



Genotype of sire and dam, parity and sex effects on growth traits of rabbits

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Abstract

Body weight (BW) and body linear measurements notably body length (BL), heart girth (HG), ear length (EL), tail length (TL), nose to shoulder (NTS) and shoulder to tail (STT) of 528 rabbits were analyzed at 6, 8 and 10 weeks of age. Three genotypes of sire and dam: Chinchilla (CHC), Californian white (CAW) and New Zealand white (NZW), 3 parities and 2 sexes (male and female) were evaluated. Statistical analyses were performed using the General Linear Model procedure of SAS. Results showed that sire genotype significantly ($P < 0.05$) affected BW (g) at 6, 8 and 10 weeks of age, with the CHC genotype weighing heavier than both NZW and CAW genotypes. The EL, BL, HG at 6 weeks of age; EL, BL, TL at 8 weeks of age; and EL, BL at 10 weeks of age were significantly ($P < 0.05$) affected by sire genotype. Dam genotype significantly ($P < 0.05$) influenced BW across all ages. The CHC genotype had the highest BW (502.79g, 826.62g and 1103.64g) at 6, 8 and 10 weeks of age respectively, while the NZW genotype had the lowest BW (736.56g and 986.10g) at 8 and 10 weeks of age, respectively. Sex had no significant ($P > 0.05$) effect on all growth parameters measured at various ages. Parity on the other hand, significantly ($P < 0.05$) influenced the BW of the three genotypes at 6, 8 and 10 weeks of age. While rabbits that belong to parity 3 had the highest BW at 6 and 8 weeks of age, those in the parity 1 had the lowest BW at 6, 8 and 10 weeks of age, respectively. It was concluded that this results confirmed the superiority of CHC over NZW and CAW in terms of growth traits, irrespective of being sire or dam genotype.

Keywords: Genotype, Growth traits, Sire, Dam, Rabbit.

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Introduction

An understanding of the phenotypic expression of genes is the fundamental basis upon which the importance of livestock through breeding is founded (Ibe, 1995). In general, genes express themselves phenotypically in two ways; non-additive gene action and additive gene action. In non-additive gene action, there is no straight line phenotypic progression from one extreme to the other. Non-additive gene action tends to lower the heritability and increase the expression of

hybrid vigour (Akanno and Ibe, 2005). Additive gene action affects many important traits in farm animals (polygenic traits) such as growth rate and body conformation (Kabir *et al.*, 2012). Polygenic traits mostly determined by additive genes will be medium to highly heritable and will be affected very little by crossbreeding or inbreeding. Traits affected mostly by non-additive gene action will usually be lowly heritable, will be improved by crossbreeding and will show a decline when inbreeding is practiced

(Obasi and Ibe, 2008). The potential growth of an animal, its pattern of development and to some extent, its ultimate carcass composition in terms of the proportions of muscle, bone and fat are genetically predetermined (Lebas, 1969). Growth rate and development in the rabbit dependent on the genotype (Lukefahr *et al.*, 1996), where some rabbits reach 2kg at eight weeks of age (Chen *et al.*, 1978) while others achieve much poorer growth (Lang, 1981). The objective of this study is to evaluate the growth traits of rabbit as influenced by parity, sex and the respective genotypes of sire and dam.

Materials and Methods

Experimental site

The experiment was conducted at the Rabbitry unit of the research and teaching farm, Department of Animal Science, Ahmadu Bello University Zaria, Nigeria. The site falls within the Northern Guinea Savannah zone and detailed description of the location was given by Kabir *et al.* (2014).

Experimental animals and management

Three genotypes of sire and dam (Table: 1) Chinchilla (CHC), Californian white (CAW) and New Zealand white (NZW), as well as 3 parities and 2 sexes (male and female) were evaluated. The study consisted of 528 rabbits analyzed at 6, 8 and 10 weeks of age. All the experimental rabbits were housed under uniform conditions of management in hutches measuring 72cm x 62cm x 52cm. Experimental diets fed to the animals has CP content of 18.47%, CF of 6.6% and energy value of 2650 Kcal ME/kg diet. Design of the mating plan was given in Table 1 as earlier described by Kabir *et al.*, (2014). Thus, the arrangement is such that bucks that sired purebred kits also sired crossbred kits. Body linear measurements were taken using flexible tailor's tape calibrated in centimeters (cm) while weight was in gram (g) obtained using the 10kg capacity digital scale (Mettler Toledo, Top Pan Sensitive Balance). Body weight (BW) was obtained by taking the weight of each rabbit; Ear

length (EL) was measured as the distance from the point of attachment of the ear to the tip of the ear; Nose to shoulder (NTS) was measured as the distance from the nose to the point of the shoulder; Shoulder to tail-drop (STT) was the distance from the point of the shoulder to the pin bone (otherwise called coccygeal vertebra); Heart girth (HG) refers to the body circumference and was measured just behind the fore-legs; Body length (BL) was the longitudinal distance from the point of the shoulder to the tuberosity of the ischium; Length of front and back leg (LFL and LBL) was the length of front and back legs measured in centimeter.

