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Heritability of Interior Egg Quality Traits for Japanese Quail

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Abstract

In this study, heritability, genetic and phenotypic correlations for internal egg quality traits of Japanese quail were estimated by using ASREML, a restricted maximum likelihood (REML) procedure using a derivative free algorithm. Data were obtained from 1567 eggs collected 3 d sequentially from 584 pedigreed Japanese quails. Egg weight (EW), height (YH), diameter (YD), weight (YW), index (YI), and ratio (YR) of yolk, height (AH), weight (AW), and ratio (AR) of albumen, and Haugh unit (HU) were examined. (Co)Variance components and genetic parameters were estimated. Heritability of EW, YH, YD, YW, YI, YR, AH, AW, AR, and HU were 0.83±0.012, 0.40±0.035, 0.50±0.032, 0.74±0.019, 0.39±0.034, 0.53±0.030, 0.40±0.034, 0.80±0.015, 0.43±0.034 and 0.38±0.035 respectively. High positive genetic and phenotypic correlation among egg, yolk and albumen mass and negative correlations between yolk and albumen ratio were detected. This result indicates that selection for increased egg weight will increase both yolk and albumen weight, but an increase in the proportion of yolk will reduce the albumen part of egg.

Key words: *Coturnix coturnix japonica*, REML, genetic parameters.

INTRODUCTION

Japanese quail *(Coturnix coturnix japonica)* is one of the farmed avian species for commercial egg production all over the world. Its body and egg size is small, but its age of sexual maturity (6-8 weeks) is low and rate of egg production (280-300 eggs/year) is high [1]. Egg is an inexpensive, but nutritious food and its qualities are the traits of economic interest in commercial egg production. The trend in egg consumption is moving towards the form of industrially processed egg products [2]. Hence, yolk and albumen weight and their ratio to total egg weight are the main concern in egg processing and bakery industries [2, 3]. On the other hand, an avian egg is a microhabitat in which the embryo develops to be ready for its life in external environment. The contents and composition of an egg can thus directly affect the hatchability, chick quality and even future performance of the folk [2, 4-7].

It has been shown that several factors such as hen age, season, breed and lines within breed affected the proportion of egg components [8, 9]. Egg composition was established to be highly associated with egg weight [9, 10]. Fletcher et al. [10] reported that albumen weight was more closely related to changes in egg weight than yolk weight. However, positive relationship between yolk:albumen ratio and egg weight [9] indicated that heavier eggs had high yolk proportion. Haugh Unit is a measure of albumen height after correcting for the difference in egg size. Haugh Unit is widely used to measure the albumen quality, because it allows comparing eggs of unequal size.

Information on heritability of traits is essential for understanding how individual characteristics change from one generation to another in response to selection [11]. Knowledge on the genetic correlations among concerned traits is important to plan the breeding schemes and to predict the potential progress for commercial quail production. Hence, the objectives of the current study were to estimate the genetic and phenotypic parameters of internal characteristics for Japanese quail egg using restricted maximum likelihood (REML) procedure.

MATERIALS AND METHODS

Eggs were collected from the quails (12 weeks of age) pedigreed through eight successive generations at the Quail Breeding Unit of Gaziosmanpasa University, Tokat, Turkey. Totally 1567 eggs from 584 female quails, which are daughters of 91 sires, were collected in three sequential days. Chicks were raised in quail battery brooders until five weeks of age. Then, the females were caged individually in 25X25X30 cm stainless steel wire mesh cages. Birds were housed for the first three weeks at 24 hours lighting, following weeks at 16:8 light:dark cycle. Birds were allowed *ad libitum* access to food and water. They were fed with 24% crude protein (CP) and 3200 kcal ME/kg starter diet for 21 days, 19% CP and 3000 kcal ME/kg grower diet between 21 and 35 days of age and thereafter 17% CP and 2750 kcal ME/kg breeder diet.

