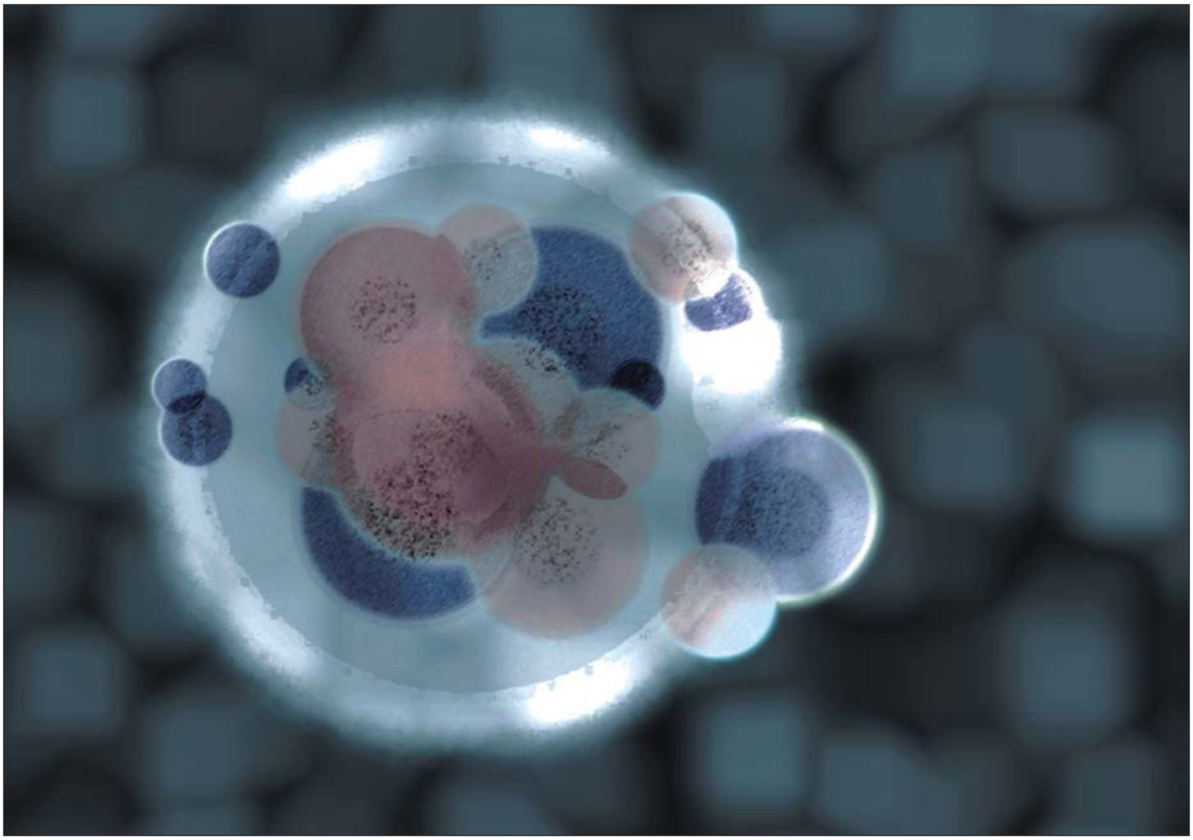

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Body Measurements of Rabbit Breeds and Crosses at Weaning and Post-weaning Ages

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Abstract: Weaning and post- weaning linear data taken on 259 and 215 rabbits from 73 and 62 litters were used in the study. The litters representing 8 genotypes were assessed for body linear measurements namely 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) at weaning and post- weaning ages of 35 and 56 days, respectively. The least squares model included the main effects of genotype, sex, parity of dam, season, first order interactions between genotype, sex, parity and season and random error. Genotype differed significantly ($p<0.001$) in all measurements at both ages with crossbred New Zealand Dutch-belted x New Zealand Dutch-belted (NZWDBD x NZWDBD) recording superior performance in 35- day linear measurements and in 56-day NTS, HGT and LTE. The sex had similar effect on all the measurements. The females were bigger and longer than the males. Parity exerted strong influence ($p<0.001$) on 35-day and 56- day linear traits except 56-day LTE. Season effect on the measurements at both ages were significant ($p<0.001$).The dry season kits were bigger and longer in 35-day linear measurement means than those born in the wet season. Studies of linear measurements and factors influencing them would attempt to answer the question of optimal body shape and size of meat animals such as rabbit. The results of such study like this would guide decisions that aim at improving performance characteristics of animals.

