Genetic parameters of egg production trait in Alabio and Mojosari ducks under selection

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Abstract. Genetic parameters for egg production traits in Alabio and Mojosari ducks were estimated. Egg production data were collected from 530 Alabio and 461 Mojosari ducks. The ducks were 6th generation of selection program for egg production trait at the BPTU-HPT Pelaihari. Heritability values were estimated using paternal half-sib correlation method in a one-way analysis of variance. The result showed that heritability estimates for body weight at 16 weeks of age were high, in Alabio ducks (0.63±0.242) and in Mojosari duck (0.88±0.269). Heritability for body weight at first egg was 0.55±0.23 in Alabio duck and 0.44±0.222 in Mojosari duck. The heritability estimates for number of eggs from months 1-3 (EN3) and 1-6 (EN6), ranging from 0.30 to 0.46. The heritability for number of eggs from months 1-12 (EN12) was high in Alabio duck (0.62) and moderate in Mojosari duck (0.46). The EN12 had high genetic correlation with EN3 and EN6 (ranging from 0.80 to 0.99). EN12 had a negative genetic correlation with body weight and age at first egg (between -0.81 and -0.21). This finding indicates that EN3 could be used as a selection criteria to increase EN12 in Alabio and Mojosari ducks.

1. Introduction

Ducks contribute 13.4% to the total poultry egg production in Indonesia [1]. Alabio and Mojosari ducks are Indonesian local ducks, which have been included as national germplasm by the Indonesian Ministry of Agriculture, with reference number of 2921/Kpts/OT.140/6/2011 (Alabio duck) and 2837/Kpts/LB.430/8/2012 (Mojosari duck) [2, 3]. Because of their potential and importance as egg producers, as well as becoming a part of maintaining livestock biodiversity, an effort to increase the duck productivity is a need.

Genetic improvement of the ducks is a concrete option for increasing their productivity, because genetic information is inherited from parents to offspring. Therefore, some schemes of selection is needed to increase the productivity of the ducks. Selection criteria in duck composes of economically important traits, such as egg production. The initial step in the selection schemes is the availability of information regarding the superiority of animal, known as breeding value (BV)[4]. Therefore, to determine an accurate breeding program in a population, it is important to understand the genetic
parameters for the trait of interest. The genetic parameters include heritability and genetic correlation for economically important traits [5].

The genetic parameters such as heritability and genetic correlation are often used as the basis for selection schemes and therefore, the genetic parameters should be estimated in each population [6]. This study aimed to estimate the genetic parameters egg production traits in Alabio and Mojosari ducks.

2. Materials and methods

2.1 Materials

2.1.1. Animals and Data. Data were collected from the records of the 6th generation of Alabio and Mojosari ducks, kept under selection program from 2017 to 2018 at the BPTU-HPT Pelaihari, South Kalimantan. A total of 547 (530 females and 17 males) Alabio ducks and 477 (461 females and 16 males) Mojosari ducks were used in this study. The ducks were kept on individual pens during the laying phase. The ducks were fed in accordance to the procedures applied at the BPT–HPT Pelaihari.

2.1.2. Traits measured. Body weight at 16 weeks of age (BW16) and at first egg (BW1st EGG), age at first egg (AGE1st EGG), average weight of the first three eggs produced (EW1st), and total number of eggs produced during laying phase (EN) were measured. Total number of eggs produced during laying phase was classified into three categories including total number of eggs produced from months 1 to 3 (EN3), 1 to 6 (EN6), and 1 to 12 (EN12). In this study, the total number of eggs produced in a week, a month, and a year were the total number of eggs produced for seven days, four weeks (28 days), and twelve months (48 weeks or 336 days), respectively.

2.2 Methods

2.2.1. Estimates of Heritability. Heritability was estimated using paternal half sib correlations method in one way analysis of variance. The statistical model was follows

\[ Y_{ik} = \mu + \alpha_i + e_{ik}, \]

where \( Y_{ik} \) = the observed phenotype, \( \mu \) = population mean, \( \alpha_i \) = sire effect, and \( e_{ik} \) = random error [7].

The heritability was calculated using the following formula:

\[ h^2 = \frac{\sigma^2_s}{\sigma^2_s + \sigma^2_w} \]

where \( \sigma^2_w \) = variance within sire, and \( \sigma^2_s \) = variance between sires.

2.2.2. Estimates of genetic correlation. Genetic correlation was estimated using paternal half sib correlation method in a one way analysis of covariance [7,8], The formula used as was follows:

\[ \Gamma_c = \frac{4 \text{Cov}_{xy}}{\sqrt{4 \sigma^2_x \sigma^2_y}} \]

3. Results and discussion

3.1. Body weight and number of eggs
Mean and standard deviation of body weight and number of egg produced during laying phase are shown in Table 1. The mean body weight at 16 weeks of age (BW16) in Alabio duck was 1291.33±146.93 g, which was quite similar to Mojosari duck (1299±142 g). The mean body weight at
first egg in Alabio duck (BW1\textsuperscript{*}EGG) was 1612.40 ± 183.3 g, which was higher than that in Mojosari duck (1544 ± 120 g). Our results were quite similar to the findings of [9], who reported that body weight at first egg in Alabio and Mojosari ducks were 1621.75 and 1610.75 g, respectively. The means age at first egg (AGE\textsuperscript{1}EGG) were 168 ± 17.16 days of age in (Alabio duck) and 168 ± 21 days of age in (Mojosari duck), which were quite similar to the results of [10], who reported that the average age at first egg in Alabio and Mojosari ducks are 24.27 weeks (169.84 days) and 24.53 weeks (171.71 days), respectively.

