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Studies of Pre-Weaning Physical Measurements in Rabbits in Humid Tropics of Nigeria

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Abstract: Pre-weaning linear measurements on 280 and 261 kits from 78 and 74 litters at 21 and 28 days of age, collected over 3 years were used in the study. Evaluation criteria include nose to shoulder length(NTS), Shoulder To Tail (STL), trunk length (TLK), heart girth (HGT), height at withers (HTW) and length of ear (LTE).The least squares model included main effects of genotype, parity, sex, season, first-order interactions between genotype,sex, parity and season and random error. Genotype, parity, sex and season differences were detected for linear traits considered. Crossbred New Zealand white x Chinchilla (NZW xCHA) and New Zealand white. Dutch-belted x New Zealand white. Dutch-belted (NZWDBDxNZWDBD) had best performance over the other genotypes. Parity means were significantly ($p<0.05$) different for all traits except 21-day HGT. Parity 6 was superior in 21-day linear traits and in 28- NTS and STL. Sex mean values for 21-day linear measurements were different ($p<0.05$) except HGT with females being consistently bigger and longer than males. Sex means were similar at 28 days where females recorded longer STL and HWT and wider HGT than males. The mean values by season differed ($p<0.05$) in 21-day NTS, STL and TKL and in 28-day measurements except LTE. Dry season measurements were superior at 28 days. The linear body measurements would provide quantitative measures of body size and shape. Assure factors influencing them should be given attention in breeding programmes.

Key words: Pre-weaning, measurements, rabbit, humid tropics

INTRODUCTION

Live animal measurements have attracted serious attention in livestock industry world wide for variety of reasons. Various body measurements have been used to predict body weight and carcass composition; describe biological variations and relationships with measures of performance, productivity and carcass characteristics; assess effects of cross breeding for selection of replacement animals and evaluation of breeds in controlled environments; provide quantitative measures of body size and shape for various farm animals and to uncover interactions between heredity and environment and establish possible corrections for carcass composition[1-8]. The deficiency of using weight changes as a measure of growth has been observed[9]. Weight ignores differences among internal and external structures, is subject to short-term changes imposed by processes of production such as management system, pregnancy and season and weight information does not indicate composition or shape of the animal[2,9,10]. But linear measurement considers variation in endomorphic, mesomorphic and ectomorphic structures and allows comparison of growth in different parts of the body. The question of optimal size and shape of various animals in different ecological zones have generated controversy among scientists. A quantitative measurement for animal conformation will enable reliable genetic parameters for these traits to be estimated and permit its inclusion in breeding programmes. However, there is a dearth of information on linear body measurement of domestic rabbit in the humid tropics. This work was undertaken to determine the pre-weaning performance of purebred and crossbred groups of rabbits using linear body measurements.

MATERIALS AND METHODS

Location of study: The study was conducted in the rabbit unit of the Teaching and Research Farms, Federal University of Technology, Akure Nigeria. Akure is situated on 350.52 m above sea level at latitude 7°14^{1}N and at longitude 5°14$_{1}$E. The city falls within the rainforest zone of the humid tropics which is characterized by hot and humid climate. The mean annual rainfall is 1500 mm and the rain period is bimodal with a short break in August. The mean annual relative humidity is 75% and that of temperature 15-20°C.

Experimental animals and their management: 280 kits from 78 litters and 261 kits from 74 kits at pre-weaning ages of 21 and 28 days obtained from breeding programme involving New Zealand white and Chinchilla purebreds and their crossbreds were used in the study. These litters representing 8 genotype groups namely New Zealand white x New Zealand white (NZW x NZW) and Chinchilla x Chinchilla (CHA x CHA) purebreds and New Zealand white x Chinchilla (NZW x CHA) New Zealand white Dutch belted x New Zealand white Dutch belted (NZWDBD x NZWDBD), New Zealand white x New Zealand white Dutch belted (NZW x NZWDBD) New Zealand white Croel x New Zealand white Croel (NZW CRL x NZW CRL), Chinchilla x New Zealand white Dutch belted (CHA x NZWDBD) and Chinchilla x New Zealand white Croel (CHA x NZW CRL) crossbreds where assessed for the effects of genotype and some non genetic factors on linear parameters at 21 and 28 pre-weaning ages. The breeding season covered 3 years of data collection starting in the raining period (June) of 1998.

