Heterosis Value Estimation of Magelang and Tegal Crossed Ducks Morphometrics Characteristics

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Abstract. The aim of this research is to estimate the heterosis value of Magelang and Tegal crossed ducks morphometrics characteristics. The cross between the Magelang duck male and the Tegal female is called Maggal (F1). The research material are 319 ducks consisted of Magelang and Tegal ducks with 10 males and 70 females each, also the cross result of 239 Maggal ducks. Research method is experiment. The variable measured was the morphometric characteristics (body weight, body length, chest circumference, abdominal circumference, shank length, pubis length, and neck length) of the duck aged at 6 months. The heterosis value is obtained by comparing the ability of the cross with the parent. This research has shown heterosis in body weight, body length, chest circumference, abdominal circumference, shank length, pubis length, and neck length of 6 month old Gallang and Maggal duck were 0.03; 0.01; 0.06; 0.02; -0.05; 0.01; and 0.03. Based on the results of this study, it can be concluded that the heterosis value of Magelang and Tegal crossed ducks morphometrics characteristics were relatively low. The positive heterosis value in body weight, body length, chest circumference, abdominal circumference, pubis length, and neck length, while shank length negative.

Keywords: crossed bred, heterosis, Magelang ducks, morphometrics, Tegal ducks

1. Introduction

Duck is a potential poultry after chicken to produce egg and meat. Duck population in Central Java is the third biggest after West Java and East Java. In 2018 duck population in Central Java was 4,978,129 and reached 5,210,950 in 2018 [2]. Local duck breeds in Central Java are Tegal duck and Magelang duck with an excellent egg production. Magelang ducks have a relatively bigger body weight than that of Tegal duck. Magelang duck’s body weight is 1,600 ± 0.16 g) [11], while [5] reported 1,550.18 ± 133.87 g. According to [15] the morphometric characteristics of female Tegal duck consists of 5.66-cm beak length, 20.86-cm dorsal length, and 11.14-cm shank length. In contrast, Magelang ducks have a 6.17 cm beak length, 25.95 cm dorsal length, and 14.03 cm shank length. Tegal ducks lay egg for the first time when 132 days old, and the egg production is 72.23% [16], compared to 171 ± 9.3 days old by [14]. The egg production of Magelang duck is 70.24 ± 4.10% [6].

Heterosis refers to a condition where the crossbreed of inbred or purebred exhibits a better or higher value than both parent population [9]. Crossbreeding may occur in different methods such as
reciprocal crossbreeding – a reverse crossbreeding where both parents are male in one crossbreed, and female in the other [4]. A multiple reciprocal selection could improve the ability of specific combination by selecting two population simultaneously [21]. Magelang-Tegal duck reciprocal mating is expected to produce better offspring in egg production, body weight or body measurement compared to the parents. Studies of heterosis value of Indonesian local ducks’ crossbreeds have been reported. However, there were small publications on the heterosis value of morphometric characteristics (body weight, body length, chest girth, abdominal circumference, shank length, pubic length and cervix length) of Magelang-Tegal duck reciprocal crossbreeding (6-month old and the offspring). This study is expected to estimate the heterosis value of morphometric characteristics of male Magelang duck – female Tegal duck crossbreed under the name Maggal (F1).

2. Methodology
A total of 319 Tegal and Magelang ducks consisted of 10 male and 70 female from each breed and 239 Maggal (the crossbreed). The materials were feed for ducks aged 2-5 months old (growing phase) made of 50% rice bran and 50% BR-1, and the 6-month-old ducks (laying phase) were offered feed made of 25% layer concentrate, 50% rice bran and 25% ground corn. Other materials and equipment included rice husk, thermometer, hygrometer, metline, digital scale, and cage properties. This study was conducted under an experimental method. The measured variables were morphometric characteristics (body weight, body length, chest girth, abdominal circumference, shank length, pubic length and cervix length) of 6-month old ducks. Measurement was taken once a month from three to six months using a digital scale for body weight and a metline for other variables. The body length (cm) was measured from the tip of thoracic bone to the first surface of tail bone. Chest girth (cm) encompassed the inner chest part and attached to the wing base. Abdominal circumference (cm) was circular from the end point of sternum. Shank length (cm) was measured from the metatarsus length. Pubic length (cm) was from the cloaca to the tail base (pygostyle bone). Cervix length (cm) was measured from the skull joints and skull atlas to the first thoracic spine. Heterosis value was obtained by comparing the ability between the crossbreeds and the parents. The observation data were analysed with standard deviation by [18]:

