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RESEARCH ARTICLE

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Phaneroptic characteristics and morphometrics of Tukong indigenous chicken in West Kalimantan, Indonesia

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ABSTRACT

Tukong is one of the indigenous chicken breed from Indonesia, which exhibits an abnormality in their tail development, known as rumpless chicken. Despite its potential role for the local community, information regarding this unique breed's phenotypic and genetic characteristics is scarce. The present study aimed to characterise 205 (53 roosters and 152 hens) Tukong indigenous chickens (>8 months old) based on 7 phaneroptic characteristics and 10 morphometrics traits. The results showed that the roosters predominant plumage colour of the neck, body, and back were red, black, and red, respectively, while those for the hens were all black. Most roosters and hens had yellow beak, red comb, pea comb, red earlobe, orange eye, yellow shank, and white skin. Variations were also found in morphometrics traits. Diversity phaneroptic characteristics and morphometrics observed in Tukong chicken for evaluations to identify resources for effective breed improvement and conservation strategies of indigenous chickens in Indonesia.

HIGHLIGHTS

- Phaneroptic characterisation and morphometrics of Tukong an indigenous rumpless chicken from Indonesia, is important as first step in designing a breeding program.
- Variation observed in both phaneroptic characterisation and morphometrics traits could be valuable for selection of economic traits.

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rumpless chicken; phaneroptic; morphometrics; diversity; conservation

Introduction

Indonesia is home to a diverse range of livestock, including at least 27 different indigenous chicken breeds (Ulfah et al. 2017; Mahardhika et al. 2021). Due to natural and artificial selection (Otecko et al. 2019), these chickens exhibit varied physical traits and significant genetic diversity, requiring ongoing study for conservation and utilisation. Among them, the Tukong chicken stands out due to its unique rumplessness (lack of tailbone) (Tribudi et al. 2023), but its population is limited, and its biological documentation is sparse (Tribudi et al. 2021) (Figure 1 and 2). The origins of Tukong chickens are unclear, though local elders believe they descend from the Tabulangking chicken, a wild jungle fowl from West Kalimantan (Gufroni and Ibrahim 2005). Tukong chickens are primarily raised for cockfighting and as a source of meat and eggs, but their rumplessness is considered a defect, making them unsuitable for traditional and religious ceremonies (Tribudi et al. 2023).

Before starting breeding programs, accurate morphological data is crucial for conserving and utilising the breed. Chicken genetic resources can be identified through detailed analysis of phenotypic, genetic, and distributional information (Brito et al. 2021). Physical characteristics provide insights into biological equilibrium, helping to trace the origins and relationships among livestock breeds (Maharani et al. 2021). Meanwhile, quantitative traits allow for the analysis of morphometric variations, distinguishing populations and

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Figure 1. Images of the Tukong rooster.

addressing issues related to morphological evolution and species diversity in evolutionary studies. Previous studies presented phenotypic characterisation of indigenous Indonesian chicken breeds, such as Pelung (Asmara et al. 2018, 2019), Burgo (Setianto et al. 2019), Gaga (Abinawanto and Effendi 2017), Ketawa (Abinawanto et al. 2021), and Nunukan (Alwi et al. 2014). So far, only very limited information about Tukong was reported, such as production characteristics (Tribudi et al. 2021), egg characteristics (Tribudi et al. 2023), reproduction and sperm quality (Tribudi et al. 2024), general appearance and growth performance (Gufroni and Ibrahim 2005). Meanwhile, the phaneroptic characteristics of the Tukong, which are important for conservation efforts, have not yet been documented. The lack of data regarding phaneroptic diversity posed a major challenge in designing suitable breeding programs. Therefore, the primary objective of this study was to conduct for the first time a comprehensive morphological analysis, encompassing both phaneroptic characteristics and morphometrics of the Tukong chicken.

