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The Relationship Between Body Size and Bone Weight (Breast and Thigh) in Kampung Chicken (*Gallusdomesticus*) Results Third Generation Selection

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ABSTRACT

The aim of this study is to identify the characteristics of body size and shape in kampung chickens, as well as the relationship between body size and meat weight. To achieve this, 200 kampung chicken DOC were directly observed using purposive sampling. Purposive sampling where the chickens were divided into 3 groups of body weight, namely high, medium and low.Body size was recorded at 4, 6, 8, 10, and 12 weeks of age, and the weight of flesh and bone at 12 weeks of age was analyzed using the t-test.The samples used to obtain the weight of meat and bones (breast and thighs) were 35 males and 23 females.The study used principal component analysis to identify body size and shape characteristics for males and females. Regression and correlation analysis were then conducted to determine the relationship and closeness between body size and the weight of flesh and bone.The results of the study showed that the body size and weight of flesh and bone in kampung male chickens aged 12 weeks were significantly higher (P<0.01) than in females. The characteristic body size of male and female kampung chickens was the length of the thigh, while the typical body shape was the length of the back and chest.Furthermore, the study found that chest length was highly correlated with male breast meat weight, while thigh length was highly correlated with female thigh meat weight. Thigh length was also correlated with femur weight in both males and females.In conclusion, this study highlights the importance of body size in determining the weight of meat and bone in kampung chickens. Chest and thigh lengths can be used as selection criteria for male and female kampung chickens to increase meat weight in future generations.

Keywords: Chicken, Bone weight, Breast and thigh, Correlation, Body size

Introduction

Kampung chicken is a widely spread type of poultry in Indonesia, known for its diverse genotypes and phenotypes. The kampung chicken *(Gallus domesticus)*is a source of genetic wealth for local livestock, and its distribution is nearly uniform throughout Indonesia (Amlia *et al.*, 2016). To understand their bone growth and body structure, studying body size is crucial. The size of livestock directly affects the growth of bones and meat, with body measurements such as chest length, back length, wing length, femur length, tibia length, and shank length often used to determine body weight.

In particular, the breast and thigh of the kampung chicken are highly sought after due to their high meat-to-bone ratio.The breast is a popular part of the carcass, with thick flesh and flesh and little bone (Patriani, 2019; Widiyawati *et al.*, 2020). The breast includes a part of meat and small bone, making it an basic portion of the carcass, and boneless meat is exceedingly esteemed for its consumable parcel and as a reference for measuring generation levels.

Improving the genetic quality and environment can increase the productivity of kampung chickens (*Gallus domesticus*). Selection and crossing can be used to improve gene quality, as Putri *et al.* (2020) suggest, with selection criteria variables used to make direct or indirect selections. Endeavors can moreover be made to extend bone development, which, concurring to Permadi *et al.* (2020), is speedier in male local chickens than in females. The greater the bones, the more meat can be created.

To determine the shape and closeness of the relationship between body size and meat and bone weight, this study focused on third-generation kampung chickens. Correlation, a method of estimating the closeness of relationships between variables, was used to determine the correlation coefficient between known and predicted variables.

In summary, studying body size is crucial in understanding the bone growth and body structure of kampung chickens. Progressing hereditary quality and the environment can increment efficiency, with boneless meat being exceedingly esteemed consumable parcel of the carcass. The shape and closeness of the relationship between body measure and meat and bone weight can be decided utilizing relationship, shaping the premise for relapse conditions. Improving genetic quality and the environment can increase productivity, with boneless meat being a highly valued consumable portion of the carcass. The shape and closeness of the relationship between body size and meat and bone weight can be determined using correlation, forming the basis for regression equations.

Materials and Methods

This research was conducted at the experimental cages of Jambi University's Faculty of Animal Husbandry for 5 months, from July 1st to November 30th, 2022. The study utilized 200 birds of third-generation DOC kampung chicken. To obtain meat weight and bone measurements (chest and thigh), a purposive sampling technique was employed, and the chickens were divided into three groups based on body weight: high, medium, and low. A total of 35 males and 23 females were used in the study. DOCs were randomly obtained from hatched eggs and reared until 12 weeks old, with Novo brand complete feed produced by Charoen Phokpand as the main source of food, along with drinking water. Figures can be seen in Figure 1, 2, 3, 4 and 5.

The research utilized a range of tools, including cages, feeders, drinkers, incubators, knives, plastic, basins, digital scales, calipers, buckets, wood shavings for litter, and 25-watt lamps. The method involved direct observation of 200 kampung chickens, starting from DOC until they reached 12 weeks of age, and each chicken was marked or numbered to track their progress throughout the study. The chickens were housed in a battery cage with a wire base measuring 1 x 1 x 0.5 m^3, with eight chickens in each cage. They were fed ad libitum with complete Novo brand feed produced by Charoen Phokpand.

Data collection was carried out by measuring the chickens' body size using a measuring tape and caliper and weighing the meat and bone weight (breast and thighs) using a digital scale with an accuracy of 0.1 g. The chickens were measured at 4, 6, 8, 10, and 12 weeks of age. This study provides valuable insights into the growth and development of DOC kampung chickens, contributing to the understanding of their optimal rearing conditions and potential for meat production.

