Journal of Fisheries & Livestock Production

Ologbose et al., J Fisheries Livest Prod 2017, 5:3
DOI: 10.4172/2332-2608.1000250

Research Article Open Access

Effect of Breeds, Sex and Age on Interrelationship between Body Weight and Linear Body Measurement in Rabbits

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Abstract

One hundred and forty-four rabbits comprised three genetic groups viz 48 Dutch (DUT) X New Zealand white (NZW), 48 NZW X NZW and 48 DUT X DUT were used to study the influence of breeds, age and sex on the interrelationship of body weight (BW) and linear body measurements (LBMs) body length (BL), heart girth (HG), Height at withers (HTW), Fore limb (FLL) and Hind limb length (HLL).These rabbits were grouped based on their breeds, age and sex. Data were also classified on the basis of breeds, sex and age for 4 weeks, 8 weeks and 12 weeks. The results indicated that both sex and age significantly (p 0.05) influenced all the LBMs. Correlation analysis between all pairs of Key measurements were also positive significantly (p 0.05) correlated for all ages as well as in both sexes. Regression analysis revealed that male Dutch rabbit recorded the higher value at 4 weeks, while, the female observed the higher value at 8 weeks. This also revealed that heart girth (HG) could be used as a single predictor of body weight (BW) for both sexes at 4 and 8 weeks of age. While, height at wither (HTW) is being considered as a single predictor for female at 12 weeks. It is therefore, concluded that breeds, age and sex had significant influence on the interrelationship between BW and LBMs.

Keywords: Dutch and New Zealand; Age; Sex; Body weight; Linear body measurements

Introduction

Breed of rabbits is one of the factors that influence general performance of rabbits most especially growth performance. The assessment of rabbit's genotype cannot be over emphasized for economic traits, most especially when rabbit is raised for commercial purposes as we know that availability of rabbit end product will absolutely depend on their growth performance. It is essential to know that diversity of rabbit genotypes has given great opportunity to improve the efficiency of commercial meat production through crossing [1]. Many investigators had reported that genotypes had an influence on both body weight and linear measurements of rabbits. These contribute greatly to the optimal performance of the animals [2]. Several research findings have shown that linear body measurements are closely related to live weights in farm animals. The linear body measurements can be used to predict live weight of farm animals at relatively lower costs with a high relative accuracy and consistency. Kempster reported that body dimensions describe an animal more completely than conventional methods of weighing and grading. Prediction for growth characters in weaner rabbits is important because heavier marketable body weight constitutes immensely to the economics of rabbit farms.

Rabbit is available as another choice of meat producing livestock in the tropic humid environment. Rabbit production is increasing due to its high reproductive performance, genetic variability, roughage utilization potentiality and very low cost of production since, it requires little capital, space and labour. Likewise, rabbit meat is of high protein level and of high values due to its low cholesterol.

It is imperative to improve rabbits in order to increase their contribution to the much needed animal protein in Nigeria. It is essential for rabbit breeders to establish the relationship that exists between life weight and linear measurements as well as to organize the breeding programmes, so as to achieve an optimum combination of body weight and good conformation for maximum economic returns [3]. This makes the work of the breeders easier and faster as its effects can then be concentrated on traits that are easier to measure. Body dimension describes an animal more completely than conventional methods of weighing and grading.

Linear body measurements provide good report on performance, productivity and carcass quality of animals [4]. Linear body measurements allow comparisons of growth in different parts of the body [5]. The various body constituent parts develop at different rates and these alterations determine the shape, conformation and body proportion of the animal with a specific period of time [6]. Ibe and Ezekwe [7] reported that the inter-relationship existing between body weight and linear body characters of meat animals have found useful application in quantifying body size and shape as well as growth performance, productivity and carcass characteristics of animals. Most of the linear body measurements reflect primarily the growth of the long bones when taken sequentially over a period of time. Animal's body changes in shape has been used as predictors of both animal live weight and carcass composition. Live weight is very important variable in determine the market value of an animal [5]. In a similar vein, Akpan [8] reported that increasing meat yield from animal require genetic improvement of their body weight and this involves proper measurement of growth traits. Linear measurements have been used to predict growth performance of some farm animals by different authors such as in the case of poultry [9,10], goats [11], sheep, cattle and pigs [12]. In an attempt to genetically improve rabbits, Cheeke [13] reported on the characterization of physical body traits of domestic rabbits in the humid tropics and observed significant differences for all the live body traits considered using New Zealand White, Chinchilla and

