Nigerian J. Anim. Sci. 2020 Vol 22 (2):48-56 (ISSN:1119-4308)

Phenotypic correlation and carcass traits prediction using live body weight in four genetic groups of rabbit raised in tropical rain - forest zone of Nigeria

***Sam, I. M., Essien, C. A. and Ekpo, J. S.**

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:** sidorenyin@yahoo.com;* ***Telephone Number: +234 8029004857

Target Audience: *Animal Breeders, Rabbit farmers, Policy makers*

Abstract

A study was conducted to determine the phenotypic correlation between live body weight and carcass traits (dress weight, foreleg, thoracic, loin, hind leg and skin) and to predict the weight of carcass parts from live body weight in rabbits. Four genetic groups were involved: two purebreds Chinchilla (CHA) and New Zealand White (NZW) and their reciprocal crossing [CHA sire x NZW dam (CHA x NZW) and NZW sire x CHA dam (NZW X CHA)]. The breeding of these genetic groups generated one hundred and twenty-six kittens. These kittens were raised to maturity (12 weeks) before data on carcass performance were obtained. The parameters studied were live body weight, dress weight, weights of foreleg, thoracic, loin, hind leg and skin. The data obtained from this study were subjected to Pearson correlation and linear regression analysis. The results indicate that live body weight was moderate to high and positively correlated with all the carcass components in the four genetic groups except in NZW x CHA in which body weight was negatively correlated with loin and hind leg (-0.514 and -0.040 respectively) and it was also negatively correlated with thoracic (-0.142) in CHA x NZW. The prediction equations for carcass traits indicate that dress weight, foreleg, thoracic and loin in the four genetic groups were predicted with more accuracy than the prediction of hind leg and skin. The highest R^2 (0.828) was recorded in CHA X CHA genetic group for prediction of dressed weight. The actual and computed carcass weights were almost similar which indicate that carcass parts can be predicted from live body weight with accuracy. It was concluded that live body weight can be used as indirect selection criteria for carcass traits in rabbits (dress weight, foreleg, thoracic and loins. This investigation also demonstrates the applicability of regression equation to predict carcass traits in rabbit industry.

Key words: *Rabbit, Correlation, Regression, Carcass traits, Genetic group*

Description of Problem

The past few decades has recorded an increasing interest in production and consumption of rabbit in Nigeria and globally. This is probably link to recent awareness for the need to consume low-calorie and easily digestible meat (1).

In the past, rabbits were sold whole but due to high cost of production leading to high price of whole rabbit in addition to reduction in purchasing power, customers now demand for rabbit parts with the loin and hind part being the most valuable cuts (2). The commercial rabbit industries need breeds with fast rate of growth and more lean meat.

There are several reports showing that there are differences in body weight and carcass traits among strains of rabbits (1, 3, 4). Researches have also shown positive and significant correlations between live body weight and carcass characteristics (5, 6, 7) indicating that body weight could be good indicators of carcass traits in rabbits. Several other authors also proposed simple and multiple regression equations for prediction of carcass traits (8, 6, and 5) in Danish white, New Zealand white and Californian white.

Strategies to improve carcass values could significantly improve the financial return from rabbit (9). Improvement of carcass characteristics in rabbit has been reported to require reliable and easy to applied method to obtain slaughter value traits based on certain pre-slaughter measurements (9). Several studies with different species of animals indicated that different breeds of each species differ considerably from each other in terms of body weight and conformation. As such equation formulated using body measurement of a particular breed may not applied to another breed of the same species. In rabbits the model formulated for Danish white, New Zealand white and Californian by (9) differs significantly.

It is important to know the association existing between live bodyweight and carcass traits in rabbits. This is because the knowledge of this relationship will enable breeders to predict the carcass traits from live body weight before slaughter. Thus, helping the farmers to fix prices and predict income/gain from each rabbit before slaughter. Therefore, the objective of this study was to estimate the phenotypic correlations and regression coefficient between live body weight and carcass traits in four genotypes of rabbits.

