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Influence of Genotype x Environment Interaction on Post-weaning Growth Performance of the Domestic Rabbit

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Abstract: Data on 83 progeny of New Zealand White (NZW), Chinchilla (CHIN), Dutch (DUT) breeds of rabbit and their crossbreds collected over a period of 8 weeks (11 – 18weeks) were used to determine the influence of genotype x environment (feed regime) interaction on post-weaning growth traits. The experiment was designed as a 4 feed regime x 6 genotype factorial in randomized complete block design (RCBD). Genotype and feed regime were the factors of interest while parity served as block. The genotypes were NZW x NZW, CHIN x CHIN, DUT x DUT, NZW x CHIN, NZW x DUT and CHIN x DUT. The feed regime consist of *ad libitum* concentrate + forage (control), *ad libitum* concentrate + 20% restricted forage, 20% restricted concentrate + *ad libitum* forage and 20% restricted concentrate + 20% restricted forage. Traits studied were body weight (BW), body length (BL), heart girth (HG), head-to-shoulder (HS), shoulder-to-tail (ST), length of hind limb (LHL), ear length (EL) and height at withers (HTW). Genotype x feed regime interaction was not significant (P>0.05) for all traits measured at different ages. Differences among feed regimes were significant (P<0.05) for BL, HG, ST and HTW in week 17 only. There were significant differences (P<0.05) among the genotypes for post-weaning growth performance at the different ages. CHIN x CHIN was superior over other genotypes for most of the growth traits studied and at most ages followed by NZW x NZW. Feed intake of rabbits in the study population can be restricted up to 20% without adversely influencing their post-weaning growth performance. In general, the result indicates that Chinchilla and New Zealand White breeds are the most suitable for both pure and crossbreeding programs for optimum genetic improvement of rabbit species in the study area.

Key words: Genotype x environment interaction, post-weaning growth, feed restriction, rabbits

INTRODUCTION

Variations exist in the growth performance of the different breeds of rabbits. These variations are attributed to genetic and environmental factors. Environmental variations result from managerial, climatic and nutritional factors[14]. Ibe and Nwakalor[18] indicated that body size and conformation traits are highly heritable traits, suggesting that differences are expected among different genotypes. Several genetic factors such as breed, litter size, weaning age, sex etc and non-genetic factors such as diseases, season, temperature, housing, feeding, have been noted to influence post-weaning growth performance of rabbits[4,23]. The productivity of an animal is, therefore, largely determined by the interaction between genotype and environment[12,24]. Post-weaning growth is important in the economics of rabbit production, since it influences the rate of attainment of market weight.

Rabbits are conventionally fed *ad libitum* (concentrate and forage) to enhance their growth and reproductive performance[6]. However, with the recent phenomenal rise in the cost of feeds and feeding stuffs in most parts of the humid tropics farmers now engage in indiscriminate feed restriction programmes, aimed majorly at reducing cost of production and consequently increase profitability. Reports from the temperate regions have indicated that feed restriction reduces post-weaning digestive disorders[9], improves feed efficiency[8,17] and reduces carcass fat[20,30]. Boist *et al.*[8] reported that a feeding level of 60% was more efficient in reducing the negative impact of epizootic rabbit enteropathy syndrome conditions. Gidenne *et al.*[17] indicated that mortality and morbidity were significantly reduced during feed restriction (a feeding level of 80% and 70%, respectively).

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There is dearth of information on the effect of feed restriction on growth traits of rabbit in the literature, except perhaps on body weight gain. Biobaku and Adegoke[7] observed no significant difference in mean daily body weight gain among rabbits fed *ad libitum* and those fed for 8 and 16 hours, respectively. Information on the effect of feed restriction on growth traits is particularly important in the tropics as animal productivity is generally low in this area compared to the temperate regions. Cheeke[11] reported a productivity of 50% or less of what is typical in the temperate areas for all animals including rabbits in the tropics. Therefore, unguided practices could further deteriorate this situation. Some researchers have advocated that growth traits of chicken are affected by feed restriction[19,21,26]. Similar studies are lacking for rabbits particularly in the humid tropics. A study to investigate whether or not feed restriction could influence growth traits of rabbits is then necessary. Rabbits excel ruminants and rank close to modern broiler chicken in terms of growth rate[2]. Forages, on the other hand, are scarce and lignified during dry seasons leading to fluctuations in body weight of forage fed animals including rabbits and can influence their growth rates at such times. Selection of genotypes that can thrive well under limited feeding conditions is thus necessary for sustainability of production.

