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Genetic evaluation for egg mass in partial periods and complete period in meat quails[1]

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ABSTRACT - The objective of this study was to obtain estimates of genetic and phenotypic parameters for egg mass of meat quails and also to propose an optimal age for selection of birds through the egg mass. The data used in this study came from 3,503 female meat quails (UFV1: 1.811 quails; UFV2: 1.692 quails) of the Poultry Breeding Program from Universidade Federal de Viçosa. The traits examined were egg mass in partial periods until 77, 112, 147 and 182 days, and egg mass in the total period of 407 days by the use of single and bi-trait animal models. For the genetic group UFV1, the heritability values for the periods were high: 0.58, 0.59, 0.57, 0.59 and 0.24 (until 77, 112, 147,182 and 407 days, respectively). The values of genetic correlations were medium, ranging from 0.51 (77 and 407 days) to 0.61 (112 and 407, 147 and 407 days). For the genetic group UFV2, the estimates of heritability were of low magnitude: 0.05, 0.03, 0.04, 0.05, and 0.11 (until 77, 112, 147, 182, and 407 days, respectively). The values for genetic correlation ranged from 0.61 (112 and 407 days) to 0.93 (77 and 407 days). For the genetic group UFV1, the second partial period (112 days) for selection of meat quails using the egg mass trait is recommended, due to a higher value of heritability and a higher value of genetic correlation with the total and relative efficiency close to the unity in this period. In the genetic group UFV2, the first partial period (77 days) is indicated, since it had a higher estimation of genetic correlation and a higher relative efficiency. The choice of these partial periods reduces the generation interval, increasing the intensity of selection and an increase in genetic gain per unit of time.

Key Words: animal model, *Coturnix coturnix*, egg weight, genetic correlation, heritability, relative efficiency

Introduction

Brazil is known on the world stage as one of the main suppliers of animal-origin products. This business in Brazil is linked to the advancements in animal husbandry in the last two years. Because it possesses wide areas of mild climate, the country has invested in research on nutrition, management and breeding of domestic species, aiming at improving the quality of animal-origin products and increasing the exportations. In this scope, the diversification of animal-origin protein sources is also present, and concerning this, quail raising has gained important market share.

The main determining trait of income in egg production are the egg mass and feed efficiency, with feed intake and body weight considered, singly, of little importance (Lopes et al., 1986). The egg-laying rate is not the best criterion of selection of laying birds, once increase in the egg-laying rate corresponds to decrease in the average egg weight, caused by the response correlated to selection (Zanella et al., 1987). The egg mass corresponds to the product of egg production by the average weight of eggs in the plot (Brunelli et al., 2010), and is one feature with potential for the improvement of quail performance, once it affects the production cost or the system quality, as well as egg production, intake, feed conversion, weight and mortality rate (Piccinin, 2006). As a consequence of the negative genetic correlations between egg-laying rate and egg weight, the indirect selection of egg mass is more efficient for increase in the number and weight of eggs than the selection at the egg-laying rate itself (Bohren, 1970).

Biegelmeyer et al. (2008), working with European quails, found egg mass values between 120.63 and 155.44 g, in an evaluation period of 13 days, and average egg weight /bird between 11.38 g and 14.08 g. Dionello et al. (2011) conducted a study to verify the traits that could serve as selection criteria. In this study, the following traits were utilized: production in number, weight and mass of eggs in meat quails of up to 406 days of age under selection for greater weight at 21 days, in defined periods of intervals of 182, 112, 91, 56 and 28 days. Random regression models with homogeneous and heterogeneous residual variances were

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utilized. The heritability values for egg mass varied from 0.01 to 0.15, considering the homogeneous residual variances. For heterogeneous residual variances, heritability values varied from 0.01 to 0.20.

The objective of the present study was to evaluate the genetic and phenotypic parameters for egg mass, evaluate the genetic associations between egg mass in the partial and total periods and to propose an ideal age for selection of quails through egg mass.

Material and Methods

A database of 10 generations of *Coturnix coturnix* from the breeding program of the birds from the Departamento de Zootecnia of Universidade Federal de Viçosa, in Viçosa, Minas Gerais, Brazil, totaling 3.505 females, was utilized.

The evaluated data were obtained from two genetic groups of meat quails, with 1811 UFV1 females and 1692 UFV2 females. For each generation, at the starting stage of raising, birds were housed in stall of concrete floor lined with wood shavings bed, equipped with protection circle and heating through heat brooders, by utilizing one hood for approximately 750 quails. In the starter phase, up to the 42nd day of life, diet with 26% crude protein and 2.950 kcal metabolizable energy per kg of the diet was supplied *ad libitum* to tray feeder troughs. Water was also supplied *ad libitum*, through pressure cup drinkers. Until the 14th day of life, light programs of 24-hour illumination were used. From the 14th to the 28th days of life, natural lighting was adopted. The selections were based on body weight, with the aid of 0.01g precision scale and, performed on the 28th day of life, when the 204 best females and the 102 best males within each group were selected, at each generation. The chosen animals were transferred to the individual galvanized cages for control of egg production, following the criterion of 1 male:2 females. Galvanized cages had dimensions 0.9 m length × 0.44 m width × 0.23 m height, with 0.15 of the width belonging to egg trimmers, during the evaluation of egg-laying, totaling six sections in each cage. Cages were equipped with linear feeders of galvanized sheet on the frontal part and poultry drinker in between the cages, with running water supply. From this period, a lighting program with 16 hours of illumination was adopted. Unselected animals remained on the floor until 42 days of age, and were sent to slaughter afterwards.

