Effect of *Garcinia kola* (bitter kola) on growth performance and meat quality of broiler chickens

Gabriel A.Udo, *Glory E. Enyenihi and Emmanuel N. Ogbuzuru

Department of Animal Science, University of Uyo, Uyo, AkwaIbom State
*Corresponding Author: gloryenyenihi@yahoo.com Phone Number: 08028259884

ABSTRACT

The effect of *Garciniakola* on the performance and meat quality of broiler chickens was investigated. A total of one hundred and eighty unsexed day-old Anak broiler chicks were randomly assigned to five treatments containing thirty-six chicks each. Each treatment was replicated three times, containing 12 birds each. Adopting the completely randomized experimental design (CRD), five diets were formulated for starter and finisher phases. Treatment one (T1) was the control diet while T2, T3, T4 and T5 contained 0.5, 1.0, 1.5 and 2.0% *G. kola* respectively. Feed and water were provided *ad libitum* to the birds. Proximate analysis showed that *G. kola* contained crude protein (2.29%), nitrogen-free extract (65.70%), ash (13.97%), crude fiber (9.32%) and energy (280.43 kcal/g). Phytochemical result showed that *G.kola* contained oxalate (6.57 mg/100 g), tannin (17.55mg/100g), phenols (116.02 mg/100), an alkaloid (2.61 g/100 g), saponin (1.96 g/100 g) and flavonoid (7.56 g/100 g). At the starter phase, *G.* kola reduced the weight gain and feed intake of the broilers but did not affect the feed: gain ratio. In the finisher phase, G. kola inclusion above 0.5% reduced final live body weight ($P<0.05$). However, in both phases, there were no significant ($P>0.05$) differences in daily gain, feed intake andfeed conversion ratio. General acceptability, colour, flavour, tenderness and juiciness of the meat were found to be best at a 0.5% level of inclusion. Therefore, G. kola, is not recommended during the starter phase as it affects feed intake and weight gain. It can be fed to finisher birds but not beyond 0.5% level of inclusion.

Keywords: Broilers, Garcinia kola, Growth, Meat

INTRODUCTION

Bitter kola (*Garcinia kola*) tree belongs to the botanical family of Guttiferae and genus, *Garcinia* (Plowden, 1992). Bitter kola is a perennial rain forest tree crop, well cultivated in the West Indies, West, and Central Africa. In Nigeria, it is particularly common in the Southwest States (Iwu *et al.,* 1993). It is an evergreen tree which can grow up to 30 m height but usually up to about 12-15 m. The fruits are reddish yellow when ripe (orange –like pod); with the edible portion contained in the pod. Each fruit contains about 6-8 smooth elliptically shaped seeds with brown coat. Bitter kola is popularly called in Nigeria languages as "Namijingoro" in Hausa, "Orogbo" in Yoruba, "Efiari" in Efik, "Effiat" in Ibibio and "Agbilu" in Igbo. It contains a lot of valuable constituents that can be utilized by human beings and animals alike. Bitter kola

has numerous medicinal uses like anti-parasite, purgative, anti-cough, used to prevent and relieve colic, chest cold, etc. Bitter kola is known to have an elaborate complex mixture of phenolic compounds including bioflavonoids, xanthones and benzophenones (Iwu *et al.,* 1990). The bioflavonoid possesses anti-inflammatory, anti-microbial, anti-viral and anti-diabetic properties (Adedeji *et al.,* 2006).

In recent years, local plant materials have been assessed as additives in poultry feed to overcome major problems in the poultry industry such as having positive effects on digestibility and feed utilization (Sayda *et al.,* 2012). Phytogenic feed additives have attracted increasing interest as an alternative feeding strategy to replace antibiotic and or inorganic growth promoters. This has occurred especially in the European Union, where antibiotics have been banned completely from use as additives in livestock feeds since 2006, because of a suspected risk of generating microbiota with increased resistance to the antibiotic used for therapy in humans and animals (Windisch *et al.,* 2008). Pro-nutrients are substances that could have the same effect as antibiotics as feed additives and are defined as micro ingredients included in the formulation of animal feeds with physiological and microbiological functions different from any other nutrients (Biovet, 2005). Estimates by WHO (2002) showed that most of the rising antimicrobial resistance problems in human medicine is due to the overuse and misuse of antimicrobials. The best-known examples are the food-borne pathogenic bacteria Salmonella and Campylobacter and the commensal (harmless in healthy persons and animals) bacteria *Enterococcus*. Increasing animal body weight gain and improving feed conversion ratio are measures that can indicate increased profitability for the producer.

