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Original Contribution

HERITABILITIES AND GENETIC AND PHENOTYPIC CORRELATIONS OF EGG QUALITY TRAITS IN KHAZAK LAYERS

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ABSTRACT

The aim of this study was to investigate the genetic and phenotypic correlations of egg quality traits in Khazak chicken. Albumen height (AH), albumen weight (AW), eggshell color (ESC), yolk color (YC), eggshell index, long length of egg (ELL), short length of egg (ESL), eggshell weight (ESW), egg weight (EW), Haugh units, and yolk weight (YW) were measured in 201 eggs collected 6 d sequentially from 85 Khazak layers caged individually. The ASReml was applied to estimate heritabilities and genotypic and phenotypic correlations for these egg quality traits. Heritabilities of AH, AW, ESC, YC, eggshell index, ELL, ESL, ESW, EW, Haugh units, and YW were 0.42, 0.61, 0.15, 0.19, 0.30, 0.36, 0.49, 0.54, 0.50, 0.46, and 0.32, respectively. The genetic correlations between EW and AW, YW, and ESW were high ranging from 0.78 to 0.93, whereas those for ESC with YW were low −0.89. Thus although heritabilities for these traits were moderate to high, genetic correlations with EW were high, suggesting a major relationship between EW and ESW as well as internal egg quality in Khazak layers.

Key words: egg production, genetic parameters, native chicken, Khazak

INTRODUCTION

The Khazak is an Iranian native chicken which comes from the Sistan region in eastern of Iran. It rear as a native chicken for egg production in Institute of Damhae Khas (University of Zabol). People of Sistan region were used widely for egg production. The chickens had never been properly defined; they were morphologically more heterogeneous than Part. In 2006, chickens from these breeds were sampled among those still maintained in traditional farms in order to be incorporated within the Poultry genetic conservation program. Their genetic characteristic, as well as the process followed to purify them in relation to some traits, has been presented previously (1, 2).

Khazak chicken has short leg and very light weight as dwarf layers. Feed consumption is an important cost in the production of eggs. In general, the dw gene depresses growth in layer-type stocks by approximately 30% (3) and reduces egg size primarily due to the reduction in body size (4). Facing a global lack of animal and poultry feedstuffs, the potential in using the Khazak chicken to reduce feed intake may once again gain importance in certain areas of the Iran. Therefore it is important to characterize the Khazak chicken on egg production and egg quality. Although there is considerable literature on genetic parameters of egg characteristics, most are base on simple model (5). Moreover, eggs have to be broken to measure their internal egg quality, and information on genetic parameters of interior and exterior egg quality traits may allow for selection via sib relationships. The restricted maximum likelihood (REML) method (6), allows for more accurate estimates of genetic parameters and estimates of breeding values. Studies related to the egg quality traits of nondwarf chicken have been reported (7, 8, 9, 10, 11). There is no information on genetic parameters for interior and exterior egg quality of Khazak chicken.

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MATERIALS AND METHODS

Stock, Husbandry, and Traits Measured

Khazak layers that developed at Institute Damhae Khas University of Zabol was used for the current study. Eggs obtained from these chickens with full pedigree were incubated at the same time. Chicks were hatched and were vent sexed, pedigreed, wing banded, and vaccinated against Marek's disease. The period of light was gradually decreased from 24 h to 22 h during the first 2 wk, and then birds were continued on natural light until transferred to single-hen cages at 16 wk of age, when the daily length of natural light was approximately 8 h. Then the photoperiod was increased by 1 h/wk until 17 h of light was achieved. All pullets were kept in the same laying house to minimize environmental effects. The laying mash consisted of 19% CP and 2,750 kcal of ME/kg. Eggs (n = 201) were obtained from 85 hens on 6 d consecutively when hens were 40-65 week of age. Data were obtained daily for the eggs laid on that day with the average for the 6 d used as the value for each hen. Cracked, soft-shell, and double yolk eggs were not used. External and internal egg quality traits including egg weight (EW), eggshell index (ESI), long length of egg (ELL), short length of egg (ESL), eggshell color (ESC), eggshell weight (ESW), albumen height (AH), yolk color (YC), albumen weight (AW), Haugh units (HU), yolk weight (YW), and yolk color (YC) were measured. The procedure followed was to weigh the egg to the nearest 0.01 g. Then shell color was measured on the blunt region, equatorial region, and sharp region, respectively using an EQ-Reflectometer 2 and the average of the 3 considered as the value for the egg. Then its length and width at midpoint were measured in millimeters using Veterinary and Livestock Instruments 2 (VLI) for ESI and ELL. The shell of the egg was then weighed (0.01 g), and AH was measured (mm) using VLI for AH. Yolk and albumen were then separated and weighed (0.01 g), and YC was measured using Roche Yolk Color Fan. Haugh units were calculated. The ESI was calculated by the formula ESI = ESL/ELL, where ESL is the short length of an egg, and ELL is the long vertical length of an egg. The albumen ratio (AR, %), the eggshell ratio (ESR, %), and the yolk ratio (YR, %) were expressed as AW/EW×100, ESW/EW× 100, and YW/EW× 100, respectively.

