INFLUENCE OF GENOTYPE ON BODY WEIGHT AND MORPHOMETRIC TRAITS OF RABBITS RAISED IN THE TROPICS

SAM, Idorenyin Meme, UKPANAH, Unwana Anietie and UDOFIA, Itoro Etim
Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State, Nigeria.

Corresponding Author: Sam, I. M. Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State, Nigeria. **Email:** sidorenyin@yahoo.com **Phone:** +234 8029004857

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ABSTRACT

Two breeds of rabbits New Zealand white (NZW) and Chinchilla (CHA) were crossbred to produce both pure and crossbred genotypes. Four genotypes NZW x NZW, CHA x CHA, NZW x CHA and CHA x NZW were generated to obtain one hundred and twenty (126) kittens, examined for the influence of genotypes on body weight and morphometric traits performance. Body weight an d morphometric traits were measured early in the morning at weeks 2, 4, 6, 8 and 10. The traits measured were body weight (BWT), body width (BWD), Neck length (NL), leg length (LL), ear length (EL), body length (BL), heart girth (HG), shoulder to tail (ST) and thigh length (TL). The data obtained were subjected to analysis of variance and phenotypic correlations between body weight and morphometric traits as well as among morphometric traits were estimated. The results indicated that genotype had significant (p<0.05) influence on body weight and other morphometric traits measured with cross bred NZW x CHA genotype showing superiority in body weight and other morphometric traits than other genotype studied at all ages. Positive high (p<0.001) and significant (p<0.05) correlations were established among the morphometric traits measured, and between BWT with other morphometric traits except the relationship with BWD and ST at week 10. It was concluded that NZW x CHA had a significant higher performance in body weight and morphometric traits in the study area and thus should be recommended to farmers to meet protein requirement of individuals in the area of this study.

Keywords: Rabbit, Genotype, Body weight, Morphometric traits

INTRODUCTION

Rabbits possess excellent reproductive and growth potentials and its improvement cannot be overemphasized. This is due to its contribution to the much needed animal protein in developing countries like Nigeria. The knowledge of genetic parameters for economic importance traits is very crucial in genetic improvement in farm animals (Akanno and Ibe, 2006; Okoro *et al*., 2010).

Evaluation of morphometric traits have been used as a tool for examining breed performance based on phenotypic observation (Ibe and Ezekwe, 1994; Ozoje and Herbert, 1997). Estimation of morphometric traits in animals are very vital in estimating genetic parameters in animal breeding programs (Chineke, 2000).

Assessment of morphometric traits have been used to study the effect of crossbreeding as a medium for selecting and replacement of animals (Adewumi *et al.,* 2006). Morphometric traits are excellent factors in meat production prediction since it determines the market value of the animals (Ikeobi and Faleti, 1996).

Breeds such as New Zealand, Dutch and Chinchilla (CHA) remain the most commonly farmed breeds which have peculiar characteristics that distinguish them from one another (RABBITFARM, 2020). Morphometric traits have been used to evaluate breed performance, predict live weight gain and examine reproductive performance as well as correlation among the morphometric parameters with a view to studying the interactions between heredity and the environment in several animals; rabbit (Onasanya *et al.*, 2017), goats (Akpa, 2000; Ozoje and Mgbere, 2002; Sam *et al.*, 2016) and chicken (Monsi, 1992).

Earlier reports by Mallam *et al.* (2018) showed that there were significant differences among different genotypes for post weaning growth performance of rabbits at all ages. The study reported the superiority of CHA x CHA genotype over other genotypes used in the breeding programme. Similarly, Ajayi *et al.* (2018) observed that crossbred rabbits were significantly superior in most post weaning growth parameters measured over the purebreds. Obasi *et al.* (2019) observed significant differences among the genotypes studied (CHA x CHA, New Zealand white (NZW) x NZW, CHA x NZW and NZW x CHA), the crossbred NZW x CHA had significantly better body weight and linear body measurements than the purebreds.

The objective of this study was to examine the influence of genotype on body weight and morphometric traits of two breeds of rabbits and their reciprocal crosses raised in the tropics.