The inclusion of organic products may positively affect these parameters in poultry (Flint and Garner, 2009). Whereas the inclusion of antibiotics in livestock feed is aimed at eliminating or reducing specific or general bacterial populations in a preventive manner to improve feed utilization and hence profit, the addition of organic products or photogenic to feeds may be a viable substitute to increase the profitability of animal agriculture (Flint and Garner, 2009).

Phytogenic feed additives are plant extracts or materials which have beneficial effect on animal productivity and health especially the monogastric animals (Ndelekwute and Enyenihi, 2017). A large

variety of plant materials have properties which can potentially improve feed intake, digestion, feed conversion and body weight gain (Lovkova*et al.,* 2001). The mode of action of these feed additives is not completely clear. They have antimicrobial, antiviral, antioxidant, and many other biological activities (Ertas*et al.,* 2005). They act as digestibility enhancers, stimulating the secretion of endogenous digestive enzymes (Williams and Losa, 2001). These characteristics made phytogenic additives a promising group of growth promoters that are presently being tried in the animal feed industry.

Consequently, the animal feed industry, exposed to increasing consumer pressure to reduce the use of animal growth promoters (mostly inorganic) in poultry diets, must find alternative feed additives (Humphrey *et al.,*2002).

Scientific evidence exists that herbs and plant extracts stimulate the growth of beneficial bacteria and minimize pathogenic bacteria activity in the gastrointestinal tract of poultry (Langhout, 2000). Previous studies on using bitter kola as a feed additive are still limited and largely inconclusive. Therefore, this study is aimed at exploring the effect of bitter kola on growth performance at different growth stages, and organoleptic properties of broiler chickens.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Poultry Unit of the Teaching and Research Farm University of Uyo. Uyo is located between latitude $4^0 31^{'}$E and $45^0 31^{'}$N and $4^0 45^{'}$ N and longitude 7^0 $31^{'}$E and $45^0 351$'E of Greenwich Meridian with an altitude of 38m above sea level, a mean rainfall of 2115mm and monthly sunshine of above 3 hours 31 minutes. (Meteorology Station, University of Uyo).

Procurement and Processing of Experimental Materials

Bitter Kola (*G.* Kola) seeds were purchased from a local market within the Uyo metropolis. The seeds were sliced after removing the brown testa (coat), sun-dried and ground into powdery form.

Experimental Birds and Design

A total of one hundred and eighty unsexed day-old ANAK chicks were bought from GabtyAgric Services in Uyo metropolis. The experimental birds were allotted into five treatment groups replicated three times with 12 birds per replicate in a completely randomized design (CRD).The statistical model (Equation 3.1) is expressed mathematically below.

Equation 3.1 $Y_{ij} = \mu + T_i + e_{ij}$

Where:

Y_{ij}= Single observation

μ = overall mean

T_i = Treatment effect (*Garcinia*kola)

e_{ij} = Random error

Experimental Diets

The broiler birds (ANAK breed) were fed formulated diets containing maize, soybean meal, wheat bran, *G. kola*, bone meal, fishmeal, limestone, methionine, salt, and vitamin/mineral premix. The ingredient and nutrient composition of the experimental diets are presented in Table 1 and Table 2. A total of five diets were formulated, where treatment 1 (diet without bitter kola) served as a control, treatment 2 was a diet with 0.5 kg/100 kg of feed, Treatment 3 was a diet with 1 kg/100 kg feed, Treatment 4 was a diet with 1.5 kg/100 kg feed, and Treatment 5 was a diet with 2.0 kg/100 kg feed.

Data Collection

The data collected for this experiment include data used for the computation of growth performance, carcass evaluation, and sensory analysis.

The data for growth performance response was calculated by taking the weight of the animals and feed periodically. The measured growth performance indices include the initial body weight (g/bird), final body weight, average daily weight gain, total feed intake, total weight gain, mortality, and feed conversion ratio. Mortality was calculated by taking the percentage of the broilers that died per treatment during the experiment.

