Pattern of Early Growth Traits and Predictions in Progenies of Mongrel Rabbits

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Authors' contributions

This work was carried out in collaboration between both authors. Author UHU designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors UHU and MMU managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

A research lasting six months was carried out with progenies of mongrel rabbits to investigate the pattern of early growth traits and to predict body weight. Rabbits were managed extensively, and fed *ad libitum* proprietary feed (15% CP and 2300 Kcal/kg ME), supplemented with forages. Data collected (body weight; head and neck circumferences; body, ear and face lengths; hind and forelimbs) were analyzed using regression, in Gen Stat software computer programme, 13th edition. Prediction equations for estimating body weight using linear body measurements were determined. Results revealed a pattern of gradual increase in body weight from birth till 70th day. Highest percentage increase was observed from birth to day 14. Linear body measurements ranked in the following order: hind limb (45.60 cm), body length (39.69 cm), body circumference (37.81 cm), forelimb (25.53 cm), ear length (22.50 cm), neck circumference (18.16 cm), head circumference (17.17 cm), and face length (16.08 cm). When body weight was predicted within specific age groups, face length and head circumference were not part of the prediction equations. Body weight was predictable from face length, hind limb, body and neck circumferences when age was not considered. Prediction equations involving more linear parameters were more reliable than those with fewer body parameters.

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1. INTRODUCTION

Domestic rabbit (*Orytolagus cuniculus*), described as a micro-livestock species appears to be the cheapest and sustainable means of producing high quality animal protein for the expanding population of less developing countries like Nigeria [1]. It has been identified as an economic livestock that could bridge the wide gap in dietary protein intake in Nigeria. Rabbit produces about 47 kg of meat per doe per year, which is enough to solely meet the animal protein requirements of a medium-sized family under small scale rural farming system [2]. Rabbit production may provide the impoverished urban population and the resource – poor dwellers the opportunities to earn additional income on a sustainable basis.

Growth traits of rabbits are affected by a number of factors: environment, nutrition, breed, age, sex, climate, among others [3]. To determine live weight of rabbits, simple and easily measurable morphological variables of different parts of the body can be used indirectly. Knowledge of weight estimation and linear measurements in rabbit production is useful in the control and management of the animals during the entire rearing process [3]. It has been used in administering medication, nutritional rationing and marketing of animals. Linear measurements can be used to assess growth rate, feed utilization and carcass characteristics [4].

Relating body weight with linear body measurements is one way of predicting body weight of rabbits [4,5,6]. This is relevant especially in rural communities where there is absence of conventional weighing scales. Simple linear body measurements that can readily predict body weight without rabbit slaughter is highly desirable as it will ensure the selection of animals that will reach market weight and size at relatively faster rate. Ozoje and Mgbere [7] opined that the final body weight of animals is a reflection of the sum total of the weight of all its component parts. This means that a change in any one of the component parts could impart positively or negatively on the final body weight, depending on the direction of the change. Olutogun [8] posited that body weight tends to increase as body dimensions increase. Data obtained from such relationships are therefore useful tools for breeders in selecting animals destined for use as breeding stock and also in predicting body weight without resulting to animal slaughter [4].

This study therefore aimed at investigating the pattern of early growth traits of the available mixed (mongrel) breeds so that appropriate management/breeding strategies could be put in place. The objectives of the study were:

- To investigate the pattern of early growth traits in progenies of mongrel rabbits.
- To predict body weight in progenies of mongrel rabbits using linear body measurements.

2. MATERIALS AND METHODS

Experimental site was the Rabbitary Unit, Teaching and Research Farm, Department of Animal Science, University of Uyo, Uyo. Nigeria. Uyo is located between latitude 05° 02′ North and longitude 07° 56′ East. Uyo has natural day length of 12-13 hours. The monthly mean minimum temperature ranged from 21.3℃ to 24.9℃ and the mean maximum temperature ranged from 28.4℃ to 34.5℃. The annual mean rainfall ranged between 2000 mm and 3000 mm. Relative humility ranged from 78 - 93% courtesy Geography Department, Meteorological station, University of Uyo, Uyo, Nigeria. The experiment lasted six (6) months (January to June, 2015).

2.1 Management of Experimental Animals

Four does and one buck from The Rabbitry Unit, Teaching and Research Farm of the Department of Animal Science, University of Uyo were selected and used for the research. Animals were managed intensively and fed *ad libitum* with proprietary diet (15% CP and 2300 kcal/kg ME) in the morning, supplemented with forages in the evening. Clean water was supplied *ad libitum*. Prophylactic medications were administered against prevalent rabbit infections. Multivitamin preparations were administered in drinking water to boost appetite. The principles of animal care were adhered to strictly throughout the duration of the study.

