

Nutritional evaluation of tigernut (*Cyperus esculentus*) meal as a replacement for maize in broiler diets



Archibong, E. E., *Nsa, E. E. and Umoren, U. E.

Department of Animal Science, University of Calabar, Calabar

Abstract

*Corresponding Author: E-mail: essienkate@gmail.com

A total of three hundred (300) day old unsexed "Fidan" broiler chicks averagely weighing 100.25 ± 0.44 g were used to study the response of broiler birds to diets containing different levels of yellow tigernut meal (TNM) as a replacement for maize. The birds were randomly allotted to five dietary treatments of three replicates each containing 60 and 20 birds respectively. After 28 days, the birds were again randomized based on weights to commence the finisher phase in a completely randomized design. The treatment diets consisted of 0%, 25%, 50% 75% and 100% of TNM as replacement for maize as diets 1 (control) 2, 3, 4 and 5 respectively. The result showed TNM to be low in protein (5.04%), moderate in fibre (13.01%) and high in ether extract (27.46%). Among the antinutritional factors, alkaloids, phytate and tannin were relatively high; 2.63mg/kg, 1.44mg/100g and 1.01mg/100g, respectively. Average weight gain (AWG) and final live weight (FLW) were high for birds fed 25 TNM and significantly ($p < 0.05$) higher than the birds on control at the starter phase. However, at the finisher phase, the values were similar except for birds on 100% TNM that showed significant ($p < 0.05$) depression in AWG and FWG. Feed intake was significantly affected by TNM inclusion levels and tended to improve ($p < 0.05$) significantly as the level of TNM increases in the diets at the starter phase. And at the finisher phase, there was no significant ($p > 0.05$) differences in feed intake across the treatment diets. The feed conversion ratio and protein efficiency showed similar trend both in starter and finisher phases of broiler production, except that at the starter phase, there was poor feed utilization as the level of TNM exceeded 25%, while at the finisher phase, depression only set in at 100% TNM. Feed cost (₦/kg) increased as the level of TNM increased in the diets. Among the nutrient utilization only fibre and ether extract were significantly ($p < 0.05$) affected and this occurred only at 100% TNM. The TNM inclusion had no significant effect on the dressing percentage. Of all the carcass parameters measured only gizzard, caeca and abdominal fat showed significant differences, which all tended to increase ($p < 0.05$) significantly as the level of TNM increases in the diets. It was concluded that at starter phase TNM as replacement for maize should not exceed 25% and at finisher phase, it may not exceed 75% for optimal growth performance.

Keywords: Tigernut, anti-nutritional factors, nutrient retention.

Introduction

The search for lesser known and underutilized crops, many of which are potentially valuable as animal feed has been intensified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world. In Nigeria, conventional feedstuffs especially energy sources like maize, wheat, millet and guinea corn are becoming increasingly costly and scarce. This has led to the search for

alternative feedstuffs for use in animal production especially poultry species, which are the major sources of animal protein in Nigeria. Such alternative feed ingredients should of necessity be available all year round; easy to be procured and processed, if need be, into usable forms and must have a comparable cost advantage over the conventional feed stuffs (Oyebiyi *et al.*, 2007). Such feed stuffs must not be a staple item for human food (Okonkwo and Adikpe, 1988). At present in Nigeria, there

Nutritional evaluation of tigernut (Cyperus esculentus)

are many agricultural and industrial by-products that have found their usefulness in livestock feeding (Aina, 1990; Longe *et al.*, 1997; Sobimiwa, 1998; Agunbiade *et al.*, 1999; Oluokun and Olaokun, 1999; Ukachukwu *et al.*, 2002; Oladunjoye *et al.*, 2003; Togun and Oseni, 2005). A species that can be exploited in this direction is *Cyperus esculentus* commonly called tigernut. It possesses as much agronomic and nutritional potential as the conventionally used energy sources. Tigernut is commonly known as earth almond, *chufa*, *chew-fa* and *Zulu* nuts in Spain. It is known in Nigeria as *Aya* in Hausa, *Ofio* in Yoruba, *Akihausa* in Igbo and *Isip-Isong* in Efik where these varieties (black, brown and yellow) are cultivated. Among these, only two varieties, yellow and brown are readily available in the market. The yellow variety is preferred to all other varieties because of its inherent properties like its bigger size, attractive colour and fleshier body. The yellow variety also yields more milk upon extraction, contains lower fat and more protein and possesses less anti-nutritional factors especially polyphenols (Okafor *et al.*, 2003). Tigernut can be eaten raw, roasted, dried, baked or can be made into a refreshing beverage called *Horchata De Chufas* or tigernut milk. In Nigeria, the Tigernut can be grown virtually everywhere. Residue after milk extraction is being discarded by the beverage industries as waste, even though it is said to have high energy content. The successful exploitation of this plant would add to the feed resources available to the livestock industry in Nigeria. With its inherent high yield, high energy content, tolerance to wide variety of soil, resistance to most of the common pests, a success in this research will contribute in solving the problem of scarcity and high cost of feed ingredients (maize, millet, guinea corn and so on) in