Materials and methods

Animals and study sites

In this study, Tukong chickens were selectively bred at a farm in Pontianak, West Kalimantan. The initial

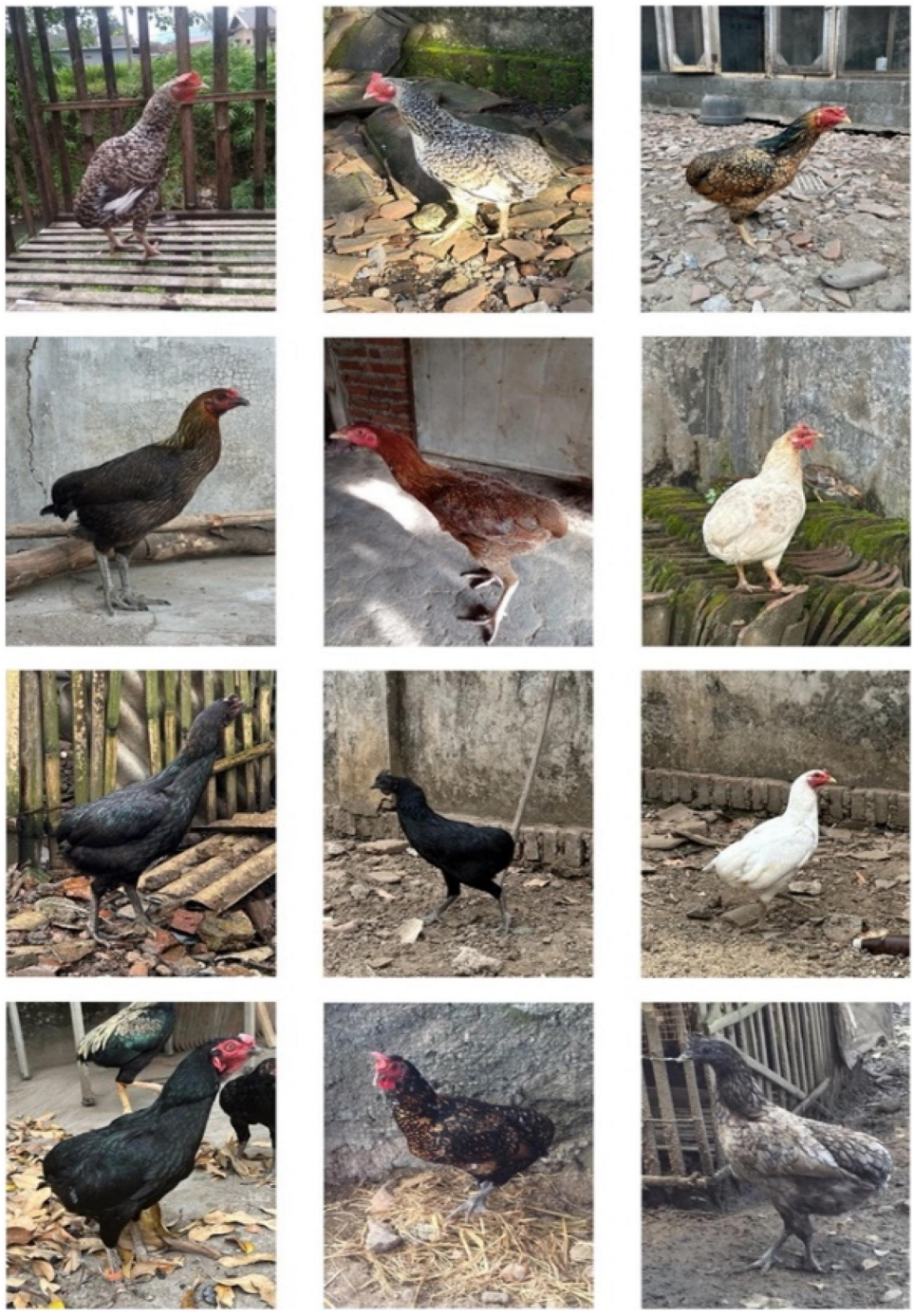

Figure 2. Images of the Tukong hens.

population (G0) included 23 sexually mature Tukong chickens (8 roosters and 15 hens), all over 8 months old, sourced from their native habitats in Landak and Bengkayang Regencies of West Kalimantan (Figure 3). From this G0 population, 205 offspring (53 roosters and 152 hens) were produced and used as samples, following The Food and Agriculture Organization (2012) recommended sample size for breed characterisation: 10–30 for roosters and 100-300 for hens. The study spanned 18 months, from June 2022 to December 2023.