The carcass evaluation was conducted at the end of the experiment using 6 random birds per treatment with two coming from each of the replicates. The birds were deprived of feed but given water a day before slaughtering. The birds were weighed just before slaughtering thereafter they were bled and immersed in steaming water for a few minutes to aid defeathering. After defeathering, the carcasses were weighed again to determine dressed weight before evisceration. Other parts of the carcass such as breast, thigh, back, head, wings, drumsticks, shank, and neck were also weighed and calculated using the equations below.

$$\text{Cut parts}(\%) = \frac{\text{Weight of body part (g)}}{\text{Dressed weight (g)}} \times 100$$

The meat samples for sensory evaluation of the carcass were prepared by boiling. The method of Abu *et al.* (2015) was adopted. Samples were washed individually in clean water packed in a transparent double-layer

polythene bag and tagged for identification. The meat samples were thereafter boiled in water for 30 minutes and were cooled under room temperature and served to a panel of ten assessors previously trained in basic organoleptic assessment procedures.

Sensory evaluation was conducted on boiled meat and evaluated by a ten-member trained panel. The test materials were obtained from the breast meat of broilers in all treatment groups to ensure portion control. The panelists rated the meat for colour, flavour, tenderness and juiciness using a rank test whereas a 9-point hedonic scale (Larmond, 1997) was used for general acceptability. The panellists were not allowed to have any information about the samples. The panellists were equally not permitted to gain access to the processing area to avoid being influenced by the aroma of the meat. The panellists were trained before the sensory test and advised to disregard personal preferences while conducting the test. Panelists were exposed to the various terminologies used to describe the various sensory attributes as well as the scale method used to indicate intensity. Biscuits and water were given to the panellists after testing each meat sample as this helped to prevent the influence of the previous meat sample on subsequent samples.

Statistical Analysis

The data obtained from the study were subjected to analysis of variance (ANOVA) using SPSS software (IBM SPSS Statistics version 20) while Duncan's multiple range test option of the software was used for post hoc (means separation).

RESULTS AND DISCUSSION

Proximate and Phytochemical Composition of *Garcinia Kola*

The proximate composition of *Garcinia kola* is presented in Table 3. The results showed that moisture, fat, crude protein, carbohydrate, and energy were lower than the values reported by Eleyinimi *et al.* (2011) and Mazi *et al.* (2013). However, Adesuyi *et al.* (2011) reported that *G.* kola had higher values of ash, protein, and fat. The variation that occurred could be because of differences in soil type and agronomic practices (Enwere, 1998; Morah, 2004). Energy, carbohydrate, ash, and fibre showed potential for use as feed additives, although the protein level is very low (2.29%).

The results of phytochemical analysis showed that values of oxalate, saponin, tannin, alkaloid and phenol are higher than the values reported by Mazi *et al.,* (2013) while in agreement with the report of Windisch *et al.* (2008). However,

the value reported for hydrogen cyanide is lower than the value reported earlier by Joseph *et al.* (2017). This variation observed could be due to agronomic conditions and the stage of maturity of *G. kola.*

Effect of *Garcinia kola* on Growth Performance of Starter Broiler Chickens

The performance of starter broiler chicks fed with a supplemented diet of *Garcinia* kola is presented in Table 4. The result showed that supplementing broiler diets with Garcinia kola significantly affected ($p<0.05$) the final weight, daily weight gain, total feed intake and daily feed intake. However, there was no significant difference ($p>0.05$) in the feed conversion ratio of the birds fed the control diets and those fed diets containing varying levels of *G. kola.* The differences observed between the birds fed the control diets and those fed the treated diets show that the control birds had significantly higher live weight, daily weight gain, total feed intake, and daily feed intake.

The higher lightweight observed in birds fed the control diets can attributed to the higher intake which may have been influenced by the reduced acceptability of the diets supplemented with *G. kola.* Irrespective of the significant differences in their final live weight and weight gain, feed conversion ratio between the birds was however similar which indicates that G. kola does not have any significant influence on feed utilization and feed efficiency of broiler chickens but it has led to a less competitive weigh gain and this can be linked to a reduced feed intake observed in birds on the treatment diets.

In an earlier study, Mohammed and AbdulMalik (2013), found that *Garcinia kola* had a significant positive effect on weight gain ratio, and weight gain during the starter phase. However, the finding in this study is contrary as the optimal weight gain was recorded in the birds on the control diet. On the other hand, Ibekwe and Orok (2010) did not find any significant difference in the growth performance of broiler starters and hence recommended that *Garcinia kola* does not have any value with respect to broiler growth performance.

