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Breeds influence on growth ability and predicting body weight from linear body measurements of ducks at various ages

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ABSTRACT

A total of one hundred and twenty ducklings (i. e. 60 Muscovy and 60 Mallard) were used for the study to evaluate the breeds effect on growth performance and prediction of body weight using linear body measurements of two breeds of ducks with the aid of General Linear Model and stepwise regression procedure of SPSS. Data on individual body weight (BW), body height (BH), body length (BL) breast circumference (BC), thigh length (TL), bill length (BIL), wing length (WL)and shank length (SL) of 120 ducks were collected on Muscovy and Mallard ducks and used to predict body weight at 4 and 8 weeks. The results showed that Muscovy (56.6t ± 6.7 – 1037.5 ± 30.29 g) was significantly superior ($P<0.05$) to Mallard (51.8 ± 1.66 – 875.44 ± 70.30 g) in body weight and in all the linear body measurements from day old to week 10. Individual body weight and linear body measurements was predicted at various ages (4 and 8 weeks) by genetic groups. The values of the coefficient of determination (R^2) ranged from (88.6 – 97%) and (81.8 – 90.3%) in Muscovy and Mallard, respectively at week 4, while, (R^2) ranged from (58.7 – 92%) and 80.1 – 86.9%) in Muscovy and Mallard, respectively at week 8. Since linear body measurements that can readily predict body weight without ducks being slaughtered, it is therefore, highly desirable as it will ensure the selection of animals that will reach market weight and size at relatively faster rate. This will also serve as a tool for breeders in selecting animals destined for use as breeding stock. These Muscovy and Mallard can be improved by exploiting the principle of phenotypic plasticity to obtain strains to complement other breeds of duck. Muscovy can also be used to upgrade some other indigenous ducks for better performance in a systematic breeding program.

***Keywords*:** Duck Genotypes, Growth performance, Body weight prediction, morphometric traits, Muscovy, Mallard

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1. INTRODUCTION

Growth in animals is a function of time, nutrition, on individual breed, husbandry system; health management practices among other varieties and animals of different ages have different live weight which provides reliable and informative measure for selection (Thiruvenkander, 2005). Body weight of an animal is a phenotypic expression of its genetic makeup under the prevailing environmental or rearing condition. Body weight plays an important role in the determination of market price in farm animal (Momoh and Kershima, 2008).

Body weight of animals is the worth for the linear body measurement of the animals. It has been highlighted specifically in its use for predicting live weight and relationship with the body morphometric traits (Tegbe and Olurunju, 1988, Adewunmi *et al*., 2006). Disparity in body weight within a flock can be ascribed to genetic variation and environmental factors that impose on individuals (Ayorinde and Oke, 1995). Linear body measurements are advantageous in live weight determination (Gul *et al*., 2005). The relationships existing among linear body traits provide a useful information on performance, productivity and carcass characteristics (Kabir *et al*., 2010). A number of external body parts are known to be positively correlated with body weight (Okon *et al*., 1997).

Adeniji and Ayorinde (1990) reported that development of relationship between body weight and conformation traits, such as shank length, thigh length, breast width, neck length and back length make the work of breeders easier and faster as efforts can be focused on those traits that are easier to be measured. Linear body measurements have also been used to predict live weight in poultry (Gueye, 1998). A number of external body parts are known to be positively correlated with body weight (Okon *et al*., 1997). The increase in body size or weight is one of the important criteria to select the ducks as meat animals. Usually body weight is used to evaluate body development in the animal.

The different body parts develop at varying rates and these changes determine the shape, conformation, and body proportion of the animals at a given time. In meat animals, linear body measurements are important traits which can be used as a means for describing the size and shape of farm animals. It is important to have knowledge of the variation of morphometric traits in duck genetic resources, as such measurements have been discovered to be very useful in comparing body size and by implication shape of the animals. The main objective of this study is to determine breeds influence on growth performance and to examine the relationship between body weight and linear body measurements in Muscovy and Mallard ducks reared under the Nigeria environmental conditions, as well as to develop regression equations for the prediction of body weight from linear measurements at different ages.