MATERIALS AND METHODS

This experiment was carried out at the Rabbitry Unit of Teaching and Research Farm of Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government. The location lies between latitudes 5^0 17′ N and 7^0 27′ N and longitudes 7^0 30′ E and 7^0 58′ E of the Greenwich Meridian. The climate is typically humid tropical with relative humidity ranging from 56.01 to 103.83 % and an annual rainfall ranging from 1680 mm to 1700 mm with annual temperature ranges of about 22^0C to 37^0C (Wikipedia, 2017).

Experimental Animals and Management: On arrival, the rabbits were allowed to acclimatize for two weeks to the environment before commencing the study. These animals were given Ivomectin injection subcutaneously to treat both external and internal parasites that may affect the reproductive performance of the animals. They were also treated prophylactically (preventive treatment) with Amprolium 200 (Emperium Hydrochloric) for one week against coccidiosis given via drinking water. Multivitamins were also given to the rabbits to boost them up for the study. Every other cares as applicable to international, national and University guidelines for the care and used of animals were followed (SAMRC, 2004).

A total of 40 adult rabbits (New Zealand White, NZW and Chinchilla, CHA) comprising 18 NZW does and 18 CHA x CHA does, 2 NZW bucks and 2 CHA bucks were used. One NZW buck was selected to mate with 9 NZW does and the second NZW buck was selected to mate with 9 CHA does. While one CHA buck was selected to mate with 9 CHA does and the second CHA buck selected to mate with 9 NZW does. At the end of breeding period one hundred and twenty six (126) kittens produced from the crosses comprising of NZW x NZW, CHA x CHA, NZW x CHA and CHA x NZW (Table 1) were used for this study.

Table 1: Mating scheme and number of progeny produced

Genotype	Number of sire	Number of Dam	Number of Progeny
CHA x CHA	1	9	35
NZW x NZW	1	9	27
CHA x NZW	1	9	31
NZW x CHA	1	9	33

Note: CHA = Chinchilla; NZW = New Zealand White

The rabbits were kept in 4 hutches each measuring 170 x 32 cm^2 and consisting of 10 cells, each of which measured 34 x 30 x 28 cm^3

such that one rabbit was accommodated in one cell. Identification marks such as tags were placed on the cell in which each rabbit was accommodated.

All the rabbits in their respective cells were fed with 600 g (300 g each in the morning and evening) of forages such as *Ipomea batata*, *Centrosema* spp. and *Peuraria phaseoloides*. Commercial feed (Hybrid Growers Mash) was also given with drinking water *ad-libitum*. The diet fed to the animals consisted of 18 % CP, 2600 Kcal/kgME and 8 % CF as provided by the manufacturer. Routine management operations were carried out on a daily basis as follows: Every morning before the rabbits were fed, left over forages were discarded before new ones were replaced and each hutch was properly cleaned. Feaces (droppings) were packed and removes, urine were also cleaned off in all hutches. The feeding and drinking troughs were cleaned on a daily bases before fresh water and feed were supplied. Pregnancy was detected by careful abdominal palpation on 14th and 21st days after mating, if confirmed pregnant, nest boxes were provided on 28th day of pregnancy.

Measurement of Morphometric Traits: Sensitive weighing balance (S. Miller Digital Scientific Scale) was used in weighing the animals, while a tailor's tape was used in measuring morphometric traits on biweekly basis. Both weight and body linear measurements were recorded early in the morning before feeding.

The morphometric traits measured were; body weight (BWT), ear length (EL), Neck length (NL), leg length (LL), body and Neck length (BNL), Body length (BL), heart girth (HG), tail length (TL). The measurements were taken according to methods describe by Obasi *et al.* (2019) as given below:

Body and neck length: measuring tape was used to measure the distance from the base of the ear to the base of the tail.

Hearth girth: a circumferential measure was taken round the chest region behind the front legs.

Body width: measurement was when rabbit is held in a resting position from the front leg to the hind leg.

Neck length: measurement was taken from the base of the head to the shoulder.

Leg length: measurement was taken from the base of the tail to the feet.

Ear length: measurement was taken from the tip of the ear to the base of the ear.

Body length: measurement was taken from the base of the shoulder to the base of the tail.

