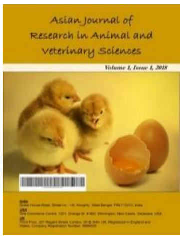

Asian Journal of Research in Animal and Veterinary Sciences

1(3): 237-243, 2018; Article no.AJRAVS.43225

Anti-nutritional Factors of Composite Mango (*Mangifera indica*) Fruit Reject Meal and Its Value in the Nutrition of Finisher Broiler Chickens

Kanan Tyohemba Orayaga[1*], Oluwabiyi Ikeolu Atanda Oluremi[1], Comfort Dooshima Tuleun[1] and Silvanus Ngbede Carew[2]

[1]*Department of Animal Nutrition, University of Agriculture, Makurdi, P.M.B. 2373, Benue State, Nigeria.*
[2]*Department of Animal Production, University of Agriculture, Makurdi, P.M.B. 2373, Benue State, Nigeria.*

Authors' contributions

This work was carried out in collaboration between all authors. All authors were involved in designing the study. Author KTO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OIAO, CDT and SNC managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRAVS/2018/43225
Editor(s):
(1) Dr. Jean-Marie Exbrayat, Professor, Reproduction and Comparative Development, University of Lyon, General Biology, Catholic University of Lyon, Ecole Pratique des Hautes Etudes, France.
(2) Dr. Jean Beguinot, Department of Biogeosciences, University of Burgundy, France.
Reviewers:
(1) Juan Carlos Troiano, University of Buenos Aires, Argentina.
(2) George P. Laliotis, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece.
(3) Animetu Seghosime, University of Benin, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/27255

Original Research Article

Received 09 July 2018
Accepted 06 September 2018
Published 16 November 2018

ABSTRACT

Aim: Investigation was made to ascertain the level of some anti-nutrients in composite mango fruit reject meal (MFRM) and its effect on the performance of finisher broiler chickens.
Methodology: Mango fruit reject meal was analysed for anti-nutritional factors and incorporated into finisher broiler diets at 0, 11, 12, 13 and 14% to obtain five diets. Two hundred 28-day-old *Arbor Acre* broiler chickens were randomly allocated to the five dietary treatments in a completely randomised design (CRD), and fed for 35 days.
Results: Anti-nutritional factor levels were; tannin 2.10%, phytate 0.48%, saponin 2.96%, flavonoid

**Corresponding author: E-mail: orayacollins@gmail.com, orayacollins@yahoo.com;*

3.77% and oxalate was 3.35%. Mean final body weights and daily weight gains were significantly depressed (P<0.05) at 11% and 13% level of MFRM inclusion but similar to the control at 12% and 14% MFRM. There was no significant difference (P>0.05) for feed intake and digestibility of nutrients among the treatment groups. The cost/kg weight gain was not significantly affected (P>0.05) as well.

Conclusion: Mango fruit reject meal supported growth performance of finisher broiler chickens at 12% and 14% level comparable to maize, and 14% inclusion of MFRM was optimal.

Keywords: Anti-nutrients; broiler chickens; mango fruit reject; growth performance.

1. INTRODUCTION

Cull fruits or rejected fruits such as mango, unlike other agro-industrial by-products which are known to have low nutritional value due to low nutrient content, high fibre, low palatability or presence of anti-nutritional factors [1], are not always diminished in nutrient content [2]. Agro-products rejects such as cashew nut rejects are only unfit for human consumption but are reported to have high value for animal feeding [3]. Mango fruits that are unfit for human consumption are usually rejected and wasted; though considered one of the most important tropical fruit crops [4]. The fruit consists of a woody endocarp (pit), a resinous edible mesocarp (flesh) and a thick exocarp (peel). The majority of mango production is consumed fresh, and about 1-2% of the production is processed to make products such as juices, nectars, concentrates, jams, jelly powders, fruit bars, flakes and dried fruits [5]. Mango varieties too fibrous or too soft for fresh consumption can be used for juice making [6] and fruit processing yields about 40-50% of by-products, which can be used to feed livestock [7]. These by-products are also potential sources of pectins and phenolic compounds, some of which have antioxidants activities [5].