Observed variables

The variables observed in this study include: chest length, measured using a caliper (in cm), from the sternum's front to the rear end at 4, 6, 8, 10, and 12 weeks of age, wing length, measured using a caliper (in cm), from the base of the humerus to the tip of the phalanges at 4, 6, 8, 10, and 12 weeks of age, back length, measured using a measuring tape (in cm), from the border between the spine and the cervical vertebrae to the tip of the coccyx at 4, 6, 8, 10, and 12 weeks of age, the length of the thigh at the age of 4, 6, 8, 10 and 12 weeks which is the length of the femur, namely from the joint of the base of the thigh bone to the joint of the base of the upper tibia bone and the length of the tibia bone, namely from the joint of the base of the upper bone of the tibia to the joint below the tibia bone, measured using a caliper (cm), shank length, measured using a caliper (in cm), along the tarsometatarsus bone (shank) formed from the union of the second, third, and fourth metatarsal bones at 4, 6, 8, 10, and 12 weeks of age, breast meat weight, measured using a digital scale with an accuracy of 0.1 g, by separating the bones from the breast part of kampung chickens at the age of 12 weeks, thigh meat weight, measured using a digital scale with an accuracy of 0.1 g, by separating the bones from the kampung chicken thighs at the age of 12 weeks. The parts to be measured can be seen in Figure 6.

Data analysis

The mean difference test (t test) was used to see the average difference between body weight at 2, 4, 6, 8, 10, and 12 weeks of age and carcass pieces in male and female kampung chickens. analysis using the t-test the average difference test (Gaspersz, 2006) with the following formula:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\sum(X_{J1} - \overline{X}_1)^2}{n_1(n_1 - 1)} + \frac{\sum(X_{J2} - \overline{X}_2)^2}{n_2(n_2 - 1)}}}$$

Information:

t = calculated t value
Xi = sample mean in the first group
X2 = sample mean in the second group
X J1 = the value of the J-observation in the first group
XJ2 = value of the J-observation in the second group
n1 = number of samples in the first group, and
n 2 = number of samples in the second group

The principal component analysis is a statistical technique used to determine the determinants of size and shape. The principal component analysis is used to see differences in size or shape characteristics between male and female kampung chickens. The size and shape equations are derived from the covariance matrices. The mathematical model used for this analysis (Gaspersz, 2006) is as follows:

$$Yj = a_{1j}X_1 + a_{2j}X_2 + a_{3j}X_3 + \cdots + a_{5j}X_5$$

Information:

Y_j : jth principal component (j=1,2; 1=size, 2=shape)
$X_{1,2,3,\ldots 5}$: variable to 1,2,3, …, 5
$a_{1,1j,1j,\ldots}$: eigenvector variable i (1,2,3, …, 5) and the jth component.

The regression analysis used multiple and simple linear regression analysis to see the relationship between size at 4, 6, 8, 10, and 12 weeks of age and the weight of flesh and bone (breast and thigh). Simple linear regression is

Figure 1. Research cage.

Figure 2. DOC kampung chicken.

Figure 3. Meat weight and bone measurements (chest and thighs).

Figure 4. Drinking water.

Figure 5. Novo brand complete feed.

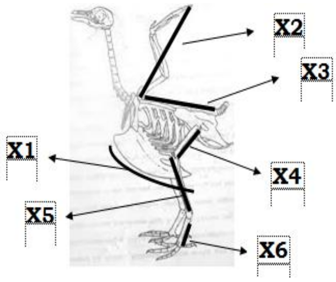

Figure 6. Kampung chicken anatomy and research measurements. X1 = chest length, X2 = wing length, X3 = back length, X4 = femur length, X5 = the tibia, and X6 = shanked.

based on a functional or causal relationship between one independent variable (X) and one dependent variable (Y). The general equation for simple linear regression is (Hanief and Himawanto (2017):

$$Y = a + bX$$

Information:

Y : variable (the weight of meat and bone (breast and thigh))
a : Constant
b : Regression coefficient
X : Value of independent variables (chest length, wing length, back length, lengthfemur, tibia length, shank length).

Multiple linear regression test is part of the development of a simple regression test. Its use is to estimate the value of the dependent variable (Y) if there are 2 or more independent variables (X) (Hanief and Himawanto, 2017). Multiple linear regression analysis, the independent variable (X) is used more than one, for example X1, X2, X3, ..., Xn. One dependent variable (Y) is influenced by several independent variables (Paiman, 2019).

$$Y= b_0 +b_1 X_1 +b_2 +b_3 X_3 +.......+ b_5 X_5$$

Information:

Y : Dependent variable (the weight of meat and bone (breast and thigh))
a : Constant
b_1 : Regression coefficient of body size at 4, 6, 8, 10, and 12 weeks (X2)
$b_{2,3,4,5}$: ....($X_{2,3,4,5}$)
X : Value of independent variables (chest length, wing length, back length, length femur, tibia length, shank length).

Correlation analysis was used to see how close the relationship between body size and flesh and bone weight (chest and thighs) was. To calculate the correlation coefficient (r), the following formula is used:

$$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[N.\Sigma X^2 - (\Sigma X)^2][N.\Sigma Y^2 - (\Sigma Y)^2]}}$$

Information :

r : Correlation coefficient value
n : Number of samples
ΣX : The total number of variables X
ΣY : The total number of Y variables
XY : The sum of the multiplication results of the variables X and Y
(ΣX2) : The sum of the squares of the variable X
(ΣX)2 : Square of the number of variables X
(ΣY2) : The sum of the squares of the variable Y
(ΣY)2 : Square of the sum of Y variables
X : Free variable (chest length, wing length, back length, femur length, tibia length, shank length).
Y : Dependent variable (Breast meat weight and thigh meat weight).

Results and Discussion

Body size

Body size is a factor that needs to be studied to determine the bone growth and body structure of chickens. The size of livestock affects the development of bones and meat produced. The larger the livestock's frame size, the more significant the body size (Sitanggang *et al.*, 2015; Depison *et al.*, 2022). The results of the average body size can be seen in Table 1.

