Nigerian J. Anim. Sci. 2018, 20 (1): 17-25

Influence of genotype on post-weaning growth performance of domestic rabbits

***[1]Mallam, I., [1]Kabir, M., [2]Nwagu, B.I., [2]Achi, N.P., [1]Achi, J.N., [2]Alao, R.O and [1]John, P.A.**

[1]Department of Animal Science, Ahmadu Bello University, Zaria.
[2]National Animal Production Research Institute/Ahmadu Bello University, Shika-Zaria.

***Corresponding Author:** mallamiliya2011@gmail.com. Phone no. +2348188146452*

***Target Audience:** Animal breeders/Scientists, Rabbit farmers.*

Abstract

Data on 48 weaned New Zealand White (NZ), Chinchilla (CH) and Dutch (DU) breeds of rabbits and their crosses obtained from 6 to 14 weeks were used for this study. The genotypes were New Zealand White × New Zealand White (NZ×NZ), Chinchilla×Chinchilla (CH×CH), Dutch×Dutch (DU×DU), New Zealand White × Chinchilla (NZ×CH), New Zealand White × Dutch (NZ×DU) and Chinchilla × Dutch (CH×DU). Traits studied were body weight (BW), body length (BL), chest girth (CG), head-to-shoulder (HS), shoulder-to-tail drop (ST), length of hind leg (LHL), ear length (EL) and, height at withers (HTW). There were significant (P<0.05) differences among the genotypes at different ages. CH×CH was superior over other genotypes for most of the post-weaning growth traits studied at different ages (480.0g, 650.0g, 941.3g, 1206.0g and 1401.8g mean body weights at week 6, 8, 10, 12 and 14, respectively). This was followed by CH×DU (476.3g, 601.3g, 751.0g, 910.0g and 1086.3g for the same parameters. The results indicated that CH×CH and CH×DU genotypes could be most suitable for optimum genetic improvement. It can be concluded that CH×CH genotype performed better in most of the post-weaning growth traits. Therefore, CH×CH is recommended for higher body weight and linear body measurement after weaning.

Keywords: *Genotype, Post-weaning, Growth performance, Domestic rabbits*

Description of Problem

Variations exist in the growth performance of different breeds of rabbit. These variations are attributed to genetic and environ-mental factors. Environmental variations result from managerial, climatic and nutritional factors. Ibe and Nwakalor (1) indicated that body weight and conformation traits are highly heritable traits. This suggests that differences are expected among different genotypes. Several genetic factors such as breed, litter size, weaning age and sex as well as non-genetic factors such as diseases, season and temperature, housing and feeding have been noted to influence post-weaning growth performance of rabbits (2). The productivity of an animal is therefore, largely determined by the interaction between genotype and environment (3). Post-weaning growth is important in the economics of rabbit production, since it influences the rate of attainment of market weight. Kabir *et al*. (4) reported that New Zealand White rabbit were superior for litter size at birth and at weaning, but Chinchilla breed is the best for individual weight at birth and at weaning as well as milk yield and mothering ability. Body weight and body measurements are good

indicators of growth performance in domestic animals including rabbits. Body weight and body measurements are used to characterize rabbit breeds, contrast variation in size and shape (5) and estimate carcass and body weight (6). Rabbits need less space and feed due to small body size, shorter generation interval, high prolificacy, faster growth and high feed conversion efficiency which are characteristics that makes it a suitable meat producer (7, 8). These qualities make rabbit production a panacea to animal protein deficiency in developing countries (9).

Selection of genotypes that can thrive well is thus necessary for sustainable production. This study was therefore aimed at evaluating the influence of genotypes on post-weaning growth performance of domestic rabbits.

Material and Methods

Description of Experimental Site

The study was conducted at the Skills Acquisition and Entrepreneurship Development Centre of National Agricultural Extension Research and Liaison Services (NAERLS), Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Zaria is located within the Northern Guinea Savannah Zone of Nigeria between latitude 11^0 33' N and longitude 12^0 33'E. The Annual rainfall of Zaria ranges from 1102mm to 1904m per annum which last from May to Mid-October. The mean temperature fluctuates from 31^0C maximum during the dry season to 18^0C minimum during the wet season. The relative humidity during the dry and wet season was 21% and 72% respectively (10).

