Body weight and body size measurement of five Indonesian local chicken

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Abstract. Phenotypic characteristics are essential in creature hereditary asset protection and improvement. Phenotypic characteristics of 152 female and 52 male Indonesian Chicken gathered from five populations (Kedu, Gaga, Merawang, Nunukan, and Pelung) were collected. The quantitative traits data, including body weight (BW) and body size measurement, consists of 11 variables, such as beak length (BL1), wattle length (WL1), breast width (BWI), breast circumference (BC), wing length (WL2), breast length (BL2), femur length (FL), tibia length (TL), shank length (SL), shank diameter (SD), and third finger length (TFL) were measured and analyzed using analysis of variance to test the effect of different breed populations. As a result, the male and female Pelung chicken has a higher value in all characteristics, except for WL1 in female Pelung, compared to other breeds. For the BL1 and TL traits, both male and female Kedu chicken has the lowest value. All observed quantitative variables were higher in male compare to female chickens. In conclusion, Indonesian local chicken phenotypic differences provide the potential for future genetic improvement within the breed populations and could be used for designing breeding programs and selection.

1. Introduction
Local chickens, or known as a native chicken, are raised in rural families. It plays a crucial role as a source of protein and in the economic needs of rural families. Indonesian local chickens are very diverse and vary widely from color to feathers, beak, skin, body shape, growth, and appearance of production and reproduction. Characteristics of phenotypical chickens are affected by environmental and genetic factors [1]. Phenotypic traits are physical appearance that can be measured quantitatively and qualitatively [2].

Indonesia has 31 breeds of local chicken; there were many phenotypic characteristics. The chicken variance of being caused by the current genetic differentiation of the population [3]. The breed of local chicken is Black Kedu, Gaga, Merawang, Nunukan, Sentul, and Pelung [4–7]. The morphometric profile (height, body length, beak, wing length, and body weight) is essential to identify the phenotypic characteristics of local chickens and useful in designing genetic improvement. Furthermore, a genetic diversity study could be used to analyze the population for conservation purposes [8]. Phenotypic characterization was also an essential information to design livestock development, and breeding programs to manage Animal Genetic Resources (AnGR) [9].

Numerous endeavors have started to characterize animals in creating breeds to supply an establishment of economic hereditary with improvement approaches. Currently, the food and agricultural organization’s (FAO) program of the joined-up countries offers a crucial mechanism for the worldwide management of farm animal genetic resources or FAnGR [10]. The characteristic of body
size, plumage color, body conformation, and many other phenotypic characteristics are essential in livelihood and household food security in rural families [11]. The current pattern of local chicken improvement depends on the varieties (inside and between breeds) of specific traits. Such a combination is an incredible chance for conservation programs. In general, there currently exists considerable phenotypic diversity, including body weight. In addition to body morphometry, which presently exists useful for breeding or population identification in addition to classification. A limited study on the characterization of local chicken breeds in Indonesia has been discovered. Commonly, the phenotypic diversity of the local Indonesian chicken has not existed studied in detail. Therefore, the objective of this study was to characterize local chicken populations in Indonesia based on their phenotypic properties.

2. Materials and method

2.1. Location of the study and experimental animals
A total of 52 sample male chickens consist of Pelung (10), Nunukan (10), Kedu (12), Merawang (10), and Gaga (18) were collected. For the female chickens, 152 samples were collected, which consist of Kedu Hitam (32), Nunukan (30), Merawang (30), Pelung (30), and Gaga (30). All birds were selected randomly within five populations of Indonesia local chicken. Each breeds collected from a different location, such as Temanggung District, Central Java (for Kedu Chicken), Bantul and Kendal District (for Gaga Chicken), Belitung Island (for Merawang Chicken), Nunukan Island (for Nunukan Chicken), Cianjur District (for Pelung Chicken). All chicken populations (except Gaga chicken) kept under controlled breeding management. The local chicken breed in this study was registered by The Ministry of Agriculture, the Republic of Indonesia.

