Journal of Tropical Biodiversity E-ISSN: 2774-4116

Morphometric Characteristics Of Merawangarab Chicken Based On Multivariate Analysis and Multiple Regression

Sri Darwati[1)], Harini Nurcahya[2)], Hajran Fashbir Pambudi[1)]

[1)]*Departement of Animal Production and Technology, IPB University*

[2)] *Universitas Nasional, Jakarta*

*Correspondence Author: harininurcahya@yahoo.com

OPEN ACCESS

Submission: 28 July 2026
Accepted: 3 August 2026
Publication: 5 August 2026

Abstract

This study aimed to analyze morphometric characteristics of merawangarab chicken using multivariate analysis. Twenty five of merawangarab chicken with 12th weeks age was used. Merawangarab chicken were observed for body weight, body length, wing length, femur length, and tibia length. Data were analyzed using multivariate analysis Principal Component Analysis (PCA) and multiple regression. Body size and body weight still vary. The first component was mainly associated with body size. Results indicated that the first principal component represented body size index, explaining 93,8% of total variance. Between variables there was a significant positive correlation (P <0.05) between variables and multiple linear equations Weight = -871 +6.88 Chest Length + 12.49 Tibia Length + 2.58 Femur Length (mm) with R2 = 90.5. Conclusion PC1 controls the variety of variables measured, with a close relationship between variables and still varied and can be used to estimate body weight.

Keywords: merawangarab chicken, morphometric, multivariate analysis, multiple regression

INTRODUCTION

Merawang chicken and arab chicken are local chickens in Indonesia. Merawang chicken has great potential to be developed as a dual-purpose chicken producing eggs and meat. Merawang chicken produces 160-180 eggs per year (BPPMT 2025). Arab chicken is a type of poultry with potential as an egg-laying hen. The relative egg production of arab chicken is 235 eggs per year (BBPP Kupang 2021).

Crossbreeding involves mating a male chicken with a hen from a different breed, or the reverse. Crossbreeding is carried out to ensure superior growth compared to purebred merawang and arab chickens, and to produce a large number of chicks (DOC) by using female arab chickens with high egg production. Efforts to combine the potential of merawang chicken

with arab chicken to improve the genetic quality of local chickens are being made through crossbreeding these two chicken lines. Based on the combined potential of both, crossbreeding between mgerawan chicken and arab chicken is expected to produce a local chicken that produces superior eggs with good growth, thus the crossbreed also has the potential to produce meat (Darwati et al. 2019).

Morphometrics is a reference for quantitative analysis, including body size and shape. Initial body size can be an indicator of subsequent growth, feed efficiency, and potential harvest yield (Primawati et al. 2021). Morphometric analysis is performed on an organism and is useful in analyzing the fossil record, the impact of mutations on shape, developmental changes in shape, differences in variation between ecological factors and shapes, and for estimating quantitative genetic parameters of shape (Kurniawan and Arifianto 2017). Morphometrics is the study of variation and changes in livestock body size, allowing for quantitative identification and description of livestock potential (Zafitra et al. 2020). Morphometrics is a measurement used to quantitatively determine an organism's morphology (Aryanti et al. 2021). Morphometric analysis combined with multivariate statistics such as PCA (Principal Component Analyses) can help identify the most important traits contributing to phenotypic diversity.

PCA shows a clear separation between strains. Fast-growing and slow-growing strains exhibit distinct characteristics. Fast-growing strains have relatively shorter and thicker tibia. Slow-growing strains have longer and slimmer tibiae (Pulcini et al. 2021). Regression analysis not only provides information on the relationships between variables but also provides more accurate estimates for forecasting. The purpose of this study was to examine the morphometric characteristics of merawangarab chickens at 12 weeks of age using multivariate PCA and multiple regression analysis.

METHOD

Materials

The chicken sample consisted of 25 unsexed Merawangarab chickens, 12 weeks old. The feed used was a mixture of 60% commercial starter broiler feed and 40% rice bran. Body weight and body measurements were taken.