Effect of *Garcinia kola* on Growth Performance of Finisher Broiler Chickens

Just as observed in the starter phase of this study, the dietary supplementation of *G. kola* had a significant effect ($p<0.05$) on the final weight of the broiler chickens but did not have a significant effect ($p>0.05$) on the feed conversion ratio. These findings agree with the report of Esiegwu *et al.,* (2014) and Yan *et al.* (2011). Also, this is an indication

that at this phase of production, the birds were used to the taste of the feed and as such had no negative impact on total feed intake, daily feed intake, and daily weight gain and feed conversion ratio. Frutos (2004) on the other hand reported that bitter kola in feed significantly reduces feed intake.

This report (Frutos, 2004) disagrees with the result of the present report which shows that the feed intake trend did not show any significant (P>0.05) differences. Final live weight was significantly higher in control compared to birds on 1.0, 1.5 and 2.0% levels of bitter kola. However, there was no significant difference between the control and the group that was fed 0.5% bitter kola.

As against the findings in this present study where the weight gain was not affected in the finisher stage, a positive significant effect on weight gain of finisher broiler chickens has been reported in earlier studies (Adedeji *et al.,* 2006; Esiegwu and Udidiebie, 2009; Ibekwe *et al.,* 2010; Owen *et al.,* 2020). In a recent study (Ugwu *et al.,* 2021) however, the effect of *Garcinia kola* was evaluated and reported no significant difference in growth performance and organ development of the finisher broiler chickens at the rate of 0, 5, 10 and 20 g/kg. The variation in these findings can be attributed to the differences in the rate of supplementation. For this present study, a maximum of 2.0% of feed was used but in other studies like Ugwu *et al.* (2021) only 0.2% supplementation was carried out and this can account for the absence of a significant effect of *G. kola.* On the other hand, Esiegwu and Udedibie (2009) reported a significant effect of *G. kola* on weight gain and feed efficiency at 2.5%.

Effect of *Garcinia* Kola Supplemented Diet on Sensory Evaluation of Broiler Meat

The dietary effect *of Garcinia* kola on broiler meat is shown in Table6. The result shows significant (P<0.05) differences in all the parameters measured (general acceptability, colour, flavour, tenderness, and juiciness).However, groups fed 0.5, 1.5 and 2% *G.* kola were generally more accepted than the control and group on 1.0%. It was observed 1.0% level of inclusion had better colour compared to the control and at 0.5%. Equally, at 1.5 and 2.0% the colours were the same. The best flavour was judged to be best in the group that fed 0.5% which was similar to the control and 1.5% inclusion level. Equally, it was observed that at a 0.5% inclusion level, the tenderness quality of broiler meat was highest compared to other inclusion levels, but similar to the control. Juiciness was best in the group that fed 0.5% compared to control

and other groups that fed *G. kola. The explanation for this may however be connected with the* fact that 0.5% had the least impact on the protein and crude fat content of treatment diets. These two nutrients however, could affect the general characteristics of broiler meats. There is, however, a paucity of data on the effect of *Garcinia kola* on the organoleptic properties of broiler chickens.

Conclusion and Recommendation

The inclusion of *Garcinia kola* during the starter and finisher phases reduced the feed intake and weight gain of the broiler chicken. However, during the finisher stage, the 0.5% inclusion did not have any significant reduction in the final live weight of the broiler chicken. The inclusion of G. kola is therefore not recommended during the starter phase and not beyond 0.5% during the finisher phase. 0.5% inclusion during the finisher phase is also recommended as it improves the organoleptic properties of the broiler chicken meats.

References

Abu, O. A., Olaleru, I. F.&Omojola, A. B. (2015). Carcass characteristics and meat quality of broilers fed cassava peel and leaf meals as replacement for maize and soya bean meal. *Journal of Agriculture and Veterinary Science*, 8(3), 41-46.

Adedeji, O. S., Farinu, G. O., Ameen, S. A. & Olayemi, T. B. (2006). The effects of dietary bitter kola (G. kola) inclusion on body weight, haematology, and survival rate of pullets' chicks. *Journal of Animal and Veterinary Advances*, 5(3), 184-187.

Adesuyi, A. O.,Elumm, I. K., Adaramola, F. B. & Nwokocha, A. G. M. (2011). Nutritional and phytochemical screening of Garcinia kola.*Advance Journal of Food Science and Technology*, 4(1), 9-14.