Tail length: measurement was taken from the base of the tail to the end of the tail.

Statistical Analysis: All data collected were subjected to Analysis of Variance (ANOVA) using SPSS package and significant means were separated using Duncan's New Multiple Range Test (Duncan, 1955). The correlation coefficients among the studied traits were obtained. The linear model used was: $Yi_j = \mu + B_i + E_{ij,}$ where Yi_j = measured traits, μ = population mean, B_i = effect of the genetic groups (NZW x NZW, NZW x CHA, CHA x CHA and CHA x NZW) and E_{ij} = random error effect (Kaps and Lamberson, 2004).

RESULTS AND DISCUSSION

The effect of genotype on body weight and morphometric trait of rabbits indicated that there were significant differences (p<0.05) between the genetic groups (CHA x CHA, CHA x NZW, NZW x CHA and NZW x NZW) (Table 2). NZW x CHA was observed to have significantly higher (p<0.05) values in all the morphometric traits measured than the other genetic groups at week 2. At week 4, the same trend was observed except in TL which had no significant differences (p>0.05) between the genetic groups. At week 6, there were no significant differences (p>0.05) observed between the genetic groups in NL, LL, BNL, EL, BL and HG.

Table 2: Effect of genotype on body weight and morphometric traits of rabbit

Age (weeks)	Breed	BWT	BWD	NL	LL	EL	BNL	BL	HG	TL
2	CHA x CHA	136.09±11.72^{a}	13.88±0.46^{a}	6.16±0.16^{a}	4.72±0.10^{a}	4.28±0.14^{a}	16.41±0.55^{a}	10.61±0.45	12.26±0.42^{a}	5.24±0.16^{b}
	NZW x NZW	185.88±4.90^{c}	16.93±0.39^{b}	5.86±0.09^{b}	5.20±0.17^{b}	4.70±0.07^{b}	15.93±0.37^{a}	11.36±0.34	14.66±0.36^{c}	4.60±0.10^{a}
	CHA x NZW	146.30±4.13^{b}	16.23±0.84^{b}	6.69±0.29^{a}	5.57±0.12^{b}	4.56±0.15^{a}	17.48±0.53^{b}	11.85±0.30	13.60±0.54^{b}	5.44±0.19^{b}
	NZW x CHA	178.44±6.28^{d}	16.21±0.38^{b}	7.51±0.12^{c}	5.53±0.15^{b}	4.97±0.15^{b}	19.39±0.46^{c}	11.87±0.38	14.36±0.24^{c}	5.88±0.12^{b}
4	CHA x CHA	338.23±23.15^{b}	21.39±0.60	7.71±0.20^{a}	6.93±0.18	6.80±0.17	23.52±0.52	14.71±0.67^{a}	17.47±0.39^{b}	7.73±0.21
	NZW x NZW	450.66±77.16^{c}	23.00±1.52	8.36±0.13^{b}	7.33±0.16	7.53±0.29	21.66±0.88	20.00±1.73^{c}	16.06±1.03^{a}	7.03±0.29
	CHA x NZW	274.54±10.18^{a}	21.25±0.91	7.41±0.27^{a}	7.09±0.17	6.87±0.29	22.92±0.53	14.58±0.69^{a}	16.40±0.54^{a}	8.29±0.90
	NZW x CHA	492.38±17.15^{d}	21.62±1.31	8.60±0.19^{b}	7.28±1.40	7.16±0.29	23.88±0.83	16.96±0.60^{b}	19.22±0.36^{c}	8.68±0.31
6	CHA x CHA	413.53±25.69^{b}	24.53±0.53^{a}	9.93±0.27	8.22±0.24	8.17±0.18	20.14±2.12^{a}	16.20±0.57	19.02±0.54^{b}	8.50±0.19^{a}
	NZW x NZW	430.62±20.34^{c}	25.42±0.54^{a}	10.64±43	8.42±0.23	8.34±0.20	21.43±3.13^{b}	16.31±0.65	18.95±0.71^{a}	8.62±0.23^{a}
	CHA x NZW	393.16±17.94^{a}	24.75±0.38^{a}	9.70±0.23	8.05±0.13	8.33±0.19	21.75±0.62^{b}	16.60±0.58	18.68±0.33^{a}	8.21±0.94^{a}
	NZW x CHA	580.18±17.73^{d}	27.15±0.44^{b}	11.01±0.51	8.81±0.22	8.78±0.15	24.93±0.42^{c}	17.85±0.36	20.11±0.31^{c}	9.39±0.24^{b}
8	CHA x CHA	678.40±48.60^{b}	25.46±0.85^{a}	10.50±0.29	8.72±0.23	8.36±0.09^{a}	25.30±0.93^{c}	18.60±0.46	19.70±1.00	9.08±0.22
	NZW x NZW	690.45±32.62^{c}	25.64±0.95^{a}	10.31±0.32	8.50±0.32	8.56±0.40^{a}	24.53±0.71^{b}	18.50±0.36	19.81±0.98	9.34±0.32
	CHA x NZW	558.50±4.90^{a}	26.84±0.42^{b}	10.12±0.23	8.77±0.23	9.02±0.22^{b}	23.62±0.82^{a}	17.12±1.06	19.42±0.81	9.12±0.37
	NZW x CHA	724.16±25.96^{d}	27.70±0.42^{b}	11.16±0.29	9.40±0.17	9.15±0.09^{b}	27.31±0.62^{d}	18.86±0.24	20.79±0.47	9.50±0.31
10	CHA x CHA	779.00±39.24^{c}	29.38±1.08	9.82±0.08^{a}	9.12±0.24^{a}	9.18±0.20	27.00±0.93a^{c}	17.84±0.84^{a}	20.30±1.12^{a}	9.98±0.13^{a}
	NZW x NZW	732.14±32.15^{b}	29.10±1.52	9.92±0.91^{a}	9.10±0.54^{a}	9.63±0.41	26,43±0.83^{b}	18.34±0.62^{a}	20.47±1.54^{a}	9.72±0.24^{a}
	CHA x NZW	699.00±0.57^{a}	28.50±0.95	9.82±0.12^{a}	9.80±0.40^{a}	9.85±0.50	19.22±5.64^{a}	23.02±2.21^{c}	21.47±1.54^{ab}	9.90±0.05^{a}
	NZW x CHA	853.33±30.70^{d}	29.66±1.28	11.05±0.41^{b}	10.15±0.16^{b}	9.56±0.34	29.33±0.42^{d}	20.26±0.46^{b}	23.23±0.76^{b}	10.58±0.13^{b}