Data Analysis

Body weight and body measurements were taken when the chickens were 12 weeks old. The data obtained were analyzed using multivariate analysis and multiple linear regression. Principal Component Equation, each principal component is a linear combination of the original variables, according to Gasperz (1992):

$$PCk = a_{k1}Z1 + a_{k22}Z2 + \cdots + a_{kp}Zp$$

Where:

PC = k^{th} principal component;

a_{kj} = coefficient (loading/eigenvector);

Zj = j^{th} standardized variable; and

p = number of variables.

The multiple linear regression analysis model used is based on Kartiningrum et al. (2022).

$$Y = a + b1X1 + \cdots + bnXn$$

Where:

Y'= body weight;

X1, ⋯, Xn = linear body measurements (independent variables);

a = constant (the value of Y' when X1, X2, ⋯, Xn = 0); and

b = regression coefficient.

Principal Component Analysis (PCA) was performed to reduce dimensionality and identify the primary sources of variation among egg quality traits. Prior to analysis, all variables were standardized to eliminate scale effects. Components with eigenvalues greater than one were retained based on the Kaiser criterion. The interpretation of components relied on factor loadings. All analyzes were conducted using statistical software.

Observed Variables

The variables measured at 12 weeks of age were:

1. Tibia length, measured from the patella to the tip of the tibia using a caliper;
2. Femur length, measured from the upper pelvis and the lower tibia using a caliper;
3. Chest length, measured from the sternum using a digital caliper; and
4. Body weight, measured using a digital scale.

The observed variables (Figure1) were measured using FAO (2012).

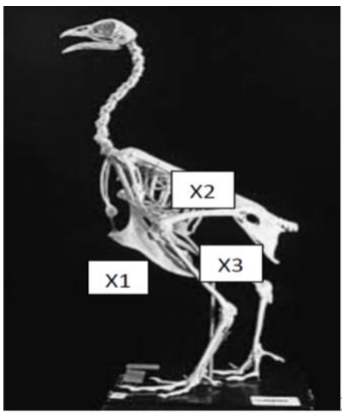

Figure 1. Body Size, X1: Chest Length; X2; Femur Length; X3: Tibia Length (Waggoner and Hutchinson 2001)

RESULT

Table 1. Descriptive Analysis of Body Weight and Body Size of Merawangarab Chickens 12 weeks age

Variable	Mean	Standard Deviation	Coefisien of Variance
Body Weight (g)	914,9	193,90	21,19
ChestLength (mm)	80,76	9,98	12,36
Tibia Length (mm)	83,47	7,64	9,15
Femur length (mm)	72,59	9,45	13,01

Body weight and body size were variation. Body weight and body size vary widely. Body weight, chest length, and femur length vary significantly compared to tibia length.

Table 2. Eigenvalue Analysis of Correlation Matrix of Merawangarab Chicken

Component	PC1	PC2	PC3	PC4
Eigenvalue	3,7533	0,1291	0,0667	0,0509
Proportion	0,938	0,032	0,017	0,013
Cumulative	0,938	0,971	0,987	1,000

Based on the results of the PCA analysis for chicken body size, PC1 = 93.8% of the variance, and PC2 = 3.2%, with the remainder being very small. This means that almost all variation in chicken body size is controlled by one main factor, namely PC1.

Table 3. Eigenvector of PCA

Variable	PC1	PC2	PC3	PC4
Body Weight (g)	0,501	-0,364	-0,755	-0,216
ChestLength (mm)	0,504	-0,228	0,607	-0,570
Tibia Length (mm)	0,505	-0,254	0,230	0,792
Femur length (mm)	0,490	0,867	-0,090	-0,009

PCm dominates the body size variation and can represent almost all of the observed body size data in Merawangarab chickens. Data variation is almost entirely explained by a single main factor. This was because the measured body sizes are highly correlated and there was a single dominant factor. Based on the general PCA criteria, the Kaiser criterion (Eigenvalue > 1) means PC1 (eigenvalue > 1), thus PC 1 alone was sufficient because its eigenvalue was 3.755 with a cumulative variance of 93.8%. The screen rule (elbow test) shows a significant decrease from PC1 to PC2, from 0.938 to 0.032. This indicates that PC1 was an important component related to body shape (Figure 2)