Key words: Measurements, rabbit, weaning, ages

INTRODUCTION

Linear body measurements could be a means of describing the size and shape of farm animals. Body size and shape (conformation) as important traits in meat animals had been largely estimated quantitatively by scale weights, generally described by visual appraisal, giving rise to objective scores and such descriptions as blocky, rangey, compact etc. However, various linear body traits have traditionally been assessed and recorded in many countries[1,2] and their relationships with body size, shape and production have been investigated[3]. The different body parts develop at varying rates and these changes determine the shape, conformation and body proportion of the animal at a given time[4].Where weighing scales are not readily available for example in rural areas[5,6], linear measurements have been used to predict performance characteristics in poultry[7,8], goats[9], sheep[10,11] and cattle[4,12].Surprisingly, there is a dearth of information on linear body measurements of domestic rabbits in the humid tropics. Thus, this study aimed at reporting the weaning and post-weaning performance of pure and crossbred group of rabbits using some linear body measurements and possible factors influencing them.

MATERIALS AND METHODS

Data used for this study were collected on 466 kits from 109 litters obtained from a random cross breeding experiment involving 13 bucks and 49 does at FUTA Teaching and Research Farm between 1998 and 2001. The mortality recorded over the course of the experiment decreased these numbers to 259 and 215 kits from 73 and 62 litters at 35 and 56 days of age respectively. The 49 does which comprised 15 New Zealand white (NZW) and 13 Chinchilla (CHA) purebreds and 11 New Zealand white x Dutch belted (NZW-DBD) and 10 New Zealand white x Croel (NZW-CRL) crossbreds were randomly assigned to the 13 bucks (3 NZW and 5 CHA purebreds and 3 NZW-DBD and 2 NZW-CRL crossbreds) for mating early in the morning. The litters that evolved from the mating procedure, representing 8 genotypes were 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

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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. The kits were sexed at 21 days. Litters were weaned at 35 days of age when each kit was individually ear-tagged and weighed. Littermates were kept together in the same cage to 56 days of age.

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 60 cm 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 rabbits 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 2300 k 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% ash, 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.

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 weaning and post-weaning ages of 35 and 56 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 on 259 and 215 kits at 35 and 56 days of age. Mortality accounted for the differences in number of kits at various 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 pin bone 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 35 and 56 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

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

Season: Dry and wet.

Analytical procedures: The effects of genotype, parity, sex and season on the linear body measurements at weaning age of 35 and post-weaning age of 56 days were estimated from least squares procedures of unequal sub-class numbers according to the method of Harvey[13]. 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} = $U+B_i+C_j+P_k+S_l+(BC)_{ij}+(BP)_{ik}+(BS)_{iL}+(CP)_{ij}+(CS)_{iL}+(PS)_{kL}+(BCP)_{ijk}+(BPS)_{ikL}+(BCS)_{ijL}+(CPS)_{jkL}+E_{ijklm}$

Where,

Y_{ijklm} = The observation of the dependent variable on the mth 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 ith genotype and kth parity

$(BS)_{il}$ = Effect of interaction between ith 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 lth season

E_{ijklm} = Random error normally, identically and independently distributed with 0 mean and variance σ^2e.

RESULTS

Linear body measurements at 35 days of age: The analyses of variance indicated strong significant (p<0.01 and p<0.001) effects of genotype on all the linear parameters. Another important source of variation for all measurements was parity. Parity strongly influenced (p<0.01and p<0.001) (STL), (HGT) and (HWT) (Table 1). It as well exerted significant (p<0.05) effects on (LTE) and (TKL). Sex had similar effect on all the measurements. Season had highly significant (p<0.01and p<0.001) influences on (NTS), STL, HGT and TKL. It's significant (p<0.05) effect was also observed for HWT and LTE. Various interactions involving genotype and parity for NTS, STL, TKL; genotype and season for STL, TKL; parity and season for STL, HWT; genotype and parity and season for NTS, STL, HWT, LTE and TKL were significant (p <0.01 and p<0.01) source of variation. Apart from these interactions others were not important (Table 1).