livestock feed industry. It will provide feed millers and poultry farmers with readily available high quality alternative feed ingredient that is relatively cheaper thereby reducing the cost of poultry production. This study therefore, was designed to determine the level of replacement of maize with tigernut on performance of broiler chicken.

Materials and methods

Test ingredient and diets

Yellow species of tigernut were purchased in jute bags in plateau state, Nigeria. The remaining ingredients were bought from local markets within Calabar Metropolis, Cross River State, Nigeria. The tigernut was further sun-dried by spreading it on concrete slab and allowed to dry for three days after which it was milled with a meadow model 35 harmer mill and sieved through a mesh of 5mm to produce the meal. The composition of the test ingredient is shown in Table 3. The tigernut meal (TNM) was then included into the starter and finisher diets and made to replace maize at 0%, 25%, 50%, 75% and 100% to form treatment diets 1 (control), 2, 3, 4 and 5, respectively.

Animal management

Three hundred day-old broiler chicks were used for the study. The birds were weighed and randomly allotted to the five treatment diets. At starter phase, sixty birds were allotted to each treatment and within each treatment group; chicks were further divided into three replicates of 20 birds each. At the finisher phase, birds were weighed again and re-randomized into the five finisher diets of 54 birds per treatment; each treatment was replicated thrice with 18 birds each. The chicks during the starter phase were given all routine vaccination and necessary medications. Feed and water were given *ad libitum* throughout the experimental period. The birds were reared

Table 1: Ingredient composition of the experimental broiler starter diets

Ingredient (%)	0	25	50	75	100
Maize	56.00	42.00	28.00	14.00	0.00
Tigernut meal	0.00	14.00	28.00	42.00	56.00
Wheat offal	7.00	7.00	7.00	7.00	7.00
Soybean meal	30.00	30.00	30.00	30.00	30.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell meal	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
* Vitamin/mineral premix	0.25	0.25	0.25	0.25	0.25
Total (%)	100.00	100.00	100.00	100.00	100.00
Calculated values					
Crude protein (%)	24.11	23.84	23.51	23.34	23.11
ME(Kcal/kg)	2950.50	2937.56	2920.64	2903.88	2889.55
Crude fibre (%)	3.98	4.30	4.52	4.90	5.17
Ether extract	3.52	3.53	3.56	3.60	3.63
Calcium	1.25	1.25	1.23	1.23	1.20
Phosphorus	0.83	0.84	0.84	0.86	0.88
Determined values (%)					
Crude protein (%)	23.57	23.31	23.10	22.68	22.20
Crude fibre (%)	4.06	4.17	4.34	4.75	4.95
Ether extract	3.51	3.53	3.55	3.58	3.61
Calcium	1.23	1.23	1.21	1.19	1.17
Phosphorus	0.80	0.82	0.84	0.88	0.92

* Vitamin/mineral premix containing the following per kg. Vitamin A, 10,000,000 IU; vitamin D3, 2,000,000 IU; Vitamin E, 20,000 IU; Vitamin K, 2,000 mg; Thiamine, 1,750 mg; Riboflavin B2, 5,000 mg; Pyridoxine B6, 2,750 mg; Antioxidant, 125 g; Niacin, 27,500 mg; Vitamin B12, 15 mg; Panthothenic acids, 7,500 mg; Biotin, 50 mg; Choline chloride 400 g; Manganese, 80 g; Zinc, 50 g; Iron, 20 g; Copper, 5 g; Iodine 12 g; Selenium, 200 mg; Cobalt, 200 mg.