Table 1. Average body size of male and female kampung chickens of various ages (weeks)

Variable	Age (weeks)	Gender	
		Male	Female
Chest length (mm)	4	49.13 ± 5.82[a]	47.87 ± 5.67[b]
	6	62.48 ± 5.94[a]	58.42 ± 5.21[b]
	8	74.70 ± 6.60[a]	70.94 ± 5.19[b]
	10	85.62 ± 7.94[a]	80.28 ± 9.43[b]
	12	94.41 ± 7.20[a]	87.51 ± 6.64[b]
Thigh length (mm)	4	112.25 ± 13.12[a]	111.37 ± 15.33[b]
	6	143.17 ± 11.31[a]	133.97 ± 23.44[b]
	8	176.79 ± 16.32[a]	169.63 ± 10.84[b]
	10	202.37 ± 15.85[a]	191.06 ± 23.54[b]
	12	222.78 ± 14.10[a]	204.12 ± 11.36[b]

[a,b] Different superscripts on the same line mean significantly different ($p<0.05$).

The growth and body structure of chickens are influenced by various factors, one of which is their body size. A study by Sitanggang *et al.* (2015) suggests that the livestock's frame size significantly affects bone growth and meat production. As shown in Table 1, the average body size of chickens in terms of chest and thigh length varies depending on genetic and environmental factors.

Comparing the results with Puteri *et al.* (2020) research, the current study found that the body size of chickens in chest length was lower at 8 weeks of age. The uniform ecological conditions were considered in this study, such as feeding and rearing the chickens in the same cage environment, making environmental diversity almost non-existent. Despite that, the body size differences between the chickens were believed to be caused by genetic potential, origin location, and the rearing and mating systems applied (Hikmawaty *et al.*, 2014: Wahyuni *et al.*, 2022).

The current study's t-test results showed no significant difference between the length of the chest and thigh length in male and female kampung chickens at 4 weeks of age. However, after 6 weeks of age, the body size of male chickens significantly increased compared to the female chickens, particularly in chest length. At 8 and 10 weeks, the body size of chest and thigh length in male kampung chickens was significantly higher than in female kampung chickens. Similarly, at 12 weeks, chest and thigh length body measurements of kampung chicken males were significantly higher than in female kampung chickens.

This study's findings align with previous research suggesting that male livestock typically has a larger body frame than females, resulting in better performance (Sari *et al.*, 2021; Abdu *et al.*, 2021; Prawira *et al.*, 2021). Sadick *et al.* (2020) also note that the size of the body frame significantly determines an animal's body size. Moreover, that male chickens have higher growth regulatory hormones than females, making their body size more important (Pagala *et al.*, 2019; Wahyudi *et al.*, 2022).

In summary, the current study highlights the importance of body size in determining the growth and structure of chickens. It also suggests that genetic and environmental factors play a vital role in determining the body size differences among male and female chickens.

According to Tamzil and Indarsih (2020) that there are differences in the body size of male and female super kampung chickens, where the body size of male kampung chickens is more significant than female super kampung chickens. Furthermore, it was also stated that there were differences in body size for male and female Sentul chickens (Abdu *et al.*, 2021), male and female Merawang chickens (Sari *et al.*, 2021) and male and female Bangkok chickens (Rahayu *et al.*, 2021; Wahyudi *et al.*, 2022).

Weight of flesh and bones (breast and thigh)

Formation of high carcass meat, influenced by the ratio of meat and bone.Pieces of poultry breast have thick flesh with small bones. The boneless portion of the chicken breast is then weighed (Putra *et al.*, 2015). The results of the average weight of meat and bone can be seen in Table 2.

Meat from the carcass part separated from the bone is also called boneless meat. The boneless process or separation of meat from chicken bones consists of two parts: the boneless part on the chest and the boneless on the thighs. The ratio of meat and bone influences the formation of high-carcass meat.

The study's findings in Table 2 reveal a significant difference between the average weight of meat and bones in male and female native chickens at 12 weeks of age. As expected, livestock with larger bones tend to produce larger carcass pieces and grow faster than smaller ones (Lukmanudin *et al.*, 2018). The results of the t-test also confirm that the meat weight in male kampung chickens at 12 weeks of age is significantly higher ($p<0.05$) than that of female kampung chickens

Interestingly, the bone weight in male kampung chickens was also significantly higher than in female kampung chickens. The weight of breast bones was 27.06 ± 5.65 g for males and 20.96 ± 4.03 g for females, while the weight of thigh bones was 64.29 ± 16.76 g for males and 47.78 ± 7.53 g for females. Permadi *et al.* (2020) stated that bone growth in male kampung chickens is faster than bone growth in female kampung chickens.

Based on the results of this study, it can be seen that the larger the bone in the chicken, the more meat is produced. This follows the opinion of Rizkuna *et al.* (2014), which states that longer bones are thought to have a larger meat mass

Table 2. Average meat and bone weight of male and female free-range chickens aged 12 weeks

Variable	Gender	
	Male	Female
CMW (g)	144.20 ± 27.78[a]	121.17 ± 22.38[b]
TMW (g)	185.00 ± 27.00[a]	141.04 ± 19.02[b]
CBW (g)	27.06 ± 5.65[a]	20.96 ± 4.03[b]
TBW (g)	64.29 ±16.76[a]	47.78 ± 7.53[b]

CMW=chest meat weight, TMW=thigh meat weight, CBW= chest bone weight, TBW=thigh bone weight, W=week.
[a,b] Different superscripts on the same line mean significantly different (p<0.05).

