THE PERFORMANCE OF MONGREL RABBITS IN A TROPICAL ENVIRONMENT

Commented [ZT1]: THE MONGREL RABBITS' ACTIVITY IN A TROPICAL SETTING

Abstract

A total of sixty progenies were used to evaluate growth traits comprising of body weight and linear body parameters in mongrel rabbits, estimate phenotypic correlations among growth traits and develop regression models to predict body weight using linear body measurements. Body weight and linear body measurements comprising; Ear length, Heart girth, Body length, Fore-limb, Hind limb and Tail length were taken from 8 weeks to 16 weeks of age. Results showed that age exerted ($P < 0.05$) significant influence on all growth traits. Positive and strong association was observed between body weight and all linear body parameters throughout the period of the study. This implies that, an improvement in any of linear parameters will bring about an improvement in body weight vice versa. Body weight was significantly predicted using linear body measurements with high to medium degree of validity. Higher validity were observed in the multiple model when more traits where fitted into the prediction equation.

Commented [ZT2]: During the study period, a positive and substantial correlation was found between body weight and all linear body parameters.

Keywords: mongrel, growth performance phenotypic correlations, body weight prediction.

Introduction

Nigeria alongside several nations in sub-sahara Africa is faced with food insecurity and under nourishment. FAO (2020), reported that though the food insecurity is a worldwide issue, it is rather in the increase in sub- sahara Africa. FAOSTAT (2019), observed that Nigeria's per capita food supply of animal source which are superior protein sources is 8 litres of milk, 9kg of meat and 3.5kg of eggs per year with a consumption levels of milk and meat lower than the continental averages of 44 litres and 19kg respectively. Thus indicating that Nigeria is equally faced with insufficient protein intake. Furthermore, the increasing population and urbanization of Nigeria aggravates the existing problem (FAO 2017).

Commented [ZT3]: Thus, it may be concluded that Nigeria faces the same problem of inadequate protein intake. In addition, Nigeria's growing urbanisation and population make the issue worse (FAO 2017).

Livestock farming provides a means of improving food insecurity and insufficient animal protein in Nigeria (Ayeni *et al*., 2023). Protein from livestock which are not readily considered in animal husbandry are being explored (Obasi *et al*., 2019). Domestic rabbits falls in this category, and is of advantage due to its; fast growth rate, ability to convert 20% forage to meat, short gestation period, high prolificacy, high protein level (20.8- 21.3 %), rich in vitamins and minerals, low in sodium, fat, and cholesterol, making it of high nutritive value (Rotimi and Ati, 2020; Sanah *et al*., 2022; Siddiqui *et al*., 2023). Growth in all animals is a complex process controlled by both genetic and non-genetic factors. Although the growth performance of an animal is a phenotypic attribute influenced by the environment, to a large extent however, it is a manifestation of the genetic constitution of the animal (Oleforuh-Okoleh *et al*., 2017).

Growth performance and body conformation traits are important parameters in assessing the potential of genetic improvement and development of mongrel rabbits to enhance their contribution to the much needed animal protein in Nigeria. Morphological variation within species is of great biological interest both as descriptive and analytical tool. Sexual dimorphism on morphological traits is important in descriptive studies to characterise population composition and

evaluate the genetic variation within and between populations of rabbits. Thus the knowledge obtained will be essential in planning breeding programmes and in adopting breeding strategies. It will also be essential in assessing growth rate of mongrel rabbits.

Correlations expresses the relationships between phenotypic values of the animals, which could be seen on the performance of the animals.The knowledge of the relationships between body weight and growth traits (correlation) are useful tools for breeders in selecting animals as breeding stock and for predicting body weight (Udoh and Udofot, 2016). Obasi *et al*. (2019) reported positive and significant phenotypic correlations between linear body measurements and bodyweight indicating that an improvement in one trait would lead to a corresponding improvement in the other provided environmental influence is excluded.

