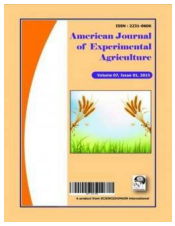

American Journal of Experimental Agriculture
11(4): 1-7, 2016, Article no.AJEA.22340
ISSN: 2231-0606

SCIENCEDOMAIN *international*
www.sciencedomain.org

Comparative Evaluation of Composite Cassava Root Meal, Palm Oil and Crayfish Waste Mixture as Substitute for Maize in Broiler Chicken Diet

E. E. Nsa[1], G. S. I. Wogar[1*] and I. A. Akpan[1]

[1]Department of Animal Science, University of Calabar, Calabar, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEA/2016/22340
Editor(s):
(1) Hugo Daniel Solana, Department of Biological Science, National University of Central Buenos Aires, Argentina.
(2) Zhen-Yu Du, School of Life Science, East China Normal University, China.
Reviewers:
(1) Bergaoui Ridha, National Institute of Agronomy, Tunisia.
(2) Adela Marcu, Banats University of Agricultural Sciences and Veterinary Medicine, Romania.
Complete Peer review History: http://sciencedomain.org/review-history/13408

Original Research Article

Received 29th September 2015
Accepted 11th November 2015
Published 24th February 2016

ABSTRACT

Aim: To investigate the response of broiler chickens to diets containing levels of composite cassava root meal, palm oil and Cray fish dust (CCPCM) as replacement for maize.
Study Design: The experiment involved five treatments with three replicates per treatment in each of starter and finisher phases in a Completely Randomized Design.
Place and Duration of Study: The study was carried out in the Teaching and Research Farm of the University of Calabar, Nigeria, between September 2014 and December, 2014.
Methodology: Three hundred (300) one week old unsex broiler chicks were randomly allotted to five dietary treatments consisting of three replicates of 20 birds each. The control diet (T1) contained 56% maize which was replaced with 25%, 50%, 75% and 100% of CCPCM to form T2, T3, T4 and T5 respectively. The mixture was in such that it insinuates the maize in Crude Protein and Metabolisable energy (Iso-nitrogenous and Iso-Calorie). After 21 day of feeding the experimental meal, two hundred and forty of the birds were further re- randomized into 5 dietary treatments of three replicates. The control diet (T1) contained 60% maize and was replaced with 25%, 50%, 75% and 100% of CCPCM. The diets were all made to be iso-nitrogenous and iso-caloric.

**Corresponding author: E-mail: ikaniw45@yahoo.com, ikaniw@yahoo.com;*

Results: The final live weight (FLW), weight gain (WG) and feed conversion ratio (FCR) did not vary significantly with the control up to 50% at starter phase and up to 75% at finisher phase but above this levels they showed significant (P=0.05) depression. Feed intake at starter phase were significantly (P=0.05) affected only at above 50% replacement of maize with CCPCM while At the finisher phase the feed intake were not significantly affected by the levels of CCPCM in the diets. Cost of feed per kg decreased while cost of feed per kg live weight gain increased (P=0.05) with increasing level of CCPCM up to 75% inclusion level.
Conclusion: It was concluded that 50% and 75% CCPCM could replace maize in broiler starter and finisher diets respectively.

Keywords: Composite cassava root meal; palm oil; crayfish meal; broiler chickens.

1. INTRODUCTION

The highly growing demand for maize as a result of its use in most livestock feeds, as food to man and as well as raw materials for industries, has in turn raised its market price beyond the reach of an average Nigerian farmer [1,2]. Thus research for cheaper feedstuffs has been the concern of animal nutritionists [3-5].

Cassava root meal is a less well known source of energy in livestock feed. This is because of its bulkiness, low level of protein (1.2-2.4%) which is low quality, relatively low level of energy (2360 Kca/kg) when compared to maize and its high levels of Linamarin and Lotaustralin, a cyanogenic glucoside which releases highly toxic hydrogen cyanide(HCN) during hydrolysis at the time of digestion [6,7].

