Disparities in the body, chest, and wing morphometric among three subspecies of local male chickens for genetic breeding

H D Putranto1,2, Nurmeiliasari3, Y Yumiati4 and A M Nur5

1 Department of Animal Science, Faculty of Agriculture, Universitas Bengkulu, Indonesia, 38371A, E-mail: heri_dp@unib.ac.id
2 Graduate School of Natural Resources Management, Faculty of Agriculture, Universitas Bengkulu, Indonesia 38371A
3 Department of Animal Science, Faculty of Agriculture, Universitas Bengkulu, Indonesia, 38371A, E-mail: sari_nurmeiliasari@unib.ac.id
4 Department of Agribusiness, Faculty of Agriculture, Universitas Dehasen Bengkulu, Indonesia, 38227, E-mail: yossie.yumiati.fp@gmail.com
5 Graduate School of Natural Resources Management, Faculty of Agriculture, Universitas Bengkulu, Indonesia 38371A, E-mail: simpleaang@gmail.com

Abstract. Local chickens in developing countries, including Indonesia, have great potential to be developed into natural superior breeds to support food security and improve farmer welfare. Meanwhile, the major endemic subspecies found in the Bengkulu province are burgo and kampung chicken, as well as ketarras which are recently bred intensively. Therefore, this study aims to analyze the disparities in the morphometrics of three subspecies of local male chickens specifically on the body weight, length, chest girth and length, as well as wing span. Based on the results, the male burgo chicken morphometrical size was significantly smaller than ketarras, while the ketarras chicken was significantly smaller than kampung (P < 0.05). Furthermore, the average body weights for the burgo, ketarras and kampung chicken were 1.0, 1.2 and 1.9 kg cock-1, respectively, while the average of body length, chest and chest length, as well as wing span were 29.9, 40.0, 47.7 cm cock-1; 26.2, 30.1, 36.3 cm cock-1; 12.6, 17.8, 20.3 cm cock-1, and 34.4, 41.9, 55.9 cm cock-1, respectively. Therefore, it was concluded that the burgo and kampung chicken have the smallest and biggest morphometric sizes respectively.

1. Introduction

Local chickens have great potential to be developed into natural superior breeds to support food security and improve farmer welfare [1]. Meanwhile, the majority of rural and semi-urban families in developing and underdeveloped countries keep a small flock of local chickens in the backyard. In Indonesia and other countries, local chicken plays an important role and contributes significantly to the food security of households in rural and semi-urban communities.

According to [2], there are 32 sub-species of local chickens with different morphological characteristics. Kampung is widely known as the most abundant local chicken in Indonesia, meanwhile, this study introduced burgo as a potential local chicken in the Bengkulu province. This sub-species is produced from a cross between the male red jungle fowl and female kampung chicken [1, 3, 4], and elevate the sociocultural status of its owner as a precious pet. Furthermore, a new sub-species called ketarras chicken is also raised by farmers in Bengkulu Province. It is produced from a cross between...
male Arab and female arras chickens, with a genetic composition of 75% genes for Arab chicken and 25% genes for laying hen [5]. According to [6, 7], arras chickens are produced by crossing male Arab chicken with a female laying hen.

A previous study [8] reported that local chickens in developing and underdeveloped countries in Asia and Africa are one of the poultry species which have great potential for a dual-function status namely as egg and meat producer in Bangladesh [9, 10], China [11, 12], India [13], Indonesia [14, 15, 16], Oman [18], Thailand [19, 20], Eritrea [21], and Ethiopia [22, 23, 24].

Based on a previous study [1], the morphometric size of female burgo chicken was smaller compared to kampung. However, there is no scientific evidence regarding differences in the morphometric sizes among the male burgo, ketarras, and kampung chicken. Therefore, this study is expected to enrich morphological existing data and support a conservation program of burgo and ketarras chicken, as local poultry in Indonesia. In addition, the results are expected to be used as a reference for a breeding development program in the future. Therefore, this study aims to analyze the disparities in the morphometric sizes of three local male chicken subspecies namely burgo, ketarras and kampung specifically on body weight, length, chest girth, and length as well as wing span.

2. Methodology

This study was conducted in five stages: feed, cage, and animal preparation, research, as well as data analysis [1], for almost 6 months between 2019-2020 in the Commercial Zone and Animal Laboratory, Department of Animal Science, Faculty of Agriculture Universitas Bengkulu. The field research activities began by collecting an adequate number of male kampung, burgo, and ketarras chicken (between 20 to 48 weeks-old). A total of 60 healthy samples consisting of 10 members each were collected.

