Journal of Innovative Agriculture: 9(2) : 21-27, 2022
DOI: 10.37446/jinagri/rsa/9.2.2022.21-27
Research paper

The influence of sex and age on growth rate of domestic rabbits (*Oryctolagus cuniculus*)

Vida Korkor Lamptey[1], Julius Kofi Hagan[2], Bernard Ato Hagan[3], Francis Kruenti[1,*], Doris Yaa Osei[1]

[1]Council for Scientific and Industrial Research – Animal Research Institute, Katamanso, P.o. Box AH 20, Achimota, Accra, Ghana.
[2]Department of Animal Science, University of Cape Coast, Cape Coast, Ghana.
[3]Department of Animal Proudction and Health, University of Energy and Natural Resources, P.O. Box 214, Sunyani, Ghana.

Received: 15 May 2022
Accepted: 11 June 2022
Published: 30 June 2022

***Correspondence**
Francis Kruenti
fkruenti@gmail.com

The experiment was conducted to measure the effect of age and sex on growth traits and their relationships in rabbits. 96 8-weeks-old (male and female) weaned composite rabbits were used in a completely randomized experiment. Data was analysed with the General Linear Model procedure of SAS (version 9.4). Differences between means were separated with the Tukey Comparison Method at 5% probability level. Body weight of the rabbits significantly increased as they grew from week 8 (577.51g) to 2090.51g in the 20th week. Sex had no significant effect on the rabbits' body weight and post weaning average daily gain (PWADG) but the males were heavier than the females at all ages except the weaning age. There was medium to high positive correlation (r = 0.379 to r = 0.974) between body weights at all ages. The association between body weight and PWADG was negatively low in the younger animals, but the traits however had positive but low to medium correlation from week BW14 to BW20. Body weight of the does had low to high and positive correlations among the different ages. The younger does up to week 12 presented negative relationship between body weight and PWADG but from week 13 to week 20, the duo related positively. Body weight of the bucks had medium (0.455) to high (0.979) positive associations among the ages. Body weight and PWADG had negative correlation in the younger bucks up to week 13 except for week 12 (r = 0.051) but correlated positively in the older females from week 14. Growth rate is faster in younger rabbits than older ones and so younger rabbits must be managed adequately up to week 16 to boost their system for growth and to reach marketable sizes early. Bucks increase in weight faster than the does, and so must be housed separately to avoid bullying. For improved body weight, rabbits should be selected for breeding at a younger age.

Key words: *rabbits, body weight, sex, age, correlation*

INTRODUCTION

Animal protein supply in Ghanaian diets and diets of other sub-Saharan African countries remains woefully inadequate. This is because the local meat production has not kept pace with population growth to meet the demands, thus forcing the country to depend on meat imports to the neglect of the development and sustainability of the local livestock industry (Banson et al., 2015). Rabbit production can function as a sustainable system because it involves the use of renewable on-farm resources such as: local breeds, feedstuffs, simple hutches/houses and equipment (constructed from local materials) and cheap family labour (Petrescu et al., 2013). Early sexual maturity, short gestation period, high prolificacy and fecundity, and short generational interval are the characteristics of rabbits aside their ability to efficiently convert food to meat (Akanno & Ibe, 2005; Dalle Zotte, 2014; Udeh, 2013) As a result of these, they can be used as a cheap source of protein (Apori et al., 2014) knowing that rabbit meat consists of about 22.4% protein (Hernández & Dalle Zotte, 2010). Rabbit meat in addition has high digestibility, good taste and low sodium, fat and cholesterol contents (Herbert, 2011). Therefore, their production can be an alternative approach to solve employment and protein shortages, to improve the diet and income of both rural and urban families, but the business has not been given adequate attention. There are low records of success on sustainable long-term genetic improvement programmes designed to assist smallholder rabbit producers in sub-Saharan Africa. This could be attributed to uncoordinated and poorly defined research in the industry, heavy dependence on foreign aid and lack of facilities needed to implement such programmes – resulting to over reliant on the use of exotic rabbits in Ghana (Apori et al., 2014) even though they perform poorly under the country's warm and humid conditions.