Materials and Methods

This experiment was carried out at the Rabbitary 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 50 17′ N and 70 27′ N and longitudes 70 30′ E and 70 58′ E of the Greenwich Meridian. The climate is typically humid tropical with relative humidity ranging from 56.01 to 90 % and an annual rainfall ranging from 1680 mm to 1700 mm with annual temperature ranges of about 220C to 370C (10).

Experimental animals and management:

On arrival, the rabbits were allowed to acclimatize to the environment for two weeks 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 (11). A total of forty (40) adult rabbits [New Zealand White (NZW) and Chinchilla, (CHA)] comprising eighteen (18) NZW does and eighteen (18) CHA does, two (2) NZW bucks and two (2) CHA bucks were used. The mating ratio used was one buck to nine does in each genetic group. 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 were used for this study. The rabbits were kept in four 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 was also cleaned off in all hutches. The feeding and drinking troughs were cleaned on a daily basis before fresh water and feed were supplied. Pregnancy was detected by careful abdominal palpation on 14^{th} and 21^{st} days after mating, if confirmed pregnant, nest boxes were provided on 28th day of pregnancy.

Data collection

At the age of 12 weeks, five (5) rabbits from each genetic group were randomly selected after starving them overnight. The rabbits were weighed individually to obtain live body weight and thereafter slaughter and dissected according to methods recommended by (12). Slaughtered rabbits were bled, skinned and emptied of the digestive tract & urogenital organs before being weighted (Dress weight). The carcass cut (Thoracic cage, loin, forelegs, hind legs and skin) were weighed immediately using sensitive weighing balance (S. Miller Digital Scientific Scale) and were expressed in grammes. Dressings out percentage were calculated thus: Dressed Weight divided by carcass weight, multiply by 100

Data analysis

The relationships between live body weight and carcass traits and among the carcass traits (Thoracic cage, loin, forelegs, hind legs and skin) were investigated using (13). Prediction equations of carcass traits from live body weight were performed using the linear regression model, $y = a + bx$, where: y = predicted carcass trait; x = live body weight; b = slope; a = intercept. Correlations and prediction equations were separately studied for the four genetic groups.

Results and Discussion

The means and their corresponding standard errors as well as coefficient of variation for live body weight and carcass traits of four genetic groups and the overall totals are presented in Table 1. The results indicate that overall live body weight (LBW) was 886.50g; dress weight (DRWT) 440.95g; dressing percentage (DRS) 49.32%, foreleg(FOREL) 30.95g; thoracic (THOR) 71.20g ;loin 89.65g, hind leg (HIND) 68.60g and skin 76.40g. Measures of live weight and carcass characteristics exhibited low to moderate variability, varying from 4.62% for skin in NZW x CHA to 41.19% for loin in CHA x CHA. But in the overall mean measurement the lowest CV was observed in DRS% 17.55% while the highest was observed in 41.99%. The moderate variability in most of the carcass traits in the four genetic groups indicate that these traits could respond to selection and should be exploit.

The mean live body weight in the four genetic groups are similar to reports of (14) who studied litter traits in a diallel crossing of three breeds of rabbit (California white, Chinchilla and New Zealand white) in northern guinea savannah zone of Nigeria. However, it was lower than the findings of (15) who studied carcass traits of crossbreed rabbit bucks fed diets supplemented with pumpkin stem waste.

Table 1: Descriptive statistics of live body weight and carcass characteristics of four genetic groups of rabbits

