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Selection for Economic Traits in Chickens Breeding Program According to Genetic Parameters and Correlation Between Traits

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Abstract: Identification of genes determining the expression of economically important traits of plants and animals is a main research focus in agricultural genomics. Most of these traits are characterized by a wide variability of the expression of genes at certain *loci* called quantitative trait loci (QTL). Characterization of the chromosomal regions carrying QTL can be applied in marker-assisted Selection (MAS) to improve breeding efficiency. Molecular linkage maps in combination with Powerful statistical methods facilitate the genetic dissection of complex traits and the chicken is Ideally suited for this task due to a relatively short life cycle and large number of progeny. Native chickens are important in some rural areas. They usually produce meat and eggs without extra feed, only picking food. Improving their economical traits, such production efficiency would save these genetic resources. The genetic parameters for various traits of economic importance were studied in an Iranian Native chickens population under short term selection for egg production and body weight for over 2 years. The parameters studied were body weight at day old (BW1), 8 weeks (BW8) and body weight at 12 weeks (BW12), the weight of first egg (EGGW1) and egg weight at 30weeks of age (EGGW30) also the average number of stock eggs per day(EGG/DAY). They showed mostly moderate to high heritability estimates. All these values were 0.56 to 0.44, 0.51 0.2, 0.56 and 0.15 respectively. Higher heritability estimate were obtained for body weight traits. There were positive genetic correlation between weight traits and egg weight traits. Higher estimate was obtained for BW1 and EGGW30(0.64). However, negative genetic correlation between body weight traits and number of eggs are estimated. In the result, selection for body weight traits before mature ages will cause gain in egg weight traits and it will be useful in breeding plans.

Key words: Genetic parameters · Closed flock · Selection · Native chicken

INTRODUCTION

Native chickens are important in some rural areas. They usually produce meat and eggs without extra feed, only picking food. Improving their economical traits, such production efficiency would save these genetic resources.

Identification of genes determining the expression of economically important traits of plants and animals is a main research focus in agricultural genomics. Most of these traits are characterized by a wide variability of the expression of genes at certain *loci* called quantitative trait loci (QTL). Characterization of the chromosomal regions carrying QTL can be applied in marker-assisted Selection (MAS) to improve breeding efficiency. Molecular linkage maps in combination with Powerful statistical methods facilitate the genetic dissection of complex traits and the chicken is Ideally suited for this task due to a relatively short life cycle and large number of progeny [1].

[2] showed that age at sexual maturity, number of ages, egg weight and body weight at 8^{th} week of age are among most important traits for improving economical efficiency of Iranian native fowl. Although, natural selection is the great evolutionary force that fuels genetic change in all living things, selection at the long term has important responses such as increasing of inbreeding and decreases genetic variation. However, changes in average of production traits and population response in breeding programs after a few generations of selections depended on accuracy and intensity of selection, effective size of population and the rate of inbreeding.

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Poultry breeding involves populations in which gene frequencies are influenced by selection. The genetic change because of selection is manifested by the change in the heritability estimates. The evidence of changes in the genetic constitution of a population under selection is manifested by changes in phenotypic performance [3] Correlations permit prediction of direction and magnitude of change in the dependent trait as a correlated response to direct selection of the principal trait [4]. Thus, correlations are of great interest to the breeder. The extent and direction of correlated selection response are determined by the genetic correlation or covariance between the concerned traits [5]. Therefore, for improving the total economic value of an animal, it is important to know both the effect of the trait actually being selected and its effect on the other traits. This information becomes more relevant especially in flocks that undergo selection, in view of the fact that continued selection tends to bring about change in the genetic correlations among traits [6].

The objective of this study is to estimate genetic parameters (heritability, genetic, phenotypic and environment correlations) among the economic traits in an Iranian Native chickens population kept at the centre of investigation on native poultry Jahad keshavarzi organization of Fars province.