Egg production was assessed by the number of eggs collected individually, from the 42nd to the 407th day of life, completing, thus, one year of egg-laying. The average weight of eggs, in grams, was obtained through collection and weighing on 0.01 g precision scale during three consecutive days, at 77, 112, 147 and 182 days of life. For the obtainment of egg mass, the number of eggs laid per period was multiplied by the respective egg average weight in the period. The traits analyzed were egg mass in the partial periods until 77 days, 112 days, 147 days, 182 days and egg mass in the total period, until 407 days. For obtaining total egg mass, the egg average weight in the four periods was multiplied by the total egg production. The software SAS (Statistical Analyses System, version 9.2) was utilized for structuring of the data.

In order to estimate the genetic and phenotypic parameters, the components of variance and covariance were obtained through the method of restricted maximum likelihood, by utilizing the single-trait animal model, and for partial and total production, bi-trait animal model was utilized, through the software REMLF90. The initial values, which are requested by REMLF90, were obtained through variance analyses and the literature. Fixed effect of generation/hatch was considered for the trait egg mass in partial and egg mass in total period.

The model utilized can be represented in the matrix form by: $y = X\beta + Z\alpha + \varepsilon$, where: y is the vector of observations; X is the incidence matrix of fixed effects; β is the vector of fixed effects; Z is the incidence matrix of random effects; α is the vector of random effects; ε is the vector of residues.

The relative efficiency of the selection obtained through the partial period in relation to the total period was calculated according to the formula described by Falconer (1989):

$$RE = \frac{h_{pp}\ x\ r_g}{h_{pt}}$$

where: h_{pp} is the square root of the heritability of the partial period; h_{pt} is the square root of the heritability of the total period; r_g is the genetic correlation between the partial and the total period.

The advantage of utilizing the relative efficiency is at the possibility of comparing the genetic gain in a feature by utilizing the correlated response in another. If the reason is greater than one unit, the correlated response is favorable, and the genetic gain will be greater than the direct selection in the other feature.

Results and Discussion

The first partial period, until 77 days (Table1), was the one which presented greater variation (48.10%). This variation is due to the difference of the beginning of egg-

Table 1 - Means of egg mass in grams and respective standard deviations (SD), coefficients of variation (CV) and standard error of the mean (SEM) for genetic group UFV1

Partial periods	Means	SD	CV (%)	SEM
M77	246.43	118.55	48.10	3.44
M112	650.62	180.15	27.69	4.73
M147	1048.29	260.61	24.86	6.78
M182	1446.50	353.95	24.47	9.14
M407	3837.29	679.21	17.70	30.05

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

laying in animals. Some females are earlier at the beginning of egg-laying; however, some require more time. The other partial periods (until 112, 147 and 182 days) kept similar variation, showing that in this period, animals have a more regular tendency at egg-laying.

The overall mean of the mass of eggs produced in gram/bird/day was 10.51, which was close to the 10.82 g/bird/day found by Mori et al. (2005), superior to the 9.82 g/bird/day obtained by Costa et al. (2008) and inferior to the 11.42 g/bird/day found by Gotuzzo et al. (2009).

The heritability values for the initial periods were of high magnitude (Table 2), varying from 0.57 (until 147 days) to 0.59 (until 112 and 182 days): much higher than the 0.24 found in the total period. These values are superior to those found by Dionello et al. (2011), also in meat quails.

The heritability estimate for the total period was also much lower in comparison with the values found in the four partial periods (until 77, 112, 147 and 182 days). One possible explanation is the effects of permanent environment that accumulate over time in the trait. As the model utilized does not take the effects of permanent environment, they accumulate in the residue, inflating it and overestimating the environmental variance, which results in lower estimate of heritability. The same was observed by Sarmento et al. (2011), when working with Santa Inês sheep, where the model that did not consider the effect of permanent environment presented heritability estimate higher than those which considered it.

The values of genetic correlation were average (Table 3), varying from 0.51 (until 77 and 407 days) to 0.61 (until 112 and 407, 147 and 407 days). These values are inferior to those found by Gotuzzo et al. (2009). An explanation for the difference in the correlation values found in the literature is mainly due to the number of days that compose each period and the amount of periods utilized. These correlation values also indicate that the gene regulation of the trait at the start of egg-laying probably differs from the genes that act at the end of egg-laying.