Phaneroptic characteristics and morphometrics

The phaneroptic characteristics are based on the guidelines given by The Food and Agriculture Organization and include feather colour, comb shape, comb colour, earlobe colour, beak colour, eye colour, skin colour, and shank colour. The same person scored all phaneroptic to avoid individual variation. The morphometrics based on recommendations from The Food and Agriculture Organization (2012) and

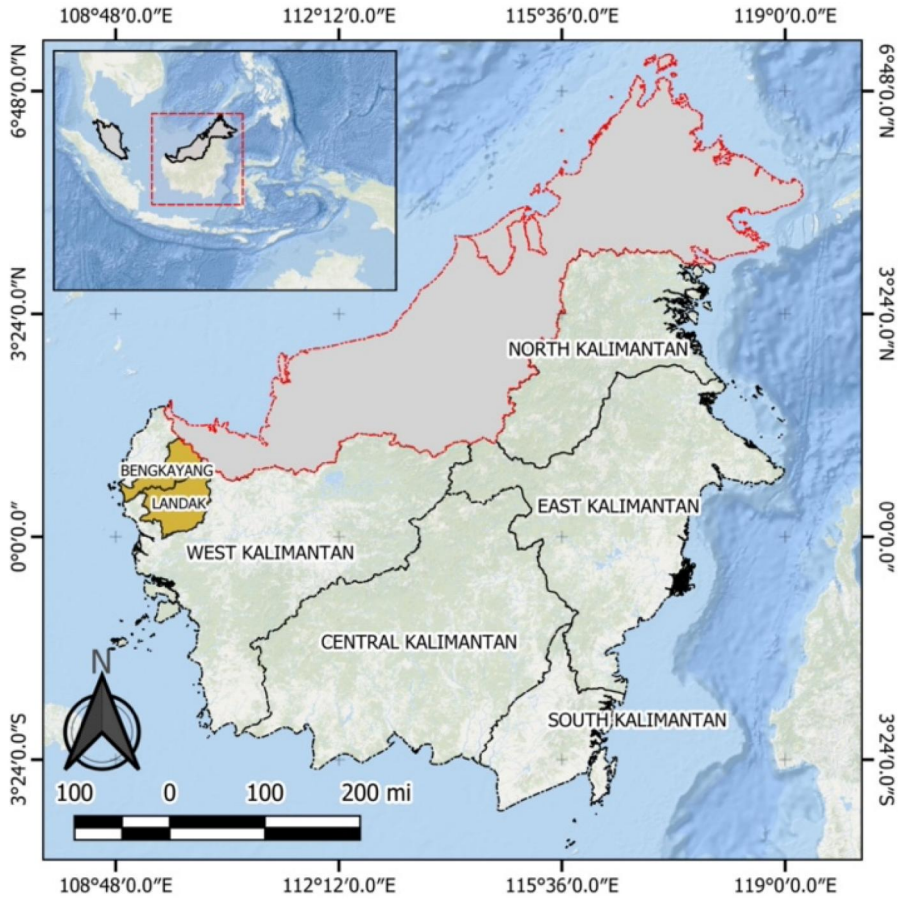

Figure 3. Map of study sites in Landak and Bengkayang Regency, West Kalimantan Province, Indonesia.

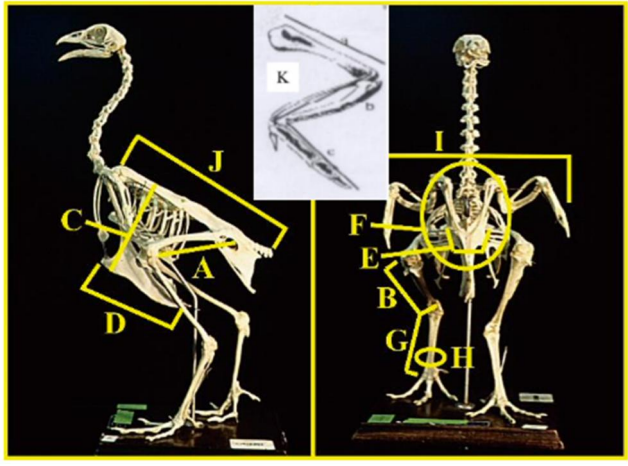

Figure 4. Body measurement of chicken (A: femur length; B: tibia length; C: chest depth; D: chest length; E: chest width; F: chest circumference; G: shank length; H: shank circumference; I: wingspan; J: back length; K: wing length; a: humerus; b: ossa antebrachii (radius and ulna); c: metacarpus and phalanges) (Waggoner and Hutchinson 2001).

Maharani et al. (2021) consisted of body weight (BW, kg), breast length (BrL, cm), breast circumference (BrC, cm), back length (BcL, cm), wing length (WL, cm), tibia length (TL, cm), femur length (FL, cm), shank length (SL, cm), shank circumference (SC, cm) and beak length (BeL, mm) (Figure 4).