Body weight of live animals and their carcass composition are very important components use to determine their meat yield and market value (Abdullah et al., 2003). To increase the meat yield of animals, proper genetic improvement and management of their body weight (Akpa, 2000) at different ages (weaning and post weaning) are required. However, to achieve better growth of livestock, selection of genotypes that have the potential for appreciable body weight (growth) is necessary (Ekpenyem, 2002). Meanwhile, any attempt to improve body weight in rabbits would largely depend on its relationship with other linear measurements which were found to be positive, high and significant in an experiment (Abdullah et al., 2003). Nonetheless, these associations can also be affected by the sex and/or age of the animals because changes in body length of rabbits have been linked to age and sex Ologbose et al. (2017). Hence, there is the need to study the response of growth traits to sex and age of rabbits as well as their relationships to ease the selection of the rabbits for breeding purposes.

MATERIALS AND METHODS

Location of the study area

The study was conducted at the Rabbit Unit of the Council for Scientific and Industrial Research-Animal Research Institute (CSIR-ARI) at Katamanso in the Greater Accra Region of Ghana. CSIR-ARI is located on latitude 5.7252259 °N and longitude -0.1549277°W. The station lies within the coastal savannah zone, characterized by dry weather conditions from November to March, a maximum of 222.0 mm of precipitation in June, and an average annual rainfall of 810.0 mm.

Experimental animals, housing and management

A total of 96 weaned composite breeds of domestic rabbits that were 8 weeks old were purchased from selected commercial rabbit farmers in the Greater Accra region and used in a Completely Randomized Design experiment. The animals were put into male and female groups of 48 animals each. The animals in each sex group were randomly regrouped into 4 treatment groups with 4 animals in a cage and replicated thrice. All the rabbits were kept under the same environmental conditions in wooden cages that were cleaned daily from droppings (urine and faeces) and fed a composite diet that was made up of forages (*Panicum maximum*, *Brassica oleracea*, *Stylosanthes guianensis* and *Musa paradisiaca*) in clean feeders. Water was provided using automatic nipple drinkers. Prior to the experiment, the animals were subjected to pre-conditioning to minimize the noise (biasness).

Measurement of the growth traits

The weekly body weight of each rabbit was measured for 12 consecutive weeks using a digital top pan balance in grams. The rabbits were weighed individually in the morning between 7:00-9:00 am Greenwich Meridian Time (GMT) before they were fed on each experimental day by a trained person to avoid variations due to measurement (Shawulu and Ajayi, 2011). The post weaning average daily gain (PWADG) was derived from the body weight using the Mathematical expression below.

$$\text{PWADG} = \frac{Final\ body\ body\ weight - Initial\ (weaned)\ weight}{Number\ of\ experimental\ days}$$

Statistical analysis

Data obtained was analysed with the General Linear Model procedure of SAS (version 9.4) with age and sex as fixed factors. Differences between the means were separated using the Tukey Comparison Method at 5% probability level. The model used was:

$Y_{ijk} = u + S_i + A_j + e_{ijk}$

Where: Y_{ijk} = observed for body weight

S_i = fixed effect of the i^{th} sex of rabbits

A_j = fixed effect of the j^{th} age of rabbits

e_{ijkl} = random residual error associated with each observation $\sim N(0,\sigma^2_e)$ where σ^2_e is residual variance.

RESULTS AND DISCUSSION

Generally, body weight increased significantly as the rabbits advanced in age from 577.51 g at the weaning age of 8 weeks to 2090.51 g at 20 weeks of age (Table 1). However, the rabbits grew faster (Figure 1) during the early stages (8 to 16 weeks of age) compared to the later phase (17 to 20 weeks of age).

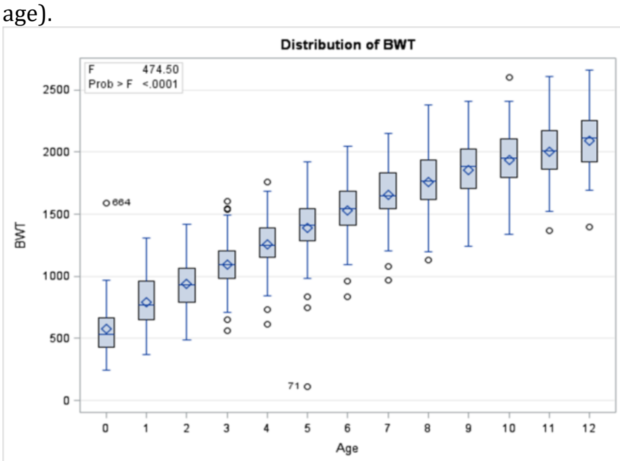

Figure 1. Growth rate of rabbits

Table 1. The least square means ± standard error for body weight of rabbits at different ages