Table 1. Feed formulation.

| Feed  | Volume (%) | Nutrition Contents                     |
|-------|------------|----------------------------------------|
|       |            | Crude Protein (%) | Metabolic Energy (kcal/kg) |
| Corn  | 70         | 8.8                     | 3,740                    |
| Concentrate | 30 | 33                     | 2,800                    |
| Total | 100        | 41.8                    | 6,540                    |

The samples were obtained using a purposive sampling technique from the Department of Animal Science intensive system, Faculty of Agriculture, Universitas Bengkulu. The uniformity of the sample was relatively higher than the chicken reared by the farmers. Meanwhile, the intensive rearing system involves feeding with a combination of voer (pellets) in the form of 30% crumble and 70% corn twice a day and water ad libitum. The feed formulation and nutrition contents are shown in Table 1. A digital hanging scale (3 kilograms capacity and 20 grams sensitivity) was used to measure body weight, while a 150 cm ruler tape (0.01 mm sensitivity) was used to measure body and chest length and girth, as well as wing span, with a 16-megapixel camera and stationaries.

The data were collected based on direct measurements of 10 burgo, 10 ketarras and 10 adults male kampung chicken. The process was repeated 2 times, and the average values were used as final data [1]. It was assumed that there was no bone growth when the chicken reached 5 months (20 weeks). A previous morphometric study showed that the measurement activity in adult chicken provides more accurate results. Furthermore, morphometric observation was performed on each sample, meanwhile, the parameters protocol was modified from a previous study [1] and include:

a. Body weight
   It was measured by using a scale in unit of grams. This activity was carried out in morning before the feeding time.

b. Body length
   It was obtained by measuring the length of mandibular bone to the tip of the pygostyle bone using a measuring tape in cm.
c. Chest length
It was obtained by measuring the length of sternum bone using a measuring tape in cm.

d. Chest girth
It was obtained by measuring the chest girth on the back of both wings using a measuring tape in cm.

e. Wing span
It was obtained by measuring the distance between the tip of the left and right wing (the tip of the phalanges bone) in cm.

Morphometric data were analyzed using analysis of variance, while significant effects were further analyzed using Duncan’s Multiple Range Test.

3. Results and discussion
The results from this study are expected to enrich previous biological information of the Indonesian poultry especially on the endemic chicken subspecies and its morphometric characteristics [1]. The results as presented in Table 2 show that the male burgo chicken morphometrical size was significantly smaller than ketarras, while ketarras was significantly smaller than the kampung chicken (P < 0.05). Table 2 showed that the average body weight of male burgo chicken (1.0 kg cock$^{-1}$) was significantly lower than ketarras and kampung, while the average body weight of the male ketarras chicken (1.2 kg cock$^{-1}$) was significantly lower than kampung, which had the highest average body weight (1.9 kg cock$^{-1}$). Furthermore, the average body length of the male burgo chicken (29.9 cm cock$^{-1}$) was significantly shorter than ketarras and kampung, while the average body length of the male ketarras chicken (40 cm cock$^{-1}$) was significantly shorter than kampung which had the longest average body length (47.7 cm chicken$^{-1}$).

The results also showed that the average chest girth of the male burgo chicken (26.2 cm cock$^{-1}$) was significantly bigger than ketarras and kampung, while the average chest girth of the male ketarras chicken (30.1 cm cock$^{-1}$) was significantly bigger than kampung which had the biggest average chest girth (36.3 cm cock$^{-1}$). Furthermore, the average chest length of the male burgo chicken (12.6 cm cock$^{-1}$) was significantly shorter than ketarras and kampung, while the average chest length of the male ketarras chicken (17.8 cm cock$^{-1}$) was significantly shorter than kampung which had the longest average chest length (20.3 cm cock$^{-1}$). Also, the average wing span of the male burgo chicken (34.4 cm cock$^{-1}$) was significantly shorter than ketarras and kampung, while the average wing span of the male ketarras chicken (41.9 cm cock$^{-1}$) was significantly shorter than kampung which had the longest average wing span (55.9 cm cock$^{-1}$).

Table 2. Average body weight, body length, chest girth, chest length and wing span among male kampung, burgo and ketarras chickens.

| Body Parts     | Male Chicken Subspecies |                 | P
|----------------|-------------------------|-----------------|----|
|                | Burgo | Ketarras | Kampong |    |
| Body weight$^1$| 1.0a±0.1 | 1.2b±0.2 | 1.9c±0.2 | *  |
| Body length$^2$| 29.9a±0.4 | 40.0b±2.5 | 47.7c±2.3 | *  |
| Chest girth$^3$| 26.2a±0.5 | 30.1b±0.9 | 36.3c±0.5 | *  |
| Chest length$^4$| 12.6a±0.6 | 17.8b±0.4 | 20.3c±0.5 | *  |
| Wing span$^5$  | 34.4a±1.6 | 41.9b±2.3 | 55.9c±2.3 | *  |

$^a$Significant at P < 0.05
$^b$body weight in kg cock$^{-1}$ unit
$^c$body length in cm cock$^{-1}$ unit
$^d$chest girth in cm cock$^{-1}$ unit
$^e$chest length in cm cock$^{-1}$ unit
$^f$wing span in cm cock$^{-1}$ unit
In general, Table 2 shows that the burgo chicken body weight and length, chest girth and length, as well as wing span morphometric size were smaller and shorter compared to ketarras and kampung. Therefore, among the 3 subspecies, burgo is the smallest male local chicken in the Bengkulu province. Furthermore, the results showed that kampung body, chest, and wing morphometric size were bigger and longer than ketarras and burgo chicken, therefore, the kampung chicken in this study is the biggest male. These results are similar to a previous report [1] on the comparison of female chicken morphometric sizes which showed that the female burgo chicken is significantly smaller than kampung.