Mango fruits are produced on a large scale around many countries of the world, with total world figure put at 38 million metric tones [8] and Nigeria occupies the 8th position, on the list of top most producers of mango around the world [4]. In Nigeria, Benue state is the highest quantitative producer of mango fruit [9] as cited [10]. They also cited Ajayi and Nyishir [11] who reported that though there is no clear figure of mango production in Benue state, the state supplies mango fruits to many other states of the country. A large quantity of the fruit wastes away because of non-availability of fruit processing factories. Orayaga and others [2] reported significantly depressed performance at 15% inclusion of MFRM in poultry diets; putting the optimum level of 10%.

This research was therefore conducted to determine the anti-nutritional factors in composite mango fruit rejects meal and the effect on the performance of finisher broiler chicken; identifying the optimum level.

2. MATERIALS AND METHODS

2.1 Experimental Location

The experiment was conducted at the Experimental Poultry House of the Livestock Unit, on the Teaching and Research Farm, Federal University of Agriculture, Makurdi in Benue State, Nigeria. The area is warm with a minimum temperature range of 21.71 $\pm$ 3.43°C and a maximum temperature range of 32.98 $\pm$ 2.43°C [12].

2.2 Preparation of Mango Fruit Rejects and Diets

Mango fruit rejects (test ingredient) were collected from mango tree stands of mixed varieties around Makurdi town and environs in its season (February and May). The composite rejected mango fruits were cleaned with a piece of cloth and sliced using a kitchen knife to about 3mm thick of peels and pulp together, and the seeds discarded. Sliced pieces of composite mango fruit reject were sun-dried for seven days or until it attained less than 10% moisture to obtain the mango fruit reject meal (MFRM) which was stored in polyethene sacks to the time it was used. Before the composite mango fruit reject meal was incorporated into the diets, it was milled using a corn milling machine. This was sub-sampled for determination of anti-nutrients namely; phytate, tannin, saponin, flavonoid and oxalate. Phytate was determined using the spectrophotometric method [13], tannin and Saponin were determined following the procedure of Harborne [14], oxalate was determined as reported [15], while flavonoid was determined using the method of Khatiwora and others [16].

Mango fruit reject meal was incorporated in broiler finisher diets at 0, 11, 12, 13 and 14% to give diets T1, T2, T3, T4 and T5, respectively with 0% MFRM (T1) serving as the control (Table 1). Proximate composition of the MFRM was adopted from the report of Orayaga and Sheidi [2], which became a guide to the inclusion of the MFRM in diets. Diets compounded were sub-sampled and their proximate composition and gross energy determined using the procedure outlined by AOAC [18].

2.3 Experimental Birds, Design and Management

Two hundred (200) 28 day-old *Arbor Acre* broiler chicks were used in the experiment which lasted for five weeks (35 days). The broiler chicks were randomly allocated to 5 dietary treatments, balancing for body weight. Each treatment group, forty birds, was replicated four times and each replicate had ten (10) birds. The experimental design was a completely randomised design (CRD).

Standard management procedures as outlined [19] were followed and vaccinations as recommended by the National Veterinary Research Institute, Vom, Nigeria, were followed. Feed and clean cool drinking water were supplied to the birds *ad libitum* all through the experimental period, which was 35 days.

During the last week of the experiment, a digestibility trial was carried out. Three finisher broiler chickens per replicate were transferred to metabolic cages and allowed three-day adjustment period before they were served weighed diets. The total faecal collection was

Table 1. Composition (%) of experimental diets for finisher broiler chicken

Ingredients	Experimental diets				
	T1 0% MFRM	T2 11% MFRM	T3 12% MFRM	T4 13% MFRM	T5 14% MFRM
Maize	54.86	43.86	42.86	41.86	40.86
Soybean meal	24.69	24.69	24.69	24.69	24.69
Maize offal	9.00	9.00	9.00	9.00	9.00
Brewers dried grain	5.00	5.00	5.00	5.00	5.00
MFRM	0	11.00	12.00	13.00	14.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	0.50	0.50	0.50	0.50	0.50
Blood meal	2.50	2.50	2.50	2.50	2.50
Methionine	2.50	2.50	2.50	2.50	2.50
Lysine	0.20	0.20	0.20	0.20	0.20
Common Salt	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated values					
M.E (kcal/kg)	3107.92	3057.92	3054.92	3052.92	3050.92
Crude protein (%)	20.41	19.70	19.70	19.60	19.60
Crude fibre (%)	4.95	4.99	4.99	5.00	5.00
Crude fat	4.12	3.97	3.97	3.96	3.96
Calcium (%)	1.30	1.30	1.30	1.30	1.30
Phosporus (%)	0.85	0.85	0.86	0.86	0.86
Lysine (%)	1.10	1.08	1.07	1.06	1.06
Methionine (%)	0.58	0.58	0.57	0.57	0.57

