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Response to Selection for Body weight and Linear Body Traits in Breeds of Rabbit

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Abstract

An assessment of the selection response of body weight and linear body traits in breeds of rabbit in Zaria, Kaduna State, Nigeria was conducted. A population of 48 matured rabbits consisting of three breeds; New Zealand white, Chinchilla and Dutch was used in the experiment. Each breed represented a treatment group and was used to generate 288 rabbits in a nested design. The populations were selected at six weeks of age in all the generations. The growth traits considered were; body weight, ear length, nose to shoulder, body length, length of back leg, thigh length, and heart girth and thigh circumference. Data generated were subjected to analysis of variance using the SAS software. The New Zealand White had a higher body weight of 1157.92±22.75g and 1229.35±24.07g in generations one and two respectively, and heart girth of 20.09±0.14cm, thigh length of 15.93±0.09cm, body length of 44.52±0.48cm and thigh circumference 10.96±0.09cm in generation one. The length of back legs and heart girth in generation two were better expressed in Chinchilla and Dutch breeds, respectively. The selection response range was 19.45 - 22.20kg and 13.59 - 14.95kg in males and females respectively for body weight while the linear body traits ranged from 0.01 - 0.30cm and 0.01 - 0.28cm for males and females respectively in New Zealand white. For chinchilla, responses to selection for body weight were 9.45-10.33kg and 1.85 - 14.54kg for males and females respectively while linear body traits ranged from 0.01- 0.33cm for both males and females. The response to selection for body weight in Dutch ranged from 7.48 - 27.40kg and 18.38 - 18.66kg for males and females respectively, whereas for the linear body traits the range was 0.01 - 0.34cm and 0.02 - 0.40cm for males and females respectively. It was observed that the Dutch genotype had the best selection progress for body weight and linear body traits and therefore recommended for improvement of body weight and linear body traits.

Keywords: Rabbit, Selection, Response, Body weight, Linear traits

1.0 Introduction

Local breeds of rabbits in Nigeria are small and take longer periods to grow and have low productivity (Ahmed, 2003). Rabbits are pseudo-ruminant animals and induce ovulators where eggs are released by sexual intercourse (Diane, 2020). Rabbit sometimes exhibits false pregnancy during which features of pregnancy are displayed but not pregnant (Diane, 2020). The differences in weight and morphological traits among different rabbits breed which are associated with growth rate and body weight explain the genetic makeup of such genotypes (Onasanya et al., 2017; Sam et al., 2020a). The increase in body weight and linear body traits are directly proportional to the increase in the age of the animal (Onasanya et al., 2017). Linear body traits explain basic information on the morphology characteristic of the animal and have helped in making decisions on large-scale production for commercial purposes (Osario et al., 2002). Body measurements have been used in rabbits to contrast differences in size and shape (Oliveira et al., 2004). Body size and shape which are important components of linear body traits are genetically and phenotypically correlated with body weight (Akanno and Ibe, 2005; Sam et al., 2020b). The characterization of local genetic resources depends on the knowledge of the variation of morphological traits, which have played a very important role in the classification of livestock based on size and shape (Ferra et al., 2010).

The selection of rabbit breeds adapted to certain environmental conditions is very important for rabbit production (Kumaresan et al., 2011). Slaughter performance traits are improved through the selection of high-growth rate rabbits (Shahin and Hassan, 2002). Selection for carcass traits is also an alternative and effective tool for meat-type rabbits (Szendro et al., 2004). Improvement of body weight through selection shortens the time spent on the production of meat rabbits and improves feed utilization, quality and quantity of meat. Direct selection on a single trait affects the performance of economically important traits unselected which could be lost (genetic drift) thereby reducing the overall economic importance or merit of the selected population (Nath et al., 2011). Genetic drift, individual measurement sampling, breed, environmental interactions and period trends in environment and natural selection are the possible causes of different responses in a selection population (Hill, 2011). The success in a selected population for several traits simultaneously is the product of the selection differential (determined by the selection intensity) and the aggregate genotype (Kluyts et al., 2007).

Genetic differences between and within breeds explain diversity and valuable assets that the adaptability of a population depends on (Woolliams et al., 2005). Loss of genetic diversity is often associated with inbreeding, selection, gene flow and migration (Willi et al., 2006). The present study was therefore aimed at determining response to selection for body weight and linear body traits in three breeds of rabbits in two generations of selection.

2.0 Materials and Methods

2.1 Study Area

The research was conducted at the Rabbit Unit of the Department of Animal Science Research and Teaching Farm, Faculty of Agriculture, Ahmadu Bello University, Zaria. The area location is described by (Kabir, 2006).

