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Estimation of Pre- and Post-Weaning Body Weight of Rabbits in a Humid Tropical Environment Using Linear Body Measurements

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Abstract: This study was conducted to evaluate the possibility of predicting body weight (BW) of the domestic rabbit using linear body measurements both at pre- and post-weaning ages. Body weights of 6 genotypes – New Zealand White (NZW), Chinchilla (CHIN), Dutch (DUT), NZW x CHIN, NZW x DUT and CHIN x DUT were predicted. The linear traits measured were body length (BL), heart girth (HG), head-to-shoulder (HS), shoulder-to-tail drop (STD), length of hind limb (LHL), ear length (EL) and height at withers (HTW). Stepwise multiple regression procedure was used to obtain the prediction equations and the associations between BW and the linear traits. At pre-weaning age, STD was the best predictor for the genotypes apart from CHIN x CHIN and NZW x DUT which had BL as best estimator. At post-weaning, STD, BL, HG and HTW were best predictors for NZW x NZW, CHIN x CHIN; DUT x DUT, NZW x CHIN; NZW x DUT and CHIN x DUT, respectively. The coefficient of determination (R^2) were all positive and highly significant ($P < 0.001$) in the two stages. For the pre-weaning phase, R^2 values were all high and ranged between 87.0% and 97.3% while in the post-weaning stage, it ranged from moderate (56.8%) for NZW x DUT to high (95.1%) for NZW x CHIN. BW and the linear traits, except HS, LHL and EL, were significantly ($P < 0.001$) associated, indicating strong interrelationships between BW and the traits. With the prediction models, approximate body weights of rabbits can be obtained using linear body measurements.

Key words: Prediction model · Body weight · Genotype · Rabbit · Humid tropics

INTRODUCTION

Growth rate or body size of animals can be viewed as a set of size-age correlated points that change until maturity [1]. In livestock production, the objectivity of live body measurements has appealed to many researchers as a means of describing the size and shape of farm animals [2]. In line with this, linear body measurements have been used to characterize breeds, evaluate breed performance and predict live body weight of animals [3, 4, 5]. This latter report is attributed to the high genetic correlation between body weight and linear traits. For instance, Adeleke, *et al.* [6] observed that, chickens live weight is positively correlated with other linear body traits and gave breast girth as the best predictor of live weight. In the domestic rabbit, Oke *et al.* [7] found height at withers as the best predictor of body weight at 20 weeks of age and body length at 16 weeks of age. In another study, Abdullah, *et al.* [8] indicated shoulder-to-tail drop as the best single predictor of body weights for rabbits followed by body length and heart girth. Linear body measurements have been used extensively to predict body weight in poultry and the ruminants both in the temperate and tropical regions. According to Chineke, [9] and Nwagu, *et al.* [10] such studies are few and/or non-existent for rabbits. The report of Oke, *et al.* [7] that few genetic studies have been carried out on domestic rabbits in the humid tropics corroborates this earlier finding.

Linear body measurements are less subjected to short-term changes as in body weight and allow comparisons of growth in different parts of the body [11]. The use of linear body measurements to predict live body weight of animals is perceived more reliable compared to the use of weighing scales which could introduce biases as a result of feed in the gut. Moreover, weighing scales are not readily available in most rural African farming communities [12, 13]. Nigeria is not an exception. Hence, in the absence of a weighing scale or when the reliability

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of such scale is questionable, then there is need for a standard weight-estimating method that is user- friendly and practical at the farm level. Bhadula, *et al*. [14] stated that the best method of weighing animals in the absences of scales is to regress body weight on certain body traits that are easily estimated.

Many management decisions are made based on body weight of animals. For example, reliable estimates of body weight have been found to aid selection for improved reproductive performance. Live weight of animals is also an important character in determining their market values. Thus, body weight estimates would help to standardize the marketing of animals especially in chickens and rabbits, with particular reference to Nigeria where such standardization is non-existent. Unfortunately, till date the selection of animals mainly chickens, rabbits and small ruminants in Nigeria is largely done by visual assessment and in most cases holding them with hands to ascertain how weighty they are. The accuracy of such subjective assessment is usually biased as it often results to selection of perceived trueness to existing types. This means that the weight of animals is either over or under estimated in such circumstance. This is because the accuracy of subjective selection depends entirely on the experience of the individual. Owing to the in efficiencies associated with weighing scales and visual assessment of animals, studies determining predictive equations for reliable estimates of body weight are of utmost importance especially in Nigeria where such studies are obviously lacking, especially with rabbits.

Rabbit is a suitable complement to poultry in terms of rapid growth rate and percentage of meat production. The meat which has been found to be bristle, palatable, highly nutritious and a good source of high quality protein [15] is relished in Nigeria. With this, rabbit rearing now forms a significant proportion of livestock farming in many rural areas of this country. This is due to the increased awareness of rabbit production as a panacea to animal protein deficit in the diets of Nigerians. Moreover, the prolific nature of rabbits coupled with its short gestation period and generation interval makes it the choice animal for multiplication.