2. MATERIALS AND METHODS

2. 1. Experimental Location and Duration

The experiment was carried out at the poultry unit of the Department of Animal Science, University of Port Harcourt Demonstration Farm (Livestock Section) Choba Campus, Rivers State, Nigeria. The campus is located at latitude 4.8943N and longitude 6.91053E. The altitude is 15 m above the sea level. Port Harcourt is classified as a tropical wet climate with very short dry seasons with annual average rainfall of 1,950.7 mm. Average temperatures are typically between 25 – 28 ºC in the city, and relative humidity is above 85%.

2. 2. Experimental Animals and Management

A total of one hundred and twenty day-old ducklings (i.e. 60 of Muscovy and 60 Mallard) were purchased from a reputable hatchery in Oyo State, Nigeria, and brooded for 4 weeks on deep litter. The ducks were randomly divided into 3 replicate per breed (i.e 20 ducks per replicate). They were weighed on arrival from hatchery. The experimental animals were penned on a deep litter and were also provided with fresh drinking water and wallowing trough for their water-related activities like preening, bathing, etc. to exhibit their wild nature. They were also fed *ad libitum* with commercial feed throughout the experimental period. Necessary vaccines and medication were provided also for the experiment animals.

Experimental Procedure and Data Collection: Data on growth rate was collected biweekly from the two breeds of ducks and the following parameters were necessary and determined using measuring tape and electronic weighing scale.

Body Weight (BW): Body weight is the entire weight of the body. **Body Height (BH):** was measured from the tip of the webbed to the proximity of the head. **Body Length (BL):** was measured from the point from the joint of the neck to the joint of the caudal end (tail). **Breast Circumference (BC):** was measured under the wing from the beginning of the chest to the end.

Thigh Length (TL): was measured from the length from the joint of the lap to the point where the feet attaches. **Bill Length (BIL):** was measured from the length between the tip of the bill and the rear end of the beak. **Wing Length (WL):** taken from the shoulder joint to the extremity of the terminal phalanx **Shank Length (SL):** was measured from the shank joint to the extremity of the digitus pedis. To ensure accuracy each measurement was taken twice and the mean was use in subsequent analysis. The same person took all measurements and weighing throughout, thus eliminating errors due to person differences as suggested by (Shahin and Hassan, 2000).

2. 3. Statistical Analysis

The data were analysed to obtain mean and standard errors for body weight and linear body measurements. Analysis of variance (ANOVA), using the General Linear Model Procedure of Statistical Procedure for the Social Science (SPSS, 2010) was employed in the analysis. The analysis was done on weekly basis. Mean separation for significant effect was done using Duncan's New Multiple Range Test (Duncan, 1955). Data collected were also subjected to regression analyses, the coefficient of determination (R^2) was used to compare the accuracy of prediction. Measurements obtained from the linear body measurements were regressed against the body weight of Muscovy and Mallard breeds of ducks at weeks 4 and 8. Model for predicting body weight using linear body parameters was analyzed using Stepwise Linear Regression Procedure of SPSS. Each model is of the general form in Expression (1)

$$BW_i = a + b_i X_i + b_2 X_2 + \ldots\ldots\ldots\ldots + b_k X_k \quad \ldots\ldots\ldots\ldots(1)$$

BW_i = Body weight for the i-th Strain
a = Intercept $b_i - b_k$ = Partial regression coefficients $X_i - X_k$ = Linear body parameters.

where: BW is the body weight, a is the regression intercept, B_1 is the i-th partial regression coefficient ofthe i-th linear body measurement, X_1 or the i-th factor scores (FS).

3. RESULT

Table 1. Effect of Breeds on Body Weight and Linear Body Measurements of ducks from day old – week10