The objective of this study is to investigate the influence of genotype x environment (feed regime) interaction on post-weaning growth performance of the domestic rabbit. This will permit the determination of the optimum combination of genotype and feed regimes that will enhance optimum growth performance of rabbits in a humid tropical environment, particularly with regard to the humid zones of Nigeria.

MATERIALS AND METHODS

Location of Study: This study was carried out at the Rabbitry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The University is located on latitude 05 29^0 North and longitude 7 33^0 East on an elevation of 122 m above sea level. It lies within the tropical rainforest zone, with an average rainfall of 2169.8 mm in 148 – 155 rain days. It has a humid climate and temperature ranges from 22°C in the wet season to 34°C in the dry season. Mean relative humidity stands at 85% but daily values are subject to variations.

Management of Experimental Animals: The genotypes used for this study were generated by the mating of 18 breeding does and 6 bucks randomly sampled from an unselected rabbit population maintained at the Unit. Matings were carried out in the morning and 14 days *post coitus* according to Table 1. The does were palpated to determine pregnancy. Non-pregnant does were re-mated until conception occurred. A total of 83 kits comprising of 6 genotypes resulted from the matings. The genotypes were New Zealand White (NZW) x New Zealand White, Chinchilla (CHIN) x Chinchilla, Dutch (DUT) x Dutch, NZW x CHIN, NZW x DUT and CHIN x DUT. Kits were weaned at 10 weeks of age after which their feed intake was restricted till the 18th week. They were fed concentrate ration (16.5% crude protein and 2.80 Mcal/kg gross energy) and forage-*Panicum maximum*, *Asphillia africana* (grass) and *Centrosema pubescens, Tridax procumbens* (legumes). Forages were fed whole and tied to metal strings of cages to allow collection of remnants the following day. The control groups were fed *ad libitum*. Water was given *ad libitum* to all experimental animals. The rabbits were housed in individual row cages made of metal and wire-gauze. Management operations were routinely carried out throughout the experimental period. Kits were individually identified using ear tags.

Feed Restriction: Four feeding regimes were designed and administered to the different genotype groups as follows:

- *Ad libitum* concentrate + *ad libitum* forage (control)
- *Ad libitum* concentrate + 20% restricted forage
- 20% restricted concentrate + *ad libitum* forage
- 20% restricted concentrate + 20% restricted forage

Determination of the percentage of concentrates and forage fed to the restricted groups was based on total intake of the control kits on the previous day. Depending on the number weaned in each parity, 2 or 3 kits from each parity in each of the 6 different genotypes were randomly selected and assigned to each of the four feeding regimes.

Experimental Design, Traits Measured and Statistical Analysis: The design was a 4 feed regime x 6 genotype factorial in randomized complete block design, with unequal replications (2 or 3). There were 2 parities. Parity constituted the block, whereas genotype and feed regime were the factors of interest. The statistical model used to describe the data is:

- $Y_{ijkl} = \mu + P_i + G_j + F_k + (GF)_{jk} + e_{ijkl}$

where:

- Y_{ijkl} = Single observation on the lth progeny of the jth genotype placed on the kth feed regime in the ith parity.

Table 1: Mating scheme and distribution of progeny per mating group.

