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Effect of Genotype on Pre-Weaning Growth Performance of the Domestic Rabbit in a Humid Tropical Environment

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Abstract: Growth traits were measured weekly on 83 progeny of multiparous does and the data used to determine the influence of genotype on pre-weaning growth performance of the domestic rabbit. 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. The experiment was randomized complete block design with genotype as the factor of interest. Traits measured were body weight (BW) and linear body measurements-body length (BL), heart girth (HG), shoulder-to-tail (ST), length of hind limb (LHL), ear length (EL) and height at withers (HTW) from 3-8 weeks of age. There were significant differences ($P < 0.05$) among the genotypes for pre-weaning growth performance at all ages studied. CHIN x CHIN was significantly superior ($P < 0.05$) to other genotypes for most of the growth parameters studied, followed by NZW x NZW. The result of this study demonstrates plausible improvement of body weight and growth traits of rabbits in the study population at early ages.

Key words: Genotype · Growth · Humid tropics · Performance · Pre-weaning · Rabbit

INTRODUCTION

The level of animal protein consumption has direct influence on the general well-being and health of any populace. The overwhelming animal protein deficiency common in most rural families in developing countries remains to be alleviated. Ojating [1], using Nigeria as a case study, advocated the rearing of short-cycle micro-livestock such as the domestic rabbit in order to maintain sustainable animal protein sufficiency in developing countries. Domestic rabbits serve as cheap source of high quality protein that can substantially improve the level of animal protein production and consumption in these countries. Rabbits have high reproductive potentials and fast growth rate [2] due to their high feed utilization efficiency.

Studies on pre-weaning growth performance is important since in breeding all stages of growth are inter-related and cannot be viewed as isolated traits. Osinowo *et al*. [3] noted that pre-weaning performance traits such as weight gain till weaning, weaning rate and weaning weight influenced herd productivity. In a study with Japanese quail, Shokoohmand *et al*. [4] showed that selection for body weight at early ages had positive effect on body weight at later ages. McNitt and Moody [5] and Lukefahr *et al*. [6] identified pre-weaning variables as major factors affecting post-weaning performance of rabbits. This means that improvement of economic traits at pre-weaning stage could lead to better weaning and post-weaning performance of rabbits. McNitt and Lukefahr [7] suggested that heavy weaning weight is important as it could lead to attainment of market weight at an early age. Therefore, consideration of pre-weaning performance of the domestic rabbit in the humid tropics is important for their genetic improvement for better future performances particularly for the commercial meat type rabbit. Information on pre-weaning differences in terms of growth traits of rabbits reared in the tropics mostly in Nigeria is scant in literature. Research interest has majorly been on pre-weaning litter traits.

This investigation was, therefore, aimed at evaluating the influence of genotype on pre-weaning growth performance of the domestic rabbit. Such a study will lend tips towards developing efficient breeding programmes for breeding heavier and early maturing rabbits, moreso in Nigeria where little effort towards a planned breeding programme for genetic improvement of the domestic rabbit has been made.

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MATERIALS AND METHODS

Study Area: The study was conducted at the Rabbitary Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike lies on latitude 05° 29' North of the Equator, 07° 33' East of the Greenwich at an altitude of 122m above sea level. It is located in the tropical rain forest zone of West Africa, with a maximum daily temperature of about 34°C. Annual rainfall ranges from 2100 to 2500 mm. Mean relative humidity is about 85%, although daily values are subject to wide variation

Management of Experimental Animals: A total of 83 kits representing 6 genotypes were generated from a random mating of 18 does and 6 bucks. The genotypes were New Zealand White (NZW), Chinchilla (CHIN) and Dutch (DUT) and their crosses. There were 14, 10 and 17 kits from the pure matings (NZW x NZW), (CHIN x CHIN) and (DUT x DUT), respectively. The numbers of kits from the crossbred matings, NZW x CHIN, NZW x DUT and CHIN x DUT were 11, 14 and 17, respectively. The animals were housed in individual row cages made of metal and wire-guaze. Routine management operations were carried out regularly throughout the experimental period. Concentrate ration (16.5% protein and 2.80Mcal/kg gross energy) plus forage (*Panicum maximum, Aspillia africana* (grass) *and Tridax procumbens, Centrosema pubescens (*legume)) and water were offered *ad libitum* till weaning at 8 weeks of age.