This investigation was, therefore, aimed at predicting live body weights of rabbits using different linear body measurements at pre- and post-weaning ages. Our main focus is to proffer a simple and general solution to both breeders and buyers towards obtaining nearest estimates of body weight of rabbits in the absence or unreliability of weighing scales. With adequate training, this will undoubtedly help farmers (both rural and commercial) to successfully obtain precise and accurate estimates of body weight for production and marketing efficiency.

MATERIALS AND METHODS

Experimental Site: The experiment was conducted at the Rabbitary Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The University lies on latitude 05°29' N and 7°33' E at an altitude of 122 m above sea level. It falls within the tropical rain forest zone, with maximum daily temperatures of 22°C and 34°C in wet and dry seasons, respectively. Annual rainfall is within the range of 2100 to 2500 mm. Average relative humidity is around 85%, although daily values are subject to variations.

Experimental Animals and Their Management: Six genotypes comprising New Zealand White (NZW), Chinchilla (CHIN), Dutch (DUT) and their crosses – NZW x CHIN, NZW x DUT and CHIN x DUT were used for the study. A total of 83 kits were generated from both pure and main crosses as indicated in Table 1. There were 2 parities. Kits were weaned at 10 weeks of age. Thereafter, the weaning rabbits were reared till the 18th week.

Table 1: Mating scheme and distribution of offspring per mating genotype

Mating Genotype*	Number of bucks	Number of does	Number of parities	Number of kits
Pure cross				
NZW x NZW	1	3	2	14
CHIN x CHIN	1	3	2	10
DUT x DUT	1	3	2	17
Main cross				
NZW x CHIN	1	3	2	11
NZW x DUT	1	3	2	14
CHIN x DUT	1	3	2	17
Total	6	18	2	83

*NZW = New Zealand White; CHIN = Chinchilla; DUT = Dutch

Kits were housed in individual galvanized wire cages. The rabbits were fed concentrate (16.5% CP and 2.80 Mcal/kg gross energy) as well as forage – *Aspillia africana*, *Panicum maximum* (grass) *Tridax procumbens*, *Centrocema pubescens* (legumes). However, the feed intakes of the kits were restricted after weaning till the end of the experiment. Details of the feed restriction are given by [16]. Water was provided *ad libitum* to all experimental animals.

Data Collection and Traits Measured: Data were taken on each progeny resulting from the 6 mating starting from week 3 to week 18. Measurements were done on a weekly basis and taken on the kits before they were fed in the mornings.

The traits measured were individual body weights (BW) and linear body measurements (LBMs) – body length (BL), head-to-shoulder (HS), shoulder-to-tail (ST), heart girth (HG), length of hind limbs (LHL), ear length (EL) and height at withers (HTW). All traits, apart from BW and HTW, were measured using a tailors tape. BW was measured with a weighing scale and HTW with a centimetre ruler.

Regression Analysis: Body weight was regressed on linear body measurements using the Stepwise Multiple Regression Procedure (SPSS[17]). Regression equations were determined for each genotype and the association between BW and LBMs were assessed. Each model is of the general form

$$Bw_i = a + b_1X_1 + b_2X_2 + ... + b_kX_k + e_i$$

Where,

Bw_i = Body weight (dependent variable) of the i^{th} genotype

a = Intercept

$bi - b_k$ = Regression coefficients

$X_i - X_k$ = Linear body measurements (independent variables)

e_i = Random error

The accuracy of the prediction was compared using the coefficient of determination (R^2). The regression equation ignored the effect of feed restriction at post-weaning ages. This is because genotype x feed restriction interaction did not differ significantly for the different genotypes studied [16].

RESULTS

Prediction equations, R^2 (%) and standard error (SE) for the fitted function of the 6 rabbit genotypes are given in Tables 2 and 3 for pre- and post-weaning ages, respectively. In the pre-weaning phase, the R^2 were all high and positive and the regressions were also highly significant (P < 0.001). At pre-weaning stage, STD was the best predictor of body weight for NZW x NZW, DUT x DUT, NZW x CHIN and CHIN x DUT while BL was the best estimator of body weight for CHIN x CHIN and NZW x DUT. R^2 ranged from 87.0% for CHIN x DUT to 97.3%

Table 2: Prediction equations for body weight using linear body measurements for the different genotypes (pre-weaning phase)

Genotype*	Prediction equation	R^2 (%)	SE (b)	Sign
NZW x NZW	BW = -695.34 + 46.33 STD	97.3	46.11	***
CHIN x CHIN	BW = -815.10 + 62.01 BL	92.3	61.22	***
DUT x DUT	BW = -622.79 + 42.35 STD	92.7	55.17	***
NZW x CHIN	BW = -625.45 + 41.80 STD	92.7	60.96	***
NZW x NZW	BW = -743.62 + 58.63 BL	95.6	40.22	***
CHIN x DUT	BW = -483.80 + 35.81 STD	87.0	61.64	***

*NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch; *** = Significance (P < 0.001)

Table 3: Prediction equations for body weight using linear body measurements for the different genotypes (post-weaning phase)

Genotype*	Prediction equation	R^2 (%)	SE (b)	Sign
NZW x NZW	BW = -845.32 + 51.41 STD	93.4	109.67	***
CHIN x CHIN	BW = -1099.06 + 58.93 STD	85.9	176.05	***
DUT x DUT	BW = -1173.03 + 78.79 BL	94.2	109.30	***
NZW x CHIN	BW = -876.06 + 66.03 BL	95.1	90.51	***
NZW x DUT	BW = -1578.29 + 154.56 HG	56.8	79.46	***
CHIN x DUT	BW = -337.01 + 144.66 HTW	92.7	112.51	***

*NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch; *** = Significance (P < 0.001) for NZW x NZW. In the post-weaning stage, body weights of NZW x NZW and CHIN x CHIN were best predicted using STD. BL was the best predictor for DUT x DUT and NZW x CHIN, HG for NZW x DUT and HTW for CHIN x DUT. Here, the coefficient of determination ranged from moderate (56.8%) for NZW x DUT to high (95.1%). HS, LHL and EL showed no significant association with live body weight.

DISCUSSION

Body weight is a very important characteristic in animal production for selection criteria and economic benefits. Therefore, accurate estimation of live body weight from live animal's simple body measurements is beneficial to livestock enterprises. A producer can measure all the body measurements easily from a live animal and can approximately determine body weight.

From the result, all the linear body measurements except HS, LHL and EL could be used to predict body weight of rabbits accurately both at pre-and post-weaning ages. The high R^2 values observed in this study shows the relative contributions of the different traits to the body weight of the rabbit genotypes studied at both growth phases. The significant associations indicate a strong interrelationship between body weight and the measured traits. The observations made in this study agree with the earlier findings of Oke, *et al.* [7], [8,9] and [18]. The results of this study also corroborated the reports of Orheruata, *et al.* [19] who obtained high and positive associations between body weight and linear measurements of rabbits measured from weaning to 15 weeks post-weaning ages. These authors, however, suggested hind limb length as best estimator for body weight which is contrary to our report of STD followed by BL as best predictors of body weight at both ages. In another study, Akanno and Ibe, [20] also noted high and positive associations between body weight and linear measurements of rabbits (Dutch, New Zealand White and their crossbreds) at 3, 6, 9 and 12 weeks, respectively. Their estimated R^2 values ranged between 63.5% and 93.7% and they suggested BL, body width and STD as important estimators of body weight at the various weeks studied. These findings are similar to our observations. On the contrary, Yakubu and Ayoade, [21] used principal component factor (PCF) analysis to quantify size and morphological indices of domestic rabbits and concluded that PCF-based prediction model is preferred to linear measure-based models since it combines both size and shape components in a composite index for prediction. In a similar study, Acheneje, [22] regressed linear measurements against live weight of guinea pigs at 4, 6, 8, 10 and 12 weeks using linear, quadratic and exponential regression analyses. Based on the R^2 values, Acheneje, [22] concluded that exponential equation was superior in terms of goodness of fit to the data and prediction of body weight.

The practical implication of this work is that with the aid of regression equations involving these traits studied, approximate values could be substituted to obtain estimates of rabbit body weight for the age brackets reported in this study. The choice of trait(s) will then be at the breeder's discretion in terms of ease of measurement of such a trait by the breeder. Knowledge of an animal's live weight is very useful for marketing and breeding purposes.

However, the problems with prediction models especially to a non-breeder and/or rural farmers is the level of education of these categories of people in terms of taking accurate linear measurements and applying them adequately to the models. One plausible solution to this problem will be to develop charts by breeders in this region indicating expected body weights for different possible linear body traits based on the models. These could then be made available to farmers as extension guides. With this, the live weight of rabbits could be estimated to the nearest kilogram (kg) and thereafter evaluated for selling and/or breeding which in turn will enhance farmers' profitability, moreso in rural enterprises.

CONCLUSION

Linear body measurements are biased by the level of gut fill. Therefore, accurate estimate of body weight is expected when these LBMs are substituted in the prediction models. Nonetheless, there may be need for further investigation of this study using quadratic and possibly cubic regression functions in order to establish the best relationship between body weight and linear body traits. High degree of reliability of regression estimates of body weight in the domestic rabbit could aid in the selection of both breeder and meat type rabbits for improved reproductive and production performance, particularly in rural areas or where weighing scale is not readily available.

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