Egypt. Poult. Sci. Vol. (43) (IV): (595-615)(2023) **(2310-1269)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

PREDICTION MODELS FOR CARCASS TRAITS AND BONE GEOMETRICS USING LIVE BODY WEIGHT IN BROILER CHICKENS RELATED TO STRAIN, SEX AND ITS INTERACTIONS

A.M. Abdelmoniem*, M.Y. Mahrous, S.A. El-Safty and Mona A.M. Hemida

Dep. of Poult. Prod., Fac. of Agric., Ain Shams Uni., Hadayek Shoubra, 11241 Cairo, Egypt.

***Corresponding author:** Dr. Abdelmoniem Hanafy, Email: abdelmoniem_hanafy@agr.asu.edu.eg

Received: 04/10/2023 Accepted: 16 /11/2023

ABSTRACT: This study aims to develop predictive equations for muscle and bone indexes using live body weight and to characterize the correlation between body weight, bones morphometrics and carcass characteristics of two sexed broiler strains. Six hundred chicks were reared and distributed into four groups. Carcass traits, bone and breast morphometrics were measured. Pearson correlation calculated among carcass traits, body measurements, breast morphometrics and bone geometrics. Linear regression model calculated to predicting with breast index, tibia seedor index and femur seedor index using live body weight. Main results showed that the strain had an insignificant effect on the tibia and femur traits, while sex had significant effect on most tibia and femur traits. The TSI (Tibia Seedor Index) and FSI (Femur Seedor Index) were higher in males of Ross strain than Cobb males and all females. Shank and keel length were higher in males than females and in Cobb than Ross strain. Sex and strain significantly affected the breast muscle width and circumference of males than females and Ross than Cobb strain, while BI (Breast Index) was insignificant higher for Ross and males than Cobb and females. Carcass results demonstrated that males of Ross always recorded higher values compared to another groups. LBW (Live Body Weight) was significantly positive correlated with drum % in Ross females, dressed weight % in Ross males and high significantly positive with FRI (Femur Robusticity Index) in Cobb males, while it had significantly negative correlation with BI in Ross females and TRI (Tibia Robusticity Index) in Cobb females. The BI, TSI and FSI could be used for predicting carcass quality as well as live body weight in different strains and both sexes. In conclusion, it could be beneficial to raise each sex or strain separately to utilize each alone when its traits correlated or predicted with specific traits. Males of Ross strain showed the preference performance compared to other groups.

Keywords: Prediction, correlation, bone, carcass, broiler

INTRODUCTION

Production of chicken meat broiler is depending on many factors like the variety on the modern broiler chicken strains and the improving of its management and health. To achieve advancement in this field the chicks must express its full genetic capacity (Henrique *et al.,* 2017). Chickens bone geometrics are important as they indicate the basic supportive and protective functions while, body measurements and breast morphometrics play a significant role in carcass characteristics and final body weight. In industry forums, there has been extensive discussion about the poultry skeleton. Commercial poultry strains have created to increase meat output (Applegate and Lilburn, 2002). According to Warris (2010), animal tissue development occurs in a specific order over each stage of an animal's life cycle, with the maturation of the nervous system occurring first, followed by the formation of bone, muscle, and then fat. According to Moran and Todd (1994), the femur could cause more of a challenge than the tibia in processing related skeletal issues. Based on Singh *et al.* (1985) results, heavier birds should have longer shank and keel bones. According to Ojedapo *et al.* (2012), body weight would rise with linear body dimensions. Between 70 to 80 percent of bone mass is determined genetically, whereas only 20 to 30 percent can be attributable to outside variables, the two most significant of which are management and food (Eastell and Lambert, 2002). Conventional broiler chicken production cycles often take no longer than 38 to 42 days, and the breeding firm attests that there are only minor differences in the live body weight of male and female broilers at that age (Müsse *et al.,* 2022). For instance, the live weights stated in the (Aviagen catalogue, 2022) for the conventional strain Ross-308 are 2150 g for female and 2441 g for male broilers after 35 days of fattening. Another illustration: After 35 days of fattening, the live weights for the conventional strain Cobb 500 broilers are 2348 g for females and 2694 g for males (Cobb catalogue, 2022). The correlation between body weight and features of tibia and femur development in male and female New Hampshire chickens who was initially described by (Buckner *et al.,* 1950). Their data's regression analysis revealed that body weight was a factor in >98% of the variation in tibia and femur length. One of the four main factors that lower the economics of production is impaired bone development, which restricts the growth of poultry and increases mortality and losses because of improper carcass classification in slaughterhouses (Damaziak *et al.,* 2014 and Gocsik *et al.,* 2014). The development of regression equations using some measurements is an indirect, accurate, and non-invasive way to estimate carcass components, according to research by (Costa *et al.*, 2020 and Gomes *et al.*, 2021). This study aims to study the relationships among bone morphometrics carcass characteristics, body measurements and their correlations, in additional to strain and sex effect. Also, to develop regression equations for predicting bones and muscle geometric indices related to live body weight in studied genetic groups.

1. MATERIALS AND METHODS

1.1. Experimental Site and Time

This study was conducted during the summer season of year 2021in the Poultry Research Farm, Faculty of Agriculture, Ain Shams University, which located in the semi-warm temperate zone between $30^{o}21$ N and $31^{o}14$ E.

1.2. Experimental Birds and Design

A total of six hundred chicks from "Cobb-500 and Ross-308" broiler strains were raised, and sex separated at 1 day of the age by vent sexing involves opens-up the chick's cloaca slightly, allowing to see if the chick had a small bump, which would refer that the chick is a male. In a completely randomized design, the chicks were separated at random into two strains of each sex, with thirty chicks per replicate.

1.3. Experimental Diets and Management

The genetic groups were fed on a commercial starter diet from 1 to 10 days of age, a commercial grower diet from 11 to 24 days of age and commercial finisher diet from 25 day of age until 35 day. Food and water for all birds provided *ad libitum*. All chicks brooded and reared under similar environmental conditions in floor pens at a wood shavings litter up to 5 wk. The average minimum and maximum ambient temperatures and relative humidity followed according to the commercial catalog of broiler chickens. Continuous lighting program followed during the 5 weeks.

1.4. Collected data

1.4.1. Body weight and Carcass characteristics

At 35 days, five randomly selected birds per every genetic group and sexes slaughtered and dissected, and measurements made of the carcass characteristics. Birds individually weighed before slaughtered. The birds eviscerated by removing the viscera. The dressing, breast muscles (minor and major pectorals) and leg muscles (thigh and drumstick) weighed in grams. The giblets (liver, heart, and gizzard) weighed in grams. Edible parts contain dressing carcass plus giblets. Inedible parts such “abdominal fat, head, foot, feather” and lymphoid organs “thymus, spleen and bursa glands” removed and weighed, while blood calculated by subtracting bird weight before and after bleeding, and then calculate edible and inedible parts percentages to live body weight pre-slaughtering. All measurements expressed as a percentage proportion of the live body weight.

1.4.2. Breast morphometrics

Breast length (BL) and breast width (BW) measured with a 0.01 mm precision digital caliper in selected birds from each genetic group. The maximum distance between the two points on the breast defined as BW, the longest distance between two sites on the sternum from front to back was determined as BL (Yamak *et al*., 2017). The breast index (BI) equation (BW*BL) utilized according to (Xu *et al*., 2018). Breast circumference (BC) was measured by wrapping a flexible tape around the total breast muscle from the upper mid-point.

1.4.3. Bone morphometrics

The same five chickens slaughtered previously from each group were studied to measuring the morphometric analysis of tibia and femur bones sampling based on their average live body weight. The wet tibia weight of the birds was taken after the birds slaughtered by carefully removing the tibia bones from both sides, cleaning them of any soft tissues and cartilages using a scalpel blade, and weighing in relation to their live body weight, as shown by (Abdelaziz *et al*., 2019). According to the procedure outlined by Samejima *et al.* (1989), the tibia length and tibia width were measured with a digital caliper with 0.01 mm precision.

The Tibia length (TL) measured in (mm) from the proximal end to the distal end and the width at the medial diaphysis. The Tibia width (TW) of the proximal and distal tibia epiphyses measured in (mm). Femur length (FL) measured in (mm) from the proximal end of the shaft to lateral condyle and the Femur width (FW) in (mm) at the medial diaphysis (Zhang and Coon, 1997).

1.4.4. Bone geometrics indices

Geometric parameters (Seedor index and robusticity index) of the tibia (TSI) and femur (FSI) bones calculated. Bone weight/length index known as the Seedor index obtained by dividing the tibia weight by its length**,** Seedor index displays the mineral density of the bone as an absolute number (Seedor *et al.,* 1991) and calculated according to the following formula**:**

Seedor index= bone weight (mg) **/** bone length (mm)

The robusticity index was determined for tibia (TRI) and femur (FRI) bones using the following formula (Reisenfeld, 1972), respectively:

Robusticity index= bone length (mm) / cubic root of bone weight

1.4.5. Body measurements

Body measurements (BM) were taken in vivo on marketing age of 35 days before slaughtering using a digital caliper in millimeter. Birds were placed upright on a flat surface, then body measurements were taken, these were: Shank length (SL): was measured along the length of the tarsometatarsus from the hock joint to the metatarsal pad, Shank circumference (SC): was taken as the girth around the shank of the bird by wrapping a flexible tape, Keel length (KL): was measured as the chicken was held on its back and measuring the distance from the anterior to the posterior edge of the keel, Body depth (BD): was measured from the anterior point on the bird back to the inferior point on abdomen side. All measurements were made by the same person for consistency purposes and to avoid undesirable measurement errors.

1.4.6. Statistical analysis

The data analyzed using the general linear model procedure of the SAS software program, version 9.4 (SAS Inst. Inc., Cary, NC). Strain (Ross-308 and Cobb-500), sex (male, female), and their interactions were included as fixed factors and examined using the two-way ANOVA approach. Initially, descriptive statistics for the variables were collected using MEANS procedure. The Duncan's Multiple Range tests used for mean separation and analysis of variance at 0.05 significant level is considered.

1.4.7. Statistical models

1.4.7.1. Pearson Correlation

Pearson’s Correlation (rP) analyses test was used to determine the relationships between independent variable (body weight) and dependent variables (bone morphometrics, carcass traits and body measurements), they were determined at 35 d of age at slaughter for each sex per strain, using the PROC CORR procedures of (IBM SPSS Statistics v20, 2011) software. The level of significance was set for $P \leq 0.05$ and $P \leq 0.01$.

The correlation coefficients (r) among all parameters under study were calculated according to Snedecor and Cockren (1978)

1.4.7.2. Linear Regression

Simple linear regressions were developed to estimate functional relationships among variables using the REG procedure of (SAS v9.4, 2004). The goodness of fit of the models was determined using the determination coefficient (R^2), root mean square error (RMSE).