Data analysis

Data obtained were subjected to analysis of variance using the general linear model (GLM) procedure of SAS (2002). The design of the experiment was the Nested type (Hierarchical type) according to Henderson, (1963), in which a sire was mated to several dams with each mating producing several offspring. The model is as given below:

$$Y_{ijk} = \mu + B_i + S_{ij} + D_{ijk} + E_{ijkl}$$

Where; Y_{ijkl} = Observation on the i^{th} rabbit of the k^{th} doe mated to the j^{th} sire of the i^{th} genotype; μ = overall mean, B_i = effect of the i^{th} genotype; S_{ij} = effect of the j^{th} sire of the i^{th} genotype; D_{ijk} = effect of the k^{th} doe mated to the j^{th} sire of the i^{th} genotype; E_{ijkl} = random error.

Results

Effects of genotypes of sire and dam on growth traits of rabbits

Tables 2, 3 and 4 show the effects of genotype of sire, genotype of dam, parity and sex on body weights and body linear measurements of rabbits at various ages. Sire genotype significantly ($P < 0.05$) affected body weight (BW) at 6, 8 and 10 weeks of age, with the Chinchilla (CHC) genotype weighing heavier than New Zealand white (NZW) and California white (CAW) genotypes. For body linear measurements, ear length (EL), body length (BL) and heart girth

(HG) at 6 weeks of age; EL, BL and tail length (TL) at 8 weeks of age, as well as EL and BL at 10 weeks of age were significantly ($P<0.05$) affected by sire genotype.

Similarly, dam genotype significantly ($P<0.05$) influenced BW across all ages. The CHC genotype had the highest BW (502.79g, 826.62g and 1103.64g) at 6, 8 and 10 weeks of age respectively, while the NZW genotype had the lowest BW (736.56g and 986.10g) at 8 and 10 weeks of age, respectively. Significant ($P<0.05$) differences were observed due to dam genotype on EL, BL, TL and HG at 6 and 8 weeks of age. All other linear measurements were also affected at 10 weeks of age except TL and shoulder to tail-drop (STT).

Effect of parity and sex on growth traits of rabbits

Effect of sex and parity on growth parameters of rabbit is presented in Tables 2, 3 and 4. Sex had no significant ($P>0.05$) effect on all growth parameters measured at the various ages. Parity on the other hand, significantly ($P<0.05$) influenced the BW of the three genotypes at 6, 8 and 10 weeks of age. While rabbits that belong to parity 3 had the highest BW at 6 and 8 weeks of age, those in the first parity had the lowest BW at 6, 8 and 10 weeks of age, respectively. Significant ($P<0.05$) parity effect for all body measurements was observed except for length of back leg (LBL) at 8 and 10 weeks of age.

Table 1: Mating plan for experimental rabbit genotypes

Sire genotype	Dam genotype		
	(CHC)	NZW)	(CAW)
CHC	CHC x CHC	CHC x NZW	CHC x CAW
NZW	NZW x CHC	NZW x NZW	NZW x CAW
CAW	CAW x CHC	CAW x NZW	CAW x CAW

Table 2: Sire and dam genotypes, parity and sex effects on body weight (g) and body linear measurements (cm) of rabbits at 6 weeks of age

