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# Prediction of body weight with morphometric traits in some broiler chicken strains

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**Abstract**

*Morphometric traits also called linear body measurements or conformation traits are important parameters in predicting body weight especially in commercial breeders and producers. Thus, the study was carried out to predict body weight of broiler using linear body measurement. In this study, a total of 270 day old broiler chicks comprising of 90 chicks each of Abor Acre, Ross and Marshal Strains were used. Data were collected on body weight using body measurements to include breast length (BRL), thigh width (TW), shank length (SL), keel length (KL), wing length and drumstick length (DL). The regression analysis was simple linear regression. The values of the coefficient of determination ($R^2$) in Abor Acre, Ross and Marshall strains ranged from 89.8 – 99.8; 88.4 – 98.9; and 80.8 – 99.5 respectively with thigh width showing the highest % $R^2$ value of 99.8% in week 2; 66.5 – 97.9; 60.3 – 80.4 and 28.6 – 72.3 respectively with breast length (97.9%) having the highest %$R^2$ value. This showed that breast length was the best predictor of the body weight of the broiler in week 4; 38.5 – 100; 88.0 – 98.6; 17.0 – 94.8 with shank length (100%) showing a 100% $R^2$ value. This showed that breast length was the best predictor of the body weight of the broiler in week 4; 38.5 – 100; 88.0 – 98.6; 17.0 – 94.8 with shank length (100%) showing a 100% $R^2$ value in week 6; 76.9 – 96.3, 72.2 – 88.8 and 58.1 – 97.6 respectively with wing length recording the highest % $R^2$ value in week 6; 76.9 – 96.3, 72.2 – 88.8 and 58.1 – 97.6 respectively with wing length recording the highest value (97.9%) week 8. The different strains had different coefficient of determination ($R^2$) values above 50% with different linear body parameter at different ages of the birds, indicating that any of the linear body parameter could be used to predict body weight of broiler chicken although, accuracy of prediction increased with increasing $R^2$ value. Amongst all the linear body parameters evaluated, the shank length of Abor Acres strain had highest $R^2$ value (100%) in week 6. Thus shank length was the best linear body parameter with 100% accuracy of prediction, and may be useful criterion in estimation of growth and prediction of body weight.*

**Keywords:** broiler strains, prediction, body weight, morphometric traits

## Introduction

The acute problem of animal protein in Nigeria and the need to improve animal protein production has been felt. Consequently, the average Nigerian does not have access to recommended animal protein requirements. FAO (1997) recommended 56g of animal protein intake for growing and developing individuals per day. Christopher *et al.* (1997) reported that Nigerians consume only 15g of animal protein per day. There has been a call for substantial increase in the intake of protein of animal origin in developing countries like

Nigeria. This can be achieved through the production of broiler starinstha have fast growth and attain market weight timely.

Morphometric traits also called linear body measurements or conformation traits are important parameters in predicting body weight and this has been observed by commercial breeders and producers. Breeders, therefore, breed desirable sizes of chickens which also have the desirable production traits particularly body weight (Ojedapo *et al.* 2010).

Apart from body weight, a number of conformation traits are known to be good indicators of good growth and market value of broiler (Ibe, 1989). Amao *et al.* (2012) reported that most of the linear body measurements reflect primarily the long bones of the animals. Such conformation traits include shank length, breast width, kneel length, wing span, chicken height, body length, and head circumference (Ojo *et al.,* 2010). Combination of body weight and conformation for maximum economic returns (Adeniji and Ayorinde, 1990). The knowledge of interrelationships among body measurements can be applied in selection and breeding (Monsi, 1992). Moreso, the importance of determining interrelationships of linear body parameters in poultry depends on extent they can predict of traits such as body weight. However, body weight and body conformations are important parameters for measuring growth in the domestic chickens. The mechanism involved in the control of growth in chicken are too complex to be explained only under univariate analysis because all related traits are biologically correlated due to pleiotropic effect of gene and linkage of loci (Rosario *et al.,* 2008). Linear body measurements have been used to predict live weights in poultry (Okon*et al.,* 1997), Prediction of body weight with morphometric traits in broilers is therefore important; these forms the basis and justification of the study**.**The objective of the study was therefore to predict body weight determine the rate of growth within each strain using prediction equation.