2.2 Animals and Management

The experimental rabbits were sourced from a reputable farm within Zaria metropolis, where 12 bucks and 36 does of six months of age were used. The breeds used were New Zealand white (NZW), Chinchilla (CHC) and Dutch (DUC) with four bucks and 12 does for each breed. They were raised in a conducive environment in a battery cage system. Amprolium® and Ivomectin® were administered against coccidiosis, external and internal parasites. Feed and water were provided ad libitum. Formulated concentrate diet containing 2800 ME Kcals /Kg metabolizable energy, 15% crude protein, 15% crude fibre, 4.3% ether extract and groundnut haulms was given. Cleaning of the cages was carried out regularly.

2.3 Mating

Mating was carried out in a ratio of 1:3 where does were introduced to their respective sire groups Table 2.1. They were allowed and observed after a successful mating, thereby returning to their respective cage. The does were checked for pregnancy at about 14 days after successful mating through clear observation of the abdomen and palpation of the region as pregnancy advanced. Kindling nest boxes were introduced a few days to kindling. Immediately kindling was discovered the followings were recorded; date of kindling, taken as the day when successful kits were born, litter size taken as the number of kits produced at one birth-still birth and neonatal mortality, litter weight which is the weight of the kits at birth and this were measured using a sensitive digital scale (g) (Mettler Toledo®, Top Pan Sensitive Balance, J. Liang Int. Ltd. U.K), and individual kit weight is the weight of the kits divided by a total number of kits and this was measured using the digital sensitive scale in grams (g) (Mettler Toledo®, Top Pan Sensitive Balance, J. Liang Int. Ltd. U.K). Kits were handled with nylon disposable hand gloves to avoid rejection of the kits by their dams within 12 hours after kindling; litters were checked, recorded and thereafter examined every morning to get rid of the dead kits. Identifications were done at two weeks of age, where the kits were sexed and ear tagged. At 35 days, they were separated from their dams according to sire identification number and transferred to standard progeny metal cages. A mass selection method was used, that is individuals with the highest body weight (400 g) were selected per breed.

Table 2.1: Pure crossing for offspring generation one and two

Sire		Dam	Progeny
NZW	×	NZW	NZW
CHC	×	CHC	CHC
DUC	×	DUC	DUC

New Zealand white (NZW), Chinchilla (CHC), Dutch (DUC), and generation (G)

2.4 Data Collection

2.4.1 Body Weight

The body weight was measured in grams at two weeks intervals using a 40-kilogram (Kg) weighing scale.

2.4.2 Linear Body Measurement

Linear body traits were measured at two weeks intervals throughout the experiment in centimeters (cm), using flexible tape according to the anatomic reference point of Teguia et al. (2008), thus, as follows;

- Ear length (EL): Measured from the ear base to the zygomatic arch of the ear.
- Body length (BL): Diagonal distance from the points of shoulder to points of hip or first thoracic vertebrae to base of tail or hip bone.
- Length of back leg (LBL): Distance from the thigh region to the tip of the claw.
- Thigh length (THL): Distance from the first joint between the pelvic to the knee region.
- Nose to shoulder (NTS): Distance from the point of the nose to the shoulder (fore limb).
- Heart girth (HG): This refers to the circumference of the heart between the forelimbs.
- Thigh circumference (TC): This refers to the circumference of the thigh.

2.5 Statistical Analysis

Data obtained on different generations were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2002) to test the effects of the breed and generation on growth traits. The significant means in terms of body weight and linear body traits were separated using the Duncan Multiple Range Test (DMRT) of SAS (Duncan, 1955). The following model was used for body weight and linear body traits.

$$\mathrm{Yijkl} = \mu + \mathrm{Gi} + \mathrm{Bj} + \mathrm{GBijk} + \mathcal{E}\mathrm{ijkl} \quad \text{……………Equation 1}$$

Where:
μ = Overall mean,
Gi = ith effect of generations one and two,
Bj = jth effect of breed (NZW, CHC and DUT),
GBijk = interaction between generations and breeds,
Ɛijkl = Random error (All error terms assumed to be random, normally distributed and independent with expectation equal to zero) and
Yijkl = Observation on the measurable characteristics of the ijklth rabbit

2.5.1 Selection Response (ΔG)

The selection response was computed for body weight (BW) and linear body traits; ear length (EL), nose to shoulder (NTS), body length (BL), length of back leg (LBL), thigh length (THL), heart girth (HG) and thigh circumference (TC) for generation one and two in both sex using the following formula described by (Fayeye, 2014).

$$\Delta \mathrm{G} = h2 * SD \quad \text{……………Equation 2}$$

Where:
ΔG = Selection response (genetic gain),
h2= Realized heritability and
SD = Selection differentials

2.5.2 Selection differential (SD)

The selection differential was computed using the formula (Fayeye, 2014).