Table 3. Equation of body size and body shape of male kampung chickens and female kampung chickens

Type		Equality	KT (%)	Λ
Male kampung chicken	Body size	0.446 CL + **0.485 TL**+ 0.471 WL + 0.373 BL + 0.453 SL	79.4	397.090
	Body shape	-0.153 CL - 0.130 TL - 0.069 WL + **0.901 BL**0.379 SL	10.9	54.370
Female kampung chicken	Body size	0.398 CL + **0.476 TL**+ 0.451 WL + 0.448 BL + 0.460 SL	79.3	3966.570
	Body shape	**0.848 CL**- 0.134 TL - 0.474 WL + 0.058 BL - 0.188 SL	9.6	47.810

KT=total diversity, CL=chest length, TL= thigh length, WL=wing length, BL=back length, SL=shank length.

space so that bones with optimal length will produce higher carcass weights.

The ratio of meat and bone-in chicken carcasses is the weight of meat compared to the weight of bones in the carcass. The higher the value of the ratio of meat and bone in the carcass, the higher the proportion of carcass parts that can be consumed (Suhita *et al.*, 2019).

Principal component analysis

Principal component analysis (PCA) is a useful tool for discerning the differences in body size and shape between chickens. Mahmudi *et al.* (2019) stated that quantitative traits can be used to determine the level of livestock productivity, identify and determine characteristics in livestock which include size and shape. Identification of phenotypic characteristics using principal component analysis aims to determine the characteristics and body shape. Table 3 presents the similarities in size and shape, total diversity (KT), and eigenvalues (λ) of both male and female kampung chickens.

Table 3 shows that the highest eigenvector in the body size equation in both male and female kampung chickens is the length of the thigh (the combined length of the Femur and Tibia), while the shape determinant in the male kampung chicken is the back length and the female kampung chicken is the chest length. The results of this study on kampung male chickens are the same as that of research Puteri *et al.* (2020) that the tibia is the length that characterizes the size of KUB chickens, while the back length characterizes the shape of KUB chickens. The results of this study are different when compared to the results of Ashifudin *et al.* (2017), who suggested that the wings' length is a significant identifier for body size in second chicken breeds, and the femur's length is the identifier for body shape.

The results of Prawira *et al.* (2021) which states that the determinant of size in male and female kampung chickens is chest circumference, while the determinant of the shape of male kampung chickens is the width of the chest and the female's upper body length. Furthermore, the research results from Wahyuni *et al.* (2022) state that the determinant of body size in Sentul and kampung chickens is the chest circumference and the determinant of body shape is the chest width in Sentul chickens and wing length in kampung chickens, which suggested that wing length is a significant identifier for body size in the second race chicken, and femur length is an identifier for body shape. This difference highlights the genetic differences that exist between the different chicken lines, as studied by Mahmudi *et al.* (2019).

Furthermore, the environment and topography of the rearing area also play a role in determining body size, in addition to genetics. This underscores the importance of proper rearing and care for chickens to achieve optimal body size and shape. The findings of this study provide useful information for breeding and selection programs aimed at improving chicken productivity and quality.

The relationship between body size and weight of flesh and bones (chest and thigh)

To further explore the relationship between body size and weight of flesh and bone (breast and thigh) in male and female kampung chickens of different ages, regression equations, correlation coefficient values (r), and determination values (r2) can be found in Tables 4 to 7. These tables offer valuable insights into the quantitative impact of each independent variable on the dependent variable, allowing for a more in-depth analysis of the data.

Table 4 shows that the results of simple linear regression analysis and multiple linear regression between the length of the chest and thighs had a very significant effect (p<0.05) on the weight of meat and bones (breast and thighs) in free-range male chickens aged 12 weeks. Meaning that the size of the body size will affect the size of the meat weight and bones. The regression equation, in general, shows a positive and significant relationship.Simple linear regression analysis and multiple linear regression between the length of the chest and thighs with the weight of the meat and bones (breast and thighs) in male kampung chickens aged 12 weeks showed positive and negative values.

Based on Table 4 it can be seen that all equations have simple linear regression, which has a positive value, meaning that if it has a positive value, then every increase in body size is followed by an increase in meat and bone weight, for

Table 4 . Regression equation between body size (chest length and thigh length) and flesh and bone weight (chest and thigh) in male kampung chickens of various ages (week)