Experimental Design, Data Collection and Statistical Analysis: The design was randomized complete block design with parity as block and genotype as factor of interest. The statistical model is

$$Y_{ijk} = \mu + P_i + G_j + e_{ijk}$$

where

Y_{ijk} = Observation on k^{th} progeny of the j^{th} genotype in the i^{th} parity.
μ = Overall mean.
P_i = Effect of the i^{th} parity (block)
G_j = Effect of j^{th} genotype
e_{ijk} = Random error, independently and identically normally distributed with zero mean and constant variance [iind $(0, \sigma^2)$].

Individual body weights and linear body measurements namely body length (BL), heart girth (HG), shoulder-to-tail (ST), length of hind limb (LHL), ear length (EL) and height at withers (HTW) were taken on weekly interval from 3 to 8 weeks of age. Measurements were done prior to feeding in the morning. Apart from body weight and height at withers, all other parameters were measured with a tailor's tape. Body weights (g) were measured with a weighing scale while HTW were measured using a centimetre ruler.

Data collected were subjected to analysis of variance (ANOVA) using the General Linear Model procedure of Statistical Procedure for the Social Sciences (SPSS[8]). Mean separation for significant effects was done using Duncan's Multiple Range Test [9].

RESULTS

Body Weight: The analysis of variance showed significant ($P < 0.05$) effect of genotype on body weight in all the weeks. There was consistent increase in body weight with age as expected. Means of body weight (BW) for the different genotypes is given in Table 1. CHIN x CHIN purebred had the heaviest body weight although the difference with NZW x NZW in week 8 was not significant ($P > 0.05$). Generally, no significant differences ($P > 0.05$) in body weight were observed between DUT x DUT, crosses involving DUT (NZW x DUT and CHIN x DUT) and NZW x CHIN.

Linear Body Measurements: There was also a significant effect of genotype on the linear body measurements studied. Means of body lengths (BL) of kits for the six genotypes are given in Table 2. The trend was generally similar to that for body weight. CHIN x CHIN had significantly ($P < 0.05$) longer bodies (17.63 – 24.90cm) than the other genotypes. However, body lengths of CHIN x CHIN progeny were similar ($P > 0.05$) to those of NZW x NZW in weeks 3, 7 and 8. Body lengths of purebred DUT x DUT and the crossbreds NZW x CHIN, NZW x DUT and CHIN x DUT were not significantly different ($P > 0.05$) in all the weeks, except in week 3. In weeks 4, 5 and 6, body lengths of NZW x NZW progeny were significantly different ($P > 0.05$) from those of DUT x DUT and the crossbreds.

The means of genotypes for heart girth (HG) are given in Table 3. Again, CHIN x CHIN purebreds performed significantly better ($P < 0.05$) than progeny of the other genotypes. However, differences between CHIN x CHIN and DUT x DUT in weeks 3 and 4 and between CHIN x CHIN and NZW x NZW in week 8 were not significant ($P > 0.05$). Purebred DUT x DUT and the crossbreds (NZW x CHIN, NZW x DUT and CHIN x DUT) were significantly different ($P < 0.05$) only in week 4. Generally, crossbreds compared favourably with NZW x NZW purebred.

