THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Performance, Carcass Indices and Cost Benefit Analysis of Grower Pig Fed Tiger Nut Residue

Dr. Comfort Abel Essien
Lecturer,Department of Animal Science, AkwaIbom State University, Nigeria

Abstract:
A sixty day (60) feeding trial was conducted to evaluate the effect of feeding graded levels of tigernut residue (TNR) on the growth performance, carcass and organ characteristics and cost benefits of growing pigs. A total of 36 pigs (land race and large white) at 10 weeks of age were used for the experiment. Four experimental diets were formulated to incorporate TNR as maize substitute at 0%, 10%, 20% and 30% levels to form T_1, T_2, T_3 and T_4 respectively. The experimental pigs were individually weighed and assigned to four dietary treatments with three replicates of three animals each in a completely randomized design. Data collected were statistically analyzed. The results of growth performances showed no significant differences (p>0.05) across treatment groups. Pigs fed 10% and 20% TNRdiets recorded numerical increase in final weight and weight gain values over 0% and 30% groups. The feed intake of the pigs was statistically similar (p>0.05) across treatment. Better feed conversion ratio and feed efficiency values were obtained from 10% and 20% TNR groups. The live weight, dressed weight, dressed percentage and primal cut-parts (ham, hand and shoulder hind leg trollers, rib, head, tail, loin, bacon, back fat thickness and abdominal fat) were not significantly (p>0.05) affected by the treatment. The internal organs (liver, kidney, spleen, lungs, heart, small intestine and large intestine) were not significantly (p>0.05) affected by the diets across treatment groups. Cost of feed/kg (₦) and feed cost per kg weight gain decreased significantly (p>0.05) with the inclusion of TNR in the diet. The result showed that TNR could replace maize up to 30% level in growing pig diet without any adverse effect on the performance, carcass/organ characteristics and also give lower cost of feeding.

Keywords: *Tigernut residue, Performance, carcass, cost of feeding, pig*

1. Introduction

Pigs are prolific monogastric species which have the ability to convert feed to animal products. Their short generation intervals not only guarantee the supply of animal protein but also a quick turnover rate of investment. Pig production has therefore been advocated as a short-term measure toward alleviating animal protein deficit especially in areas where there are no religious edicts preventing their production and consumption (1).

The need to provide feed is basic to any livestock enterprise. However, making the feed cheaply available is more compelling to profitable and sustainable livestock development (2). Pigs are omnivorous, they can tolerate all kinds of feed. Cereal which hasbeen the major energy source in pig diet has become very expensive. The production of cereal does not keep pace with it demand (3). Therefore, the use of cheap and readily available unconventional feed resources such as agro by-products or wastes to replace maize which serves as amajor energy source in pig diet becomes necessary.
Many plants by-products and waste have proved valuable in enhancing the performance of this speciessuch as cassava peels, yam peels, cocoyam peels, wheat bran, rice offal etc.

In Nigeria, tigernut residue is one of the many under exploited agro by-product. Tigernut seems to have potentials as energy source in pig nutrition. The residue is readily available and there is minimal pressure on its utilization, sometimes it is thrown as wastes. Tigernut residue is gotten after the extraction of milk from the local milk processors. Information on the value of tigernut residue as energy feed source in livestock feed is very limited. However, (4) reported a high crude fibre (18%) and ether extract (24.21%) content in tigernut residue. High fibrecontent in monogastric diet is known to decrease the digestibility and metabolizable energy concentration, the fibrous portion of the feed also influences the digestibility of other feed constituently exerting a protective action encasing these constituents in a digestive proof shed as it were, thereby obstructing the access of digestive enzymes(5).(4) also reported that TNR is rich in iron, calcium, magnesium and sodium (70.179, 10.641, 10.820 and 13.611 ppm) respectively.However, (6) reported that tigernut residue could enhance the performance and carcass characteristics of broiler finisher. Thus, this studywas designed to investigate the effect of feeding graded levels of tigernut residue on the performance, carcass/organ indices and to determine the cost benefit of using tigernut residue in growing pig diets.