Commented [ZT4]: Clarifying the purpose of the research

MATERIALS AND METHODS

A total of 16 mature mongrel rabbits comprising of 4 males and 12 females were purchased from a reliable rabbit vendor within the State to reproduce progenies for the research. Rabbits were housed individually in three tier wooden hutches of 60 cm x 60 cm and 60 cm from the ground. The hutches were thoroughly washed with detergent and disinfected a week to the arrival of the rabbits. Rabbits were flushed qualitatively a week to mating and then mated at the ratio of 3:1 female to male. Tag numbers were assigned to each hutch and each rabbit was systematically ear numbered with permanent marker for easy identification. Concrete drinkers and feeders were provided. Rabbits were fed *ad libitum* with grower's mash (top feed) and supplemented with forages such as *Centrosema pubescens*, *Pannicum maximum* as suggested by Obasi *et al*., (2019). Clean water was provided daily. Matured rabbits and rabbits at weaning were given Ivomec injections against endo-parasites and ecto-parasites. Kitten were sexed and weaned at the 8th week. Prophylactic medications were administered to weaning rabbits against prevalent rabbit infections such as, coccidiosis, mucoid enteritis, pasteurellosis, etc. Multivitamins were administered in drinking water to boost appetite.

DATA COLLECTION

The following data were collected:

1. Body weight of the kittens were measured weekly using sensitive scale weighing balance (top loading pan scale of 20 kg capacity with 0.01 kg accuracy) and recorded in (g) from 8 weeks to 16 weeks.
2. Linear body measurements comprising of:

a) Body length: length between the neck region to the base of the tail (cm).
b) Heart girth: body circumference of chest region (cm).
c) Length of forelimb: length from the base of ulna bone to the tip of the feet (cm).
d) Length of hind limb: length from the base of the pelvic bone to the tip of the feet (cm).
e) Tail length: length from the base to the tip of tail (cm).
f) Ear length: length from the base to the tip of ear (cm); were measured weekly from 8 weeks to 16 weeks using tailor's tape. All measurements were taken in the morning before feeding and by the same person to avoid variations.

EXPERIMENTAL DESIGN

Data collected were subjected to analysis of variance in CRD using SPSS, significant means were separated by DMRT.

The general linear model for the experiment was: $\mathbf{Y_{ij}=\mu+S_i+e_{ij}}$.
Where;

Y_{ij}…. individual observation

μ …. general mean

S_i …. effect of i^{th} sex (1,2)

e_{ij}…. residual error

RESULTS AND DISCUSSION

Growth pattern of Mongrel rabbits from week 8 to 16

Mongrel rabbit according to the result obtained in this study (table 1) had progressive increase in body weight from 501.83 ± 49.67 g at week 8 to 1300 ± 16.35 g at week 16, this conforms to the report of Onasanya *et al.,* (2017) who observed that body weight proportionately increases with increase in age. Lamptey *et al.,* (2022) also noted that rabbits have progressive growth which is more rapid at the early stage of growth. Linear body parameters also had corresponding increase as body weight was increasing. This agrees with the findings of Sam *et al.,* (2020) who observed that linear body measurements increased as bodyweight increased. The result implies that growth is influenced by age.

The body weight of mongrel rabbits recorded in this study at week 8 (501.83 ± 9.67 g) agrees with Sam *et al.,* (2020) who reported a body weight of 558.50 ± 4.90 g in Chinchilla × New Zealand white but was slightly below 577.51 ±22.18 g obtained by Lamptey *et al.,* (2022) with domestic rabbits. The slight difference could be because of the difference in breeds. Body weight of mongrel rabbits 896.92 ± 13.05 g obtained at week 12 of this research is in line with 873.30 ± 42.23 g obtained by Onasanya *et al.,* (2017) with California white x New Zealand white rabbits, 853.33 ± 30.70 g obtained by Sam *et al.,* (2020) with New Zealand white x Chinchilla rabbits and 890 ± 0.01 g obtained by Rotimi (2022) with New Zealand white x Chinchilla rabbits.