Week	Breed	BW	BH	BL	BC	TL	BIL	WL	SL
Wk0	Mu	56.67±6.29^{a}	4.70±0.00^{a}	7.00±0.00^{a}	8.50±0.00^{a}	3.50±0.00^{b}	2.0±0.00^{a}	4.0±0.00^{a}	1.3±0.12^{a}
	Ma	51.8±1.66^{b}	4.27±0.23^{b}	6.00±0.00^{b}	7.00±0.00^{b}	3.87±0.12^{a}	1.83±0.2^{b}	3.4±0.51^{b}	1.2±0.17^{b}
Wk2	Mu	196.3±6.35^{a}	9.00±0.00^{a}	8.40±0.00^{b}	13.7±0.00^{a}	6.80±0.00^{a}	3.90±0.00^{a}	5.50±.519^{b}	2.53±0.05^{a}
	Ma	124.3±27.03^{b}	8.97±0.40^{b}	8.73±0.12^{a}	12.23±.23^{b}	5.20±0.17^{b}	2.67±.05^{b}	6.43±.462^{a}	2.07±0.29^{b}
Wk4	Mu	637.52±25.7^{a}	14.44±0.30^{a}	15.13±0.19^{b}	25.45±1.27^{a}	11.03±0.48^{a}	5.32±0.05^{a}	11.57±0.11^{a}	5.30±0.40^{a}
	Ma	541.43±36.^{7b}	13.44±0.66^{b}	15.26±1.40^{a}	19.13+1.02^{b}	9.78+0.54^{b}	4.75±0.46^{b}	9.42±0.64^{b}	4.55±0.33^{b}
Wk6	Mu	871.7±55.10^{a}	16.16±1.37^{a}	18.84±0.42^{b}	26.04±1.18^{a}	11.98±0.10^{a}	5.55±0.72^{b}	12.59±0.78^{a}	5.67±0.55^{a}
	Ma	748.60±54.49^{b}	15.11±0.19^{b}	20.42±5.55^{a}	20.84+1.90^{b}	10.57+0.27^{b}	5.63±0.57^{a}	11.26±0.23^{b}	5.00±0.23^{b}
Wk8	Mu	1035.1±33.63^{a}	24.08±52.01^{a}	19.99±0.79^{a}	28.63±1.01^{a}	12.74±0.02^{a}	6.56±0.17^{a}	14.79±0.65^{b}	6.21±0.64^{a}
	Ma	855.56±69.70^{b}	19.01±1.48^{b}	17.51±0.79^{b}	21.91±1.14^{b}	10.61±0.50^{b}	5.72±0.39^{b}	19.07±1.95^{a}	5.42±0.25^{b}
Wk10	Mu	1037.5±30.29^{a}	25.45±2.15^{a}	19.58±0.11^{a}	29.00±0.91^{a}	25.41±0.76^{a}	6.69±0.13^{a}	14.91±0.92^{b}	6.35±0.41^{a}
	Ma	875.44±70.30^{b}	19.27±1.21^{b}	17.32±1.79^{b}	22.31±1.20^{b}	11.10±0.41^{b}	5.94±0.47^{b}	21.20+2.97^{a}	5.62±0.30^{b}

*. Shows significant difference ($p<0.05$) across the columns
a,b means within the same row with different superscript, differ significant ($p<0.05$), body weight (BW), body height (BH), body length (BL) breast circumference (BC), thigh length (TL), bill length (BIL), wing length (WL) and shank length (SL).

Table 1 shows the effect of breeds on body weight and linear body measurements of Ducks. The results indicated significant differences ($p<0.05$) of effect of breeds on body weight and linear body measurement between the two breeds of ducks.

Body weight was significantly higher in Muscovy (56.67±6.29 g – 1037.5±30.29 g) than Mallard (51.8±1.66 g – 875.4±70.30 g) from day old to week 10, respectively. Also body dimensions of Muscovy were higher than those of Mallard in most of the weeks studied.

Table 2. Stepwise Multiple Regression of Body Weight on Linear Body Measurement of Muscovy and Mallard Ducks and Prediction Equation at week 4

Breeds	Prediction Equations	R^2 (%)	F	SE	SIG
Muscovy	BW = –408.32+72.70BL BW = –217.77+33.6BC BW = –240.99+80.75TL	92.2 97 88.6	154.39 458.49 101.39	66.39 39.56 80.32	0.02 0.04 0.01
Mallard	BW = –236.92+79.38BL BW = –260.18+40.30BC BW = –112.16+145.80SL	82.2 81.8 90.3	59.93 58.47 120.65	83.42 84.26 61.62	0.03 0.02 0.07

Key: R^2 **=** Coefficient of determinant
SE = Standard error. body weight (BW), body height (BH), body length (BL) breast circumference (BC), thigh length (TL), bill length (BIL), wing length (WL) and shank length (SL)

Table 2 shows the stepwise multiple regression of body weight on linear body measurement of Muscovy and Mallard ducks and prediction equation at week 4.

At 4 weeks body circumference had the highest coefficient of determinant (R^2) values of 97%, followed by body length (92.2%) and thigh length (88.6%) recorded the least coefficient of determinant (R^2) of the accounted variation for body weight in Muscovy ducks, while Mallard recorded coefficient of determinant (R^2) of 90.3% of shank length followed by body length (82.2%) and breast circumference (81.8%) recorded the least (R^2 %).