Experimental Rabbits and Management

A total of 48 weaned rabbits from 6 different genotypes (New Zealand White × New Zealand White, Chinchilla × Chinchilla, Dutch×Dutch, New Zealand White × Chinchilla, New Zealand White × Dutch and Chinchilla × Dutch) were randomly selected and used for the experiment. The stock, from which the 8 experimental rabbits per genotype were randomly selected, comprised of 66 weaned rabbits. The experimental rabbits were fed concentrate ration (16% crude protein and 2504Kcals/kg metabolizable energy) and forage legume. Forage legume (*Digitaria smutssi*) was chopped and mixed with the formulated feed before feeding. The rabbits were housed in individual row cages made of metal and wire-gauze of $60\times44\times50cm^3$. Routine management operations such as regular cleaning and disinfection of pens, cages, feeders and drinkers were carried out throughout the research period.

Traits Measured

The traits measured were body weights (BW) and linear body measurements (LBMs) namely body length (BL), chest girth (CG), head-to-shoulder (HS), shoulder-to-tail (ST), length of hind limb (LHL), ear length (EL) and, height at withers (HTW). Body weight was taken in grams using a weighing scale (Dimensions: 56 x 47 x 37cm, Model Number: KFC, Manufacturer: Yongkang Huaying Weighing Apparatus Company limited, China) and height at withers with a ruler in centimeters. Measurements were done on a bi-weekly basis for 5 weeks (6, 8, 10, 12 and 14 weeks). All the traits, with the exception of body weight and height at withers were measured using measuring tape in centimeters as described below.

The anatomical reference points were in accordance with the standard zoometrical procedures (11, 12).

Body length (BL): Distance from the points of shoulder to points of hip or first thoracic vertebrae to base of tail or hip bone (cm).

Chest girth (CG): This refers to the body circumference and was measured just behind the forelegs using a measuring tape (cm).

Head to shoulder (HS): Is the distance from nose to the point of the shoulder (cm)

Shoulder-to-tail-Drop (ST): This is the distance from the point of the shoulder to the pin bone otherwise called (Coccygeal vertebrae) and was measured using a measuring tape (cm)

Length of Hind Limb (LHL): Hind limb is a posterior **limb** of an animal. The term hind leg is often instead used. This is the distance from the base of the hind leg to the tip or feet of the hind leg (cm)

Ear length (EL): Measured from the ear base to the zygomatic arch of the ear (cm)

Height at withers (HTW): Vertical distance from ground to the point of withers measured vertically from the ridge between the shoulder bones to the fore feet. This was taken using a graduated measuring ruler in centimeters (cm).

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of (13). Significant means were separated using Duncan Multiple Range Test (14) modeled in (13) statistical package.

The statistical model considered was:

$Y_{ij}=\mu+G_i+e_{ij}$

Where:

Y_{ijk}= Single observation on the i^{th} genotype.

μ=Overall mean

G_i=Fixed effect of the i^{th} genotype, i= (1, 2, 3…6)

e_{ij} =Random error =NiiD(0, σ^2), independently and identically normally distributed with zero mean and constant variance.

Results and Discussion

The least square means of growth traits of different genotypes of rabbits at 6 weeks of age:

The least square means of growth traits for the different genotypes of rabbits at 6 weeks of age is presented in Table 1.Genotype affected ($P<0.05$) body weight and linear body measurements of rabbits. Chinchilla×Chinchilla had the highest body weight (480.0±12.31g), body length (20.83±0.41cm), length of hind leg (18.82±0.40cm), ear length (8.30±0.16cm) and shoulder-to-tail (28.0±0.47cm). New Zealand White×Dutch had the highest value for height at withers (8.53±0.19cm). Dutch × Dutch gave higher value for chest girth (13.85±0.29cm); CH×DU had the highest value for head-to-shoulder (12.65±0.19cm). New Zealand White × New Zealand White had the lowest values for body weight (322.5±12.21g), chest girth (11.75±0.21cm) and ear length (6.75±0.14cm) while CH×CH had the lowest value for height at wither (6.73±0.13cm); NZ×CH had the least value for body length (18.23±0.40cm). The results show that CHxCH genotype was superior compared to the other genotypes in most of the growth traits measured at 6 weeks of age. The observed differences could be due to the fact that growth parameters are highly heritable traits suggesting that the differences among different genotypes are expected and selection based on individual or genotype performance could successfully improve these traits. This finding also agrees with the report of (15) who stated that the