2.2 Mating

Breeding animals were flushed one week before mating. Date and time of mating were recorded. Does were palpated on the 14th day after mating to confirm conception. Thirty-three kittens

generated from the four does were used for the research. Kittens were inspected twice daily and weaned at 42 days of age.

2.3 Data Collection

Kittens were systematically ear numbered and identified with their dams for purposes of data collection. Data on the following parameters as described by [9] were taken once a week on each kitten for 70 days: body weight; body, head and neck circumferences; body face and ear lengths; fore and hind limbs. Body weights of kittens were taken from 7 days old whereas other linear parameters were taken from 14 days old. Body dimensions were measured with a tailor's measuring tape (1 – 100 cm); body weight was assessed with a digital sensitive scale (AHOUS) measured from 0.1 g – 1.0 kg.

2.4 Statistical Analysis

All data were analysed with Gen Stat software computer programme, 13th edition. Regression (simple and multiple) was carried out to obtain prediction equations for body weight using specific body dimensions. Body weight measurement (g) was the dependent variable (Y) while the linear measurements (cm) were the independent variables (X). In addition, weight and linear changes were calculated using percentage as shown below for Tables 1 and 2:

1. Formula: $\frac{\text{Present value} - \text{initial value}}{\text{Initial value}}$ x 100%

2. Formula: Highest value – lowest value = Increase during the measurement period.

3. RESULTS AND DISCUSSION

3.1 Early Growth Pattern in Progenies of Mongrel Rabbits

Body weight of kittens increased with age from birth to 70 days of age. Orheruata [10] attributed this trend to the multiplication in body cells and skeletal size. Highest percentage increase (81 – 94%) was observed from birth to day 14 (Table 1).

There was no regular pattern for subsequent measurement periods, but there was a general decline in percentage body weight increase per measurement period as kittens grew older. Linear body parameters increased with age but the increase varied with body parts. Ebegbulem [11] observed that growth is continuous with age. These variations in increase portrayed the contributions of the various body parameters to the final body weight of kittens (Table 2).

The pattern of increase, expressed in percentage for linear body parameters are presented in Table 1. Trend of body weight increase from kittens of all does (Fig. 1) reveal a pattern of gradual increase from birth till 70th day. Further breeding researches should investigate the patterns of growth in mongrel rabbits beyond 70 days of age.
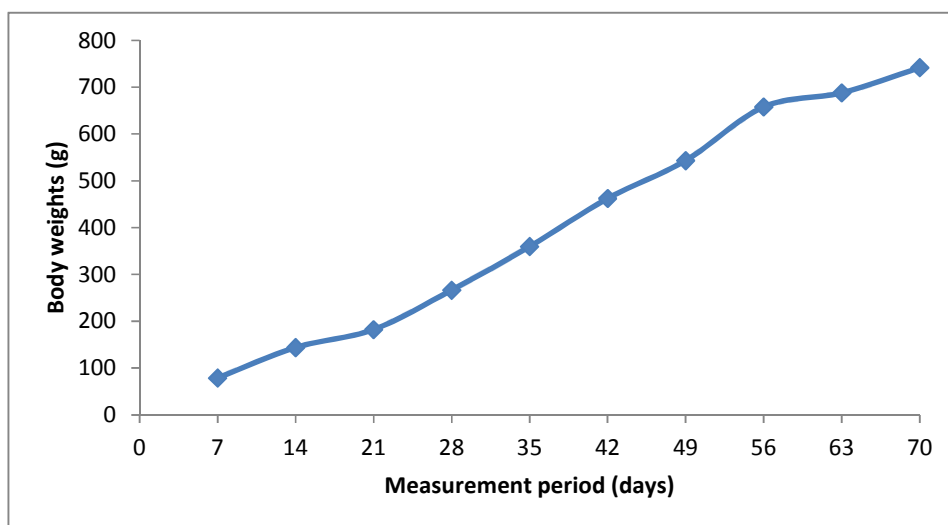

Fig. 1. Trend of body weight from kittens of different does

Table 1. Pattern of increase (%) for body weight and linear body parameters from day 7 to day 70