Description	Variable	Equality
Chest length	General	CMW = -139.4 + 0.163 CL 4 W + 0.594 CL 4 W - 1.362 CL 8 W + 1.372 CL 10 W + 2.359 CL 12 W
	CL 4 W– CMW	CMW = 3.9 + 2.855 CL 4 W
	CL 6 W– CMW	CMW = -28.4 + 2.762 CL 6 W
	CL 8 W– CMW	CMW = -36.7 + 2.422 CL 8 W
	CL 10 W–CMW	CMW = -77.4 + 2.589 CL 10 W
	CL 12 W– CMW	CMW = -145.7 + 3.071 CL 12 W
	General	TMW = -45.5 + 1.245 CL 4 W+ 1.30 CL 6 W- 1.36 CL 8 W+ 0.627 CL 10 W+ 1.440 CL 12 W
	CL 4 W – TMW	TMW = 43.8 + 2.873 CL 4 W
	CL 6 W – TMW	TMW = 20.6 + 2.632 CL 6 W
	CL 8 W – TMW	TMW = 30.7 + 2.066 CL 8 W
	CL 10 W – TMW	TMW = 2.0 + 2.137 CL 10 W
	CL 12 W – TMW	TMW = -48.3 + 2.471 CL 12 W
	General	CBW= -11.9 - 0.215 CL 4 W+ 0.060 CL 6 W+ 0.212 CL 8 W+ 0.344 CL 10 W+ 0.005 CL 12 W
	CL 4 W – CBW	CBW= 10.85 + 0.330 CL 4 W
	CL 6 W – CBW	CBW= -0.81 + 0.446 CL 6 W
	CL 8 W – CBW	CBW= -8.18 + 0.472 CL 8W
	CL 10 W – CBW	CBW= -7.28 + 0.401 CL 10W
	CL 12 W – CBW	CBW= -8.8 + 0.380 CL 12W
	General	TBW= -29.2 - 0.491 CL 4 W+ 0.798 CL 6W- 0.466 CL 8W+ 1.037 CL 10W+ 0.145 CL 12W
	CL 4 W –TBW	TBW = 22.6 + 0.849 CL 4 W
	CL 6 W – TBW	TBW = -9.0 + 1.174 CL 6 W
	CL 8 W – TBW	TBW = -7.5 + 0.961 CL 8W
	CL 10 W – TBW	TBW = -19.3 + 0.977 CL 10W
	CL 12 W – TBW	TBW = -25.9 + 0.955 CL 12W
	General	CMW = 83.4 + 0.605 CBW+ 0.692 TBW
	CBW– CMW	CMW = 100.2 + 1.625 CBW
	TBW–CMW	CMW = 93.2 + 0.793 TBW
	General	TBW = 115.9 + 1.156 CBW+ 0.588 TBW
	CBW–TMW	TMW= 130.3 + 2.023 CBW
	TBW - TMW	TMW= 134.8 + 0.781 TBW
Thigh length	General	CMW = -217.9 + 0.041 TL 4 W+ 0.690 TL 6W- 0.552 TL 8W-0.030 TL 10W+ 1.626 TL 12W
	TL 4 W – CMW	CMW = -3.0 + 1.311 TL 4 W
	TL 6 W – CMW	CMW = -101.0 + 1.712 TL 6W
	TL 8 W – CMW	CMW = -11.0 + 0.878 TL 8W
	TL 10 W – CMW	CMW = -99.7 + 1.205 TL 10W
	TL 12 W – CMW	CMW = -204.0 + 1.563 TL 12W
	General	TMW = -154.0 - 0.241 TL 4 W+ 0.092 TL 6 W- 0.478 TL 8 W+ 0.836 TL 10 W+ 1.203 TL 12 W
	TL 4 W – TMW	TMW = 61.5 + 1.100 TL 4 W
	TL 6 W – TMW	TMW = -32.6 + 1.520 TL 6 W
	TL 8 W – TMW	TMW = 21.8 + 0.923 TL 8 W
	TL 10 W – TMW	TMW = -79.7 + 1.308 TL 10 W
	TL 12 W – TMW	TMW = -149.0 + 1.499 TL 12 W
	General	CBW = -3.8 + 0.0468 TL 4 W+ 0.048 TL 6 W+ 0.2194 TL 8 W+ 0.198 TL 10 W- 0.270 TL 12 W
	TL 4 W – CBW	CBW = 7.89 + 0.1707 TL 4 W
	TL 6 W – CBW	CBW = -10.9 + 0.2649 TL 6 W
	TL 8 W – CBW	CBW = -14.95 + 0.2376 TL 8 W
	TL 10 W – CBW	CBW = -17.45 + 0.2199 TL 10 W
	TL 12 W – CBW	CBW = -14.5 + 0.1867TL 12 W
	General	TBW = -20.3 + 0.762 TL 4 W- 0.253 TL 6 W+ 0.228 TL 8 W+ 0.535 TL 10 W- 0.509 TL 12 W
	TL 4 W –TBW	TBW = -25.8 + 0.803 TL 4 W
	TL 6 W – TBW	TBW = -29.9 + 0.658 TL 6 W
	TL 8 W – TBW	TBW = -27.5 + 0.519 TL 8 W
	TL 10 W – TBW	TBW = --56.8 + 0.599 TL 10 W
	TL 12 W – TBW	TBW = -67.2 + 0.590 TL 12 W
	General	CMW = 83.4 + 0.605 CBW+ 0.692 TBW
	CBW–CMW	CMW = 100.2 + 1.625 CBW
	TBW–CMW	CMW = 93.2 + 0.793 TBW
	General	TMW= 115.9 + 1.156 CBW+ 0.588 TBW
	CBW– TMW	TMW= 130.3 + 2.023 CBW
	TBW-TMW	TMW= 134.8 + 0.781 TBW

CL=chest length, TL=thigh length, CMW=chest meat weight, TMW=thigh meat weight, CBW= chest bone weight, TBW=thigh bone weight, W=week.

example, the highest partial regression in kampung roosters is the relationship between breast length and weight breast meat aged 12 weeks with the equation Y = -145.7 + 3.071 X and thigh length with breast meat weight Y = 204.0 + 1.563 X. This means that each addition of 1 cm to each measure of breast length and thigh length can cause the weight gain of meat and bones to increase according to the regression coefficients of 3.071 g and 1.563 g. Paiman (2019) stated that the regression line in the equation means that every 1 cm increase in body size will increase the weight of flesh and bone according to the coefficient value.