Table 1. Body weight and egg production trait in Alabio and Mojosari ducks

| Trait          | Unit | Breed          | Alabio          | Mojosari         |
|---------------|------|----------------|-----------------|-----------------|
| BW16          | Gram | 1291.33±146.93 | 1299±142        |
| BW1\textsuperscript{*}EGG | Gram | 1608.14±135.81 | 1544±120        |
| AGE\textsuperscript{1}EGG | Day  | 168±17.16      | 168±21          |
| EW1\textsuperscript{*} | Gram | 59.65±4.20     | 57.71±4.92      |
| EN3           | Egg  | 55±15          | 59±15           |
| EN6           | Egg  | 115±29         | 128±23          |
| EN12          | Egg  | 204±45         | 205±48          |

BW16 : body weight at 16 weeks of age, BW1\textsuperscript{*}EGG : body weight at first egg, AGE\textsuperscript{1}EGG : age at first egg, EW1\textsuperscript{*} : average weight of the first three eggs produced, EN3 : total number of eggs produced from months 1 to 3, EN6 : total number of eggs produced from months 1 to 6, EN12 : total number of eggs produced from months 1 to 12

The total number of eggs produced from months 1 to 12 (EN12) was 204 eggs in Alabio duck and 205 eggs in Mojosari duck, which was equal to 61% for 363 days. The results of this study were higher than those reported by [9], of which the average egg production in Alabio and Mojosari ducks for 40 weeks is 56.78% and 53.41%, respectively.

3.2. Heritability

Table 2 showed heritability estimates for egg production traits in Alabio and Mojosari ducks. The heritability estimates for body weight at 16 weeks of age (BW16) were high, with estimates of 0.67±0.243 in Alabio duck and 0.888±0.269 in Mojosari duck. The magnitudes of heritability can be classified as low (less than 0.2), moderate (0.2–5.0), and high (higher than 0.5) [11]. The present results were similar to the findings of [12], who reported that heritability for body weight at 16 weeks of age in Brown Tsiya duck is 0.61±0.19. Meanwhile [13] reported that heritability estimate for body weight at 110 days of age in Alabio ducks is 0.55±0.33. In the present study, Alabio and Mojosari ducks had high heritability for age at first egg (AGE\textsuperscript{1}EGG), with estimates of 0.59±0.232 and 0.846±0.246, respectively. Lower estimates were reported by some studies including 0.128±0.076 in Shan Ma duck [14] and 0.35±0.20 in Alabio duck [13].

Table 2. Heritability and standard error for egg production traits in Alabio and Mojosari ducks

| Trait          | n | h\textsuperscript{2} | n | h\textsuperscript{2} |
|---------------|---|----------------------|---|----------------------|
| BW16          | 484 | 0.63±0.24            | 452 | 0.88±0.26            |
| AGE\textsuperscript{1}EGG | 530 | 0.59±0.23            | 461 | 0.84±0.24            |
| BW1\textsuperscript{*}EGG | 459 | 0.56±0.23            | 455 | 0.44±0.22            |
| EW1\textsuperscript{*} | 445 | 0.34±0.20            | 448 | 0.94±0.22            |
| EN3           | 455 | 0.43±0.21            | 455 | 0.30±0.196           |
| EN6           | 455 | 0.45±0.21            | 454 | 0.46±0.22            |
| EN12          | 423 | 0.62±0.23            | 423 | 0.46±0.22            |

BW16 : body weight at 16 weeks of age, AGE\textsuperscript{1}EGG : age at first egg, BW1\textsuperscript{*}EGG : body weight at first egg, EW1\textsuperscript{*} : average weight of the first three eggs produced, EN3 : total number of eggs produced from months 1 to 3, EN6 : total number of eggs produced from months 1 to 6, EN12 : total number of eggs produced from months 1 to 12
The total number of eggs produced in EN3 and EN6 had moderate heritability ranging from 0.30 to 0.46. The heritability estimates for EN3 in Alabio and Mojosari ducks were 0.43±0.21 and 0.30±0.196, respectively. The heritability estimate for EN6 in Mojosari duck (0.46 ± 0.22) was quite similar to that in Alabio duck (0.45±0.214). [14] reported similar heritability estimates for EN3 and EN6 are 0.425±0.139 and 0.428±0.152, respectively. The low heritabilities were reported by some studies including 0.235±0.087 in Alabio duck [15] and 0.27±0.035 in Magelang duck [16]. The estimates of heritability for EN12 were high (0.62±0.234) in Alabio duck and moderate (0.460±0.22) in Mojosari duck. High heritability values indicate a high genetic influence of additives on a trait compared to non-additive and environmental factors.