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Received June 28, 2017; **Accepted** September 05, 2017; **Published** September 11, 2017

Citation: Ologbose FI, Ajayi FO, Agaviezor B (2017) Effect of Breeds, Sex and Age on Interrelationship between Body Weight and Linear Body Measurement in Rabbits. J Fisheries Livest Prod 5: 250 doi: 10.4172/2332-2608.1000250

Dutch breeds of rabbits. Abdullah et al. [5] observed very high, positive and highly significant correlation coefficients exist on both body weight and all the linear body measurements he examined. Traits with highly and positively correlated in a breeding programme have tendency of achieving increased body weight through body width in the selection index. Selection for growth rate in rabbits is usually done on the basis of body weight measurement of individual animals. To achieve better growth rate, therefore, selection of genotypes with potential for appreciable body weight is necessary [14]. Linear body measurements allow comparisons of growth in different parts of the body [5]. The live body weight and linear body measurements contribute greatly to the performance of the animal [15,16]. Improvement of rabbits is important in order to increase their contribution to the much needed animal protein in Nigeria. One of the pre-quisite for genetic improvement is the knowledge of genetic parameters for important economic traits [9]. Rabbit producers are interested in the relationship that exists between body weight and physical characteristics, since this reflect performance of the rabbits. According to Khali et al. [3] breeders need to sure of the relationship that exists between these parameters and to organize the breeding programmes so as to achieve an optimum combination of body weight and good conformation for maximum economic returns. Relating body weight to linear body measurements is a way of predicting body weight of rabbits. This is relevant especially in rural areas where conventional weighing scales are not available. It also serves as a tool for breeders in selecting animals with desired traits for breeding stock.

It is very imperative that a reliable method of estimating body weight of rabbit is important in assessing the nutritional requirements, growth rate and drug doses of the animals.It is obvious that there is insufficient information or reported work on influence of genotype, age and sex on body weight and linear body measurements of rabbits in Nigeria. It is against this background that the investigation was undertaken with the objective of investigating the influence of genotype and sex on the interrelationship of the body weight and linear body measurements of rabbits.

Materials and Methods

The data for this study were collected from one hundred and forty four rabbits from three different genotypes (i.e., NZW X NZW, DUT X DUT and DUT X NZW). These rabbits were grouped based on their breeds, ages and sexes.

The experiment was conducted at Rabbitary unit, Teaching and Research Farm, University of Port Harcourt Rivers State. The rabbits were sourced from VOM Jos, Plateau State and ADP, Rivers State, Nigeria. The animals were housed in hutches made of metals and dimension of each hutch is 60 cm × 60 cm × 60 cm. The hutches are large enough to allow for easy movement. Feeders and drinkers were also provided. The rabbits were fed ad libitum with conventional feed (growers pelletized feed) in the morning and supplemented with forages like Panicum maximum, Aspilia africana and Centrosema molle in the afternoon.

Body weight of individual rabbit was measured using weighing balance with accuracy of 25 g. The following linear body measurements were recorded using a measuring tape,

Body length: which is the length between the tip of the nose and rump.

Height Girth: Body circumference is taken just behind the fore legs.

Fore limb: The length from the point of attachment of the fore leg to the tip of the fore leg.

Hind limb: The length from the point of attachment of the hind leg to the tip of hind leg.

Data collected were classified in relation to the age and sex of the rabbits. Means+SE for body weight and linear body measurements were estimated using descriptive statistic. While, the interrelationship of the body weight and linear body measurements were also estimated for different ages and sexes.