	N	Growth traits								
		BW	EL	BL	TL	HG	NTS	STT	LFL	LBL
Sire genotype										
CHC	157	512.51±7.43 ^a	4.28±0.03 ^b	12.77±0.12 ^b	4.15±0.29 ^a	13.53±0.10 ^a	8.66±0.04 ^a	17.85±0.07 ^b	7.96±0.03 ^a	11.99±0.03 ^a
NZW	183	455.6±6.36 ^b	4.37±0.03 ^a	12.89±0.11 ^a	4.18±0.29 ^a	13.59±0.09 ^a	8.63±0.03 ^a	17.83±0.08 ^b	7.92±0.03 ^a	11.98±0.02 ^a
CAW	188	454.99±7.32 ^b	4.27±0.02 ^b	12.70±0.11 ^c	4.16±0.34 ^a	13.53±0.09 ^a	8.67±0.03 ^a	18.03±0.08 ^a	7.95±0.039 ^a	11.99±0.02 ^a
Dam genotype										
CHC	163	502.79±9.06 ^a	4.41±0.44 ^a	12.79±0.12 ^b	4.16±0.35 ^b	13.48±0.09 ^b	8.69±0.04 ^a	17.93±0.08 ^a	7.95±0.03 ^a	12.0±0.32 ^a
NZW	183	461.28±5.92 ^b	4.24±0.32 ^b	12.70±0.11 ^c	4.14±0.31 ^b	13.51±0.09 ^b	8.65±0.03 ^a	17.93±0.08 ^a	7.95±0.03 ^a	11.99±0.33 ^a
CAW	182	456.09±6.50 ^c	4.28±0.28 ^b	12.88±0.10 ^a	4.20±0.26 ^a	13.65±0.09 ^a	8.63±0.03 ^a	17.84±0.08 ^b	7.92±0.03 ^a	11.97±0.31 ^a
Parity										
1	199	375.57±3.10 ^c	4.04±0.02 ^c	10.92±0.02 ^c	3.85±0.02 ^b	12.03±0.30 ^b	8.61±0.03 ^b	17.79±0.07 ^b	7.86±0.03 ^b	11.93±0.02 ^b
2	174	522.03±5.63 ^b	4.42±0.02 ^b	13.82±0.03 ^b	4.34±0.01 ^a	14.46±0.21 ^a	8.61±0.03 ^b	17.77±0.08 ^b	7.90±0.03 ^b	11.96±0.02 ^b
3	155	540.68±4.99 ^a	4.51±0.03 ^a	14.02±0.03 ^a	4.37±0.01 ^a	14.48±0.18 ^a	8.77±0.04 ^a	18.17±0.09 ^a	8.09±0.03 ^a	12.09±0.03 ^a
Sex										
Male	249	472.45±6.32 ^a	4.29±0.02 ^a	12.79±0.09 ^a	4.16±0.02 ^a	13.55±0.08 ^a	8.66±0.03 ^a	17.89±0.07 ^a	7.96±0.02 ^a	12.04±0.31 ^a
Female	279	472.18±5.65 ^a	4.32±0.02 ^a	12.79±0.09 ^a	4.17±0.02 ^a	13.55±0.07 ^a	8.65±0.03 ^a	17.89±0.06 ^a	7.93±0.02 ^a	11.97±0.32 ^a
Overall	528	472.30±4.21	4.31±0.02	12.79±0.07	4.16±0.31	13.55±0.05	8.66±0.02	17.89±0.05	7.94±0.02	11.99±0.01

^{abc} =Means within the same column having the same letter are not significantly ($P>0.05$) different.

BW=Body weight, EL=Ear length, BL=Body length, TL=Tail length, HG=heart girth, NTS=Nose to shoulder, STT=Shoulder to tail-drop,

LFL=Length of front leg, LBL=Length of back leg. N = number of rabbits

CHC=Chinchilla, NZW=New Zealand White, CAW=California White.

Table 3: Sire and dam genotypes, parity and sex effects on body weight (g) and body linear measurements (cm) of rabbits at 8 weeks of age.