The rabbits were housed in hutches. Each hutch has the following dimensions: Length 105 cm, width 85 cm and height 60 cm. The hutches placed inside a low walled house built with concrete block and corrugated iron sheets as roofing material were raised on wooden or metallic legs about 60cm above the ground. The wooden and metallic hutches were covered to some extent with mesh that could permit inspection, ventilation and dropping of waste on the cemented floor. Kindling boxes, (each having the following dimensions: Length 40 cm, width 30 cm and height 25 cm) were provided inside does hutches. Also supplied in each hutch were feeding and watering troughs, which were made from tins.

The rabbit were given *Ad libitum* access to commercial diets in the morning, supplemented with sweet potato leaves and *Aspillia africana* in the evening over the course of the experiment. The chemical composition of the commercial diet consisted of 2300k cal kg^{-1} metabolisable energy, 15% crude protein, 8% ash, 7.2% fibre, 0.67% ether extract, 8.24% moisture content and 91.76% dry matter. The chemical composition of the sweet potato leaf was 11.68% crude protein 7.68% ash, 3.22% fibre, 0.72% ether extract, 93.12% moisture content and 6.88% dry matter while that of *Aspillia africana* was 17.41% crude protein, 12.98% ah, 6.65% fibre, 0.77% ether extract, 93.33% moisture content and 6.67% dry matter.

Clean water was supplied regularly. The incidence of diarrhoea was combated with antibiotics such as embassin forte[R]. To ensure absence of haemoparasites, internal and external parasites the animals were treated with Ivomec injection. The kits were maintained on doe's milk. At pre-weaning age of 21days when the kits sex was determined, they were taking little concentrates and leafy supplements provided in the doe's cages.

Data collection: Basic information of genetic groups, sex, parity, season, buck and doe were kept on each kit in addition to linear body measurement record at pre-weaning ages of 21 and 28 days. The linear traits studied were Nose To Shoulder length (NTS), Shoulder to Tail Length (STL), trunk length (TLK), heart girth (HGT), height at withers (HTW) and length of ear (LTE). The measurements were taken with the aid of a measuring tape and ruler. Mortality accounted for the differences in number of kits at both ages. The descriptions of the measurements are as follows:

Head to shoulder length: The distance from the nose to the point of the shoulder.

Shoulder to tail length: The distance from the point of shoulder to the pinbone or to the end of the coccygeal vertebrae.

Trunk length: The longitudinal distance from the point of the shoulder to the tuberosity of the ischium

Heart girth: Measured as body circumference just behind the fore leg.

Height at withers: Measured on the dorsal midline of the highest point on the withers.

Length of ear: The distance from the point of attachment of the ear to the head to the tip of the ear.

All measurements were taken in the morning before feeding the animals. Each animal was gently restrained while taking the measurements. Each dimension taken was recorded in centimeters.

The linear measurements taken at 21 and 28 days based on genetic groups, sex, parity and season were used for analysis. The factors were defined as shown.

Genetic groups: New Zealand white x New Zealand white (NZW x NZW), Chinchilla x Chinchilla (CHA x CHA), New Zealand white x Chinchilla (NZW x CHA), New Zealand white Dutch-belted x New Zealand white Dutch-belted (NZWDBD x NZWDBD), New Zealand white x New Zealand white Dutch-belted (NZW x NZWDBD), New Zealand white Croel x New Zealand white Croel (NZWCRL x NZWCRL), Chinchilla x New Zealand white Dutch-belted (CHA x NZWDBD) and Chinchilla x New Zealand white Croel (CHA x NZWCRL)

Sex: Male and female

Table 1: Mean squares (Ms) from the analyses of variance for linear measurements at 21 days of age