Burgo as one of Indonesia's local chickens especially in the Bengkulu Province, has 3 functions namely ecological, economic and aesthetic [3, 4, 25]. The ecological function is the use as a prey in the nature food chain, while the economic function is the use as a hunted animal and a potential genetic source for domestic animals. Furthermore, the esthetic function is the use as an ornamental pet. This subspecies is one of the genetic sources of Indonesian local chickens (Figure 1) and is produced from a cross between a male red jungle fowl and a female kampung chicken.

![Figure 1. Profile of male burgo chicken](image)

The ketarras chicken is produced from a cross between male arab chicken and brown laying hen. The F1 result from this cross-breed is named arras chickens which are assumed to have a genetic combination of 50% purebred and 50% arab chicken. The qualitative characteristic of arras chickens includes the presence of various feather color patterns, while the quantitative characteristic includes the ability to produce an adequate number of eggs similar number to its parent with a more dominant eggshell color, similar to that of the purebred. Therefore, the selling price of arras chicken eggs is lower compared to kampung.

Furthermore, to produce eggs which have similar characteristics to kampung, the female arras is cross-breed with a male arab chicken. This cross mated chicken named ketarras (Figure 2) has a genetic combination of 25% purebred laying hen with 75% arab chickens [5, 6, 7], and produces brownish-white eggs similar to the color of kampung chicken eggs but with high productivity.

![Figure 2. Profile of male ketarras chicken](image)
Based on the results, the morphometric sizes of the burgo chicken are bigger and longer compared to previous reports [1, 26]. The body size is approximately 0.25 kg heavier and 2 cm longer than [26], while the chest size is approximately 2 cm bigger and 1.5 cm longer compared to [1]. However, there is no report on the wing span morphometrics, nevertheless, it was assumed that the morphometric disparities in the burgo chicken are caused by sex, age, and genetic variations. In general, the male body size is bigger than the females.

The morphometric sizes of the male ketarras chicken in this study ranged between the value for burgo and kampung. Furthermore, the body, chest and wing sizes are bigger and longer than burgo, but smaller and shorter compared to kampung. The body sizes are approximately 0.2 kg heavier and 10 cm longer than burgo, and 0.7 lighter and 7 cm shorter than kampung, while the chest and wing sizes are approximately 4 cm bigger, 5 cm and 7 cm longer than burgo respectively. In addition, the chest and wing sizes are approximately 6 cm smaller, 2 cm and 15 cm shorter than kampung respectively.

The kampung chicken body weight (1.9 kg) is approximately 0.7 kg heavier compared to [1, 27] and 0.5 kg heavier than [28] while, the average body length in this study was 47 cm and is approximately 17 cm longer than a previous study [1]. Furthermore, the body length is 15 cm longer compared to [29]. The kampung chicken chest length is approximately 6 cm longer than [1], and 7 cm longer than [28] which reported that the average chest length of kampung chicken was 12.65 cm. This variation in results is caused by differences in sex, genetic, environmental factors and the age of chickens at the time of measurement.

Chest girth is a body circumference measured posteriorly from the base of the wing [30]. A previous study [31] stated that chest girth correlates with female and male body weight. Furthermore, [1] stated that adult female burgo chickens have great potential to be used as a dual-purpose poultry species namely as a meat and egg producer.

A previous study [1] stated that the average bone growth increases at the age of 4 to 12 weeks, decreases from 12 to 20 weeks and stops after 5 months of age. Furthermore, [32] reported that a change in body weight indicates the development of a young chicken's body, while changes in body measurement indicate growth and development of body parts. This implies that only a few changes occur in the bones when the chicken is fully matured. The bone measurements provide more accurate results for body size hence, it is used to observe the morphometric characters.

The differences in the body, chest and wing morphometric sizes observed in this study is presumably caused by genetic and environmental factors. This result is supported by [33, 34] which stated that variations in an individual is caused by genetic and environmental factors. Another study reported that differences in animal body size is caused by genetic and environmental factors [35]. Specifically, the disparities in the morphometric sizes of burgo, ketarras and kampung chicken are probably caused by high variation of phenotypic properties and the presence of genetic interactions with the environment [32].

4. Conclusion

Based on the results, the morphometrics of male burgo, ketarras, and kampung chickens in Bengkulu Province are different. The burgo chickens have the smallest morphometric sizes while kampung have the biggest among the 3 subspecies.

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Acknowledgments
This research is part of Hibah Kompetitif Penelitian Nasional Skim Hibah Kompetensi which is fully funded by DRPM the Ministry of Research, Technology and Higher Education Republic of Indonesia. The research team would like to thank the DRPM the Ministry of Research, Technology and Higher Education Republic of Indonesia, LPPM Universitas Bengkulu, Department of Animal Science Faculty of Agriculture Universitas Bengkulu, and members of the research group.