Biovet S. A. Laboratory. (2005). The intensive production and spreading of high productivity genetic stocks have conditioned the common use of chemical substances known as 'growth promoters.' Retrieved from http://www.thepigsite.com/articles/pp3-4.

Elenyinmi, A. F., Bressler, D. C., Amoo, I. A., Sporns, P. & Oshodi, A. A. (2006).Chemical composition of bitter kola (Garcinia kola) seed and hulls.*Polish Journal of Food and Nutrition Sciences,* 15(4), 395.

Enwere, N. J. (1998). Foods of plant origin. Afro-Orbis Publication Limited, University of Nigeria, Nsukka, Nigeria, 169-180.

Ertas, O. N., Güler, T., Çiftçi, M., Dalkılıç, B. & Simsek, Ü. G. (2005). The effect of an essential oil mix derived from oregano, clove, and anise on broiler performance. *International Journal of Poultry Science, 4*(11), 87-884.

Esiegwu, A. C.& Udedibie, A. B. I. (2009). Growth performance and microbial activities in broilers fed supplementary bitter kola (Garcinia

kola). *Animal Production Research Advances,* 5(1).

Esiegwu, A. C., Okoli, I. C., Emenalom, O. O., Esonu, B. O. & Udedibie, A. B. I. (2014). The emerging nutraceutical benefits of the African wonder nut (Garcinia kola Heckel): A review. *Global Journal of Animal Scientific Research,* 2(2), 1-10.

Flint, J. F. & Garner, M. R. (2009).Feeding beneficial bacteria: A natural solution for increasing efficiency and decreasing pathogens in animal agriculture.*Journal of Applied Poultry Research,* 18, 367-378.

Frutos, P., Hervas, G., Giráldez, F. J. & Mantecón, A. R. (2004). Review. Tannins and ruminant nutrition. *Spanish Journal of Agricultural Research,* 2(2), 191-202.

Glick, Z.& Joslyn, M. A. (1970).Food intake depression and other metabolic effects of tannic acid in the rat.*Journal of Nutrition,* 100, 509-515.

Humphrey, B. D., Huang, N. & Klassing, K. C. (2002). Rice expressing lactoferrin and lysozyme has antibiotic-like properties when fed to chicks. *Journal of Nutrition,* 132, 1214-1218.

Ibekwe, H. A. & Orok, E. E. (2010). Proximate composition of Aframomummelegueta seeds, Garcinia kola seeds, and growth performance of broiler chicks treated with powders from these seeds. *International Journal of Poultry Science*, 9(12), 1152-1155.

Iwu, M. M. (1993). *Handbook of African medicinal plants*.CRC Press.

Iwu, M. M., Igboko, A. O. & Tempesta, M. S. (1990). Antidiabetic and aldose reductase activities of biflavanones of Garcinia kola.*Fitoterapia,* 61(1), 178.

Joseph, K. S., Bola, S., Joshi, K., Bhat, M., Naik, K., Patil, S., Bendre, S., Gangappa, B., Haibatti, V. & Payamalle, S. (2017). Determination of chemical composition and nutritive value with fatty acid compositions of African mangosteen. *Erwerbs-Obstbau,* 59, 195-202.

Langhout, P. (2000). New additives for broiler chickens. *World Poultry,* 16(3), 22-27.

Larmond, E. (1997). Laboratory methods for sensory evaluation of food. Florida: Agriculture Canada Publication.

Lovkova, M. Y., Buzuk, G. N., Sokolova, S. M. & Kliment'eva, I. (2001). Chemical features of medicinal plants (Review). *Applied Biochemistry and Microbiology,* 37, 229-237.

Mazi, E. A., Okoronkwo, K. A. & Ibe, U. K. (2013). Physico-chemical and nutritive properties of bitter kola (Garcinia kola).*Journal of Nutrition and Food Sciences, 3*(4), 218-223.

Mohammed, A. A. & Abdulmalik, M. A. (2013).Effect of bitter kola (Garcinia kola) as dietary additive on the performance of broiler chicks. *Journal of Environmental Ecology*, 4(2), 95-104.

Morah, N. F. (2004). Mineral and nutritive value of Dennehiatripetala fruits.*Journal of Fruit Science,* 59(6), 437-442.

Ndelekwute, E. K. & Eyenihi, G. E. (2017).

Lime juice as source of organic acid for growth and apparent nutrient digestibility of broiler chicken. *Journal of Veterinary Medicine and Surgery*, 1, 27-32.