MFRM= Mango fruit reject meal

**Premix = Animal care vitamin/mineral premix included at 0.25%, translating to 24000iu vitamin A, 6000iu vitamin B, 60mg vitamin E, 5mg vitamin K3, 2mg Folic acid, 80mg Niacin, 20mg Calpan, 4mg vitamin B1, 10mg Vitamin B2, 7mg vitamin B6, 0.04mg Vitamin B12, 0.16mg Biotin and 250mg antioxidant per kg diet. The minerals values per kg diet were: cobalt 0.5 mg, copper 16mg, selenium 0.5mg, iodine 24mg, iron 80mg, manganese 140 mg, zinc 120mg and chloride 400mg*

ME= metabolizable energy calculated from the determined proximate components using the formula ME= 37 (%CP) + 81.8 (%EE) + 35.5 (%NFE) [17] done for four days, oven dried, and aliquot samples of the faeces and diets were analysed for proximate constituents. All feed ingredients acquired and processing activities involved were monetised and price per kg of each ingredient was determined for economic analysis.

2.4 Data Collection and Analysis

Data was collected on growth performance parameters (final live body weight, weekly live body weight, feed consumption and water intake). Weight gain, feed conversion ratio and water–feed ratios, and economics of production were determined. Feed consumed during the digestibility trial, and faecal weights were recorded, analysed for proximate constituents and digestibility coefficients of nutrients calculated as outlined [1]. Mean values of collected and appropriately processed data were subjected to analysis of variance using the SPSS software [20] which was also configured to automatically separate means that were significantly different (P<0.05) using its Duncan Multiple Range Test.

3. RESULTS AND DISCUSSION

Phytate (0.48%), tannin (2.10%), saponin (2.96%), flavonoid (3.77%) and oxalate (3.35 %) were found in composite mango fruit reject meal (Table 2). Tannin, saponin, flavonoid oxalate was relatively more than phytate. They were lower in the composite mango fruit meal than the kernel where the tannin level was reported as 3.2% [21]. Tannin level as low as 0.5% is considered high; more than enough to cause a significant effect on the performance of farm animals [22]. They form complexes (chelates) with proteins and metals, making them unavailable for utilisation by the animal. Although tannins have traditionally been considered anti-nutritional in activity, it is now known that their beneficial or anti-nutritional properties depend upon their chemical structure and dosage [23]. Another nutrient binder in MFRM is oxalate. Its level was also high. It has been reported that in the body, oxalic acid combines with divalent metallic cations such as calcium (Ca^{2+}) and iron (II), Fe^{2+} to form crystals of the corresponding oxalates which are then excreted in urine as minute crystals [24]. These oxalates can form larger kidney stones that can obstruct the kidney tubules. An estimated 80% of kidney stones are formed from calcium oxalate [25]. This binding activity may make some nutrients unavailable for intestinal absorption. Oxalates levels above 0.1% in animal diets adversely affect growth performance and 375 mg/kg body weight results in death in rats.

Table 2. Anti-nutritional factors in composite mango fruits reject meal

Anti-nutrient	Level (%)
Phytate	0.48
Tannin	2.10
Saponin	2.96
Flavonoid	3.77
Oxalate	3.35

Saponins are bitter and as such their presence in feedstuff or diets reduces the palatability of such feedstuff or diets [26].