Table 2: Ingredient composition of the experimental broiler finisher diets

Ingredient (%)	0	25	50	75	100
Maize	61.00	45.75	30.50	15.25	0.00
Tigernut meal	0.00	15.25	30.50	45.75	61.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Soybean meal	23.50	23.50	23.50	23.50	23.50
Fish meal	1.50	1.50	1.50	1.50	1.50
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell meal	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
* Vitamin/mineral premix	0.25	0.25	0.25	0.25	0.25
Total (%)	100.00	100.00	100.00	100.00	100.00
Calculated values					
Crude protein (%)	20.50	20.25	20.00	19.75	19.50
ME(Kcal/kg)	3102.50	3098.40	3094.48	3090.38	3086.20
Crude fibre (%)	5.31	5.91	6.32	6.39	7.22
Ether extract	3.39	3.41	3.54	3.75	3.98
Calcium	1.24	1.24	1.24	1.25	1.25
Phosphorus	0.80	0.82	0.84	0.86	0.89
Determined values (%)					
Crude protein (%)	21.36	21.19	21.06	20.88	20.76
Crude fibre (%)	5.17	5.29	5.40	5.78	6.20
Ether extract	3.48	3.50	3.65	3.80	4.18
Calcium	1.25	1.25	1.26	1.26	1.27
Phosphorus	0.79	0.81	0.83	0.85	0.87

* Vitamin/mineral premix containing the following per kg. Vitamin A, 8,000,000 IU; vitamin D3, 1,600,000 IU; Vitamin E, 5,000 IU; Vitamin K, 2,000 mg; Thiamine, 1,500 mg; Riboflavin B2, 4,000 mg; Pyridoxine B6, 1,500 mg; Antioxidant, 125 g; Niacin, 1,500 mg; Vitamin B12, 10 mg; Panthothenic acids, 5,000 mg; Folic acid, 500 mg; Biotin, 20 mg; Choline chloride 200 g; Manganese, 80 g; Zinc, 50 g; Iron, 20 g; Copper, 5 g; Iodine 12 g; Selenium, 200 mg; Cobalt, 200 mg.

Nutritional evaluation of tigernut (*Cyperus esculentus*)

on deep litter house with wood shaving as litter material.

Experimental design and digestibility studies

The experiment was a completely randomized design. At eight weeks of age, four birds per replicate were randomly selected and kept in metabolic cages. The birds were fed with the same diets offered during the feeding trial. Records on feed intake and faeces were taken on a daily basis with the use of electronic weighing balance. The daily faeces were dried to a constant weight of 80°C in the oven. The dried samples were ground in a hammer mill and stored at room temperature for proximate analysis. Digestibility trial was carried out and lasted 10 days.

Data collection

Body weights of birds were collected weekly while feed intake was daily. At the end of the experiment which lasted for 56

days, six birds per replicate were randomly selected fasted for eighteen hours, weighed and slaughtered by severing the jugular vein. The birds were bled, dipped in hot water for a minute and defeathered. They were cut into retail parts and weighed. The prevailing market prices of the feedstuffs as at the time of the study were used to calculate the cost benefit ratio.

Chemical analysis

Test ingredients, feed and dropping samples were dried at 60°C for 24 hours before analysis. Dry matter (DM), ash, CP (Nx6.25), ether extract (EE) and crude fibre (CF) were determined according to AOAC (1990) methods. Tannin was determined according to Follin Denis methods (AOAC, 1990); phytate by methods of Wheeler and Farrel (1971), saponin, oxalate, cyanogenic glycosides and alkaloids as described by Iyayi *et al.* (2008). Average values were taken after four times of analysis.