growth rate and development in rabbit is breed dependent. The findings is similar and agrees with the report of (16) who reported that the mean body weight and some linear body measurements of CHxCH (546.0g) at 6 weeks was higher than those for NZxNZ (476.92g), DUxDU (390.0g), NZxCH (394.0), NZxDU (348.57g) and CHxDU (361.25). The mean values obtained in this study for BW at week 6 for NZxCH (420.0±12.31g), NZxDU (445.0±12.18g) and CHxDU (476.3±12.25g) were higher than the values reported by (16) and this could be that the rabbits used in this study have high reproductive potentials and fast growth rate compared to the rabbits used by the authors. (17) Suggested that heavy weaning weight is important and it could lead to attainment of market weight at an early age. The mean linear body measurements obtained was generally lower than the values reported by (17). The reason could be due to variation in the genetic and environmental factors such as climate, temperature, disease, nutrition, which are known to affect the performance of rabbits.

The least square means of growth traits of different genotypes of rabbits at 8 weeks of age:

The least square means of growth traits for the different genotypes of rabbits at 8 weeks is presented in Table 2. The Chinchilla × Chinchilla had higher value ($P<0.05$) for body weight (650.0±17.03g), head-to-shoulder (13.33±0.20cm), length of hind leg (20.33±0.26cm), ear length (9.25±0.08cm) and shoulder-to-tail (31.25±0.71cm) at 8 weeks of age while New Zealand White×Dutch had the highest mean body length (23.24±0.46cm), followed by CH×CH (22.9±0.46cm). New Zealand White×Dutch had the highest value for chest girth (15.8±0.17cm) followed by CH×DU (15.35±0.14cm). Height at wither (8.45±0.10cm) for Chinchilla×Dutch was higher compare to other genotypes and the Dutch×Dutch had the lowest body weight (470.0±16.98g) followed by NZ×NZ (475.0±17.00g). New Zealand White × New Zealand White had the lowest value for chest girth (13.63±0.14cm), head-to-shoulder (10.78±0.14cm) ear length (7.70±0.05cm) and shoulder-to-tail (27.23±0.66 cm).

There was significant ($P<0.05$) difference in body weight and linear body measurements among all the genotypes. This implies that genotype had influence on growth traits of rabbit at week 8.Chinchilla x Chinchilla showed superiority over other genotypes for five growth traits (BW, HS, LHL, EL and ST), followed by NZ x DU for two traits (BL and HG). This could be because Chinchilla is a hardy breed adapting easily to new environments and is characterized by fast growth rate, efficient feed conversion rate and it has a genetic potential for increased body weight gain (18). The implication of the result is that the CHxCH proved the best in terms of having the highest preponderance of genes, which additively impact on growth traits. This agreed with the findings of (19) who reported that the CHxCH breed could possibly increase growth performance because of their higher general combining ability (GCA). The body weight (650.0±17.03g) for CHxCH at 8 weeks of age obtained is lower than the values reported by (16) and (19) and this could be due to environmental and genetic differences which affect rabbit's growth. For instance, the body weight for CHxCH reported by (16) was 741.0g while the body weight

reported for NZxNZ by (19) was 770.61±14.84g but the BL (22.90cm) and EL (9.25cm) obtained for CHxCH was higher than the value reported by (19). The value for ST, HTW for all the genotypes are within the range reported by (16).

The least square means of growth traits of different genotypes of rabbits at 10 weeks of age:

The least square means of growth traits for the different genotypes of rabbits at 10 weeks is shown in Table 3. At 10 weeks of age, Chinchilla × Chinchilla had higher mean body weight (941.3±19.17g), length of hind leg (22.33±0.40cm), height at wither (10.58±0.06cm), ear length (9.73±0.10cm) and shoulder-to-tail (33.58±0.58cm) while the New Zealand White × New Zealand White had the least values for chest girth, head-to-shoulder and ear length (14.6±0.08cm, 11.63±0.40cm and 8.03±0.04cm) respectively. The Dutch×Dutch had the least mean body weight (552.5±18.68g) and body length (22.38±0.21cm) and it had the second lowest mean value for ear length (8.53±0.06cm) and shoulder-to-tail (29.35±0.49cm). New Zealand White × Chinchilla had the second lowest mean value for chest girth (14.75±0.06cm) while NZ×DU had the highest head-to-shoulder length (18.80 ± 0.59cm) and second to the highest length of hind leg (21.05±0.39cm) and CH×DU had the highest body length (22.4±0.20cm).