Multiple linear regression equations show positive and negative regression coefficients. The regression coefficient is positive meaning that if it has a positive value then every increase in the length of the breastbone and thighs is followed by an increase in the weight of the meat and bones (breast and thighs), the regression coefficient is negative meaning that if it has a positive value then every increase in the length of the breastbone and

Table 5. Regression equation between body measurements (chest length and thigh length) by weight of meat and bone (breast and thigh) in female kampung chickens of various ages (week)

Description	Variable	Equality
Chest length	General	CMW= -103.5 - 0.10 CL 4 W- 0.129 CL 6 W+ 0.729 CL 8 W+ 1.034 CL 10 W+ 1.170 CL 12 W
	CL 4 W – CMW	CMW = -11.6 + 2.774 CL 4 W
	CL 6 W – CMW	CMW = -18.0 + 2.382 CL 6 W
	CL 8 W – CMW	CMW = -94.0 + 3.034 X CL 8 W
	CL 10 W – CMW	CMW = -30.6 + 1.890 CL 10 W
	CL 12 W – CMW	CMW = -105.9 + 2.594 CL 12 W
	General	TMW= -68.9 - 1.14 CL 4 W+ 1.275 CL 6 W+ 0.04 CL 8 W- 0.032 CL 10 W+ 2.17 CL 12 W
	CL 4 W – TMW	TMW = 51.8 + 1.863 CL 4 W
	CL 6 W – TMW	TMW = 16.3 + 2.136 CL 6 W
	CL 8 W – TMW	TMW = 3.9 + 1.933 CL 8 W
	CL 10 W – TMW	TMW = 52.5 + 1.103 CL 10 W
	CL 12 W – TMW	TMW = -30.8 + 1.964 CL 12 W
	General	CBW = -8.0 - 0.695 CL 4 W + 0.453 CL 6 W+ 0.428 CL 8 W- 0.259 CL 10 W+ 0.299 CL 12 W
	CL 4 W – CBW	CBW = 27.71 - 0.141 CL 4 W
	CL 6 W – CBW	CBW = 12.80 + 0.140 CL 6 W
	CL 8 W – CBW	CBW = 13.5 + 0.106 CL 8 W
	CL 10 W – CBW	CBW = 27.46 - 0.0810 CL 10 W
	CL 12 W – CBW	CBW = 23.6 - 0.030 CL 12 W
	General	TBW = -21.0 - 0.329 CL 4 W+ 0.033 CL 6 W+ 1.087 CL 8 W- 0.314 CL 10 W+ 0.351 CL 12 W
	CL 4 W –TBW	TBW = 30.5 + 0.362 CL 4 W
	CL 6 W – TBW	TBW = 23.3 + 0.419 CL 6 W
	CL 8 W – TBW	TBW = -5.3 + 0.748 CL 8 W
	CL 10 W – TBW	TBW = 32.9 + 0.186 CL 10 W
	CL 12 W – TBW	TBW = 14.1 + 0.385 CL 12 W
	General	CMW= 70.7 - 2.23 CBW+ 2.033 TBW
	CBW – CMW	CMW= 121.5 - 0.01 CBW
	TBW – CMW	CMW= 57.2 + 1.339 TBW
	General	TMW= 80.5 + 0.38 CBW+ 1.098 TBW
	CBW –TMW	TMW= 107.9 + 1.580 CBW
	TBW - TMW	TMW= 82,9 + 1,217 TBW
Thigh length	General	CMW= -118.0 + 0.390 TL 4 W+ 0.076 TL 6 W+ 0.320 TL 8 W+ 0.262 TL 10 W+ 0.398 TL 12 W
	TL 4 W – CMW	CMW= 20.7 + 0.902 TL 4 W
	TL 6 W – CMW	CMW= 63.2 + 0.432 TL 6 W
	TL 8 W – CMW	CMW= -89.9 + 1.245 TL 8 W
	TL 10 W – CMW	CMW= 16.3 +0.549 TL 10 W
	TL 12 W – CMW	CMW= -141.9 + 1.289TL 12 W
	General	TMW= -51.0 + 0.218 TL 4 W- 0.097 TL 6 W- 0.329 TL 8 W+ 0.440 TL 10 W+ 0.898TL 12 W
	TL 4 W – TMW	TMW= 52.9 + 0.792 TL 4 W
	TL 6 W – TMW	TMW= 99.0 + 0.314 TL 6 W
	TL 8 W – TMW	TMW= -42.0 + 1.079 TL 8 W
	TL 10 W – TMW	TMW= 57.7 + 0.688 TL 10 W
	TL 12 W – TMW	TMW= -126.6 + 1.311 TL 12 W
	General	CBW= -9.1 - 0.1050 TL 4 W+ 0.0311 TL 6 W+ 0.179 TL 8 W- 0.0790 TL 10 W+ 0.110 TL 12 W
	TL 4 W – CBW	CBW= 21.89 - 0.0084 TL 4 W
	TL 6 W – CBW	CBW= 21.02 - 0.0004 TL 6 W
	TL 8 W – CBW	CBW= -1.2 + 0.1309 TL 8 W
	TL 10 W – CBW	CBW= 26.20 - 0.0274 TL 10 W
	TL 12 W – CBW	CBW= -0.3 + 0.1040 TL 12W
	General	TBW= -45.5 - 0.176 TL 4 W+ 0.0373 TL 6 W+ 0.340 TL 8 W- 0.0795 TL 10 W+ 0.321 TL 12W
	TL 4 W –TBW	TBW= 39.6 + 0.073 TL 4 W
	TL 6 W – TBW	TBW= 44.08 + 0.0276 TL 6 W
	TL 8 W – TBW	TBW= -24.4 + 0.425 TL 8 W
	TL 10 W – TBW	TBW= 39.1 + 0.0456 TL 10 W
	TL 12 W – TBW	TBW= -31.2 + 0.387 TL 12W
	General	CMW= 70.7 - 2.23 CBW+ 2.033 TBW
	CBW – CMW	CMW= 121.5 - 0.01 CBW
	TBW – CMW	CMW= 57.2 + 1.339 TBW
	General	TMW= 80.5 + 0.38 CBW+1.098 TBW
	CBW – TMW	TMW= 107.9 + 1.580 CBW
	TBW-TMW	TMW= 82.9 + 1.217 TBW