2.2. Traits measured
The quantitative data collected using a digital hanging scale (5 kg capacity and 20 gr sensitivity) for body weight and a 15 cm vernier caliper (0.01 mm sensitivity) for body size. Body size measurement consists of 11 variables, such as beak length (BL1), wattle length (WL1), breast width (BWI), breast circumference (BC), wing length (WL2), breast length (BL2), femur length (FL), tibia length (TL), shank length (SL), shank diameter (SD), and third finger length (TFL). All data were tabulated in excel before further analysis.

2.3. Statistical analysis
Analysis of variance (ANOVA) was used to analyze the effect of the breed on quantitative traits. In addition, to significantly differ means (P<0.05) among breed further tested by the Duncan's multiple range test. The ANOVA performed using SPSS (2009) version 23 (SPSS Inc., Chicago, IL, USA). The statistical model used in this study as follows:

\[ Y_{ij} = \mu + G_i + e_{ij} \]  

\( Y_{ij} \) is the individual body measurement, 
\( \mu \) is the overall mean 
\( G_i \) is the fixed effect of the breed 
\( e_{ij} \) is the random error.

3. Results and discussion

3.1. Profile of quantitative traits in female chicken
The profile of female quantitative traits among five Indonesia local chicken breeds was presented in table 1. The female Pelung chicken has a higher value in all characteristics, except for WL, compared to other breeds. The female Nunukan and Gaga chickens visually share the same body size. However, the Nunukan chicken was lowest in BW, WL1, BWI, BC, and SD; meanwhile, the female Gaga chicken...
was most inferior in WL2, BL2, FL, SL, and TFL. For the BL1 and TL traits, the Kedu chicken has the lowest value.

Based on the body weight traits, the female Pelung was significantly higher than other breeds (P<0.05). Since the female Pelung chicken has the highest body weight, it could be considered that female Pelung chicken was categorized as a meat-type chicken. This finding supported by FAO [9] stated that in correlation to meat yield, the bodyweight could be used as an indicator for production. The female Nunukan and Gaga chicken share a similar lower body weight compared to others. These study was different from the result reported by [12,13], which has 1590±157.20 g and 1710.1±371.6 g body weight for female Nunukan and Gaga chicken, respectively.

Table 1. Quantitative traits value among Indonesian local female chicken populations.

| Traits  | Kedu (n=32) | Gaga (n=30) | Merawang (n=30) | Nunukan (n=30) | Pelung (n=30) |
|---------|-------------|-------------|-----------------|----------------|--------------|
| BW(g)   | 1,606.12±317.40c | 1,311.17±204.28d | 2,142.83±289.01b | 1,256.70±262.35a | 3,076±829.88a |
| BL1 (cm) | 1.80±0.21c | 1.99±0.21b | 2.08±0.12b | 1.99±0.14a | 2.37±0.23a |
| WL1 (cm) | 1.67±0.40a | 1.74±0.53a | 1.94±0.56a | 1.19±0.38b | 1.80±0.60a |
| BWL (cm) | 6.57±0.41c | 6.30±0.38ad | 7.28±0.56b | 6.10±0.62ad | 8.53±0.79a |
| BC (cm) | 25.52±1.91c | 25.65±1.48e | 28.42±1.91b | 24.92±2.50c | 35.57±3.35c |
| WL2 (cm) | 17.22±1.59c | 17.22±0.62c | 19.49±0.85b | 17.46±0.68d | 24.42±1.29a |
| BL2 (cm) | 9.46±0.48c | 9.15±0.58b | 10.69±0.72b | 9.31±0.58b | 12.02±0.65b |
| FL (cm) | 9.25±0.69bc | 8.34±0.68a | 9.46±0.61b | 8.92±0.67b | 10.64±0.84a |
| TL (cm) | 10.52±0.55d | 12.16±0.60bc | 12.37±0.72b | 11.82±0.90c | 15.21±0.84a |
| SL (cm) | 7.88±0.64b | 7.06±0.39d | 7.54±0.38c | 7.33±0.50b | 9.11±0.65a |
| SD (cm) | 1.01±0.09c | 0.97±0.06b | 1.08±0.07b | 0.92±0.07d | 1.26±0.11b |
| TFL (cm) | 4.54±0.42c | 4.13±0.32d | 4.74±0.34b | 4.60±0.30bc | 5.71±0.36c |

Note: Means that share different superscript in the same row are significantly different (P<0.05).