Trait	CHAXCHA		NZWXNZW		CHAXNZW		NZWXCHA		TOTAL	
	Mean(±se)	CV%	Mean(±se)	CV%	Mean(±se)	CV%	Mean(±se)	CV%	Mean(±se)	CV%
LBW	877.40 ± 49.09	11.74	843.40 ± 63.02	16.71	615.20 ± 38.64	14.04	1210.00 ± 74.44	13.75	886.50 ± 55.33	27.92
DRWT	379.20 ± 41.98	24.76	447.00 ± 47.72	23.87	301.20 ± 34.82	25.85	636.40 ± 78.85	27.71	440.95 ± 36.60	38.14
DRS%	43.66 ± 3.07	15.74	52.53 ± 2.19	9.35	49.15 ± 5.39	24.55	51.96 ± 3.93	16.92	49.32 ± 1.93	17.55
FOREL	29.80 ± 3.35	25.16	29.80 ± 3.10	23.30	24.80 ± 2.08	18.78	39.40 ± 1.07	6.11	30.95 ± 1.69	24.44
THOR	57.00 ± 5.32	20.91	63.00 ± 5.40	19.47	49.80 ± 4.38	19.69	115.00 ± 10.48	20.39	71.20 ± 6.68	41.99
LOIN	89.40 ± 16.46	41.19	97.00 ± 15.70	36.19	62.20 ± 4.16	14.97	110.00 ± 7.58	15.41	89.65 ± 6.87	34.29
HIND	67.20 ± 7.95	26.48	75.00 ± 4.47	13.33	55.20 ± 3.54	14.34	77.00 ± 3.39	9.85	68.60 ± 3.08	20.10
SKIN	77.60 ± 6.14	17.71	74.00 ± 7.31	22.10	56.40 ± 3.42	13.59	97.60 ± 1.86	4.26	76.40 ± 4.10	24.05

LBW= Live body weight, DRWT= Dressed weight, DRS%= Dressing percentage, FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg,, CV= Coefficient of variation

Correlation between live body weight and carcass traits

Correlation coefficients (r) between live body weight and carcass traits of NZW X NZW and CHA X CHA genetic group of rabbits are shown in Table 2. In NZW X NZW, significant positive correlations were obtained between live body weight and all the carcass traits and among the carcass traits except relationship with skin weight. The correlation coefficient (r) ranges from moderate to high (r = 0.961, 0.713, 0.289, 0.787, 0.189 and 0.359 for dress weight, dressing percentage, foreleg, thoracic, loin and hind leg respectively). The correlation among the carcass trait in NZW x NZW genetic group were also positive except the relationship between dressing weight and thoracic (r = -0.670) and relationship between dressing percentage and thoracic (- 0.413) which were high and negative.

The phenotypic correlation between live body and carcass traits in CHA x CHA genetic group showed that live body weight had positive and highly significant ($p < 0.001$) correlation with all the carcass traits. The correlation coefficient ranges from moderate to high (r = 0.279 – 0.947). The highest correlation coefficient was observed between loin and live body weight (r = 0.947) whereas the least was obtained between skin and thoracic.

The estimate of phenotypic correlation between live body weight and carcass traits as well as among the carcass traits in CHA x NZW and NZW x CHA genetic group is presented in Table 3. The results indicate that, in CHA x NZW live body weight and carcass characteristics were significantly ($p < 0.005$, $p < 0.01$) and positively correlated with all the carcass traits and their correlation coefficient (r) ranged from 0.068 – 0.988. Except the relationship between live body weight and dress weight which was negative (r = - 0.142). The highest correlation coefficient was observed between live body weight and foreleg (r = 0.988). In NZW x CHA genetic group, significant positive correlations were also obtained between live body weight and dress weight (r = 0.879), foreleg (r = 0.256), thoracic (r = 0.285).However, negative correlations were observed between live body weight with loin and hind leg (r = -0.514 and – 0.040 respectively). In this genetic group (NZW x CHA) there was no correlation between live body weight and skin weight (r = 0). Dress weight and loin were also negatively correlated (r = -0.136). The relationship among the carcass traits were significantly positive ($p< 0.05$; $p<0.001$). The correlation coefficient ranged from moderate to high (r = 0.163 – 0.934).

The positive correlation value recorded in this study for most of the carcass traits and live body weight in all the four genetic groups indicate that live body weight and these carcass traits are influenced by the same genes in the same direction. This is in line with the reports of (9), who reported that live body weight showed the highest correlation with meat weight in the whole carcass and its valuable parts. 6, 7 also shared the same opinion. In broiler chicken (16) also reported that live body weight showed strong and positive relationship with carcass traits.