Parameter	Doe	Measurement period (days)								
		14	21	28	35	42	49	56	63	70
Body weight (g)	1	94	30	54	35	18	30	10	15	-5
	2	81	65	38	31	31	3	19	3	23
	3	87	20	64	33	34	13	18	5	6
	4	87	12	50	47	43	25	24	-2	7
FL (cm)	1	8	7	11	14	3	6	5	6	
	2	17	9	11	10	9	3	0.8	0.8	
	3	7	28	13	12	6	3	7	5	
	4	5	6	13	18	4	15	-4	7	
HL (cm)	1	16	7	13	15	2	1	8	5	
	2	9	8	4	11	20	12	0	6	
	3	9	8	16	19	7	11	3	5	
	4	9	8	7	21	3	11	5	7	
EL (cm)	1	30	7	28	2	7	2	12	4	
	2	8	7	14	2	12	5	1	4	
	3	25	52	10	8	2	2	3	14	
	4	50	44	17	6	8	8	3	1	
HC (cm)	1	5	4	2	3	2	3	8	6	
	2	18	10	2	2	4	7	2	3	
	3	4	6	0.4	1.5	3	3	0.7	5	
	4	10	4	4	5	3	1	2	5	
BC (cm)	1	7	6	6	7	8	14	9	1	
	2	5	1	3	2	2	5	8	4	
	3	7	21	-2	14	7	4	3	3	
	4	4	16	2	19	9	6	3	2	
BL (cm)	1	13	15	2	1	10	0.9	7	4	
	2	13	11	1	0	.5	2	2	5	
	3	9	36	13	5	7	1	4	4	
	4	11	37	23	5	0.6	9	3	5	
FL2 (cm)	1	6	11	5	2	1	4	0.8	4	
	2	2	3	2	0	5	5	10	7	
	3	25	20	6	6	2	8	1	1	
	4	11	6	18	4	4	7	2	1	
NC (cm)	1	11	2	5	1	1	5	1	6	
	2	2	13	3	6	4	3	1	9	
	3	13	17	6	10	4	0.8	1	3	
	4	16	14	7	7	10	3	4	0.5	

FL=Forelimb, HL=Hind limb, EL=Ear length, BL=Body length, FL2=Face length, BC=Body circumference, NC=Neck circumference, HC=Head circumference, BL=Body weight

The results revealed a pattern of gradual increase from birth till 70th day. Ebegbulem [11] also reported a gradual increase in the body weight of rabbits as they grew older.

All kittens increased in weight from birth, although at varying percentages. Further breeding researchers should investigate the pattern of growth in mongrel rabbits beyond 70 days.

3.2 Prediction of Body Weight in Mongrel Rabbits Using Linear Body Measurements

Prediction equations for body weight in mongrel rabbits using linear body measurements are presented in Tables 3 and 4.

The prediction equations indicated that body weights in mongrel rabbits (kittens) are predictable from the various linear body parameters measured in this study. Obike [12] also observed that body weight of rabbits could be predicted using various body parameters. This assertion is in line with our study, that body weight of mongrel rabbits could be predicted using any of the body measurements. However, when predictions were considered on specific age groups (Table 3), body weight was not predictable from face length and head circumference.

At the early growth phase (1 to 28 days), body weight was only predictable from body circumference. This was probably because other

body parts were too small to make meaningful contributions to body weight. As the kittens grew older, other body parts increased in size and were involved in the prediction equations. Therefore, at 29 to 49 days old, face length (FL), Neck Circumference (HC), Body Circumference (BC) and Ear Length (EL) were parts of the prediction equations to determine body weight of mongrel rabbits.

At 50 to 70 days old, body weight (BL), hind limb (HL), Neck circumference (NC), fore limb (FL) and body circumference formed parts of the prediction equations. More prediction equations were involved to determine body weight as kittens grew older. Prediction of body weight at specific age groups in mongrel rabbits using

linear body measurements were highly reliable (R value ranged from 0.741 to 0.900).

Prediction equations involving more linear parameters were more reliable than those with fewer body parameters. Prediction equations became more reliable with age, with the most reliable estimate (R = 0.900) being observed at 50-70 days. The overall prediction equations for body weight irrespective of age (Table 4) were more reliable (R = 0.917 to 0.946) than the equations predicted at specific age groups. However, it was observed that equations involving more body parameters were more reliable. This result is in agreement with the observations of other researchers: [12,13] in rabbits, [14] in sheep and [15] in goats. Although

Table 2. Body weight and contributions of linear body parameters (cm) to body weight