\[
\bar{Y} = \frac{\sum_{i=1}^{N} Y_i}{N} \quad \text{Mean value:} \quad Sd_{Y} = \sqrt{\frac{\sum (Y_i - \bar{Y})^2}{N - 1}} \quad \text{Standard deviation:}
\]

\[\bar{Y} = \text{mean value of sample } Y, \quad Y_i = \text{the quantitative characteristics of } i\text{-individual}, \quad N = \text{total sample}, \quad Sd_y = \text{standar deviasi of sample } Y\]

One sample t-test was used to test one value with the others that belong to a sample (as a comparison). A t-test was conducted by calculating the t-statistic value according to [18]:

\[
t = \frac{\bar{Y}_1 - \bar{Y}_2}{Sd \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}
\]

\[\bar{Y}_1 = \text{mean value of sample } Y1, \quad \bar{Y}_2 = \text{mean value of sample } Y2 \text{ as a comparison}, \quad Sd = \text{standar deviasi of the population}, \quad N_1 = \text{total sample 1}, \quad N_2 = \text{total sample 2}\]

Heterosis value was obtained by comparing the ability of the crossbreed with the parents. All studied and measured parameters were subjected to estimation of heterosis percentage calculation according to [1] in [20] using the following formula:
Where $\mu_{F1}$ = the mean of the first generation of the crossbred line, $\mu_{P1}$ = the mean of the first purebred parent and $\mu_{P2}$ = the mean of the second purebred parent.

3. Results and Discussion

Production performance. The mean value and the standard deviation of duck morphometric characteristics of Magelang, Tegal and the crossbreed F1 (Maggal) are presented in Table 1.

Table 1. Mean value and standard deviation of duck morphometric characteristics of Magelang, Tegal and the crossbreed F1 (Maggal)

| Characteristics | Magelang (F0) | Tegal (F0) | Maggal (F1) |
|-----------------|--------------|------------|-------------|
| Body weight (g) | 1,557 ± 154.08$^a$ | 1,395 ± 172.19$^b$ | 1,517.77 ± 151.33 |
| Body length (cm) | 23.2 ± 0.86$^{ns}$ | 24 ± 1.01$^{ns}$ | 23.94 ± 0.81 |
| Chest girth (cm) | 28.1 ± 1.24$^{ns}$ | 27.9 ± 1.23$^{ns}$ | 29.6 ± 1.27 |
| Abdominal Circumference (cm) | 31.1 ± 1.07$^{ns}$ | 29.8 ± 1.17$^{ns}$ | 31.15 ± 0.94 |
| Shank length (cm) | 6.1 ± 0.20$^{ns}$ | 7 ± 0.29$^{ns}$ | 6.20 ± 0.28 |
| Pubic length (cm) | 6.1 ± 0.41$^{ns}$ | 6 ± 0.45$^{ns}$ | 6.14 ± 0.26 |
| Cervix length (cm) | 21.5 ± 0.94$^a$ | 23 ± 1$^b$ | 22.99 ± 0.87 |

Values bearing different superscripts within rows show significant difference based on t-test.