Onunkwor, D. N., Udokwu, I. U., Ekundayo, E. O., Ezenyilimba, B. N., Omumuabuike, J. N. & Ezeoke, F. C. (2022). Serum biochemical assay of broiler chickens administered water containing various medicinal plant leaf methanol extract. *Nigerian Journal of Animal Production,* 49(2), 95-100.

Plowden, C. C. (1992). *A manual of plant names* (3rd ed.). London: George Ltd.

Sayda, A. M., Ali, H., Abdalla, O. & Mohammed, A. E. (2012).Citrulluscolocynthis (Handal) seed meal as a natural feed supplementation in broiler chickens' diets. *Egyptian Poultry Science Journal,* 32(2), 237-246.

Ugwu, P. C., Ikenna-Ezeh, N. H., Nwogo, N. G. & Nnadi, P. A. (2021). Effect of dietary inclusion of Garcinia kola dried seed powder on growth performance and immune response of Newcastle disease vaccinated broiler chicks. *Animal Research International,* 18(3), 4186-4194.

WHO. (2002). World Health Organization: Use of antimicrobials outside human medicine and resultant antimicrobial resistance in humans. Retrieved from https://apps.who.int/inf-fs/en/fact268.html

Williams, P. & Losa, R. (2001).The use of essential oils and their compounds in poultry nutrition. *World's Poultry Science Journal,* 17, 14-15.

Windisch, W., Schedle, K., Plitzner, C. & Kroismayr, A. (2008).Use of phytogenic products as feed additives for swine and poultry.*Journal of Animal Science, 86*, 140-148.

Yan, L., Meng, Q. W. & Kim, I. H. (2011).The effect of an herb extract mixture on growth performance, nutrient digestibility, blood characteristics, and fecal noxious gas content in growing pigs.*Livestock Science, 141*, 143-148.

Table 1: Composition of Broiler Starter diet

Ingredient (%)	T1 (0%)	T2 (0.5)	T3 (1.0)	T4 (1.5)	T5 (2.0)
Maize	54.00	54.00	54.00	54.00	53.00

Wheat bran	7.10	6.60	6.10	5.60	6.10
Garcinia Kola	0	0.50	1.00	1.50	2.00
Soybean meal	32.00	32.00	32.00	32.00	32.00
Fishmeal	3.0	3.0	3.0	3.0	3.0
Bone meal	3.00	3.00	3.00	3.00	3.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	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**	**100**	**100**	**100**	**100**
Calculated nutrient composition (%)					
Crude protein	23.25	23.19	23.11	23.03	23.02
Energy**	2850.26	2844.53	2838.81	2833.08	2803.81
Crude fibre	3.19	3.14	3.09	3.04	3.07
Ether extract	3.16	3.16	3.16	3.16	3.15
Calcium**	1.09	1.13	1.16	1.19	1.23
Phosphorus **	0.95	1.04	1.13	1.22	1.32
Methionine	0.57	0.55	0.55	0.55	0.58
Lysine	1.69	1.69	1.69	1.69	1.69

1kg of premix contains: vitamin A (5,000,000iu), vitamin D_3 (1,000,000,iu), vitamin E (16,000mg), vitamin K, (800mg), vitamin B_{12} (22,000mg), Niacin (22,000mg), vitamin B_2(10mg), Folic Acid (400mg), Biotin (32mg), Chlorine Chloride (200,000mg), Zinc (32,000mg), iodine(600mg), Cobalt (120mg), selenium (40mg), Antioxidant (48,00mg),**calculated.Source: Field data 2021.

Table 2: Composition of Broiler Finisher Diet

Ingredient Percentage	T1 (0)	0.5	1.0	1.5	2.0
Maize	65.00	65.00	65.00	65.00	65.00
Wheat bran	3.30	2.80	2.30	1.80	1.30
Garcinia Kola	0	0.50	1.00	1.50	2.00
Soybean meal	25.00	25.00	25.00	25.00	25.00
Fishmeal	3.00	3.00	3.00	3.00	3.00
Lysine	0.10	0.10	0.10	0.10	0.10
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Vitamin/mineral premix	0.25	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**	**100**
Calculated Nutrient Composition (%)					
Crude protein	20.35	20.17	20.10	20.03	20.02
Energy	3020.93	3015.20	3009.48	3003.75	2999.96
Crude fibre	3.95	3.85	3.79	3.61	2.94
Ether extract	3.38	3.79	3.81	3.39	3.41
Calcium	1.07	1.10	1.14	1.17	1.21
Phosphorus	0.95	1.04	1.13	1.22	0.94
Methionine	0.42	0.41	0.42	0.42	0.52
Lysine	1.35	1.35	1.35	1.35	1.35