The positive correlation between live body weight and carcass traits in the four (4) genetic groups also suggests that there are direct relationships between live body weight and carcass traits, and that carcass weight is as a result of increase in live body weight (17, 18). These authors earlier reported that positive significant correlation could indicate that the pairs of traits are controlled by the same genes in the same direction, thus selection and improvement for live body weight will lead to improvement of carcass traits. The zero correlation recorded between live body weight and skin as well as negative correlation between live body weight with loin, hind leg and skin in CHA x NZW genetic groups suggests that the genes controlling their expression work in opposite direction and improvement in one trait will lead to reduction in the performance of the other. It has earlier been stated by (17) that negative correlation denoted that such pairs of trait have indirect relationship and are at least controlled by the same genes in different directions. Therefore, selection for one trait will lead to reduction of the other. Phenotypic correlation estimates between live body weight and carcass traits could guide the breeder in the choice of traits to incorporate into his selection index.

Table 2: Estimate of phenotypic correlation between live body weight and carcass traits as well as among the carcass traits of NZW X NZW (above diagonal) and CHA X CHA (below diagonal)

	LBW	DRWT	DRS%	FOREL	THOR	LOIN	HING	SKIN
LBW	1	0.961**	0.713*	0.289*	0.787**	0.189	0.357*	-0.125
DRWT	0.910**	1	0.876**	0.455*	-0.670	0.398	-0.098	0.154
DRS%	0.732**	0.910*	1	0.611*	-0.413	0.593*	0.383	0.597*
FOREL	0.537*	0.811**	0.827**	1	0.012	0.653*	0.270	0.625**
THOR	0.530*	0.558*	0.743**	0.512*	1	0.406*	0.489*	0.3808
LOIN	0.947**	0.864**	0.668**	0.617**	0.546*	1	0.516*	0.723**
HIND	0.432*	0.739**	0.899**	0.932**	0.661**	0.448*	1	0.917**
SKIN	0.624**	0.876**	0.841**	0.861**	0.279	0.555*	0.808**	1

*P < 0.05, **P < 0.001, LBW= Live body weight, DRWT= Dressed weight, DRS%= Dressing percentage, FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg,

Table 3: Estimate of phenotypic correlation between live body weight and carcass traits as well as among the carcass traits of CHA X NZW (above diagonal) and NZW X CHA (below diagonal)

	LBW	DRWT	DRS%	FOREL	THOR	LOIN	HING	SKIN
LBW	1	0.407	-0.142	0.323*	-0.271	0.511*	0.267	0.315*
DRWT	0.879**	1	0.838**	0.988**	0.441*	0.791**	0.429*	0.903**
DRS%	0.653**	0.934*	1	0.886**	0.719**	0.617*	0.331*	0.809**
FOREL	0.256	0.646*	0.813**	1	0.508*	0.837**	0.354*	0.948**
THOR	0.285	0.693**	0.896**	0.907**	1	0.444*	0.574*	0.397*
LOIN	-0.514	-0.136	0.163	0.306*	0.361*	1	0.162	0.909**
HING	-0.040	0.435*	0.706**	0.904**	0.879**	0.681*	1	0.068
SKIN	0.00	0.277	0.382*	0.769**	0.449*	0.337*	0.705	1

*P < 0.05, **P < 0.001, LBW= Live body weight, DRWT= Dressweight, DRS%= Dressing percentage, FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg,

Prediction of carcass traits from live body weight

Regression equations for predicting carcass traits from live body weight for the four genetic groups of rabbits are shown in Table 4. The coefficient of determination (R^2)for predicting dress weight, foreleg, thoracic, loin and skin from live body weight was significant (p < 0.05) for CHA x CHA ($R^2 value$ varied from 0.828, 0.289, 0.281, 0.897 and 0.390, respectively) but the R^2 value predicting hind legs from live body weight was not significant (P < 0.05) in CHA x CHA. In NZW x NZW, the R^2 predicting dressed weight, weights of thoracic and hind leg were significant (p < 0.05) with R^2value of 0.923, 0.620 and 0.123 respectively. But R^2 value for fore leg, loin and skin were found to be non-significant (p > 0.05) with R^2values of 0.083, 0.036 and 0.016 respectively. In CHA x NZW genetic group, the coefficient of determination $R^2$was only significant for predicting dress weight and loin (R^2 = 0.166 and 0.266 respectively).