	Noseto Shoulder		Shoulder to Tail		Heart girth		Withers height		Ear length		Trunk length	
Source of Variation	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
Genotype	7	3.84***	7	7.41***	7	5.10***	7	3.25***	7	4.89***	7	5.86***
Sex	1	0.31*	1	2.89*	1	0.88	1	0.61*	1	0.60*	1	0.73
Parity	5	7.62***	5	3.49*	5	1.35	5	3.26***	5	1.74*	5	1.93*
Season	1	19.49***	1	4.07*	1	7.26	1	0.18	1	4.15	1	3.82*
Genotype x Parity	15	2.55***	15	10.14***	15	3.58***	15	3.67***	15	4.73***	15	7.14***
Genotype x Season	4	2.08*	4	6.80**	4	1.30	4	1.54	4	2.49**	4	7.36***
Genotype x Sex	7	0.10	7	0.62	7	0.15	7	0.16	7	8.33	7	0.62
Parity x Season	3	0.10	3	7.66	3	0.81	3	3.97***	3	3.05**	3	6.80**
Sex x Parity	5	0.13	5	0.14	5	0.36	5	0.23	5	4.18	5	0.16
Sex x Season	1	7.38	1	0.32	1	0.15	1	0.24	1	5.25	1	0.22
Genotype x Sex x Parity	11	0.65	11	1.88	11	0.62	11	0.18	11	0.233	11	1.57
Genotype x Sex x Season	2	5.08	2	0.54	2	0.30	2	1.39	2	0.123	2	0.20
Sex x Parity x Season	1	0.53	1	2.83	1	5.14	1	0.28	1	1.95	1	0.92
Error	195	0.698	195	1.200	195	0.78	195	0.73	195	0.584	195	1.35

*p<0.05 **p<0.01 ***p<0.001

Parity: 1, 2, 3, 4, 5 and 6

Season: Dry and wet.

Analytical procedures: The effects of genotypes, parity, sex and season on the linear body measurements at pre-weaning ages of 21 and 28 days were estimated from least squares procedures of unequal sub-class numbers according to the method of Harvey[11]. Where significant differences were observed, differences between means were tested using the Duncan's multiple range test procedures outlined in the Harvey's statistical package. The model used was:

$$Y_{ijklm} = U + B_i + C_j + P_k + S_l + (BC)_{ij} + (BP)_{ik} + (BS)_{iL} + (CP)_{jk} + (CS)_{iL} + (PS)_{kL} + (BCP)_{ijk} + (BPS)_{ikL} + (BCS)_{ijL} + (CPS)_{jkL} + E_{ijklm}$$

Where Y_{ijklm}=the observation of the dependent variable on the *m*th kit of the ith genotype of the jth sex of the kth parity of lth season of birth

- U = overall mean of all observations.
- B_i = effect of the ith genotype of kit ($_i$ = NZW x NZW, CHA x CHA, NZW x CHA, NZWDBD x NZWDBD, NZW x NZWDBD, NZWCRL x NZWCRL, CHA x NZWBD and CHA x NZWCRL
- C_j = effect of jth sex of kit ($_j$ = male, female)
- P_k = effect of parity ($_k$ = 1, 2, 3, 4, 5, 6)
- S_l = effect of ith season ($_l$ = dry, wet)
- $(BC)_{ij}$ = effect of interaction between ith genotype and jth sex
- $(BC)_{ik}$ = effect of interaction between *i*th genotype and *k*th parity
- $(BS)_{il}$ = effect of interaction between *i*th genotype and lth season
- $(CP)_{jk}$ = effect of interaction between jth sex and kth parity
- $(PS)_{kl}$ = effect of interaction between kth parity and lth season
- $(BCP_{)ijk})$ = effect of interaction between ith genotype, jth sex and kth parity
- $(BCS)_{ijl}$= effect of interaction between ith genotype, and jth sex, and lth season
- $(CPS)_{jkl}$ = effect of interaction between jth sex, kth parity and *l*th season
- E_{ijklm} = random error normally, identically and independently distributed with 0 mean and variance ó^{2}e.

RESULTS

Linear body measurements at 21 days of age: Tables 1 and 2 present mean squares and least-square means with their corresponding standard errors for Nose To Shoulder (NTS), Shoulder To Tail (STL), hearth girth (HGT), height at withers (HWT), trunk length (TKL) and length of ear (LTE) at 21 days of age. Genotype strongly influenced (p<0.001) linear traits at 21 days of age. Sex effect was an important source of variation (p<0.05) for all measurements studied except HGT. Parity had highly significant effect (p<0.001) on NTS and HWT. It also influenced LTE and SLT significantly (p<0.05). The analysis of variance further uncovered high significant (p<0.01, p<0.001) effects of season on NTS, STL and TKL. The sex, parity and season effect on HGT were similar. The interactions between genotype and parity for all linear traits, genotypes and season for STL, LTE and TKL and parity and season for HWT, LTE and TKL were highly significant (p<0.01, p<0.001). The interaction involving genotype and season was also significant (p<0.05) for NTS.

