egg production traits decreased as selection continued (Sharma et al., 1996). The obtained heritability of body weight and egg production traits in this research showed a gradual improvement over the selection period.

Table 3. Estimation of genetic parameters in Esfahan native chickens

	BW1	BW8	BW12	WSM	ASM	EN	AEW	Eint
BW1	0.42 ± 0.01	0.82 ±0.02	0.25 ± 0.4	0.46 ± 0.05	0.09 ± 0.03	-0.04 ± 0.02	0.11 ± 0.01	-0.03 ± 0.03
BW8	0.17 ±0.04	0.16 ± 0.01	0.58 ± 0.02	0.20 ± 0.03	0.01 ± 0.00	-0.09 ± 0.01	0.38 ± 0.04	-0.05 ±0.05
BW12	0.18 ± 0.01	0.56 ± 0.04	0.14 ± 0.01	0.38 ± 0.05	0.11 ± 0.04	-0.14 ± 0.04	0.39 ± 0.02	-0.18 ± 0.02
WSM	0.07 ± 0.04	0.05 ± 0.02	0.18 ± 0.05	0.18 ± 0.00	0.15 ± 0.03	-0.10 ± 0.05	0.15 ± 0.4	-0.16 ±0.04
ASM	0.01 ± 0.00	0.03 ± 0.04	0.08 ± 0.04	0.90 ± 0.04	0.15± 0.01	-0.20 ± 0.02	0.54 ± 0.01	-0.22 ± 0.05
EN	-0.04 ± 0.01	0.07 ± 0.01	0.15 ± 0.03	0.87 ± 0.05	0.65 ± 0.4	0.16 ± 0.01	-0.09 ± 0.02	0.95 ± 0.03
AEW	0.07 ± 0.02	0.05 ± 0.03	0.18 ± 0.02	0.75 ± 0.05	0.80 ± 0.5	0.78 ± 0.05	0.36 ± 0.01	-0.03 ± 0.04
Eint	-0.01 ±0.02	0.08 ± 0.04	0.14 ± 0.01	0.81 ± 0.04	0.14 ± 0.2	0.90 ± 0.4	0.91 ± 0.4	0.12 ± 0.01

Heritability's (diagonal), and genetic (above diagonal), and environmental (below diagonal) correlations (± SE) of the investigated traits. BW1, BW8, and BW12: body weight at birth , 8 and 12 weeks of age , respectively, WSM : age at sexual maturity, ASM: age at first egg, EN: egg number, AEW: average egg weight at 28, 30 and 32 weeks of age, Eint: egg production intensity [= (egg number/days of recording) × 100]

Genetic and environmental correlations

Genetic correlations (Table 3) among body weight traits varied from moderate to high (0.20 to 0.91), which are in the range of previous reports (Dana et al., 2011; Niknafs et al., 2012) but the estimated value for the genetic correlation between BW1 and BW8 (0.82) was higher than their reports. Genetic correlations between age at sexual maturity and body weight traits were low and close to zero, except between BW12 and ASM (0.11) and between WSM and ASM (0.15), being close to the lower end of the range reported by Niknafs et al. (2012). However, low negative genetic correlations were reported by others (Kamali et al., 2007; Lwelamira et al., 2009). Relatively low negative genetic correlations among body weight traits and egg number agreed with previous findings (Kamali et al. 2007; Niknafs et al. 2012). Positive genetic correlations were observed between body weight traits and egg weight while the correlation between egg number and egg weight was weak and negative, as also shown by others (Kamali et al. 2007; Lwelamira et al. 2009; Niknafs et al. 2012). Simultaneous selection for egg number and body weight may be appropriate for improvement of these traits. A negative association between egg number and age at sexual maturity was recorded, indicating that decreased age at first egg (sexual maturity) could increase the number of eggs during the laying period. But improvement in egg number may result from a decrease in egg weight due to the negative correlation between egg number and egg weight. Such negative genetic correlation values have been reported by previous researchers (Ghazikhani et al., 2007; Kamali et al., 2007; Emamgholi Begli et al., 2010; Niknafs et al., 2012). We found a moderate positive correlation between age at first egg and egg weight, thus increased age at sexual maturity could result in a reduction in egg number while having a positive effect on the egg weight. The genetic correlation between egg number and egg intensity was very high (0.95), therefore, selection for egg number could improve both traits. There were not any considerable environmental correlation between body weight traits in general. Considerable environmental correlation between egg numbers and intensity of egg production were observed. There was also a high environmental correlation between age and weight at sexual maturity, therefore, uniform management and environmental improvement may improve phenotypic means of the population.

Conclusions

The estimated heritability values for studied traits were within the range of values reported in previous studies. There were considerable genetic variations in important traits of Esfahan native fowls. Growth and egg production are the most important traits in chicken under rural production system. Since these chickens are kept both for meat and egg production, selection criteria should include both growth and reproductive traits simultaneously.