Age (Weeks)	Mean Body Weight ± SE
8	577.51±22.18^{j}
9	794.23 ± 22.29^{i}
10	935.74 ± 22.29^{g}
11	1092.69±22.41^{h}
12	1258.21±22.52^{g}
13	1390.28±22.76^{f}
14	1532.24 ± 22.76^{e}
15	1658.43± 22.76^{d}
16	1757.86 ± 22.88^{c}
17	1854.51 ± 22.88^{bc}
18	1937.71± 22.88^{b}
19	2005.49± 22.88^{ab}
20	2090.51± 22.88^{a}

Means that carry different superscripts are significantly different at $p<0.05$; SE: standard error; p-value: probability value ($p < 0.05$)

Effect of age on body weight of rabbits

Findings of the current investigation show that rabbits grow at a slower rate after post weaning. This means that at the younger stages, rabbits are able to utilize feed for faster growth than the adult stages. As animals grow they may direct feed nutrients to develop body organs needed for other physiological activities such as reproduction rather than for growth (muscle development) which could result in the reduction in growth as the rabbits advance in age; or due to changes in nutrition and/or hormones (Godfrey and Barker, 2001). Therefore, young rabbits must be managed adequately to boost their system for growth and to reach marketable size early since body weight is essential in determining the growth and price of animals at the farm gate and markets (Ayo-Ajasa et al., 2018; Okoro et al., 2010) making the trait important to both farmers and consumers. The slow growth rate detected as rabbits grew from the 17th week is an indication that excess resources (feed and medication) may be needed to enhance growth as rabbits grow which will increase the cost of production to reduce farmers' profit. It would therefore be prudent for rabbit breeders to select traits in younger rabbits than in their adult counterparts during breeding if the objective is to improve growth.

At all ages, positive correlation existed between body weights but the coefficient of correlation (r) consistently decreased as the age differences were further apart. However, the highest correlation coefficient of 0.974 and the lowest correlation coefficient of 0.379 for body weight were recorded between weeks BW16 and BW17, and between week BW8 (weaning age) and week BW20 accordingly. The association between body weight and post weaning average daily gain (PWADG) was negatively low in the younger rabbits at week BW9 to week BW13 except for week BW0 that recorded a negative but high correlation coefficient of -0.520. Meanwhile, for the same parameters, from weeks BW14 to BW20, positively low to medium correlations were found (Table 2). The results also indicate variation in both the magnitude and direction of the association between the two traits but the values of the correlation coefficient increased as the rabbits grew.

Phenotypic correlation of weaning weight and post-weaning average daily gain of rabbit at different ages

The enhancement of growth (body weight) and nutritional composition of animals to increase their input to global protein demands has become needful but efforts are required both at the breeding and production (rearing) stages to realize this objective. This, however, cannot be entirely met if

Table 2. Phenotypic Correlation of Post Weaning Weight and PWADG of Unsexed Rabbits

	BW9	BW10	BW11	BW12	BW13	BW14	BW15	BW16	BW17	BW18	BW19	BW20	PWADG
BW8	0.903	0.851	0.790	0.724	0.656	0.661	0.629	0.587	0.507	0.506	0.457	0.379^{NS}	-0.520
BW9		0.961	0.889	0.828	0.762	0.787	0.754	0.720	0.643	0.637	0.592	0.505	-0.326^{NS}
BW10			0.940	0.901	0.825	0.857	0.824	0.788	0.718	0.702	0.654	0.580	-0.211^{NS}
BW11				0.958	0.875	0.918	0.880	0.835	0.777	0.742	0.671	0.598	-0.150^{NS}
BW12					0.909	0.937	0.915	0.868	0.831	0.785	0.714	0.652	-0.030^{NS}
BW13						0.875	0.851	0.813	0.779	0.725	0.664	0.609	-0.012^{NS}
BW14							0.972	0.940	0.909	0.874	0.803	0.748	0.112^{NS}
BW15								0.968	0.948	0.918	0.851	0.803	0.187^{NS}
BW16									0.974	0.952	0.915	0.872	0.293^{NS}
BW17										0.964	0.932	0.900	0.389
BW18											0.951	0.920	0.408
BW19												0.971	0.498
BW20													0.593