The collected eggs were labelled to identify each female egg. Eggs were weighted with a 0.01 g sensitive electronic scale. The eggs were broken on a table with a glass cover. A three-legged micrometer sensitive to 0.01 mm was used to measure the height of yolk and albumen; and an electronic digital micrometer sensitive to 0.01 mm was used to measure the yolk diameter. After this process, the yolk was departed from the albumen part and weighed to get the yolk weight. Shells of broken eggs were washed with slightly flowing water to separate remaining albumen. Air-dried egg shells were weighted together with the shell membrane. These data were used to determine the additional internal quality traits of eggs with these formulas:

Albumen weight = Egg weight – (Yolk weight + Shell weight)

Albumen ratio (%) = (Albumen weight / Egg weight) x100

Yolk index (%) = (Yolk height / Yolk diameter) x100

Yolk ratio (%) = (Yolk weight / Egg weight) x100

Haugh unit (HU) = 100 log·(Albumen height (mm) + 7.57 - 1.7·Egg weight (g)$^{0.37}$)

(Co)variance components and genetic parameters were estimated using restricted maximum likelihood (REML) procedures (ASREML software; [12]).

Rearing group (generation) was included as fixed effect in the model for each trait, because of its significant effects in preliminary variance analyses. Animals were fitted as random effect into the model in order to estimate the additive direct genetic effect. Genetic and phenotypic correlations between traits were estimated in bivariate analyses with the same fix and random effects.

$$Y_{ij} = \mu + a_i + b_j + e_j \quad (1)$$

Where: μ is the population mean, a_i is the animal additive genetic effect, bj is the effect of rearing group, e_{ij} is the random residual error.

RESULTS AND DISCUSSION

Means, standard errors, coefficient of variations, minimum and maximum values for egg weight and internal quality characteristics of Japanese quail eggs were presented in Table 1. Egg weight can be divided into albumen and yolk weight, because they cover the highest proportion of total egg weight. Yolk ratio (30.49%) was half of the AR (60.83%) and both of them constituted over 90% of total egg weight. Yolk index and HU were calculated as 46.47±0.156, 89.98±0.158, respectively. These values reported here agreed with those of other researches [13-16]. Egg composition of the domestic fowls varies due to differences in genetic makeup and managements. Additionally, changes in interior egg quality traits could also be expected during egg production period [17].

Table 1. Descriptive statistics over the females for internal characteristics of Japanese quail egg (N=584)

Traits	Mean	SE	Min	Max	CV (%)
EW (g)	11.06	0.038	8.57	14.05	8.33
YH (mm)	11.11	0.028	8.80	13.36	6.05
YD (mm)	24.01	0.054	20.00	27.38	5.46
YW (g)	3.38	0.016	2.25	4.58	11.24
YI (%)	46.47	0.156	36.80	56.42	8.09
YR (%)	30.49	0.078	23.63	36.30	6.20
AH (mm)	4.55	0.023	2.49	6.27	12.30
AW (g)	6.73	0.027	4.67	9.04	9.65
AR(%)	60.83	0.085	52.47	68.64	3.36
HU	89.98	0.158	78.80	98.70	4.23

N = Number of females; SE = standard error; Min and Max = minimum and maximum values; CV (%) = coefficient of variation; EW = egg weight; YH = yolk height; YD = yolk diameter; YW = yolk weight; YI = yolk index; YR = yolk ratio; AH = albumen height; AW = albumen weight; AR = albumen ratio; HU = Haugh unit.

Heritability, genetic and phenotypic correlations for egg weight and examined internal quality traits were presented in Table 2. Estimated heritability for egg, yolk and albumen weights were high and estimated to be 0.83±0.012, 0.74±0.019, 0.80±0.015 respectively. The other heritability values were ranged high to moderate, and the lowest one was estimated for HU (0.38±0.035). Similar to the findings in this study, high heritability values (>0.5) were reported for egg characteristics of Japanese quail [18, 19, 20].