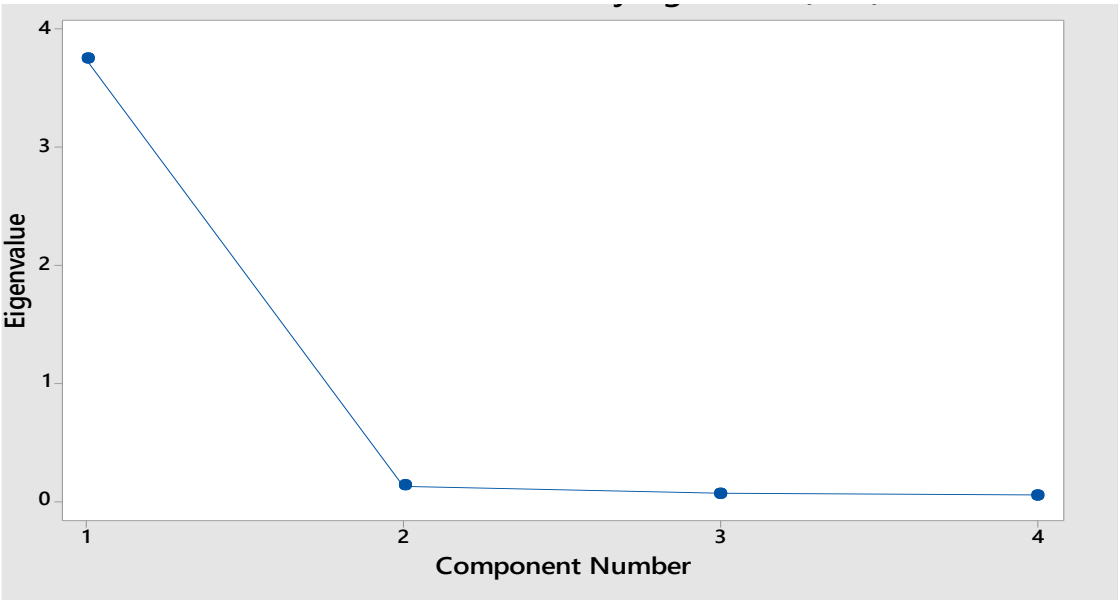

Figure 2. Screen Role Component Role

Table 4. Correlation Values between Measured Variables

Correlation	Body Weight	Chest Length	Tibia Length
Chest Length	0,934		
	0,000		
Tibia Length	0,941	0,948	
	0,000	0,000	
Femur Length	0,886	0,898	0,899
	0,000	0,000	0,000

The results of the correlation analysis between the measured variables showed that all variables were positively and significantly correlated (P<0.01). Chest length, tibia length, and femur length were positively and significantly correlated with body weight. Estimation of body weight from the three body measurements was continued with multiple regression analysis.

Table 5. Multiple Linear Regression Analysis on Merawangarab Chicken

Variance	Coef.	SE Coef.	T-Value	P-Value
Constant	-871	174	-5,00	0,000
Chest Length	6,88	4,34	1,59	0,128
Tibia Length	12,49	5,69	2,19	0,040
Femur Length	2,58	3,33	0,77	0,447

The results of multiple regression analysis for the measured variables showed that tibia length had a significant effect on body weight (P<0.05), thus the multiple linear equation was Body Weight=-871 +6.88 Chest Length (mm) + 12.49 Tibia Length (mm) + 2.58 Femur Length

(mm) with R2=90.5 so that every increase in chest length, femur length, and tibia length would be followed by an increase in body weight.

DISCUSSION

Body Size Diversity

Genetic diversity remained high in body weight, chest length, femur length, and tibia length as shown in Table 1. Talebe et al. (2021) stated that a coefficient of diversity of less than 10% indicated a homogeneous chicken population. The variables chest length, tibia length, and femur length are related to muscle tone and, therefore, can be predicted for meat production. The diversity in body size and weight in merawangarab chickens indicated that merawangarab chickens still have potential for selection in merawangarab breeding programs for meat production.