Table 3: Proximate composition of sun dried tigernut meal and antinutritional factors of tigernut

Components (% DM)	Values	±SD
Moisture	7.35	2.11
Crude protein	5.014	0.33
Crude fibre	13.01	1.13
Ether extract	27.46	3.25
Ash	3.03	0.41
Nitrogen free extract	51.53	2.90
Gross energy (kcal/g)	4.08	0.66
Anti-nutrients (mg/100g):		
Phytate	1.44	0.08
Cyanogenic glycosides	0.67	0.05
Tannin	1.01	0.41
Saponin	0.58	0.05
Oxalate	0.61	0.02
Polyphenols	1.00	0.07
Alkaloids	2.63	0.04

Values are means of triplicate determinations ±SD – Standard Deviation

Results and discussion

The proximate composition of tiger nut meal showed that it has 5.04% crude protein which is very low when compared to other fibre feedstuff as revealed by Oyenuga (2000). However, it has a high level of fibre 13.01% and other extract of about 27%. It could therefore be said to be

an energy source feedstuff. Table 2 showed the growth performance of the broilers at the starter and finisher phases. At the starter phase, the final body weight (FBW) and the average weight gain (AWG) of chicks were highest at the 25% inclusion level of tigernut which were significantly ($p < 0.05$) better than the control, thereafter, both

parameters decreased ($p < 0.05$) with increasing level of TNM. The decreasing weight may be attributed to the tannin and phytate content of TNM which increased with increasing diet levels. The presence of these anti-nutritional factors has been shown to reduce growth rate of broiler due to a reduced protein and specific amino acid utilization (Douglas *et al.*, 1992; Elkin *et al.*, 1995; Fanimó *et al.*, 2007).

The high fibre content of the feed, which increased with the level of TNM, may also be attributed to the poor weight gain and final body weight of birds as TNM increased in the diets. This is in line with the report of Nsa *et al.* (2007) who earlier in their experiment with fibrous feed in broiler diet, was found to depress chicks weight gain and final live weight.

At the finisher phase, the AWG and FWG only depressed ($p < 0.05$) significantly at total replacement of maize with TNM (100% TDM), which may indicate that birds can tolerate up to 75% replacement of maize with tigernut without any negative effect on the AWG and FWG at the finisher phase. This observation showed that mature birds could tolerate higher levels of anti nutritional factors and fibre than younger birds. However, this finding was contrary with the report of Addy and Etesholas (1984) where replacement levels beyond 50% of maize with TNM in diet of broilers led to reduced weight gain; this could be attributed to different environmental influences on the birds in the separate studies.

At the starter phase, average feed intake (AFI) increased significantly ($p < 0.05$) with increase in the TNM levels in the diets. This is in support with the report of Savory and Gentle (1976); Fanimó *et al.*, 2007) that high fibre increases feed intake to allow birds meet their requirement for some dietary component, other than energy. However, at the finisher phase there was no

significant ($p < 0.05$) differences in feed intake. This observation could be attributed to the facts that matured birds, can tolerate higher level of fibre and antinutritional factors than young birds (Nsa, 2008).

Higher value of feed conversion ratio with increasing level of TNM was noticed at the starter phases, which probably indicate a reduction in feed utilization as the level of TNM increased in the diets. This is again in line with Ortiz *et al.* (1994), Fanimó, (2007) who reported adverse effect of tannin/phytate containing extract of feed on feed utilization. The feed conversion ratio at finisher phase showed no significant differences except at 100% TNM which was significantly poor. An indication that mature bird can utilized more fibre and anti-nutritional factors than young chicks. The protein efficacy ratio showed similar trend like feed conversion ratio as significant ($p < 0.05$) decrease was only noticed in diet with 100 TNM at the finisher phase. This confirms earlier studies by Oyawoye and Nelson (2002) who showed poor protein utilization at high levels of rice offal fed to young cockerels and they attributed it to the high fibre level of rice offal.

The nutrient utilization estimates (Table 3) showed that the inclusion levels of tigernut meal in the diets had no significant ($p < 0.05$) effect on the nutrient digestibility by the birds except on the fibre and ether extract at 100% the diet is at the high level of TNM which were significantly ($p < 0.05$) higher than all the other treatment groups. This may be due to the fact that TNM is fibrous and birds could be able to utilize them even at 100% level of replacement. This however, contradicts the reports of Oluokun and Olalokun (1999), Onifade, (1993), Onifade and Babatunde (1997), Fanimó *et al.* (2007) that high fibre content interfered with nutrient availability at the tissue level thereby reducing the nutrient available for growth maintenance. Fibre is believed to

Nutritional evaluation of tigernut (Cyperus esculentus)

decrease the availability of nutrients by reducing the period of exposure of the food to the digestive enzymes and absorptive surfaces. This in turn impaired absorption of nutrient (Hedge *et al.*, 1978).