The ease of cultivation, tolerance to draught and poor soil condition, lower cost of production, stable market price, all year availability makes it preferable to maize [8]. Supplementation of cassava meal with good Protein and energy sources like crayfish dust and palm oil respectively coupled with good processing methods such as cooking, sun drying, roasting, ensiling or fermentation to reduce or eliminate the hydrogen content before they are incorporated in diets could make it compete with maize [2].

Most of the fish meal used in poultry diets in Nigeria are not just expensive but are also contaminated and of poor quality, research for cheaper protein source to replace fish meal has been concern of animal nutritionist [3].

The use of Cray fish waste, as feed for various categories of livestock has been a continuous subject of investigation [4]. The use of Cray fish waste was explored in this experiment. Cray fish waste has been reported to constitutes over 70% of sea catch and on processing leaves the head, limbs, tails and so on to be waste that are often discarded. It is rich in protein that varies from 46.00 – 58.00% [9,10,4]. Is an essential protein source in broiler diets [10].

Palm oil has relatively 2-3 times more energy than maize per unit value [11,12]. It reduces dustiness [13,14]. Is one of the good sources of energy in broiler diets [14].

This study therefore is designed to investigate the effect of replacing maize with composite mixture of cassava root meal with Cray fish waste and palm oil in broiler chicken diets.

2. MATERIALS AND METHODS

2.1 Location of Experiment

The experiment was conducted at the University of Calabar Teaching and Research Farm of the Department of Animal Science, Calabar, Nigeria, between Sept, 2014 and Dec, 2014.

2.2 Test ingredients and Diets

A local Variety (TMS-30572) of fresh cassava tubers, crayfish waste, palm oil and maize were bought from Calabar. The cassava tubers were peeled, washed, milled in a hammer mill then squeezed using pressure technique, thereafter sieved through a mesh of 5 mm, the crystalline dust were subjected to frying. The representative samples of the test ingredients were subjected to test for proximate analysis [15]. The cassava meal, crayfish waste and palm oil were mixed in proportion of 14:2:0.5 respectively that made the resulting mixture to have the same levels of protein and energy as the experimental maize through calculation and subsequent chemical analysis. The fortified meal was then used to replace maize at 0, 25, 50, 75 and 100% levels. The composition of the diets, are shown in Tables 1 and 2.

2.3 Animals Feeding and Management

Three hundred (300) unsexed one week old-Elite broiler chicks previously brooded with commercial broiler starter diet were weighed and randomly allotted to the five treatment diets. Each dietary treatment had 60 chicks, of three replicates with 20 birds per replicate.

At the end of 21 days of the starter phase experiment, two hundred and forty (240) of the birds were selected and re-randomized into the five experimental finisher diets. Each treatment had 48 birds of 16 birds per replicate.

At the end of the experiment, 4birds per replicate were randomly selected and kept in metabolic cages for feacal collection. The birds were allowed 6 days of adaptation to their different diets followed by 5 days of collection of droppings. The droppings were collected every morning and stored at-18℃. The samples were pooled: Individual samples were thawed, mixed and dried.

Feed and water were given *ad libitum* and the birds were reared on deep litter house with wood shavings as litter material.

2.4 Experimental Design and Data Collection

The experiment was designed to be a Completely Randomized Design. The first phase (starter phase) lasted for 21 days while the second phase (Finisher phase) lasted for 28 days.

Individual birds were weighed at the beginning of the experiment to obtain the initial weight of birds and subsequently weight were taken weekly, feed intake was measured by calculating the difference in the quantity of feed offered daily and the quantity left and at the end of the finisher phase, 5 birds per replicate were sacrificed for abdominal fat measurement. Nutrient retention was calculated based on the data gotten from birds kept in metabolic cages.

Table 1. Gross composition of experimental diet (broiler starter)

Ingredients	Replacement level of maize with fortified cassava root meal				
	0%	25%	50%	75%	100%
Maize	56.00	42.00	28.00	14.00	0.00
CCPCM	0.00	14.00	28.00	42.00	56.00
Soybean meal	34.00	34.00	34.00	34.00	34.00
Wheat offal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	2.00	2.00	2.00	2.00	2.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vit/mineral premix*	0.25	0.25	0.25	0.25	0.25
Calculated analysis					
CP%	24.01	24.00	24.00	24.00	24.00
M.E.K Cal/Kg	2890.90	2895.10	2897.00	2899.34	2901.28
Determined Analysis					
CP%	23.78	23.81	23.55	23.71	24.02
Crude fiber%	4.21	4.38	4.53	4.60	4.77
Ash%	6.42	6.23	6.12	6.06	6.01
Determined analysis (fortified cassava root meal mixture)					
CP%	9.98				
(M.E.) Kcal/Kg	3434.10				
Crude fiber%	4.56				
Ether extract %	4.97				
Ash%	5.43				

