Morphometric analysis of IPB-D1 chicken in free-range and intensive rearing systems in the tropics region

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Abstract. IPB-D1 chicken is a local chicken breed developed for meat production and fast growth. This chicken is formed from crossbreeding broiler breeds (Cobb) with 3 other local chicken breeds, Kampung, Pelung, and Sentul Chicken. It has advantages in disease resistance and body weight. In this study, IPB-D1 chickens were studied for morphometric characteristics in two (2) different rearing systems, namely free-range and intensive systems. The material used was 120 IPB-D1 roosters aged 20 weeks, consisting of 90 heads reared in the free-range system and 30 heads intensively. The method used was observation. The parameters measured were morphometric variables of chickens in free-range and intensive systems. The rearing system treatment showed no difference in femur length, tibia length, tarsometatarsus circumference, third finger length, and wing length, but showed significant differences in tarsometatarsus length, maxilla length, and cockscomb height between intensive and free-range rearing systems in the tropics. Free-range rearing can increase tarsometatarsus length and maxilla length.

1 Introduction

Chicken is one of the most popular livestock among Indonesians, known as a meat producer and widely utilized as a source of protein. Chicken meat, especially local chicken, is highly demanded by the Indonesian people because it can be obtained easily in the market and is widely cultivated by the Indonesian people. One of the current superior local chicken breeds, IPB-D1 chicken, was developed as a meat producer [1]. This type of chicken is formed to

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inherit genetic advantages from local chickens native to Indonesia, namely disease resistance, and from purebred chickens (Cobb) as meat producers. The superior performance of IPB-D1 chickens is expected to be able to adapt and produce high yields in tropical Indonesia.

The rearing system plays an important role in supporting chicken production. The maintenance system that is widely practiced is the intensive and semi-intensive system. The intensive system is characterized by controlled maintenance, feeding, and drinking, and the environment is arranged according to the comfort of the livestock. However, there are weaknesses in this intensive system, namely that livestock are less able to express their normal behavior, so they do not meet the principles of animal welfare [2]. Currently, the issue of animal welfare in poultry rearing systems is a major issue that must be accommodated. There are many reports that there is a positive correlation between semi-intensively reared animals and performance, as well as the meat quality of semi-intensively reared chickens with backyard access [3, 4].

Semi-intensive rearing is currently developing, known as free-range systems [5]. A free-range rearing system is one that is designed for chickens to thrive and express their natural instincts [6]. Free-range is one way of raising livestock that accommodates the principles of animal welfare formulated by The Royal Society for the Prevention of Cruelly to Animals (RSCPA). Livestock raised with welfare will be able to move more freely and express their natural behavior so as to reduce stress in livestock [7]. IPB-D1 chickens in this study were kept in an intensive system and a free-range system.

On the other hand, one form of effort to increase livestock productivity is through selection. However, characterization is necessary as a basis for selecting local chickens. Characterization is the first step for breeding livestock in order to identify important traits of economic value such as body weight and body weight gain as well as livestock characteristics. Characterization of local chickens including IPB-D1 chickens can be done by identifying morphometrics. Morphometrics are quantitative traits that can be used as selection criteria to increase the productivity of local chickens. Quantitative traits of local chickens based on morphometrics include body length, neck length, wing length, wingspan, breast circumference, breast width, head length, head width, beak length, cockscomb length, cockscomb height, tibia length, metatarsus length, metatarsus circumference, longest finger length, femur length, maxilla length, sternum length, and body weight [8-10].

These morphometric variables can characterize the size and body shape of local chickens that are useful for predicting production potential, opportunities to increase livestock productivity, and as a reference for standardizing local chicken traits such as IPB-D1 chickens. Morphometrics is a good indicator and has a close correlation with live weight [11]. Morphometrics can be used as an indicator at the chicken selection stage [12]. Through this research, the morphometrics of IPB-D1 chickens in free-range rearing will be studied and compared with the intensive system.

2 Materials and Methods

This research was conducted at the Animal Husbandry Education and Research Unit (UP3J) of IPB University, Jonggol District, Bogor Regency. The research was conducted from October 2022 to July 2023.

2.1 Materials

The materials used in this study were 120 IPB-D1 chickens aged 20 weeks as parent stock. The observed chickens consisted of 30 chickens reared in the intensive system, and 90 chickens reared in cages with free-range access. The main tools and materials used in this study consisted of 2 m × 6 m colony cages for males reared in portable cages with free-range

access, and 4 m × 3 m colony cages for males reared in permanent (intensive) cages. The portable cages were equipped with a free-range area measuring 12 m × 12 m as many as 3 units of rotational grazing, and overgrown with various grass forages bordered by a net fence to avoid livestock from predators. Feed management was used in intensive system and free-range is same. Other supporting tools as observation instruments are digital vectors, rulers, and stationery.