The cost per kg diets though not significantly affected ($p < 0.05$) seems to increase as inclusion level of tigernut meal (TNM) increased in the diets. This is due to the high cost of tigernut when compared to maize. This high cost of TNM could be attributed to its scarcity in the southern part of Nigeria, unawareness of its potentials in animal feed and its high demand in processing industry for its milk and oil. This in turn possibly led to increased cost/kg diet, cost of feed consumed and cost of feed/kg weight gain. However, up to 50% of TNM inclusion still gave the least N/kg meat produced.

Result of the carcass characteristics is shown in Table 4. The dressing percentage was not significantly affected by the varying dietary inclusion level of TNM. The mean values for dressing percentage are in consonance with the range of 65.63-73.33% reported by Adeyemo and Longe (2007). The mean weights of cut parts as percentage of live weight were not also significantly ($p < 0.05$) affected by treatment

diets. Apart from abdominal fat, lungs and caeca which tended to increase ($p < 0.05$) as the inclusion levels of TNM increased in the diets, other measured internal organs showed non-significant differences across the treatment diets.

The non-significant influence of tigernut inclusion in diets on the liver, kidney and heart may be an indication of absence of severe toxicity since hypertrophy or hypotrophy of these organs has been associated with the presence of toxins (Aderemi, 2003; Ewuola *et al.*, 2003). The enlargement of the caeca and the gizzard could be attributed to the high level of fibre in the diets. It has been shown that these organs are always enlarged when high fibrous feeds are fed to broilers (Nsa *et al.*, 2009). Furthermore, the enlargement of the caeca as the inclusion of TNM increased in the diet could be attributed to the activities of micro flora in further digestion and absorption process (Wong and Gibson, 2000). The high level of abdominal fat as the inclusion levels of TNM increased in the diets was due to the high ether extract (27.46%) of tiger nut. High TNM inclusion in the diet means high fat content. Birds are known to store excess fat in their abdomen from diet with high fat content (Nsa *et al.*, 2010).

Table 4: Effects of replacing dietary maize with tigernut on the performance of starter broiler chicks

Performance indices	Replacement levels of Tigernut meal					SEM
	0%	25%	50%	75%	100%	
Initial body weight (g/bird)	100.18	100.30	100.43	100.23	100.29	0.44
Final body weight (kg/bird)	0.96 ^b	1.11 ^a	1.07 ^{ab}	0.89 ^c	0.85 ^c	0.07
Daily weight gain (g/bird)	31.46 ^b	35.73 ^a	34.33 ^{ab}	25.94 ^c	22.81 ^c	1.26
Daily feed intake (g/bird)	72.36 ^b	79.32 ^a	74.15 ^b	60.70 ^c	54.29 ^d	2.19
Feed conversion ratio (g feed/g gain)	2.30 ^b	2.22 ^{bc}	2.16 ^c	2.34 ^{ab}	2.38 ^a	0.21
Daily protein intake (g/bird)	17.06 ^a	18.49 ^a	17.13 ^a	13.77 ^b	12.05 ^b	0.36
Feed cost (₦/kg)	88.00	89.10	91.21	93.16	94.89	
₦/kg meat produced	202.40 ^b	197.80 ^d	197.01 ^d	217.99 ^c	225.84 ^a	
Cost reduction (%)	-	22.73 ^a	2.66 ^b	-7.70 ^c	-11.58 ^d	
Mortality (%)	0.00	0.00	0.00	1.00	1.00	

Means within the same row with different superscripts are significantly different ($p < 0.05$).