The regression equations for predicting bone geometry and breast indexes from linear body weight were calculated according to Steel and Torrie (1984) using the following formulas for the simple regression equation:

$Y = a + b x + e$

Where Y is the dependent variable (live body weight); x is one of the independent variables: FSI (Femur Seedor Index), TSI (Tibia Seedor Index) and BI (Breast Index); a is the intercept that represents the estimate of dependent variable when the independent variable is zero; b is the regression coefficient associated with the independent variables; e is residual (error).

2. RESULTS AND DISCUSSION

2.1. Carcass characteristics

Table 1 and 2 presented the carcass edible and inedible parts percentages. Ross-308 strain presented superior live body weight in relation to Cobb-500 that was significantly higher at 35 day of age. The superior live body weight of Ross-308 chicks male chicks at 35 day of age was on both hybrid. At the same time live body weight had significant interaction ($p \leq 0.05$) between strain and sex when the male Ross-308 strain had the heaviest live body weight at 35 day of age. Hascik *et al*. (2010) found no significant differences between Cobb-500 and Ross-308 with regard to BW. In contrast to our results a higher precocity of the Cobb strain was conducted comparing with other broiler chicken strains (Danisman and Gous, 2011; Faridi *et al*., 2012 and Sakomura *et al*., 2011). On the other hand, Api *et al*., (2017) indicate a superiority of females live body weight in relation to males regardless of age in broiler strains.

Dressing percentages wasn't significantly differed between the studied groups as there was no significant effect due to neither strain, sex nor their interaction, however the Ross-308 strain had the superior dressing percentages compared to Cobb-500. The same result was observed by Fernandes *et al*. (2013), Likewise, Moreira *et al.* (2003) did not find significant differences neither for males or females on the carcass yield at 42 day of age.

Breast muscle is one of the most expensive and treasured part of carcass. Longer breasts and more uniform in muscle thickness resulted in better yield and reduce meat leftovers. Like the previous results, the whole and the major breast muscles percentages did not significantly affect by the studied factors (strain, sex and their interaction). On the contrary, the minor breast muscles percentages were significantly affected by sex as inversely the females of both strains significantly had a higher minor breast muscles percentages compared to male. Our results are in agreement with Janisch *et al.*, (2011), Fernandes *et al*. (2013) and Hassan *et al*., (2021) they found that breast yield wasn't significantly differed between Cobb 700 and Ross 308 strains and even between sexes. Inversely, Dalólio *et al.,* (2016) and Api *et al.,* (2017) observed greater breast yield for Cobb strain compared with the other broiler chicken strains.

Despite non-significant effect of strain, sex and their interaction on the hind parts of carcass, the male Ross-308 chickens had non significantly higher percentages of thigh and drumstick muscles. Likewise, Hassan *et al*., (2021) found non-significant different between Cobb500 and Ross on leg yield. Also, Nogueira *et al*., (2019) found that drumstick, thigh wasn't significantly affected by both sex and strain. As well as, Fernandes *et al.* (2013) found that bone leg percentages wasn't significantly affected by strain or sex. The same like was Janisch *et al.,* (2011) who found that leg yield wasn't significantly differed between Cobb 700 and Ross 308 strain at 28 and 41. However, Ristic (2005) found that thigh yield at slaughter weight was significantly higher for the Ross 308 strain compared to Cobb500. On the contrary, Marcato *et al.* (2006) concluded significantly larger drumsticks in chicken of Cobb-500 genotype than in other genotypes.

Giblet weight percentages also wasn't significantly differed due to both strain and sex with the non-significant superior percentages for the Ross-strain.

Inedible parts of carcass showed in table 2. The Cobb-500 significantly had a higher blood and foots weight percentages, significantly lower abdominal fat weight percentages and a non-significant higher head weight percentage compared to the Ross-308 which consequently reflected on the whole inedible parts weight percentages which were non significantly increased at the Cobb-500. Likely, Hassan *et al.,* (2021) found that Cobb 500 strain had a higher abdominal fat percentages compared to the rest hybrid. Foot weight percentages was significantly affected by sex when the male had the higher percentages.

2.2. Breast morphometrics

Table 3 illustrated breast muscles morphometrics. Breast muscles length wasn't significantly differed among strain, sex and their interaction. However, Cobb-500 had slightly longer breast muscle length. on the other hand breast muscles width was significantly differed between strain and sex but there wasn't a significant effect for strain and sex interaction. (Chen *et al*., 2023) showed that breast width in broiler males increased with highly significant ($p \leq 0.01$) than females.

Also, breast muscles circumference was significantly differed between strain and follow the same trend of the breast bones morphometrics previously mentioned as it had a significantly higher breast muscles circumference for male chickens regardless of strain compared to female ones. The same results obtained by (Chen *et al*., 2023) when showed that breast circumference in males of yellow Chinese broiler strain recorded 28.46 cm higher than females 26.41 cm. The current study reported that breast muscles indexes weren't affected by strain, sex or their interaction.

2.3. Bone morphometrics

As a result of the short production cycle of commercial broiler chickens its locomotors bones did not reach maturity or to its static growth before the marketing age (Mabelebele *et al.,* 2017). Femur and tibia bones play a major role as a supporting structure for faster growing of broiler chicken (Applegate and Lilburn, 2002).

Bone morphometrics for both sexes of Ross-308 and Cobb-500 strains at 35 days of age illustrated in table 4**.** Tibia weight % was significantly affected by sex and the interaction (s*x**)** as generally the males had significantly highest tibia weight. Also, the Cobb-500 males had significantly higher tibia weight percentage compared to the rest studied groups.

Femur weight percentage was also estimated at 35 days of age showed that there were no significant differences neither between strains nor sexes. Also, there was no significant interaction for both sex and strain on femur weight.

Tibia length and width had in-significantly affected by strain however the males had a significant longer and wider tibia compared with females, but the Cobb-500 males had a non-significant longer and wider tibia compared to the rest groups. The same as femur length and width were not significantly affected by strain but was affected by sex when males had significantly longer and wider femur than females. Mabelebele, *et al.* (2017) found that sex and breed affected the bone length, weight and width of Ross-308 broiler at 90 days of age.

The femur bone length in the current study at 35 days for Ross-308 and Cobb-500 broiler male and female were 74.25 and 70.00 mm, respectively, whereas for males and females Cobb-500 were 100.05 and 94.11 mm, respectively. The femur length values for both strain and sex were lower than the values reported by Mabelebele *et al.* (2017) that Ross 308 broiler femur length for male and female were 96.89 and 92.38 mm at 90 days respectively this might be due to age differences. The tibia bone length in the current study at 35 days for Ross-308 and Cobb-500 broiler male and female were 98.31 and 93.55 mm, respectively, whereas for males and females Cobb-500 recorded 100.05 and 94.11 mm, respectively, whereas Mabelebele *et al* (2017) indicated a higher value for tibia lengths for Ross-308 broiler 144.90 for males and 126.06 mm for females. The males in the present study, regardless of the strain, had heavier, wider, and longer tibia and femur compared to their females. Our results are agreed with that mentioned by (Charuta *et al.,* 2013) who indicated that bone length is related to sexual dimorphism. The significantly heavier femur and tibia bone weights of Cobb-500 and Ross-308 males was in agreement with the findings of Applegate and Lilburn (2002) who observed that sex had an effect on tibia and femur weights.

Our results indicated that tibia and femur width of male and female of Ross-308 and Cobb-500 strains follow a similar trend as the bone weights and lengths. Increase in bone length would be expected to correlate with the bone width indicating the overall bone size (Van Wyhe *et al.,* 2012) which was higher in tibia bones of Ross-308 broiler chickens and in femoral bones of Cobb 500 in our current study. If the bone length continues to grow and increase without the increase in bone width, this could predispose chickens to increase skeletal problems.

2.4. Bone geometrics Indices

Bones geometrics which clarified in table 5 are important as an indication of the basic supportive and protective internal structures of the broiler chickens (Charuta, 2013). Bone geometry analysis varied among strain and sex of chickens. Tibia and femur seedor index were not significantly differed among both strains. In the other hand, it was significantly higher at males compared to males regardless of strains. The Seedor index that is also known as bone weight/bone length index is an indication of bone density (Seedor, 1995). Higher bone densities in the current study were observed for male of both Ross-308 and Cobb-500 strains. Robusticity index of both tibia and femur was not significantly differed due to strain or sex or their interaction among the studied groups. Safaeikatouli *et al*., (2012) pointed out that bone low robusticity index is an indication of a strong bone structure, that fact explain the non-significant lighter values of tibia and femur robusticity of males compared to females of both studied breeds.

2.5. Body measurements

The chicken chest is the main element in meat growth. The chest size used to determine the quality of the meat because most of the muscle, which is the biggest carcass issue, is around the chest (Lisnahan, 2017). chest muscle the part of the chicken body that responds to food quality and quantity is the and followed by the thigh muscle (Kita *et al.*, 2002) Shank length and circumference.

Body measurements (BM) were taken at 35 day of age are presented in table 6. There was a significant effect of strain, sex and their interaction on shank length which was significantly longer at Cobb-500 compared to Ross-308 strain. However, Ross-308 shank circumference was significantly the highest values because body length is affected by bone growth while shank circumference is affected by the increasing breast meat and body weights (Lisnahan *et al.*, 2020) that was higher at Ross strain as we mentioned previously. Following the similar trend of carcass shank length and circumference were significantly higher at males compared to female ones regardless of strain. Also the interaction between strains and sex significantly related to shank length and circumference as males of Cobb-500 had the longest shank where the males of Ross-308 had the widest circumference.

Keel length wasn't significantly affected by strain with a non-significant superior for Cobb-500. In the other hand, Keel length was significantly affected by sex as the males had the higher values compared to females however strain and sex interaction haven't a significant effect on keel length. Body depth was significantly affected by strain as the Ross-308 had the higher value (100.94 mm) compared to Cobb-500 (90.44 mm). Body depth was not significantly differed by sex factor however males had non-significantly higher than females. Also, there wasn't strain and sex interaction.

2.6. Pearson correlations

Table 7 presents on upper of diagonal the correlations between carcass characteristics and bone geometrics for Ross-308 broiler males, and under the diagonal those of Ross-308 broiler females. Similarly, table 8 presents on upper of diagonal the correlations between carcass characteristics and bone geometrics for Cobb-500 broiler males, and under the diagonal those of Cobb-500 broiler females.