Statistical Analysis

The units for analysis were the average of the values for eggs from each hen over the 6 d. The means of egg quality traits were calculated with the MEANS procedure of the SAS software package (12). An animal model was constructed as follows:

$$Y_{ij} = \mu + a_i + e_{ij}$$

Where Y_{ij} is the $_{ij}$th average phenotypic record of the egg quality trait, μ is the common mean, a_i is the $_i$th individual breeding value, and e_{ij} is the error. The REML procedure was applied to estimate heritabilities and phenotypic and genotypic correlations using the ASReml 9.0 software package. The procedures were run following the manual for ASReml. Pedigree information for one generation of ancestors was included in the relationship matrix. Heritabilities were estimated using single-trait analysis. Initial values of genetic and environmental variances were the value of variance for corresponding trait and random values, respectively. Genetic and phenotypic correlations between pairs of traits were estimated using a 2-trait analysis. The genetic and environmental variance estimates from the results of single-trait analyses and random covariance values were set as initial values.

RESULTS AND DISCUSSION

Descriptive Statistics of Egg Quality Traits

Means and standard error of the traits measured in the current experiment are presented in **Table 1**. Means for EW, ESI, ESL, ELL, ESC, ESR and ESW were 43.04 g, 0.77, 3.9 cm, 5.08 cm, 1.52, 1.18, and 4.41 g, respectively. Means for AH, AW, HU, YC, YW, AR and YR were 5.94 mm, 23.41 g, 81.36, 8.72, 14.20 g, 53.73 % and 32.88 percent respectively.

***Table 1.** Descriptive statistics of egg quality traits*

Trait[1]	Mean ±SE
External egg quality	
EW (g)	43.04±6.02
ESL (cm)	3.9±0.18
ELL (cm)	5.08±0.29
ESC	1.52±0.60
ESW (g)	4.41±0.69
ESR (%)	1.18±1.08
ESI	0.77±0.03
Internal egg quality	
AH (mm)	5.94±1.37
AW (g)	23.41±4.18
AR (%)	53.73±3.65
HU	81.36±9.96
YW (g)	14.20±1.90
YR (%)	32.88±3.19
YC	8.72±1.5

[1]EW = egg weight; ESL = short length of egg ; ELL = long length of egg; ESC = eggshell color; ESW = eggshell weight; ESR%= eggshell ratio; ESI = eggshell index; AH= albumen height; AW= albumen weight; AR= albumen ratio; HU= Haugh unit; YW= yolk weight; YR= yolk ratio; YC= yolk color;

Heritabilities and Genetic and Phenotypic Correlations

Heritabilities ranged from 0.15 for ESC to 0.61 for AW **(Tables 2 and 3),** and few values were low. The genetic and phenotypic correlations among external and internal egg quality traits are summarized in **Tables 2 and 3**, respectively. The highest genetic and phenotypic correlations between external egg quality traits were between EW and ESL (0.96 and 0.91, respectively). The highest genetic and phenotypic correlations between internal egg quality traits were AW and HU (0.99 and 0.97, respectively). The genotypic and phenotypic correlations were estimated between internal and external traits **(Tables 4 and 5).** The highest genetic and phenotypic correlations between internal and external egg quality traits were between EW and AW, ESC and HU (0.93 and 0.95, respectively).

This is the first time that genetic parameters have been estimated in Khazak chicken and their genetic potential estimated accurately for egg quality, egg weight and eggshell color.

Heritabilities of EW from many reports ranged from 0.48 (13) to 0.71. The value of the current estimation was 0.50. These high values suggest that simple mass selection for this trait could achieve rapid improvement. The estimations of heritability for AW were similar to previous reports (14, 15). The heritability for ESW estimated by Francesch et al. (1997) was similar to the present study. Heritabilities for HU and AH were approximately similar other report (5), however this heritability is higher from report on two Leghorn Strains (16). The genetic correlation of EW with ESC for Khazak layers (-0.19) was differ out from those for Catalan layers (0.00 – 0.30) (13). It could be argued that essentially Khazak chicken is white color egg layer. Study with populations of Rhode Island Reds and Light Sussex breeds selected for several years for egg production show that there is a positive genetic correlation between light reflection and egg production, which is equivalent to the negative values for Egg shell color with egg production (3). The genetic correlation of ESC for Khazak layers with other external traits was between -0.40 and +0.75.