Table 2: Least square means for linear measurements (cm) at 21 days of age

Variable	NO	NosetoShoulder r	ShouldertoTail l	Heart girth	Withersheight t	Ear length	Trunk length
Genetic group							
NZW x NZW	50	9.45±0.145^{bc}	18.32±.200^{b}	14.45±0.120^{cd}	6.70±0.132^{b}	5.81±0.167^{e}	14.69±0.162^{bc}
CHA x CHA	68	9.48±0.174^{bc}	18.82±0.187^{ab}	14.55±0.122^{bc}	6.68±0.146^{b}	6.81±0.145^{d}	14.69 + 0.15^{bc}
NZW x CHA	32	10.28±0.196^{ab}	19.73±0.369^{a}	15.72±0.287^{a}	7.50±0.264^{a}	7.06±0.22^{ab}	15.97+ 0.316^{a}
NZWDBDxNZWDBD	25	9.83±0.207^{b}	19.43±0.263^{a}	15.05±0.143^{ab}	7.80±0.125^{a}	7.17±0.107^{a}	15.55+ 0.178^{a}
NZW x NZWDBD	23	10.38±0.204^{ab}	18.56±0.557^{ab}	14.51±0.270^{bc}	6.58±0.257^{b}	6.42±0.218^{d}	15.00+0.460^{ab}
NZWCRLx NZWCRL	20	9.9±0.266^{b}	17.63±0.487^{c}	14.02±0.193^{d}	7.28±0.132^{ab}	6.70±0.184^{cbd}	14.22+ 0.415^{c}
CHA x NZWDBD	41	10.55±0.168^{ab}	18.98±.207^{ab}	14.43±0.125^{cd}	6.99±0.967^{b}	6.84±.689^{abc}	15.43+ 0.177^{a}
CHA x NZWCRL	21	10.19±0.284^{ab}	19.59±0.292^{a}	14.67±.153^{bc}	7.01±0.178^{ab}	7.18±0.116^{a}	15.71+ 0.270^{a}
Parity							
1	42	9.35±0.176^{c}	18.23±0.262^{c}	14.46±0.133	6.39±0.131^{c}	6.23±0.140^{c}	14.70+ 0.220^{c}
2	50	9.07±0.147^{c}	18.48±.150^{bc}	14.27±0.100	6.68±.160^{bc}	6.46±0.166^{bc}	14.93+0.126^{bc}
3	53	9.21±0.154^{c}	19.13±.261^{ab}	14.52±0.168	7.23±0.128^{a}	6.49±0.160^{bc}	15.35+0.223^{abc}
4	67	10.35±0.141^{b}	18.92±.247^{abc}	14.70±0.146	7.35±0.147^{a}	6.99±0.117^{a}	15.27+0.199^{ab}
5	48	10.51±0.163^{b}	19.24±.203^{ab}	14.51±0.166	7.04±.117^{ab}	6.88±0.113^{ab}	15.51+0.172^{b}
6	20	11.55±0.191^{a}	19.42±0.103^{a}	14.79±0.163	7.46±0.254^{a}	7.15±0.257^{a}	15.78 + 0.284^{a}
Sex							
Male	128	9.54±0.113^{b}	18.56±0.141^{b}	14.29±.7786	6.86±0.233^{b}	6.51±0.975^{b}	14.99 + 0.118^{a}
Female	152	10.01±0.106^{a}	19.07±0.103^{a}	14.69±0.872	7.11±0.889^{a}	6.78±0.023^{a}	15.35 + 0.121^{b}
Season							
Dry	131	9.23±0.155^{b}	18.61±0.141^{b}	14.48±0.22	6.93±0.938	6.51±0.839	14.98 + 0.116^{b}
Wet	149	10.27±0.222^{a}	19.04±0.146^{a}	14.55±0.874	7.06±0.479	6.79±0.083	15.37 + 0.122^{a}
Overall mean	280	9.80±0.882	18.85±0.103	14.52±0.4	7.00±0.46	6.66±0.31	15.19±0.566

Means with different superscripts in the same column are significantly different ($p<0.05$, $p<0.01$, $p<0.01$)

Genotype means were significantly ($p<0.05$) different for all the traits. Generally, New Zealand white x Chinchilla (NZW x CHA) had better performance in linear traits than the other genotypes. It was followed by New Zealand white Dutch-belted x New Zealand white Dutch-belted (NZWDBD x NZWDBD) and Chinchilla x New Zealand white Croel (CHA x NZWCRL).