At 10 weeks of age Chinchilla x Chinchilla still maintained superiority for most of the growth traits over other genotypes. This can be attributed to the greater heritable traits in growth parameters of CH ×CH breed as reported by (20). This could also be that CHxCH breed of rabbit have high milk yielding capacity for maintenance of their kits and the genetic potential of transmitting desirable genes for fast growth rate (4). Body weight at week 10 for NZxNZ (565.00 ±18.88g) and CHxCH (941.3±19.17g) were lower than the value reported by (19). The variation could be as a result of non-genetic factors such as diseases, season, temperature, housing, feeding which have been noted to influence post-weaning growth performance of rabbits (2). But EL, BL, CG values were within the range reported by (21) at 10 weeks of age.

The least square means of growth traits of different genotypes of rabbits at 12 weeks of age:

The mean of growth traits for the different genotypes of rabbits at 12 weeks is presented in Table 4. In all the growth traits measured at week 12 for all the genotypes, CHxCH had higher values than other genotypes except for CG (19.05±0.27cm) in NZxDU, which is higher than the value obtained in CHxCH (17.88±0.22cm). This could be because CHxCH had the ability to transmit favourable genes for improved growth rate compared to the other genotypes (NZxNZ, DUxDU, NZxCH, NZxDU and CHxDU).The body weight obtained at week 12 for CHxCH (1206.0 ± 23.03g), NZxCH (884.0 ± 22.75g) and CHxDU (910.0 ± 22.91g) are higher than the values reported by (23). These differences can be attributed to breed and environmental factors.

The observed differences agreed with the report of (15*)* who stated that growth rate and development in rabbit is breed dependent. This could be because CHxCH had the ability to transmit favorable genes for improved growth rate compared to the

other genotypes (NZxNZ, DUxDU, NZxCH, NZxDU and CHxDU).

The least square means of growth traits of different genotypes of rabbits at 14 weeks of age:

The least square means of growth traits for the different genotypes of rabbits at 14 is reported in Tables 5. Chinchilla × Chinchilla was found to have higher mean body weight (1401.75 ± 27.70g), body length (28.63 ± 0.34cm), head-to-shoulder length (16.2 ± 0.13cm), length of hind leg (25.55 ± 0.21cm), height at wither (11.4 ± 0.21cm), ear length (11.35 ± 0.13cm), shoulder-to-tail Drop (42.13 ± 0.50cm) except for chest girth (17.68 ± 0.19cm). Chinchilla × Dutch had the second highest in terms of body weight (1086.25 ± 27g) and chest girth (17.85 ± 0.18cm). The least mean body weight (870.00 ± 26.32g) and chest girth (16.28 ± 0.17cm) were found in Dutch × Dutch. Genotypes had significant ($P<0.05$) effect on the mean growth traits of rabbits at 14 weeks of age. This implies that growth rate and development is breed dependent (15). The body weight of all the genotype ranged between (870.0±26.32 g-1401.75±27.7g). The results obtained for CHxCH consistently showed superiority in terms of body weight (1401.75±27.7g) and most of the linear body measurements measured at 14 week of age, which means CH breed had a genetic potential for increased body weight gain at all ages. Therefore, genetic improvement of these growth traits by individual selection method will be successful. Body weight of CHxCH (1401.75 ± 27.7g) was higher followed by CHxDU (1086.25 ± 27.7g), NZxDU (1048.75 ± 27.7g), NZxCH (1031.25 ± 27.59g), NZxNZ (942.50 ± 26.84g) while the least was obtained in DUxDU (870.00 ± 26.32g). This variation in genotype for growth traits was also reported by (23).