**1 kg of premix contained the following: vitamin A (5000,000 I.U), Vitamin D3 (1,000,000 I. U.), Vitamin E (16,000 mg), Vitamin K3 (800 mg), Vitamin B1 (1,200 mg), Vitamin B2 (22,000 mg), Niacin (22,000 mg), Calcium pantothenate (4,600 mg), Vitamin B6 (2,000 mg), Vitamin B12(10 mg), Folic aci (400 mg), Biotin (32 mg), Cholin chloride (200,000 mg), Manganese (48,000 mg), Iron (40,000 mg), Zinc (32,000 mg), Copper (3,400 mg), Iodine (600mg), Cobalt (120 mg), Selenium (48 mg), Antioxidant (48,00 mg)*

Table 2. Gross composition (%) of the experimental diets (broiler finisher)

Ingredients	Replacement level of maize with composite cassava root meal, palmoil and crayfish waste mixture				
	0%	25%	50%	75%	100%
Maize	60.00	45.00	30.00	15.00	0.00
CCPCM	0.00	15.00	30.00	45.00	60.00
Soybean meal	27.00	27.00	27.00	27.00	27.00
Wheat offal	5.50	5.50	5.50	5.50	5.50
Palm kernel cake	3.00	3.00	3.00	3.00	3.00
Fish meal	1.5	1.5	1.5	1.5	1.5
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vit/mineral premix*	0.25	0.25	0.25	0.25	0.25
Calculated analysis					
CP%	21.00	21.00	21.00	21.00	21.00
M.E.(KCal/Kg)	3100.03	3100.21	3100.76	3100.90	3102.00
Determined analysis					
CP%	19.93	19.73	19.59	19.98	21.02
Crude fiber%	6.58	7.01	7.65	7.99	8.33
Ash%	6.77	6.79	6.41	6.63	6.19

**1 kg of premix contained: Vitamin A (5,000,000 I.U.), Vitamin D3 (1,000,000 I.U), Vitamin E (16,000 mg), Vitamin K3 (800 mg), Vitamin B1 (1,200 mg), Vitamin B2 (22,000 mg), Niacin (22,000 mg), Calcium pantothenate (4,600 mg), Vitamin B6 (2,00 mg), Manganese (48,000 mg), Zinc (32,000 mg), Copper (3,400 mg), Iodine (600 mg), cobalt (120 mg), Selenium (48 mg), Antioxidant (48,00 mg)*

2.5 Chemical Analysis

Feed, test ingredients and droppings samples were dried at 60℃ for 24 hours and milled (1 mm screen) before analyses and all analyses were performed on dried samples, except for nitrogen (N) of droppings which was determined in fresh samples. Dry Matter (DM), Ash, Crude Protein (NX6.25), Crude Fiber (CF) were determined [15].

2.6 Statistical Analyses

All data collected were subjected to analysis of variance (ANOVA) using the Completely Randomized Design [16]. and treatment means were separated using The Multiple Range Test [17] Prevailing prices of feed ingredients at the time of the experiment were used to calculate the economic parameters such as cost of feed per kg (N), cost of feed per weight gain (N).

3. RESULTS AND DISCUSSION

The results of the performance of broiler chicken fed the experimental diets are presented in Tables 3 and 4.