Growth performance of finisher broiler chickens fed diets containing MFRM is presented in Table 3. Mean final weight, daily weight gain, protein intake and FCR were significantly different (P<0.05). Birds fed diet containing 11% MFRM (T2) and those fed diet containing 13% MFRM (T4) were depressed for mean final weight and daily weight gain, and those fed diet containing 12% MFRM (T3) and those fed diet containing 14% MFRM (T5) were similar to the control. The broiler chickens fed diets containing 11% MFRM (T2), 13% MFRM (T4) and 14% MFRM (T5) had significantly depressed (P<0.05) FCR and protein intake. The trend where treatment group fed diet containing 11% MFRM (T2) performed less compared to chickens on diets containing 12% MFRM (T3) and 14% MFRM (T5) may not be due to dietary effect since they had higher percentages of MFRM. It is likely that sex ratio was the reason for the variation in performance since on the observation of the trend, it was noted that T2 and T4 had more females. Sex is known to significantly affect the performance of broiler chickens with the males being superior [27,28]. It has been reported that male broiler chickens are significantly heavier (p<0.05) compared to females [29]. It was therefore suggested that domination of this treatments (T2 and T4) by females was responsible for their depressive growth performance. Consequently, the seemingly low performance of T2 (11% MFRM) is ignored and T5 (14% MFRM) is considered the optimum level of MFRM inclusion in finisher broiler chickens. While the optimum level of MFRM inclusion is 10% at the broiler starter phase [30]; it is 14% for finisher broiler chickens. Factors responsible for the significant variation in digestibility such as the presence of anti-nutritional factors like tannin were probably responsible for the depressed performance as well. Increase in tannin levels was reported to correspondingly reduced protein retention. Tannin is known to reduce the nutritional value of a diet, mainly due to a decrease in the availability of protein for use and impairment of digestive enzyme activity [31]. As a result, nitrogen retention and use of the amino acids are reduced due to the reduction in protein digestibility [32].

The coefficient of digestibility of nutrients by broiler finisher chickens fed diets containing 0, 11, 12, 13 and 14% MFRM are presented in Table 4. Coefficients of digestibility for dry matter (DM), crude protein (CP), nitrogen-free extract (NFE), ether extract (EE), crude fibre (CF), total digestible nutrients (TDN) and metabolisable energy (ME) were not significantly affected (P>0.05) among the treatments groups. This has confirmed and strengthens the fact that finisher broiler chickens could handle MFRM better than the chicks. At the chick stage, 11% MFRM (T2) was optimal for nutrient digestibility [30]. However, at the finisher, 14% MFRM (T5) is the optimum in terms of nutrient digestibility.

The result of the economics of production is presented in Table 5. There was no significant difference among the treatments for feed cost per kg weight gain, benefit, and cost to benefit ratio per finisher broiler chicken. However, the cost of feed consumed, total cost of production, and revenue were significantly different (P<0.05). Though, the cost due to feed and total cost of production were significantly higher (P<0.05) for the control ($ 2.04 and $ 5.04) and least for T5 ($1.77 and $ 4.77) respectively, the revenue was equally highest at the control ($ 8.44), giving rise to statistically equal benefit ($2.84- $3.40) and cost-benefit ratio (1.48 – 1.68) among the treatment groups and as such putting the overall economics of production on non-significant difference across the treatments. The non-significant difference in the overall economics of production means that MFRM can be used

Table 3. Performance of broiler finisher chicken fed diets containing varying levels of mango fruit reject meal

Average parameters	Experimental diets					
	T1	T2	T3	T4	T5	SEM
Initial live body weight (g)	693.75	693.75	688.75	691.75	693.75	-
Final live body weight (g)	2022.50^{a}	1827.50^{b}	1925.00^{ab}	1853.75^{b}	1892.50^{ab}	41.51*
Daily weight gain (g)	37.96^{a}	32.39^{b}	35.32^{ab}	33.20^{b}	34.25^{ab}	1.20*
Daily feed intake (g)	107.41	104.17	107.60	105.82	106.66	1.39^{ns}
Feed conversion ratio (FCR)	2.83^{a}	3.22^{b}	3.12^{ab}	3.19^{b}	3.15^{b}	0.1*
Daily protein intake (g)	21.92^{a}	20.52^{b}	21.20^{ab}	20.74^{b}	20.91^{b}	0.27*
PCE	1.73	1.60	1.67	1.60	1.64	0.01^{ns}
Daily water intake (ml)	347.27	325.59	327.68	333.97	340.28	8.75^{ns}
Water:feed ratio (ml/g)	3.23	3.213	3.05	3.16	3.19	0.03^{ns}
Mortality (%)	1.25	0	0.25	0	0.5	-

*^{a,b} Means on the same row with different superscripts are significantly different (P<0.05), SEM= standard error of mean, ^{ns} no significant difference (P>0.05), *= significant (P<0.05), T1= Diet containing 0% MFRM, T2 = Diet containing 11% MFRM, T3 = diet containing 12% MFRM, T4= Diet containing 13% MFRM, T5 = Diet containing 14% MFRM, PCE= Protein conversion efficiency*

Table 4. Effect of dietary levels of mango fruit reject meal on the digestibility of nutrients of finisher broiler chicken