Body length of mongrel rabbits recorded in this study at week 8 (30.60±0.18 cm) is lower than 34.95 ± 4.42 cm obtained by Ologbose *et al*., (2017) but higher than 17.12 ± 1.06 cm and 18.86 ± 0.24 cm obtained by Sam *et al.,* (2020). 35.38 ± 0.18 cm obtained at 12 week of this study is lower than 38.8 ± 2.89 cm reported by Ologbose *et al*., (2017). Body length obtained in the other weeks of this study is likewise, higher than those obtained by other authors, this may be as a result of the difference in breeds used and the environment. Sam *et al.,* (2020); and Adamu *et al.,* (2021) observed that variation of some morphometric traits among different genotypic groups could be attributed to the influence of genetic makeup on growth rate and body weight. Ear length value obtained in this study, 8.3 ± 0.06 – 10.63 ± 0.05 cm is in line with the values obtained by Onasanya *et al.,* (2017), Anya *et al.,* (2018), Rotimi (2022) and Sam *et al.,* (2020). All working with different breeds rabbits, this might imply that ear length of rabbits have same pattern of growth across the breeds. Hearth girth of mongrel rabbits observed in this study at week 8; 16.76 ± 0.13 cm is lower

than 18.05 ± 1.60 cm obtained by Ologbose *et al*., (2017), 19.42 ± 0.81 cm and 20.79 ± 0.47 cm obtained by Sam *et al.*, (2020). The difference could be because of the difference in breeds and the environment. However, 21.10 ± 0.14 obtained at week 12 is in line with 20.68 ± 2.76 cm obtained by Ologbose *et al*., (2017) but slightly higher than 19.39 ± 0.11 cm obtained by Rotimi (2022). Also, 20.28 – 22.25 cm obtained by Anya *et al.* (2018) in matured rabbits aligns with 16.76 ± 0.13 – 24.88 ± 0.20 cm range obtained in this study. Fore limb value which ranged from 10.88 ± 0.06 – 14.74 ± 0.10 cm was lower than 15.00 ± 2.00 – 17.30 ± 1.86 cm obtained by Ologbose *et al*., (2017) but in line with 12.73- 13.55 reported by Anya *et al.*, (2018) in matured rabbits.
Hind limb value reported in this study was slightly lower than that of Ologbose *et al*., (2017) but in line with Anya *et al.*, (2018). Tail length obtained was lower than that of Onasanya *et al.*, (2017) but in line with Anya *et al.*, (2018).

Table 1: Body weight and linear body measurements for week 8, 10, 12, 14 and 16

	Mean ± SEM				
	Week 8	Week 10	Week 12	Week 14	Week 16
Body Weight	501.83±9.67 ^{e}	684.67±10.95 ^{d}	896.92±13.05 ^{c}	1088.67±15.32 ^{b}	1300±16.35^{a}
Ear Length	8.36±0.06^{e}	8.85±0.58 ^{d}	9.63±0.06 ^{c}	10.13±0.05 ^{b}	10.62±0.05 ^{a}
Heart Girth	16.76±0.13^{e}	18.41±0.13 ^{d}	21.10±0.14 ^{c}	22.88±0.16 ^{b}	24.88±0.20 ^{a}
Body Length	30.60±0.18 ^{e}	32.88±0.17 ^{d}	35.38±0.18 ^{c}	37.36±0.18 ^{b}	39.89±0.24 ^{a}
Fore limb	10.88±0.06 ^{e}	11.66±0.07 ^{d}	12.74±0.89 ^{c}	13.69±0.08 ^{b}	14.74±0.10 ^{a}
Hind Limb	15.47±0.10 ^{e}	16.70±0.10 ^{d}	18.36±0.10 ^{c}	19.89±0.13 ^{b}	21.42±0.14 ^{a}
Tail length	6.66±0.06 ^{e}	7.33±0.52 ^{d}	7.98±0.57 ^{c}	8.49±0.06 ^{b}	8.98±0.06 ^{a}

a,b,c = means in a row within a parameter with different superscripts are significantly ($p<0.05$) different from each other.