The mean values of the body linear traits by sex were different ($p<0.05$) except HGT. The females were consistently bigger and longer than males in all body measurements. There were significant differences in parity means for all the measurements except HGT. The kits of sixth parity dam were consistently superior in all traits over other parities. The effect o season means differed significantly ($p<0.05$) for NTS, STL, and TKL and not for HGT and HWT. The kits born in the wet season were consistently bigger and longer than those born in the dry season.

Linear body measurements at 28 days of age: The mean squares, least square means and standard errors for linear body measurements at 28 days of age are given in Tables 3 and 4. Genotype was a strong source of variation ($p>0.001$) for Nose To Shoulder (NTS), Shoulder To Tail (STL), hearth girth (HGT), length of ear (LTE) and trunk length (TKL). It also exerted significant ($p<0.05$) effect on height at withers (HWT). Parity had significant influence ($p<0.05$) on NTS, STL and HWT. Its effects ($p<0.01$, $p<0.001$) on HGT, LTE and TKL were also significant. Sex influence on all linear traits was similar. Season effects were significant ($p<0.05$) for NTS, HWT and TKL. Its strong effects ($p<0.01$, $p<0.001$) were observed for STL and HGT. Significance was obtained for these interactions ($p<0.001$) for genotype x parity for STL and HGT; ($p<0.001$) for genotype x season for STL and HGT; ($P<0.05$, $p<0.01$) for genotype x season for STL and LTE; ($p<0.01$) for sex x parity for TKL; ($p<0.001$) for genotype x season x parity for STL, HGT and TKL and ($p<0.05$) for genotype x season x parity for LTE. Apart from these, the interactions involving the factors for other linear traits were not important.

The means for NTS, STL, HGT, HWT, LTE and TKL by genotype were statistically different. The highest mean values for the linear traits were observed for New Zealand white. Dutch-belted x New Zealand white. Dutch-belted (NZWDBD x NZWDBD) except length of ear (LTE) for which Chinchilla x New Zealand white Croel (CHA x NZWCRL) (8.53 + 0.11 cm) assumed superiority over other genotypes.

Sex means for all the measurements were not different ($p>0.05$). The males were longer and bigger in NTS (11.50 + 0.02 cm vs 11.42 + 0.608 cm), LTE (8.05 + 0.629 cm vs 8.01 + 0.419 cm) and TKL (17.25 + 0.134 cm vs 17.24 + 0.123 cm) than the females. But in STD, HGT and HWT measurements the females performed better than the males.

The mean values for all the linear measurements by parity differed significantly ($p<0.05$, $p<0.01$, $p<0.001$). Parity 6 kits were superior in linear traits such as NTS (12.26+0.18 cm), STL (22.47+0.46 cm) and TKL (18.18+0.417 cm). While kits of parities 1, 4 and 4 were superior in HGT, HWT and LTE, respectively.

Table 3: Mean Squares (Ms) from the analyses of variance for linear measurements at 28 days of age

	Nose to Shoulder		Shoulder to Tail		Heart girth		Withersheight		Ear length		Trunk length	
Source of Variation	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
Genotype	7	2.82***	7	10.78***	7	3.01***	7	2.67*	7	2.66***	7	6.48***
Parity	5	1.79*	5	4.66*	5	2.97*	5	3.66*	5	2.92***	5	4.33**
Season	1	5.46*	1	19.98**	1	16.08*	1	2.998*	1	7.96	1	8.52*
Sex	1	1.82	1	1.78	1	0.45	1	7.76	1	0.70	1	1.91
Genotype x Parity	16	1.33	16	6.76***	16	3.72***	16	1.52	16	2.18	16	5.18
Genotype x Season	5	0.90	5	6.39*	5	3.11**	5	1.45	5	51.30***	5	2.47***
Genotype x Sex	7	0.43	7	0.92	7	0.22	7	9.06	7	0.14	7	0.50
Parity x Season	3	4.43	3	10.92*	3	1.55	3	3.16	3	2.98**	3	6.29
Sex x Parity	5	0.50	5	0.73	5	0.57	5	8.37	5	0.38	5	0.63**
Sex x Season	1	1.89	1	3.72	1	0.74	1	0.22	1	0.56	1	2.60
Genotype x Parity x Season	3	11.74	3	17.67***	3	5.17***	3	1.80	3	1.59*3	1	2.60***
Genotype x Sex x Parity	11	0.31	11	1.17	11	0.39	11	0.24	11	0.39	11	0.80
Genotype x Sex x Season	4	0.18	4	9.20	4	0.11	4	6.06	4	0.22	4	4.20
Sex x Parity x Season	3	0.89	3	2.52	3	0.73	3	1.07	3	0.98	3	1.25
Genotype x Sex x Parity x Season	1	3.59	1	6.84	1	3.22	1	1.74	1	4.96	1	2.94
Error	179	0.585	179	2.18	179	0.85	179	0.44	179	0.58	179	1.47