	N	Growth traits								
		BW	EL	BL	TL	HG	NTS	STT	LFL	LBL
Sire genotype										
CHC	157	812.96±14.28 ^a	5.47±0.03 ^b	15.34±0.18 ^b	5.17±0.02 ^a	15.26±0.12 ^a	10.53±0.06 ^b	19.44±0.11 ^b	9.75±0.05 ^b	13.40±0.03 ^a
NZW	175	770.61±14.84 ^b	5.61±0.04 ^a	15.48±0.18 ^a	5.10±0.03 ^a	15.26±0.12 ^a	10.52±0.05 ^b	19.48±0.09 ^b	9.75±0.04 ^b	13.40±0.02 ^a
CAW	171	735.42±14.42 ^c	5.41±0.03 ^b	15.29±0.16 ^c	5.08±0.03 ^a	15.23±0.11 ^a	10.63±0.05 ^a	19.68±0.09 ^a	9.85±0.04 ^a	13.39±0.02 ^a
Dam genotype										
CHC	155	826.62±18.78 ^a	5.64±0.05 ^a	15.32±0.19 ^b	5.08±0.03 ^b	15.14±0.12 ^c	10.62±0.06 ^a	19.61±0.09 ^a	9.83±0.04 ^a	13.47±0.03 ^a
NZW	170	736.56±11.50 ^c	5.40±0.03 ^b	15.26±0.17 ^c	5.12±0.02 ^a	15.22±0.11 ^b	10.58±0.06 ^a	19.59±0.10 ^a	9.82±0.04 ^a	13.39±0.02 ^b
CAW	178	755.79±12.91 ^b	5.46±0.03 ^b	15.52±0.16 ^a	5.15±0.02 ^a	15.37±0.11 ^a	10.49±0.06 ^b	19.42±0.09 ^b	9.71±0.05 ^b	13.35±0.02 ^b
Parity										
1	182	549.79±4.29 ^b	5.14±0.02 ^c	12.46±0.01 ^c	4.99±0.04 ^b	13.30±0.03 ^b	10.50±0.05 ^b	19.43±0.09 ^b	9.70±0.04 ^b	13.38±0.02 ^b
2	167	899.32±9.56 ^a	5.68±0.03 ^b	16.92±0.03 ^b	5.19±0.01 ^a	16.36±0.01 ^a	10.47±0.05 ^b	19.34±0.09 ^c	9.71±0.04 ^b	13.39±0.02 ^b
3	154	893.95±6.88 ^a	5.72±0.03 ^a	17.14±0.04 ^a	5.19±0.01 ^a	16.34±0.01 ^a	10.72±0.06 ^a	19.88±0.11 ^a	9.98±0.05 ^a	13.43±0.03 ^a
Sex										
Male	238	770.66±12.52 ^a	5.47±0.03 ^a	15.34±0.15 ^a	5.10±0.02 ^a	15.25±0.09 ^a	10.57±0.05 ^a	19.56±0.08 ^a	9.81±0.04 ^a	13.41±0.02 ^a
Female	265	771.69±11.59 ^a	5.51±0.03 ^a	15.37±0.14 ^a	5.13±0.02 ^a	15.25±0.09 ^a	10.55±0.04 ^a	19.52±0.08 ^a	9.77±0.03 ^a	13.39±0.02 ^a
Overall	503	771.21±8.50	5.49±0.02	15.37±0.09	5.12±0.01	15.25±0.07	10.56±0.03	19.54±0.06	9.79±0.03	13.40±0.01

^{abc} =Means within the same column having the same letter are not significantly ($P>0.05$) different.

BW=Body weight, EL=Ear length, BL=Body length, TL=Tail length, HG=heart girth, NTS=Nose to shoulder, STT=Shoulder to tail-drop,

LFL=Length of front leg, LBL=Length of back leg. N = number of rabbits

CHC=Chinchilla, NZW=New Zealand White, CAW=California White.

Table 4: Sire and dam genotypes, parity and sex effects on body weight (g) and body linear measurements (cm) of rabbits at 10 weeks of age.