All the correlations are significant at $p< 0.0001$; NS: not significant knowledge of the relationships between the body parameters that affect animals' performance (Okoro et al., 2010) are not readily available; because such knowledge help in the selection of traits during breed formation. A change in any one trait could impact positively or negatively on the final body weight of animals depending on the direction of the change (Egena et al., 2014). Positively related traits can be selected together for enhancement using limited resources while negative correlation means a decrease in one trait, would cause an increase in the other and the vice versa. In regards, the negative association detected between body weight and post weaning daily gain of the younger rabbits up to week 13 means that the two traits cannot be selected for improvement simultaneously in the animals during the specified weeks but this does not make breeding economical. Although there may be limited data available on the association between body weight and post weaning average daily gain, Petrescu-Mag et al. (2014) also found negative relationship between other linear body parameters in the same animal. The current data show that when rabbits grow from week 14 to week 20, an improvement in the post weaning average daily gain would result to a proportionate increase in body weight and so the duo could be improved together in adult rabbits using limited resources because both parameters are said to be under the same gene action (pleiotropy) (Mutai et al., 2018). In addition, the decreasing order of the coefficient of correlation (r) of body weight as the rabbits aged indicates a reduction in growth rate as rabbits advance in age; therefore, farmers must put in place good management practices (especially provision of quality feed) to ensure that their animals get a good start when they are young to maximize productivity with limited resources. However, the low to high positive associations found between the body weights at the different ages agree with other authors (Egena et al., 2014; Okoro et al., 2010). Body weight of the female rabbits (does) had low to high but all positive correlations between the different weeks – with the lowest (r = 0.264) and highest (r = 0.980) between weeks BW8 and BW20 and between weeks BW15 and BW16 correspondently (Table 3). There was negative relationship between body weight and post weaning average daily gain in the younger females from the weaning age (BW8) up to week 12 in a decreasing order of correlation coefficient. But from week 13 to week 20, the duo related positively in an increasing order of correlation coefficient (Table 3). Body weight of the bucks (males) had almost high and positive association between the various weeks except those of week 8 against weeks 18, 19 and 20 that were medium in magnitude. Whereas the lowest correlation coefficient, r (0.455) for body weight in the bucks was recorded between weeks 8 and 20, the highest r (0.979) was recorded between weeks 19 and 20. Similarly, there was negative relationship between the body weight and post weaning average daily gain in the younger males up to week 13 in a decreasing order of r except for week 12 when the traits recorded a positive but low correlation (r = 0.051). From week 14 to week 20, the two traits related positively in an increasing order of r (Table 4).

Table 3. Phenotypic Correlation of Post Weaning Body Weight and PWADG of Female Rabbits

	BW9	BW10	BW11	BW12	BW13	BW14	BW15	BW16	BW17	BW18	BW19	BW20	PWADG
BW8	0.935	0.895	0.802	0.726	0.646	0.602	0.596	0.553	0.424^{NS}	0.439^{NS}	0.362^{NS}	0.264^{NS}	-0.596
BW9		0.968	0.886	0.798	0.744	0.721	0.704	0.673	0.556	0.561	0.512^{NS}	0.389^{NS}	-0.440^{NS}
BW10			0.937	0.875	0.838	0.806	0.778	0.747	0.645	0.633	0.580	0.489^{NS}	-0.324^{NS}
BW11				0.954	0.921	0.899	0.853	0.812	0.730	0.696	0.603	0.509^{NS}	-0.232^{NS}
BW12					0.947	0.922	0.893	0.842	0.782	0.728	0.629	0.545	-0.144^{NS}
BW13						0.967	0.947	0.919	0.867	0.805	0.720	0.647	0.004^{NS}
BW14							0.977	0.960	0.922	0.880	0.789	0.713	0.097^{NS}
BW15								0.980	0.944	0.912	0.828	0.755	0.130^{NS}
BW16									0.965	0.938	0.883	0.815	0.227^{NS}
BW17										0.960	0.902	0.848	0.359^{NS}
BW18											0.932	0.885	0.378^{NS}
BW19												0.955	0.499^{NS}
BW20													0.617