$SD = PS - PO$ ……………………………………………………………...Equation 3

Where:
PS= Mean of selected parents and
PO= Population mean

3.0 Results and Discussion

3.1 Body Weight and Linear Body Traits

Body weight and linear body traits were significantly (P<0.05) affected by Generation and breeds Table 3.1. It was observed that the New Zealand White had high values of 1157.92±22.75g for body weight, 20.09±0.14cm heart girth, 15.93±0.09cm thigh length, 44.52±0.48cm body length and 10.96±0.09cm thigh circumference in generation one. The ear length (11.83±0.10cm), nose to shoulder (17.00±0.21cm) and length of back legs (23.48±0.23cm) were observed to be higher in Chinchillas. However, the Dutch breed recorded the least estimate on some traits namely; body weight (843.91±23.51g), ear length (10.11±0.10cm), nose to shoulder (13.12±0.21cm), length of back legs (17.83±0.23cm), heart girth (16.34±0.15cm), thigh length (13.86±0.08cm), body length (40.12±0.45cm) and thigh circumference (7.95±0.09cm) in generation one.

In generation two, New Zealand White was observed to have a higher body weight of 1229.35±24.07g. Chinchilla had a high value of 23.36±0.25cm for the length of the back legs, while the heart girth of 19.81±0.16cm was better observed in Dutch. The high values observed in some traits of rabbits can be due to high additive genetic variance on their part. This corroborates with the report of Fayeye (2014) who stated that response due to additive genetic variance in one generation of a particular trait builds upon the gains in the subsequent generation. The variation in body weight observed could be attributed to breed or environmental influence. This corroborates with the results of Jimoh and Ewuola, (2018) who also observed that rabbits in the tropics are susceptible to heat stress due to high ambient temperature which affects their performance. According to Iraqi, (2008) disparities in growth traits sometimes are influenced by breed, managerial and nutritional factors, year, month and/or season of kindling, parity, and litter size at birth. The approach and period of estimation, genotype, handle and environmental factors may be responsible also for the disparities obtained (Zalla et al., 2007).

Table 3.1: Body weight (g) and linear body trait (cm) performance of rabbit in generation one and two

	Generation One			Generation Two		
Traits	**NZW**	**CHC**	**DUC**	**NZW**	**CHC**	**DUC**
BW	1157.92±22.75[a]	1071.08±23.30[b]	843.91±23.51[c]	1229.35±24.07[a]	1107.40±25.84[b]	1110.55±25.18[b]
EL	10.62±0.11[b]	11.83±0.10[a]	10.11±0.10[c]	11.35±0.11[a]	10.95±0.11[b]	11.04±0.10[b]
NTS	14.27±0.23[b]	17.00±0.21[a]	13.12±0.21[c]	16.76±0.21[a]	16.86±0.23[a]	15.96±0.22[b]
LBL	22.90±0.22[b]	23.48±0.23[a]	17.83±0.23[c]	22.02±0.23[c]	23.36±0.25[a]	22.35±0.24[b]
HG	20.09±0.14[a]	19.15±0.15[b]	16.34±0.15[c]	18.93±0.14[c]	19.38±0.16[b]	19.81±0.16[a]
THL	15.93±0.09[a]	15.60±0.08[b]	13.86±0.08[c]	14.58±0.09[a]	14.32±0.09[b]	14.17±0.09[b]
BL	44.52±0.48[a]	43.26±0.45[b]	40.12±0.45[c]	43.52±0.46[a]	42.41±0.05[b]	43.61±0.49[a]
TC	10.96±0.09[a]	10.41±0.09[b]	7.95±0.09[c]	10.63±0.09[a]	10.18±0.10[b]	10.72±0.10[a]

abc means with different superscripts on the same row are significantly (P<0.05) different. NZW=New Zealand White CHC=Chinchilla, DUC=Dutch, M= Male; F= Female. BW = body weight, EL=ear length; BL=Body length; LBL= length of back legs; THL=thigh length, NTS= nose to shoulder, HG= heart girth, TC=thigh circumference

3.2 Selection Response of the Breeds

The selection response of body weight and linear body traits in New Zealand white are presented in Table 3.2. The observed body weights were 19.45g and 22.20g for males, and 13.59g and 14.95g for females in generations one and two, respectively. While other linear body traits decreased as generation increase ranged from 0.01 to 0.30 and 0.01 to 0.28 in males and females, respectively.

The selection response for body weight obtained in both sex (male and female) in all the generations explains the rate of difference or variation amongst the populations used. The decrease in selection response of the ear length, nose to shoulder, length of back legs, heart girth, thigh length, body length and thigh circumference in generation two could be attributed to genetic drift, low phenotypic variation or correlated response. Also, it has been reported that, if selection is made for single traits, the maximum selection progress will be for that trait. Fayeye (2014) reported that selection progress is normally highest in generation one, and decreased with progress selection until it finally ceased.