In males of Ross-308 strain, live body weight was highly and positively correlated with dressed % (P=0.03; r=+0.94). Furthermore, drumstick % recorded highly and negatively correlation with keel length (P=0.036; r=-0.773). Also, FSI in Ross-308 males positively correlated with BI and BD (P=0.032, r=-0.787 & P=0.048, r=-0.736), respectively. Moreover, TRI showed highly significant negatively correlation with shank length (P=0.003, r=-0.935).

Concerning females of Ross-308 strain, live body weight was highly and negatively correlated with breast index (P=0.025; r=-0.811), but positively and highly correlated with the drumstick weight percentage (P=0.03, r=+0.794). Moreover, the drumstick percentage was very weakly correlated (P=0.464, r=+0.048) with the total breast muscle percentage. The dressed weight percentage was highly and negatively correlated with total breast muscle percentage (P=0.032, r=-0.936) while the thigh weight percentage was highly and positively associated with total breast muscle percentage (P=0.035, r=+0.777). In Ross-308 females, the breast index % was negatively significant correlated with both drum weight % and TSI (P=0.035, r=-0.776 & P=0.046, r =-0.741), respectively. Furthermore, the keel length was highly and negatively correlated with body depth (P=0.032, r=-0.785) while was highly and positively associated with shank length, FRI and TRI (r =+0.753, r=+0.795 & r=+0.842), subsequently. Also, shank length in Ross-308 females showed negatively correlated with FSI and TSI (P=0.243, r=-0.358 & P=0.033, r=-0.782), respectively, but showed highly significant positively association with FRI and TRI (P=0.018, r=+0.840 & P=0.002, r=+0.947), respectively.

With respect to Cobb-500 strain, LBW in males recorded higher positively correlation with FRI than females (P=0.007, r=+0.902 & P=0.386, r=-0.154), respectively, while negatively significant correlated with TRI (P=0.029, r=-0.797) in females and (P=0.418, r=+0.11) in males. Breast index % showed higher positively correlation with TBM % in males than females (P=0.03, r=+0.94 & P=0.09, r=+0.62), respectively. Also, BI % achieved higher positively correlation with keel length in males than females (P=0.024, r=+0.82 & P=0.283, r=+0.298), respectively. On the other hand, BI % was higher negatively correlated with thigh % in males than females (P=0.044, r=-0.748 & P=0.471, r=-0.038), consequently, but higher negatively correlated with FSI in females than males (P=0.044, r=-0.746 & P=0.074, r=-0.667), consequently. Total breast muscle % was negatively correlated with thigh muscle % in males higher than females (P=0.02, r=-0.96 & P=0.08, r=-0.65), respectively, while both males and females were approximating in negatively correlation values for TBM % with FSI (P=0.05, r=-0.90 & P=0.006, r=-0.91). The TBM % recorded positively correlation with TSI in males, on contrary of females which had negatively significant correlation (P=0.196, r=+0.61 & P=0.021, r=-0.83), respectively. With respect to thigh muscle %, it was positively significant correlated with drumstick muscle % in females, while had negatively in-significant correlation in males (P=0.034, r=+0.77 & P=0.35, r=-0.199), respectively. The thigh muscle % showed higher positively correlation with FSI in males (P=0.002, r=+0.943) than females (P=0.174, r=+0.469).

Ebong *et al*. (2023) reported that Breast weight had a significant (p<0.05) correlation with keel length trait 0.204. Similarly, thigh weight also had a significant (p<0.05) and positive correlation with all the morphometric traits. Dress weight had a significantly high and positive correlation with body weight.

As an overall, the total breast muscle % and breast index was more associated with the other carcass and bone traits in all studied groups. Furthermore, there were a lot of fluctuations in correlations among various traits to four studied chicken groups. The significant correlation between body weight with breast and thigh weights is due to increased muscle tissue deposition in these parts of the carcass (Ogah, 2011). More research (Melo *et al.,* 2003; Yang *et al.,* 2006; Mendeş & Akkartal, 2009 and Erensoy *et al.,* 2020) found high and significant relationships between body weight with body measurements, carcass traits and primal cut weights. This shows that body weight and body measures could be used to predict carcass composition with high accuracy.

2.7. Linear regressions

The linear regression analyses of femur seedor index, tibia seedor index and breast index of both sexes for Ross-308 and Cobb-500 broiler chickens as a function of carcass are presented in figures (1-12) and table 9 which presents regression equations, coefficients of determination, root mean standard error, Durbin-Watson test, and levels of statistical significance of models predicting the FSI, TSI and BI of four studied groups based on live body weight all groups. Data showed that all linear regression models were adequate as could be seen from non-statistical significance (p>0.05). The comparison of models elevated that the R^2 was beneficial indicator of the dependent variable, explained with regression accuracy.

In the equations generated to predict FSI the R^2 ranged from 0.12 to 0.24 for Ross-308 strain. Regarding the equations TSI developed to predict the carcass quality, R^2 ranged from 0.66 to 0.77 for Ross-308 strain and from 0.28 to 0.67 for Cobb-500 strain. The prediction equations obtained for developed BI trait generated to predict the R^2 ranged from 0.44 to 0.53 for Cobb-500 strain. The current generated prediction models had lower, moderate to high accuracy; therefore, high accuracy prediction models can be used by specialist researchers to obtain information on the carcass quality of commercial broiler chicken strains.

After evaluation of regression accuracy, the most accurate were selected for validation of their prediction power (TSI models for Ross 308 males “R^2=66.35%” – Ross 308 females “R^2=77.16%” and Cobb 500 females “R^2=66.8%) and for (BI models for Ross

308 females "R^2=73.56%" and Cobb 500 males "R^2=53.31%).

Ebong *et al*. (2023) indicated that the coefficient of determination R^2 recorded in keel length for predicting dressed weight was 70.01% and they showed that (dressed weight, thigh weight and breast weight) that the R^2 values were more than 50% in all the morphometric traits used, suggesting that any of the morphometric traits could be used to predict carcass yield in Ross-308. It is known that R^2 value above 50% can be used for accurately predict parameter (Altman and Krzywinski, 2015). The better prediction accuracy as more variables were included in the regression equation had earlier been reported by (Ajayi *et al*., 2008). Congetosi *et al.* (1983) defines coefficient of determination as the percentage of flactuati on in the value of the dependent variable that can be explained by variations in the value of th e independent variable. Body weight and linear body measurements have a relationship (Ige, 2013). Aside from body weight, linear body measurements are a good predictor of chicken market value (Ukwu *et al.*, 2014). Several authors have reported on the assessment of chicken body weight and linear body measurements in the literature (Momoh & Kershima, 2008; Alabi *et al.*, 2012; Ukwu *et al*., 2014). In addition to calculating the tissue composition of the carcass in poultry of various breeds and sexes, the mathematical models established in this sort of study contribute to determine the ideal market age (Faridi *et al.*, 2012). According to Adenaike *et al.* (2023), morphometric characteristics play a significant impact in the prediction of live body weight and carcass yields in broiler chickens.

3. CONCLUSION

In conclusion, it could be concluded that males of Ross-308 strain showed the preference performance compared to other groups in carcass characteristics, bone geometric and body measurements to make specific recommendations for breeders and researchers.

4. ACKNOWLEDGEMENT

This paper is based upon work supported by the Science, Technology Innovation Funding Authority (STDF) under grant (Technology Development Grants, STDF-TDG).

Table(1): Edible parts of carcass for both sexes of Ross 308 and Cobb 500 broiler chickens.

Variable	Sex	Strain				Overall	Probability		
		Ross 308	cv%	Cobb 500	cv%	(Sex)	S	X	S×X
Body weight, g	Male	2230.83±28.11	3.08	1965.00±53.10	6.62	2097.92[a]	0.0041	<.0001	0.0011
	Female	1764.17±24.67	3.42	1785.83 ±38.15	5.23	1775.00[b]			
Overall (Strain)		1997.50[a]		1875.42[b]					
Dressing wt. %	Male	74.65±0.67	1.79	73.95±0.48	1.30	74.30	NS	NS	NS
	Female	74.73±0.23	0.62	73.20±1.28	4.31	73.82			
Overall (Strain)		74.69		73.50					
Breast Muscle wt. %	Male	24.11±0.78	7.97	23.12±1.06	7.96	23.78	NS	NS	NS
	Female	23.99±0.72	7.35	23.95±0.96	9.85	23.97			
Overall (Strain)		24.05		23.68					
Major Breast muscle wt.,%	Male	20.37±0.52	6.36	19.60±0.80	7.06	20.12	NS	NS	NS
	Female	19.74±0.68	8.46	19.83±0.79	9.81	19.78			
Overall (Strain)		20.06		19.75					
Minor Breast muscle wt.,%	Male	3.73±0.27	18.07	3.52±0.36	17.75	3.66[b]	NS	0.0394	NS
	Female	4.24±0.17	10.07	4.12±0.19	11.78	4.18[a]			
Overall (Strain)		3.99		3.92					
Thigh muscle wt., %	Male	14.18±0.53	9.30	13.34±0.56	10.46	13.76	NS	NS	NS
	Female	14.23±0.43	7.54	13.33±0.25	4.74	13.78			
Overall (Strain)		14.20		13.33					
	Male	10.44±0.46	10.94	9.98±0.43	10.70	10.21	NS	NS	NS
	Female	10.48±0.53	12.44	10.10±0.25	6.07	10.29			
Overall (Strain)		10.46		10.04					
Drumstick muscle wt. %	Male	9.99±0.14	3.54	10.13±0.39	9.43	10.06	NS	NS	NS
	Female	10.07±0.26	6.42	9.24±0.26	7.15	9.65			
Overall (Strain)		10.03		9.69					
Boneless Drumstick wt., %	Male	6.91±0.15	5.41	6.86±0.31	11.32	6.89[a]	NS	0.0387	NS
	Female	6.69±0.13	4.99	6.14±0.19	7.63	6.42[b]			
Overall (Strain)		6.80		6.50					
Edible Parts wt., %	Male	78.39±0.70	1.80	79.00±1.08	3.35	78.76	NS	NS	NS
	Female	78.45±0.21	0.55	76.78±1.15	3.69	77.45			
Overall (Strain)		78.42		77.89					
Liver wt., %	Male	2.18±0.10	9.72	1.81±0.09	12.96	1.96	NS	NS	NS
	Female	2.23±0.07	6.56	2.12±0.13	15.34	2.17			
Overall (Strain)		2.21		1.97					
Gizzard wt., %	Male	1.15±0.07	12.93	1.01±0.04	11.63	1.07	NS	NS	NS
	Female	1.12±0.02	5.33	1.06±0.06	14.90	1.09			
Overall (Strain)		1.13		1.03					
Heart wt., %	Male	0.404±0.021	10.41	0.432±0.027	15.58	0.421	NS	NS	NS
	Female	0.375±0.031	18.77	0.386±0.016	10.31	0.382			
Overall (Strain)		0.388		0.409					
Giblets wt., %	Male	3.74±0.16	8.93	3.26±0.12	9.24	3.45	NS	NS	NS
	Female	3.72±0.09	5.14	3.58±0.18	12.51	3.63			
Overall (Strain)		3.73		3.42					

cv%=coefficient of variability, [a,b]Means within the same row with different letters are significantly different (P≤0.05). Edible parts = dressing carcass plus giblets (liver, heart, and gizzard)

Table (2): Inedible parts of carcass for both sexes of Ross 308 and Cobb 500 broiler chickens.