All the correlations are significant at P< 0.0001; **NS**: not significant

Table 4. Phenotypic Correlation of Post Weaning Body Weight and PWADG of Male Rabbits

	BW9	BW10	BW11	BW12	BW13	BW14	BW15	BW16	BW17	BW18	BW19	BW20	PWADG
BW8	0.889	0.825	0.784	0.723	0.663	0.707	0.658	0.616	0.563	0.549	0.520^{NS}	0.455	-0.468^{NS}
BW9		0.956	0.895	0.864	0.798	0.853	0.808	0.776	0.726	0.712	0.680	0.618	-0.216^{NS}
BW10			0.946	0.929	0.837	0.902	0.867	0.830	0.782	0.764	0.725	0.663	-0.1101^{NS}
BW11				0.965	0.860	0.935	0.906	0.860	0.818	0.782	0.733	0.674	-0.077^{NS}
BW12					0.894	0.951	0.935	0.888	0.864	0.821	0.770	0.722	0.051^{NS}
BW13						0.831	0.807	0.766	0.738	0.689	0.647	0.601	-0.013^{NS}
BW14							0.969	0.929	0.901	0.877	0.825	0.785	0.129^{NS}
BW15								0.961	0.952	0.927	0.876	0.845	0.233^{NS}
BW16									0.982	0.964	0.938	0.910	0.337^{NS}
BW17										0.968	0.955	0.938	0.413^{NS}
BW18											0.963	0.942	0.429^{NS}
BW19												0.979	0.493^{NS}
BW20													0.573

All the correlations are significant at P< 0.0001; NS: not significant

Effect of sex on coefficient of correlation (r) of body weight and post-weaning average daily gain of rabbits at different ages

The results presented in Tables 3 and 4 show that, body weight of both female and male rabbits can be affected by their age, but the reduction in the coefficient of correlation (r) of their body weight as they aged indicates that their growth rate may decrease as they grow older irrespective of their sex. Therefore, farmers must put in the best management practices for male and female rabbits at their early stages to ensure that they grow at a faster rate.

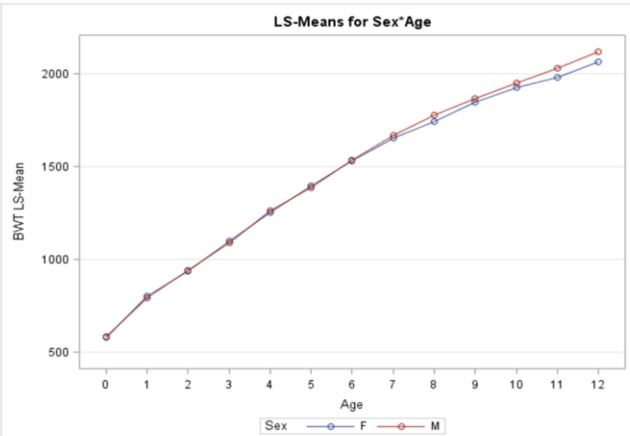

Figure 2. Effect of Sex on Post Weaning Growth of Rabbits

Table 5. Body Weight (grams) and Post-weaning Average Daily Gain (grams/ day) of Female and Male Rabbits at Different Ages

Sex	Mean ± SE	p-valves
	WK8	
F	579.48 ±30.031	0.927
M	575.65 ± 29.135	
	WK12	
F	1255 ± 29.823	0.890
M	1261±29.823	
	WK16	
F	1746 ± 33.807	0.610
M	1770 ± 33.446	
	WK20	
F	2070 ±33.243	0.384
M	2111±32.888	
	PWADG	
F	17.71 ± 0.428	0.306
M	18.33 ± 0.423	

WK: week; PWADG: post weaning average daily gain; SE: standard error; p-value: probability value ($p < 0.05$)

However, the low to high positive association found between the ages concords to Mutai et al. (2018) who have also propagated low to high positive association between body parameters of male and female rabbits in Kenya, and proposed that the association could be valuable for selection. From the present results, it is obvious that the body weight of rabbits (except for the bucks at week 12) cannot be enhanced alongside post weaning average daily gain when the animals are selected earlier in their life for breeding purposes irrespective of their sex. This is because of the negative relationship detected between the two traits in this work and that of Egena et al., (2014). Even if the attempt is made in young males at 12 weeks of age, the improvement would be slow thus undesirable for breeding purposes (Blanco et al., 2014). Nevertheless, body weight and post weaning average daily gain can be improved simultaneously relatively easier in both male and female rabbits as they grow from week 13 and week 14 correspondently. The current results show that sex and age can affect the two traits; therefore, selection of traits in rabbits for breeding activities must be guided by research findings.