2. Materials and Methods

2.1. Experimental Site

The research was conducted at the piggery unit of the teaching and research farm of AkwaIbom State University, ObioAkpa Campus. ObioAkpa is located between latitude 5'17'N and $5^0$27'N' and between longitude $7^0$27'N and $7^0$58'E with an annual rainfall ranging from 3500mm – 5000mm and average monthly temperature of 250^0C and relative humidity between 60 -90% (7). The piggery house is an open sided, concrete floor and roofed with corrugated roofing sheet, each of the pens has a separate, feeding, watering trough and a wallow.

2.2. Source and Processing Method of Tigernut Residue

The tigernutresidues were bought from tigernut milk processors at Ibagwa, Military Barrack, Abak in AkwaIbom State. The residue was sun-dried for 3 – 4 days, thereafter bagged in polythene bags and stored prior to proximate analysis and feed formulation.

2.3. Proximate Analysis

The proximate analysis of the tigernut residue was carried out according to the method described by (8)

2.4. Experimental Diets

Four experimental diets were formulatedto meet the nutrient requirement of the grower pigs.The diets were formulated to contain varying levels of tigernut residue replacing dietary maize at 0%, 10%, 20% and 30% as T_1, T_2, T_3 and T_4 respectively. Gross composition of the experimental diet is presented in Table 1.

2.5. Tigernut Residue Inclusion Levels in the Diets (%)

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**
Maize	50.00	40.00	30.00	20.00
Tigernut Residue	0.00	10.00	20.00	30.00
Soya Bean Meal	25.00	25.00	25.00	25.00
Palm Kernel Cake	10.00	10.00	10.00	10.00
Wheat Offal	10.00	10.00	10.00	10.00
Bone Meal	4.00	4.00	4.00	4.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total **Calculated chemical composition**	100.00	100.00	100.00	100.00
Crude Protein (%)	20.55	19.95	19.35	18.75
Crude Fibre	4.18	4.81	5.44	6.07
Ether Extract	2.47	4.24	4.64	5.04
Ash	3.27	3.64	3.97	4.38
ME (kcal/kg)	292.26	297.26	302.26	307.26

Table 1: Composition of Experimental Diets with Graded Level of Tigernut Residue

Vitamin mineral premix to provide per kg diet: VitA 10,000 iu; Vit D_3 200iu, Vit E, 12mg; Vit. K 2mg; Vit Bi, 1.5mg; Vit B_2, 4mg; Vit B_6, 1.5mg; Vit. B_{12}, 12mg; Niacin, 5mg; Panthothenic acid 5mg; Folic acid 5m; Biotin, 2mg; Choline Chloride 100mg; Manganese, 75mg; zinc, 5mg; iron 2mg; Copper 5mg; Iodine, 1.0mg; Selenium, 2.0mg; Cobalt, 5mg; Antioxidant, 125mg.

2.6. Experimental Animals and Management

Thirty-six pigs (landrace and large white) at 10 weeks old, with the average initial weight of 12kg were selected and distributed into four groups of (9) nine animals on equal weight basis and were assigned to one of the four experimental diets in a completely randomized design. Each group was further replicated three times with three pigs per replicate. The pigs were housed in individual pens and allowed to acclimatize for 14 days and fed basal diet before the commencement of the experiment. Feed and water were given to pigsadlibitum. Medications were administered routinely as scheduled on the farm. Strict sanitary measures were adhered to during the course of the experiment. The experiment lasted for sixty days.

2.7. Carcass and Organ Evaluation

At the end of the 60 days feeding trial three (3) pigs from each treatment were randomly selected, weighed, tagged according to their replicate, fasted over-night of feed to reduce the gastro intestinal content. Slaughtering was done by manual exsanguinations by severing the jugular vein, carotid arteries and trachea with a knife after stunning, the animal was suspended by its hind legs to allow complete bleeding. The slaughtered pigs were scalded and eviscerated.