Variable	Sex	Strain				Overall (Sex)	Probability		
		Ross 308	cv%	Cobb 500	cv%		S	X	S×X
Blood wt., %	Male	5.02±0.30	13.72	6.03±0.23	9.52	5.525	0.0029	NS	NS
	Female	4.92±0.17	8.86	6.03±0.44	18.08	5.475			
Overall (Strain)		4.97[b]		6.03[a]					
Feather wt., %	Male	6.90±0.33	10.72	7.06±0.24	8.32	6.98	NS	NS	NS
	Female	6.48±0.35	13.42	5.16±1.18	56.36	5.82			
Overall (Strain)		6.69		6.11					
Head wt., %	Male	2.14±0.08	9.32	2.16±0.06	7.44	2.150	NS	NS	NS
	Female	2.00±0.04	5.64	2.25±0.05	4.56	2.125			
Overall (Strain)		2.070		2.205					
Feet wt., %	Male	3.40±0.11	8.08	3.67±0.09	6.12	3.535[a]	0.0046	0.0002	NS
	Female	2.96±0.03	3.21	3.27±0.08	5.11	3.115[b]			
Overall (Strain)		3.18[b]		3.47[a]					
Abdominal fat wt., %	Male	2.11±0.22	21.60	1.62±0.09	14.50	1.715	0.0046	NS	NS
	Female	1.99±0.15	17.02	1.52±0.13	21.52	1.730			
Overall (Strain)		2.05[a]		1.42[b]					
Spleen wt., %	Male	0.089±0.036	57.20	0.042±0.007	44.50	0.066	0.0252	NS	NS
	Female	0.077±0.018	47.64	0.044±0.011	50.57	0.061			
Overall (Strain)		0.083[a]		0.043[b]					
Bursa wt., %	Male	0.076±0.009	17.56	0.083±0.016	49.01	0.081	NS	NS	NS
	Female	0.097±0.028	59.65	0.074±0.022	75.89	0.083			
Overall (Strain)		0.087		0.079					
Thymus wt., %	Male	1.269±0.086	16.77	1.000±0.15	27.15	1.135[b]	NS	0.0082	NS
	Female	1.476±0.186	22.21	1.552±0.11	16.63	1.503[a]			
Overall (Strain)		1.361		1.276					
Inedible Parts wt., %	Male	21.004±0.70	6.54	21.365±1.08	12.61	21.185	NS	NS	NS
	Female	19.977±0.21	2.03	19.900±1.15	12.21	19.939			
Overall (Strain)		20.491		20.633					

cv%=coefficient of variability,

[a,b]Means within the same row with different letters are significantly different (P≤0.05).

Table (3): Breast muscle morphometrics for both sexes of Ross 308 and Cobb 500 broiler chickens.

Variable	Sex	Strain				Overall (Sex)	Probability		
		Ross 308	cv%	Cobb 500	cv%		S	X	S×X
Breast Muscle Length, cm	Male	15.75±0.73	11.49	16.41±0.30	4.48	16.08	NS	NS	NS
	Female	15.91±0.23	3.67	16.08±0.39	6.03	16.00			
Overall (Strain)		15.83		16.25					
Breast Muscle Width, cm	Male	15.25±0.31	4.97	14.33±0.35	6.10	14.79[a]	0.0291	0.0037	NS
	Female	14.00±0.28	5.05	13.25±0.44	8.18	13.62[b]			
Overall (Strain)		14.62[a]		13.79[b]					
Breast Muscle Circumference, cm	Male	34.66±0.49	3.49	33.41±0.58	4.27	34.04[a]	0.0125	0.0187	NS
	Female	33.50±0.25	1.88	32.25±0.42	3.21	32.87[b]			
Overall (Strain)		34.08[a]		32.83[b]					
Breast Muscle Index, cm^2	Male	240.62±13.84	14.09	235.79±9.91	10.29	238.21	NS	NS	NS
	Female	222.91±6.30	6.92	213.20±9.10	10.45	218.06			
Overall (Strain)		231.77		224.50					

cv%=coefficient of variability,

[a,b]Means within the same row with different letters are significantly different (P≤0.05).

Table (4): Bones morphometrics for both sexes of Ross 308 and Cobb 500 broiler chickens.

Variable	Sex	Strain				Overall (Sex)	Probability		
		Ross 308	cv%	Cobb 500	cv%		S	X	S×X
Body weight, g	Male	2230.83±28.11	3.08	1965.00±53.10	6.62	2097.92[a]	0.0041	<.0001	0.0011
	Female	1764.17±24.67	3.42	1785.83 ±38.15	5.23	1775.00[b]			
Overall (Strain)		1997.50[a]		1875.42[b]					
Tibia weight, g	Male	20.17±0.36	4.47	20.01±0.50	6.16	20.09[a]	NS	<.0001	NS
	Female	15.88±0.38	5.89	15.57±0.37	5.83	15.73[b]			
Overall (Strain)		18.03		17.79					
Tibia weight %	Male	0.905±0.025	6.82	1.021±0.013	3.16	0.962[a]	NS	0.0029	0.0053
	Female	0.901±0.014	4.07	0.871±0.031	8.58	0.887[b]			
Overall (Strain)		0.902		0.946					
Femur weight, g	Male	13.77±0.27	4.95	12.55±0.37	7.29	13.16[a]	NS	<.0001	NS
	Female	10.34±0.46	11.07	10.64±0.32	7.39	10.49[b]			
Overall (Strain)		12.05		11.59					
Femur weight %	Male	0.618±0.018	7.12	0.640±0.018	7.18	0.629	NS	NS	NS
	Female	0.587±0.028	11.67	0.596±0.019	7.82	0.591			
Overall (Strain)		0.602		0.618					
Tibia length, mm	Male	98.31±0.55	1.37	100.05±1.62	3.97	99.18[a]	NS	0.0006	NS
	Female	93.55±1.19	3.12	94.11±1.56	4.07	93.83[b]			
Overall (Strain)		95.93		97.08					
Femur length, mm	Male	74.25±1.50	4.95	73.96±1.42	4.70	74.11[a]	NS	0.0031	NS
	Female	70.00±1.16	4.09	69.27±1.19	4.23	69.64[b]			
Overall (Strain)		72.13		71.62					
Tibia width., mm	Male	8.35±0.21	6.05	8.70±0.39	10.97	8.53[a]	NS	0.0013	NS
	Female	7.55±0.18	5.90	7.57±0.20	6.48	7.56[b]			
Overall (Strain)		7.95		8.13					
Femur width., mm	Male	9.41±0.229	5.97	8.84±0.37	10.47	9.13[a]	NS	0.0019	NS
	Female	7.82±0.33	10.58	8.19±0.28	8.65	8.01[b]			
Overall (Strain)		8.62		8.52					

cv%=coefficient of variability,

[a,b]Means within the same row with different letters are significantly different (P≤0.05).

Table (5): Bone geometric analysis for both sexes of Ross 308 and Cobb 500 broiler Chickens.

Variable	Sex	Strain				Overall (Sex)	Prob.		
		Ross 308	cv%	Cobb 500	cv%		S	X	S×X
Tibia Seedor Index (mg/mm)	Male	205.22±3.24	3.87	200.15±4.92	6.02	202.68[a]	NS	<.0001	NS
	Female	170.02±5.19	7.48	165.57±3.45	5.11	167.79[b]			
Overall (Strain)		187.621		182.861					
Femur Seedor Index (mg/mm)	Male	185.58±3.08	4.07	169.60±2.47	3.57	177.59[a]	NS	<.0001	0.0195
	Female	147.75±6.37	10.56	153.62±4.20	6.70	150.69[b]			
Overall (Strain)		166.671		161.616					
Tibia Robusticity Index	Male	3.61±0.02	1.34	3.68±0.05	3.80	3.64	NS	NS	NS
	Female	3.70±0.08	5.28	3.76±0.05	3.45	3.73			
Overall (Strain)		3.65708		3.72825					
Femur Robusticity Index	Male	3.09±0.05	4.12	3.18±0.03	2.78	3.14	NS	NS	NS
	Female	3.21±0.05	4.25	3.15±0.04	3.71	3.18			
Overall (Strain)		3.15842		3.16733					

cv%=coefficient of variability, [a,b]Means within the same row with different letters are significantly different (P≤0.05).

Table (6): Body measurements for both sexes of Ross 308 and Cobb 500 broiler chickens.

Variable	Sex	Strain				Overall (Sex)	Probability		
		Ross 308	cv%	Cobb 500	cv%		S	X	S×X
Shank Length, mm	Male	95.17±0.66	1.70	95.74±0.78	2.00	95.46[a]	0.0095	<.0001	0.0308
	Female	82.50±1.75	5.22	87.97±0.54	1.51	85.23[b]			
Overall (Strain)		88.83[b]		91.86[a]					
Shank Circumference, mm	Male	15.08±0.30	4.87	14.16±0.21	3.64	14.62[a]	0.0079	0.0079	NS
	Female	14.16±0.16	2.88	13.41±0.39	7.23	13.79[b]			
Overall (Strain)		14.62[a]		13.79[b]					
Keel Length, mm	Male	134.20±2.58	4.72	132.41±2.31	4.29	133.31[a]	NS	0.0083	NS
	Female	116.54±6.96	14.63	126.88±1.42	2.74	121.71[b]			
Overall (Strain)		125.378		129.652					
Body Depth, mm	Male	103.99±2.57	6.05	92.76±1.48	3.92	98.37	0.0024	NS	NS
	Female	97.89±5.14	12.88	88.12±1.07	2.99	93.01			
Overall (Strain)		100.94[a]		90.44[b]					

cv%=coefficient of variability,

[a,b]Means within the same row with different letters are significantly different (P≤0.05).

Table(7): Pearson correlation coefficients between carcass characteristics and bone geometrics for Ross308 broiler males (upper diagonal) and females (lower diagonal) at 35 days of age.