Average Daily Gains in Body weight and linear body measurements of Mongrel Rabbits

The average daily gains of mongrel rabbit without recourse to sex is presented in table 2. There were gains in body weight and linear body measurements throughout the period of this study from week 8 to week 16. The average daily body weight gain obtained in this study, which ranged from 13.06 - 15.16 g, is lower than 37.84 - 40.36 g obtained by El Sawy *et al.*, (2023) with New Zealand rabbits, this could be attributed to the difference in breeds and age of rabbits used in this study. However, the range of values agrees with Idowu *et al*, (2022) who obtained a range of 13.02 - 16.21 g/d in mixed breed of rabbits at week 7 to week 10. The result also aligns with the report of Al-Amin *et al.*, (2019) who obtained an average body weight of New Zealand rabbits at 8-9 weeks to range from 10.56 - 20.20 g. Age had significant ($p<0.05$) effect on the body weight gains and gains in linear body measurements obtained in this study. This implies that the animals gained weight with age.

Table 2 Average Daily Gain of Mongrel Rabbit

	Mean ± SEM			
Parameters	Week 8 – 10	Week 10- 12	Week 12-14	Week 14 – 16
Body Weight	13.06±0.39^{b}	15.16±0.48^{a}	13.83±0.54^{ab}	15.10±0.62^{a}
Ear Length	0.04±0^{b}	0.06±0^{a}	0.04±0.01^{b}	0.04±0^{b}
Heart Girth	0.12±0.01^{c}	0.19±0.01^{a}	0.13±0.03^{ab}	0.14±0.16^{b}
Body Length	0.16±0.01^{ab}	0.18±0.01^{a}	0.14±0.04^{b}	0.18±0.01^{a}
Fore limb	0.06±0^{b}	0.08±0 ^{a}	0.07±0.02^{ab}	0.08±0.01^{a}
Hind Limb	0.09±0^{b}	0.12±0^{a}	0.11±0.02^{a}	0.11±0.01^{a}
Tail length	0.05±0^{a}	0.05±0^{a}	0.04±0.01^{b}	0.04±0^{b}

a b c = means in a row within a parameter with different superscripts are significantly different

Phenotypic Correlations between Body Weight and Linear Body Measurements of Mongrel Rabbit

Mongrel rabbits recoded positive and strong association between body weight and linear body measurements all through the period of this study (table 3-5). Ologose *et al.* (2017), Obasi *et al*. (2019) and Sam *et al.* (2020) all recorded positive association between body weight (BW) and linear body measurement (LBM). The highest phenotypic correlation between body weight and linear body measurements at week 8 was obtained between body weight (BW) and hearth girth (HG- 0.752) followed by body weight and body length (BL- 0.664). Ologose *et al.* (2017) and Sam *et al.* (2020) observed that hearth girth and body length had the highest association with body weight at week 8. The strong association recorded between BW and (HG and BL) indicate that HG and BL can be used to predict BW at 8 week of age and also selected for improvement of growth traits. Phenotypic correlation amongst LBM were all positive at week 8 ranging from very high to low. This implies that all the linear parameters had the same direction of growth though at different rate. The result in this study agrees with that of, Ologose *et al.* (2017), Obasi *et al.* (2019) and Sam *et al.* (2020). The strongest correlation amongst LBM (0.607) was obtained between heart girth and ear length this implies that the selection of one would result in great benefit to the other. While ear length and hind limb had the least correlation, this implies that the selection of one would have the least benefit on the other. Ologose *et al.* (2017) and Sam *et al.* (2020) had high correlation between hearth girth and other morphometric traits implying that an improvement on hearth girth will result in corresponding improvement of other LBM.

At week 10 phenotypic correlation between body weight and linear body measurement observed, were all positive and highly significant ($p<0.01$). Sam *et al.* (2020) also recorded positive

correlation between BW Band LBM at week 10. The highest correlation in this study was obtained between body weight and hind limb (0.672) followed by body weight and body length (0.602) while the least correlation (0.444) was with ear length. LBM all expressed positive correlations, the strongest association was between body length and hearth girth (0.629) while the least was between ear length and tail length (0.260). Ayo-Ajasa *et al.* (2018) reported body length and hearth girth to have high correlation between each other and can be selected for improvement.