3.1 Final Body Weight and Weight Gain

The final body live weight FBLW and body weight gain (BWG) did not vary (P>0.05) significantly up to 50% and 75% replacement level of maize with fortified cassava root meal (FCRM) in both starter and finisher diets respectively, but above these levels there were significant (P<0.05) depression as the level of fortified FCRM increased in the diets. This observation indicated that younger chicks could conveniently tolerate up to 50% CCPCM as replacement for maize while older birds could tolerate a higher level of 75%. The poor performance of young chicks when the level of FCRM was above 50% may be due to higher dietary fiber as contributed by CCPCM (Table 1). Mature birds are said to tolerate higher level of fiber than young birds [18,14]. This observation for chicks is in consonant with these authors [19,20,12,8,21]. They all confirmed that replacement levels beyond 50% of maize in diet of grower cockerels, weaner rabbit and layers may lead to reduction in weight gain. The step up for matured birds up to 75% may probable due to the cassava meal being fortified with Cray fish and palm oil to have equivalent protein and energy levels with maize.

3.2 Feed Intake

The feed intake was not significantly (P>0.05) influenced up to 50% CCPCM replacement level in the young chicks but with significant decrease as level of CCPCM was above 50%. This lower feed intake at a high level of replacement of

maize could be due to high fiber level in the diet as contributed by high level of CCPCM. Young birds are noted to consume less feed with relative high level of fiber [14,22]. Finisher birds however, showed no significant differences (P>0.05) in feed intake among all the treatment means. This means that there was no inhibition in the consumption of any of the diets. Any differences observed in other performance parameters could therefore only arise from the utilization of the diets. Each ingredients apart from maize and the test ingredients (CCPCM) was included at the same level, therefore, any differences in the utilization of the diets could be attributed to the replacement levels of test ingredients with maize. This observed similarity in feed consumption across the treatment diets could be due to all the experimental diets having the same energy level since birds will eat to satisfy their energy requirement [23]. The improved feed intake as compared to the chick phase shows that matured birds can consume more fibrous feed [24].

3.3 Feed Conversion Ratio

The Feed Conversion Ratio showed similar trend with live weight as birds above 50% and 75% replacement levels of maize with CCPCM in starter and finisher phases respectively had significantly (P<0.05) poor FCR, an indication that high level of CCPCM in diets of broiler chicks discourages effective utilization of feed by the birds.

3.4 Nutrient Retention

Results of proximate components and energy retention at finisher phase are shown in Table 4. There were no significant (P<0.05) differences at finisher phase across the treatments diets. This means that there were no differences in the utilization of the nutrients. This, at first look, is at variance with observations on the production performance of the birds. It could be that at the time of the metabolism trial (which is at the end of experimental feeding trial) the birds had

Table 3. Effect of replacing maize with composite cassava root meal, palm oil and Cray fish waste mixture in broiler starter diets

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM
Initial body wt(g)	76.75	78.00	80.13	77.45	75.92	1.26NS
Final body wt(g)	760.13^{a}	755.40^{a}	731.00^{a}	632.71^{b}	540.40^{c}	2.47*
Average Weight gain, g/d	22.40^{a}	22.21^{a}	20.64^{a}	16.17^{b}	14.29^{b}	0.19*
Feed intake g/d	60.61^{a}	60.06^{a}	57.40^{ab}	49.17^{b}	45.88^{b}	2.10*
FCR	2.71^{d}	2.70^{d}	2.78^{c}	3.04^{b}	3.21^{a}	0.05*
PER	1.54	1.54	1.50	1.37	1.30	0.03NS
Cost/kg feed(N	101.20^{a}	96.40^{b}	90.20^{c}	80.53^{d}	75.17^{e}	1.45*
Cost/kg WG(N	274.25^{a}	260.28^{b}	250.76^{c}	244.81^{d}	241.30^{d}	3.55*

Means followed by different superscript letters in the same row differ significantly

Table 4. Effect of replacing maize with composite cassava root meal, palm oil and Cray fish waste mixture in broiler finisher diets