Parameter	Mean values				Final measurement
	Doe	Highest	Lowest	Increase	
BW (g)	1	763.14	71.58	691.56	
	2	687.12	60.18	626.94	
	3	829.14	82.05	747.09	
	4	641.68	58.60	583.08	2648.67
FW (cm)	1	14.20	8.30	5.90	
	2	12.60	7.00	5.60	
	3	14.40	6.50	7.90	
	4	13.33	7.20	6.13	25.53
HL (cm)	1	23.20	12.00	11.20	
	2	21.60	11.00	10.60	
	3	23.80	11.00	12.80	
	4	22.00	11.00	11.00	45.60
EL (cm)	1	10.60	6.30	4.30	
	2	10.00	6.00	4.00	
	3	11.20	4.00	7.20	
	4	10.00	3.00	7.00	22.50
HC (cm)	1	15.50	11.05	4.45	
	2	13.20	8.00	5.20	
	3	14.80	11.50	3.30	
	4	14.22	10.0	4.22	17.17
BC (cm)	1	25.20	14.00	11.20	
	2	22.00	16.00	6.00	
	3	23.00	13.00	10.00	
	4	21.11	11.00	10.11	37.31
BL (cm)	1	23.40	15.80	7.60	
	2	22.20	15.00	7.20	
	3	23.40	11.00	12.00	
	4	21.89	9.00	12.89	39.69
FL$_2$ (cm)	1	12.10	8.50	3.60	
	2	11.80	8.30	3.50	
	3	11.80	6.00	5.80	
	4	10.44	7.26	3.18	16.08
NC (cm)	1	12.80	9.02	3.78	
	2	12.00	7.84	4.16	
	3	12.20	7.02	5.18	

FL=Forelimb, HL=Hind limb, EL=Ear length, BL=Body length, FL2=Face length, BC=Body circumference, NC=Neck circumference, HC=Head circumference, BL=Body weight

Table 3. Prediction equations for body weight using linear body measurements

Age (days)	Dependent variables (Y)	Prediction equations	R^2
1-28	Body weight	$-345.011 + 38.130_{BC}$	0.886
29-49	Body weight	$-362.883 + 73.742_{FL}$	0.741
	Body weight	$-753.829 + 60.208_{FL} + 55.820_{FC}$	0.820
	Body weight	$-723.128 + 28.349_{FL} + 55.614_{FC} + 17.724_{BC}$	0.845
	Body weight	$-807.795 + 20.866_{FL} + 46.011_{FC} + 18.570_{BC} + 28.817_{EL}$	0.855
50-70	Body weight	$-341.160 + 47.138_{BL}$	0.781
	Body weight	$-536.978 + 31.163_{BL} + 25.279_{HL}$	0.850
	Body weight	$-804.601 + 29.385_{BL} + 22.274_{HL} + 33.907_{NC}$	0.877
	Body weight	$-917.00 + 523.610_{BL} + 17.737_{HL} + 29.118_{NC} + 29.772_{FL}$	0.891
	Body weight	$-903.457 + 16.118_{BL} + 17.036_{HL} + 25.947_{NC} + 27.985_{FL} + 10.528_{BC}$	0.900

FL=Forelimb, HL=Hind limb, EL=Ear length, BL=Body length, FL2=Face length, BC=Body circumference,
NC=Neck circumference, HC=Head circumference

Table 4. Overall prediction equations for body weight using linear body measurements

Dependent variables (Y)	Prediction equations	R^2
Body weight	$-558.977 + 93.461(FL)$	0.917
Body weight	$-567.611 + 59.540(FL) + 21.413(HL)$	0.934
Body weight	$-610.157 + 40.358(FL) + 17.757(HL) + 17.477(BC)$	0.942
Body weight	$-747.396 + 43.074(FL) + 15.187(HL) + 13.819(BC) + 17.227(HC)$	0.944
Body weight	$-803.586 + 36.613(FL) + 14.975(HL) + 12.408(BC) + 17.091(HC) + 12.568(NC)$	0.946

FL=Forelimb, HL=Hind limb, EL=Ear length, BL=Body length, FL2=Face length, BC=Body circumference,
NC=Neck circumference, HC=Head circumference

these researchers were not breed and age specific, the combinations of more than one parameter predicted body weight of rabbits with 83% accuracy. When body weight in mongrel rabbits were predicted from linear body measurements without recourse to age groups (Table 4), body weight was not predictable from face length, ear length and body length. Therefore body weights in mongrel rabbits are only predictable from face length, hind limb, body circumference, head circumference and neck circumference when age is not considered.

4. CONCLUSION AND RECOMMENDA-TION

4.1 Conclusion

Body weight of kittens from all does increased gradually with age from birth to 70 days old. Highest percentage increase was observed from birth to day 14. There was a general decline in percentage body weight increase per measurement period as kittens grew older,

probably due to kittens increasing their activities, having lesser time to suckle and nibbling on forages and concentrates of lesser qualities than dams' milk.

Linear body parameters increased with age but varied with the body parts, portraying the contributions of the various body parameters to body weight.