At week 12, body weight had positive and significant correlation ($p<0.01$) with all LBM studied. Obasi *et al.* (2019), equally obtained positive correlation at week 12 of their study. The highest correlation was with body length (0.650) while the least was with ear length (0.440).This implies that body length is the most suitable for selection at week 12. LBM all had positive correlation the strongest was between body length and ear length while the weakest was between ear length and tail length.

Phenotypic correlation between BW and LBM at week 14 was positive and highly significant ($p<0.01$). Body length had the strongest association while heart girth had the weakest. Correlation on LBMs were all positive. Body length and ear length had the strongest association while hearth girth and tail length had the weakest.

There were positive correlation between body weight and amongst linear body measurements at week 16 expect for hearth girth and tail length which was negative. A negative correlation signifies that the selection of one for improvement would result in the reduction of the other. Obasi *et al*. (2019) and Sam *et al*. (2020) reported negative correlations amongst some morphometric traits. The best correlation between BW and LBM was BL while amongst LBM was between BL and HL, implying that body length (BL) if selected for improvement will positively affect all growth traits at week 16.

It is observed that correlation coefficient in all ages between BW and LBMs were positive, this means that as the LBMs or BW is increasing, a corresponding increase is expressed in the other. This mean that as any one linear body measurement or body weight is increasing, a corresponding increase is expressed in the other. The result Implies that, the improvement of body weight would result in a corresponding improvement of all the linear body measurements. The high and positive phenotypic correlations observed among the linear body measurements indicate high genetic variation, which supports high selection response. Implying that, any of the linear body parameters can be selected for improvement of body weight and that these correlated traits could jointly be selected, such that an improvement in one linear body measurement proportionately leads to simultaneous improvement in the other. This shows that growth in mongrel rabbit is asymmetrical with other parts. It is also indicator that as the rabbit grows, all the other parts are growing concurrently.

Table 3 Phenotypic correlation of body weight and linear body measurement at week 8 (above diagonal) and week 10 (below diagonal)

	BW	EL	HG	BL	FL	HL	TL
BW		0.637**	0.752**	0.664**	0.577**	0.542**	0.554**
EL	0.444**		0.607**	0.509**	0.457**	0.254	0.266*
HG	0.602**	0.443**		0.573**	0.520**	0.489**	0.393**
BL	0.642**	0.500**	0.629**		0.520**	0.501**	0.404**
FL	0.513**	0.514**	0.513**	0.544**		0.377**	0.270*
HL	0.672**	0.374**	0.477**	0.582**	0.458**		0.459**
TL	0.587**	0.260*	0.356**	0.432**	0.416**	0.516**	

BW = body weight, EL = ear length, HG = hearth girth, BL = body length, FL = fore limb, HL = hind limb, TL = tail length ** = highly significant P < 0.01 * = significant P < 0.05

Table 4.Phenotypic correlation of body weight and linear body measurement at week 12 (above diagonal) and week 14 (below diagonal)

	BW	EL	HG	BL	FL	HL	TL
BW		0.440**	0.513**	0.650**	0.634**	0.559**	0.571**
EL	0.500**		0.331**	0.579**	0.350**	0.350**	0.286*
HG	0.353**	0.318*		0.544**	0.290*	0.405**	0.298*
BL	0.667**	0.608**	0.587**		0.559**	0.539**	0.481**
FL	0.499**	0.223	0.364**	0.519**		0.501**	0.504**
HL	0.556**	0.438**	0.313*	0.544**	0.536**		0.521**
TL	0.529**	0.540**	0.169	0.536**	0.341**	0.532**	

BW = body weight, EL = ear length, HG = hearth girth, BL = body length, FL = fore limb, HL = hind limb, TL = tail length ** = highly significant P < 0.01 * = significant P < 0.05