VARIABLE		LBW	Dressed %	TBM %	BI	KL	BD	SL	Thigh %	Drum%	FSI	TSI	FRI	TRI
LBW	**Pearson Correlation**	**1**	**.940***	**-.381-**	**.288**	**.234**	**-.716-**	**-.213-**	**.634**	**-.012-**	**-.129-**	**-.496-**	**-.208-**	**.330**
	Sig. (1-tailed)		.030	.228	.290	.328	.055	.343	.088	.491	.404	.159	.347	.262
Dressed%	**Pearson Correlation**	**-.629-**	**1**	**-.778-**	**.501**	**.166**	**-.781-**	**.106**	**.544**	**.352**	**-.147-**	**-.498-**	**-.463-**	**.023**
	Sig. (1-tailed)	.186		.111	.250	.417	.110	.447	.228	.324	.427	.251	.269	.488
TBM%	**Pearson Correlation**	**.228**	**-.936-***	**1**	**.142**	**.567**	**.328**	**-.646-**	**-.496-**	**-.584-**	**.036**	**-.302-**	**.031**	**.650**
	Sig. (1-tailed)	.332	.032		.394	.120	.263	.083	.159	.112	.473	.280	.477	.081
BI	**Pearson Correlation**	**-.811-***	**.144**	**.289**	**1**	**-.072-**	**.288**	**-.437-**	**.237**	**.210**	**.787***	**-.142-**	**-.739-***	**.207**
	Sig. (1-tailed)	.025	.428	.289		.446	.290	.193	.325	.345	.032	.394	.047	.347
KL	**Pearson Correlation**	**.046**	**-.368-**	**.572**	**.328**	**1**	**-.570-**	**-.237-**	**-.276-**	**-.773-***	**-.570-**	**-.361-**	**.418**	**.488**
	Sig. (1-tailed)	.466	.316	.118	.263		.119	.325	.298	.036	.119	.241	.205	.163
BD	**Pearson Correlation**	**.180**	**-.775-**	**-.129-**	**-.289-**	**-.785-***	**1**	**-.238-**	**-.227-**	**.306**	**.736***	**.271**	**-.413-**	**-.062-**
	Sig. (1-tailed)	.366	.113	.404	.289	.032		.325	.333	.278	.048	.301	.208	.453
SL	**Pearson Correlation**	**.088**	**-.459-**	**.715**	**.302**	**.753***	**-.719-**	**1**	**-.105-**	**.251**	**-.318-**	**.698**	**.464**	**-.935-****
	Sig. (1-tailed)	.434	.270	.055	.280	.042	.054		.422	.316	.270	.061	.177	.003
Thigh%	**Pearson Correlation**	**.173**	**-.842-**	**.777***	**.247**	**.069**	**.140**	**.561**	**1**	**-.041-**	**.287**	**.109**	**-.047-**	**.108**
	Sig. (1-tailed)	.372	.079	.035	.319	.448	.396	.123		.470	.290	.419	.464	.420
Drum%	**Pearson Correlation**	**.794***	**-.370-**	**.048**	**-.776-***	**-.045-**	**.400**	**-.324-**	**-.217-**	**1**	**.389**	**-.019-**	**-.680-**	**-.482-**
	Sig. (1-tailed)	.030	.315	.464	.035	.466	.216	.266	.340		.223	.486	.069	.167
FSI	**Pearson Correlation**	**-.074-**	**.541**	**.059**	**-.179-**	**-.510-**	**.615**	**-.358-**	**.106**	**.237**	**1**	**.199**	**-.691-**	**-.012-**
	Sig. (1-tailed)	.444	.229	.456	.367	.151	.097	.243	.421	.325		.353	.064	.491
TSI	**Pearson Correlation**	**.488**	**-.252-**	**-.621-**	**-.741-***	**-.527-**	**.534**	**-.782-***	**-.547-**	**.689**	**.042**	**1**	**.446**	**-.757-***
	Sig. (1-tailed)	.163	.374	.094	.046	.142	.138	.033	.131	.065	.468		.188	.041
FRI	**Pearson Correlation**	**.138**	**-.527-**	**.407**	**.243**	**.795***	**-.832-***	**.840***	**.252**	**-.291-**	**-.802-***	**-.490-**	**1**	**-.189-**
	Sig. (1-tailed)	.397	.237	.212	.321	.029	.020	.018	.315	.288	.027	.162		.360
TRI	**Pearson Correlation**	**-.135-**	**-.334-**	**.742***	**.548**	**.842***	**-.727-**	**.947****	**.491**	**-.412-**	**-.361-**	**-.870-***	**.800***	**1**
	Sig. (1-tailed)	.400	.333	.046	.130	.018	.051	.002	.162	.209	.241	.012	.028	

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

LBW =Live body weight, **TBM**=Total Breast Muscle, **BI**=Breast Index, **KL**=Keel Length, **BD**=Body Depth, **SL**=Shank Length, **FSI**=Femur Seedor Index, **TSI**= Tibia Seedor Index, **FRI**=Femur Robusticity Index, **TRI**=Tibia Robusticity Index.

Table 8): Pearson correlation coefficients between carcass characteristics and bone geometrics for Cobb500 broiler males (upper diagonal) and females (lower diagonal) at 35 days of age.

VARIABLE		LBW	Dressed %	TBM%	BI	KL	BD	SL	Thigh %	Drum %	FSI	TSI	FRI	TRI
LBW	**Pearson Correlation**	**1**	**.675**	**.083**	**.682**	**.620**	**.477**	**.602**	**-.277-**	**-.377-**	**-.115-**	**.527**	**.902****	**.110**
	Sig. (1-tailed)		.070	.459	.068	.095	.169	.103	.298	.231	.414	.141	.007	.418
Dressed%	**Pearson Correlation**	**.452**	**1**	**.023**	**.384**	**-.038-**	**.478**	**.144**	**-.372-**	**.119**	**-.385-**	**.669**	**.430**	**-.325-**
	Sig. (1-tailed)	.184		.488	.226	.472	.169	.393	.234	.411	.226	.073	.198	.265
TBM%	**Pearson Correlation**	**-.100-**	**.155**	**1**	**.941***	**.759**	**.223**	**.201**	**-.961-***	**.696**	**-.900-**	**.608**	**-.225-**	**-.707-**
	Sig. (1-tailed)	.426	.385		.030	.120	.388	.400	.020	.152	.050	.196	.388	.146
BI	**Pearson Correlation**	**.548**	**.538**	**.624**	**1**	**.817***	**.614**	**.663**	**-.748-***	**-.367-**	**-.667-**	**.432**	**.612**	**.163**
	Sig. (1-tailed)	.130	.135	.093		.024	.097	.076	.044	.237	.074	.196	.099	.379
KL	**Pearson Correlation**	**.348**	**-.337-**	**-.009-**	**.298**	**1**	**.466**	**.681**	**-.366-**	**-.692-**	**-.211-**	**.046**	**.731***	**.503**
	Sig. (1-tailed)	.250	.257	.493	.283		.176	.068	.238	.064	.344	.466	.049	.154
BD	**Pearson Correlation**	**-.191-**	**-.311-**	**-.221-**	**-.627-**	**.104**	**1**	**.316**	**-.315-**	**-.674-**	**-.442-**	**-.108-**	**.609**	**.499**
	Sig. (1-tailed)	.358	.274	.337	.092	.422		.271	.272	.071	.190	.419	.100	.157
SL	**Pearson Correlation**	**.214**	**-.646-**	**.153**	**.165**	**.497**	**-.214-**	**1**	**-.101-**	**-.433-**	**-.051-**	**.143**	**.685**	**.502**
	Sig. (1-tailed)	.342	.083	.386	.378	.158	.342		.425	.196	.462	.394	.067	.155
Thigh%	**Pearson Correlation**	**.277**	**-.076-**	**-.652-**	**-.038-**	**.090**	**-.555-**	**.268**	**1**	**-.199-**	**.943****	**-.639-**	**-.017-**	**.421**
	Sig. (1-tailed)	.297	.443	.080	.471	.432	.126	.304		.353	.002	.086	.487	.203
Drum%	**Pearson Correlation**	**.200**	**.020**	**-.320-**	**.323**	**.450**	**-.640-**	**.186**	**.777***	**1**	**-.186-**	**.551**	**-.723-**	**-.901-****
	Sig. (1-tailed)	.352	.485	.268	.266	.185	.085	.362	.034		.362	.128	.052	.007
FSI	**Pearson Correlation**	**.105**	**-.241-**	**-.912-****	**-.746-***	**-.156-**	**.399**	**-.056-**	**.469**	**-.041-**	**1**	**-.479-**	**.090**	**.329**
	Sig. (1-tailed)	.421	.323	.006	.044	.384	.217	.458	.174	.469		.168	.433	.262
TSI	**Pearson Correlation**	**.421**	**-.349-**	**-.826-***	**-.343-**	**.418**	**.134**	**.362**	**.701**	**.413**	**.779***	**1**	**.113**	**-.738-***
	Sig. (1-tailed)	.203	.249	.021	.253	.205	.400	.240	.061	.208	.034		.416	.047
FRI	**Pearson Correlation**	**.154**	**-.156-**	**.748***	**.656**	**.234**	**-.531-**	**.713**	**-.087-**	**.073**	**-.679-**	**-.323-**	**1**	**.522**
	Sig. (1-tailed)	.386	.384	.044	.078	.328	.139	.056	.435	.446	.069	.266		.144
TRI	**Pearson Correlation**	**-.797-***	**-.243-**	**.444**	**-.075-**	**.054**	**.143**	**-.230-**	**-.520-**	**-.068-**	**-.564-**	**-.625-**	**.056**	**1**
	Sig. (1-tailed)	.029	.321	.189	.444	.459	.394	.331	.145	.449	.122	.092	.458	

*. Correlation is significant at the 0.05 level (1-tailed).