The organs were weighed using a sensitive weighing balance. Back fat thickness was measured at the 1st and 4th ribs with verniercalipers. The carcass length was measured from the anterior tip of the pubic bone to the anterior edge of the first rib.

2.8. Data Collection

The initial weights of the pigs were taken and subsequent live weights were recorded weekly. The weight gain was calculated by subtracting the initial weight from the final weight using a 100kg capacity weighing balance. Feed intake was obtained as the difference between the total quantity of feed offered and the quantity not consumed. Feed conversion ratio was calculated by dividing the daily feed intake by daily weight gain. Efficiency of feed utilization was calculated by dividing daily weight gain by the daily feed intake. Survivability (%) this was obtained by the dividing the number of survived pigs with total number of pigs multiplied by 100.

2.9. Statistical Analysis

Data obtained in the study were subjected to analysis of variance using SAS statistical package. (9) and means were separated using Duncan Multiple Range Test (DMRT) of the same statistical software.

2.9.1. Feed Cost Benefit

The economic analysis was done to determine the economic advantage for substituting tigernut residue from maize in the diet of growing pigs. Cost of feed was calculated based on the prevailing cost of ingredient per kg as at the time the experiment was conducted by summing the price per kg of feed ingredient, multiplied by their pro portions in the feed formula then dividing by 100. Average feed cost (AFC) was gotten by multiplying cost per kg feed by daily feed intake, while the total feed cost (TFC) was gotten by multiplying total feed intake by cost per kg feed. The cost per kg body weight gain was calculated by multiplying cost per kg feed by feed conversion ratio.

3. Results and Discussion

The results of the proximate and anti-nutritional composition in tigernut residue are shown in table 2. The results showed that tigernut residue is low in crude protein (3.0%) but high in crude fibre (17.21%) and ether extract (22.5%) which could make it a good source of dietary energy in livestock feed. The results of the anti-nutritional factors indicated low levels of hydrogen cyanide, alkaloids, oxalate, phytate, saponin flavonoid and tannin (2.11, 1.73, 2.28, 1.13, 3.41, 3.11 and 1.50 mg) respectively. Amongst all the anti-nutritional factors detected in tigernut residue phytate recorded the least value (0.13%)phytate are known to inhibit the absorption of mineral such as iron, zinc and calcium and also influenced digestive enzymes by reducing the digestibility of starches, protein and fat (10).

Components % DM	Values	± SD
Moisture	11.8	0.75
Ash	0.5	0.07
Crude Protein	3.0	0.17
Crude Fibre	17.21	0.78
Crude Lipid	22.51	0.07
Nitrogen Free Extract	44.98	0.41
Anti-nutrients (mg/100g)		
Tannin	1.50	0.37
Cyanogenic glycoside	2.11	0.01
Alkaloids	1.73	0.13
Oxalate	2.28	0.18
Phytate	1.13	0.01
Saponin	3.41	0.04
Flavonoid	3.11	0.38

Table 2: Proximate Composition and Anti-Nutritional Factors in Tigernut Residue

Values are means of triplicate determinations, ± standard deviation

The results of the performance indices of the experimental pigs are presented in Table 3. There were no significant differences (p>0.05) in all the performance parameters determined. The final weight and weight gain of the pigs were statistically similar. Pigs in T_2 had the highest numerical but insignificant final weight and weight gain values followed by T_3, T_4 and T_1. The least value for the two parameters were recorded in T_1.