MATERIALS AND METHODS

Five generations of data from a poultry-breeding program were provided by an investigation centre on native poultry in Iran. The birds originally were collected from different area of the Fars province. Selection procedures for these birds were on the basis of estimated breeding value and calculated genetic and environmental parameters using BLUP in an animal model [7]. A pedigree file of 14250 birds were used to calculate genetic and environmental parameters on some economically traits as; body weight at day old (BW1), body weight at 8 weeks (BW8), body weight at 12 weeks (BW12), the weight of first egg (EGGW1) and egg weight at 30weeks of age (EGGW30) also the average number of stock eggs per day (EGG/DAY). The birds were maintained under uniform management conditions as far as possible.

Genetic parameters were estimated by Mixed Model Least Squares [8], animal model and Maximum Likelihood whereby the variance components were partitioned into those of the traits and generations. The model fitted was of the nested design. The genetic and phenotypic correlations between six traits were estimated from variance and covariance component analysis. Statistical models include generation, Hatchery and sex effects for body weight traits and generation, sexual maturity age group effects for egg production traits.

Statistical model for body weight traits:

$$Y_{ijkl} = \mu + G_i + H_j(G_i) + S_k + b_1(F_{ijkl} - \overline{F}) + e_{ijkl}$$

where; Y_{ijkl} is the body weight record of the l^{th} progeny of the k^{th} sex mated of the j^{th} hatchery to i^{th} Generation.

μ= the common mean of body weight traits, G_i=effect of i^{th} Generation(Fix effect), $H_j(G_i)$= effect of j^{th} hatchery on i^{th} generation(Fix effect), S_k= effect of k^{th} sex (Fix effect), b_1= Regression coefficient of inbreeding effect on traits $\overline{F}$ = the common mean of inbreeding in the population, F_{ijkl}= inbreeding effect (variable effect) and e_{ijk} = random error

Statistical model for Egg production traits:

$$Y_{ij} = \mu + G_i + b_1(F_{ij} - \overline{F}) + b_2(A_{ij} - \overline{A}) + e_{ij}$$

where; Y_{ij} is the Egg production records of the i^{th} progeny of the j^{th} Generation, μ = the common mean of Egg production traits, G_i = effect of i^{th} Generation (Fix effect), b_1 = Regression coefficient of inbreeding effect on traits, $\overline{F}$ = the common mean of inbreeding in the population, F_{ij} = inbreeding effect (variable effect), b_2 = Regression coefficient of age of sex maturity on egg production traits, $\overline{A}$ = the common mean of age of sex maturity in the population, A_{ij}=effect of age of sex maturity (variable effect) and e_{ijk} = random error.

RESULTS AND DISCUSSION

The heritability estimates in animal model for economic traits studied are presented in Table1. There were significant different (p<0.001) between both sex of birds in body weight at day old (BW1) that means

Table 1: Estimated heritability and different Variances in the economic traits

Traits	*$\delta^2 a$	**$\delta^2 e$	***$\delta^2 p$	****h^2	Log L
BW1	4.482	3.498	7.98	0.56±0.012	-16460.6
BW8	2090.82	5254.23	4736.05	0.44±0.02	-64634.6
BW12	5536.86	5254.83	5254.83	0.51±0.02	-71395.5
EGGW1	3.36	13.61	16.97	0.2±0.2	-20882.8
EGGW30	5.57	4.36	9.93	0.56±0.022	-16413.5
EGG/DAY	0.19	0.11	0.12	0.15±0.025	10893.8

*Genetic (Additive) Variance
**Environmental Variance
***Phenotypic Variance
****Heritability

Table 2: Genetic, phenotypic and environmental correlations between the economic traits

