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Estimates of Genetic and Phenotypic Correlations Between Monthly and Cumulative Egg Productions in a Commercial Broiler Female Line

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Abstract: The purpose of this study was to estimate genetic and phenotypic correlations between monthly and cumulative egg productions in a commercial broiler line. Egg productions of 16483 hens from 1198 sires and 4564 dams were used in the analysis. The period of data collection was from 24 to 55 weeks of age. From the weekly productions, 8 monthly records on 28-day basis and a cumulative egg production were created. A multi-trait animal model using Restricted Maximum Likelihood (REML) was used to estimate (co)variance components of egg records. The estimates of heritability for monthly records ranged from 0.076 (M8) to 0.424 (M1). The first month showed the highest heritability among all periods. Also, the heritability of 0.147 was obtained for cumulative egg production. Genetic correlations between cumulative egg numbers and monthly records varied from 0.651 (with first month) to 0.946 (with sixth month). The corresponding estimates for phenotypic correlations were generally lower than the genetic correlations. However, the pattern of variations was almost similar. With considering age at sexual maturity as a covariate in the model, the genetic and phenotypic correlations between the first month and cumulative egg production decreased by about 64.06% (from 0.651 to 0.234) and 50.61% (from 0.413 to 0.204), respectively. The results of this study showed that improvement of cumulative egg number is feasible through selection according to each monthly record after second month.

Key words: Genetic parameters · Egg production · Age at sexual maturity · Broiler line

INTRODUCTION

Egg production is an important trait for commercial broiler companies. This trait depends on weeks or months of production and generally continues from 24 to 64 weeks of age (about 40 weeks). The heritability of egg number has been reported from 0.01 to 0.61 [1-10]. These estimations showed that the additive genetic variance of egg production ranged from low to high. Also, selection for improving of egg number is mainly based on part records. However, selection basis of part records has some unfavorable effects, like earlier age at sexual maturity, poorer laying persistency after egg production peak and low selection accuracy [10]. For genetic evaluation of egg production traits, we have to estimate genetic correlations between part and total records. Hence, the purpose of this study was to estimate genetic and phenotypic correlations between monthly and cumulative egg productions in a commercial broiler line.

MATERIAL AND METHODS

The data were collected from a commercial broiler line. Egg production of 16483 hens from 1198 sires and 4564 dams was recorded for the analysis. The period of data collection was from 24 to 55 weeks of age (32 weeks). Monthly egg numbers were generated by summing the egg numbers of 4 consecutive weeks and cumulative egg number was obtained by adding the total eggs of whole production period. The structure of data has shown in Table 1.

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Table 1: Structure of data

Traits	N	Minimum	Maximum	Mean	SD	CV (%)
M1	16483	0	27	8.98	6.28	69.96
M2	16483	0	28	20.50	6.38	31.10
M3	16483	0	28	20.32	6.37	31.35
M4	16483	0	28	18.97	6.46	34.06
M5	16483	0	28	17.50	6.52	37.24
M6	16483	0	28	15.87	6.90	43.44
M7	16483	0	27	14.46	7.10	48.87
M8	16483	0	26	11.32	7.37	65.09
CM1-8	16483	0	205	127.91	40.18	31.41

M = monthly egg production (e.g. M1 = egg production of month 1 to M8 = egg production of month 8); CM1-8 = cumulative egg number from M1 to M8; N=number of records; SD= standard deviation; CV= Coefficient of variation

Table 2: Estimates of variance components and heritabilities for monthly and cumulative records using multi-trait animal model without and with ASM