The growth rate of animal obviously depends on its level of feeding if the level is high, growth will be rapid and animal reaches a specified weight at an early stage (11). Also, theweight of pigs at any point in time is a function of cumulative growth of component parts provided all things being equal (12). The numerical increase in the final weight and weight gain of pigs in T_2, T_3 and T_4 over T_1 despite the increasing level of tigernut residue may be attributed to the high ether extract content in tigernut residue which might have contributed to the high metabolizable energy obtained in the diets. Fat has definite advantages over carbohydrate or protein as source of energy. Its calorific value is more than double (9.3kcals/g) that of carbohydrate (4.0kcals/g) (13). (14) reported that whenpigsare fed liberal amount of high energy diet, they are likely to over consumed diets and become fat. The author further opined that fat tends to improved metabolic efficiency in animals; fat in diet increased the utilization of dietary energy in excess of the increase expected when the ME of the fat is added to the metabolizableenergy (ME) values of the other dietary constituents. Factors which may influence the metabolizable energy (ME) contribution of fats to diets include, the fatty acid contribution, free fatty acid content of the fat, supplemental dietary fat level, diet composition, age and type of animals (14). Therefore, the result obtained in this study with respect to the two parameters determined, showed that the diet composition was suitable for the age and class of animal given, thereby resulting in the proper utilization of the nutrient in the feed by the animals. The non-insignificant differences (p>0.05) observed in this study for final weight and weight gain of pigs agrees with the report of (15) where broilers fed 25% - 75% tigernut based diet did not indicate significant difference in their final weight and weight gain values.

More so, the numerical but insignificant increase obtained in these results for the afore-mentioned parameters could indicate a low level of anti-nutritional factors present in tigernut residue as indicated in the results of the anti-nutritional analysis presented in table 2. (16, 17, 18) reported that the presence of anti-nutritional factors in feed causes a reduction in growth rate of broilers due to a reduced protein and specific amino-acid utilization.

The feed intake of the experimental pigs across treatment was statistically similar. It was observed that feed intake increased numerically as the level of tigernut residue increased in the diet. T_4 recorded the highest numerical value for feed intake while T_1 had the least value. This could be attributed to the high fibre content in the diet;thus, agreeing with the reports of (19) and (20) that feed intake of non-ruminant is influenced greatly by dietary fibre characteristics. (21) reported that higher feed consumption rate could be attributed to an attempt for mono gastric animals to increased their feed intake when fed diets that contained increasing level of insoluble non-starch polysaccharides.(18) reported that high fibre diet increases feed intake of birds to allow them meet their requirement for some dietary component other than energy.

The results for feed conversion ratio and efficiency of feed utilization showed that the feeds were similarly utilized by the experimental animals. Pigs that have low feed conversion ratio are considered efficient users of feed. Pigs in T_2 had the best feed conversion ratio and feed efficiency values. There were no significant differences (p>0.05) in the values of the two parameters across treatment. The results showed that pigs in T_2 required less feed to gain 1kg weight. The results obtained in this study for feed conversion ratiois in line with the report of (22) where pigs fed 12% tigernut based diet had a better feed conversion ratio than the control. (11) also reported that pigs fed beniseedhull at 25 – 75% inclusion level had lower feed conversion ratio than the control. This result also supports the finding of (15) where broilers fed 25 – 75% tigernutdiet did not indicate significant differences in their values for feed conversion ratio.

There was no significant(p>0.05) difference in the feed efficiency of the birds. The values obtained for all the treatment were statistically (p>0.05)similar. T_2 and T_3 had the best feed efficiency values. The result obtained in this study for feed efficiency could be attributed to the high ether extract content in tigernut residue over maize in the diet (tigernut residue 22.5% and maize 4% ether extract).

3.1. Tigernut Inclusion Levels in the Diets (%)

Parameter	T_1(0)	T_2(10)	T_3(20)	T_4(30)	SEM
Initial Weight (kg)	12.67	13.10	12.91	12.51	0.36
Final Weight (kg)	44.41	45.31	45.10	44.31	3.37
Weight Gain (kg)	31.74	32.21	32.19	31.80	2.11
Daily Weight Gain (kg)	0.53	0.54	0.54	0.53	0.01
Feed Intake (kg)	87.78	87.71	88.13	88.81	3.21
Daily Feed Intake (kg)	1.46	1.46	1.47	1.48	0.05
FCR	2.75	2.70	2.72	2.79	0.07
Feed Efficiency	0.36	0.37	0.37	0.36	0.01
Survivability	100.00	100.00	100.00	100.00	0.00