References

Dana, N., Vander Waaij, E., Van Arendonk, J., 2011. Genetic and phenotypic parameters estimates for body weight and egg production in Horro chicken of Ethiopia. *Tropical Animal Health and Production* 43, 21-28.

Emamgholi Begli, H., Zerehdaran, S., Hassani, S., Abbasi, M. A., KhanAhmadi, A. R., 2010. Heritability, genetic and phenotypic correlations of egg quality traits in Iranian nativefowl. *British Poultry Science*,51, 740 - 744.

Emamgholi Begli, H., Zerehdaran, S., Hassani, S., Abbasi M. A. KhanAhmadi, A. R., 2011. Estimation of genetic parameters for important economic traits on Yazd native fowl. *Iranian Journal of Animal science* 4, 67-70 (In Persian).

Engstrom, G., Liljedahl L. E., Wilhelmson, M. , Johansson, K., 1992. The pattern of genetic and environmental variation in relation to ageing in laying hens, *Genetic Selection Evolution* 24, 265–275

Fairful, R.W., Gowe, R. 1990. Poultry Breeding and Genetics, (Elsevier Science, Amsterdam)

Francesch , A., Estany, J., Alfonso , L. , Iglesias, M., 1997. Genetic parameters for egg number, egg weight, and eggshell color in three Catalan poultry breeds. *Journal of Poultry Science* 79, 1627- 1631

Ghazikhani Shad, A., Nejati Javarami, A., Mehrabani Yeganeh, H., 2007. Animal model estimation of genetic parameters for most important economic traits in Iranian native fowls. *Pakistan Journal of Biological Science* 10, 2787-2789

Horst, P., 1989. Native fowls as reservoir for genomes and major genes with direct and indirect effect on the adaptability and their potential for tropically oriented breeding plans. *Archive fur Geflugelkunde* 53, 93-101

Kamali, M. A., Ghorbani, Sh., Moradi Sharbabak, M., Zamiri, M.J., 2007. Heritability's and genetic correlation of economic traits in Iranian native fowl and estimated genetic trend and inbreeding coefficients , *British Poultry Science* 48: 443- 448

Kianimanesh, H. R., Nejati Javaremi, A., Rahimi, G., 2002. Estimation of economic indices for important production traits of the Iranian native fowls, *First seminar on genetics and breeding applied to livestock, Tehran, Iran*

Ledur, M. C., Fairfull, R. W., McMillan, I., Asseltine, L., 2000. Genetic effects of aging on egg production traits in the first laying cycle of White Leghorn strains and strain crosses. *Journal of Poultry Science*, 79: 296–304

Ledur, M. C., Liljedahl, L. E., McMillan, I., Asselstine, L., Fairfull, R. W., 2003. Genetic effects of aging on fitness and no fitness traits in laying hens housed three per cage. *Jour nal of Poultry Science* 82:1223-1234

Lwelamira, J., Kifaro, G. , Gwakisa, P., 2009. Genetic parameters for body weights, egg traits and antibody response against New- castle Disease Virus (NDV) vaccine among two Tanzania chicken ecotypes. *Tropical Animal Health and Production* 41, 51–59

Misztal, I., 1999. BLUPF90 Family. Available at URL: http://ncead.uga.edu/~ignacy /newprograms.html.

Muir W. M.- Wong G. K.- Zhang Y.- Wang J.- Groenen M. A.- Crooijmans R. P.- Megens H. J.- Zhang H.- Okimoto R.- Vereijken A.- Jungerius, A.- Albers, G. A.- Lawley, C. T.- Delany, M. E.- Maceachern, S.- Cheng, H. H. (2008). Genome- wide assessment of worldwide chicken SNP genetic diversity indicates significant absence of rare alleles in commercial breeds. *Proceedings of the National Academy of Sciences, USA*, 105, 17312-17317.

Norris, D., Ngambi, J., 2006. Genetic parameter estimates for body weight in local Venda chickens. *Tropical Animal Health and Production* 38, 605–609

Sabri, H. M., Wilson, H. R., Harms, R. H. , Wilcox, C. J., 1999. Genetic parameters for egg and related characteristics of White Leghorn hens in a subtropical environment, *Genetics and Molecular Biology* 22, 183–186

SAS Institute. 2003. SAS /STAT User's Guide: Statistics. Release 8.2. SAS Institute Inc., Cary, NC.

Sang, B. D., Kong, H. S., Kim, H. K., Cho, C. H., Kim, D., Cho, Y. M., Sang, B. C., Lee, J. H., Jeon, G. J. , Lee, H. K., 2006. Estimation of genetic parameters for economic traits in Korean native chickens, *Asian-Australasian Journal of Animal Sciences* 19, 319–323

Sharma, D., Johari, D. C., Kataria, M. C., Singh, B. P., Singh, D. P. , Hazary R. C., 1996. Effect of long term selection on genetics of economic traits in White Leghorn. *Asian-Australasian Journal of Animal Sciences* 9, 455–459

Communicating editor: *Ali K Esmailizadeh*