*p<0.05 **p<0.01 ***p<0.001

Table 4: Least square means for linear measurements (cm) at 28 days of age

Variable	NO	Nose to Shoulder	ShouldertoTail	Heart girth	Withersheight	Ear length	Trunk length
Genetic groupNZW x NZW	56	11.11±.121^{cd}	21.61± 0.170^{bc}	15.76± 0.130^{ab}	8.63± 0.104^{ab}	7.68±.136^{b}	17.00± 0.140^{ed}
CHA x CHA	65	11.60± 0.118^{abc}	21.90± 0.207^{ab}	15.75±0.157^{ab}	8.03± 0.130^{b}	7.76± 0.141^{ab}	17.39± 0.168^{bcd}
NZW x CHA	30	11.44± 0.196^{bc}	22.28±0.383^{ab}	15.99± 0.238^{ab}	8.11± 0.145^{b}	8.04± 0.163^{a}	17.77± 0.314^{abc}
NZWDBD x NZWDBD	23	11.98± 0.334^{a}	22.52± 0.318^{a}	16.23± 0.214^{a}	8.87± 0.121^{a}	8.37±.119^{a}	17.84± 0.217^{ab}
NZW x NZWDBD	19	11.69±0.129^{ab}	20.70± 0.431^{bc}	15.99± 0.302^{ab}	8.11± 0.235^{b}	7.53± 0.200^{b}	16.54± 0.366^{cde}
NZWCRL x NZWCRL	16	11.11± 0.180^{cd}	20.20± 0.602^{c}	15.23± 0.289^{bc}	8.69± 0.188^{ab}	8.11± 0.211^{a}	16.31± 0.483^{e}
CHA x NZWDBD	35	11.15± 0.121^{cd}	21.14± 0.181^{bc}	15.02± 0.181^{c}	8.04± 0.125^{b}	8.21± 0.112^{a}	17.05±0.251^{bcde}
CHA x NZWCRL	17	11.62± 0.136^{ab}	22.52± 0.145^{a}	15.55±0.145^{ab}	8.66± 0.464^{ab}	8.53± 0.211a	18.09± 0.274^{a}
Parity							
1	38	11.41± 0.107^{b}	21.87± 0.23^{ab}	16.01± 0.147^{a}	7.88± 0.114^{d}	7.68± 0.134^{b}	17.37± 0.189^{b}
2	55	11.13± 0.116^{b}	21.14± 0.223^{b}	15.34± 0.147^{bc}	7.94± 0.120^{c}	7.89± 0.124^{b}	16.72± 0.179^{b}
3	50	11.20± 0.168^{b}	21.69± 0.315^{ab}	15.66± 0.170^{ab}	8.84±0.118^{ab}	8.31± 0.170^{ab}	17.24± 0.247^{b}
4	67	11.35± 0.122^{b}	21.62±0.223^{ab}	15.62± 0.157^{ab}	8.86± 0.859^{a}	8.69± 0.002^{a}	17.27± 0.180^{b}
5	43	11.41± 0.176^{b}	20.87± 0.259^{ab}	14.99± 0.179^{c}	8.48± 0.119^{bc}	8.03± 0.44^{ab}	16.71± 0.220^{b}
6	8	12.26± 0.181^{a}	22.47± 0.46^{a}	15.96± 0.193^{b}	8.00± 0.178^{abc}	8.00± 0.149^{b}	18.18± 0.417^{a}
Sex							
Male	119	11.50± 0.021	21.60± 0.126	15.51± 0.108	8.32± 0.560	8.05±0.629	17.25± 0.134
Female	142	11.42± 0.608	21.61± 0.150	15.69±0.627	8.35±0.535	8.01± 0.418	17.24±0.123
Season							
Dry	110	11.65±0.501^{a}	21.89± 0.185^{a}	15.96± 0.63^{a}	8.54± 0.761^{a}	8.14± 0.161	17.36± 0.147^{a}
Wet	151	11.27±0.608^{b}	21.33± 0.130^{b}	15.23± 0.580^{b}	8.13± 0.580^{b}	8.79± 0.507	17.13± 0.112^{b}
Overall mean	261	11.22± 0.22	21.39±0.111	15.55± 0.166	8.32±0.346	8.66±0.028	17.01± 0.051