Table 1: Mean body weights (g) for the different genotypes of rabbits (3-8 weeks)

	Week					
Genotypes	3	4	5	6	7	8
NZW x NZW	229.29^{b}	319.29^{ab}	373.57^{ab}	476.92^{ab}	586.92^{ab}	658.38^{a}
CHIN x CHIN	288.00^{a}	384.00^{a}	460.00^{a}	546.00^{a}	639.00^{a}	741.00^{a}
DUT x DUT	204.12^{b}	264.21^{b}	338.82^{b}	390.00^{bc}	476.00^{bc}	524.29^{b}
NZW x CHIN	177.27^{b}	259.09^{b}	324.55^{b}	394.00^{bc}	451.00^{c}	499.00^{b}
NZW x DUT	173.57^{b}	248.57^{b}	327.86^{b}	348.57^{c}	429.09^{c}	494.00^{b}
CHIN x DUT	179.41^{b}	248.24^{b}	286.25^{b}	361.25^{c}	407.50^{c}	487.50^{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 2: Mean body lengths (cm) for the different genotypes of rabbits (3-8 weeks)

	Week					
Genotypes	3	4	5	6	7	8
NZW x NZW	15.51^{ab}	15.57^{b}	19.50^{b}	20.35^{b}	22.26^{ab}	23.38^{ab}
CHIN x CHIN	17.63^{a}	19.41^{a}	21.08^{a}	22.03^{a}	23.63^{a}	24.90^{a}
DUT x DUT	16.32^{ab}	17.51^{a}	18.81^{b}	19.91^{b}	21.09^{bc}	22.72^{bc}
NZW x CHIN	14.86c	16.41^{b}	17.83^{b}	19.44^{b}	20.49^{c}	21.68^{bc}
NZW x DUT	15.32^{bc}	16.89^{b}	18.37^{b}	18.84^{b}	20.15^{c}	21.41^{c}
CHIN x DUT	15.38^{b}	17.15^{b}	18.50^{b}	19.45^{b}	20.74^{bc}	21.92^{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

Table 3: Mean heart girth (cm) for the different genotypes of rabbits (3-8 weeks)

	Week					
Genotypes	3	4	5	6	7	8
NZW x NZW	11.71^{b}	12.22^{bc}	13.09^{b}	13.87^{b}	14.13^{b}	14.93^{ab}
CHIN x CHIN	13.42^{a}	14.12^{a}	15.00^{a}	15.62^{a}	15.80^{a}	15.77^{a}
DUT x DUT	12.71^{ab}	13.38^{ab}	13.44^{b}	13.08^{b}	13.93^{b}	13.86^{bc}
NZW x CHIN	11.44^{b}	11.99^{c}	12.60^{b}	13.46^{b}	13.79^{b}	14.09^{bc}
NZW x DUT	11.44^{b}	11.87^{c}	12.63^{b}	12.39^{b}	13.16^{b}	13.67^{b}
CHIN x DUT	11.38^{b}	11.94^{c}	12.53^{b}	13.77^{b}	13.01^{b}	13.46^{c}

$^{a-c}$ Means with different superscripts within the same column are significantly different ($P < 0.05$); NZW: New Zealand White, CHIN: Chinchilla, DUT: Dutch

Table 4: Mean shoulder-to-tail drop (cm) for the different genotypes of rabbits (3-8 weeks)

	Week					
Genotype	3	4	5	6	7	8
NZW x NZW	19.61^{b}	21.76^{b}	23.79^{b}	25.27^{b}	27.73^{b}	29.20^{b}
CHIN x CHIN	21.57^{a}	23.86^{a}	26.42^{a}	28.04^{a}	29.99^{a}	31.91^{a}
DUT x DUT	18.63^{b}	20.81^{b}	23.04^{b}	24.13^{b}	25.80^{bc}	27.39^{b}
NZW x CHIN	18.15^{b}	20.36^{b}	22.55^{b}	24.49^{b}	26.05^{bc}	27.40^{b}
NZW x DUT	18.23^{b}	20.49^{b}	22.48^{b}	23.50^{b}	25.90^{bc}	27.05^{b}
CHIN x DUT	18.05^{b}	20.58^{b}	22.26^{b}	23.68^{b}	25.28^{c}	27.09^{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 length of hind limb (cm) for the different genotypes of rabbits (3 – 8 weeks)