The BL1 of Gaga, Merawang, and Nunukan chicken did not significantly differ (P>0.05). The BL1 of Gaga chicken was lower than reported by [6] and [13]; meanwhile, the Nunukan chicken was lower than [12]. The BL1 of the Gaga chicken is lower than the results reported by [6], ranging from 2.57–3.07 cm. Almost all of the WL1 showed no significant difference except for the Nunukan, which had the shortest WL1 and was significantly different from other chickens. The BWL of Merawang and Pelung chickens were substantially higher (7.28 cm and 8.53 cm) than Kedu, Gaga, and Nunukan chickens, which averaged around 6.10–6.58 cm. The same thing was obtained in the variables of BC, WL2, and BL of Merawang and Pelung chickens, which had a higher data record than the other three breeds (P<0.05). This result differs from the results reported by [6,14,15]. For FL, almost all chicken had a significant difference (P<0.05), except for Kedu and Merawang chicken, which had nearly similar FL, namely 9.25 cm and 9.46 cm. Pelung chicken has the highest TL (15.21 cm) compared to other chicken (P<0.05). As for the size of the TL, the Gaga chicken has no significant difference with the two chicken from Kalimantan and Bangka Belitung, namely Nunukan and Merawang.

The SL of Kedu, Gaga, and Pelung were significantly different (P<0.05). Among the phenotypic local chicken in Indonesia, the most elongate SL was Pelung chicken (15.21 cm), while Merawang and Nunukan chicken almost had the same SL (7.54±0.38 cm and 7.33±0.50 cm, respectively). The length of shank affect to BW therefore SL could be a factor that can be predicted the weight of the chicken. [16,17] reported a strong relationship between SL or BC with BW affected the higher muscle deposition in the breast. Kedu and Gaga chicken had no different SD (P>0.05) compared to others, which varied in diameter and showed significant differences (P<0.05). According to [18], shank bone is related to the ability of the chicken to support the body. The more comprehensive SD has an excellent ability to support BW [19].

For the TFL, the Nunukan and Merawang chicken has no different lengths and are almost similar to the Kedu chicken, even though they are having the smallest TFL compared to others. For Pelung and Gaga, the TFL was significantly different from the other three chicken (P<0.05). TFL can be used to differentiate between each breed of Indonesian local chicken. These results are in agreement with [20];
many variables of body size that have a strong influence in differentiating between types of chicken were FL, TL, SL, SC, WL2, BL1, and TFL.

3.2. Profile of quantitative traits in male chicken

The profile of male quantitative traits among five Indonesia local chicken breeds was presented in Table 2. Pelung chicken had the highest BW and body size which differed significantly (P<0.05) not be compared. The lowest mean value of the BW was recorded in Nunukan chicken (1650.50±423.05 g). In Kedu chicken (1.84±0.24 cm), the lowest value for BL1 was observed. The lower Nunukan and Kedu chicken (3.06±0.80 cm/3.86±0.71 cm) were observed for WL1. Mean values of WL1 (4.42±0.16 cm) were observed for WL1. Mean values of BWI range between 6.56±0.86 cm (Nunukan chicken) and 9.78±0.70 cm (Pelung chicken). The lowest value for BWI (25.75±2.55 cm) was recorded in Nunukan chicken which did not significantly different (P>0.05) with Kedu chicken (25.89±1.16 cm). In WL2, Nunukan chicken had the lowest value (19.84±1.00 cm) which no significant difference (P>0.05) with Kedu and Nunukan chicken (19.84±2.64 cm and 20.49±1.15 cm). The lowest mean values of BL2 was observed in Nunukan chicken (10.50±0.82 cm). The FL was recorded with the interval between 9.34±0.66 cm (Gaga chicken) and 12.30±1.15 cm (Pelung chicken).