There was no significant effect of sex on the body weight of the rabbits at the various ages (Table 5). However, the males were slightly heavier than the females at all the ages except at the weaning age of 8 weeks (Figure 2). Similarly, sex did not substantially affect the post weaning average daily gain of the rabbits but the trait was slightly higher in the males (18.33 grams/ day) than the females (17.71 grams/ day).

Interaction effect of age and sex on body weights and post-weaning average daily gain of rabbits

The key objective of the rabbit industry is meat production, so selection and breeding are geared towards growth traits (Apori et al., 2014) to increase their contribution to the much-needed animal protein. Growth of rabbits can be dependent on their age and/or sex (Ologbose et al., 2017) whose study on the body weight of the Dutch and New Zealand breeds found almost heavier body weight in the males than the females at weeks 4, 8 and 12; as well as the declaration made by Olutogun et al. (2003) that, various body parts of animals develop at different rates and these variations determine their conformation, shape and body proportion at specific periods of time. Although the findings of this work did not show any significant effect of age and sex interaction on body weight and post weaning average daily gain, the slight differences detected could call for care when grouping rabbits for mating purposes. This means that both the does and bucks used for reproductive purposes must be weighed irrespective of their age to ensure that males used for breeding are not heavier than the females. Nevertheless, the bigger sizes of the males render them more opportunity to mate with the females in a colony because their competitive ability would be higher (Gatford et al., 1998). In the past, Ologbose et al., (2017) also found higher but significant body weight and other linear body measurements in male than female rabbits at different ages. Again, the higher post weaning average daily gain detected in the bucks (males) over the does (females) means that the former has a better feed conversion ratio than the later.

CONCLUSION

Although live weights of animals are important variable in the determination of the market value, there was no significant effect of sex on post weaning growth rate of the rabbits used in this study, but the males turn to be slightly heavier than the females. Selection for PADG in rabbits should be done at later stages of their growth to illicit positive change. Phenotypic correlation of body weights turn to be stronger or higher at ages that are closer to each other than those that are further apart.

ACKNOWLEDGEMENT

The writers are thankful to David Amedorme of CSIR- Animal Research Institute for his support during the conduct of this research work.

AUTHOR CONTRIBUTIONS

Vida Korkor Lamptey and Julius Kofi Hagan conceived the research idea, and developed the work proposal. Vida Korkor Lamptey, Bernard Ato Hagan and Doris Yaa Osei conducted the experiments with procedural advice from Julius Kofi Hagan. Bernard Ato Hagan analysed the data. Vida Korkor Lamptey and Francis Kruenti wrote the manuscript and Bernard Ato Hagan proofread the manuscript.

COMPETING INTERESTS

The authors have declared that no conflict of interest exists.

ETHICS APPROVAL

Not applicable

REFERENCES

Abdullah, A. R., Sokunbi, O. A., Omisola, O.O., & Adewumi, M. K. (2003). Interrelations between bodyweight and body linear measurements in domestic rabbits (*Oryctolagus cuniculus*). *Proceedings of the 28th Annual Conference of Nigerian Society of Animal Production*, Nigeria, 133-136.

Akpa, G. N., 2000. Factors affecting growth and body measurements of traditionally-managed Red Sokoto goats. *Proceedings of the 23rd Annual Conference of Nigerian Society of Animal Production*, Umudike, Nigeria, 462-463.

Apori, S. O., Hagan, J. K., & Osei, Y. D. (2014). Growth and reproductive performance of two rabbit breeds reared under intensive system in Ghana. *Tropical Animal Health and Production*, *46*(7), 14-20.

Ayo-Ajasa, O. Y., Wheto, M., Egbeyale, L. T., Njoku, C. P., Sanwo, K. A., & Azeez, F. A. (2018). Prediction of body live weight from body length and heart girth of rabbit. *Nigerian Journal of Animal Science*, *20*(4), 333-337.