## Materials and methods

### *Location of study*

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State. The teaching and research farm has annual rainfall of 2177mm, temperature range of 22°C – 36°C and relative humidity above 50% - 90% (NRCRI). It is located at latitude 05°29 North and 07°32 East on an elevation of about 122m above sea level; these metrological data were obtained from the metrological station at the National Root Crops Research Institute, Umudike, Abia State.

### *Experimental birds and management*

A total of 270 broiler chicks comprising of 90 chicks each for Arbor Acre, Ross and Marshall strains were used for the study. The chicks were purchased from a reputable hatchery in Nigeria. The experimental birds were grouped into 3 treatments (strain) replicated 5 times with 18 birds per replicate.

The brooding house was partitioned into pens in line with the design of the experiment. The floor of the brooding pens was covered with wood shaving and they will be kept dry throughout the experiment period by replacing the wet litter with new ones. Electricity, lantern and stoves was used to heat up the brooding house, shallow plastic feeders and chick fonts was used to provide feed and water to the chicks respectively.

Health management practices was used carried out on the broiler chicks. The chicks were given anti-stress at arrival to boost

their energy level. They were given Newcastle Disease Vaccine (NDV) intraocular (I/0).

Coccidiostat and other anti-biotics were also administered viadrinking water. Birds were also dewormed and acaricide sprayed to check worms and ectoparasites respectively.

The chicks were fed *ad-libitum* on a commercial broiler starter diet containing 21% CP and 2900Kcal/kg/me from 1-4 weeks of age followed by a finisher diet containing 19% CP and 3000Kcal/me from 5 – 8 weeks of age and water was provided *ad-libitum*.

***Data collection***

Parameters measured include:

**Body Weight:** Body weight was measured weekly using a top loading 20kg scale with sensitivity of 10g

**Thigh Weight:** this was taken from the beginning of the fibula to the hock joint.

**Shank length:** this was taken from the beginning of the hock joint to the last ring before the tarsal or meta-tarsal digit.

**Breast Width:** This was taken from the point of depression to the sharp edge.

**Keel Length:** This was taken from the V-joint to the end of the sternum.

**Drumstick Length:** Length of the Femur bone

**Wing Length:** Distance between the tip of the phalanges and the coracoids-humerus joint

**Body Length:** The distance between the base of the neck and pygostlye.

The body traits were measured using tailor's (cm) tape and body weight with weighing scale.

***Statistical analysis***

Data collected from the experiment were statistically analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0.

Regression of body weight on each of the linear body parameter with respect to age was done to determine rate of growth, within each strain.

The regression model used was:

$W_i = a + b\,(Age)_I + e_i$

Where $W_i$ = the $i^{th}$ body weight (g) or linear body parameter (cm)

a = regression constant//intercept

b = The required growth rate or regression coefficient

$(Age)_I$ = Age/Independent variable (week)

$e_{ij}$ = Random error

**Result and discussion**

***Regression equations and growth rates of broiler strains***

Regression equations of broiler strains in week 2. The regression equations of broiler strains in week 2 are presented in Table 1

Prediction equations relating the body weight and linear body measurements with age in three broiler strains studied in week 2 are shown in Table 1. The values of coefficient of determination (%$R^2$) ranged from 89.8 – 99.8; 88.4 – 98.9; and 80.8 – 99.5 in Arbor Acre, Ross and Marshall strains respectively with thigh width having the highest %$R^2$ value of 99.8% in week 2. This implies that thigh width could be the best predictor of the body weight of broiler strains. This result agreed with Udeh and Ogbu (2011) who reported that Arbor Acre strain with 96.7% in thigh width was the best predictor of the body weight of broiler strains.