Table 3.2: Selection response of body weight (g) and linear body traits (cm) in New Zealand White

		Traits							
Sex	**Gen**	**BW**	**EL**	**NTS**	**LBL**	**HG**	**THL**	**BL**	**TC**
Male	**G1**	19.45	0.12	0.28	0.30	0.15	0.10	0.31	0.23
	G2	22.20	0.01	0.02	0.03	0.06	0.04	NE	0.06
Female	**G1**	13.59	0.10	0.26	0.28	0.11	0.08	0.14	0.19
	G2	14.95	0.07	0.02	0.04	NE	0.01	0.01	0.07

BW = body weight, EL=ear length; BL= Body length; LBL= length of back legs; THL= thigh length, NTS=nose to shoulder, HG= heart girth, TC=thigh circumference, Gen= generation, NE=not estimable.

The selection response for Chinchilla rabbits is presented in Table 3.3. The following values were obtained for body weight (9.57g and 10.33g) in males and (14.54g and 1.85g) in females. Progress ranges of 0.01cm to 0.33cm were recorded for linear body traits in both sexes. The response of 9.57g and 10.33g for body weight in generation one and two respectively in males was lower than 49.8 g/d and 45.9 g/d reported by Piles and Blasco (2003) on the growth rate of rabbits. Moura et al. (2001) also reported 17.2 g in rabbits. The observed values of 14.54g and 1.85g for body weight in generations one and two in females were higher than 0.6 g/d for average daily gain reported by Szendro et al. (1992). However, most of the traits decreased as the selection advanced. This is attributed to a decrease in the additive gene action as the population becomes homogeneous. Nwagu (2007) reported that selection progress tends to decline and eventually disappear in a long-term selection applied to a closely related population as a result of an increase in homozygosity or genetic drift due to inbreeding.

Table 3.3: Selection response of body weight (g) and linear body traits (cm) in Chinchilla

		Traits							
Sex	**Gen**	**BW**	**EL**	**NTS**	**LBL**	**HG**	**THL**	**BL**	**TC**
Male	**G1**	9.45	0.12	0.30	0.33	0.11	0.09	0.29	0.13
	G2	10.33	0.01	0.04	0.01	0.03	0.01	0.03	0.01
Female	**G1**	14.54	0.10	0.29	0.33	0.10	0.07	0.21	0.12
	G2	1.85	0.01	0.01	NE	0.03	NE	0.02	NE

BW=body weight, EL=ear length; BL=Body length; LBL=length of back legs; THL=thigh length, NTS= nose to shoulder, HG=heart girth, TC=thigh circumference, Gen=generation, NE=not estimable,

The selection response of body weight and linear body traits in Dutch are presented in Table 3.4. Based on values recorded for males, the thigh length (0.04cm) was not affected positively by selection in generation two. In the same vein in females, the nose to shoulder 0.05cm and thigh length 0.02cm showed a similar trend. The response of 7.48g and 27.40g for body weight in generations one and two were at variance with the report of Gomez et al. (2000) who recorded 38g for body weight. The researcher also observed the selection progress of 0.6g/d for average daily gain. The decline in selection response of the thigh length in males, and nose to shoulder and thigh length in females explain low additive gene variance play on the expression of the trait. This is an indication that some information on the relatives, which include ancestral records and records of collateral relatives, may better the responses in some traits with low progress under selection (Kabir, 2010).

Table 3.4: Selection response of body weight (g) and linear body traits (cm) in Dutch

		Traits							
Sex	**Gen**	**BW**	**EL**	**NTS**	**LBL**	**HG**	**THL**	**BL**	**TC**
Male	**G1**	7.48	0.03	0.01	0.01	0.10	0.08	0.12	0.01
	G2	27.40	0.09	0.24	0.34	0.30	0.04	0.32	0.23
Female	**G1**	18.38	0.05	0.06	0.05	0.06	0.03	0.16	0.04
	G2	18.66	0.07	0.05	0.40	0.25	0.02	0.25	0.20

BW = body weight, EL=ear length; BL=Body length; LBL= length of back legs; THL=thigh length, NTS=nose to shoulder, HG=heart girth, TC=thigh circumference, Gen=generation, NE=not estimable.

4.0 Conclusion and Recommendation

Traits of interest under high additive gene variance improved significantly in the advanced generation of selection. However, improving body weight through selection improved the linear body traits in Dutch rabbits. Therefore Dutch breed could be a better choice genotype for the improvement of growth traits.

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