	Week					
Genotype	3	4	5	6	7	8
NZW x NZW	14.12^{ab}	15.99^{ab}	17.46^{b}	19.20^{ab}	20.42^{ab}	21.05^{b}
CHIN x CHIN	14.84^{a}	16.99^{a}	18.97^{a}	20.18^{a}	21.33^{a}	22.45^{a}
DUT x DUT	15.03^{c}	15.15^{bc}	17.12^{b}	18.67^{bc}	19.77^{bc}	20.69^{bc}
NZW x CHIN	12.67^{c}	14.55^{c}	16.43^{b}	17.69^{c}	18.84^{c}	19.82^{bc}
NZW x DUT	13.56^{bc}	15.15^{bc}	16.87^{bc}	17.68^{b}	18.64^{c}	19.45^{c}
CHIN x DUT	13.03^{c}	15.11^{bc}	16.74^{b}	17.74^{c}	18.65^{c}	19.78^{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

Table 6: Mean ear length (cm) for the different genotypes of rabbits (3 – 8 weeks)

	Week					
Genotype	3	4	5	6	7	8
NZW x NZW	6.14^{ab}	6.94^{b}	8.10^{b}	8.65^{b}	9.07^{b}	9.41^{b}
CHIN x CHIN	6.54^{a}	7.72^{a}	8.64^{a}	9.29^{a}	9.82^{a}	10.29^{a}
DUT x DUT	5.68^{bc}	6.79^{b}	7.63^{b}	8.22^{bc}	8.73^{bc}	9.22^{b}
NZW x CHIN	5.61^{c}	6.71^{b}	7.60^{b}	8.23^{bc}	8.77^{bc}	9.23^{b}
NZW x DUT	5.35^{c}	6.59^{b}	7.54^{b}	8.09^{c}	8.61^{bc}	8.94^{b}
CHIN x DUT	5.45^{c}	6.56^{b}	7.48^{b}	8.10^{c}	8.51^{c}	8.99^{b}

$^{a-c}$ Means with different superscript within the same columns are significantly different (P < 0.05); NZW: New Zealand White, CHIN: Chinchilla, DUT: Dutch

Table 7. Mean height at withers (cm) for the different genotypes of rabbits (3 – 8 weeks)

	Week					
Genotype	3	4	5	6	7	8
NZW x NZW	3.13^{c}	4.00	4.94^{b}	5.55^{ab}	5.96^{b}	6.48
CHIN x CHIN	4.25^{a}	4.91	5.40^{a}	5.97^{a}	6.61^{a}	7.15
DUT x DUT	3.20^{bc}	3.78	4.53^{bc}	5.21^{bc}	5.81^{bc}	6.35
NZW x CHIN	3.58^{b}	4.39	4.91^{b}	5.30^{bc}	5.83^{bc}	6.49
NZW x DUT	3.21^{bc}	3.94	4.63^{bc}	4.98^{c}	5.66^{bc}	6.36
CHIN x DUT	2.94^{c}	3.71	4.39^{c}	4.97^{c}	5.43^{c}	5.93

$^{a-c}$ Means with different superscripts within the same column are significantly different (P < 0.05); NZW: New Zealand White, CHIN: Chinchilla, DUT: Dutch

Mean values of shoulder-to-tail (ST) for the six genotypes are given in Table 4. There was a significant (P < 0.05) effect of genotype in all the weeks. Purebred CHIN x CHIN had significantly (P < 0.05) higher ST values with a range of 21.57 – 31.91 cm, whereas CHIN x DUT had the least values (18.05 – 27.09 cm). There were no significant differences in growth traits among NZW x NZW, DUT x DUT and the crossbreds - NZW x CHIN, NZW x DUT and CHIN x DUT for the periods measured.