3.3. Genetic correlation
Estimates of genetic correlation between egg production traits are shown in Table 3. Genetic correlation between EN3, EN6, and EN12 were positively high. The genetic correlation between EN3 and EN12 was 0.80 in Alabio duck and 0.95 in Mojosari duck. High genetic correlation was also found between EN6 in both duck populations. Some studies reported a positive correlation of short-term egg production with long-term egg production. [17] reported the genetic correlation between 15 weeks egg production and 52 weeks egg production in Muscovy Duck being 0.84. In Shan Ma duck, genetic correlation between 210 days egg production and 300 days egg production is 0.840±0.087 [14].

BW16 and EN12 had a negative correlation, [18] also reported a negative correlation between weight at 18 weeks of age and egg production traits, (rg = -0.70 to -0.20). The AGE14EGG and EN12 had a negative genetic correlation, these results were in line with reports from [17] who obtained negative genetic correlation between age at first egg and 40- and 52-weeks egg production, with values of -0.98±0.01 and -0.96±0.02, respectively.

Table 3. Genetic correlation between egg production traits in Alabio and Mojosari ducks

| Trait      | n  | Alabio          | Mojosari         |
|------------|----|-----------------|------------------|
| EN3-EN6    | 493| 0.96±0.01       | 455              |
| EN3-EN12   | 493| 0.80±0.05       | 455              |
| EN6-EN12   | 493| 0.90±0.02       | 455              |
| BW16-EN12  | 454| -0.35±0.33      | 412              |
| AGE14EGG-EN12 | 493| -0.30±0.34      | 444              |

| Trait      | n  | Alabio          | Mojosari         |
|------------|----|-----------------|------------------|
| EN3-EN6    | 493| 0.96±0.01       | 455              |
| EN3-EN12   | 493| 0.80±0.05       | 455              |
| EN6-EN12   | 493| 0.90±0.02       | 455              |
| BW16-EN12  | 454| -0.35±0.33      | 412              |
| AGE14EGG-EN12 | 493| -0.30±0.34      | 444              |

EN3 : total number of eggs produced from months 1 to 3, EN6 : total number of eggs produced from months 1 to 6, EN12 : total number of eggs produced from months 1 to 12, BW16 : body weight at 16 weeks of age, AGE14EGG : age at first egg

4. Conclusion
The heritability estimates for egg production traits in Alabio and Mojosari ducks are moderate to high. Furthermore, positive and negative genetic correlations were found between egg production traits. A high-positive genetic correlation between EN3 and EN12 was found in both duck populations. This indicates that EN3 could be used as a selection criteria to increase EN12 in Alabio and Mojosari ducks.

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References
[1] Direktorat Jenderal Peternakan dan Kesehatan Hewan 2018 (Jakarta: Direktorat Jenderal Peternakan dan Kesehatan Hewan Kementerian Pertanian Republik Indonesia)
[2] Kementan 2011 (Jakarta: Kementerian Pertanian Republik Indonesia)
[3] Kementan 2012 (Jakarta: Kementerian Pertanian Republik Indonesia)
[4] Edi K 2009 (Yogyakarta: Graha Ilmu)
[5] Warwick E J, Astuti J M, Hardjosubroto W 1990 (Yogyakarta: Gadjah Mada University)
[6] Boukila B, Desmarais M, Pare J P and Bolamba D 1987 Poul. Sci. 66 1077–84
[7] Hardjosubroto W 1994 (Jakarta: PT. Gramedia Widiasarana)
[8] Becker A W 1992 (Washington: Academic Enterprises. Pullman)
[9] Purba M, Prasetyo L H, Hardjosworo P S and Ekastuti R D 2004 Seminar Nasional Teknologi Peternakan dan Veteriner (Bogor) pp 639–45
[10] Prasetyo L H dan T S 2000 J. Ilmu Ternak dan Vet. 5 210–4
[11] Stevens L 1991 (Cambridge: Cambridge University Press)
[12] Tai C, Rouvier R and Poivey J P 1989 Genet. Sel. Evol. 21 377
[13] Sidadolog J H P, Damayanti I and Maharani D 2017 The 7th International Seminar on Tropical Animal Production (Yogyakarta) pp 266–75
[14] Lin R L, Chen H P, Rouvier R and Marie-Etancelin C 2016 Poult. Sci. 95 2514–9
[15] Prasetyo L H and Susanti T 2008 (Bogor) pp 588–92
[16] Purwantini D, Ismoyowati and Santosa S A 2016 J. Indones. Trop. Anim. Agric. 41 61–9
[17] Hu Y H, Poivey J P, Rouvier R, Liu S C and Tai C 2004 Br. Poult. Sci. 45 180–5
[18] Cheng Y S, Poivey J P, Rouvier R and Tai C 1996 Genet. Sel. Evol. 28 443–55