	Without ASM				With ASM			
Traits	σ_a^2	σ_e^2	σ_p^2	$h^2 \pm S.E$	σ_a^2	σ_e^2	σ_p^2	$h^2 \pm S.E$
M1	15.79	21.43	37.22	0.424 ± 0.018	2.64	11.20	13.84	0.192 ± 0.018
M2	6.42	40.33	46.75	0.137 ± 0.013	3.18	26.93	30.11	0.103 ± 0.014
M3	4.18	42.70	46.88	0.089 ± 0.012	3.72	34.52	38.24	0.094 ± 0.014
M4	4.06	43.26	47.32	0.086 ± 0.012	3.80	36.34	40.13	0.096 ± 0.014
M5	3.69	43.31	46.99	0.078 ± 0.011	3.54	37.42	40.97	0.082 ± 0.013
M6	4.40	45.14	49.54	0.089 ± 0.012	4.18	40.41	44.59	0.089 ± 0.013
M7	4.16	45.96	50.12	0.083 ± 0.011	4.07	42.04	46.11	0.081 ± 0.012
M8	3.11	37.76	40.88	0.076 ± 0.011	3.02	35.60	38.62	0.072 ± 0.011
CM1-8	270.03	1563.98	1834.01	0.147 ± 0.016	161.17	1205.02	1366.18	0.118 ± 0.016

M= monthly egg production; CM1-8= Cumulative egg number from M1 to M8; σ_a^2 = direct additive genetic variance; σ_e^2 = residual variance; σ_p^2 = phenotypic variance; h^2 = heritability; *S.E.* = standard error.

Statistical Analyses: A multi-trait animal model using Restricted Maximum Likelihood (REML) was used to estimate (co)variance components of 8 monthly records and the cumulative egg numbers as follows:

$$y_{ijk} = \mu+G_i+H_j+a_k+e_{ijk}$$

Where y_{ijk} is the monthly record or cumulative egg number of the hen, μ is the grand mean, G_i is the fixed effect of generation (9 levels), H_j is the fixed effect of hatching time (4 levels), a_k is the random additive genetic effect of the hen and e_{ijk} is the random residual effect. To indicate the effect of age at sexual maturity (ASM) on (co)variance components and genetic parameters, the data were reanalyzed by fitting this effect as a covariate in the model. Estimates of covariance components and their respective parameters were carried out using DFREML program [11].

RESULTS AND DISCUSSION

Estimates of variance components and heritabilities of monthly records and cumulative egg production are presented in Table 2. Without fitting ASM as a covariate in the model, the estimates of heritability for monthly records ranged from 0.076 (M8) to 0.424 (M1). The first month showed the highest heritability among all periods. These results were in accordance with the reports of other studies [1, 4, 7, 9, 12]. The exception of two first periods, the estimates of heritability were not changed by considering ASM in the model. The heritability of monthly egg records, for both without and with considering ASM in the model, is plotted as a function of months in Figure 1.

The heritabilities of 0.147 and 0.118 were obtained for cumulative egg production, without and with taking account of ASM, respectively. While these estimates

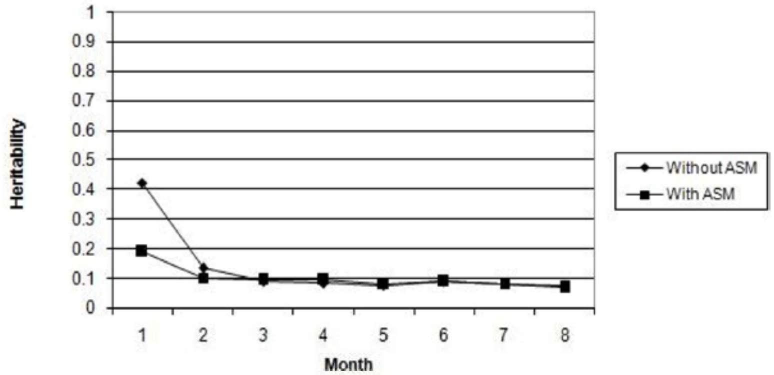

Fig. 1: Changes of heritability over month without and with considering ASM in the model