2.2 Methods

In this study, measurements were made on linear body surface size variables, based on the method of Nishida et al. (1982) [13]. The variables used consisted of femur (FEM), tibia (TIB), tarsometatarsus (TAR), tarsometatarsus circumference (TC), third finger (F3), wing length (WL), maxilla (MAX), and cockscomb height (CH). An illustration of the measured variables is presented in Figure 1.
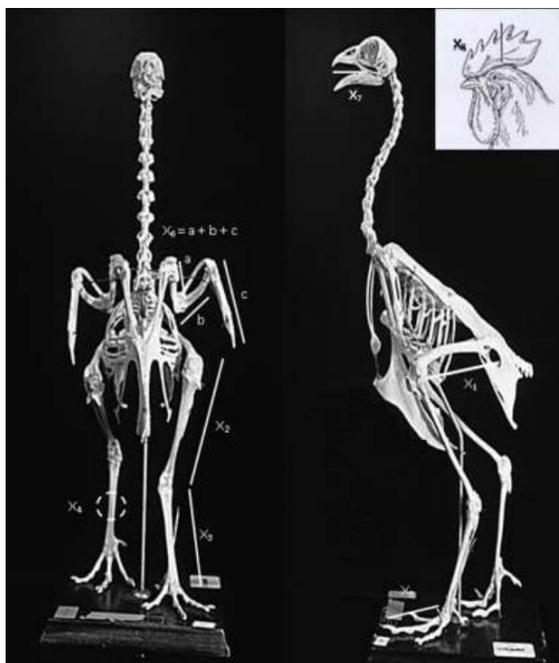

Fig. 1. Variable body surface sizes of chickens observed [14].
Description: X1= femur length; X2= tibia length; X3= tarsometatarsus length; X4= tarsometatarsus circumference; X5= third finger length; X6= wing length, X7= maxilla length; X8= cockscomb height.

2.3 Data Analysis

Descriptive analysis is used to determine the mean (x) and standard deviation (SD) [15]. Furthermore, the T-test is used to determine the average difference in the measurement data of roosters raised in an intensive system with roosters in a free-range system. The T-test formula is according to Steel and Torrie (1993) [16].

3 Results and Discussion

Chickens in this study were male, totaling 120 chickens, consisting of 30 intensively reared chickens and 90 free-range chickens. Morphometric observation data of chickens in two rearing systems are presented in Table 1.

Table 1. Average results of morphometeric measurements of IPB-D1 roosters

Variables	Morphometric	
	Intensive	*Free-range*
Femur Length	90.92±5.97 (6.57)	96.81±6.18 (6.38)
Tibia Length	150.88±9.81 (6.50)	149.69±9.93 (6.63)
Tarsometatarsus Length	108.02±7.13 (6.60)[a]	110.51±5.19 (4.70)[b]
Tarsometatarsus Circumference	39.67±3.60 (9.09)	41.78±2.77 (6.63)
Third Finger Length	65.25±4.00 (6.13)	61.85±3.98 (6.43)
Wing Length	247.33±13.70 (5.54)	256.44±14.04 (5.48)
Maxilla Length	36.48±2.47 (6.77)[a]	36.48±1.64 (4.49)[b]
Cockscomb Height	31.87±9.27 (29.09)[b]	29.43±7.20 (24.45)[a]

Description: Mean (mm) ± sd (coefficient of variation).
Different superscripts on the same line indicate significant differences (P<0.05)

3.1 Morphometric polymorphism

Morphometric observations of IPB-D1 chickens in the intensive cage system showed femur length (6.57). tibia length (6.50). tarsometatarsus length (6.60). tarsometatarsus circumference (9.09). third finger length (6.13). wing length (5.54). and maxilla length (6.77) were in the medium category. while cockscomb height (29.09) was in the high category. Furthermore. the free-range cage system showed that tarsometatarsus length (4.70) and maxilla length (4.49) were in the low category. while femur length (6.38). tibia length (6.63). tarsometatarsus circumference (6.63). third finger length (6.43). and wing length (5.48) were in the medium category. and comb height (24.45) was in the high category. This is in accordance with the opinion which states that the coefficient of diversity can be divided into three (3). namely low diversity (KK≤5). medium (5<KK<15). and high (KK≥15) [17]. This indicates that the maintenance of IPB-D1 chickens in free-range cages is expected to increase the morphometric uniformity of tarsometatarsus length and maxilla length. This is in accordance with the theory which states that genetic factors and environmental factors can cause diversity [18]. Genotype determines the potential of the character. while the environment determines the potential limit of the gene [19, 20].