Conclusion and Applications

1. The Chinchilla x Chinchilla maintained its superiority in terms of body weight and most of the linear body measurements studied from 6 to 14 weeks of age. The body weights obtained were 480.0 ± 12.31g, 650.0±17.03g, 941.30 ± 19.17g, and 1206.0 ± 23.03g and 1401.75 ± 27.7g at week 6, 8, 10, 12 and 14 respectively, which is higher than the values obtained for the other genotypes at those ages.
2. Chinchilla x Chinchilla genotype is the best for selection and breeding/ production purposes aimed at improving post-weaning growth traits rabbits in the

Table 1. Least square means of growth traits for the different genotypes of rabbits at 6 weeks of age

GENOTYPE	GROWTH TRAIT							
	BW(g)	BL(cm)	CG(cm)	HS(cm)	LHL(cm)	HTW	EL	ST
NZxNZ	322.5±12.21^{c}	18.65±.0.31^{bc}	11.75±0.21^{b}	8.33±0.15^{c}	16.8±0.37^{bc}	7.35±0.16^{c}	6.75±0.14^{d}	22.45±0.44^{c}
CHxCH	480.0±12.31^{a}	20.83±0.41^{a}	13.53±0.26a	12.48±0.18^{a}	18.82±0.40^{a}	6.73±0.13^{d}	8.30±0.16^{a}	28.0±0.47^{a}
DUxDU	351.3±11.20^{c}	19.55±0.37^{b}	13.85±0.29^{a}	8.13±0.15^{b}	17.58±0.39^{b}	7.93±0.18^{b}	7.30±0.14^{c}	25.38±0.43^{b}
NZxCH	420.0±12.22^{b}	18.23±0.40^{c}	13.75±0.25^{a}	10.48±0.17^{c}	16.93±0.37^{bc}	7.45±0.14^{bc}	7.13±0.13^{cd}	24.75±0.43^{b}
NZxDU	445.0±12.18^{ab}	19.08±0.41^{bc}	13.25±0.23^{a}	7.85±0.14^{c}	16.18±0.29^{c}	8.53±0.19^{a}	7.05±0.13^{cd}	22.43±0.42^{c}
CHxDU	476.3±12.25^{a}	18.58±0.40^{bc}	13.75±0.21^{a}	12.65±0.19^{a}	16.5±0.36^{bc}	7.73±0.16^{bc}	7.88±0.15^{b}	25.53±0.44^{b}

^{abc} Means within the same column having the same letter are not significantly($P>0.05$) different. CH =Chinchilla, NZ= New Zealand White, DU= Dutch, BW=Body weight, BL= Body length, CG= chest girth, HS= Head-to-shoulder, LHL= Length of hind leg, HTW=Height at wither, EL= Ear length, ST=Shoulder-to-tail-drop.

Table 2. Least square means (± SE)of growth traits for the different genotypes of rabbits at 8 weeks of age

GENOTYPE	GROWTH TRAIT							
	BW(g)	BL(cm)	CG(cm)	HS(cm)	LHL(cm)	HTW(cm)	EL(cm)	ST(cm)
NZxNZ	475.0±17.00^{d}	21.98±0.45^{ab}	13.63±0.14^{d}	10.78±0.14^{c}	18.1±0.24^{c}	7.38±0.05^{b}	7.70±0.05^{d}	27.23±0.66^{bc}
CHxCH	650.0±17.03^{a}	22.9±0.46^{ab}	13.9±0.15^{cd}	13.33±0.20^{a}	20.33±0.26^{a}	8.18±0.07^{ab}	9.25±0.08^{a}	31.25±0.71^{a}
DuxDU	470.0±16.98^{d}	21.53±0.43^{bc}	13.8±0.15^{d}	11.3±0.18^{c}	19.75±0.25^{ab}	8.43±0.09^{a}	8.18±0.07^{c}	27.88±0.61^{bc}
NZxCH	585.0±17.13^{bc}	22.0±0.45^{ab}	14.3±0.16^{c}	11.98±0.19^{b}	19.5±0.25^{b}	8.43±0.09^{a}	8.00±0.07^{c}	28.48±0.70^{b}
NZxDU	537.5±17.02^{c}	23.24±0.46^{a}	15.8±0.17^{a}	10.9±0.17^{c}	19.9±0.26^{ab}	8.20±0.06^{ab}	8.15±0.07^{c}	27.35±0.69^{bc}
CHxDU	601.3±17.14^{b}	20.48±0.39^{c}	15.35±0.14^{b}	13.28±0.20^{a}	17.53±0.24^{c}	8.45±0.10^{a}	8.40±0.08^{b}	29.33±0.81^{b}

^{abc} Means within the same column having the same letter are not significantly(P>0.05) different. CH =Chinchilla, NZ= New Zealand White, DU= Dutch, BW=Body weight, BL= Body length, CG= chest girth, HS= Head-to-shoulder, LHL= Length of hind leg, HTW=Height at wither, EL= Ear length, ST=Shoulder-to-tail-drop.