Genotype means differed for all the linear measurements. New Zealand white Dutch-belted x New Zealand white Dutch-belted (NZWDBDxNZWDBD) maintained superiority in all linear traits over the other genotypes. It was closely followed by New Zealand white x Chinchilla (NZWxCHA) in nose to shoulder (NTS - 12.83±0.184 cm), shoulder to tail (STL) 24.62±0.458 cm) and TKL (19.43±0.358 cm) (Table 2).

The means by sex were similar for all the linear traits. The females were bigger and longer in all measurements than the males.

Parity means differed for all the linear measurements except HGT. The mean values for all the linear traits were inconsistent with parity. Kits of parity 6 were larger in mean values for all the linear body measurements than other parities.

Season means were different for all the body measurements. The dry season kits were significantly (p < 0.05) bigger and longer than those kits born in the wet season.

Linear body measurements at 56 days of age: The analyses of variance revealed strong influences (p<0.001) of genotype on all the measurements studied. The significant (p<0.05, p<0.01and p<0.001) effects of parity for all the measurements except LTE were recorded. Except for HWT, seasonal effects were significant (p<0.05, p<0.01and p<0.001) for other linear measurements. Sex differences were not observed for any of the measurements. The interaction involving genotype and parity for NTS, STL and TKL was significant (p<0.001). There were as well significant (p<0.001) interactions between genotype and parity for TKL and between genotype and season for TKL. In addition, interactions between genotype and season for LTE, STL; and among sex and parity and season for STL and TKL were significantly (p<0.05) different. Other interactions were considered unimportant for any of the traits (Table 3).

Genotype means of NTS (15.18±0.258 cm), HGT (20.02±0.499 cm), LTE (12.04±0.239 cm) for New Zealand white Dutch-belted x New Zealand white Dutch-belted (NZWDB x NZWDBD) were significantly higher than those of the other genotypes. New Zealand white x New Zealand white (NZW x NZW) was superior in HWT (12.46±0.292 cm), New Zealand white x Chinchilla (NZWxCHA) recorded the highest mean values of 23.71±0.262 cm for TKL and (31.10±0.311 cm) for STL (Table 4).

Table 1: Mean squares (MS) from the analyses of variance for linear measurements (cm) at 35 days of age

	Nose to shoulder		Shoulder to tail		Heart girth		Withers height		Ear length		Trunk length	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Source of Variation												
Genotype	7	3.13***	7	11.67***	7	11.71**	7	0.92**	7	2.26**	7	8.07***
Parity	5	1.38*	5	11.65**	5	3.72**	5	3.15***	5	1.80*	5	5.49*
Season	1	8.91***	1	47.63***	1	27.11**	1	2.83*	1	0.46*	1	20.37**
Sex	1	0.20	1	2.59	1	0.86	1	0.28	1	1.05	1	2.62
Genotype x Parity	18	1.38**	18	9.39***	18	7.05	18	1.04*	18	1.47*	18	7.45***
Genotype x Season	4	1.58*	4	19.10**	4	15.85	4	1.79*	4	0.47	4	11.51***
Genotype x Sex	7	0.15	7	1.76	7	0.60	7	0.18	7	0.34	7	0.99
Parity x Season	3	0.45	3	18.46***	3	6.34	3	3.87***	3	2.48*	3	4.69
Sex x Parity	5	0.12	5	1.01	5	0.12	5	0.14	5	0.18	5	0.67
Sex x Season	1	0.15	1	4.91	1	0.23	1	0.23	1	0.86	1	2.38
Genotype x Parity x Season	1	9.72***	1	56.02***	1	13.14	1	11.18***	1	8.22***	1	31.01***
Genotype x Sex x Parity	11	0.43	11	1.74	11	1.16	11	0.13	11	0.17	11	0.85
Genotype x Sex x Season	3	0.19	3	0.57	3	0.48	3	0.33	3	0.34	3	0.22
Sex x Parity x Season	2	0.52	2	8.21	2	3.69	2	1.37	2	1.58	2	6.53*
Genotype x Sex x Parity x Season	1	5.74	1	3.12	1	0.26	1	0.39	1	0.63	1	2.06
Error	179	0.62	179	3.01	179	1.18	179	0.595	179	0.79	179	2.06

*p < 0.05, * *p < 0.01 and* * *p < 0.001

Table 2: Least square means for linear measurements (cm) at 35 days of age (weaning age)