Data analysis

The data on phaneroptic characteristics were analysed using descriptive statistics and compared in percentages. A t-test analysis was performed to test the effect of dimorphism sex (roosters and hens) on the morphometric data. Data analyses, graphical data visualisation, and presentations were performed using R software ver. 4.3.1.

Results and discussion

Analysis of feather colours in Tukong chickens revealed significant variations in the neck and back areas between roosters and hens (Figures 5A and B). The black feather colour dominates the body (37.5%), neck (24.34%), and back (37.5%) of Tukong hens, while in roosters, it is only dominant on the body (28.3%). Roosters have three main colours for the neck and back: red (32.08%), yellow (26.42%), and white-gold (24.53%). The feather colour diversity is much higher

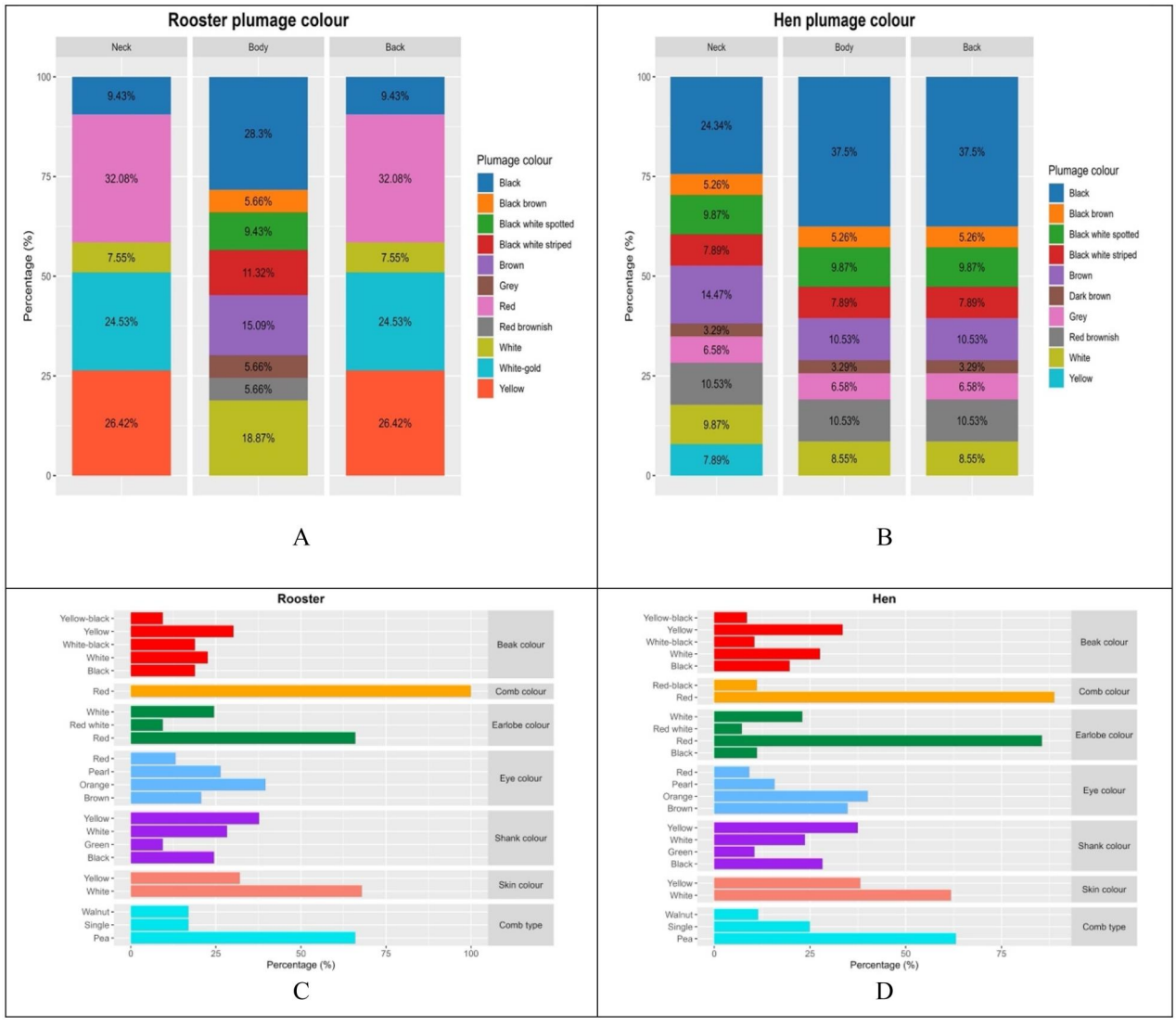

Figure 5. Phaneroptic characteristics of the Tukong roosters ($n = 53$) and hens ($n = 152$). The plumage colours for neck, body and back are presented for the roosters (A) and hens (B); beak, comb, earlobe, eye, shank and skin colour and comb type are presented for roosters (C) and hens (D).