Table 3. Least square means (± SE) of growth traits for the different genotypes of rabbits at 10 weeks of age

GENOTYPE	GROWTH TRAIT							
	BW(g)	BL(cm)	CG(cm)	HS(cm)	LHL(cm)	HTW(cm)	EL(cm)	ST(cm)
NZ×NZ	565.0±18.88^{d}	23.45±0.21^{b}	14.6±0.08^{d}	11.63±0.40^{c}	20.10±0.22^{c}	8.88±0.02^{bc}	8.03±0.04^{d}	29.43±0.50^{c}
CH×CH	941.3±19.17^{a}	24.23±0.23^{a}	16.7±0.09^{ab}	14.13±0.48^{b}	22.33±0.40^{a}	10.6±0.06^{a}	9.73±0.10^{a}	33.58±0.53^{a}
DU×DU	552.5±18.68^{d}	22.38±0.21^{c}	15.45±0.06^{c}	12.7±0.55^{bc}	20.90±0.25^{b}	8.93±0.04^{bc}	8.53±0.06^{c}	29.35±0.49^{c}
NZ×CH	703.8±18.90^{bc}	23.98±0.22^{ab}	14.75±0.06^{d}	12.8±0.56^{bc}	20.7±0.24^{bc}	8.98±0.05^{bc}	8.63±0.05^{bc}	31.6±0.52^{b}
NZ×DU	670.0±18.78^{c}	24.43±0.24^{a}	16.42±0.07^{a}	18.8±0.59^{a}	21.05±0.39^{b}	8.88±0.03^{bc}	8.73±0.09^{bc}	30.7±0.50^{bc}
CH×DU	751.3±19.00^{b}	22.4±0.20^{c}	16.7±0.09^{b}	13.53±0.46^{b}	19.2±0.23^{d}	9.00±0.05^{b}	8.83±0.09^{b}	31.95±0.53^{b}

^{abc} Means within the same column having the same letter are not significantly(P>0.05) different. CH =Chinchilla, NZ= New Zealand White, DU= Dutch, BW=Body weight, BL= Body length, CG= chest girth, HS= Head-to-shoulder, LHL= Length of hind leg, HTW=Height at wither, EL= Ear length, ST=Shoulder-to-tail drop.

Table 4. Least square means (± SE) of growth traits for the different genotypes of rabbits at 12 weeks of age

GENOTYPE	GROWTH TRAIT							
	BW(g)	BL(cm)	CG(cm)	HS(cm)	LHL(cm)	HTW(cm)	EL(cm)	ST(cm)
NZxNZ	738.0±22.52^{c}	25.73±0.20^{c}	16.53±0.23^{c}	12.73±0.11^{d}	20.60±0.20^{d}	8.68±0.06^{f}	8.58±0.06^{d}	32.33±0.43^{d}
CHxCH	1206.0±23.03^{a}	27.8±.025^{a}	17.88±0.22^{b}	15.98±0.15^{a}	25.03±0.28^{a}	11.15±0.09^{a}	11.03±0.09^{a}	40.48±0.50^{a}
DuxDU	725.0±22.50^{c}	23.18±0.18^{d}	15.65±0.20^{d}	12.83±0.11^{d}	21.4±0.25^{bcd}	9.18±0.07^{d}	8.70±0.07^{d}	31.78±0.39^{e}
NZxCH	884.0±22.70^{b}	25.33±0.22^{c}	15.78±0.20^{d}	13.6±0.11^{c}	21.6±0.26^{bc}	9.55±0.10^{c}	9.15±0.09^{c}	31.78±0.40^{e}
NZxDU	890.0±22.75^{b}	26.38±0.24^{b}	19.05±0.27^{a}	13.95±0.12^{b}	22.25±0.25^{b}	10.18±0.11^{b}	9.65±0.09^{b}	34.03±0.41^{b}
ChxDU	910.0±22.91^{b}	23.43±0.19^{d}	17.12±0.21^{c}	13.83±0.11^{bc}	21.3±0.23^{cd}	9.33±0.09^{c}	9.33±0.07^{c}	33.35±0.40^{c}