| Table 2. Quantitative traits value among Indonesian local male chicken populations. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Parameters                      | Kedu (n=10)     | Gaga (n=18)     | Merawang (n=10) | Nunukan (n=10)  | Pelung (n=10)   |
| BW (g)                          | 1.955±161.88    | 2.06±264.75     | 2.763±220.05    | 1.650±423.05    | 3.554±524.86    |
| BL (cm)                         | 1.84±0.24       | 2.07±0.22       | 2.37±0.21       | 2.18±0.20       | 2.52±0.20       |
| W (cm)                          | 3.86±0.71       | 4.74±0.86       | 4.83±0.98       | 3.06±0.80       | 5.38±1.37       |
| BWI (cm)                        | 7.66±0.42       | 7.16±0.47       | 8.41±0.23       | 6.56±0.86       | 9.78±0.70       |
| BC (cm)                         | 25.89±216       | 28.87±215       | 31.87±182       | 27.55±255       | 35.23±163       |
| WL (cm)                         | 19.84±2.64      | 20.49±1.15      | 22.61±1.21      | 19.82±1.00      | 27.91±1.25      |
| BL2 (cm)                        | 11.22±0.45      | 11.02±0.64      | 12.55±0.57      | 10.50±0.82      | 13.60±0.48      |
| FL (cm)                         | 10.05±0.58      | 9.34±0.66       | 10.86±0.52      | 10.18±0.79      | 12.30±1.15      |
| TL (cm)                         | 12.48±0.86      | 14.65±1.15      | 14.87±0.70      | 13.52±0.60      | 18.03±1.37      |
| SL (cm)                         | 9.59±0.60       | 8.89±0.48       | 9.44±0.62       | 9.43±0.15       | 11.19±0.58      |
| SD (cm)                         | 1.31±0.25       | 1.25±0.11       | 1.36±0.12       | 1.18±0.15       | 1.53±0.14       |
| TFL (cm)                        | 5.14±0.23       | 4.87±0.38       | 5.43±0.28       | 5.26±0.34       | 6.67±0.48       |

Note: Superscript mean in the same rows with different superscripts are significantly different (P<0.05).

In the TL the mean value (Kedu and Nunukan chicken) was defined as the lowest in 13.52±0.60 cm and 12.48±0.86 cm, respectively. The lowest mean value for SL was observed in Gaga chicken (8.89±0.48 cm) with Nunukan and Merawang chicken (9.43±0.05 cm / 9.44±0.62 cm) not having major differences (P>0.05). The shank diameter varied from 1.18±0.15 (Nunukan chicken) to 1.53±0.14 cm (Pelung chicken). For TFL, in Gaga chicken, the lowest mean (4.87±0.38 cm) was recorded. The mean value of BW in Pelung chicken was higher than those reported by [21–23], observed a mean value for BW in Merawang chicken (2261.3 kg) was lower than that obtained in this study. The overall mean values for BW (2352.79±727.78 kg), WL1 (4.42±0.16 cm), and TL (14.87±1.84 cm) in this study were higher than those reported by [24] in Northwest of Algeria male chicken, whereas BL1 (2.18±0.31 cm) and BL (11.67±1.24 cm) were shorter than Northwest of Algeria male chicken. For SL, the overall mean values of 9.60±1.01 cm obtained in this study was shorter than three genotypes of native chicken in Bangladesh (10.35, 11.09 and 11.09 cm), higher than Kaffa Zone chicken (8.44±0.04 cm) and Sri Lanka village chicken reported by [25–27] respectively.

4. Conclusion

The phenotypes of Indonesian local chicken are varied and these variations provide opportunities for future genetic improvement within the breeding populations and could be used for breeding programs and selection design. Furthermore, these phenotypic diversity could not ascertain the genetic structure of the populations, and the need for genetic characterization based on molecular techniques is ultimately needed.
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