Table 3: Performance of Growing Pigs Fed Graded Levels of Tigernut Residue

The carcass and organ characteristics of growing pigs fed graded levels of tigernut residue are presented in Table 4. The live weight; dress weight and dressed percentage of the slaughtered pigs were not significantly affected by the treatment diet. Pigs in treatment T_2 and T_3 showed higher numerical values over T_4 and T_1. The values for T_4 and T_1 were similar thus, agreeing with the report of (23) who confirmed that heavy pigs produced greater dressed weight. The primal cut-parts (ham, hand and shoulder, hind leg, trotter, head, tail, loin rib and bacon were not significantly (p>0.05)affected by the diets across treatment.

They were slight increase in the values for back fat thickness and abdominal fat of the pigs but the values were statistically similar. The values increased with increase in the level of tigernut residue in the diets. T_4 had the highest but insignificant value followed by T_3, T_2 and T_1 for the two parameters. Back fat thickness is used as an index for determining the degree of fatness in pigs. The numerical increase observed in this study could relate to the high ether extract (22.51%) content in tigernut residue. (24) reported that birds are known to store excess fat in their abdomen from diet with high fat content. However, the back fat thickness values obtained in this study were lower than the recommended back fat thickness values for market pigs within 20-105kg by (14).

There were no significant effects in all the organ parameters determined. Liver and kidney are involved in the elimination of toxins and metabolic waste from animal's body, otherwise known as organs of biotransformation. The enlargements of the organs are always linked with the presence of anti-nutritional factors in the diet. The similarity in values obtained for liver and kidney across treatment indicated low level of anti-nutritional substances in the diet.The heart, spleen and lungs were not significantly affected by the treatment diet. The heart is primarily responsible for pumping blood and distributing oxygen and nutrients throughout the body. The lungs function in the process of gas exchange while the spleen helps in the filtering of blood thus, the removal of old and damaged red blood cells in the body. The non-significant difference observed in the lungs, spleen and heart of the slaughtered pigs showed that the treatment diet promotes normal erythropoietin and transportation of oxygen chemicals and nutrients which are essential to life. There were no observed abnormalities on all the organs determined in this study.

3.2. Tigernut Inclusion Levels in the Diets (%)

Parameter	T_1(0)	T_2(10)	**T_3(20)**	**T_4(30)**	**SEM**
Live Weight (kg)	43.71	45.10	44.32	43.31	3.11
Carcass Weight (kg)	25.71	27.21	26.32	24.81	2.02
Dressed Percentage (%)	58.82	60.92	59.39	57.28	3.21
Ham %	26.19	28.21	27.01	26.31	2.03
Hind Leg	3.01	3.51	3.11	3.00	0.11
Hand and Shoulder	28.13	30.11	28.21	27.51	2.31
Head	11.21	11.41	11.51	11.09	0.76
Rib	14.30	14.51	14.43	14.31	1.02
Tail	0.31	0.32	0.41	0.31	0.01
Trotter	3.81	4.31	4.11	3.89	0.31
Back Fat Thickness	1.50	1.61	1.81	1.83	0.03
Abdominal Fat %	2.00	2.51	2.62	2.81	0.07
Bacon	3.81	4.55	4.61	3.92	0.31
Carcass Length CM	35.10	35.51	36.31	35.41	3.01
Loin	4.11	4.53	5.11	4.31	0.37
Organ					
Heart	0.46	0.58	0.58	0.41	0.02
Kidney	0.21	0.21	0.18	0.19	0.01
Liver	2.10	2.15	2.27	2.01	0.05
Lung	1.06	1.08	1.03	1.05	0.01
Spleen	0.18	0.18	0.16	0.15	0.01
Small Intestine	3.18	4.01	4.16	3.21	0.21
Large Intestine	3.10	3.19	3.21	3.41	0.11