Table 1 shows that morphometric characteristics (body length, chest girth, abdominal circumference, shank length and pubic length) are not statistically different ($P>0.05$), but Magelang duck exhibits a relatively higher score than Tegal duck. Body weight and cervix length was statistically and significantly different ($P<0.05$). Magelang ducks body weight was relatively higher than that of Tegal duck, but the cervix lengthnya was shorter. The 6-month-old Maggal ducks weighed 1,517.77 ± 15.33 g, while Tegal duck (F0) weighed 1,395 ± 172.19 g. Therefore, Maggal duck had a higher body weight than Tegal duck. That crossbreeding different breeds or species could produce better quality offspring than the parents [23]. Furthermore, [15] reported that adult Magelang duck weighed 1,523.56 g. The body length of 6-month-old Maggal duck was 23.94 ± 0.81 cm, while Magelang duck (F0) and Tegal duck (F0) was 23.2 ± 0.86 cm and 24 ± 1.01 cm, respectively. That the body length of adult female Magelang ducks was 21.16 ± 1.28 cm. Therefore, Maggal duck’s average body weight was somewhere between that of Tegal duck and Magelang duck [12]. According to [22] the result of repeated selection in two lines would not be significant; therefore, a certain method to improve the result should be used. Maggal ducks have a relatively bigger chest girth than that of Magelang or Tegal ducks. Chest girth is strongly related to meat production. The main parameter of body measurement is dorsum and chest girth which factor in meat production [19]. That the chest girth has the strongest correlation with body weight in both male and female [3]. Furthermore, [21] reported that crossbreeding is conducted to obtain offspring which can control the heterosis effect and beneficial gene combinations from both breeds to support qualitative and quantitative performance; however, not every crossbred offspring exhibits positive heterosis effects. Abdominal circumference is a parameter for selecting the mother. High-producing female parents usually have a big abdominal circumference. That ducks with a high production generally have a big abdominal circumference and a wide gap between pubic bones [13]. The abdominal circumference of Maggal duck was relatively bigger than that of Magelang or Tegal ducks. That the offspring from a reciprocal crossbreeding carries 50% gene of the first parent or breed and 50% of the second breed [8]. Shank length, pubic length and cervix length of Maggal ducks were between those of Magelang or Tegal ducks. That the
productivity and productivity efficiency of the current crossbreeding of Magelang and Tegal ducks [10] could be improved when receiving a significant heterosis value in the crossbreeding.

Heterosis value. The estimated heterosis value of duck morphometric characteristics of Magelang, Tegal and the crossbreed F1 (Maggal) are presented in Table 2.

| Characteristics                  | Estimated heterosis value (%) |
|----------------------------------|-------------------------------|
| Body weight (g)                  | 0.03                          |
| Body length (cm)                 | 0.01                          |
| Chest girth (cm)                 | 0.06                          |
| Abdominal circumference (cm)     | 0.02                          |
| Shank length (cm)                | -0.05                         |
| Pubic length (cm)                | 0.01                          |
| Cervix length (cm)               | 0.03                          |

Table 2. Estimated heterosis value of duck morphometric characteristics of Magelang, Tegal and the crossbreed F1 (Maggal)

Table 2. shows heterosis that the body weight, body length, chest girth, abdominal circumference, shank length, pubic length and cervix length of Maggal ducks (F1) were 0.03; 0.01; 0.06; 0.02; -0.05; 0.01; and 0.03, respectively. Shank length did not show heterosis in Maggal ducks because shank length was estimated to have been controlled by the additive gene. That the contributing factor to heterosis is the non-additive gene (dominance, overdominance and epistasis) [9]. There was no heterosis in this study to observe the characteristics controlled by the additive gene. Heterosis could occur for different performance characteristics; therefore, heterotic characteristics exhibit heterosis. A heterosis value of the first laying age and egg production by 10% from Gaoyou – Jinding crossbreed in China, and the body weight of eight-week-old ducks and the average egg weight were 6.38% and -1.67%, respectively [7]. That hybrid power is mostly due to the dominant gene effect) [17].

4. Conclusions
The heterosis value of Magelang and Tegal crossed ducks morphometrics characteristics were relatively low. The positive heterosis value in body weight, body length, chest circumference, abdominal circumference, pubis length, and neck length, while shank length negative.

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