In NZW x CHA, the coefficient of determination R^2 was only significant (p < 0.05) for predicting dress weight (R^2 = 0.773) and loin (R^2 = 0.264).The R^2 value for predicting skin from live body weight was zero while the R^2 value for hind leg was 0.002. The R^2 measured the proportion of the total variance in the dependent variable (Y) explained by the independent variable(X). From the result of this study, it was evidence from R^2 values that dress weight, foreleg, thoracic and loin of the rabbits can be predicted with accuracy from live body weight in the four genetic groups.

Hind leg and skin can however be predicted using live body with less accuracy. This report is in consonance with the work of (16) who reported that live body weight predicted dress weight with accuracy in broiler chicken. Limited information is available in using live body weight to predict carcass parts in rabbit.

The comparison between actual and predicted values of carcass trait from live body weight in the four genetic groups of rabbit is presented in Table 5. The result indicates that in CHA x CHA, the differences between the predicted (calculated) values and the actual values were 0.018, 0.060, -0.235, 0.285, -0.33 and 0.211 for dress weight, foreleg, thoracic, loin, hind leg and skin respectively. Akaïke information criterion (19) comparing these values indicate that there were no significant differences (p > 0.05) between the actual value and predicted value for all the carcass traits.

In the NZW x NZW genetic group, the results showed that deviation of the predicted values from actual values were -0.328, 0.184, 0.400, 0.029, 0.310, and 0.408, for dressing weight, foreleg, thoracic, loin, hinge leg and skin respectively. Comparing them statistically, there were no significant (p < 0.05) differences between the predicted and actual values.

The CHA x NZW genetic group followed the same trend, the deviation of the predicted from the actual values were -0.017, 0.259, 0.143, 0.048, -0.304 and -0.03 for dressing weight, foreleg, thoracic, loin, hind leg and skin, respectively. More so, statistically there were no significant (p > 0.05) differences between the actual values and predicted values.

Comparing the actual value and predicted value in NZW x CHA genetic group, the results indicate that there were no significant (p > 0.05) differences between the actual values and predicted values, the predicted value deviations from the actual were -0.110, -0.363, 0.197, -0.410 and -0.236 for dress weight, foreleg, thoracic, loin, hind leg and skin respectively.

The actual and computed carcass weights were more or less similar which confirms the fact that carcass parts can be predicted from live body weight with accuracy. This probably might be as a result of the positive, strong and closely correlated responses of carcass traits with live body weights used in predictions.

Table 4: Prediction equation for carcass traits from live body weight of four genetic groups of rabbits