Statistical Analysis

The data collected on each animal were analysed using SPSS in relation to the rabbits sex and age. The fixed and random effects considered were the age and sex of the animals studied. The statistical model used was as follows; Yijk=U+Gi+Aij+Sijk+eijkl where.,

Yijk=Body weight of each rabbit

U=Overall mean

Gi=The fixed effect of ith breed of the animals

Aij=The fixed effect of ith age of the animals

Sijk=the random effect of jth sex of the animals

eijkl=random error

Correlation coefficients were also obtained from the parameters. The linear regression effects of independent variables on body weight were also considered in the following model

BW=b0+b1X1+b2X2+...............bnXn+ei BW=Body weight b0=interception b1......bn=the regression coefficient

X1.......Xn=Linear body parameter

E=residual error.

Results

Table 1 shows the mean+standard error of DUT X DUT, NZW X NZW and DUT X NZW at 4 weeks, 8 weeks and 12 weeks in relation to their sex.

At 4 weeks, female progenies from DUT X NZW recorded the highest BW (347.92 ± 67.81) and likewise for all the LMBs while, the male progenies from DUT X DUT recorded highest values of BW (359.09 ± 72.69) and they also recorded the highest values for LBMs. Generally, at 4 weeks Cross bred DUT X NZW recorded the highest BW (and LBMs while NZW X NZW recorded least values of BW (234.09 ± 77.68) and LBMs. At 8 weeks, female DUT X DUT recorded highest values of BW (856.25 ± 149.35) as well as in LBMs which is followed by male DUT X DUT (786.37 ± 155.45). While, the female NZW X NZW had least values of BW and LBMs.

The result obtained for 12 weeks, showed that male cross bred DUT X NZW recorded highest BW (1160.54 ± 188.36) as well as in LBMs and female cross bred DUT and NZW recorded the least values (894.12 ± 254.11).

Table 2 shows the correlation coefficient of variables. At 4 weeks, the correlation coefficient of BW and BLMs was positive and significant (p0.05), the relationship between BW and BLMs such as BL, HTW, HLL was lower than the association that exists with HG and FLL.

At 8 weeks, there was a very high, positive and significant correlation between the BW and all the variables of LBMs. But, BL and HG show higher correlation with BW.