Means with different superscripts in the same column are significantly different (p<0.05, p<0.01, p<0.001)

Season means were significantly (p<0.05, p<0.01, p<0.001) different for all linear traits except for LTE. The performance of kits born in the dry season was better for all traits than the ones born in the wet season.

DISCUSSION

Genotype strongly influenced linear traits at both ages. In general, each measurement studied increased with increase in age in each genotype. This was expected since breed combinations promote growth, which is in turn associated with increase in mature body size. Ozoje and Herbert,[2] reported similar findings in crossbreeding experiments involving goats and observed further that these increases, calculated as a percentage of their values at birth, were at different rates. This observation also agreed with the report of Russel[9] that body measurements differed in their rates of maturing. Among the genotypes NZWDBD X NZWDBD kits were generally superior in linear traits over other genotypes. Differences in linear traits reflect useful measures that depict the size and shape of animal. The height at wither at any given age reflects the animal's skeletal size, while shoulder width, pouch girth and heart girth reflects body conditions[12]. Heart girth, according to Suleiman *et al.,*[13] reflects the physiological status of the animal. Heart girth, pouch girth and shoulder width are better indicators of live weight and condition scores than height at withers. They are all highly associated with grade and dressing percentage reflecting their associations with condition scores[12].

The kits of sixth parity dams were superior over those of other parities in all linear measurements except in 28-day HGT, HWT and LTE. This might be ascribed to smaller litters recorded in the sixth parity that implied less competition amongst kits for udder sucking and available food. With such easy access to food, they grew bigger and longer than kits of parities 1, 2, 3, 4 and 5. In most cases, linear measurements followed no particular trend at both ages with parity. The significant effect of parity on linear measurements at various ages agreed with a similar work done on goats by Akpa[14]. This author further noted that kids of first parity dams were shorter than those of parities 2 and 3.

The significant sex effects ($p<0.05$) were felt on 21-day linear measurements. Similar results have been reported[15]. The females having bigger and longer body in most measurements taken than the males corroborated the findings of Lebas *et al.,*[16], Akpan,[14] and Chineke *et al.*,[15].

Season influenced ($p<0.05$, $p<0.01$, $p<0.001$) linear measurements at both ages except 21-day HGT, HWT, LTE and 28 day LTE. For the 21-day linear measurements, the kits born in the wet season were bigger and longer than those born in the dry season. The differences in linear traits of kits born in different seasons might be attributed to health and nutritional status of the does and their kits. In goats, Ozoje and Herbert,[2] reported superior body length, shoulder width and leg length for kids born in the dry season, while kids born in the rainy season were superior in heart girth. Jeffery and Berg[12] associated the superiority of kids born in the dry season with maternal nutritional status at conception since dam's weight changes 90 days prepartum highly affected kids body size at birth. Searle *et al.*,[17] also observed that individual nutritional differences might have contributed to growth difference in various animal body parts. Merino sheep subjected to contrasting nutritional regimes differed in all aspects of body size[18]. He therefore, concluded that the shape of an animal might be altered to a minor extent by food restriction so that bone occurs at the expense of other tissues.

CONCLUSIONS

Linear body measurements of meat animals have been useful in quantifying body size and shape. This study showed genotype, parity, sex and season as important sources of variation in the linear body structure of domestic rabbit. Assure, these factors should be given serious attention in breeding programmes for improving performance to increase meat yield from rabbit breeds and crosses.

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