Nutrients (%)	Experimental diets					
	T1	T2	T3	T4	T5	SEM
Dry matter	75.53	71.65	71.58	77.80	73.07	1.70^{ns}
Crude protein	68.70	56.19	58.95	69.43	62.01	2.07^{ns}
Ether extract	89.70	87.64	87.64	78.89	89.47	4.18^{ns}
Crude fibre	40.13	43.56	46.96	50.13	39.49	3.54^{ns}
Nitrogen free extract	90.97	85.20	86.54	90.83	88.11	1.83^{ns}
Energy (Kcal ME/kg)	83.53	78.05	78.65	83.64	81.40	1.82^{ns}
Total digestible nutrients	78.92	70.10	70.09	75.47	74.69	1.85^{ns}

SEM= standard error of mean, $^{ns=}$ no significant difference (P>0.05), ME = metabolisable energy
T1= Diet containing 0% MFRM, T2 = Diet containing 11% MFRM, T3 = Diet containing 12% MFRM, T4= Diet containing 13% MFRM, T5 = Diet containing 14% MFRM

Table 5. Effect of dietary levels mango fruit reject meal on the economics of producing finisher broiler chickens

Economic parameter	Experimental diets					
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**
Cost of feed consumed Per chicken ($)	2.04[a]	1.79[b]	1.83[b]	1.78[b]	1.77[b]	0.02*
Feed cost per kg weight gain ($)	1.55	1.58	1.51	1.53	1.50	0.05[ns]
Operational cost per broiler chicken ($)	0.49	0.49	0.49	0.049	0.49	-
Cost per 28 day-old chicken ($)	2.51	2.51	2.51	2.51	2.51	-
Total cost of production per broiler chicken ($)	5.04[a]	4.79[b]	4.83[b]	4.78[b]	4.77[b]	0.02*
Revenue per bird[1] ($)	8.44[a]	7.63[b]	8.04[ab]	7.74[b]	7.90[ab]	0.17*
Benefits per bird ($)	3.40	2.84	3.21	2.96	3.11	0.16[ns]
Cost/benefit ratio	1.48	1.68	1.50	1.61	1.53	0.07[ns]

*SEM= standard error of mean, [ns=] no significant difference (P>0.05), *= significant (P<0.05)*
[1]Revenue per bird obtained as a product of ₦800 which was the value of a kg live weight chicken, by the mean weight of the birds in kg.
[a,b] means on the same row with different superscripts are significantly different (P<0.05),
T1= Diet containing 0% MFRM, T2 = Diet containing 11% MFRM, T3 = Diet containing 12% MFRM, T4= Diet containing 13% MFRM, T5 = Diet containing 14% MFRM

as an energy source to feed broiler chickens at these levels of inclusion and profit will be made as in maize based diets, but more advantageous since it is not competed for by man.

4. CONCLUSION

This study has shown that mango fruit reject meal is a potential feed resource, and that it can be incorporated into broiler chicken diet at 14%.

ETHICAL APPROVAL

As per international standard or university standard, written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA. Animal nutrition. 5th Ed. London: Longman Group UK Ltd; 1995.
2. Orayaga KT, Sheidi, SS. Laying performance and egg characteristics of Japanese quail (Coturnixs coturnix japonica) fed diets containing mango fruit reject meal. Asian Journal of Advances in Agricultural Research. 2018;7(1):1-10.
3. Akande TO, Akinwumi AO, Abegunde TO. Cashew reject meal in diets of laying chickens: Nutritional and economic suitability. Journal of Animal Science Technology. 2015;57:1-7.
4. FAO. Top producers of mangoes, mangosteens and guavas; 2011. Available:www.fao.com/mango (Retrieved; 2014)
5. Berardini N, Fezer R, Conrad J, Beifuss U, Carle R, Schieber A. Screening of mango (*Mangifera indica* L.) cultivars for their contents of flavonol and xanthone C-glycosides, anthocyanins, and pectin. Journal of Agriculture, Food and Chemistry. 2005;53(5):1563–70.
6. Hui YH. Handbook of food products manufacturing. Wiley-Interscience; 2007.
7. Sruamsiri S, Silman P. Nutritive value and nutrient digestibility of ensiled mango by-products. Maejo International Journal of Science and Technology. 2009;3(03):371–378.
8. USDA. National Nutrient Database for Standard Reference. SR-23, Fruit Reports-09, Mango, Raw. 2010;449.
9. Avav T, Uza DV. Agriculture. In: Pigeonniere, AL, (Ed). Africa atlases: Nigeria Las Editors, Paris. 2002;92–95.
10. Ugese FD, Iyango PO, Swem TJ. Mango (*Mangifera indica* L.) fruit production and production constraints in Gboko local government area of Benue State. Production Agrculture and Technology. 2012;8(1):164-174.
11. Ajayi AR, Nyishir SA. Mango variety production, marketing and consumption preferences among households in Benue State, Nigeria. Proceedings of the 23rd