Means with different alphabets within the same column per two weeks are significantly different ($p<0.05$); BWT= Body weight, BWD= body width, NL= Neck length, LL= leg length, EL= ear length, BNL= Neck and body length, BL=Body length, HG= Heart girth, TL=Thigh length

At week 8, NZW x CHA was superior to other genetic groups in BWT, BWD, EL, BNL and BL. However, no significant differences (p>0.05) were observed between genetic groups in NL and LL. At week 10, the result showed significant differences (p<0.05) between genetic groups with NZW x CHA having significantly higher BWT, NL, LL, BNL, BL, HG and TL. The findings of this study were in agreement with the studies of Oke *et al.,* (2011) and Obasi *et al.* (2019) on body weight and other linear body morphometric traits of rabbits. Variation in body weight and other morphometric traits of rabbit among different genetic groups suggests that genetic makeup of rabbits influences growth rate which translate into body weight. It was observed that body weight proportionately increases with increase in age. This is expected, because as the animal grows, body size and shape are also expected to increase simultaneously with age till maturity where it gradually reduces and stop after maturity is attained (Muhammad *et al*., 2006; Fajemilehin and Salako, 2008; Onasanya *et al*., 2017).

Body weight is regarded as a function of frame work or size of the animal and its condition (Ayorinde and Oke, 1995). In the present study, crossbred NZW x CHA was superior to other genetic groups which confirmed the importance of crossbreeding in improvement of livestock. It has been indicated that crossbreeding is one of the fastest tools offered to the breeders to improve body weight and other morphometric traits of purebred animals (Ajayi *et al.,* 2018).