^{abc} Means within the same column having the same letter are not significantly(P>0.05) different. CH =Chinchilla, NZ= New Zealand White, DU= Dutch, BW=Body weight, BL= Body length, CG= chest girth, HS= Head-to-shoulder, LHL= Length of hind leg, HTW=Height at wither, EL= Ear length, ST=Shoulder-to-tail drop.

Table 5. Least square means (± SE) of growth traits for the different genotypes of rabbits at 14 weeks of age

GENOTYPE	GROWTH TRAIT							
	BW(g)	BL(cm)	CG(cm)	HS(cm)	LHL(cm)	HTW(cm)	EL(cm)	ST(cm)
NZxNZ	942.5±26.84^{c}	27.15±0.32^{bc}	17.73±0.19^{b}	13.63±0.09^{c}	22.5±0.31^{c}	9.93±0.11^{d}	9.25±0.11^{c}	36.0±0.44^{c}
CHxCH	1401.75±27.70^{a}	28.63±0.34^{a}	17.68±0.19^{b}	16.2±0.13^{a}	25.55±0.21^{a}	11.4±0.21^{a}	11.35±0.13^{a}	42.13±0.50^{a}
DuxDU	870.0±26.32^{c}	25.98±0.32^{d}	16.28±0.17^{c}	13.75±0.13^{c}	23.03±0.30^{bc}	9.38±0.10^{e}	9.05±0.12^{c}	34.1±0.34^{e}
NZxCH	1031.25±27.59^{b}	26.93±0.28^{c}	19.79±0.20^{c}	14.43±0.11^{b}	23.53±0.29^{c}	10.55±0.11^{b}	9.95±0.14^{b}	38.3±0.37^{b}
NZxDU	1048.75±27.60^{b}	27.9±0.32^{ab}	19.79±0.20^{a}	14.43±0.12^{b}	23.53±0.30^{b}	10.55±0.15^{b}	9.95±0.12^{b}	38.3±0.37^{b}
CHxDU	1086.25±27.70^{b}	25.7±0.33^{d}	17.85±0.18^{b}	13.98±0.10^{c}	22.88±0.29^{bc}	10.18±0.13^{c}	9.65±0.14^{b}	35.6±0.35^{d}

^{abc} Means within the same column having the same letter are not significantly(P>0.05) different. CH =Chinchilla, NZ= New Zealand White, DU= Dutch, BW=Body weight, BL= Body length, CG= chest girth, HS= Head-to-shoulder, LHL= Length of hind leg, HTW=Height at wither, EL= Ear length, ST=Shoulder-to-tail drop.