Mating Group*	Number of bucks	Number of does	Number of parities	Number of kits
NZW x NZW	1	3	2	14
CHA x CHA	1	3	2	10
DUT x DUT	1	3	2	17
NZW x CHA	1	3	2	11
NZW x DUT	1	3	2	14
CHA x DUT	1	3	2	17
Total				83

*NZW = New Zealand White
CHA = Chinchilla
DUT = Dutch

- μ = overall mean
- P_i = Effect of the i^{th} parity (block), i = 1, 2
- G_j = Main effect of the j^{th} genotype, j = 1 – 6
- F_k = Main effect of the k^{th} feed regime, k = l – 4
- $(GF)_{jk}$ = Effect of interaction between genotype and feed regime
- e_{ijkl} = Random error, independently and identically normally distributed with zero mean and constant variance (iind(0, σ^2))

The traits measured were individual body weights (BW) and linear body measurements (LBMs) namely body length (BL), heart girth (HG), head-to-shoulder (HS), shoulder-to-tail (ST), length of hind limb (LHL), ear length (EL) and height at withers (HTW). All the traits, with the exception of body weight and height at withers, were measured using a tailor's tape. Body weight (g) was measured using a weighing scale and height at withers with a centimeter ruler. Measurements were done on a weekly basis for 8 weeks (11 – 18 weeks).

Data collected were subjected to analysis of variance (ANOVA) for unequal subclass numbers, using the General Linear Model procedure of Statistical Procedure for the Social Sciences (SPSS[33]). Analysis was done on a weekly basis. Mean separation for significant effects was done using Duncan's Multiple Range Test[15].

RESULTS AND DISCUSSION

Effect of Interaction: The interaction between genotype and feed regime was not significant (P>0.05) for all the growth traits at all ages. The implication is that the different feed regimes did not have any differential effects on the different genotypes with respect to the growth traits studied. In other words, no combination of genotype and feed regime would be considered optimum in this study. The significance of this result in practical rabbit production is that commercial rabbit farmers in the study area may restrict concentrate and forage intake of any of the genotypes up to 20% without compromising growth of the animals. We suggest that this could lead to a concomitant decrease in production cost and increased economic returns. However, the result presented in this study may be biased due to the small sample size which could limit statistical power[32] and possibly lead to a deviation from the expected result.

Effect of Feed Regime: The effect of feed regime on the traits (Table 2) was significantly different (P<0.05) for BL, HG, ST and HTW in week 17 only. Lowest values for BL (31.17 cm), HG (17.84 cm), ST (37.93 cm) and HTW (10.99 cm) in week 17 were observed in the group subjected to 20% restricted concentrate and 20% restricted forage. Cheeke[10] and Aduku and Olukosi[3] had also reported non-significant difference between body weight of rabbits fed *ad libitum* and their restricted counterparts. Our finding indicates that rabbits could be raised on *ad libitum* feeding or subjected to any of the feed restriction levels imposed in this study without any adverse effect on their growth rate and attainment of market weight. The result obtained in this study could be attributed to the fact that rabbits generally have low maintenance requirement. Rabbits equally utilize feed more efficiently than other animal species through the practice of cecal fermentation and cecotrophy[3]. Additional nutrients resulting from this proper digestion could possibly compensate for the restrictions imposed. Further investigation may be necessary to ascertain the effect of higher levels of restriction, say 25 or 30% on the growth traits, particularly for concentrate rations.

Effect of Genotype on the Growth Traits:
Body Weight: Result of the analysis of variance showed significant differences (P < 0.05) in mean body weight of the genotypes. Means of post-weaning body weights (BW) for the different genotypes are given in

Table 2: Means of body traits for the different feed regimes in week 17.

Feed regime*	Body traits							
	BW	BL	HG	HS	ST	LHL	EL	HTW
Ad lib conc.+ *Ad lib* forage	1373.53	32.58^{a}	19.02^{a}	12.16	42.06^{a}	27.86	12.52	11.41^{ab}
Ad lib conc. + 20% RF	1306.47	31.84^{ab}	18.46^{ab}	11.89	41.18^{a}	27.18	12.09	11.14^{ab}
20% RC + *Ad lib* forage	1401.88	32.30^{ab}	19.18^{a}	12.08	41.83^{a}	27.71	12.14	11.56^{a}
20% RC + 20% RF	1224.44	31.17^{b}	17.84^{b}	11.81	37.93^{b}	27.06	12.10	10.99^{b}

a – b Means in a column with different superscripts are significantly different (P<0.05)