Genotype	Carcass traits	Equation	R	R^2	Sig
CHA X CHA	Dress weight	Y = -348.14 +0.829(x)	0.910	0.828	**
	Foreleg	Y = -4.47 + 0.039(x)	0.537	0.289	**
	Thoracic	Y = 3.243 + 0.061(x)	0.530	0.281	**
	Loin	Y = -207.44 + 0.338(x)	0.947	0.897	**
	Hind leg	Y = 1.725 + 0.075(x)	0.432	0.187	**
	Skin	Y = 4.565 + 0.083(x)	0.651	0.390	ns
/NZW X NZW	Dress weight	Y = -166.66 + 0.728(x)	0.961	0.923	**
	Foreleg	Y = -17.801 + 0.014(x)	0.289	0.083	**
	Thoracic	Y = 120.79 + (-0.069)(x)	0.787	0.620	**
	Loin	Y = 57.33 + 0.047(x)	0.189	0.056	ns
	Hind leg	Y = 96.395 + (-0.025)(x)	0.357	0.123	**
	Skin	Y = 86.243 + (-0.015)(x)	0.125	0.016	ns
CHA X NZW	Dress weight	Y = 75.43 + 0.367(x)	0.407	0.166	**
	Foreleg	Y = 14.08 + 0.017(x)	0.323	0.104	**
	Thoracic	Y = 68.72 + (-0.031)(x)	0.271	0.073	ns
	Loin	Y = 28.31 + 0.055(x)	0.511	0.266	**
	Hind leg	Y = 40.12+ 0.025(x)	0.267	0.072	ns
	Skin	Y = 39.20 + 0.028(x)	0.315	0.099	ns
NZW X CHA	Dress weight	Y = -490 + 0.931(x)	0.879	0.773	**
	Foreleg	Y = 34.68 + 0.004(x)	0.025	0.065	ns
	Thoracic	Y = 66.40 + 0.040(x)	0.285	0.081	ns
	Loin	Y = 177.33 + (-0.052)(x)	0.514	0.264	**
	Hind leg	Y = 79.184 + (-0.002)(x)	0.400	0.002	ns
	Skin	Y = 97.60 + 0(x)	0.000	0.000	ns

Sig= significance ($p < 0.05$); ns = not significance

Conclusion and Applications

1. The study revealed moderate to high positive significant correlation coefficient values between live body weight and most carcass traits as well as among the carcass traits in the four genetic groups indicating that selection for one trait will lead to improvement in another trait. Thus, these phenotypic correlation estimates between live body weight and carcass traits could guide the breeder in the choice of traits to incorporate into his selection index.

2. Also, weights of carcass traits can be predicted with reasonable accuracy from live body weight in rabbit breeds. Thereby, helping the farmers to fix prices and predict income/gain from each rabbit before slaughter.

Table 5: Actual and predicted values for carcass traits in four genetic groups of rabbits

Genotype	Carcass traits(g)	Actual value(g)	Predicted value(g)	Deviation	significance
CH X CH	Dress weight	379.20	379.218	- 0.018	NS
	Foreleg	29.80	29.740	0.06	NS
	Thoracic	57.00	56.764	-0.0235	NS
	Loin	89.40	89.115	0.285	NS
	Hind leg	67.20	67.53	-0.330	NS
	Skin	77.60	77.389	0.211	NS
NZW X NZW	Dress weight	447.00	447.32	-0.328	NS
	Foreleg	29.80	29.615	0.184	NS
	Thoracic	63.00	62.600	0.400	NS
	Loin	97.00	96.976	0.029	NS
	Hind leg	75.00	75.310	-0.310	NS
	Skin	74.00	73.592	0.408	NS
CH X NZW	Dress weight	301.20	301.217	-0.017	NS
	Foreleg	24.80	24.541	0.259	NS
	Thoracic	49.80	49.657	0.143	NS
	Loin	62.20	62.152	0.048	NS
	Hind leg	55.20	55.504	-0.304	NS
	Skin	56.40	56.43	-0.03	NS
NZW X CH	Dress weight	636.40	636.51	- 0.11	NS
	Foreleg	39.40	39.760	- 0.363	NS
	Thoracic	115.00	114.803	0.197	NS
	Loin	110.00	110.40	-0.410	NS
	Hind leg	77.00	76.764	0.236	NS
	Skin	97.60	97.60	0	NS

NS = Not significance

Acknowledgements

hors acknowledge the support of the Head and staff of Animal Science Department, Akwa Ibom State University for providing the facilities used in this study. The authors also appreciate the Head of Farm Services for his co-operation and support.