Traits correlation	*r_a	**r_e	***r_p	# individuals with record for two traits
BW1 with:				
BW8	0.34±0.03	0.09±0.02	0.22	14106
BW12	0.32±0.03	0.03±0.02	0.18	14440
EGGW1	0.51±0.04	-0.13±0.01	0.094	14020
EGGW30	0.64±0.02	-0.274±0.02	0.247	13949
EGG/DAY	-0.074±0.06	-0.014±0.02	-0.031	11703
BW8 with:				
BW12	0.94±0.008	0.56±0.01	0.74	14413
EGGW1	0.4±0.04	0.05±0.01	0.16	14122
EGGW30	0.45±0.03	0.099±0.02	0.28	14116
EGG/DAY	0.02±0.07	-0.07±0.02	-0.04	14052
BW12 with:				
EGGW1	0.43±0.04	0.07±0.02	0.19	14404
EGGW30	0.45±0.03	0.14±0.02	0.31	14392
EGG/DAY	-0.05±0.07	-0.07±0.02	-0.06	14385
EGGW1with:				
EGGW30	0.81±0.03	0.21±0.02	0.41	11109
EGG/DAY	-0.11±0.04	0.02±0.01	-0.05	11028
EGGW30 with:				
EGG/DAY	-0.02±0.02	-0.07±0.01	-0.1	10840

* Genetic Correlation

** Environmental Correlation

***Phenotypic Correlation

of Least Squares in males estimated 0.77 more than females. Also male birds had body weight in 8 and 12 weeks of age more than females, these difference was significant ($p< 0.001$).

Regression coefficient (b_2) of age of sex maturity on first egg weight estimated 0.164; it means that each day increase in age of sex maturity will cause 0.164-gram gain on the first egg weight. In addition, Regression coefficient (b_2) of age of sex maturity on egg weight at 30th weeks of age (EGGW30) estimated 0.051, it means that each day increase in age of sex maturity will cause 0.051 gram increase on the egg weight at 30th weeks of age.

The genetic, phenotypic and environmental correlations between economic traits studied is presented in the Table 2. There were positive genetic correlation between weight traits and egg weight traits. Higher estimate obtained for BW1 and EGGW30 (0.64). However, genetic correlation between body weight traits and number of eggs estimated negative.

A pedigree file collected on birds used to calculate the inbreeding coefficient and their influence on these traits. The average inbreeding coefficients for all birds were and ranged from zero to 0.15. In this population, 34.5 Present of birds were inbreed, with a mean inbreeding coefficient of 028/0. Inbreeding as variable effect has not significant effect on EGGW1; however, age of sex maturity as variable effect has significant effect ($p<0.001$) on EGGW1.

CONCLUSION

Regression coefficients of the breeding value on generation for these traits showed that after 5 generations of selection, positive genetic gains were obtained. The results reveal order to high estimates which were in agreement with other reports as [6, 9-12]. The higher estimate obtained for BW1 and BW30 agrees with the report of [13]. The result from this study further corresponds with the report of [14] for this strain.

Negative genetic correlation (-0.074) estimated between BW1 and EGG/DAY shows that would not obtain improve in number of eggs per day due to selection for BW1; However this correlation between BW1 and egg weight traits (EGGW1, EGGW30), estimated high positive (0.51 and 0.64 respectively), it means that selection for BW1 would cause positive response for these traits.

Environmental correlation between BW1 and BW30 estimated negative (-0.13 and -0.27 respectively) that it could occurred due to different environmental conditions on the studying the traits. These results of this study further corresponds with the report of [12].

The moderate to high positive correlation estimates obtained between BW8 and BW12 agreed with the general observation that body weight at all ages is highly heritable and are positively correlated [15].

The negative genetic relationship observed between body weight traits and number of eggs could be due to low body weight which reflects poor growth of the egg number forming reproductive traits which in turn would result in poor egg production and egg weight. The positive correlation observed between BW1 and EGGW30 conforms to the reports of [6]. In the base generation. The results reveal that while BW1 and EGGW30 were positively correlated, negative genetic and phenotypic correlations were obtained between EGGW30 and EGG/DAY. It indicates that chickens that attain higher body weight at the first day would lay bigger sized eggs. The negative genetic and phenotypic correlation obtained between number of eggs per day and all body weight traits suggest that the relationship could become more antagonistic during the process of selection. Regression coefficient estimated for breeding value (BV) under fix effect of generation for economical traits in this population showed that, significant genetic improvement was obtained under selection for these traits.

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