Table 5 Phenotypic correlation of body weight and linear body measurement at week 16

	BW	EL	HG	BL	FL	HL	TL
BW		0.496**	0.236	0.681**	0.679**	0.618**	0.398**
EL			0.182	0.622**	0.418**	0.580**	0.454**
HG				0.459**	0.257*	0.184	-0.005

BL	0.709**	0.717**	0.422**
FL		0.648**	0.463**
HL			0.387**
TL			

BW = body weight, EL = ear length, HG = hearth girth, BL = body length, FL = fore limb, HL = hind limb, TL = tail length ** = highly significant P < 0.01 * = significant P < 0.05

Prediction of Growth Traits of Mongrel Rabbits from week 8 to 16

Body weight was significantly (P < 0.05) predictable from linear body measurements obtained in this study for mongrel rabbits without recourse to sex using both simple and multiple regression models (table 6). Prediction was possible since there were high and positive correlations between body weight and LBMs. This agrees with Sam *et al*. (2020) who reported that linear body measurements with high and positive correlation with body weight of rabbits can be used in body weight prediction which is essential in animal improvement. At week 8, heart girth (HG) was the best linear parameter used for prediction, it had the highest correlation with body weight and can therefore be selected for genetic improvement. Ologose *et al*. (2017) also observed (HG) to be the most preferred single predictor at week 8. The highest Coefficient of determination (R^2) 57% and 72% in the simple and multiple regression models respectively, were obtained at week 8 of this study. This implies that prediction was most reliable at this week. At week 10, Hind limb (HL) was the best linear parameter used with (R^2) 45%. From week 12 to week 16 of this study, Body length (BL) was the best linear parameter for prediction, this implies that BL should be used for weight prediction in older mongrel rabbits. Higher R^2 values were obtained in the multiple regression equations where more linear parameters were used. Indicating that, multiple regression model should be more reliable. Udoh and Udofot (2016) also reported increased reliability of prediction model when more linear parameters are used for predictions.

Table 6 Simple and Multiple Regression models for predicting Body Weight of Mongrels Rabbits for week 8, 10, 12, 14 and 16

Simple Prediction equation	R^2 (%)	S.E	Sig	Multiple prediction equation	R^2 (%)	S.E	Sig
BW = -469.65 + 57.97 HG	57	49.75	**	BW = -953.22 + 30.18 HG + 12.09 BL+ 42.01 TL + 35.84 EL	72	40.80	**
BW = -595.50 + 76.66 HL	45	63.41	**	BW = -967.23 + 42.54 HL + 27.59 HG + 59.21 TL	61	54.41	**
BW = -777.40+ 46.71 BL	42	77.43	**	BW = -1168.76 + 17.43 BL + 46.57 FL + 51.83 TL + 20.97 HG	60	65.97	**

BW = -1026.54 + 56.62 BL	45	89.13	**	BW = -1180.62+ 43.94 BL + 31.56 HL	50	85.50	**
BW = - 579.67 + 47.13 BL	46	93.58	**	BW = - 800.63 + 27.77 BL + 67.39 FL	54	87.35	**

BW = body weight, EL = ear length, HG = hearth girth, BL = body length, FL = fore limb, HL = hind limb, TL = tail length, ** = highly significant P < 0.01 * = significant P < 0.05

CONCLUSION

Body weight of Mongrel rabbits increased gradually from week 8 to 16 indicating that age exert influence on the growth of animals. Linear body parameters had corresponding increase with body weight. Significant interactions were observed in some linear body parameters and also in daily gains of linear body parameters. Body weight had positive and strong association with linear body measurements in all ages of this study. Heart girth (HG) had very high association with body weight at week 8 to 10 while, body length (BL) recorded very high association from weeks 8 to 16 making them good traits for selection in the improvement of mongrel rabbits. Positive regression coefficients were obtained from linear body parameters in body weight prediction implying that linear parameters can be used in body weight prediction of mongrel rabbits.

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