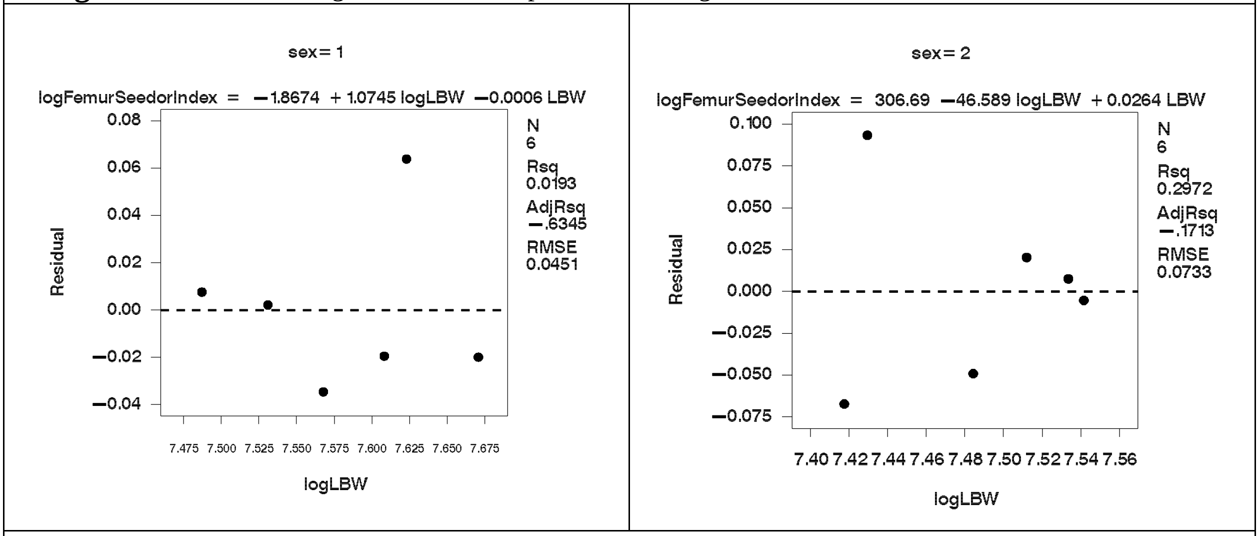
**. Correlation is significant at the 0.01 level (1-tailed).

LBW =Live body weight, **TBM**=Total Breast Muscle, **BI**=Breast Index, **KL**=Keel Length, **BD**=Body Depth, **SL**=Shank Length, **FSI**=Femur Seedor Index **TSI**= Tibia Seedor Index, **FRI**=Femur Robusticity Index, **TRI**=Tibia Robusticity Index.

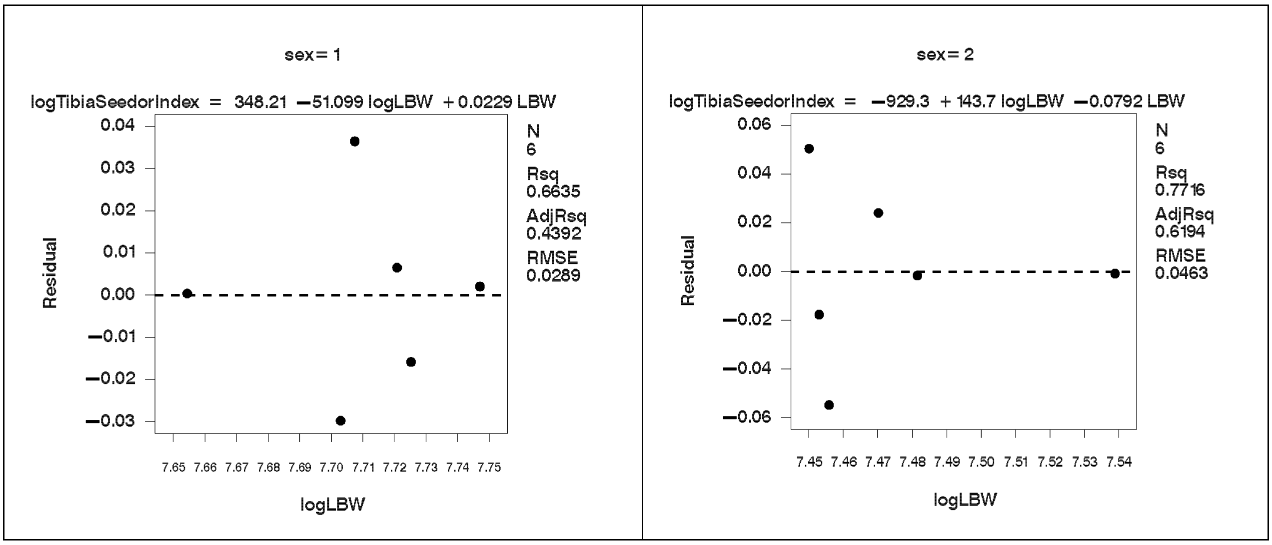
Table (9): Regression coefficients, equations, and significance level for linear model to predicting morphometric indices (Y) from live body weight (X) of broiler strains at 35 d of age.

Parameter	Strain	Sex	Linear Regression Equations	R^2	Root MSE	D-W test	*P*-value
Femur Seedor Index	Ross	Male	LogFSI=269.15-39.375LogLBW+0.0178LBW	0.2407	0.0464	0.761	0.6617
		Female	LogFSI=625.00-95.425LogLBW+0.0529LBW	0.1193	0.1292	2.127	0.8265
	Cobb	Male	LogFSI=-1.8674+1.0745LogLBW-0.0006LBW	0.0193	0.0451	1.255	0.9712
		Female	LogFSI=306.69-46.589LogLBW+0.0264LBW	0.2972	0.0733	1.496	0.5892
Tibia Seedor Index	Ross	Male	LogTSI=348.21-51.099LogLBW+0.0229LBW	0.6635	0.0289	2.379	0.1952
		Female	LogTSI=-929.30+143.7LogLBW-0.0792LBW	0.7716	0.0463	1.427	0.1091
	Cobb	Male	LogTSI=23.136-2.7853LogLBW+0.0017LBW	0.0285	0.0661	1.264	0.6041
		Female	LogTSI=304.41-46.265LogLBW+0.0263LBW	0.6680	0.0378	1.391	0.1913
Breast Index	Ross	Male	LogBI=141.67-20.513LogLBW+0.0098LBW	0.0752	0.0176	0.598	0.8893
		Female	LogBI=266.18-39.892LogLBW+0.0212LBW	0.7356	0.0458	2.550	0.1360
	Cobb	Male	LogBI=-78.708+12.63LogLBW-0.0059LBW	0.5331	0.0916	1.746	0.3190
		Female	LogBI=-331.26+51.782LogLBW-0.0286LBW	0.4452	0.1055	1.719	0.4133

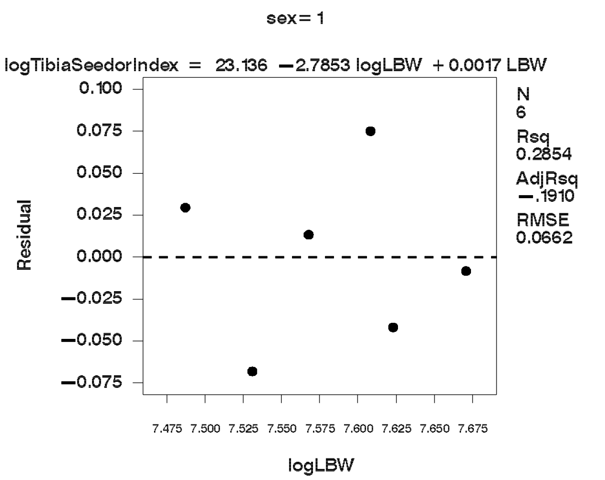
Figures 1&2: Linear regression model to predict FSI using LBW for male "1" and female "2" <u>Ross strain.</u>

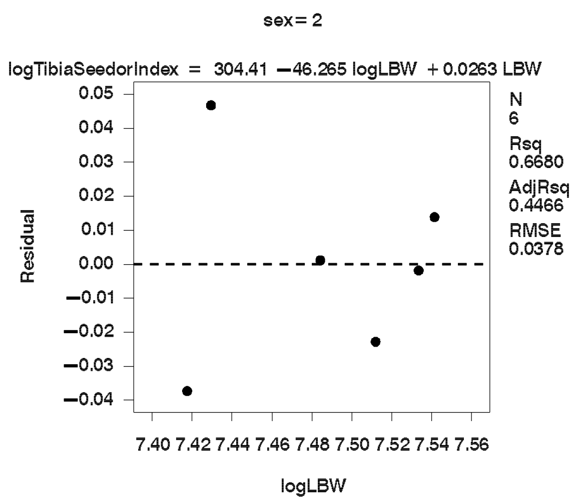


Figures 3 & 4: Linear regression model to predict FSI using LBW for male "1" and female "2" <u>Cobb strain.</u>

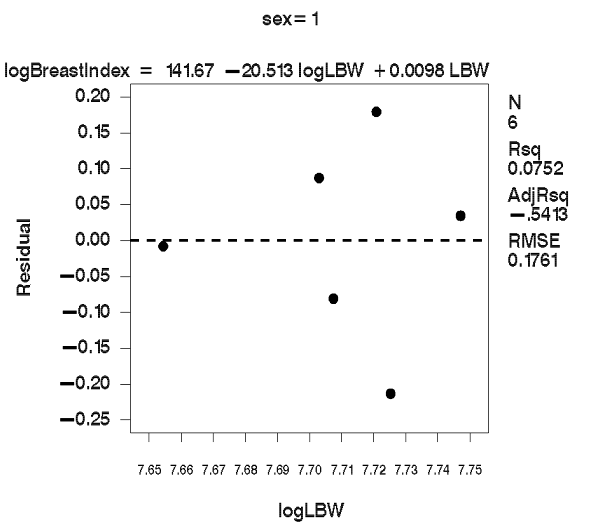


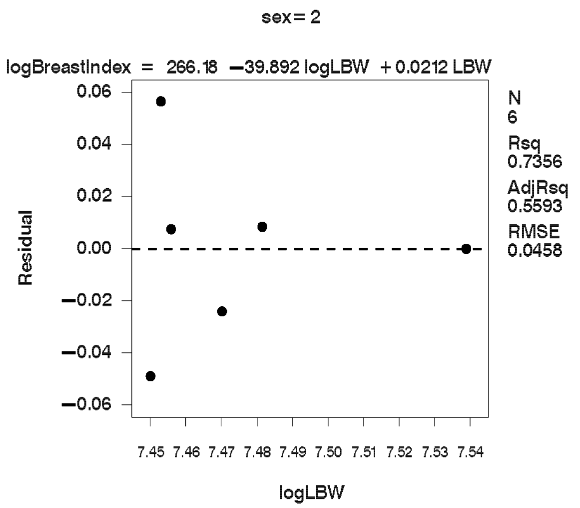
Figures 5 & 6: Linear regression model to predict TSI using LBW for male "1" and female "2" <u>Ross strain.</u>