SEM – Standard Error of Mean

Table 5: Effects of replacing dietary maize with tigernut on the performance of finisher broilers

Performance indices	Replacement levels of Tigernut meal					SEM
	0%	25%	50%	75%	100%	
Initial live weight (kg)	0.98	0.95	0.99	0.96	0.98	0.02
Final live weight (kg)	2.28 ^a	2.32 ^a	2.30 ^a	2.25 ^a	1.94 ^b	0.03
Daily weight gain (g/bird)	75.84 ^a	77.17 ^a	75.88 ^a	73.22 ^a	62.80 ^b	2.46
Daily feed intake (g/bird)	186.91	184.34	182.10	180.92	179.15	1.75
Feed conversion ratio (FCR)	2.46 ^b	2.39 ^b	2.40 ^b	2.47 ^b	2.85 ^a	2.85
Daily protein intake (g/bird)	18.56	18.50	18.55	18.57	18.30	1.55
Protein efficiency ratio (PER)	2.01 ^a	2.20 ^a	2.15 ^a	1.74 ^b	1.66 ^c	0.10
Feed cost (₦/kg)	86.50 ^c	88.33 ^d	90.11 ^c	92.26 ^b	94.01 ^a	3.46
₦/kg meat produced	200.68 ^b	189.91 ^b	199.14 ^b	253.72 ^a	272.63 ^a	10.22
Feed cost saving (%)	-	5.37 ^a	0.77 ^b	-26.43 ^c	-35.85 ^d	0.04

Means within the same row with different superscripts are significantly different ($p < 0.05$).

SEM – Standard Error of Mean.

Conclusion

The study showed that in starter diets, tigernut meal may not exceed 25% but for finisher birds, up to 75% of tigernut meal could be used to replace maize in their diets without any detrimental effect on growth performance parameters. The cost of feed per kg will however be higher, but with awareness of its potentials in poultry diets, cost price will subsequently be low as more farmers will be encouraged to go into its production across the country.

References

- Aderemi, F. A. 2003.** Effect of enzyme supplemented cassava root sievate in cassava based diet on some visceral organs of pullet chicks. *Proceedings of the 8th Annual Conference of Animal Science Association of Nigeria*, Minna, April, 17-20, 2003.
- Adeyemo, G. O. and Longe, O. G. 2007.** Effects of graded levels of cotton seed cake on performance, haematological and carcass characteristics of broilers feed day old to 8 weeks of age. *African Journal of Biotechnology*, 6(8): 1064-1071.
- Agunbiade, J. A., Adeyemi, O. A., Fasina, O. E., Ashwrobi, B. O., Adebanyo, M. O. and Wande, O. A. 1999.** Cassava peels and leaves in the diets of rabbits: Effects on performance and carcass characteristics. *Nigerian Journal of Animal Production*, 26: 30-31.
- Aina, A. B. J. 1990.** Replacing maize with cassava peels in finisher rations of cockerels: The effect on cut up pieces of the eviscerated carcass. *Nigerian Journal of Animal Production*, 17: 17-22.
- A.O.A.C. 1990.** Association of Official Analytical Chemists. *Official Methods of Analysis* 15th Ed. Washington D.C.
- Douglas, J. H. Sullivan, T. W., Abdul-Kadir, R. and Ruprow, J. H. 1992.** Influence of infrared (micronization) treatment on the nutritional value of corn and low and high-tannin sorghum. *Poultry Science*, 70:1534-1539.
- Elkin, R. G., Roggler, J. C. and Sullivan, T. W. E. 2005.** Differential response of ducks and chicks to dietary sorghum tannins. *Journal of Food Science and Agriculture*, 57: 542-553.
- Ewuola, E. O., Ogunalde, J. T., Gbore, F. A., Salako, A. O., Idahor, K. O. and Egbunike, G. N. 2003.** Performance evaluation and organ histology of rabbits fed *Fusarium*

Nutritional evaluation of tigernut (Cyperus esculentus)