Correlation among Bodyweight and Morphometric Traits: The phenotypic correlation among morphometric traits in rabbit at 2 weeks of age indicated that the correlation among morphometric traits were positive and highly significant (p<0.001) with correlation coefficient (r) ranging from 0.429 to 0.938 (Table 3). The relationship between BWT and other morphometric traits were not significant (p>0.05), though positive except for the correlation between BWT and TL which was negative (r = -0.089). The least correlation coefficient was recorded for correlation between BWT with NL (r = 0.118). The highest correlation coefficient was observed in the relationship between BWD and HG (r = 0.938).

The phenotypic correlation among morphometric traits in rabbit at 4 (below the diagonal) and 6 weeks (above the diagonal) showed positive highly significant relationship (p<0.001) between all morphometric traits except the relationship between BWT with BWD, LL, EL and BNL in which the correlation coefficients were 0.089, 0.200, 0.094 and 0.101 respectively (Table 4). The highest correlation coefficient was observed between LL and BNL (r = 0.700).

The phenotypic correlation of BWT with other morphometric traits at 6 weeks were not significant (p>0.05) except it relationship with BWD (r = 0.385) and TL (r = 0.456). The relationship among other morphometric traits (BWD, NL, LL, EL, BNL, BL, HG and TL) were all positive and significantly high (p<0.001), with the highest correlation coefficient observed between TL and BWD (r = 0.775). Ayyat *et al*. (1995) and Oke *et al*. (2011) reported similar positive and significant phenotypic correlation among morphometric traits at these ages in NZW rabbits.

The correlation coefficient among the morphometric traits at 8 weeks (below the diagonal) and 10 weeks (above the diagonal) indicated that at week 8, BWT had positive relationship with all other morphometric traits measured though not significant (p>0.05), and a negative correlation (r = -0.124) with TL (Table 5). More so, the relationships among other morphometric traits were positive though not significant (p>0.05). Positive significant relationships were observed between BWD and LL (r = 0.582), BWD and EL (r = 0.450) and BWD and HG (r = 0.648). Also, significant correlation were observed between NL and BL (r = 0.376), LL with BL, HG with TL which were (r = 0.587, 0.817 and 0.741 respectively).

At week 10, negative correlations were observed between BWD and BWT (r = -0.002), NL with BWD (r = -0.218), EL with BWT and BWD (r= -0.382 and – 0.014 respectively, BL with BWD and EL(r = -0.082 and -0.091 respectively. The correlation relationship between BL with BNL (r = 0.730) was negative and highly significant (p<0.001).

Table 3: Estimates of phenotypic correlation between morphometric traits of rabbits at two weeks of age

Traits	BWT	BWD	NL	LL	EL	BNL	BL	HG	TL
BWT	1								
BWD	0.203	1							
NL	0.118	0.429**	1						
LL	0.202	0.530**	0.572**	1					
EL	0.201	0.584**	0.598**	0.658**	1				
BNL	0.174	0.501**	0.708**	0.609**	0.685**	1			
BL	0.059	0.700**	0.496**	0.641**	0.649**	0.783**	1		
HG	0.227	0.938**	0.480**	0.513**	0.623**	0.593**	0.757**	1	
TL	-0.089	0.520**	0.609**	0.530**	0.505**	0.724**	0.690**	0.573**	1

** Significant correlation (p<0.05); **Highly significant correlation (p<0.01), BWT= Body Weight, BWD=Body width, NL=Neck length, LL= Leg length, EL= Ear length, BNL=Body and neck length, BL = Body length, HG=Heart girth, TL=Tail length*

Table 4: Estimates of phenotypic correlation between morphometric traits of rabbits at four weeks of age (below the diagonal) and at six weeks (above the diagonal)