References

1. Ibe, S.N. and. Nwakalor, L.N. (1987). Growth patterns and conformation in broilers: Influence of genotype and management on isometry of growth. *Poultry Science,* 66:1247-1251.
2. Afifi, E.A. and. Emara, M.E. (1988). Post-weaning viability of purebred and crossbred rabbits under Egyptian conditions. *Journal of Applied Rabbit Research,* 1:38-41.
3. Chineke, C.A. and Owosangba, J.O. (1999). Phenotypic correlation among some body physiological characteristics in Yankasa sheep at pre-and post-weaning ages. *In Proceedings of the Nigerian Society for Animal Production (NSAP) 26th Annual Conference,* 21-25 March, 1999, Pp.302-304.
4. Kabir, M., Akpa, G.N., Nwagu, B.I. and Adeyinka, I.A. (2012). Litter traits in a diallel crossing of three Rabbit Breeds in Northern Guinea Savannah Zone of Nigeria. *Proceedings 10th World Rabbit Congress*-September 3-6, 2012-Sharm El-Sheikh-Egypt. Pp.7.
5. Shahin, K.A. and Hassan, N.S. (2000).Sources of shared variability among body shape characters at marketing age in New Zealand White and Egyptian rabbit breeds. *Annual Zootechnology*, 49(5):435–445.
6. Oliveira, M.C., Moura, C.D., Arantes, U.M., Faria, E.B., Lui, J.F. and Caires, D.R. (2005).Body measurements and its coefficient of correlation with the performance index of sexed rabbits slaughtered at different ages. *Proceedings of the 8th World Rabbit Congress,* September 7-10, 2004, Published in 2005, Mexico. Pp.110-113.
7. Orheruata, A.M., Oyedeji, J.O., Omoyakhi, M. and Ofuoma, F. (2006).Post-weaning body morphology to sexual maturity and carcass characteristics of rabbits in the humid rain forest zone of Nigeria. *International Journal of Agricultural and Rural Development,* 7(2):40-47.
8. Kabir M., Akpa G.N, Nwagu B.I. and Adeyinka I.A. (2011).Estimates of Heritability and Repeatability for Litter Traits in Diallel Crossing of Three Rabbit Breeds. *In: Proceedings of 35th Annual Conference of the Genetics Society of Nigeria (GSN),* held at Ahmadu Bello University, Zaria, Nigeria, October. (Eds. S.G. Ado, G.N. Akpa, A.U. Dahiru, S. Muazu, M. Kabir, I.A. Adeyinka, A.K. Adamu and I.S. Usman).16–22.
9. Obike, O. M., Ibe, S.N. and Oke, U.K. (2010).Estimation of pre-and post-weaning bodyweight of rabbits in a humid tropical environment using linear body measurements. *American–Eurasian Journal of Agriculture and Environmental Science,* 9(4):440–444.
10. Meteorological Unit (2009). Institute for Agricultural Research/Ahmadu Bello University, Zaria.
11. Gueye, E.F., Ndiaye, A. and Branckaert, R.D.S. (1998). Prediction of body weight on the basis of body measurements in mature indigenous chickens in Senegal. Livestock Research for Rural Development 10: http:// www. Cipav.org.co/Irrd 10/3/sene103.htm, Retrieved on the 23rd April, 2016.
12. Teguia, A., Ngandjou, H.M., Defang, S. and Tchoumboue, T. (2008). Study

of the live body weight and body characteristics of the African Muscovy Duck (Cairina moschata). *Tropical Animal Health Production,* 40:5-10.

13. SAS Institute, (2004). SAS/STAT User's Guide version 8.2 edition: Statistics, SAS Institute Incorporation, Cary, NC.
14. Duncan, D.B., (1955). Multiple ranges and multiple F-test. *Biometrics*, 11:1-42.
15. Lukefahr, S.D. (1982).Evaluation of Rabbit breeds and crosses for overall commercial productivity. Ph.D. thesis. Oregon State University, Corvallis, USA.
16. Obike, O.M. and Ibe, S.N. (2010).Effect of genotype on pre-weaning growth performance of the domestic rabbit in a humid tropical environment. *Journal of Global Veterinaria,*4(4):388-393.
17. McNitt, J.I., and Lukefahr, S.D. (1993). Breed and environmental effects on post weaning growth of rabbit. *Journal of Animal Science,* 71:8.
18. Okorie, J.U. (1983).*A Guide to livestock production in Nigeria*. Macmillan Education limited: 148-160.
19. Kabir, M. (2010). Assessment of growth and reproductive traits in diallel crossing of three rabbit breeds. PhD. Dissertation, Faculty of Agriculture, Animal Science Department, Ahmadu Bello University, Zaria: 5-137.
20. Lukefahr, S.D. (1987). Progressive genetic applications for improved commercial production efficiency in the rabbit industry. *In proceedings of the 1987 1st North American Rabbit Congress,* Portland, Oregon.
21. Chiericato, G.M., Rizzi, C., Boiti, C. and Canali, C. (2001). A study on the effect of feeding restriction on the plasma hormonal response of Grimaud prepubertal does. *Rivistadi Coniglicoltura*, 38(2):37-40
22. Lang, J. (1981). The nutrition of the commercial rabbit. Part 2: Feeding and general aspects of nutrition. *Nutrition Abstract and Review, Series B*.51 (5):287-297.
23. Onyiro, O.M., Ibe S.N. and, Anigbogu N.M. (2008**).** Influence of genotype x environment interaction on post-weaning growth performance of the domestic rabbits. *Research Journal of Agriculture and Biological Science,* 4(6):676-684.