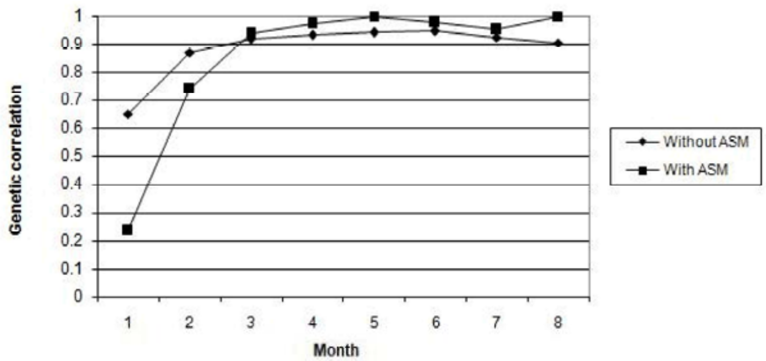

Fig. 2: Changes of genetic correlation among monthly and cumulative egg records over month without and with considering ASM in the model

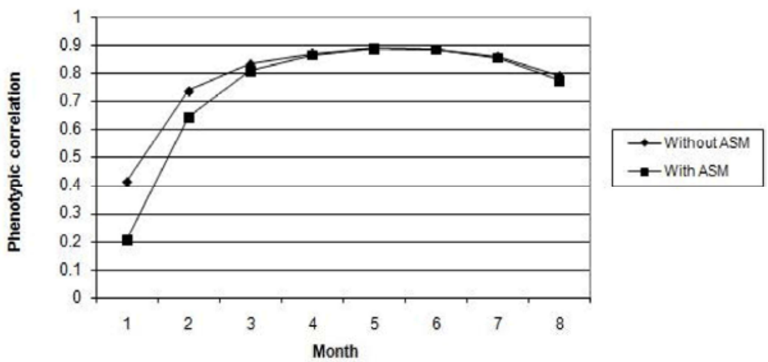

Fig. 3: Changes of phenotypic correlation among monthly and cumulative egg records over month without and with considering ASM in the model

were comparable with the results of 0.11 reported by Szyd³owski and Szwaczkowski [13] for New Hampshire strain and 0.08 to 0.10, by Wolc *et al.* [1] for Rhode Island White and Red lines, they were consistently much lower than the values of 0.47 reported by Anang *et al.* [7] on untransformed cumulative production of first 10 months in White Leghorn hens and 0.35 and 0.32 for cumulative production of 1 to 6 months in two different commercial lines of White Leghorn hens by Nurgiartiningsih *et al.* [4].

Genetic and phenotypic correlations among monthly and cumulative records of egg production, without and with considering ASM, are presented in Figures 2 and 3, respectively. Apart from the first monthly records of egg production, which indicated moderate genetic (0.651) and phenotypic (0.413) correlations with cumulative egg number, all other monthly records had high genetic and phenotypic correlations with this trait. The genetic correlations increased from 0.869 (between M2 and CM1-8) to 0.946 (between M6 and CM1-8) and then decreased gradually to 0.904 (between M8 and CM1-8). The very high genetic correlations suggest that genetic changes in cumulative egg number are possible by selection on any monthly records after the second month egg production. A similar pattern was observed for the corresponding estimates of phenotypic correlation. With the exception of the genetic correlation between M8 and CM1-8, in the case of fitting ASM in the model, the pattern of changing in genetic correlations was similar to the model without ASM. With considering ASM in the model, the genetic and phenotypic correlations between the first month and cumulative egg production decreased by about 64.06% (from 0.651 to 0.234) and 50.61% (from 0.413 to 0.204), respectively. The results of the present study are not consistent with the genetic correlation estimates of 0.83 and 0.84 (between first month egg production and cumulative production) and 0.48 and 0.42 (between sixth month egg production and cumulative production) for male and female lines of White Leghorn hens, respectively, reported by Nurgiartiningsih *et al.* [4]. However, Luo *et al.* [10] found similar results to those reported in the present study.

The results of the present study indicated that exclusion of age at sexual maturity from the analysis of monthly and cumulative records of egg production, especially for the first records of laying period, resulted to overestimation of (co)variance components and their corresponding parameters. Cumulative egg number was highly genetically correlated with monthly records of egg production, suggested that improvement of cumulative egg number is feasible through selection according to each monthly record after second month.

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