Variable	No	Nose to shoulder	Shoulder to tail	Heart girth	Withers height	Ear length	Tmnk length
Genetic group							
NZW x NZW	56	12.01±0.148^{c}	23.63±0.258^{c}	16.53±0.152^{cd}	9.49±0.131^{bcd}	8.44±0.155^{d}	18.49±0.224^{c}
CHA x CHA	66	12.66±0.106^{b}	24.61±0.282^{a}	17.01±0.184^{abc}	9.13±0.129^{abc}	8.73±0.143^{b}	19.34±0.233^{ab}
NZW x CHA	29	12.83±0.184^{ab}	24.62±0.458^{a}	17.16±0.300^{ab}	8.97±0.160^{abcd}	8.97±0.156^{b}	19.43±0. 358^{ab}
NZWDBDx ZWDBD	23	13.07±0.136^{a}	24.71±0.48^{a}	17.62±0.329^{a}	9.75±0.148^{c}	9.56±0.146^{b}	19.81±0. 370^{a}
NZW x NZWDBD	19	12.41±0.215^{b}	23.71±0.436^{ab}	17.20±0.454^{ab}	8.70±0.281^{d}	8.52±0.270^{cd}	18.91±0.361^{cde}
NZWCRLx NZWCRL	16	12.78±0.182^{bc}	23.74±0.469^{ab}	17.08±0.348^{abc}	9.30±0.168^{a}	9.00±0.158^{a}	19.14±0.359^{abc}
CHA x NZWDBD	34	12.61±0.182^{b}	23.50±0.327^{bc}	16.12±0.261^{d}	8.91±0.143^{cd}	8.89±0.129^{b}	18.89±0.286^{bc}
CHA x NZWCRL	16	12.06±0.249^{c}	24.02±0.392^{b}	16.25±0.303^{d}	9.48±0.139^{ab}	9.51±0.155^{ab}	19.12±0.344^{ab}
Parity							
1	37	12.15±0.136^{b}	23.57±0.288^{b}	17.02±0.272^{a}	8.36±0.153^{c}	8.27±0.175^{b}	18.65±0.262^{b}
2	55	12.44±0.110^{ab}	24.02±0.314^{ab}	16.74±0.233^{ab}	9.06±0.148^{b}	8.79±0.140^{ab}	18.83±0.259^{b}
3	51	12.16±0.178^{b}	24.23±0.370^{a}	16.66±0.184^{ab}	9.50±0.120^{ab}	9.03±0.177^{a}	19.07±0.290^{ab}
4	67	12.15±0.127^{b}	23.60±0.242^{b}	16.11±0.161^{ab}	9.37±0.883^{ab}	9.31±0.968^{a}	18.66±0.203^{b}
5	42	12.27±0.155^{b}	24.08±0.307^{ab}	16.80±0.251^{ab}	9.19±0.119^{ab}	8.79±0.152^{ab}	19.38±0.265^{a}
6	7	12.87±0.141^{a}	24.13±0.497^{a}	17.33±0.321^{a}	9.64±0.129^{a}	9.17±0.127^{b}	19.41±0.485^{a}
Sex							
Male	117	12.17±0.222	23.84±0.202	16.49±0.140	9.10±0.984	8.86±0.841	18.77±0.167
Female	142	12.32±0.471	23.95±0.180	16.74±0.129	9.22±0.919	8.95±0.936	19.03±0.150
Season						1.	
Dry	108	12.73±0.763^{a}	24.76±0.242^{a}	17.14±0.161^{a}	9.40±0.634^{a}	9.11±0.252	19.52±0.185^{a}
Wet	151	12.025±0.663^{b}	23.49±0.152^{b}	16.38±0.113^{b}	9.05±0.343^{b}	8.81±0.631	18.62±0.134^{b}
Overall mean	259	12.25±0.224	23.90±0.134	16.62±0.498	9.16±0.942	8.91±0.609	18.91±0.112

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

Table 3: Mean squares (MS) from the analyses of variance for linear measurements (cm) at 56 days of age