	N	Growth traits								
		BW	EL	BL	TL	HG	NTS	STT	LFL	LBL
Sire genotype										
CHC	154	1075.23±18.35 ^a	6.83±0.04 ^b	19.83±0.37 ^b	5.96±0.03 ^a	16.55±0.10 ^a	12.25±0.07 ^a	21.00±0.13 ^a	11.53±0.04 ^a	14.69±0.03 ^a
NZW	169	1045.74±21.48 ^b	6.94±0.05 ^a	20.15±0.35 ^a	5.91±0.04 ^a	16.59±0.09 ^a	12.21±0.07 ^a	20.97±0.12 ^a	11.49±0.04 ^a	14.71±0.02 ^a
CAW	177	948.15±20.34 ^c	6.83±0.04 ^b	19.79±0.33 ^b	5.91±0.04 ^a	16.55±0.09 ^a	12.25±0.06 ^a	21.11±0.13 ^a	11.51±0.03 ^a	14.70±0.01 ^a
Dam genotype										
CHC	155	1103.64±26.39 ^a	6.98±0.05 ^a	19.78±0.38 ^b	5.92±0.04 ^a	16.47±0.01 ^c	12.33±0.07 ^a	21.09±0.13 ^a	11.61±0.04 ^a	14.79±0.03 ^a
NZW	170	989.10±16.04 ^c	6.77±0.04 ^c	19.71±0.34 ^b	5.93±0.03 ^a	16.53±0.09 ^b	12.26±0.07 ^b	21.13±0.13 ^a	11.50±0.03 ^b	14.68±0.02 ^b
CAW	175	1013.17±17.59 ^b	6.87±0.04 ^b	20.28±0.32 ^a	5.93±0.04 ^a	16.68±0.09 ^a	12.13±0.06 ^c	20.88±0.13 ^b	11.43±0.04 ^c	14.62±0.02 ^b
Parity										
1	179	716.28±5.35 ^c	6.33±0.03 ^b	15.94±0.03 ^c	5.24±0.00 ^b	14.88±0.02 ^b	12.14±0.06 ^b	20.85±0.12 ^b	11.44±0.04 ^b	14.71±0.02 ^a
2	167	1220.26±11.76 ^a	7.18±0.03 ^a	23.08±0.05 ^b	5.74±0.05 ^a	17.50±0.01 ^a	12.18±0.06 ^b	20.84±0.12 ^b	11.49±0.03 ^b	14.71±0.03 ^a
3	154	1198.12±8.97 ^b	7.16±0.03 ^a	23.48±0.07 ^a	5.77±0.01 ^a	17.50±0.01 ^a	12.41±0.07 ^a	21.44±0.15 ^a	11.62±0.04 ^a	14.67±0.02 ^a
Sex										
Male	237	1030.61±17.28 ^a	6.84±0.04 ^a	19.92±0.29 ^a	5.90±0.03 ^a	16.55±0.08 ^a	12.26±0.06 ^a	21.06±0.11 ^a	11.51±0.03 ^a	14.69±0.02 ^a
Female	263	1035.19±16.13 ^a	6.89±0.03 ^a	19.93±0.28 ^a	5.95±0.03 ^a	16.57±0.08 ^a	12.22±0.05 ^a	21.01±0.10 ^a	11.51±0.02 ^a	14.70±0.02 ^a
Overall	500	1033.02±11.78	6.87±0.02	19.93±0.20	5.93±0.02	16.56±0.06	12.24±0.04	21.03±0.08	11.51±0.02	14.70±0.01

^{abc} =Means within the same column having the same letter are not significantly (P>0.05) different.

BW=Body weight, EL=Ear length, BL=Body length, TL=Tail length, HG=heart girth, NTS=Nose to shoulder, STT=Shoulder to tail-drop,

LFL=Length of front leg, LBL=Length of back leg. N = number of rabbits

CHC=Chinchilla,NZW=NewZeal and White, CAW=California White.

Discussion

Effects of genotypes of sire and dam on growth traits of rabbits

The mean body weight observed in this study for the three genotypes (CHC, NZW and CAW) at 6 weeks of age was higher than those reported by Obasi and Ibe (2008). The authors reported 384.8g, 335.12g and 335.16g for CHC, NZW and Dutch genotypes, even though their study was not age specific. Reporting on growth performance of crossbred rabbits, Oke *et al.* (2010) found significant genotype effect on most of the parameters tested. The authors reported 9.68cm (CHC x NZW) and 10.7cm (NZW x NZW), 7.48cm (CHC x NZW) and 6.03cm (NZW x NZW) for BL and HG at 6 weeks of age, which were lower than values for same traits observed in this study at same age. However the values reported by Obasi and Ibe (2008) for BL and HG in CHC (25.05 and 17.41cm) and NZW (22.03 and 15.56cm) were higher than those obtained in the present study for similar genotypes. Differences in method and time of measurement, genotype, management and environmental influences could have been responsible for differences in results obtained (Zalla *et al.*, 2007).

Parity and sex effects on growth traits of rabbits

Absence of sexual dimorphism ($P > 0.05$) for all growth parameters measured at various ages was in line with the findings of McNitt and Lukefahr (1993). Males of certain livestock species (e.g quails) are known to show faster growth rate and masculine ability, hence weighing heavier than their female counterparts due to the action of androgen hormone (McNitt and Moody, 1990). In this study sex did not affect any of the growth traits measured. The significant effect ($P < 0.05$) of parity on BW of the three genotypes at 6, 8 and 10 weeks of age agreed with the reports of McNitt and Lukefahr (1993), who confirmed the superiority of CHC over NZW and Dutch genotype in terms of growth and body weight. Rabbits that belong to parity 3 had higher body

weights and other growth traits than those from parity 2 and 1.

In conclusion, the CHC genotype showed overwhelming superiority over the NZW and CAW in terms of growth performance up to 10 weeks of age. Generally, effects of sire and dam genotypes as well as parity were found to be significant on some of the parameters measured in the rabbits at various ages.

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