Morphometric

The results of the multivariate analysis revealed only one principal component, or PC1. This indicates that almost all variation in chicken body size is controlled by a single primary factor: overall body size. The results of the Principal Component Analysis of body measurements showed that PC1 accounted for 93.8% of the total variance, indicating that overall body size was the dominant source of variation among chickens. This indicated that most morphometric traits are highly correlated and reflect general growth and differences in body shape. The PC2 and subsequent components explained minimal variance and likely represent small proportional differences among individuals.

The quantitative characteristics of the variables in the principal components in this study, namely body weight, chest length, femur length, and tibia length, differ from those of Putri et al. (2020), who found that tibia length was the defining characteristic of the body size of super kampung chickens and KUB chickens. The results of this study also differ from those of Markos et al. (2024) that analyzed separately using multivariate analysis, which found that four and seven principal components contributed approximately 74.26% and 69.77%, respectively, of the total variability in morphometric traits for male and female chickens. Ear lobe length, wing span, skull length, and leg length were the most important characteristics for distinguishing female ecotypes, while wing span, neck length, ear lobe length, spur length, body length, and leg length were the most important distinguishing characteristics among male ecotypes.

Variation in PC1 indicates that the measured body sizes move together proportionally, so that large chickens have large body parts, whereas small chickens have small body parts. This is known as the General Body Size Factor, meaning PC1 was appropriate for the overall body size index.

Chest length was an axial skeleton (body part) that reflects body capacity and body volume. Furthermore, the chest was the site of the greatest muscle attachment in chickens, thus chickens had potential as meat producers. Based on PC1, merawangarab chicken can be targeted for meat production due to its correlation with body weight and chest muscle capacity along the sternum, thus expected to produce good carcasses. This is supported by descriptive analysis results, which showed that the observed body weight and body size were still varied and still allow for selection to increase merawangarab chicken productivity. The breast area correlated with body weight. This is suspected because the breast contains more muscle than other parts (Djegho and Kihe 2020).

Correlation and Regression

The results of this study indicated that the observed variables were positively and significantly correlated ($P<0.05$), meaning that each body measurement can be used to predict other body measurements. Body size was also positively correlated with body weight, so body size can be used to predict body weight and vice versa. This contrasts with the study by Jannah et al. (2022), which found that tibia length was not correlated with body weight. Meanwhile, chest length, tibia length, and femur length increased positively and proportionally with increasing body weight. This supports the results of the PCA analysis, which showed that the four observed body measurements significantly influenced body size in the observed Merawang Arab chickens.

The multiple linear equations for Merawang Arab chickens in this study showed that each increase in chest length, tibia length, and femur length was followed by an increase in body weight. This implies that larger body size leads to increased body weight. As stated by Nurhaswinda et al. (2025), this suggests that regression analysis not only provides information on the relationships between variables but also provides more accurate estimates for forecasting.

CONCLUSION

Chest length, femur length, tibia length, and body weight of merawangarab chickens varied and were positively correlated with each other. PC1, as the General Body Size Factor, was appropriate for the overall body size index. The multiple regression equation was Weight = -871 + 6.88 Chest Length + 12.49 Tibia Length + 2.58 Femur Length with R2 = 90.5 supported PC1.

REFERENCES

Aryanti, N.P.A., Faiqoh, E., & Putra, I.D.N.N. (2021). Perbandingan morfometrik dan meristic lamun *cymodoceae serrulate* di Perairan Sanur dan Tanjung Benoa, Bali. *Journal of Marine and Aquatic Sciences*. 7(2): 148-157.

[BBPMP Babel] Balai Besar Penerapan Modernisasi Pertanian Kepulauan Bangka Belitung. (2025). KP. Petaling BRMP BABEL jaga kelestarian ayam merawang dan ayam KUB. http://babel.brmp.pertanian.go.id [diunduh 16 Maret 2026].