in hens than the roosters, where the roosters have only 5 colour types in the neck and back, whereas the hens showed 10 and 9 colour types, respectively. In contrast to this difference, the number of colours on the body is almost the same for roosters and hens. Empirical studies have consistently documented that local chicken populations across diverse regions in Indonesia typically exhibit coloured plumage at proportions ranging from 80% to 90% (Asmara et al. 2018, 2019; Maharani et al. 2021; Depison et al. 2022; Suyatno et al. 2023) with a minority displaying the white plumage colour type is in the minority and ranging from 1% to 10% in local chicken (Kunuti et al. 2021). This variability in plumage colour underscores that this trait is not under selection within the Tukong chicken breed.

There were no variance differences observed between roosters and hens (Figures 5C and 5D) for beak colour, shank colour, and skin colour. For comb and earlobe colours, only hens showed the red-black and black phenotypes, respectively 7.24% and 11.18%. Combs that develop robustly indicate high production and reproductive performance (Cai et al. 2024). In this study, most Tukong chickens exhibited a pea-shaped comb morphology. Wright et al. (2009) reported that massive amplification of a duplicated sequence in intron 1 in the SOX5 gene, and is the cause of pea-comb formation. In addition, chickens with a pea comb phenotype are preferred for cockfighting activities. The occurrence of red colour of the comb in Tukong chickens is comparable to other Indonesian local chicken breeds, such as the Black Kedu, Gaga,

Merawang, Nunukan, and Sentul chickens (Maharani et al. 2021), as well as the Lurik, Wareng, and Ranupane chickens (Suyatno et al. 2023), and Bangkok chickens (Winaya et al. 2023). Navara et al. (2012) suggested that the red colour of the comb indicates sperm maturity and quality in roosters. A previous study showed that the genes Hydroxyacid Oxidase 1 (HAO1), Bone Morphogenetic Protein-2 (BMP2), SRY-box transcription factor 5 (SOX5), and androgen receptor (AR) affect comb morphology and development (Qi et al. 2024).

The ear lobe colour of Tukong chickens predominantly exhibits red pigmentation. Red, white, or a combination of both colours are commonly observed on the ear lobes of other indigenous chicken breeds in Indonesia (Asmara et al. 2018, 2019; Maharani et al. 2019; Suyatno et al. 2023; Winaya et al. 2023), as well as in chicken populations across Asia and Africa (Moreda et al. 2014; Liyanage et al. 2015; Dahloum et al. 2016). The diversity in earlobe colours among chicken breeds can be attributed to the diverse ancestral lineages and mutations that may have arisen approximately 1,000 years ago due to hybridisation events between different subspecies of *Gallus gallus*. Notably, the introduction of white earlobes derived from *Gallus gallus gallus*, crossed with red-earlobed *Gallus gallus spadiceus* and *Gallus gallus jabouillei*, contributed to the diversity of earlobe colours observed in modern chicken populations (Nishida et al. 1988).

Variation is shown in the beak colour phenotype of Tukong chicken. The beak colouration of the chickens ranged from yellow, white, black, to yellow-black and white-black with variation in distributions of each of the colours. This variation in beak colour is attributed to the presence of lipochrome pigment (Sulaiman and Rahmatullah 2018). Regarding shank colour, yellow is dominant in both sexes, accounting for approximately 37.74% in rooster and 37.5% in hens. In this study, the skin colour was primarily white. It is noted that chickens with yellow or white skin demonstrate superior tolerance to heat stress compared to those with black skin (Brown et al. 2017). Skin colour is a hereditary trait influenced by carotenoid pigments and is further influenced by dietary factors and health conditions (Lalhlimpuia et al. 2021). The predominant eye colour in Tukong chickens is orange in hens (40.13%) and roosters (39.62%). The variation in eye colour among chickens is intricately linked to the presence of carotenoids, with melanin in the bloodstream contributing to alterations in iris surface appearance, thereby resulting in distinct iris colours that may signify different chicken breeds (Sztandarski et al. 2021).