* *Ad lib* conc. = *Ad libitum* concentrate, *Ad lib* forage = *Ad libitum* forage, RC = Restricted concentrate, RF = Restricted forage

BW = body weight (g), BL = body length (cm), HG = heart girth (cm), HS = head-to-shoulder (cm), ST = shoulder-to-tail (cm), LHL = length of hind limb (cm), EL = ear length (cm), HTW = height at withers (cm).

Table 3: Mean body weights (g) for the different genotypes of rabbits (11 – 18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	910.77^{ab}	993.08^{ab}	1053.85	1073.08	1141.54^{b}	1224.17^{b}	1254.17	1300.83
CHIN x CHIN	965.00^{a}	1077.80^{a}	1205.00	1283.00	1443.00^{a}	1531.00^{a}	1604.00	1512.40
DUT x DUT	810.00^{bc}	948.46^{ab}	1051.45	1143.85	1249.23^{ab}	1343.85^{ab}	1261.54	1484.62
NZW x CHIN	733.00^{c}	855.00^{b}	965.00	1028.00	1117.00^{b}	1166.00^{b}	1223.00	1332.00
NZW x DUT	786.67^{ab}	846.67^{b}	1035.00	1102.50	1205.00^{b}	1286.75^{b}	1347.50	1457.50
CHIN x DUT	754.00^{c}	870.00^{b}	989.33	1064.67	1136.00^{b}	1236.00^{b}	1302.00	1364.00

a-c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 3. The animals had increased body weight at all ages except for the sharp drop in weight by CHIN x CHIN at 18 weeks. CHIN x CHIN consistently showed higher body weights although the values were not significantly different (P>0.05) from those of the other genotypes in weeks 13, 14, 17 and 18. Significant differences (P<0.05) among the genotypes were observed only in weeks 11, 12, 15 and 16. Body weights of CHIN x CHIN progeny were similar (P>0.05) to those of NZW x NZW in weeks 11 and 12 as well as DUT x DUT offspring in weeks 12, 15 and 16. In weeks 11, 12, 15 and 16, the differences in mean body weight of DUT x DUT, NZW x NZW, NZW x DUT and CHIN x DUT were not significant (P>0.05).

The weight gain recorded for CHIN x CHIN (1,604 g) in this study is comparable to the gain of 1,600 g reported for NZW x NZW[22]. The latter however was at an earlier post-weaning age and without any form of feed restriction. At pre-weaning stage (results not shown), CHIN x CHIN kits had increased body weight gain till weaning. This increased weight gain by CHIN x CHIN progeny at pre-weaning ages may have influenced the higher post-weaning body weight of this genotype compared to the others even with the imposed restricted feed intake at different levels. Ayorinde[5] observed that the initial higher pre-weaning body weights of the Dutch and New Zealand White breeds gave them an advantage to 8 weeks of post-weaning age. Okorie[29] also noted that Chinchilla is a hardy breed adapting easily to new environments and is characterized by fast growth rate and efficient feed conversion rate. Our results show that Chinchilla has a genetic potential for increased body weight gain. However, investigation on the average daily gain (ADG) of the genotypes is necessary as reports from the temperate region has noted ADG as the preferred trait for post-weaning selection than individual weights at specific ages, especially in unimproved rabbit populations due to less influence of ADG by common litter effects[16, 23, 31].