Body weight in mongrel rabbits was predictable from various linear body parameters. When predictions were on specific age groups, face length and head circumference were not considered in the prediction equations. More prediction equations were involved to determine body weight as kittens grew older. Prediction equations involving more linear body parameters were more reliable than those with fewer linear body parameters. Body weight in mongrel rabbits was only predictable from face length, hind limb, body circumference, head circumference and neck circumference when age was not considered.

4.2 Recommendation

Further breeding researches should investigate the pattern of growth in mongrel rabbits beyond 70 days.

Feeding should be improved and movements of kittens restricted to encourage rapid growth as they start to move away from their dams.

Prediction equations involving more parameters should be used to determine body weight in mongrel rabbits since these are more reliable than the prediction equations with fewer linear body parameters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Egbo ML, Doma UD, Lacdacks AB. Characteristics of small scale rabbit production and management in Bauchi. Proceedings of 20th Annual Conference of Nigerian Society for Animal Production. Zaria, Nigeria. 2001;160-162.
2. Adedeji TA, Ojedapo LO, Olayeni TB, Adbullah, AR. Influence of age and sex on body weight and some linear body measurements of extensively reared West Africa Dwarf Goats in derived savanna zone of Nigeria. Journal of Animal Veterinary and Advances. 2002;1: 114-117.
3. Adeleke MA, Peters SO, Ozoje M, Ikeobi OC, Adebambo OA. Genetic parameter estimates for body weight and linear body measurements in pure and crossbreed progenies of Nigerian indigenous chickens. Livestock Research for Rural Development. 2011;20(23):10–14.
4. Isaac LJ, Udoh UH, Usoro OO, Ekanem E, Williams ME. Relationship between body weight and linear body measurements in different breeds of rabbits. Proceedings of the 36th Annual Conference of the Nigerian Society for Animal Production. Abuja, Nigeria. 2011;10-12.
5. Abdullahi AR, Sokunbi OA, Omisola OO, Adewumi MK. Interrelationships between body weight and linear body measurements in domestic rabbit (*Oryctolagus cuniculus*). Proceedings of the 28th Annual Conference of the Nigerian Society for Animal Production, Ibadan, Nigeria. 2003;133-136.
6. Chineke CA, Agaeiezor B, Ikeobi CO, Togun AG. Some factors affecting body weight and linear measurements of rabbits at post weaning ages. Proceedings of 27th Annual Conference of Nigerian Society for Animal Production (NSAP), Akure. 2002; 5-9.
7. Ozoje MO, Mgbere OO. Coat pigmentation effects in West African Dwarf goats: Live weights and body dimensions. Nigerian Journal of Animal Production. 2002;29:5-10.
8. Olutogun O, Abdullah AR, Raji AO, Adetoro PA, Adeyemi A. Body conformation characteristics of White Fulani and Gudali (Zebu) cattle breeds of Nigeria. Proceedings of 28th Annual Conference for Nigerian Society of Animal Production. Ibadan, Nigeria. 2003; 129-132.
9. Salako AE, Mgbere OO. Application of multifactorial discriminant analysis in the morphometric structural differentiation of West African Dwarf and yankasa sheep in south west Nigeria. Nigerian Journal of Animal Production. 2002;29:163-167.
10. Orheruata AM, Oyedeji JO, Omoyakhi M, Ofuoma F. Post – weaning body morphology to sexual maturity and carcass characteristics of rabbits in the humid rain forest zone of Nigeria. International Journal of Agricultural and Rural Development. 2006;7(2):40-47.
11. Ebegbulem VN, Ibe SN, Ozung PO, Ubua JA. Morphometric trait characteristics of West African Dwarf goats in Abia State, South East Nigeria. Continental Journal of Agricultural Science. 2011;5(2):1-6.
12. Obike OM, Ibe SN, Oke UK. Estimation of pre- and post-weaning bodyweight of rabbits in a humid tropical environment using linear body measurements. Journal of Agriculture and Environmental Science. 2010;9(4):440–444.
13. Oke UK, Herbert U, Obike OM, Ogbonnaya EO. Effect of weaner body weight on growth traits of rabbits. Journal of Animal Feed Resource. 2011;1(1):22–27.
14. Taye M, Bimerow T, Yitayew A, Mekuriaw SH, Mekuriaw G. Estimation of live body weight from linear body measurements of

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Farta sheep. Journal of Animal Feed Resource. 2012;2(1):98-103.

15. Okpeku M, Yakubu A, Peters SO, Ozoje MO, Ikeobi CO, Adebambo OA, Imumorin IG. Application of multivariate principal component analysis to morphological characterization of indigenous goats in Southern Nigeria. Acta Agriculturae Slovenica. 2011;98(2): 101–109.

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