- veticilliodes*, culture materials. *Tropical Animal Investment*, 6:111-117.
- 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.
- Hedge, S. N., Rolls, B. A., Turrey, C. and Coate, M. E. 1978.** The effects on chicks of dietary fibre from different sources; a growth factor in wheat bran. *British Journal of Nutrition*, 40: 63-69.
- Iyayi, E. A., Kluth, H. and Rodehutschord, M. 2008.** Effect of heat treatment on ant nutrients and precaecal crude protein digestibility in broilers feed on fur tropical seeds. *International Journal of Food Science*, 43: 610-616.
- Longe, O. G., Famojuro, E. O. and Oyenuga, V. A. 1997.** Available carbohydrate and energy values of cassava, yam and plantain peels for chicks. *East African Journal*, 42: 408-413.
- 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 hematological responses of broiler birds, fed diets containing different thermal treated castor oil seed meal (*Ricinus communis*). *Global Journal of Agricultural Sciences*, 9(2): 33-40.
- Nsa, E. E., Okon, B., Akpan, I. A., Anya, M. I., Wogar, G. S. I., Edet, G. D., Okereke, C. O. and Juobi, V. I. 2009.** Growth performance and economy of maize offal as a replacement for maize in broiler finisher diet. *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria (ASAN)*, Ogbomoso, September 14-17, 2009.
- Okafor, J. N. C., Mordi, J. I., Ozumba, A. U., Solomon, H. M. and Olatunji, O. 2003.** Preliminary studies on the characterization of contaminants in tigernut (yellow variety). *Proceedings of 27th Annual Nigerian Institute of Food Science and Technology (NIFEST) Conference, Nigeria*. October 13-17, 2003.
- Okonkwo, A. C. and Adikpe, D. A. 1988.** *Leucaena leucocephala* seed meal in the diets of laying birds and its effect on egg yolk pigmentation. *Nigerian Journal of Animal Production*, 15: 207-212.
- Oladunjoye, I. O., Amao, O. A., Emiola, I. A. and Adenola, O. A. 2003.** Potential of cowpea testa meal as a substitute for maize in the diet of rabbit. *Science Focus*, 3: 6-10.
- Oluokun, J. A. and Olaokun, E. A. 1999.** The effect of graded levels of brewers spent grains and kola nut pod meal on the performance and carcass quality of broiler birds. *Nigerian Journal of Animal Production*, 26: 71-77.
- Onifade, A. A. and Babatunde, G. M. 1997.** Comparative utilization of three Tropical by products feed resources supplemented with or without molasses by broiler chicks. *Archivos zootechnia*, 146: 137-145.
- Onifade, A. A. 1993.** Comparative utilization of three dietary fibre sources by broiler chickens. Ph.D Thesis, University of Ibadan, Nigeria.

- Oritz, L. T., Alzeiet, A. C., Trevino, J. and Castano, M. 2004.** Effect of faba bean tannins on the growth and histological structure of the intestinal tract and liver of chicks and rats. *British Poultry Science*, 6(3): 223-754.
- Oyawoye, E. O. and Nelson, F. S. 2002.** Optimum level of inclusion of rice offal in the diet of Young cockerels. *Proceedings of the 20th Annual National Conference of the Nigerian Society for Animal Production*, March 26-30, 1995. Minna, Niger State, Nigeria, P. 263.
- Oyebiyi, O. O., Farinu, G. O., Togun, V. A., Akinlade, J. A., Ajibola, H. O. and Olaniyonu, B. I. 2007.** Studies on growth and haematological attributes of weaner rabbits fed graded levels of sundried cassava peel-blood meal mixture. *Proceedings of the 32nd Annual Conference of the Nigerian Society for Animal Production*. Calabar, March 18-21, 2007. Pp. 213-216.
- Savory, G. J. 1976.** Changes in feed intake regulation in poultry (Bookman, K. N. and B. M. Freeman, (eds.) pp. 145, Longman, Edinburgh, UK.
- Sobimiwa, O. 1998.** Performance and egg quality of hens fed cocoa husk based diets. *Nigerian Journal of Animal Production*, 25(1): 22-24.
- Togun, V. A. and Oseni, B. A. 2005.** Effect of low level of inclusion of biscuit dust in broiler finisher diet on pre-pubertal growth and some haematological parameters of unsexed broilers. *Research Communication in Animal Science*, 1(2): 10-14.
- Ukachukwu, S. N., Ezeagu, I. E., Tarawali, G. and Ikeorgu, E. G. 2002.** Utilization of mucuna as a food and feed in West Africa. In: B. M. Flores, M. Eilitta, R. Myhrmans, L. B. Carew and Carsky, G. J. (eds.). *Mucuna as a food and feed: Current uses and the way forward*. Workshop proceedings held in Tegucigalpa, Honduras, April 26-29, 2000.
- Wheeler, E. I. and R. E. Farrell 1971.** A method of phytic acid determination in wheat and wheat fractions. *Cereal Chem.* 48:312-320.

Received: 14th August, 2018

Accepted: 21st December, 2018