The morphometric measurements of the roosters exceeded those of the hens across all parameters (Table 1). The diversity in body weight and body size of both the Tukong rooster and hen exhibited relatively high values. Notably, the coefficient of variation (CV) values varied, with the highest recorded in the body weight (BW) of hens (18.75%) and the lowest observed in the body length (BeL) of roosters (6.36%) among the chickens. The t-test result showed that the sex dimorphism was significantly different in morphometric traits. Morphometric traits have been extensively identified in Indonesian local chickens (Sophian et al. 2021). Measuring various body parts in chickens is a reliable predictor, given their close correlation with body weight. Morphometric measurements also aid livestock selection and facilitate cross-breeding processes between breeds and types (Kunuti et al. 2021). Table 1 illustrates that the average body weight (BW) and back length (BcL) of Tukong chickens (1.39 ± 0.26 kg and 16.41 ± 1.88 cm) were lower than Nunukan chicken originated from East Kalimantan reported by Sartika et al. (2006). The shorter BcL observed in Tukong chickens may be attributed to the absence of a pygostyle. According to Noorai et al. (2012), truncated or absent free-tail vertebrae and pygostyle structures in the rumpless phenotype result in a shorter back length than other chicken breeds.

The rumpless phenotype is also found in Araucana (Freese et al. 2014), Hongshan (Wang et al. 2018; Chen et al. 2024), and Piao (Guo et al. 2023) chicken breeds. Several studies report different causal or associated mutations in different genes associated with the rumpless phenotype. Wang et al. (2018) reported that the pseudogene LOC431648 located on the Z-chromosome appeared as a strong candidate involved in the Wnt/β-catenin signalling pathway to regulate feather development. Moreover, on the Z-chromosome, Chen et al. (2024) reported one overlapping gene (EDIL3)

Table 1. Mean, standard deviation and coefficient of variation of morphometrics measurements of Tukong chickens.

	Rooster ($n = 53$)		Hens ($n = 152$)	
Parameter	Mean ± SD	CV (%)	Mean ± SD	CV (%)
Shank length (cm)	8.93 ± 0.89^b	9.62	7.86 ± 0.94^a	12.01
Shank diameter (cm)	4.74 ± 0.42^b	8.79	4.26 ± 0.37^a	8.62
Tibia length (cm)	12.86 ± 1.58^b	12.29	11.73 ± 1.02^a	8.66
Femur length (cm)	10.83 ± 0.88^b	8.13	8.97 ± 1.20^a	13.38
Breast circumference (cm)	27.39 ± 2.36^b	8.60	25.59 ± 2.89^a	11.28
Breast length (cm)	12.47 ± 1.25^b	10.06	10.25 ± 1.37^a	13.41
Back length (cm)	17.74 ± 1.54^b	8.70	15.95 ± 1.77^a	11.08
Wing length (cm)	18.70 ± 1.26^b	6.71	16.38 ± 1.94^a	11.83
Beak length (mm)	24.52 ± 1.56^b	6.36	23.60 ± 2.93^a	12.40
Body weight (kg)	1.61 ± 0.23^b	14.07	1.32 ± 0.23^a	17.40

All morphometrics traits are significant different between rooster and hens ($p < 0.05$).

and 16 other genes associated with the rumples trait. The novel causal gene (Rum gene) produced an extensive, intronless transcript that extend the deletion, according to a different investigation by Guo et al. (2023). Rum expression is particular to embryos and controls the expression of MSGN1, which is essential for controlling T-box transcription factors necessary for the development and differentiation of mesoderms. In Piao chicken, Wang et al. (2021) reported that the Irx4, Il18, Hspb2, and Cryab as candidate genes for the rumples trait.

FAO underscores the importance of preserving the diversity of indigenous livestock genetic resources due to their potential to serve as raw materials for sustainable genetic and breed improvement efforts. Additionally, maintaining genetic diversity facilitates rapid adaptation to environmental changes and selection objectives. This research holds potential benefits by providing genetic data on Indonesian chicken breeds, fulfilling technical requirements for breed determination in Indonesia as outlined by the Ministry of Agriculture of the Republic of Indonesia 2014.

Conclusion

The present study found the considerable phaneroptic diversity and morphometrics in Tukong indigenous chicken. Phaneroptic characteristics and morphometrics is the first important step in describing the Tukong chicken breed, and the future assessment on a molecular level will contribute to the conservation and genomic characterisation of these unique characteristics.

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Ethical approval

The experimental procedures in this study was approved by the Institutional Animal Care and Use Committee (IACUC) of Universitas Brawijaya (Number: 155-KEP-UB-2022).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author

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