4 weeks							
Genotype	**Sex**	**Body weight (g)**	**Body length (cm)**	**Height at wither (cm)**	**Hearth girth(cm)**	**Fore limb(cm)**	**Hind limb(cm)**
DUT X DUT	F	303.13 + 38.82	21.12 + 1.46	6.44 + 0.98	14.06 + 1.40	10 + 1.51	15.31 + 0.96
NZW X NZW	F	234.09 + 77.68	17.73 + 3.74	6.32 + 1.12	13.36 + 1.57	8.95 + 2.10	13.14 + 1.63
DUT X NZW	F	347.92 + 67.81	26.21 + 2.19	6.54 + 1.23	14.5 + 1.73	10.17 + 1.66	16.13 + 1,43
DUT X DUT	M	359.09 + 72.69	21.55 + 1.64	6.32 + 0.68	14.27 + 0.79	10.72 + 1.42	16.05 + 1.46
NZW X NZW	M	261.11 + 93.63	21.11 + 3.69	6 + 0.97	13.78 + 2.05	10.06 + 2.10	13.33 + 1.60
DUT X NZW	M	330 + 22.97	27 + 1.25	6.85 + 0.75	15 + 1.15	10.9 + 1.60	16.05 + 0.9
DUT X DUT	F&M	335.53 + 65.79	21.37 + 1.54	6.37 + 0.80	14.18 + 1.06	10.42 + 1.47	15.74 + 1.30
NZW X NZW	F&M	246.25 + 84.01	19.25 + 4.01	6.18 + 1.04	13.55 + 1.76	9.45 + 2.12	13.23 + 1.58
DUT X NZW	F&M	339.77 + 52	26.57 + 1.83	6.68 + 1.03	14.73 + 1.49	10.5 + 1.65	16.10 + 1.13
8 Weeks							
Genotype	**Sex**	**Body weight (g)**	**Body length (cm)**	**Height at wither (cm)**	**Hearth girth(cm)**	**Fore limb(cm)**	**Hind limb(cm)**
DUT X DUT	F	856.25 + 149.25	37.25 + 1.98	9.86 + 1.13	20.5 + 2.78	15.86 + 1.73	23.25 + 1.28
NZW X NZW	F	544.64 + 139.42	33.07 + 2.09	8 + 0.48	17.07 + 2.13	15.21 + 1.72	20.14 + 1.51
DUT X NZW	F	720 + 204.06	34.3 + 5.79	9.3 + 1.25	18.7 + 3.74	15 + 2.0	20.4 + 2.76
DUT X DUT	M	786.37 + 153.45	36.46 + 2.81	9.42 + 1.02	20.09 + 1.87	16 + 1.73	22.72 + 1.27
NZW X NZW	M	731.25 + 217.84	35.38 + 2.43	8.31 + 0.96	17.81 + 1.69	15.88 + 1.81	20.56 + 1.50
DUT X NZW	M	706. 82 + 179.96	35.55 + 3.14	8.46 + 1.04	17.46 + 1.97	15.13 + 1.11	20.73 + 1.73
DUT X DUT	F&M	815.79 + 151.66	36.79 + 2.46	9.61 + 1.06	20.26 + 2.23	15.95 + 1.68	22.95 + 1.27
NZW X NZW	F&M	612.5 + 190.51	33.91 + 2.43	8.11 + 0.69	17.34 + 1.97	15.46 + 1.74	20.30 + 1.49
DUT X NZW	F&M	713.10 + 187.12	34.95 + 4.52	8.86 + 1.20	18.05 + 1.60	15.38 + 1.60	20.57 + 2.25
12Weeks							
Genotype	**Sex**	**Body weight (g)**	**Body length (cm)**	**Height at wither (cm)**	**Hearth girth(cm)**	**Fore limb(cm)**	**Hind limb(cm)**
DUT X DUT	F	1076.47 + 204.34	36.59 + 3.84	10.18 + 1.31	21.21 + 3.36	17 + 1.85	23.53 + 3.74
NZW X NZW	F	960.29 + 233.19	39.53 + 1.88	9.62 + 1.67	20.53 + 2.48	15.79 + 0.95	24.12 + 1.89
DUT X NZW	F	894.12 + 254.11	37.71 + 2.97	9.29 + 0.99	20.56 + 3.29	16.76 + 1.72	24.03 + 2.20
DUT X DUT	M	1120.59 + 206.01	38.65 + 3.51	10.24 + 1.38	21.53 + 2.18	17.53 + 1.23	24.91 + 1.62
NZW X NZW	M	1066.18 + 27.36	39.41 + 2.96	10.56 + 1.06	21.12 + 1.76	16 + 1.28	23.94 + 1.59
DUT X NZW	M	1160.54 + 188.36	40.23 + 2.13	9.85 + 1.45	20.85 + 2.00	18 + 1.87	25.42 + 0.81
DUT X DUT	F&M	1095.24 + 255.71	39.47 + 2.44	10.09 + 1.46	20.82 + 2.14	15.90 + 1.11	24.03 + 1.72
NZW X NZW	F&M	1013.24 + 255.71	39.47 + 2.44	10.09 + 1.46	20.82 + 2.14	15.90 + 1.11	24.03 + 1.73
DUT X NZW	F&M	1010 + 261.68	38.8 + 2.89	9.53 + 1.22	20.68 + 2.76	17.3 + 1.86	24.63 + 1.85

Table 1: Mean + s. E For body weight and linear body measurements.

4 Weeks	**BW**	**BL**	**HTW**	**HG**	**FL**	**HL**
BW	1					
BL	0.118345	1				
HTW	0.287614	0.556413	1			
HG	0.685989	-0.14438	0.471972	1		
FL	0.486864	0.648204	0.578691	0.303735	1	
HL	0.113658	0.273974	0.327073	0.116105	0.688062	1
8Weeks	**BW**	**BL**	**HTW**	**HG**	**FL**	**HL**
BW	1					
BL	0.832732	1				
HTW	0.657209	0.67336	1			
HG	0.849288	0.823874	0.710634	1		
FL	0.787236	0.810253	0.602077	0.74346	1	
HL	0.733153	0.82088	0 0.625979	0.738983	0.769358	1
12Weeks	**BW**	**BL**	**HTW**	**HG**	**FL**	**HL**
BW	1					
BL	0.489969	1				
HTW	0.649362	0.178847	1			
HG	0.545902	0.505179	0.521731	1		
FL	0.364875	0.374752	0.280266	0.32369	1	
HL	0.39362	0.463793	0.17544	0.40238	0.226709	1

BW: Body weight; BL: Body length; HT: Heart at wither; HG: Heart Girth; FLL: Fore limb length; HLL: Hind limb length.