Table 4: Carcass and Organ Characteristics of Pigs fed Tigernut Residue

The cost benefit analysis of growing pigs fed graded levels of tigernut residue as replacement for maize is shown in Table 5. The control diet had significantly higher cost of feed, average cost of feeding per day, total cost of feeding and feed cost/kg weight gain compared to the tiger nut residue-based diets. This may be due to the higher cost per kg of maize compared to tigernut residue (₦100 versus ₦50). The feed cost/kg and cost of feed consumed per day was least with pigs fed 30% tigernut residue (TNR). When tigernut residue (TNR) was used up to 30% level in the diet the feed cost/kg reduced steadily from (₦138.4 in T_1 to as low as ₦123.4 in T_4. The observed significant decline in the feed cost/kg from ₦138.4 to ₦123.4 might be due to the fact that tigernut residue (TNR) is considered a by-product (waste) with little or no monetary value. These results indicated that tigernutresidue is a good quality feed that support growth. More so, the results affirmed that it was cheaper to reduce maize by substituting with tigernut residue.

	T_1	*T_2*	*T_3*	*T_4*
Feed Cost/Kg (₦)	*138.4[a]*	*133.4[a]*	*128.4[b]*	*123.4[b]*
Total Feed Intake (Kg)	*87.78*	*87.71*	*88.13*	*88.81*
Total Cost Of Feeding (₦)	*12.15[a]*	*11.70[b]*	*11.32[b]*	*10.96[b]*
Average Cost Of Feeding (₦)	*202.06[a]*	*194.76[b]*	*188.75[b]*	*182.63[b]*
Feed Cost/Kg Weight Gain	*380.60[a]*	*360.18[a]*	*349.25[b]*	*344.286[b]*

Table 5: Cost Benefit Analysis of Feeding Pigs with Tigernut Residue
Ab – Means in the Same Row Having Different Superscript Are Significant
❖ *- Values Expressed in Thousand Naira*
+-₦/Kg

4. Conclusion

It can be concluded based on the findings in this study that TNR could replace maize in the diets of growing pigs up to 30% level of inclusion without any deleterious effects on the growth performance, carcass and organ characteristics. Replacing maize with TNR up to 30% level of inclusion also led to reduction in the cost of feeding.
Further Research should be conducted with higher levels of TNR.

5. References

i. Kalla, D. J. U., Habu, P. F. and Barrie, G. (2003). Analysis of swine production at Kent Academy, Plateau State, Nigeria. Trop J. Animal Prod. Sci., 6 (2): 79-84

ii. Ayuk, A. A; Okon, B. I; Okon, B; Akpan, B. J; Wogar, G. S. I. and Anya, M. I. (2008) performance and cost evaluation of weaner pigs (large white x land race) fed urea treated cocoa pod lusk diets. In Proc. 13th Ann. Conf. Anim. Sci. Ass. Nig. Ahmadu Bello University, Zaria, Nig. 15-19 September, 2008.

iii. Akpe, A. F. Ibom, L. A; Ayuk, E. A. and Egbah, J. A (2007) comparative growth study of weanerpigs fed cassava and cocoyam root meal Proc. 33rd Ann. Conf. Nig. Soc. For Anim. Prod. (NSAP) Calabar, March 18-21, 2007.

iv. Sampson. B. W. and Safiya. S. 2013. Assessment of the Nutritional and anti-nutritional component of tigernut residue. International Journal of Science and Research. ISBN online 2319-7064 vol 4, issue 6

v. Abdullahi, M. R; Ravindran, V., Wester, T. J. Ravindran, G, and Thomas, D. V. 2011. Influence of feed form and conditioning temperature on performance, apparent metabolizable energy and ideal digestibility of starch and nitrogen in broiler starter fed wheat-based diet. Anim. Feed Sci. Tech. 168:88-99

vi. Abak J. M (2019) Effect of tigernut residue as replacement for maize in finisher broiler chickens' diets. Research projects, Dept. of animal science, Faculty of Agric. AkwaIbom State University. Wikipedia. 2016

vii. A.O. A. C. 2010. Official Methods of Analysis. Association of Official Analytical Chemists International (19th Edition), Maryland U.S.A

viii. SAS 1999

ix. Konietzny, U. and Greiner. R. 2003. In Encyclopedia of Food Science and Nutrition (2nd edition).