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM
Initial body wt(g)	751.50	753.16	759.20	755.59	760.06	1.12
Final body wt(g)	2260.18^{a}	2257.55^{a}	2248.00^{a}	2227.45^{a}	2006.20^{b}	3.89*
Average Weight gain, g/d	50.52^{a}	49.60^{a}	48.90^{a}	48.56^{a}	40.40^{b}	1.38*
Feed intake g/d	121.06	120.12	118.72	116.00	112.45	6.73^{NS}
FCR	2.40^{b}	2.42^{b}	2.43^{b}	2.39^{b}	2.79^{a}	0.01*
PER	1.99	1.97	1.96	1.99	1.31	0.04NS
Cost/kg feed(N	98.65^{a}	93.81^{b}	88.11^{c}	80.10^{d}	73.40^{e}	1.67*
Cost/kg WG(N	236.76^{a}	227.02^{b}	214.11^{c}	191.44^{d}	204.79^{c}	6.77*
Abdominal fat(g)	3.13^{d}	4.66^{d}	7.01^{c}	9.66^{b}	13.15^{a}	1.88*
Nutrient utilization (%)						
Dry matter	70.36	72.11	72.23	72.25	71.55	3.43
Crude protein	61.44	60.66	60.62	60.31	60.06	5.00
Crude fiber	30.11	30.16	30.22	28.98	27.69	1.65
Ether extract	69.41	70.14	72.06	72.92	72.90	6.90
N-free extract	75.12	75.06	74.79	74.32	74.01	4.44

Means followed by different superscript letters in the same row differ significantly

adjusted and adapted to whatever adverse effects that were occasioned by the dietary levels of CCPCM. Other workers have reported adaptation of broiler chicks to diets containing cassava meal in poultry and rabbit diets [2].

3.5 Abdominal Fat Deposit

The abdominal fat significantly (P=0.05) increased as the composite cassava root meal, palm oil and Cray fish waste mixture increased in the diets with the birds in diet 5 having the highest abdominal fat deposit. This was expected as diet with excess oil and fat content promote fat storage around belly, abdominal region and some major organs in the body [13].

3.6 Cost Gain Ratio

The cost per kilogram of feed decreased (P=0.05) significantly with increasing level of CCPCM in the diets with the lowest cost of feed obtained in birds fed diet containing 100% CCPCM. This observed trend could be attributed to the lower prices of cassava root meal, Cray fish waste and palm oil that constituted the mixture when compared to the price of maize. [25-27]. Highlighted the need for dietary formulation which can be used as an alternative non-competitive, readily available and cheap ingredients which can partly replace the conventional energy and protein feedstuffs in poultry diets.

On the basis of production cost, 75% CCPCM replacement of maize gave the lowest (P=0.05) cost (N) per kilogram weight gain than all the other levels of replacement. This means that it is cheaper to raise broilers at finisher phase at 75% replacement level of maize with fortified cassava root meal.

4. CONCLUSION

It can therefore be inferred that 50% and 75% of maize replacement with fortified cassava root meal in broiler starter and finisher diets respectively were the most efficient in terms of the economy of feed conversion without any adverse effect on weight gains. Cassava root meal is relatively cheaper than maize and should be encouraged when fortified with good protein and energy sources to contribute to poultry production in the country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Durunna CS, Udebibie ABI, Anyanwu GA. Combination of maize/sorghum and cassava tuber meal as substitute for maize in diet of laying hens. A book of proceeding of the 35th Annual Conference of the Nigerian Siciety for Animal Production. Umudike; 2000.
2. Tewe OO, Olaogun OO, Adedoyin AA, Abu OA. Performance of broilers fed graded levels of Cassava starch residue. ASAN, University of Uyo. Nigeria; 2010.
3. Anoh KU, Akpet SO. Growth response of broiler chickens fed diets containing blood meal with enzyme supplementation as a replacement for fish meal. Journal of Agriculture and Vertinary Science. 2013;4:31-34.
4. Udedibie ABI, Anyaegbu BC, Onwuchekwa GC, Egbuokporo OC. Effect of feeding different levels of fermented and unfermented cassava tuber meals on the performance of broilers. Nigerian Journal of Animal Production. 2004;341:211-219.
5. Ngiki YU, Igwebuike JU, Moruppa SM. Effects of replacing maize with cassava root-leaf meal mixture on the performance of broiler chickens. Nigerian Journal of Animal Production. 2014; 34:36-46.
6. Gomez G, Valdivirsco M, Dela Questa DD, Sekoedo TS. Effect of variety and plant age on the cyanide content of whole root, cassava chips and its reduction by sundrying. Animal Feed Science and Technology. 1984;11:143-152.
7. MCDonald P, Edwards RA, Greenhalgh JFD, Morgan CA. Cassava root meal in livestock feeds. Animal Nutrition 6th Edition. Pearson Prenticve Hill, Singapore. 2002;389-614.
8. Tewe OO. Cassava for livestock feed in sub Sahara African: Strategies for industrialization commissioned paper presented at the international workshop. On cassava competitiveness. IITA. Ibadan; 2002.
9. Agunbiade JA, Tolorunji BO, Awojobi H. A. Shrimp waste meal supplementation of cassava products based diets fed to broiler chickens. Nig. J. Anim. Prod. 2004; 31(2):182-188.
10. Oduguwa OO, Fanimo AO, Jegede AV. Effect of enzyme supplementation on the utilization of shrimp waste meal based diets by broiler chickens. Nig. J. Animal Production. 2004;31:167-173.