Table 2: Coefficient of correlation between the variables.

At 12 weeks, high and positive coefficient of correlation was obtained between the BW and LBMs but HTW and HG recorded higher correlation with the body weight. While, correlation between HLL and HTW recorded the least value.

Table 3 shows the predictive regression equations which indicate high and positive significant (p 0.05) of LBMs and with BW except for

AGE	SEX	Predictive Equations	R2
4	M	BW=489.73+34.02BL – 54.75HTW+53.62HG – 2.75FLL+13.25HLL	90.1
	F	BW=77.63+3.18BL – 15.13HTW+20.27HG+15.85FLL+12.27HLL	82.2
8	M	BW=-1198.95+25.17BL+36.33HTW+19.25HG+24.13FLL+24.13HLL	86.42
	F	BW=-480.30+11.17BL+4.48HTW+24.86HG+23.08FLL+0.91HLL	89.2
12	M	BW=900.06+17.56BL+40.18HTW -7.11HG – 9.81FLL+22.08HLL	36.84
	F	BW=-1286.12+20.24BL+1.60HTW+3.85HG+8.77FLL+10.85HLL	76.6

Table 3: Predictive regression equations relating body weight to linear body measurements.

male at 12 weeks. The R2 values ranged from 36.84 –90.10 in males and 76.63–89.20 in females. At 4 weeks, the male obtained higher R2 of 90.10% with HG as the most preferred single predictor (LBM) for predicting BW. While, female recorded 82.20% with the same HG as preferred single predictor (LBM) for predicting BW.

At 8 weeks, the female recorded higher R2 value of 89.20% with HG being considered as the most preferred single predictor for predicting BW against the male which obtained 86.42% with HTW being considered as the single predictor for BW. At 12weeks, female recorded the higher positive R2 value of 76.63 with HTW as a single predictor for BW.

Discussions

Table 1 shows the mean+standard error of DUT X DUT, NZW X NZW and DUT X NZW at 4 weeks, 8 weeks and 12 weeks in relation to their sex.

At 4 weeks, female progenies from DUT X NZW recorded the highest BW (347.92+67.81) and likewise for all the LMBs while, the male progenies from DUT X DUT recorded highest values of BW (359.09+72.69) and they also recorded the highest values for LBMs. Generally, at 4 weeks Cross bred DUT X NZW recorded the highest BW (and LBMs while NZW X NZW recorded least values of BW (234.09+77.68) and LBMs. The cross bred (DUT X NZW) indicated superiority over the pure bred at the pre-weaning ages, this observation was in line with the reports of Odubote and Somade [17] and Chineke et al. [16] that pre-weaning growth performance 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. This result also shows that male rabbits obtained were significantly higher in body weight and linear body measurements at (p=0.05) than females. Gueye et al. [18] and Hamayum obtained similar result in chicken and goats. It is concluded that such sex dimorphism as observed in this investigation according to Gatford et al. [19], improves competitive ability and greater opportunity for breeding. Hence, the bigger male is most opportune to mate with females in the colon y due to its size. At 8 weeks, female DUT X DUT recorded highest values of BW (856.25+149.35) as well as in LBMs which is followed by male DUT X DUT (786.37+155.45). While, the female NZW X NZW had least values of BW and LBMs. The result obtained is in agreement with Chineke et al. [16] who reported significant breed differences for all the LBMs considered using NZW, CHA and DUT breeds of rabbits.