	Nose to shoulder		Shoulder to tail		Heart girth		Withers height		Ear length		Trunk length	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Source of variation												
Genotype	7	2.36***	7	15.50***	7	7.25***	7	6.13***	7	3.26***	7	7.78***
Parity	5	1.61*	5	9.38*	5	2.60**	5	4.31**	5	1.29	5	9.62***
Season	1	6.95***	1	52.22***	1	12.91**	1	3.74	1	2.81*	1	15.10**
Sex	1	0.20	1	0.25	1	1.64	1	7.83	1	1.60	1	0.11
Genotype x Parity	13	2.68***	13	10.92***	13	5.09***	13	2.17	13	0.96	13	3.76**
Genotype x Season	2	0.60	2	14.65*	2	2.36	2	2.79	2	2.71*	2	8.97**
Genotype x Sex	7	0.46	7	0.46	7	0.31	7	0.56	7	7.58	7	0.30
Parity x Season	3	0.36	3	4.40	3	3.87	3	1.31	3	1.66	3	3.19
Sex x Parity	5	9.15	5	2.09	5	0.47	5	0.91	5	0.41	5	1.43
Sex x Season	1	1.18	1	0.37	1	0.35	1	7.49	1	5.33	1	0.16
Genotype x Parity x Season	3	4.11***	3	18.95***	3	1.05	3	1.87	3	1.71	3	8.65***
Genotype x Sex x Parity	9	0.32	9	2.85	9	0.42	9	2.06	9	0.54	9	1.67
Genotype x Sex x Season	2	0.26	2	5.04	2	0.51	2	7.77	2	0.47	2	1.76
Sex x Parity x Season	3	1.12	3	12.35*	3	2.51	3	0.97	3	1.31	3	5.39*
Error	142	0.54	142	3.55	142	1.52	142	1.50	142	0.79	142	1.59

p < 0.05, *p < 0.01 and* * *p < 0.001

Table 4: Least square means linear measurements (cm) at 56 days of age

Genetic group	No	Nose to shoulder	Shoulder to tail	Heart girth	Withers height	Ear length	Tmnk length
NZW x NZW	50	14.63±0.139^{abc}	30.18±0.311^{ab}	19.74±0.154^{b}	12.46±.292^{b}	11.40±0.130^{b}	23.39±0.224^{b}
CHA x CHA	61	14.50±0.117^{abc}	29.42±0.324^{ab}	19.08±0.199^{bc}	10.90±0.120^{ab}	10.61±0.133^{b}	22.92±0.202^{ab}
NZW x CHA	13	15.00±0.158^{ab}	31.10±0.311^{a}	18.81±0.321^{bc}	11.39±0.105^{ab}	11.29±0.813^{a}	23.71±0. 262^{a}
NZWDBDxNZWDBD	23	15.18±0.258^{a}	29.94±0.587^{ab}	20.02±0.499^{a}	12.41±0.277^{a}	12.04±0.239^{a}	23.39±0. 406^{b}
NZW x NZWDBD	19	14.10±0.262^{bc}	28.16±0.343^{ab}	17.68±0.361^{c}	11.54±0.228^{ab}	11.08±0.239^{a}	22.09±0.236^{ab}
NZWCRL x NZWCRL	14	14.71±0.137^{ab}	29.09±0.461^{ab}	19.50±0.362^{ab}	11.44±0.309^{ab}	10.70±0.125^{b}	22.48±0.383^{ab}
CHA x NZWDBD	22	14.15±0.298^{bc}	27.85±0.478^{b}	17.98±0.338^{c}	10.53±0.214^{bc}	10.48±0.18^{b}	22.00±0.342^{b}
CHA x NZWCRL	13	13.77±0.163^{c}	26.36±0.287^{b}	17.71±0.302^{c}	10.19±0.108^{c}	10.22±0.11^{b}	20.33±0.296^{b}
Parity							
1	31	14.46±0.175^{b}	28.61±0.270^{b}	19.38±0.245^{ab}	10.50±0.203^{c}	10.38±0.226	21.97±0.224^{ab}
2	48	14.34±0.174^{b}	28.36±0.385^{b}	18.58±0.259^{abc}	10.60±0.151^{c}	10.74±0.139	21.65±0.254^{bc}
3	46	14.13±0.164^{b}	28.34±0.400^{b}	18.40±0.227^{ab}	11.52±0.323^{b}	10.96±0.145	22.29±0.238^{b}
4	50	14.03±0.119^{b}	27.65±0.284^{b}	18.33±0.221^{ab}	11.07±0.159^{ab}	10.70±0.139	21.47±0.217^{bc}
5	33	14.37±0.135^{b}	28.25±0.191^{b}	18.55±0.204^{abc}	11.60±0.113^{b}	11.26±0.113	21.99±0.147^{ab}
6	7	15.72±0.380^{a}	32.11±0.238^{a}	19.65±0.396^{a}	12.84±0.288^{a}	11.83±0.242	25.86±0.093^{a}
Sex							
Male	92	14.46±0.108	28.80±0.248	18.71±0.156	11.22±0.102	10.97±0.102	22.48±0.171
Female	123	14.55±0.129	28.97±0.190	18.92±0.147	11.49±0.142	10.98±0.774	22.86±0.134
Season							
Dry	73	14.68±0.124^{a}	28.79±0.310^{a}	19.06±0.178^{a}	11.30±0.113	11.01±0.269^{a}	22.19±0.207^{a}
Wet	142	14.34±0.548^{b}	28.98±0.161^{b}	18.56±0.129^{b}	11.41±0.125	10.95±0.627^{b}	22.89±0.117^{b}
Overall mean							
	215	14.16±0.969	28.42±0.152	18.80±0.107	11.18±0.217	10.78±0.627	22.07±0.106