x. Olajide, R; Asaniyan, E. K; Aro, S. M. and Olusegun, O. B. 2019. Performance and carcass characteristics of growing pigs fed varying levels of benniseed (sesamumindicum L.) hull in replacement for maize (zea mays CINN). Nigerian *Journal of Animal Production*.46 (1) 61-70

xi. Liu, G., Dunnington, E. A. and Siegel, P. B. 1995. Growth related traits in body weight selected lines reared under different nutritional regimes. *British Poultry Science,*36:209-219

xii. Aduku, A. O. (1991). Animal nutrition in the tropics. ISBN 978-125-742-3 page 9.

xiii. Olomu, J. M. (2011) Monogastric Animal Nutrition, Principles and Practice. ISBN 978-2692-53-0pp 31-33

xiv. Archibong, E. E; Nsa, E. E. and Umoren, U. E. (2018) Nutritional evaluation of tigernut (CyperusEsculentus) meal as a replacement for maize in broiler diets. *Nigerian Journal of Animal Production*,Vol. 45, pp 90-98

xv. Douglas. J. H. Sullivan, T. W; Abdul-kadir, R. and Ruprow, J. H. 1992. Influence of infrared (micronization) treatment on nutritional value of corn and low and high tannin sorghum. *Poultry Science*, 70:1534-1539

xvi. Elkin, R. G; Roggler, J. C. and Sullivan, T. W. (2005). Differential response of ducks and chicks to dietary sorghum tannin, *Journal of food science and agriculture,*57:542-553

xvii. Fanimo, A. O; Oduguwa, O. O; Jimoh, Y. O. and Farronbi, A. O. 2007. Performance and carcass evaluation of broiler chicks fed shrimp waste meal supplemented with synthetic amino acids. *Nigerian Journal of Animal Production,* 25 (1):17-21

xviii. Sundu, B; Kumar, A. and Dingle, J. (2005). Response of birds fed increasing levels of palm kernel meal supplemented with enzymes. *Australian Poultry Science Symposium*, 17:228-278

xix. Fatufe, A. A; Akanbi, I. O. Saba, G. H. O. Olowofeso, O. and Tewe, O. O. (2007). Growth performance and nutrient digestibility of growing pigs fed. A mixture of palm kernel meal and cassava peel meal. *Livestock Research for Rural Development.* 19:180

xx. Van Krimpen, M. M; Kwakkel, R. P; Andre, G; Den Hartog, L. A. and Verstegen, M. W. A. 2006. Effects of nutrition dilution and feed intake, eating and performance of broilers. *British Poultry Science*, 48:389-398.

xxi. Ukpabi, U. H, Mbachu, C. L. and Igboegwu, C. M (2019). Growth performance, carcass and organ characteristics of grower pigs fed varying levels of tigernut (CyperusEsculentus)seed meal. *Nigerian Journal of Animal Science*, 21(1):214-221

xxii. Nwokocha, J. I; Ifeanyi, F. E. Osegbu, U. I. 2003. Performance of growing pigs fed diets containing different levels of cassava peels and yellow maize. *Pakistan Journal of Nutrition,* 2:189-194

xxiii. Nsa, E. E; Ukachukwu S. N; Akpan, I. A; Okon, B; Effiong, O. O. and Oko, O. O. K. (2010). Growth performance, internal organ development and haematological responses of broiler birds, fed diets containing different thermal treated castor oil seed meal (RicinusCommunis). *Global Journal of Agricultural Science*,9 (2):33-40