References

1. Sam, I M., Ukpanah, U. A. and Udofia, I. E.(2020). Influence of Genotype on Body Weight and Morphometric Traits of Rabbits Raised in the Tropics, *Animal Research International*, 17(1): 3603 – 3610.
2. Hernandez, P. Gondret, F., (2002). Rabbit meat quality in: L. Maertens, P. Condert (eds). Recent Advance in Rabbit Science. ILVO, Melle Belgium, pp. 269-290.
3. Obasi, E. N., Obasi, U. I., Nosike, R. J., Obike, O. M. and Ibe, S. N. (2019). Estimate of direct and percentage heterosis of body weight and linear body measurements of rabbits. In: Proceedings of 44th Annual Conference of the Nigerian Society for Animal Production in Nigeria. Held at University of Abuja, Abuja. 17th – 21st March, 2019. Pp 81 – 85.
4. Ozimba C. E. and Lukefahr S. D. (1991). Evaluation of purebred and crossbred rabbits for carcass merits. *Journal of Animal Science*, 69: 23-71.

5. Rymkiewicz J. and Lewczuk A. (2000). Values of pre- and post-slaughter traits for estimating meat, fat and bone weight in the carcass of extensively reared New Zealand White rabbits. *Animal Science Paper and Report*, 18, 165–182.

6. Lewczuk A., Postek A., Brzozowska W., Michalik D., Janiszewska M. (2001). The value of chosen pre– and post–slaughter traits for the estimation of lean yield in valuable carcass parts of Danish White rabbit. *Animal Science Paper and Report*, 19, 141–155.
7. Lukefahr, M. S. D. and Ozimba, C. E. 1991. Prediction of carcass meat from live body Measurements in rabbits of four breed types. *Livestock Production Science*, 29: 323 – 334.
8. Ayyat M.S., Marai I.F.M., El–Sayiad G.M.A. (1995): A trial to grade New Zealand White Rabbits for broiler production at marketing and breeding. *World Rabbit Science*., *3*, 75–84.
9 Michalik, .D., Lewczuk, A.,Wilkiewicz-Wawro, E. and Brzozowski, W. (2006). Prediction of the meat content of the carcass and valuable carcass parts in French lop rabbits using some traits measured in vivo and post mortem, *Czech Journal of Animal Science.*, 51(9): 406–415.
10. Wikipedia (2017). Akwa Ibom State https://en.wikipedia.org/wiki/Akwa_Ibom_State Accessed December21, 2017.
11. SAMRC (2004). Guidelines on Ethics for Medical Research: Use of Animals in Research and Training. South Africa Medical Research Council (SAMRC), Cape Town, South Africa. Available at www.kznheaith.gov.za/research/ethics3.pdf Retrieved 21, December 2019.
12. Ekpo, J, S. Solomon, I. P. Isaac L. J and Ekpo, K. O (2009). Carcass characteristic and economic benefits of weaned rabbit fed cassava peel meal, cassava tuber meal and composite carcass tuber meal. *Asian Journal of Animal veterinary Advances*. 44. 214- 218.
13. SPSS. (2007). Scientific Package for Social Sciences
14. 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. In: proceedings of 10th World Rabbit Congress held at Sharm EL – sheikh – Egypt, September 3 – 6 2012, Pp 69 - 74
15. Ekpo, J. S., Udia, V. S., Ogundu, E. C., Sam, I. M. and Eyoh, G. D.(2016). Carcass Traits of Crossbred Rabbit Bucks Fed Diets Supplemented with Pumpkin Stem Waste. *European Journal of Advanced Research in Biological and Life Sciences,* 4(3):1 – 7.
16. Sam, I. M. (2019). Influence Of Sex On Relationship between Morphometric Trait Measurement and Carcass Traits in Broiler Chicken Raised in Humid, Journal *of Agriculture, Environmental Resource and Management*, 4(1): 395-403.
17. Ehiobu, N. G. and Kyado, J. A.(2000). Hearitabilty, Repeatability and Genetic correlation of swine. In; Proceedings of 25th Annual Conference of Nigerian Society of Animal Production Umudike Nigeria pp 260 – 263.
18. Falconer D. S. (1989). Introduction to Quantitative genetics 3rd Edition Longman group limited, Burat Mill England.
19. Akaike, H.. (1974). A New look at the Statistical Model Identification. Institute of Statistical Mathematics, Pp 716 - 723.