This indicats that the body weight of ducks could be predicted with a high degree of accuracy from breast circumference and body length.

Table 3. Stepwise Multiple Regression of Body Weight on Linear Body Measurement of Muscovy and Mallard Ducks and Prediction Equation at week 8

Breeds	Prediction Equations	R^2 (%)	F	SE	SIG
Muscovy	BW = –29.59 + 67.43WL BW = –69.72 + 46.20BH + 63.26BIL BW = 672.28 + 14.81BH	85.8 92 58.7	103.23 98.84 22.77	33.86 27.42 59.54	0.756 0.369 0.00
Mallard	BW=299.93+29.12BH BW = 620.75 + 34.49BH – 78.43SL BW = 498.47 + 36.62BH + 6.236BL – 83.11SL	80.6 86.9 80.1	66.29 49.86 44.29	34.51 29.23 25.83	0.03 0.00 0.02

R^2 = Coefficient of determinant, SE = Standard error

Body weight (BW), body height (BH), body length (BL) breast circumference (BC), thigh length (TL), bill length (BIL), wing length (WL) and shank length (SL)

Table 3 indicated the stepwise regression of body weight on linear body measurements of Muscovy and Mallard ducks and prediction equation at week 8. The results show that the value of the coefficient of determinant (R^2) ranged from 88.6 – 92% and 81.8 – 90.3% in Muscovy and Mallard, respectively, while, coefficient of determinant ranged from 58.7 – 92% and 80.1 – 86.9 in Muscovy and Mallard, respectively at week 8, respectively.

4. DISCUSSION

The results of this study are in close agreement with the earlier finding of Ojedapo *et al*. (2012) who reported that the age is a major determinant of growth and physical development of farm animals. The results also showed a progressive increase in body weight and linear body measurements over the 10 weeks period of experiment.

The body weight and linear body measurements obtained in this study, as shown in Table 1, indicated that body weight increased as the ducks matured, which also indicates a direct positive relationship between body weight and age (Ikeobi and Peter, 1996).

The results obtained in Tables 2 and 3 showed that the coefficients of determinant (R^2) were genetically high and positive, which implies that the equations could be used to predict body weight of ducks effectively. High and positive coefficient of determinant (R^2) value for any trait with body weight is inductive of the fact that the trait has a propensity to increase as body weight increases. This implies that the trait is directly influenced by changes in the body weight. According to Ozoje and Mgbere (2002) since the final body weight of an animal reflects the total of the weight of its component parts, predictive equations provides a readily available tool in estimating body weight, especially in rural communities and in the areas where standard weighing scales or balances are lacking or unavailable. All the morphometric traits were statistically significant ($P<0.05$) and have strong inter-relationship with body weight. This was in agreement with (Ajayi *et al*., 2012). The high and positive (R^2) values observed in the study imply that 50 to 99% of the variation contributing to the body weight of ducks could be attributed to the body parts measured. Since linear body measurements that can readily predict body weight without ducks being slaughtered, it is therefore, highly desirable as it will ensure the selection of animals that will reach market weight and size at relatively faster rate. This will also serve as a tool for breeders in selecting animals destined for use as the breeding stock. These Muscovy and Mallard can be improved by exploiting the principle of phenotypic plasticity (Auld *et al*., 2010) to obtain strains (Kokosynski and Bernacki, 2011) to complement other breeds of duck. Muscovy can also be used to upgrade some other indigenous ducks for better performance in a systematic breeding program.

5. CONCLUSIONS

Based on the results obtained in this study, it shows that the body weight in Muscovy seems to be better in term of its growth performance in all the body dimensions than that of the

Mallard. Hence, I will propose that Muscovy is the best breed based on the Growth performance index. There was a considerable correlation between the body weight and linear body measurements that can be used to improve the body weight. Linear body measurements and body weight of Muscovy and Mallard ducks had a significant association and that body weight could be estimated accurately, based on the value of the coefficient of determination (R^2). Finally, BC, BL, BH, TL and other linear body traits could be used for body weight prediction and genetic improvement in both, Muscovy and Mallard ducks in River State, Nigeria. Therefore, the use of linear body measurements for describing and evaluating the body size would overcome any problem associated with a visual evaluation.

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