Means with different superscripts in the same column within variable group are significantly different ($p < 0.05$, $p < 0.01$ and $p < 0.001$)

Sex means were similar for all the traits. The females were still superior to males in all body measurements.

Parity means differed significantly with kits of parity 6 maintaining superior performance in all linear measurements over the others. The mean values for NTS, STL and HGT dropped in parity 2-4, picked up in parity 5 and recorded final increase in parity 6. The mean values for LTE and TKL equally increased in parity 6.

Season means for all the measurements were different. The dry season kits were significantly ($p<0.05$) bigger and longer in NTS (14.68±0.124 vs 14.34±0.548 cm), HGT (19.06±0.178 vs 18.56± 0.129 cm), LTE (11.01±0.269 vs 10.95±0.627 cm) than wet season kits, which were superior in STL (28.89 ±0.161 vs 28.78±0.31 cm) HWT (1.41±0.125 vs 11.30±0.113 cm) and in TKL (22.89±0.117 vs 22.19±0.207 cm) over the dry.

DISCUSSION

Genotype exerted significant influence on linear traits at various ages. The linear measurements increased from weaning age through to post-weaning age. This should be attributed to breed combinations which promote growth and increase in mature body size. As expected, each measurement studied increased with increase in age in each genotype. It had been observed that these increases, when calculated as a percentage of their values at birth, were at different rates[14]. This corroborated a report by Russel[15] that body measurements differed in their rates of maturing. In the present study, genotype NZWDBD x NZWDBD kits were superior in almost all the 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[16]. Heart girth, according to Suleiman *et al.*,[17] 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[16].

The kits of sixth parity dams were superior in all linear measurements except in 35-day STL. 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 other parities. The significant effect of parity on linear measurements had been reported elsewhere[18]. This author further noted that kids of first parity dams were shorter than those of parities 2 and 3.

Sex was not an important source of variation for body measurements considered in the study. Similar results have been reported[19]. The females having bigger and longer body in most measurements taken than the males corroborated the findings of Lebas *et al.*[20], Akpan[18] and Chineke *et al.*[19].

Season influenced ($p<0.05$, $p<0.01$and $p<0.001$) linear measurements at different ages except 56- day HWT. In 35-day measurements and 56-day NTS, HGT and LTE, the dry season kits performed better than those kits born in the wet season. The superior 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[14] 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[16] 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.*[21] 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. 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[22].

Linear body measurements are important traits in meat animals. They indicate the way in which the animal body is changing shape and size over a period of time. The analyses of data on body measurements provide quantitative measures of body size and shape that are desirable, as they will enable reliable genetic parameters for these traits to be estimated and also permit inclusion in breeding programmes. Besides, the studies of linear traits reveal growth pattern which depends on the genotype and management environment of the animal. With such knowledge, a farmer can access his efforts whether he is running his rabbit business at gain or loss. This will assist him to either continue with the same rabbit genotypes and management environment or source for good ones. In the present study, genotype, parity and season are important sources of variation in rabbit linear body traits. It should be necessary to consider their contribution to rabbit performance in improvement programmes for commercial production.

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