Table 2. Genetic and phenotypic parameters for internal characteristics of Japanese quail eggs. Heritability on diagonal, genetic correlations above and phenotypic correlations below the diagonal with their standard errors

	EW	YH	YD	YW	YI	YR	AH	AW	AR	HU
EW	**0.83±0.012**	0.52±0.051	0.78±0.030	0.88±0.013	-0.23±0.063	0.17±0.057	0.13±0.065	0.96±0.006	0.26±0.061	-0.15±0.065
YH	0.39±0.031	**0.40±0.035**	0.28±0.075	0.52±0.053	0.58±0.055	0.19±0.075	0.64±0.060	0.47±0.056	0.02±0.085	0.52±0.071
YD	0.61±0.023	0.18±0.033	**0.50±0.032**	0.94±0.015	-0.62±0.051	0.68±0.045	0.12±0.079	0.61±0.044	-0.33±0.071	-0.10±0.082
YW	0.83±0.012	0.41±0.030	0.74±0.015	**0.74±0.019**	0.88±0.013	0.61±0.037	0.07±0.007	0.73±0.029	-0.23±0.062	-0.18±0.067
YI	-0.14±0.036	0.67±0.019	-0.61±0.022	0.83±0.012	**0.39±0.034**	-0.41±0.071	0.43±0.074	-0.12±0.066	0.28±0.081	0.50±0.072
YR	0.16±0.037	0.21±0.033	0.52±0.026	0.67±0.021	-0.20±0.033	**0.53±0.030**	-0.11±0.078	-0.10±0.059	-0.92±0.015	-0.14±0.079
AH	0.07±0.037	0.45±0.026	0.05±0.034	0.02±0.04	0.33±0.029	-0.08±0.035	**0.40±0.034**	-0.14±0.066	0.11±0.083	0.73±0.000
AW	0.93±0.004	0.31±0.033	0.43±0.030	0.60±0.024	-0.07±0.037	-0.17±0.037	0.09±0.036	**0.80±0.015**	0.50±0.049	-0.14±0.067
AR	0.16±0.036	-0.08±0.034	-0.27±0.032	-0.36±0.033	0.13±0.033	-0.86±0.009	0.08±0.033	0.50±0.028	**0.43±0.034**	0.03±0.086
HU	-0.12±0.036	0.37±0.028	-0.07±0.034	-0.14±0.035	0.35±0.029	-0.10±0.034	0.88±0.000	0.09±0.036	0.05±0.033	**0.38±0.035**

EW = egg weight; YH = yolk height; YD = yolk diameter; YW = yolk weight; YI = yolk index; YR = yolk ratio; AH = albumen height; AW = albumen weight; AR = albumen ratio; HU = Haugh unit.

Correlations were nearly twice higher between EW and YD than between EW and YH. However, negative genetic and phenotypic correlations were estimated between EW and YI (Table 2). This could be expected because of the calculation method of YI using YD and YH. Negative genetic and phenotypic correlations were estimated between EW and HU. This result could also be expected because the Haugh Unit is a measure of albumen quality after correcting for the difference in egg mass. Although, high favorable correlations

(>60) among weights of egg, yolk and albumen were detected, high unfavorable genetic and phenotypic correlations between YR and AR were estimated. Previous selection experiments [2] indicated that rapid response to selection in yolk proportion was possible. It has been also reported that hen age, genotype and the interactions between hen age and genotype affected the chick weight [4, 21]. Suarez et al. [21] concluded that these influences on chick weight were arisen from genotype and age effects on yolk to albumen ratio. The result reported here indicated that selection for increased egg weight would increase both yolk and albumen weight, and increase in the proportion of yolk would lead to antagonistic effect on albumen part of egg. The yolk is the concentrated source of nutrition for the embryo and such favorable correlations could be potentially used to increase the hatchability and chick quality.

REFERENCES

[1] Reddish JM, Nestor KE, Lilburn MS. 2003. Effect of selection for growth on onset of sexual maturity in randombred and growth-selected lines of Japanese quail. Poult. Sci. 82:187-191.