Annual Conference of the Horticultural Society of Nigeria. 2006;337-343.
12. TAC. Makurdi Weather Elements Records. Makurdi Metereological Station. Nigerian Air Force, Tactical Air Command, Makurdi, Nigeria; 2011.
13. Kirk RS, Sawyer R, Egan H. Pearson composition and analysis of foods. 9th Edition, Longman, Singapore; 1991.
14. Harborne JB. Phytochemical methods. 2nd Edition, Chapman and Hall, London. 1980;288-293.
15. Onwuka GL. Food analysis and instrumentation; Theory and practice. 1st Edition, Naphtal Prints, Lagos Nigeria. 2005;115-153.
16. Khatiwora E, Adsul VB, Kulkarni MM, Deshpande NR, Kashalkar RV. Spectroscopic determination of total phenoland flavonoid contents of *Ipomoea carnea*. International Journal of Chemimal Technology Research. 2010;2(3):1698-1701.
17. Pauzenga U. Feeding parent stock. Zootechnica International. 1985;22-24.
18. AOAC. Official methods of analysis. Association of Official Analytical Chemists. 16th Ed. William Tryd Press. Richard Virginia, USA. 2000;17-34.
19. Oluyemi JA, Roberts FA. Nutrient requirement of fowl. In: Poultry production in warm wet climates. 3rd Edn, MacMillan Press Lond. 2000;1-140.
20. SPSS. Statistical package for social sciences. Procedures and facilities for release. 6.0 Users' Mannual. McGraw-Hill Book Co. NY; 1999.
21. Dhingra S, Kapoor AC. Nutritive value of mango seed kernel. Journal of Science of Food and Agriculture. 1985;36:752–756.
22. Marquardt RR, Ward AT, Campbell LD, Cansfield PE. Purification, identification and characterization of a growth inhibitor in faba beans (*Vicia faba* L. var. minor). Journal of Nutrition. 1977;107:1313–1324.
23. Schiavone A, Guo K, Tassone S. Effects of a natural extract of chestnut wood on digestibility, performance traits, and nitrogen balance of broiler chicks. Poultry Science. 2008;87(3):521–7.
24. Philip AW. The Oxalate Dianion, C2O42–: Planar or Nonplanar? Journal of Chemical Education. 2012;89(3):417-418.
25. Coe FL, Evan A, Worcester E. Kidney stone disease. Journal of Clinical Investigation. 2005;115(10):2598–608.
26. Oluremi OIA, Ngi J, Andrew IA. Evaluation of the nutritive potential of the peels of some Citrus fruit varieties as feedstuff in livestock production. Pakistan Journal of Nutrition. 2007;6(6):653-656.
27. Musa HH, Chen GH, Cheng JH, Li BC, Mekki DM. Study on carcass characteristics of chicken breeds raised under the intensive condition. International. Journal of Poultry Science. 2006;5:530-533.
28. Ojedapo LO, Akinokun O, Adedeji TA, Olayeni TB, Ameen SA, Amao SR. Effect of strain and sex on carcass characteristics of three commercial broilers reared in deep litter system in derived savanna area of Nigeria. World Journal of Agricultural Science. 2008;4:487-491.
29. Olawumi SO, Fagbuaro SS. Productive performance of three commercial broiler genotypes reared in the derived savannah zone of Nigeria. International Journal of Agricultural Research. 2011;6:798-804.
30. Orayaga KT. The nutritive value of composite mango (*Mangifera indica*) fruit reject as a feed resource in broiler chicken nutrition. Ph.D Thesis, Department of Animal Nutrition, University of Agriculture, Makurdi (Unpublished). 2016;206.
31. Haslam E. Vegetable tannins. In: Conn EE. The biochemistry of plants. Academic Press, New York. 1981;7:527-544.
32. Elkin RG, Featherston WR, Rogler JC. Condensed tannins are only partially responsible for variations in nutrient digestibilities of sorghum grain cultivars. Poultry Science. 1995;74(1):125.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/27255