Table 5 shows means of lengths of the hind limb (LHL). Similar trend with BW, BL, HG and STD was observed. CHIN x CHIN progeny had significantly (P < 0.05) longer hind limbs compared to the other genotypes. However, differences between CHIN x CHIN and NZW x NZW in weeks 3, 4, 6 and 7 were not significant. Again, differences in LHL among the three crossbreds were not significant (P > 0.05).

Table 6 indicates means of ear lengths (EL) of the genotypes. Ears of CHIN x CHIN were significantly longer (P < 0.05) compared to those of other genotypes. However, the ears of NZW x NZW did not differ significantly from those of CHIN x CHIN in weeks 3 and 5. Purebred DUT x DUT and all the crossbreds showed comparative ear growth throughout the experimental period.

With the exception of weeks 4 and 8, there existed significant differences (P < 0.05) among the genotypes for height at withers (Table 7). In all the weeks in which there were significant differences, purebred CHIN x CHIN showed the highest value for height at withers (HTW) followed by NZW x NZW. Purebred DUT x DUT and the crossbreds were again not significantly different (P > 0.05) in HTW measurement for all the weeks.

DISCUSSION

In generally, the results show that CHIN x CHIN genotype was superior compared to the other genotypes in pre-weaning growth performance, followed by NZW x NZW. This corroborates the results of Chineke *et al*. [10] who reported superior performance of NZW x NZW over others, including CHIN x CHIN in body weight and all linear body parameters studied. Prayaga and Eady [11] reported significantly better individual weight performance of New Zealand White and Flemish Giant purebred over Californian crossbreds. However, the observed superiority of purebreds over crossbreds in this study is contrary to the observations of Odubote and Somade [12] and Chineke *et al*. [13] that pre-weaning growth characteristics of crossbred rabbits were significantly higher than those of purebreds. These authors attributed the higher performance of crossbreds to heterosis, indicative of preponderance of non-additive genes for these growth traits.The observed superiority of purebreds over crossbreds in our study may be due to the low number of genotypes used. On the other hand, it could suggest a preponderance of additive genes for the pre-weaning growth traits since no selection had been carried out in the population from which the experimental animals were taken. With this, the genetic relationship among these populations in terms of these growth traits could be studied.

Lukefahr [14] observed that growth parameters are highly heritable traits, suggesting that differences among different genotypes are expected and selection based on individual performance could successfully improve these traits. Factors causing variation in growth rate of rabbits have been reported to include breed and nutrition [15]. Dutch is a small breed [16] compared to Chinchilla and New Zealand White. Thus, breed might have accounted for the differences in body weight and linear body traits observed among the purebred genotypes, CHIN x CHIN, NZW x NZW and DUT x DUT. The New Zealand White rabbit has been noted as a dam breed based on its outstanding maternal genetic merits for litter size, milking and general maternal ability [2, 17]. Okorie [18] earlier reported that Chinchilla breed of rabbit is characterized by fast growth rate and good mothering ability and is, therefore, used extensively for breeding. The implication of this is that Chinchilla and New Zealand White breeds of rabbit have high milk yielding capacity for maintenance of their kits and the genetic potential to transmit desirable genes for fast growth rate. This is important in making fast genetic progress when considering growth traits.

In conclusion, from this study, the performance of Chinchilla is better compared to the other genotypes in terms of pre-weaning growth traits, followed by New Zealand White. Therefore, the two genotypes could be considered as choice genotypes for improvement of pre-weaning growth traits of rabbits in this region. The improvement and sustainability of rabbit production in this part of Nigeria will depend on how best selection is made as regards choice of genotypes and how well the breeding programme is planned. Breeders need to exploit the preponderance of additive genes in the rabbit population to bring about improvement in the growth traits. The impact on the animal protein production and consumption of the citizenry will justify the effort. However, further investigation is required for this study with larger numbers of rabbits. With larger mating population and possibly higher parities and resulting progeny, it can be argued that more significance could be found.

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