Linear Body Measurements: The means of post-weaning body length (BL) for the different genotypes are given in Table 4. CHIN x CHIN progeny had significantly (P<0.05) longer bodies than the progeny of the other genotypes in weeks 14 to 18. Differences between BL of CHIN x CHIN and NZW x NZW kits in weeks 11, 12 and 18 were not significant (P>0.05). Body length of NZW x NZW and DUT x DUT kits did not differ significantly (P>0.05) from those of the crossbreds (NZW x CHIN, NZW x DUT and CHIN x DUT). Numerically, CHIN x CHIN kits had longer bodies than all the other genotypes at all ages. Obasi[25]

Table 4: Mean body lengths (cm) for the different genotypes of rabbits (11-18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	27.36^{ab}	^{a}28.15 ^{b}	^{a}28.86 ^{b}	^{b}29.77	^{b}30.22	^{b}31.08	^{b}31.72	^{c}32.33
CHIN x CHIN	28.56^{a}	^{a}29.77	^{a}30.77	^{a}31.78	^{a}32.78	^{a}33.09	^{a}34.05	^{a}34.85
DUT x DUT	25.75^{bc}	^{b}26.73 ^{c}	^{b}28.18	29.34 ^{b}	30.17 ^{b}	^{b}30.94	^{b}31.87	32.63 ^{b}
NZW x CHIN	24.93 ^{c}	^{c}26.15	^{b}27.40	29.08 ^{b}	30.12 ^{b}	^{b}30.69	^{b}31.53	32.39^{b}
NZW x DUT	25.46 ^{c}	^{b}26.36 ^{c}	^{b}27.75	28.79 ^{b}	29.50^{b}	^{b}30.36	^{b}31.40	32.16 ^{b}
CHIN x DUT	25.53 ^{c}	^{b}26.57 ^{c}	^{b}28.24	29.11 ^{b}	29.82 ^{b}	^{b}30.51	^{b}31.39	32.15^{b}

a - c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 5: Mean heart girth (cm) for the different genotypes of rabbits (11-18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	16.08^{ab}	15.76	16.75	16.66	17.04	17.58	18.08	18.38
CHIN x CHIN	17.08^{a}	17.50	17.95	18.10	18.83	19.14	19.77	19.76
DUT x DUT	15.44^{b}	16.10	16.55	16.32	17.71	18.19	18.83	19.22
NZW x CHIN	15.04^{b}	15.81	16.49	17.13	17.65	17.96	18.49	19.13
NZW x DUT	15.03^{b}	15.59	16.84	17.18	17.64	18.43	18.61	19.46
CHIN x DUT	14.95^{b}	15.64	16.35	16.85	17.21	17.79	18.13	18.06

a – c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 6: Mean head-to-shoulder (cm) for the different genotypes of rabbits (11-18 week)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	9.14^{b}	9.82^{b}	10.25	10.76^{b}	11.13	11.62	11.99	12.33
CHIN x CHIN	10.08^{a}	^{a}10.47	10.84	^{a}11.43	11.83	12.18	12.45	12.76
DUT x DUT	9.12^{b}	^{b}9.52	9.98	10.45^{b}	10.88	11.42	11.92	12.36
NZW x CHIN	9.11^{b}	^{b}9.57	10.06	10.67^{b}	11.07	11.41	11.86	12.24
NZW x DUT	9.20^{b}	^{b}9.64	10.20	10.60^{b}	11.13	11.53	11.88	12.24
CHIN x DUT	8.89^{b}	^{b}9.30	9.81	10.44^{b}	10.93	11.47	11.86	12.20

a – c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 7: Mean shoulder-to-tail (cm) for the different genotypes of rabbits (11-18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	34.62^{ab}	^{b}36.12	^{b}37.15	^{b}38.37	^{b}39.09	40.08	^{a}40.86 ^{b}	42.03
CHIN x CHIN	36.54^{a}	^{a}38.27	^{a}39.32	^{a}40.65	^{a}42.44	43.26	^{a}44.13	44.47
DUT x DUT	31.87^{c}	^{c}33.27	^{b}35.69	^{b}37.45	^{b}38.84	39.73	^{a}40.54 ^{b}	41.56
NZW x CHIN	31.57^{c}	^{c}33.41	^{b}35.11	^{b}37.35	^{b}38.64	39.87	^{b}36.62	41.87
NZW x DUT	32.60^{bc}	34.36^{bc}	^{b}36.26	^{b}37.25	^{b}38.39	39.63	^{a}40.73 ^{b}	42.05
CHIN x DUT	32.33^{bc}	34.09^{bc}	^{b}36.11	^{b}37.80	^{b}38.83	39.28	^{a}41.10	41.95