11. Lehninger AE. Oxidation of fatty acids. Biochemistry, 4th Edition. Watt Publishers incorporated. New York; 2001.
12. Ukachukwu SN. Effect of composite cassava meal with or without palm oil and/ or methionine supplementation on broiler performance. Livestock Research for Rural Development. 2008;20(4).
13. Nsa EE, Akpan IA, Okon B, Anya MI. Performance of broiler finisher birds fed palm oil slurry as energy source. Nigerian South East Journal of Agricultural Economics and Extension. 2009;8(1):18-22.
14. Nsa EE, Isika MA, Ozung PO. Replacement effect of maize with maize offal and palm oil slurry supplemented with vitamin E on the growth performance, organs development and abdominal deposition of broiler finishers. International Journal of Agriculture. 2012;4(3).
15. AOAC. Official methods of analysis. 16th Edition. Association of Analytical Chemists, Washington D. C; 1995.
16. Steel RGD, Torrie JH. Principles and procedures of statistics. A Biometric Approach, 2nd Edition. MacGraw-Hill, New York; 1980.
17. Duncan DB. Multiple range test. Biometrics. 1955;11-42.
18. Oluyemi JA, Robert C. Poultry production in Warm Wet Climate. Macmillan Publishers. Ludan and Basigngstoke. 2000;197.
19. Aderemi FA. The effect of replacement of wheat with cassava root sievate supplemented with Enzymes on haematology and serum biochemistry of pullet chicks. Tropical J. Animal SC. 2004;(1):147-153.
20. Agugu GO, Okeke GC. The effect of replacing maize with Cassava root meal in the diets of pullet chicks. In: Proc. 30th Ann. Conf. Nig. Soc. Anim. Prod. 2005;30: 235-237.
21. Aderemi FA, Lawal TE, Iyayi F. Metabolisable energy and nutrient digestibility of growing pullets fed enzymes supplemented cassava root sievate as a replacement to wheat bran in cassava based diet. In Tropical Anim. Prod. Invest. 2003;6:142-153.
22. Udedibie ABI, Enang MT, Enyenihi GE, Obikaonu HO. Use of sun-dried cassava tuber meal, brewers' grains and palm oil to simulate maize in broiler diets. Proceedings of international conference on Global food crisis. Federal University of Technology, Owerri, Nigeria. 2009;56-59.
23. Uchegbu MC, Ogbuewu IP, Obimara SO, Obua BE. Effect of replacement of maize with cassava root meal fortified with palm oil on performance of starter broilers. Online Journal of Animal and Feed Research. 2011;1(5):171-175.
24. Udedibie ABI, Durunna CS. Combination of maize/sorghum-based dried brewer's grains, cocoyam, corn and cassava tuber meals as substitute for maize in broiler diets. Journal of Agriculture of Animal Production. 2000;3:211-219.
25. McNab BN, Shannon DWF. The nutritive value of barley, maize and oats. Bri. Poult. Sci. 1994;15:516-657.
26. Nworgu FC, Egbunike GN, Iyayi EA, Adetoro AM, Fapohunda JB. Effects of replacement of groundnut cake with full fat extruded soybean meal on broiler performance. In the Nigeria livestock industry in 21st century. Edited by Ologhobo AD and Iyayi EA. 1999;98-100.
27. Fanimo AO, Adebayo AJ, Oduguwa OO, Biobaku WO. Feeding value of cashewnut testa for broiler chickens. Nig. J. Anim. Prod. 2007;34(1):83-93.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/13408