1kg of premix contains vitamin A (5,000,000iu), vitamin D_3 (1,000,000,iu), vitamin E (16,000mg), vitamin K, (800mg), vitamin B_{12} (22,000mg), Niacin (22,000mg), vitamin B_2(10mg), Folic Acid (400mg), Biotin (32mg), Chlorine Chloride (200,000mg), Zinc (32,000mg), iodine(600mg), Cobalt (120mg), selenium (40mg), Antioxidant (48,00mg),**calculated.

Source: Field data 2021.

Table 3: Proximate and Phytochemical Composition of *Garcinia kola*

Composition	Levels	Composition	Level

Moisture (%)	7.78	Alkaloid (g/100g)	2.61
Fat (%)	0.94	Saponin (g/100g)	1.96
Ash (%)	13.97	Flavanoid (g/100g)	7.56
Crude fibre (%)	9.32	Tannin (g/100g)	17.55
Protein (%)	2.29	Phenolic compound (mg/100g)	116.02
Nitrogen Free Extract (%)	65.70	Cyanide (mg/100g)	0.10
Energy (Kcal/g)	280.43	Oxalate (mg/100g)	6.57

Source: Field data (2021)

Table 4: Effect of *Garcinia* kola on growth performance of starter broiler chickens

Treatment levels Parameters	T1 (0%)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	T5 (2.0%)	SEM
Initial live weight (g)	43.95	43.90	43.72	44.01	44.50	0.10
Final live weight (g)	913.67^{a}	741.67^{bc}	698.67^{c}	791.00^{b}	757.33^{b}	20.33
Daily weight gain (g)	31.06^{a}	24.90^{cd}	23.39^{d}	26.67^{b}	25.45^{bc}	0.73
Total feed intake (g)	1339.00^{a}	1114.67^{b}	1018.00^{b}	1136.67^{b}	1061.33^{b}	33.91
Daily feed intake (g)	47.82^{a}	39.81^{b}	36.36^{b}	40.59^{b}	37.90^{b}	1.30
Feed: gain Ratio	1.54	1.60	1.55	1.52	1.49	0.04

abcd: Means along the same row with different superscripts are significantly (P<0.05) different. SEM = standard error of the means
Source: Field data (2021)

Table 5: Effect of *Garcinia* kola on growth performance of finisher broiler chickens

Treatment levels Parameters	T1 (0%)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	T5 (2.0%)	SEM
Initial live weight (g)	913.67^{a}	741.67^{bc}	698.67^{c}	791.00^{b}	757.33^{b}	20.33
Final live weight(g)	2167.33^{a}	2093.00^{ab}	1758.00^{d}	1811.00^{cd}	1962.33^{bc}	46.51
Daily weight gain (g)	44.77	48.26	37.83	36.43	43.03	1.52
Total feed intake (g)	3525.33	3474.33	3492.33	3543.33	3655.67	32.73
Daily feed intake (g)	125.90	124.08	124.73	126.55	130.55	1.16
Feed: gain Ratio	2.81	2.57	3.30	3.47	3.03	0.12

abcd: Means along the same row with different superscripts are significantly (P<0.05) different; SEM = Standard error of the means
Source: Field data (2021)

Table 6: Effect of *Garcinia* kola supplemented diet on sensory evaluation of broiler meat.

Treatment levels Parameters	T1 (0%)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	T5 (2.0%)	SEM
General acceptability	2.80^{b}	3.70^{a}	2.80^{b}	3.70^{a}	3.90^{a}	0.14
Colour	4.80^{b}	4.90^{b}	5.50^{a}	5.20^{ab}	5.13^{ab}	0.67
Flavour	3.10^{ab}	3.60^{a}	2.20^{c}	3.10^{ab}	2.70^{bc}	0.14
Tenderness	5.10^{ab}	5.90^{a}	4.20^{b}	4.50^{b}	4.60^{b}	0.19
Juiciness	2.70^{b}	3.70^{a}	2.80^{b}	2.90^{b}	2.90^{b}	0.10

^{abc}Means along the same row with different superscripts are significantly (P<0.05) different. SEM = Standard error of the means
Source: Field data (2021)