CL=chest length, TL=thigh length, CMW=chest meat weight, TMW=thigh meat weight, CBW= chest bone weight, TBW=thigh bone weight, W=week.

thighs is followed by a decrease in the weight of the meat and bones (chest and thighs). Multiple linear regression of the relationship between breast bone length and breast meat weight at 12 weeks of age with the equation Y = -139.4 + 0.163 X1 + 0.594 X2 - 1.362 X3+ 1.372 X4 + 2.359 X5 and thigh bone length with breast meat weight Y = -217, 9 + 0.041 X1 + 0.690 X2 - 0.552 X3 - 0.030 X4 + 1.626 X5.

Simple linear regression analysis and multiple linear regression between the length of the chest and thighs with the weight of the flesh and bones (breast and thighs) in 12 weeks old kampung female chickens showed positive and negative values.

Based on Table 5 it can be seen that all equations have simple linear regression which has a positive value, meaning that if it has a positive value then every increase in the length of the chest and thighs is followed by an increase in the weight of the meat and bones, as an example of a simple regression in female free-range chicken the relationship between bone length chest with breast meat weight at 12 weeks old with the equation Y = -105.9 + 2.594 X and thigh bone length with thigh

Table 6. Correlation coefficient value (r), determination value (r2) between body size (chest length) and flesh and bone weight (breast and thigh) in male and female kampong chickens of various ages (week)

Description	Variable	Male		Female	
		r	r²	r	r²
Kampung chicken	General	0.83	0.69	0.84	0.70
	CL 4 W – CMW	0.60	0.36	0.70	0.49
	CL 6 W – CMW	0.59	0.35	0.55	0.31
	CL 8 W – CMW	0.58	0.33	0.70	0.49
	CL 10 W – CMW	0.74	0.55	0.80	0.63
	CL 12 W – CMW	0.80	0.63	0.77	0.59
	General	0.73	0.53	0.73	0.53
	CL 4 W – TMW	0.62	0.38	0.56	0.31
	CL 6 W – TMW	0.58	0.34	0.59	0.34
	CL 8 W – TMW	0.50	0.26	0.53	0.28
	CL 10 W – TMW	0.63	0.39	0.55	0.30
	CL 12 W – TMW	0.66	0.43	0.69	0.47
	General	0.61	0.37	0.68	0.47
	CL 4 W – CBW	0.34	0.12	-0.20	0.04
	CL 6 W – CBW	0.47	0.22	0.18	0.03
	CL 8 W – CBW	0.55	0.30	0.14	0.02
	CL 10 W – CBW	0.56	0.32	-0.19	0.04
	CL 12 W – CBW	0.48	0.23	-0.05	0.002
	General	0.50	0.25	0.58	0.34
	CL 4 W –TBW	0.30	0.09	0.27	0.07
	CL 6 W – TBW	0.42	0.17	0.29	0.08
	CL 8 W – TBW	0.38	0.14	0.52	0.27
	CL 10 W – TBW	0.46	0.21	0.30	0.09
	CL 12 W – TBW	0.41	0.17	0.34	0.12
	General	0.49	0.24	0.55	0.30
	CBW – CMW	0.33	0.11	0.00	0.00
	TBW – CMW	0.48	0.23	0.45	0.20
	General	0.53	0.28	0.49	0.24
	CBW –TMW	0.42	0.18	0.33	0.11
	TBW - TMW	0.49	0.24	0.48	0.23

r = correlation , r^2 = determination value, CL=chest length, CMW=chest meat weight, TMW=thigh meat weight, CBW= chest bone weight, TBW=thigh bone weight, W=week.

Table 7. Correlation coefficient value (r), determination value (r2) between body size (thigh length) with the weight of meat and bone (chest and thigh) in male and female kampung chickens of all ages (week)

Description	Variable	Male		Female	
		r	r²	r	r²
Kampung chicken	General	0.83	0.68	0.77	0.59
	TL 4 W – CMW	0.62	0.38	0.62	0.38
	TL 6 W – CMW	0.70	0.49	0.45	0.21
	TL 8 W – CMW	0.52	0.27	0.60	0.36
	TL 10 W – CMW	0.69	0.47	0.58	0.33
	TL 12 W – CMW	0.79	0.63	0.65	0.43
	General	0.82	0.67	0.82	0.67
	TL 4 W – TMW	0.53	0.29	0.64	0.41
	TL 6 W – TMW	0.64	0.41	0.39	0.15
	TL 8 W – TMW	0.56	0.31	0.61	0.38
	TL 10 W – TMW	0.77	0.59	0.81	0.66
	TL 12 W – TMW	0.78	0.61	0.78	0.61
	General	0.75	0.56	0.59	0.35
	TL 4 W – CBW	0.40	0.16	-0.032	0.001
	TL 6 W – CBW	0.53	0.28	-0.0032	0.00001
	TL 8 W – CBW	0.69	0.47	0.35	0.12
	TL 10 W – CBW	0.62	0.38	-0.16	0.03
	TL 12 W – CBW	0.47	0.22	0.29	0.09
	General	0.70	0.49	0.71	0.50
	TL 4 W –TBW	0.63	0.39	0.15	0.02
	TL 6 W – TBW	0.44	0.20	0.09	0.01
	TL 8 W – TBW	0.51	0.26	0.61	0.37
	TL 10 W – TBW	0.57	0.32	0.14	0.02
	TL 12 W – TBW	0.50	0.25	0.58	0.34
	General	0.49	0.24	0.56	0.31
	CBW – CMW	0.33	0.11	0.00	0.00
	TBW – CMW	0.45	0.20	0.45	0.20
	General	0.53	0.28	0.00	
	CBW – TMW	0.42	0.18	0.33	0.11
	TBW-TMW	0.49	0.24	0.48	0.23

r = correlation , r^2 = determination value, TL=thigh length, CMW=chest meat weight, TMW=thigh meat weight, CBW= chest bone weight, TBW=thigh bone weight, W=week.