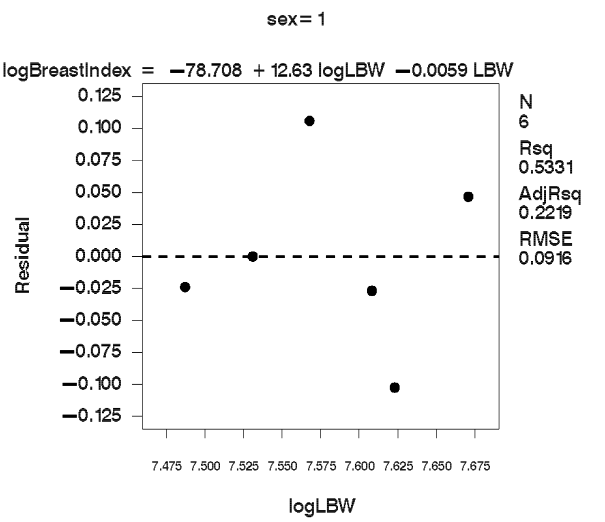


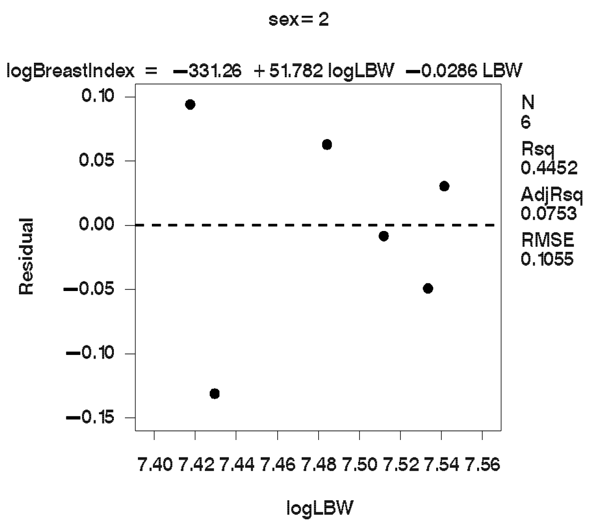
Figures 7 & 8: Linear regression model to predict TSI using LBW for male "1" and female "2" <u>Cobb strain.</u>





Figures 9 & 10: Linear regression model to predict BI using LBW for male "1" and female "2" <u>Ross strain.</u>





Figures 11 & 12: Linear regression model to predict BI using LBW for male "1" and female "2" <u>Cobb strain.</u>

REFERENCES

Abdelaziz, M.A.M., A. EL Faham and A. Abdelhady 2019. Acidification of broiler feeds in relation to bone chemical and biophysical traits Egypt. Poult. Sci. J., 39, pp. 327-344

Adenaike, A.S., B.S. Ajibade, U. Akpan, C.T. Akinrinola and C.O. Ikeobi 2023. Prediction of Carcass Weight from Live Body Weight and Morpho-Biometric Traits of Male Nigerian Indigenous Chickens Using Path Coefficient Analysis, Agriculturae Conspectus Scientificus, 88(1): 61-65.

Ajayi, F.O., O. Ejiofor and M.O. Ironkwe 2008. Estimation of Body Weight from Linear
Body Measurements in Two Commercial Meat-Type Chicken, Global Journal of Agricultural Sciences, 7(1): 57 -59.

Alabi, O.J., J.W. Ng'ambi, D. Norris and S.S.A. Egena 2012. Comparative Study of Three Indigenous Chicken Breeds of South Africa: body Weight and Linear body measurements. Agri. J. 7(3), 220 – 225.

Altman, N., and M. Krzywinski 2015. Simple Linear Regression, *Nature Methods*,
12(11):999 - 1000

Api, I., S.E. Takahashi, A.S. Mendes, R. Refati and R. Rostelatto 2017. Efeito da sexagem e linhagens sobre o desempenho e rendimento de carcaça de frangos de corte. Ciência Animal Brasileira**;**18(1):1-10.

Applegate, T.J. and M.S. Lilburn 2002. Growth of the femur and tibia of a commercial broiler line. Poultry science, 81(9), 1289–1294. doi.org/10.1093/ps/81.9.1289

Buckner, G.D., W.M. Insko, A.H. Henry and E.F. Wachs 1950. The comparative rates of growth and calcification of the femur, tibia and metatarsus bones of the male and female New Hampshire chicken having straight keels. Poultry Sci., 31 pp. 628-632

Charuta, Anna; Dzierzęcka Gappa; Małgorzata; Komosa, Marcin; Kalinowski, Łukasz and Pierzchala, Mariusz 2013. Age- and Sex-related Differences of Morphometric, Densitometric and Geometric Parameters of Tibiotarsal Bone in Ross Broiler Chickens. Folia biologica. 61. 211-20. 10.3409/fb61_3-4.211.

Chen Jin-Tian, Peng-Guang He, Jin-Song Jiang, Ye-Feng Yang, Shou-Yi Wang, Cheng-Hao Pan, Li Zeng, Ye-Fan He, Zhong-Hao Chen, Hong-Jian Lin and Jin-Ming Pan 2023. In vivo prediction of abdominal fat and breast muscle in broiler chicken using live body measurements based on machine learning, Poultry Science, V. 102, Issue 1, doi.org/10.1016/j.psj.2022.102239.

Congetosi, V.E, P.E. Taylor and P.F. Rice 1983. "Basic statistics. A Real World Approach", 3rd edition st Paul: West publishing co.pp 315-336.

Costa, Roberto; Lima, Anny Graycy; Ribeiro, Neila; Medeiros, Ariosvaldo; Medeiros, Geovergue; Gonzaga, Severino and Oliveira, Ronaldo 2020. Predicting the carcass characteristics of Morada Nova lambs using biometric measurements. Revista Brasileira de Zootecnia. 49. 10.37496/rbz4920190179.

Dalólio, F.S., J. Moreira, D.P. Vaz, L.F.T. Albino, R.V. Nunes and G.V.D. Pinto 2016. Digestible lysine for broilers from different commercial strains in the final phase. Acta Scientiarum. Animal Sciences;38(1):411-416.

Damaziak, Krzysztof; Riedel, Julia; D. Gozdowski; J. Niemiec; A. Siennicka and D. Róg 2017. Productive performance and egg quality of laying hens fed diets supplemented with garlic and onion extracts. The J. of Appl. Poult. Res. 26. 10.3382/japr/pfx001.

Danisman, R. and R.M. Gous 2011. Effect of dietary protein on the allometric relationships between some carcass portions and body protein in three broiler strains. South African Journal of Animal Science;41(1):194-208.

Eastell, R. and H. Lambert 2002. Strategies for skeletal health in the elderly. The Proceedings of the Nutrition

Society, 61(2), 173–180. doi.org/10.1079/PNS2002160

Ebong, Uko N., Idorenyin M. Sam, Comfort A. Essien and Loveday S. Okon 2023. Estimation of Carcass Yield from Morphometric Traits of ROSS 308 Strain of Broiler Chicken Raised in Humid Zone of Nigeria. AKSU J. of Agric. and Food Sci. 7(2) 52-61

Erensoy, K., M. Noubandiguim, E. Cilavdaroglu, M. Sarica and U.S. Yamak 2020. Correlations between breast yield and morphometric traits in broiler pure lines. Brazilian Journal of Poultry Science; 22:1-8.

Faridi, A., N.K. Sakomura, A. Golian and S.M. Marcato 2012. Predicting body and carcass characteristics of 2 broiler chicken strains using support vector regression and neural network models. Poultry Science; 91:3286-3294.

Fernandes, J.I.M., C. Bortoluzzi, G.E. Triques, A.F. Garcez Neto and D.C. Peiter 2013. Effect of strain, sex and age on carcass parameters of broilers. Acta Scientiarum. Animal Sciences;35(1):99-105.

Gocsik, Eva; Kortes, H; Oude, Lansink, Alfons and H. Saatkamp 2014. Effects of different broiler production systems on health care costs in the Netherlands. Poultry science. 93. 1301-1317. 10.3382/ps.2013-03614.

Gomes, M.B., M.L.M.W. Neves, L.M.G. Barreto, M.A. Ferreira, J.P.I.D.S. Monnerat, G.M. Carone, J.S. Morais and A.S.C. Véras 2021. Prediction of carcass composition through measurements in vivo and measurements of the carcass of growing Santa Inês sheep. PloS one, 16(3), e0247950. doi.org/10.1371/journal.pone.0247950

Hascik, Peter; Kacaniova, Miroslava; Michal, Mihok; Jaroslav, Pochop and Emilia, Benczova 2010. Performance of Various Broiler Chicken Hybrids Fed with Commercially Produced Feed Mixtures. International Journal of Poultry Science. 9. 10.3923/ijps.2010.1076.1082.

Hassan, F., M.A. Arshad, S. Hassan, R.M. Bilal, M. Saeed and M.S. Rehman 2021. Physiological role of arginine in growth performance, gut health and immune response in broilers: A review. Worlds. Poult. Sci. J. 77, 517–537. 10.1080/00439339.2021.1925198

Henrique, Cleoneide; Oliveira, Andréia; Ferreira, Thales; Silva, Eduardo; Mello, Bruna; Andrade, Agner; Martins, Vinícius; Paula, Fernando; Moraes, Garcia; Elis Giusti Bruno and Luís Daniel 2017. Effect of stocking density on performance, carcass yield, productivity, and bone development in broiler chickens Cobb 500®. Semina: Ciências Agrárias. 38. 2705. 10.5433/1679-0359.2017v38n4Supl1p2705.

Ige, A.O. 2013. Estimation of genetic parameters in Yoruba and Fulani ecotypes indigenous chickens of Nigeria. Transnational Journal of Science and Technology 3: 1-28.

Janisch, S., C. Krischek and M. Wicke 2011. Color values and other meat quality characteristics of breast muscles collected from 3 broiler genetic lines slaughtered at 2 ages. Poultry Science, 90, pp. 1774-1781

Kazumi, Kita; Kenji Nagao; Noriko Taneda; Yoshimi Inagaki; Kazumi Hirano; Takako Shibata; M. Aman Yaman; Michael A. Conlon and Jun-ichi Okumura 2002. Insulin-Like Growth Factor Binding Protein-2 Gene Expression Can Be Regulated by Diet Manipulation in Several Tissues of Young Chickens, The Journal of Nutrition, V.132, Issue 2, pp 145-151, doi.org/10.1093/jn/132.2.145.

Lisnahan, C.V. and O.R. Nahak 2020. Growth performance and small intestinal morphology of native chickens after feed supplementation with tryptophan and threonine during the starter phase. Vet. world, 13(12),2765–2771. doi.org/10.14202/vetworld.2020.2765-2771

Lisnahan, C.V., Wihandoyo, Zuprizal Zuprizal and S. Harimurti 2017. Effect of addition of methionine and lysine into diets based on cafeteria standards on the growth performance of native chickens at starter phase. International Journal of

Poultry Science. 16. 506-510. 10.3923/ijps.2017.506.510.

Mabelebele, Monnye, R.M. Gous, Siwela Muthulisi, H.V.M. O'Neil and Iji Paul 2017. Performance of broiler chickens fed South African sorghum-based diets with xylanase. South African Journal of Animal Science. 47. 679. 10.4314/sajas.v47i5.11.