The value of $R^2$ in this study was similar to the range (82.8 – 98.0%) reported by Nosike (2015) in local turkey varieties. The negative intercept of body weights on regression lines in some linear body parameters implies that body weight started at a very low value quite below zero and at an unknown time. All other linear body parameters in all the strains studied reported

**Table 1: The regression of body weight on linear body parameters in week 2**

| Strain | Regression Equation | $R^2$(%) | SE | LOS |
|---|---|---|---|---|
| Arbor Acre | BWT=213.163+11.103BRL | 97.9 | 0.65 | NS |
| | BWT=241.458+6.382TWD | 99.8 | 0.66 | NS |
| | BWT=95.625+43.015SL | 95.6 | 0.65 | * |
| | BWT=161.915+16.284KL | 96.6 | 0.65 | NS |
| | BWT=-52.040+16.270BL | 89.8 | 0.63 | ** |
| | BWT=433.479-13.758WL | 97.3 | 0.65 | NS |
| | BWT=121.036+24.581DSL | 93.5 | 0.64 | ** |
| Ross | BWT=198.247+27.697BRL | 94.0 | 0.85 | * |
| | BWT=8.796+59.481TWD | 88.4 | 0.82 | *** |
| | BWT=202.135+33.625SL | 97.9 | 0.86 | NS |
| | BWT=-14.294+16.770KL | 91.8 | 0.84 | ** |
| | BWT=5.928+48.850BL | 88.8 | 0.82 | *** |
| | BWT=219.740+10.417WL | 98.9 | 0.87 | NS |
| | BWT=201.536+20.629DSL | 97.2 | 0.86 | NS |
| Marshall | BWT=443.024-7.912BRL | 99.5 | 0.94 | NS |
| | BWT=534.947-22.378TWD | 97.6 | 0.93 | NS |
| | BWT=589.701-44.221SL | 96.9 | 0.92 | NS |
| | BWT=663.751-12.473KL | 97.0 | 0.92 | NS |
| | BWT=615.791-30.410BL | 93.2 | 0.90 | NS |
| | BWT=888.920-40.775WL | 80.8 | 0.84 | ** |
| | BWT=491.746-13.477DSL | 97.5 | 0.93 | NS |

***BWT=Body weight; BRL- Breast length; TWD- Thigh width; SL-Shank length; KL-Keel length; BL-Body length; WL-Wing length; DSL-Drumstick length; NS- Non significant; SE-Standard error of estimate; LOS-Level of significance; ***Significant at P<0.001; **Significant at P<0.01; * Significant at P<0.05.***

a %$R^2$ value above 50%, which implies any of linear body parameter could also be used to predict the body weight of the broilers.

***Regression equation of BWT on LBMs of broiler strain in week 4***

The regression equations of broiler strain in week 4 are presented in Table 2.

The prediction equations relating the body weight and linear body measurements in week 4. The result of the regression of three broiler strains are shown in Table 2.

The values of the coefficient of determination ($R^2$) in Arbor Acre, Ross and Marshall strains ranged 66.5 – 97.9, 60.3 – 80.4, and 28.6 – 72.3 respectively with breast length (97.9%) recording the highest %$R^2$ value. This showed that breast length became the best predictor of the body weight of the broiler strains in week 4 of age of the broilers. This observation in agreement with Ubani*et al.* (2010) who reported in their separate findings that breast length recorded the highest $R^2$ value among Nu-breed Abeokuta, Hubbard strain, Arbor Acre and Marshall strains between 3 – 5 weeks of age.

**Table 2: The regression equation of BWT on LBMs of broiler strain in week 4**

| Strain | Regression Equation | $R^2$(%) | SE | LOS |
|---|---|---|---|---|
| Arbor Acre | BWT= 213.163+11.103BRL | 97.9 | 0.65 | NS |
| | BWT=158.353+54.414TWD | 69.1 | 0.94 | *** |
| | BWT=223.411+64.533SL | 80.9 | 1.01 | *** |
| | BWT= -114.678+30.204KL | 71.4 | 0.95 | *** |
| | BWT=23.455+55.681BL | 66.5 | 0.92 | *** |
| | BWT=64.728+35.677WL | 79.8 | 1.01 | *** |
| | BWT=381.339+23.716DSL | 75.6 | 0.98 | *** |
| Ross | BWT=328.603+60.379BRL | 73.4 | 0.80 | *** |
| | BWT=289.104+36.428TWD | 76.5 | 0.81 | *** |
| | BWT=239.929+62.174SL | 76.7 | 0.81 | *** |
| | BWT=-31.635+26.244KL | 80.4 | 0.83 | *** |
| | BWT=220.861+36.60BL | 76.1 | 0.81 | *** |
| | BWT=-39.693+44.542WL | 60.3 | 0.72 | *** |
| | BWT=393.955+26.178DSL | 78.6 | 0.82 | *** |
| Marshall | BWT=-26.374+151.549BRL | 40.8 | 0.88 | *** |
| | BWT=-9.908+76.323TWD | 56.7 | 1.04 | *** |
| | BWT=84.691+90.813SL | 65.1 | 1.12 | *** |
| | BWT=-472.316-46.369KL | 56.3 | 1.04 | *** |
| | BWT=-108.454+72.761 | 72.3 | 1.08 | ** |
| | BWT=-288.154+62.211WL | 54.4 | 1.02 | *** |
| | BWT=70.035+68.717DSL | 28.6 | 0.74 | *** |