The values of relative efficiency do not surpass the unit in any of the partial periods. This way, none of these periods could be indicated for selection through the partial period in detriment of the total period, based on the relative efficiency, without considering the reduction in the generation gap. However, taking that the second partial period (until 112 days) was close to the unit (0.96), it is recommended to utilize it for selection: since it would allow reducing the generation gap, it permits up to three generations a year, besides augmenting the genetic gain of the trait.

The coefficient of variation for the first period (until 77 days) presents high value compared with the other periods (Table 4). The overall mean of mass of eggs produced in gram/bird/day was 10.56, and is also close to the 10.82 g/bird/day found by Mori et al. (2005). Nevertheless, this value is superior to the 9.82 g/bird/day obtained by Costa et al. (2008) and inferior to the 11.42 g/bird/day found by Gotuzzo et al. (2009).

Table 2 - Estimates of heritability (h²), additive genetic variances (σ_a^2), environmental variances (σ_e^2) and phenotypic variances (σ^e_p) of egg mass for genetic group UFV1

Partial periods	h²	σ_a^2	σ_e^2	σ^e_p
M77	0.58	4415.00	3163.00	7578.00
M112	0.59	16210.00	11100.00	27310.00
M147	0.57	36000.00	26920.00	62920.00
M182	0.59	71530.00	49880.00	121410.00
M407	0.24	112100.00	354300.00	466400.00

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

Table 3 - Estimates of genetic (r_g), environmental (r_e) and phenotypic (r_p) correlations of each partial period (M77, M112, M147 and M182) with the total period (M407) and relative efficiency for genetic group UFV1

Partial periods	r_g	r_e	r_p	Relative efficiency
M77	0.51	0.06	0.21	0.79
M112	0.61	0.16	0.28	0.96
M147	0.61	0.22	0.30	0.94
M182	0.57	0.22	0.28	0.89

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

The heritability values were of low magnitude, varying from 0.03 (until 112 days) to 0.11 (until 407 days) (Table 5). These values are in accordance with the 0.01 to 0.15 found by Dionello et al. (2011), when he considered a model with homogeneous residual variances.

The values of genetic correlation for group UFV2 (Table 6) varied from 0.61 (until 112 days) to 0.93 (until 77 days). These values are inferior to those found by Gotuzzo et al. (2009). The genetic correlation in the first period was high, but the heritability estimate presented low value, which considerably reduced the relative efficiency value.

This way, for genetic group UFV2, the first partial period (until 77 days) is recommended for the selection of meat quails through egg mass, once it presented higher genetic correlation estimate and higher relative efficiency. The choice for this period allows the reduction of the generation gap, increase in the intensity of selection and increase in the genetic gain per unit of time, allowing up to three generations per year.

Table 4 - Means of egg mass in grams and respective standard deviations (SD), coefficients of variation (CV) and standard error of the mean (SEM) for genetic group UFV2

Partial periods	Means	SD	CV (%)	SEM
M77	254.69	120.24	47.21	3.51
M112	652.26	186.39	28.57	4.83
M147	902.99	313.42	34.71	7.99
M182	1808.35	644.80	35.66	16.27
M407	3854.66	698.53	18.12	34.75

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

Table 5 - Estimates of heritability (h²), additive genetic variances (σ_a^2), environmental variances (σ_e^2) and phenotypic variances (σ^e_p) of egg mass for genetic group UFV2

Partial periods	h²	σ_a^2	σ_e^2	σ^e_p
M77	0.05	531.20	9346.00	9877.20
M112	0.03	1113.70	33483.00	34596.00
M147	0.04	3367.20	72764.00	76131.00
M182	0.05	14269.00	295330.00	309600.00
M407	0.11	48139.00	377240.00	425380.00

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

Table 6 - Estimates of genetic (r_g), environmental (r_e) and phenotypic (r_p) correlations of each partial period (M77, M112, M147 and M182) with the total period (M407) and relative efficiency for genetic group UFV2

Partial periods	r_g	r_e	r_p	Relative efficiency
M77	0.93	0.23	0.26	0.62
M112	0.61	0.27	0.27	0.32
M147	0.73	0.27	0.30	0.44
M182	0.70	0.27	0.30	0.47

M77 - egg mass in the partial periods until 77 days; M112 - until 112 days; M147 - until 147 days; M182 - until 182 days and M407 - total period (until 407 days).

Conclusions

The heritability estimates for egg mass in the partial periods are high for genetic group UFV1 and indicate that the genetic progress expected by means of individual selection is high. The genetic correlation values between the partial and total periods are of great magnitude, and the second partial period (until 112 days) presents relative efficiency value close to the unit, which enables the utilization of this period for selection of meat quails through egg mass. The choice for this period results in reduction in the generation gap, allowing for up to three generations per year, increasing, thus, the genetic progress of the trait. Genetic group UFV2 presents low heritability values. The values of genetic correlation between the total and partial periods range from medium to high magnitude. Although the relative efficiency values are low, the first partial period (until 77 days) is recommended for the selection of meat quails though egg mass, for it presents higher value of genetic correlation with the total production, allowing, too, up to three generations per year. The use of partial periods is recommended, because it enables reduction in the generation gap, increase in the intensity of selection and increase in genetic gain per unit of time.

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