a - c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 8: Mean length of hind limb (cm) for the different genotypes of rabbits (11-18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	23.80^{ab}	^{a}24.48	^{a}25.02^{b}	^{a}25.63^{b}	26.19	26.78	27.31	27.82
CHIN x CHIN	24.83^{a}	^{a}25.31	^{a}26.09	^{a}26.68	27.19	27.74	28.40	28.66
DUT x DUT	22.97^{bc}	23.82^{a}	24.72^{b}	25.50^{ab}	26.32	27.08	27.75	28.35
NZW x CHIN	22.16^{c}	^{b}20.81	^{b}28.90	^{b}24.65	24.41	26.28	27.08	27.55
NZW x DUT	22.83^{bc}	^{a}23.54	^{b}24.44	^{b}25.19	25.89	26.63	27.28	27.89
CHIN x DUT	22.22^{c}	^{a}23.12	^{b}24.04	^{b}25.09	25.71	26.41	26.99	27.53

a - c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 9: Mean of ear length (cm) for the different genotypes of rabbits (11-18weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	10.40^{b}	10.92^{ab}	11.28^{ab}	11.42^{ab}	11.68	12.00	12.24	12.41
CHIN x CHIN	11.19^{a}	^{a}11.39	^{a}11.57	^{a}11.81	12.08	12.32	12.51	12.59
DUT x DUT	10.05^{bc}	^{b}10.44^{c}	^{b}10.78	^{b}11.15	11.58	11.97	12.29	12.55
NZW x CHIN	10.07^{bc}	^{b}10.44^{c}	^{b}10.79	^{b}11.13	11.46	11.65	11.97	12.31
NZW x DUT	10.08^{bc}	^{a}10.47^{b}	^{b}10.85	^{b}11.10	11.40	11.63	12.04	12.35
CHIN x DUT	9.82^{c}	^{c}10.32	^{b}10.87	^{b}11.22	11.53	11.81	12.19	12.48

a – c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

Table 10: Mean of height at withers (cm) for the different genotypes of rabbits (11-18 weeks)

Genotype*	Week							
	11	12	13	14	15	16	17	18
NZW x NZW	8.62^{ab}	9.17^{ab}	9.69^{ab}	10.02	10.48	10.93^{ab}	11.42^{ab}	11.92^{ab}
CHIN x CHIN	9.16^{a}	9.60^{a}	^{a}10.00	10.30	10.97	^{a}11.34	^{a}11.64	^{a}11.74^{bc}
DUT x DUT	7.82^{c}	8.30^{c}	8.93^{c}	9.58	10.05	^{b}10.66	^{a}11.18^{b}	^{a}11.50^{bc}
NZW x CHIN	7.74^{c}	8.28^{c}	8.74^{c}	9.44	10.05	^{b}10.37	^{b}10.80	^{c}11.18
NZW x DUT	8.36^{bc}	8.84^{bc}	9.69^{ab}	10.09	10.71	^{a}11.45	^{a}11.76	^{a}12.03
CHIN x DUT	7.91^{c}	^{c}8.29	^{b}9.17^{c}	9.71	9.95	10.61^{b}	11.01^{bc}	11.37^{bc}

a – c Means with different superscripts within the same column are significantly different (P<0.05), *NZW = New Zealand White, CHIN = Chinchilla, DUT = Dutch

did obtain significantly (P<0.05) higher body length for CHIN x CHIN cross than other pure and crossbred genotypes studied. Oetting *et al*.[27] noted similar result for BL in New Zealand White, Japanese White and their crosses.

Table 5 gives the mean heart girth (HG) of the 6 genotypes. Significant differences were noted only in week 11, with HG of NZW x NZW being similar to those of CHIN x CHIN. DUT x DUT and the crossbred genotypes were similar (P>0.05) in mean HG growth. In weeks 12 to 18, all the genotypes had no significant growth difference (P>0.05) in mean HG values. However, highest numerical values were recorded among CHIN x CHIN progeny at all ages.