*BWT=Body weight; BRL- Breast length; TWD- Thigh width; SL-Shank length; KL-Keel length; BL-Body length; WL-Wing length; DSL-Drumstick length; NS- Non significant; SE-Standard error of estimate; LOS-Level of significance; ***Significant at P<0.001., **Significant at P<0.01; * Significant at P<0.05.*

***Regression equation of broiler strain in week 6***

Table 3 presents the regression of body weight on linear traits in Abor Acre, Ross and Marshall broiler strains at week 6. The values of the coefficient of determination ($R^2$) in the three strains studied in week 6 are presented in Table 3. the values ranged from 38.5 – 100; 88.0 – 98.6; and 17.0 – 94.8 in Arbor Acre, Ross and Marshall strains respectively with the shank length (100%) showing a 100% $R^2$ value. This implies that as the age increased to 6 weeks shank length was the best body weight predictor. This result is in line with the report of Ukwu *et al.* (2014) that shank length was the best predictor of body weight of Nigerian local chickens.

**Table 3: The regression equation of BWT on LBMs of Broiler strain in week 6**

| Strain | Regression Equation | $R^2$(%) | SE | LOS |
|---|---|---|---|---|
| Arbor Acre | BWT=727.577+61.049BRL | 94.4 | 1.88 | * |
| | BWT=774.209+25.515TWD | 96.6 | 1.90 | NS |
| | BWT=1042.842+2.784SL | 100.0 | 1.93 | NS |
| | BWT=600.345+16.408KL | 95.0 | 1.89 | * |
| | BWT=372.776+54.528BL | 86.8 | 1.80 | *** |
| | BWT=413.136+36.563WL | 76.5 | 1.69 | *** |
| | BWT=-101.561+102.905 | 38.5 | 1.20 | *** |
| Ross | BWT=1010.028+23.313BRL | 98.6 | 1.65 | NS |
| | BWT=668.07+42.259TWD | 88.0 | 1.56 | *** |
| | BWT=1046.968+16.176SL | 98.5 | 1.65 | NS |
| | BWT=906.677+8.261KL | 98.1 | 1.65 | NS |
| | BWT=485.562+50.063BL | 93.1 | 1.60 | ** |
| | BWT=717.414+20.977WL | 93.3 | 1.60 | ** |
| | BWT=836.183+24.831DSL | 97.0 | 1.64 | NS |
| Marshall | BWT=777.154+57.501BRL | 94.8 | 2.05 | NS |
| | BWT=520.114+50.975TWD | 88.9 | 1.98 | NS |
| | BWT=743.339+56.666SL | 90.4 | 2.01 | NS |
| | BWT=593.625+18.331KL | 89.7 | 2.00 | NS |
| | BWT=41.306+81.070BL | 84.6 | 1.94 | * |
| | BWT=325.990+43.067WL | 79.3 | 1.88 | ** |
| | BWT=-330.343+122.639DSL | 17.0 | 0.87 | *** |

*BWT=Body weight; BRL- Breast length; TWD- Thigh width; SL-Shank length; KL-Keel length; BL-Body length; WL-Wing length; DSL-Drumstick length; NS- Non significant; SE-Standard error of estimate; LOS-Level of significance: ***Significant at P<0.001; **Significant at P<0.01; *Significant at P<0.05.*

Nosike (2015) reported $R^2$ value of 98% with shank length in black phenotype of turkey strain, hence supported this study. Udeh and Ogbu, (2011) and Yakubu and Salako (2009) in separate studies supported this result in week 6.