Table 2. *Heritabilities and genetic and phenotypic correlations among, external egg quality traits*

External egg quality traits[3]	EW	ESW	ESI	ESC	ESL	ELL
EW	0.50 (0.01)	0.78 (0.012)	-0.85 (0.31)	-0.19 (0.48)	0.96 (0.30)	0.87 (0.08)
ESW	0.68	0.54 (0.01)	-0.27 (0.31)	0.75 (0.25)	0.65 (0.15)	0.81 (0.18)
ESI	-0.25	-0.10	0.30 (0.01)	-0.43 (0.57)	0.16 (0.31)	-0.61 (0.20)
ESC	0.11	0.44	-0.08	0.15 (0.02)	-0.40 (0.53)	-0.04 (0.48)
ESL	0.91	0.59	0.13	0.06	0.49 (0.01)	0.67 (0.17)
ELL	0.83	0.52	-0.73	0.10	0.58	0.36 (0.01)

[1]Heritabilities are given on diagonal, genetic correlations above diagonal and phenotypic correlations below diagonal.
[2]Standard errors of the estimates are in parentheses.
[3]EW = egg weight; ESW = eggshell weight; ESI = eggshell index; ESC = eggshell color; ESL = short length of egg; ELL = long length of egg

Table 3. *Heritabilities and genetic and phenotypic correlations among, internal egg quality traits*

Internal egg quality traits[3]	YW	AW	AH	YC	YR	HU	AR
YW	0.32 (0.01)	0.10 (0.29)	0.26 (0.32)	0.27 (0.45)	0.40 (0.23)	0.19 (0.32)	-0.47 (0.23)
AW	0.20	0.61 (0.01)	-0.26 (0.25)	0.10 (0.35)	-0.86 (0.8)	-0.40 (0.22)	0.85 (0.81)
AH	0.10	-0.04	0.42 (0.01)	0.01 (0.39)	0.40 (0.23)	0.99 (0.01)	-0.24 (0.25)
YC	0.13	0.05	-0.08	0.19 (0.01)	-0.06 (0.35)	0.13 (0.38)	-0.20 (0.37)
YR	0.48	-0.73	0.15	0.04	0.66 (0.01)	0.50 (0.21)	-
HU	0.01	-0.19	0.97	-0.05	0.22	0.46 (0.01)	-0.36 (0.23)
AR	-0.44	0.75	-0.04	-0.09	-	-0.12	0.65 (0.01)

[1]Heritabilities are given on diagonal, genetic correlations above diagonal, and phenotypic correlations below diagonal.
[2]Standard errors of the estimates are in parentheses.
[3]YW = yolk weight; AW = albumen weight; AH = albumen height; YC = yolk color; YR = yolk ratio; HU = Haugh unit; AR = albumen ratio.

Table 4. *Genetic correlations between external and internal egg quality traits*

External egg quality traits[2]	Internal egg quality traits[3]						
	YW	AW	AH	YC	YR	HU	AR
EW	0.47 (0.23)	0.93 (0.04)	-0.21 (0.27)	0.25 (0.37)	-0.63 (0.17)	-0.36 (0.24)	0.62 (0.17)
ESW	0.32 (0.28)	0.68 (0.14)	-0.24 (0.25)	0.50 (0.35)	-0.58 (0.17)	-0.34 (0.23)	0.43 (0.21)
ESI	-0.08 (0.36)	-0.21 (0.28)	0.05 (0.33)	0.001 (0.44)	0.17 (0.28)	0.05 (0.32)	-0.23 (0.28)
ESC	-0.89 (0.39)	0.25 (0.37)	0.25 (0.46)	0.69 (0.50)	-0.80 (0.25)	0.36 (0.48)	0.70 (0.32)
ESL	0.51 (0.22)	0.85 (0.07)	-0.27 (0.26)	0.25 (0.36)	-0.54 (0.19)	-0.42 (0.24)	0.47 (0.20)
ELL	0.47 (0.27)	0.81 (0.10)	-0.23 (0.30)	0.19 (0.42)	-0.55 (0.22)	-0.36 (0.28)	0.53 (0.22)

[1]Standard errors of the estimates are in parentheses.
[2]EW = egg weight; ESW = eggshell weight; ESI = eggshell index; ESC = eggshell color; ESL = short length of egg; ELL = long length of egg
[3]YW = yolk weight; AW = albumen weight; AH = albumen height; YC = yolk color; YR = yolk ratio; HU = Haugh unit; AR = albumen ratio.

Table 5. *Phenotypic correlations between external and internal egg quality traits*

External egg quality traits[1]	Internal egg quality traits[2]						
	YW	AW	AH	YC	YR	HU	AR
EW	0.59	0.90	-0.03	0.10	-0.42	-0.19	0.40
ESW	0.32	0.57	-0.11	0.09	-0.43	-0.22	0.23
ESI	-0.20	-0.24	0.05	-0.06	0.06	0.07	-0.13
ESC	-0.06	0.14	0.09	0.09	-0.29	0.95	0.19
ESL	0.56	0.35	-0.01	0.10	-0.35	-0.17	0.33
ELL	0.55	0.75	-0.05	0.12	-0.29	-0.17	0.33

[1]EW = egg weight; ESW = eggshell weight; ESI = eggshell index; ESC = eggshell color; ESL = short length of egg; ELL = long length of egg
[2]YW = yolk weight; AW = albumen weight; AH = albumen height; YC = yolk color; YR = yolk ratio; HU = Haugh unit; AR = albumen ratio.

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