[BBPMP Kupang] Balai Besar Pelatihan Peternakan Kupang. Perbedaan Ayam Elba dengan Ayam Arab dan Buras Lokal. https://bbppkupang.bppsdmp.pertanian.go.id [diunduh 16 Maret 2026].

Darwati, S., Afnan, R., Nurcahya, H., & Widayanti, N. (2019). Produksi telur dan reproduksi ayam silangan antara ayam merawang dengan ayam arab serta pendugaan nilai ripitabilitasnya. JPI. 21(2): 102-108.

Djegho, Y., & Kihe, J.N. (2020). Korelasi feontip antara ukuran bagian tubuh dengan bobot badan dari silangan ayam pedaging, kate dan lokal sabu pa umur dua beles minggu. Jurnal Nukleus Peternakan. 7(1): 151-154

[FAO] Food and Agriculture Organization of the United Nations. (2012). *Phenotypic Characterization of Animal Genetic Resources*. FAO Animal Production and Health Guidelines No 11. Roma: FAO.

Gasperz. (1992). Teknik Analisis dan Penelitian. Jilid Ke-2. Bandung: Tarsito.

Jannah, R., Junaedi, Khaeruddin, Syamsuryadi, B. (2022). Comparison of the morphometric traits and body weight of pure kampung chicken with kampung bangkok crosses chicken. Jurnal Ilmu-Ilmu Peternakan. 32(3): 363-372.

Kartiningrum, E.K., Notobroto, H.B., Otok, B.W., Kumarijati, E.N., & Yuswatingsih, E. (2022). Aplikasi Regresi dan Korelasi Dalam Analisis Data hasil Penelitian. Mojerto: STIKES Majapahit

Kurniawan, N., & Arifianto, A. (2017). Ornitologi: Sejarah, Biologi, dan Konservasi. Malang: Universitas Brawijaya Press.

Markos, S., Belay, B., & Dessie, T. (2024). Morphometric differentiation of three chicken ecotypes of Ethiopia using multivariate analysis. PloS One. 19(2): e0295134. https:/doi.org/10.1371/journal.pone.02955134.

Nurhaswinda, Egistin, D.P., M. Yahdi Rauza, M.Y., Rahma, Ramadhan R.H., Sagita Ramadani, S., & Wahyuni. 2025. Analisis regresi linier sederhana dan penerapannya. JURNAL CAHAYA NUSANTARA. Vol. 1, No. 2 (2025): 69-78, EISSN: 3093-8113. https://jurnal.cahayapublikasi.com/index.php/jcn

Putri, A.B.S.R.N., Gushairiyanto, & Depison. (2020). Bobot badan dan karakteristik morfometrik beberapa galur ayam lokal. Jurnal Ilmu dan Teknologi Peternakan Tropis. 7(3): 256-253.

Primawati, N., Nafiu, L.O., & Badaruddin, R. (2021). Karakteristik ukuran-ukuran tubuh ayam lokal umur 3-10 minggu pada strain berbeda. Jurnal Ilmiah Peternakan Halu Oleo. 3(1): 62-66.

Pulcini, D., Zilio, D.M., Cenci, F., Castellini, C., & Amato, M.G. (2021). Differences in tibiashape in organically reared chicken lines measured by means of geometricmorphometrics. Animals. 11(1): 1–10.

Talebe, Y.B., Hoda, A., & Utami, S. (2021). Analisis fenotip, pendugaan bobot tetas dan bobot hidup umur 8 minggu pada seleksi ayam kampung (*Gallus gallus domesticus*). Jurnal Ilmu dan Industri Peternakan. 7(1): 32-46.

Waggoner, B., & Hutchinson, J.B. (2001). Aves: More on Morphology. [Diunduh 2024 Januari10] dapat diakses pada https://ucmp/berkeley.edu/diapsids/birds/birdmm.html.

Zafitra, A., Gushairiyanto, H., Ediyanto, & Depison. (2020). Karakterisasi morfometrik dan bobot badan pada sapi bali dan simbal di Kecamatan Bangko Kabupaten Merangin. Majalah Ilmiah Peternakan. 23(2): 66-71.