The result obtained for 12 weeks, showed that male cross bred DUT X NZW recorded highest BW (1160.54+188.36) as well as in LBMs and female c ross bred DUT and NZW recorded the least values (894.12+254.11) . The higher values showed by male cross bred DUT X NZW could be as a result of the possession of major genes that improved growth performance in the two rabbit breeds i.e. DUT and NZW. Crossing did not only take advantage of traits with considerable non additive genetic variations (i.e. dominance and epistasis), but also made full use of differences in additive effects. Obike and Ibe [20], while, the results of Chineke et al. [16] and Abdullah et al. [5] reported superior performance of NZW over other breeds which the report obtained in his study. In the cross bred, contradicted crosses involving DUT X NZW recorded the best performance as compared to other rabbit crosses, this observation could be partly attributed to the possession of major genes that improved growth. Generally, the result showed that DUT X DUT from the pure rabbit genetic group were superior when compared to other breeds at all ages. This result corroborated with the report of Obike and performance in the two rabbit breeds. Crossing did not only take advantage of characters with considerable non-additive genetic variations (i.e. dominance and epistasis), but also exploited differences in additive effects (i.e., differences in average performance between populations as a deviation from the overall mean) between populations [16]. Table 2 shows the correlation coefficient of variables. At 4 weeks, the correlation coefficient of BW and BLMs was positive and significant (p 0.05), the relationship between BW and BLMs such as BL, HTW, HLL was lower than the association that exists with HG and FLL. This implies that HG and FL have stronger correlation with BW at 4weeks and they could be useful for predicting body weight of rabbits at 4weeks. BL also shows negative correlation with HG but, BL recorded high correlation with FLL.

At 8 weeks, there was a very high, positive and significant correlation between the BW and all the variables of LBMs. But, BL and HG show higher correlation with BW, this implies that a strong association exist between them and therefore, they could be very useful in predicting body weight of rabbits. Oke et al. [21] and Obike et al. [20] reported similar findings in rabbits.

At 12 weeks, high and positive coefficient of correlation was obtained between the BW and LBMs but HTW and HG recorded higher correlation with the body weight. While, correlation between HLL and HTW recorded the least value. It is observed that correlation coefficient in all ages were positive, this means that as the LBMs or BW is increasing, a corresponding increase is expressed in the other. This shows that growth in this breed of rabbit is asymmetrical with other parts. It is also indicator that as the rabbit grows, all the other parts are growing concurrently.

The result also showed that rabbits at week 8 recorded the highest level of association or interrelationship between BW and LBMs. This indicates that week 8 is the best age for selecting rabbits using LBMs this could be because the rabbits have overcome the stress or trauma of weaning and have access to enough feed. This age also falls within the stage of rapid growth in animals.

Table 3 shows the predictive regression equations which indicate high and positive significant (p 0.05) of LBMs and with BW except for male at 12 weeks. The R2 values ranged from 36.84–90.10 in males and 76.63–89.20 in females. The high R2 values recorded in this study implies that the predictive regression equations could be used to predict BW of rabbit accurately.

At 4 weeks, the male obtained higher R2 of 90.10% with HG as the most preferred single predictor (LBM) for predicting BW. While, female recorded 82.20% with the same HG as preferred single predictor (LBM) for predicting BW.

At 8 weeks, the female recorded higher R2 value of 89.20% with HG being considered as the most preferred single predictor for predicting BW against the male which obtained 86.42% with HTW being considered as the single predictor for BW.

At 12weeks, female recorded the higher positive R2 value of 76.63 with HTW as a single predictor for BW. The high R2 values obtained for both male and female is in agreement with the result of Okoro et al. [22] and Egena [23].

Conclusion

The DUT and NZW breeds of rabbit should be taken into account for improved breeding, crosses between these breeds and with other rabbit breeds will improve production efficiency of rabbit breeds with low production performance. Therefore, the two genotypes could be considered as choice genotypes for improvement of growth of rabbits. The improvement and sustainability of rabbit production will depend on how best selection is made as regards choice of genotypes and how well the breeding programme is planned. It is imperative that breeders should exploit the preponderance of additive genes in the rabbit population to bring about further improvement in the quantitative traits. This study shows the predictive regression equations which indicate high and positive significant ($p<0.05$) of LBMs and with BW except for male at 12 weeks. The R2 values ranged from 36.84– 90.10 in males and 76.63–89.20 in females. The high R2 values recorded in this study implies that the predictive regression equations could be used to predict BW of rabbit accurately

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