meat weight Y = -126.6 + 1.311 X. This means that every addition of 1 cm to each size of the length of the breastbone and thigh can cause the weight gain of meat and bones to increase according to the regression coefficients of 2.594 g and 1.311 g. Paiman (2019) stated that the regression line in the equation means that every 1 cm increase in body size will increase the weight of flesh and bone according to the coefficient value.

Multiple linear regression equations show positive and negative regression coefficients. The regression coefficient is positive meaning that if it has a positive value then every increase in the length of the breastbone and thighs is followed by an increase in the weight of the meat and bones (breast and thighs), the regression coefficient is negative meaning that if it has a positive value then every increase in the length of the breastbone and thighs is followed by a decrease in the weight of the meat and bones (chest and thighs). Multiple linear regression of the relationship between breast bone length and breast meat weight at 12 weeks of age with the equation Y = -103.5 - 0.10 X1 - 0.129 X2 + 0.729 X3 + 1.034 X4 + 1.170 X5 and thigh bone length with thigh meat weight Y = -51.0 + 0.218 X1 - 0.097 X2 - 0.329 X3 + 0.440 X4 + 0.898 X5.

Table 6 presents interesting findings regarding the relationship between body size, chest length, and the weight of meat and bones (breast and thighs) in male and female kampung chickens. Notably, the data collected from various ages showed that the correlation coefficients were highest at 12 weeks of age. For instance, the correlation coefficient of breast length with breast meat weight is 0.80 for males and 0.77 for females, indicating a strong relationship between these variables.

Furthermore, the correlation coefficient of chest length with breastbone weight is 0.48 for male kampung chickens, while the correlation between chest length and femur weight is 0.34 for female kampung chickens, both classified as moderate. These findings suggest that body size significantly affects the weight of flesh and bone (chest and thighs).

In terms of determination value, it was found that body size, chest length, and breast meat weight accounted for 63% of the variation in males and 59% in females. Chest length with the weight of the sternum was responsible for 23% of the variation in males, and chest length with femur weight accounted for 12% of the variation in females. These results indicate that the variation in body size and chest length is influenced by the weight of flesh and bones (breast and thighs) and other unobserved factors.

The interpretation of the value of r (correlation coefficient) is classified as a very high (+/-) correlation with a value of 0.900 to 1.000, high 0.700 to 0.900, moderate 0.500 to 0.700, low 0.300 to 0.500 and meaningless 0.000 to 0.300 (Hinkle *et al.*, 1988). The correlation coefficient at the level of reality almost never finds a correlation that is absolutely perfect (+1.00 or -1.00) or absolutely no correlation (zero, 0).

Table 7 presents interesting findings on the relationship between body size, thigh length, and the weight of meat and bones (breast and thighs) in male and female kampung chickens. The data collected from various ages shows that the correlation coefficients are the highest at 12 weeks of age. For example, in kampung roosters, the correlation coefficient of thigh length with breast meat weight is 0.79, and thigh length with thigh bone weight is 0.50. Similarly, in female kampung chickens, the correlation coefficient of thigh length with thigh meat weight is 0.78, and thigh length with thigh bone weight is 0.58. These results indicate that the size of the body has a significant effect on the weight of flesh and bone (chest and thighs).

Furthermore, the determination value of body size, thigh length, and the weight of meat and bones was found to be 63% for male and 59% for female kampung chickens. In kampung roosters, the length of the thigh with the weight of the breast meat was 63%, and the length of the thigh with the weight of the thigh bone was 25%. Meanwhile, in female kampung chickens, the length of the thigh with the weight of the thigh meat was 59%, and the length of the thigh with the weight of the thigh bone was 34%. This implies that variations in body size and thigh length are significantly influenced by the weight of flesh and bone (breast and thigh), while other unobserved factors play a role in the remaining variation.

These findings suggest that the high correlation coefficient values can be used as an indicator for selecting chickens based on body size to achieve desirable meat and bone weight (breast and thigh). As per Djego and Kihe (2020), a correlation coefficient value between 0.5-1.0 is considered high, 0.25-0.50 is moderate, 0.05-0.25 is low, and 0.00-0.05 is very low. Therefore, a high correlation coefficient value, close to 1, indicates a positive correlation (unidirectional relationship) between the body size and meat and bone weight. Overall, these findings emphasize the importance of body size in determining the weight of meat and bone in kampung chickens.

Conclusions

The conclusion of this study is that the body size characteristic of male and female native chickens is thigh length, the body shape characteristic of male native chickens is back length and the difference between female native chickens is chest length. Body size in terms of breast length and thigh length has the closest relationship with breast meat weight and thigh meat weight in free-range chicken (Gallus domesticus) as a result of third generation selection. Chest length and thigh length can be used as selection criteria for male and female native chickens to increase the weight of breast and thigh meat in the next generation.

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