Marcato, S.M., N.K. Sakomura, I.M. Kawauchi, N.A.A. Barbosa and E.C. Freitas 2006. Growth of body parts of two broiler chicken strain. XII European Poultry Conference, September 10-14, Verona, Italy. Abstr., M7, 270.

Melo, J.E., M.M. Motter, L.R. Morao, M.J. Huguet, Z. Canet and M.C. Miquel 2014. Use of in-vivo measurements to estimate breast and abdominal fat content of a free-range broiler strain. Animal Science; 77:23-31.

Mendeş, M. and E. Akkartal 2009. Regression tree analysis for predictings laughter weight in broilers. Italian Journal of Animal Science; 8:615-24.

Momohm, O.M. and D.E. Karshima 2008. Linear body measurements as predictors of body weight in Nigerian local chickens. Asset Series A8 (2): 206-212.

Moran, E.T. Jr. and M.C. Todd 1994. Continuous submarginal phosphorus with broilers and the effect of preslaughter transportation: carcass defects, further-processing yields, and tibia-femur integrity. Poult. Sci., 73 pp. 1448-1457

Moreira, Joerley; Mendes, Ariel; Antônio, Garcia; de, Oliveira; Garcia, Rodrigo and Almeida Paz Ibiara 2003. Avaliação de desempenho, rendimento de carcaça e qualidade da carne do peito em frangos de linhagens de conformação versus convencionais. Revista Brasileira de Zootecnia. 32. 10.1590/S1516-35982003000700016.

Müsse, Johanna; Helen Louton; Birgit Spindler and Jenny Stracke 2022. Sexual Dimorphism in Bone Quality and Performance of Conventional Broilers at Different Growth Phases. Agriculture 12, no. 8: 1109. doi.org/10.3390/agriculture12081109

Nogueira, B.R.F.; Reis, Matheus; A.C. Carvalho, E.A.C. Mendoza, B.L. Oliveira, V.A. Silva and A.G. Bertechini 2019. Performance, Growth Curves and Carcass Yield of Four Strains of Broiler Chicken. Braz. J. of Poult. Sci. 21. 10.1590/1806-9061-2018-0866

Ogah, DM. 2011. In vivo prediction of live weight and carcass traits using body measurements in indigenous guinea fowl. Biotech. in Animal Husbandry; 27:1827-36.

Ojedapo, L.O., S.R. Amao, S.A. Ameen, T.A. Adedeji, R.I. Ogundipe and A.O. Ige 2012. Prediction of body weight and other linear body measurement of two commercial layer strain chickens. Asian J. Ani. Sci., 6(1): 13-22.

Reisenfeld, A. 1972. Metatarsal robusticity in bipedal rats. Am. J. Phys. Anthropol., 40, pp. 229-234.

Safaei, Mohsen; F. Boldaji; Dastar, Behrouz and Hassani, Saeed 2012. The Effect of Dietary Silicate Minerals Supplementation on Apparent Ileal Digestibility of Energy and Protein in Broiler Chickens. Int. J. of Agri. and Bio, 14. 299-302.

Sakomura, N.K., R.M. Gous, S.M. Marcato and J.B.K. Fernandes 2011. A description of the growth of the major body components of 2 broiler chicken strains. Poultry Science;90(1):2888-2896.

Samejima, M., S. Ito and T. Fujioka 1989. Fujioka Principal component analysis of measurements in the skeleton of red jungle fowl and 12 breeds of domestic fowls: II. Sternum and ossa membri thoracici Japanese J. Poult. Sci., 26, pp. 157-171.

Seedor, J.G. 1995. The biophosphanate alendronate (MK-217) inhibit bone loss due to ovariectomy in rats. J. Bone Miner. Res.; 4:265–270.

Seedor, J.G., H.A. Quartuccio and D.D. Thompson 1991. The bisphosphonate alendronate (MK-217) inhibits bone loss due to ovariectomy in rats. Journal of bone and mineral research: the official journal of the American Society for Bone and Mineral Research, 6(4), 339–346. https://doi.org/10.1002/jbmr.5650060405

Singh, B., P.K. Trehan and D.S. Dhir 1985. Relationship between body weight and some other physical parameters in broilers. Indian J. Ani. Sci., 55: 826-827.

Snedecor, G.W. and W.C. Cochran 1978. In Statistical Methods 9th edn., p. 299-338. Iowa University Press, Iowa City.

Steel, R.G.D. and J.H. Torrie 1984. Principles and Procedures of Statistics: A Biometrical Approach. 2nd McGraw Hill Book Co., Singapore.

U**kwu, H.O., V.M.O. Okoro and R.J. Nosike 2014.** Statistical modeling of body weight and linear body measurements in Nigerian indigenous chicken. IOSR-Journal of Agriculture and Veterinary Science 7: 27-30.

Van, Wyhe R.C., T.J. Applegate, M.S. Lilburn and D.M. Karcher 2012. A comparison of long bone development in historical and contemporary ducks. Poult. Sci. 91: 2858-2865.

Warriss, P.D. 2010. Meat science: An Introductory Text. 2nd Ed. CABI Publish.; pp.117-122.

Xu, Yaxi; Hu, Jian; Zhang, Yunsheng; Guo, Zhanbao; Huang, Wei; Xie, Ming; Liu, Hehe; Hou, Shuisheng; Zhou, Zhengkui; Lei, Chuzhao and Liu, Xiaolin 2018. Selection response and estimation of the genetic parameters for multidimensional measured breast meat yield related traits in a long-term breeding Pekin duck line. Asian-Australasian journal of animal sciences. 31. 10.5713/ajas.17.0837.

Yamak, Umut; Sarica, Musa; Boz, Mehmet and Uçar, Ahmet 2017. Effect of production system (barn and free range) and slaughter age on some production traits of Guinea fowl. Poultry Science. 97.10.3382/ps/pex265.

Yang, Y., D.M. Mekki, S.J. Lv, J.H. Yu, L.Y. Wang and J.Y. Wang 2006. Canonical correlation analysis of body weight, body measurement and carcass characteristics of Jinghai Yellow chicken. Journal of Animal and Veterinary Advances;5: 980-4.

Zhang, B. and C.N. Coon 1997. The relations ships of various tibia bone measurements in hens. – Poultry Science 76: 1698-1701.

الملخص العربى

نماذج التنبؤ لصفات الذبيحة ومقاييس العظم بإستخدام وزن الجسم الحي لدجاج اللحم متأثراً بالسلالة والجنس والتداخل بينهما

عبدالمنعم محمد عبدالمنعم حنفي، محمود يوسف محروس، صلاح الدين عبدالرحمن الصفتي، مني أحمد محمد حميدة
قسم إنتاج الدواجن، كلية الزراعة، جامعة عين شمس، القاهرة، مصر

تهدف هذه الدراسة الي تطوير معادلات للتنبؤ ببعض أدلة صفات العظام والعضلات لدجاج اللحم اعتماداً على وزن الجسم الحي. وكذلك وصف علاقة الارتباط ما بين وزن الجسم وكل من "المقاييس الهندسية للعظم ومقاييس الجسم والصفات الشكلية لعضلة الصدر وصفات الذبيحة" لسلالتين مجنستين من دجاج اللحم التجاري. تم تربية إجمالي عدد 600 طائر من سلالتي الروس والكوب تم تجنيسهم عند الاستقبال من خلال فحص فتحة المجمع، تم أخذ صفة الوزن الحي للطيور عند 35يوم وتم قياس بعض صفات الذبيحة وصفات العظم ومقاييس الجسم للمجاميع الأربعة المدروسة. وزعت الطيور الي أربعة مجاميع بواقع 150 طائر / مجموعة "م1: ذكور روس، م2: اناث روس، م3: ذكور كوب، م4: اناث كوب" ووزعت كل مجموعة على 5 مكررات وبكل مكررة عدد 30 طائر. تم حساب معامل ارتباط بيرسون بين بعض صفات الذبيحة ومقاييس الجسم والمقاييس الشكلية لعضلة الصدر والمقاييس الهندسية لبعض العظام في المجاميع الوراثية الأربعة. وتم حساب معادلات الانحدار الخطي للتنبؤ بأدلة عضلة الصدر وعظمة الدبوس وعظمة الفخذ اعتماداً على وزن الجسم الحي. أوضحت أهم النتائج تأثير غير معنوي للسلالة على صفات عظمتي الفخذ والدبوس، في حين كان هناك تأثير معنوي للجنس على معظم صفات العظام. سجل دليل سيدور لعظمة الدبوس وكذلك لعظمة الفخذ قيم أعلي لذكور الروس، وسجل طول عظمة الساق وطول عظمة القص قيم أعلي للذكور عن الاناث ولسلالة الكوب عن الروس. أظهر كل من السلالة والجنس تأثير معنوي على كل من عرض ومحيط عضلة الصدر لصالح كل من الذكور ولسلالة الروس، في حين سجل دليل عضلة الصدر قيمة أعلي غير معنوية لكل من الذكور ولسلالة الروس. أغلب صفات الذبيحة ظهرت بها اختلافات طفيفة غير معنوية سواء تحت تأثير الجنس أو السلالة، بالرغم من ذلك سجلت ذكور الروس قيماً أعلي من غيرها بشكل غير معنوي. سجلت اناث الروس ارتباط موجب معنوي بين وزن الجسم والنسبة المئوية لعضلة الدبوس، وكذلك مع النسبة المئوية للتصافي لذكور الروس وارتباط معنوي مرتفع مع دليل قوة عظمة الفخذ في ذكور الكوب وارتباط سالب معنوي مع دليل عضلة الصدر في اناث الروس ودليل قوة عظمة الدبوس لإناث الكوب. أظهر هذا البحث إمكانية استخدام الأدلة المدروسة لبعض الصفات في التنبؤ بجودة الذبيحة اعتماداً على وزن الجسم الحي في مختلف السلالات لكلا الجنسين وخاصة معادلة FSI الخاصة بإناث سلالة الكوب ومعادلة TSI لإناث سلالة الروص ومعادلة BI لإناث سلالة الروص. مضمون التجربة أظهر أن ذكور الروس أفضل أداء انتاجي مقارنة ببقية المجاميع المدروسة، وتضمن البحث الإشارة الي إمكانية استخدام وزن الجسم الحي للتنبؤ ببعض الصفات ذات المؤشر الاقتصادي للباحث والمربي مثل دليل عضلة الصدر ودليل سيدور لكل من عظمة الفخذ والدبوس والتي أظهرت قيمها كفاءة أكثر في ذكور سلالة الروص مقارنة ببقية المجاميع المدروسة.

الكلمات الدالة: التنبؤ، الإرتباط، عظم، ذبيحة، دجاج لحم