Banson, K. E., Muthusamy, G., & Kondo, E. (2015). The Import Substituted Poultry Industry; Evidence from Ghana. *International Journal of Agriculture and Forestry*, 2015, *5*(2), 166-175.

Blanco, A. E., Icken, W., Ould-Ali, D., Cavero, D., & Schmutz, M. (2014). Genetic parameters of egg quality traits on different pedigree layers with special focus on dynamic stiffness. *Poultry Science*, *93*(10), 2457-2463.

Dalle Zotte, A. (2014). Rabbit farming for meat purposes. *Animal Frontiers*, *4*(4), 62-67.

Egena, S. S. A., Akpa, G. N., Aremu, A., & Alemede, I. C. (2014). Sources of shared variability in body weight and linear body measurement traits of two breeds of rabbit. *International Journal of Plant, Animal and Environmental Science*, *4*(2), 141-145.

Ekpenyem, B. U. (2002). The growth responses of weaner-pigs fed varying levels of palm kernel cake. *Proceedings of the 27th Annual Annual Conference of Nigerian Society of Animal Production*, Akure, 156-159.

Gatford, K. L., Egan, A. R., Clarke, I. J., & Owen, P. C. (1998). Sexual dimorphism of the somatotrophic axis. *Journal of Endocrinology*, *157*(3) 373-389.

Godfrey, K. M., & Barker, D. J (2001). Foetal programming and adult health. *Public Health Nutrition*, *4*(2B), 611-624.

Herbert, U. (2011*).* Unending seeds and waters of animal life. *Proceedings of the 12th Inaugural lecture series of Michael Okpara University of Agriculture*, Umudike, Nigeria, 9th November 2011, 1-41.

Hernández, P., & Dalle Zotte, A. (2010). *Influence of diet on rabbit meat quality*. In C. de Blas & J. Wiseman (Eds.). The nutrition of the rabbit (pp. 163-178). Oxon, UK: CABI Publishing.

Mutai, F. K., Kasili, R. W., Mamati, E. G., Mwangi, J. M., & Auma, S. A. (2018). Assessment of relationship between body weight and biometric traits using path analysis in Kenyan domesticated rabbits. *Journal of Biology, Agriculture and Healthcare*, *8*(8), 9-14.

Okoro, V. M. O., Ezeokeke, C. T., Ogundu, U. E., & Chukwudum, C. (2010). Phenotypic correlation of bodyweight and linear body measurement in Chinchilla rabbits (*Orycotolagus cuniculus*). *Journal of Agricultural Biotechnology and Sustainable Development*, *2*(2), 027-029.

Ologbose, F. I., Ajayi, F. O., Agaviezor, B. (2017). Effect of breeds, sex and age on interrelationship between body weight and linear body measurement in rabbits. *Journal of Fisheries and Livestock Production*, *5*(3), 250.

Olutogun, O., Abdullah, A. R., Raji, A. O., Adetoro, P. A., & Adeyemi, A. (2003). Body conformation characteristics of white Fulani and Gudali (Zebu) cattle breeds of Nigeria. *Proceedings of the 28th Annual Conference of the Nigerian Society for Animal production*, Ibadan, Nigeria, 129-132.

Petrescu, D. C., Oroian, I. G., Mihaiescu, T., Paulette, L., Varban, D., & Patrutoiu, T. C. (2013). Rabbit statistics overview:

production, trade, market evolution. *Rabbit Genetics*, *3*(1):15-22.

Petrescu-Mag, R. M., Oroian, I. G., Botha, M., Covrig, I., & Petrescu-mag, I. V. (2014). Morphological, productive and reproductive characterization of the Transylvanian giant rabbit (*Oryctolagus cuniculus*): first statistical report. *North-Western Journal of Zoology*, *10*(2), 400-403.

Shawulu, J.C. and I.E. Ajayi, (2011). The Effect of Sexual Dimophism on Some Cranio- Morphometrical Indices in the New Zaeland White Rabbit (*Oryctolagus cuniculus*). *Jounal of Agriculture and Veterinary Science*, *3*, 73-80.

Udeh. (2013). Prediction of body weight in rabbits using Principal Component Factor Scores in Multiple Linear Regression Model, *Rabbits Genetics*, *3*(1), 1–6.