Another research report states that native chickens have a wing length of 36.38 ± 7.81 (21) cm. femur length 88.88 ± 16.74 (19) mm. tibia length 118.67 ± 18.02 (15) mm. tarsometatarsus length 85.85 ± 21.35 (25) mm. third toe length 52.04 ± 10.81 (21) mm. tarsometatarsus circumference 4.74 ± 0.70 (15) cm [21]. Another opinion states that native chickens have a tarsometatarsus length 9.61 ± 0.89 (9.26) cm. a tarsometatarsus circumference 5.52 ± 0.65 (11.78) cm. and wing length 23.28 ± 2.18 (9.36) cm [18]. This shows that IPB-D1 chickens have a smaller level of diversity than native chickens as their parents. So. the performance of IPB-D1 chickens is good. but not as diverse as native chickens as its parents. This is the same as the results of other research. which repored that the new KUB chicken strains have low and medium diversity. such as the coefficient value. maxilla length 4.91. wing length 4.02. tarsometatarsus length 9.96. tarsometatarsus circumference 6.53. tibia length 6.76. and third toe length 8.62 [22].

3.2 Effect of intensive and free-range rearing systems

T-test results showed that femur length. tibia length. tarsometatarsus circumference. third finger length. and wing length of IPB-D1 chickens in intensive and free-range rearing systems were not significantly different ($p > 0.05$). while tarsometatarsus length. maxilla length. and cockscomb height of IPB-D1 chickens in different rearing systems showed significant differences ($p < 0.05$) with values of 108.02±7.13 and 110.51±5.19. 36.48±2.47 and 36.48±1.64. and 31.87±9.27 and 29.43±7.20. respectively. It is suspected that the free-range system causes chickens to move a lot. so that the legs of chickens are used more often and experience better growth than intensively reared chickens. In addition. chickens in free-range cages use their beaks more often to search for grass and other living things in the grazing area. thus requiring chickens to have longer beaks than animals housed in intensive systems. This is consistent with the statement from other studies. that chickens raised with free-range access have free movement space in the grazing area [5]. Chickens reared in a free-range system show greater body part activity and range of motion [23]. The phenotype of local ducks is influenced by their habitat and can be divided into several groups based on their place of life [24]. Habitat and climate differences also influence phenotypic and physiological effect in poultry [25].

Super native chickens. KUB chickens. and 8 (eight) week old native chickens have a maxilla length of 30.88 ± 2.5. 28.92 ± 1.42. 27.08 ± 1.65; wing length 170.08 ± 8.49. 166.07 ± 6.67. and 129.88 ± 5.71. respectively; tarsometatarsus length 64.96±7.37. 62.76±6.25. and 58.39±6.46; tarsometatarsus circumference 41.31±3.85. 36.44±2.38. and 34.10±3.19; tibia length 100.35±7.88. 97.76±6.61. and 90.45±6.7; third toe length 54.78±5.42. 52.11±4.49. and 48.26±5.13 [22]. The research of Putri et al. [22] has a smaller size than this study. This is because the chickens in the treatment have different ages. However. the new chicken strains (super chicken. KUB chicken. and IPB-D1 chicken) have morphometrics larger than the native chicken as the parent. Thus. the goal of making local meat-producing chickens with better performance has been achieved.

Another theory states that 20-week-old native chickens had a tarsometatarsus length of 74.59 ± 1.76. wing length of 55.90 ± 2.28. fibia length of 159.61 ± 0.99. third finger length of 76.55 ± 0.60. and tarsometatarsus circumference of 4.75 ± 0.49 [26]. Another report states that 24-week-old Sabung chickens have a maxilla length of 23.6 mm. wing length 115 mm. tibia length 92 mm. tarsometatarsus length 89 mm. tarsometatarsus circumference 69 mm. and third finger length 38 mm [27]. Research results from Nur et al. [26] and Nata et al. [27] showed smaller results compared to the results in this study. The Nunukan local chickens less than 24 weeks old had a cockscomb height of 54.21 mm. wing length of 252 mm. femur length of 109.7 mm. tibia length of 141.7 mm. tarsometatarsus length of 101.5 mm. tarsometatarsus circumference of 57.5 mm. and third finger length of 61.2 mm [28]. From the results of research. namely on the morphometrics of local Nunukan chickens. there are several variables. namely wing length. tibia length. tarsometatarsus length. and third finger length which have smaller values than the size of IPB-D1 in this study.

4 Conclusion

Body size of 20-week-old IPB-D1 chickens has a low coefficient of variation in tarsometatarsus length (free-range) and maxilla length (free-range); medium in femur length. tibia length. tarsometatarsus length (intensive). tarsometatarsus circumference. third finger length. wing length. and maxilla length (intensive); and high in cockscomb height. The rearing system treatments showed no differences in femur length. tibia length. tarsometatarsus circumference. third finger length. and wing length. but showed significant differences in tarsometatarsus length. maxilla length. and cockscomb height between

intensive and free-range rearing systems in the tropics. Free-range rearing can increase tarsometatarsus length and maxilla length.

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