For head-to-shoulder (Table 5), significant differences (P<0.05) among genotypes occurred in weeks 11, 12 and 14, respectively. In these weeks, NZW x NZW, DUT x DUT and the crossbreds were similar (P>0.05) in mean HS growth but differed significantly (P<0.05) from CHIN x CHIN, which had the highest HS values. In the other weeks with no significant difference among the genotypes, CHIN x CHIN still had the highest numerical values. Lowest mean values (8.89 – 12.20 cm) were recorded among CHIN x DUT kits.

The mean values of post-weaning shoulder-to-tail (ST) are given in Table 7. Except in weeks 16 and 18, significant differences (P<0.05) were observed among the genotypes, with CHIN x CHIN progeny having the highest values (36.54 - 44.47 cm). Chineke *et al.*[13] observed significant breed differences for shoulder-to-tail between Chinchilla, Californian and Dutch-belted breeds of rabbits.

Tables 8, 9 and 10 give mean lengths of hind limb (LHL), ear length (EL) and height at withers (HTW), respectively. For LHL and EL, significant differences were observed among genotypes from week 11 to 14. There were no significant differences thereafter, although CHIN x CHIN still ranked highest in mean LHL and EL values. CHIN x CHIN progeny did not differ significantly (P>0.05) from NZW x NZW kits for the four weeks in terms of LHL. Except for CHIN x DUT, the other genotypes compared favourably with CHIN x CHIN in EL in week 12.

No significant genotype difference was observed between CHIN x CHIN and NZW x NZW progeny for HTW in weeks 11, 12, 13, 16, 17 and 18. CHIN x CHIN kits were superior in HTW over the others except for NZW x DUT kits in weeks 16, 17 and 18. Purebred DUT x DUT and the crossbreds (NZW x CHIN, NZW x DUT and CHIN x DUT) were not significantly different (P > 0.05) for this trait.

Different body parts grow at varying rates and the changes determine an animal's conformation and body proportion at a given time[28]. The non-significant effect of genotype observed for heart girth (12-18 weeks), length of hind limb and ear length (15 – 18 weeks) could, therefore, be as a result of genetic ceiling in terms of growth rate of these component parts. Akanno and Ibe[1] had also noted that the expression of EL is largely controlled by the environment. In all the post-weaning linear body parameters measured, CHIN x CHIN progeny were generally significantly (P<0.05) superior compared to the other genotypes. The performance of CHIN x CHIN kits indicates their ability to transmit favourable genes for improved growth rate compared to the other genotypes. Generally, the superiority of the purebred CHIN x CHIN followed by NZW x NZW over the crossbreds (NZW x CHIN, NZW x DUT and CHIN x DUT) for the growth traits measured suggest a preponderance of additive genetic variance in the experimental population. This indicates high heritability of the growth traits since the experimental population from which the animals were taken is unselected. The implication of these findings is that genetic improvement of these growth traits by individual selection method will be successful.

Conclusions: The non-significant effect of interaction between genotype and environment (feed regime) for all the body parameters measured indicate that there are no specialized feed regimes for specialized genotypes in this study. This suggests that rabbits with good growth characteristics can be raised even when feed intake of the animal is restricted, irrespective of the genotype. This is practically useful considering the highly exorbitant prices of conventional energy and protein feedstuffs in today's market, which tend to force farmers out of production. The results of this study also show that purebred Chinchilla followed by purebred New Zealand White had increased post-weaning growth traits than the other genotypes. The indication is that these two breeds are the best breeds for selection and breeding/production purposes aimed at improving post-weaning growth traits of meat type rabbits in the humid tropics, with emphasis on the humid zones of Nigeria. However, there is need for further investigation of this study with larger number of rabbits. It is arguable that with sufficient numbers of mating population and resulting progeny and possibly higher parity more significance could be found.

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