***Regression equation of broiler strain in week 8***

Table 4 presents the regression of body weight on linear traits in the 3 strains at week 8.Prediction equation relating the body weight and linear body measurements in week 8 among the three strains are shown in Table 4.

The coefficient of determination ($R^2$) values in Arbor Acre, Ross and Marshall Strains ranged from 76.9 – 96.3, 72.2 – 88.8, and 58.1 – 97.6 respectively, with wing length recording the highest value (97.6%) in week 8. This implies that wing length could give the best accuracy of prediction in the assessment of body weight in broiler chicken. This result agreed with Ojo *et al.* (2010) and Ogah (2011) who in separate studies reported the highest $R^2$ value in wing length in different strains at 7 – 8 weeks of age. Nosike (2015) reported $R^2$ value of 96% with wing length in the black turkey strain.

**Table 4: The regression equation of BWT on LBMs of Broiler strain in week 8**

| Strain | Regression Equation | $R^2$(%) | SE | LOS |
|---|---|---|---|---|
| Arbor Acre | BWT=958.301+115.726BRL | 92.8 | 313.47 | 3.13 |
| | BWT=485.467+85.809TWD | 79.0 | 2.89 | *** |
| | BWT=563.318+146.536SL | 76.9 | 2.85 | *** |
| | BWT=-366.536+58.561KL | 82.0 | 2.94 | *** |
| | BWT=12.019+110.107BL | 77.9 | 2.87 | *** |
| | BWT=792.052+41.426WL | 86.6 | 3.02 | *** |
| | BWT=1074.789+40.039DSL | 96.3 | 3.19 | NS |
| Ross | BWT=720.683+169.198BRL | 88.8 | 3.35 | *** |
| | BWT=322.561+103.670TWD | 77.5 | 3.13 | *** |
| | BWT=504.472+159.943SL | 74.3 | 3.07 | *** |
| | BWT=-377.307+60.877KL | 72.2 | 3.02 | *** |
| | BWT=-317.632+137.099BL | 73.0 | 3.04 | *** |
| | BWT=584.496+56.746WL | 85.7 | 3.30 | *** |
| | BWT=-459.438+168.027DSL | 74.7 | 3.08 | *** |
| Marshall | BWT=881.857+120.981BRL | 90.8 | 3.18 | NS |
| | BWT=238.835+102.394TWD | 69.1 | 2.77 | *** |
| | BWT=707.378+120.904SL | 83.2 | 3.04 | * |
| | BWT=364.969+35.582KL | 88.7 | 3.14 | NS |
| | BWT=-448.608+139.205BL | 58.1 | 2.54 | *** |
| | BWT=1249.873+15.681WL | 97.6 | 3.30 | NS |
| | BWT=1040.988+38.276DSL | 96.1 | 3.27 | NS |

*BWT=Body weight; BRL- Breast length; TWD- Thigh width; SL-Shank length; KL-Keel length; BL-Body length; WL-Wing length; DSL-Drumstick length; NS- Non significant; SE-Standard error of estimate; LOS-Level of significance; ***Significant at P<0.001; **Significant at P<0.01; * Significant at P<0.05.*

## Conclusion

The result showed that the coefficients determination ($R^2$) values did not follow any regular pattern as different linear body parameters had highest $R^2$ values in different strains at different ages of the broiler. For instance, Arbor Acre recorded its highest values with TWD, BRL, SL and DSL in 2, 4, 6 and 8 weeks respectively. Whereas BRL, BL, BRL and WL in week 2, 4, 6, and 8 respectively recorded the highest $R^2$ values with the marshall strain. All other linear body parameters whose $R^2$values where above 50% could be used to predict the body weights of the broiler strains, although the accuracy of prediction increase with an increase in the $R^2$value.

In summary, amongst all the linear body parameters evaluated, the shank length (in Arbor strain) had the highest $R^2$ value in week 6 of this study.

Further studies are hereby recommended to ascertain the heritability of the estimator Shank length as found in this study.

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