[2] Hartmann C, Johansson K, Strandberg E, Wilhelmson M. 2000. One-generation divergent selection on large and small yolk proportion. Br. Poult. Sci. 41:280–286.

[3] Altan Ö, Ismail O, Yavuz A. 1998. Japon bıldırcınlarında (*Coturnix coturnix japonica*) canlı ağırlık yönünde yapılan seleksiyonun ve yasın yumurta özelliklerine etkileri. Turk. J. Vet. Anim. Sci., 22: 467–473

[4] Tserveni-Gousi AS. 1987. Relationship between parental age, egg weight and hatching weight of Japanese quail. British Poultry Sci. 28: 749-752.

[5] Skewes PA, Wilson HR, Mather FB. 1988. Correlations among egg weight, chick weight and yolk sac weight in Bobwhite quail (*Calinus virginianus*). Florida Science. 51:159-162.

[6] Finkler MS, Van Orman JB, Sotherland PR. 1998. Experimental manipulation of egg quality in chickens: infuence of albumen and yolk on the size and body composition of near-term embryos in a precocial bird. J Comp Physiol B. 168: 17-24

[7] Khurshid A, Farooq M, Durrani FR, Sarbiland K, Manzoor A. 2004. Hatching performance of Japanese quails. *Livestock Research for Rural Development, Vol. 16.* Retrieved March 19, 2006, from http://www.cipav.org.co/lrrd/lrrd16/1/khur161.htm.

[8] Marion WW, Nordskog AW, Tolman HS, Forsythe RH. 1964. Egg composition as influenced by breeding, egg size, age and season. *Poultry Sci*. 43: 255-264.

[9] Hussein SM, Harms RH, Janky DM. 1993. Effect of age on the yolk: albumen ratio in chicken eggs. Poult. Sci., 72: 594-597.

[10] Flecther DL, Britton WM, Pesti GM, Rahn AP, Savage SI. 1983. The relationship of layer flock age and egg weight on egg component yields and solids content. Poult. Sci., 62: 1800-1805.

[11] Falconer DS, Mackay TFC. 1996. Introduction to Quantitative Genetics, 4th edn. Longman, London.

[12] Gilmour AR, Cullis BR, Welham SJ, Thompson R. 2000. *ASREML*. NSW Agriculture, Orange, Australia.

[13] Yannakopoulas AL, Tserveni-Gousi AS. 1986. Quality characteristics of quail eggs. Bri. Poultry Sci. 27:171-176.

[14] Uluocak AN, Okan F, Efe E, Nacar H. 1995. Bildircin yumurtalarinda bazi dis ve ic kalite ozellikleri ve bunlarin yasa gore degisimi. Turk. J.Vet. Anim. Sci., 19: 181-185.

[15] Nazligul A, Turkyilmaz K, Bardakcioglu HE. 2001. A study on some production traits and egg quality characteristics of Japanese quail. Turk. J. Vet. Anim. Sci., 25: 1007-1013

[16] Kul S, Seker I. 2004. Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (*Coturnix coturnix japonica*). Int. J. Poult. Sci., 3: 400-405.

[17] Narushin VG, Romanov MN. 2002. Egg physical characteristics and hatchability. Wld's Poult. Sci., 58: 297-303

[18] Stino FKR, Kıcka MA, Kamaer GA, Altakreti BTO. 1982. Egg quality traits of the Japanese quail and their heritability in the subtropics. Archiv für Geflügelkunde. 3:104-108.

[19] Sato K, Ida N, Ino T. 1989. Genetic parameters of egg characteristics in Japanese quail. Jikken Dobutsu. 38: 55-59

[20] Minvielle F, Oguz Y. 2002. Effects of genetic and breeding on egg quality of Japanese quail. World's Poultry Science Journal. 58:291-295.

[21] Suarez ME, Wilson HR, Mather FB, Wilcox C J, McPherson BN. 1997. Effect of strain and age of the broiler breeder female on incubation time and chick weight. Poult. Sci.76:1029–1036.