Traits	BWT	BWD	NL	LL	EL	BNL	BL	HG	TL
BWT	1	0.385*	0.032	0.279	0.141	0.128	0.219	0.255	0.456**
BWD	0.089	1	0.457**	0.632**	0.526**	0.628**	0.744**	0.711**	0.775**
NL	0.331*	0.420**	1	0.545**	0.493**	0.399*	0.460**	0.574**	0.635**
LL	0.200	0.690**	0.566*	1	0.431**	0.545**	0.709**	0.699**	0.683**
EL	0.094	0.624**	0.493*	0.845**	1	0.542**	0.595**	0.573**	0.484**
BNL	0.101	0.598**	0.622**	0.700**	0.602**	1	0.623**	0.525**	0.546**
BL	0.447**	0.435**	0.680**	0.378**	0.436**	0.560**	1	0.734**	0.612**
HG	0.550**	0.556**	0.684**	0.498**	0.521**	0.638**	0.650**	1	0.672**
TL	0.319*	0.285*	0.269	0.181	0.141**	0.174**	0.174	0.374	1

** Significant correlation (p<0.05); **Highly significant correlation (p<0.01), BWT= Body Weight, BWD=Body width, NL=Neck length, LL= Leg length, EL= Ear length, BNL=Body and neck length, BL = Body length, HG=Heart girth, TL=Tail length*

Table 5: Estimates of phenotypic correlation between morphometric traits of rabbits at eight weeks of age (below the diagonal) and at ten weeks (above the diagonal)

Traits	BWT	BWD	NL	LL	EL	BNL	BL	HG	TL
BWT	1	-0.002	0.408	0.217	-0.382	0.451	-0.183	0.117	0.558
BWD	0.335	1	-0.218	0.306	-0.014	-0.082	0.195	0.625*	0.356
NL	0.138	0.121	1	0.599*	0.183	0.408	0.096	0.386	0.741**
LL	0,204	0.582**	0.231	1	0.325	0.077	0.520*	0.778**	0.716**
EL	0.026	0.450*	0.200	0.666	1	-0.091	0.227	0.446*	0.214
BNL	0.296	0.294	0.376*	0.587**	0424	1	-0.730**	0.174	0.532*
BL	0.391	0.097	0.210	0.134	0.035	0.608**	1	0.261	0.016
HG	0.084	0.648**	0.036	0.817**	0.485*	0.538*	0.324	1	0.794**
TL	-0.124	0.392	0.125	0.741**	0.511*	0.300	0.155	0.686**	1

** Significant correlation (p<0.05); **Highly significant correlation (p<0.01), BWT= Body Weight, BWD=Body width, NL=Neck length, LL= Leg length, EL= Ear length, BNL=Body and length, BL = Body length, HG=Heart girth, TL=Tail length*

The results from this study indicated that BWT had a non-significant low correlation with most of the morphometric traits at early stages of life (weeks 2, 4 and 6) was in line with reports of Onasanya *et al*. (2017) who had similar results. The authors also reported negative correlation between BWT and other measured morphometric traits as the rabbit increases in age (weeks 8 and above). The results of this study contradicted the findings of Okoro *et al*. (2010) who reported significantly high and positive relationship between BWT and other morphometric traits in CHA breeds of rabbits. This could probably be due to specific breed of rabbit used in that study (CHA) whereas the present study used NZW, CHA and their crosses.

The positive correlation coefficient observed between BWT and other morphometric traits of rabbits at all ages considered indicated that increase in body weight lead to increase in other morphometric traits except for TL at week 2 and 8, and BWD and EL at week 10. The positive correlation among other morphometric traits was an indication that improvement in one trait lead to improvement in other traits. This report was in line with the findings of Adewumi *et al.* (2006) and Onasanya *et al*. (2017) who established relationship between body weight and some morphometric traits and concluded that the correlated traits may be selected for simultaneous in improvement programmes.

At weeks 2, 4, 6, 8 and 10 a positive correlation coefficient was established between HG and other morphometric traits considered. The results also indicated that HG had high positive correlation with all other traits indicating that effort to improve HG will lead to a faster increase in other morphometric traits (BWD, NL, LL, EL, BNL, BL and TL).

Conclusion: NZW x CHA had a significant higher performance in body weight and morphometric traits measurements at all ages studied and these measurements increased as age increased in the four genotypes of rabbits studied. The study also reveals that NZW x CHA genotype is best suited in the humid tropics in meeting the protein requirement of individuals in the area of this study. The study also indicate that morphometric traits which were positively correlated with body weight and highly correlated positively among themselves could be used for body weight prediction and genetic improvement in rabbits.

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