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Growth Performance, Apparent Nutrient Digestibility, and Carcass Characteristics of Broiler Chickens Fed Diets Containing Varying Levels of Bitter ColA (*Garcinia kola*)

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Abstract
The study was conducted to investigate the effect of Bitter cola (Garcinia kola) on growth performance, apparent nutrient digestibility, and carcass characteristics of broiler chickens. Two hundred (200) day-old unsexed broiler chicks were used for the study, which lasted for eight weeks. The chickens were randomly assigned to five treatments, with forty birds per treatment. Each group was replicated four times with 10 birds per replicate in a completely randomized design (CRD). Bitter kola powder was incorporated into the feed at graded levels of 0.0g/kg (T1), 15g/kg (T2), 20g/kg (T3), 25g/kg (T4), and 30g/kg (T5). Data collected were subjected to analysis of variance and results obtained revealed that growth performance showed significant differences (P<0.05) in T4 (25g/kg) for final weight, daily weight gain, feed conversion ratio, mortality percentage, and total feed intake in T2 (15g/kg), T1 (control), and T3 (20g/kg), respectively. Daily feed intake was significantly different in T2 (15g/kg), while initial weight showed no significant difference compared to T1, which was the control. Apparent nutrient digestibility showed significant differences (P<0.05) in T4 (25g/kg) across all treatment groups. For carcass characteristics, live weight, slaughter weight, carcass weight, dressed weight, and back and all showed significant differences (P<0.05) in T4 (25g/kg). Dressed percentage, thigh, gizzard, liver, heart, and kidney were significantly different in T5 (30g/kg), while breast, drumstick, and crop were significant in T3 (20g/kg). Head and shank were significant in T2 (15g/kg), while heart, kidney, and intestine were significant in T1 (control). In conclusion, bitter cola (Garcinia kola) can be incorporated at 25g/kg of broiler chickens' diet under a semi-arid condition for improved performance without any adverse effect.
Keywords: Bitter cola, broiler chickens, growth performance, carcass digestibility

Introduction

With the increased risk of antibiotic-resistant pathogens, consumers' concerns about antibiotic residues, and the European Union ban on the use of antibiotics as growth promoters (AGP) in animal feed, alternative approaches are being considered to enhance livestock growth performance, particularly in

swine and poultry production (Windisch *et al.,* 2008). Antibiotics have traditionally been used in poultry farming to promote, prevent diseases, and improve feed efficiency. However, the indiscriminate use of these drugs has led to the development of antibiotic resistance in both animals and humans, raising alarms in the food industry and health sectors (Manyi-Loh *et al.*, 2018). As consumer demand grows for antibiotic-free poultry products, there is an urgent need to identify natural alternatives that can maintain poultry health and productivity without compromising food safety.

In recent years, the need to increase the awareness and utilization of botanicals as a substitute for antibiotics and non-conventional feed resources has been highlighted at different national and international fora. Numerous studies are exploring the use of botanicals, unconventional plant sources traditionally used in humans, as feed additives. The beneficial effects associated with plants and plant extracts largely pertain to health benefits, such as stimulating endogenous digestive enzymes and providing antioxidants (Lee *et al.*, 2004b).

Bitter cola *(Garcinia kola)* belongs to a family of tropical plants known as Guttifera (Plowden, 1992) and is found in moist forests and grows as a medium-sized tree, up to 12 m high. *Garcinia kola* is a dicotyledonous plant that is used in traditional medicine for various ailments such as sore throat and arrow "poisoning". Other medicinal uses include its use as an anti-parasitic, anti-microbial, anti-viral, anti-inflammatory agent, etc.

Bitter cola contains (*Garcinia kola*) phenolic compounds that possess anti-inflammatory, anti-microbial, anti-diabetic, and antiviral properties (Adedeji *et al.,* 2006). The presence of bioflavonoids and xanthones that act as potent antioxidants in bitter kola seeds has been confirmed.

Bitter cola (*Garcinia kola*) has been suggested as a good replacement for antibiotics in promoting growth in poultry due to its medicinal properties, its properties include the presence of tannins, xanthones, garcinol, kolaveron, saponins, and alkaloids, which are believed to enhance growth, boost immunity, and offer anti-microbial and anti-inflammatory benefits (Smith *et al.,* 2021). Reducing the use of antibiotics in poultry production not only mitigates the risk of antibiotic resistance but also can improve the quality of the end product and increase profitability (Jones and Adams, 2019). As consumer demand grows for antibiotic-free poultry products, there is an urgent need to identify natural alternatives that can maintain poultry health and productivity without compromising food safety The efficacy of bitter cola (*Garcinia kola*) as an antibiotic growth promoter was evaluated in broiler chicks to assess its impact on growth and blood profiles (Ogunleye *et al.,* 2020). Hence, this study aimed to determine the effects of bitter cola on growth performance, carcass characteristics, and apparent nutrient digestibility of broiler chickens.

Materials and Methods

Experimental Site

The study was conducted at the poultry unit, Teaching and Research Farm of the Department of Animal Science, University of Maiduguri. Maiduguri is situated at latitude 11^0 5' North, longitude 30^0 0' East, and an altitude of 354m above sea level (Raji *et al*., 2010). Maiduguri falls within the Sehelian Region (Semi-Arid Zone) of West Africa, which is characterized by short duration of rainfall varying from 2-4 months (June-September). The rainfall varies from 300-500mm per

annum, and the ambient temperature rises from 25^0C - 28^0C in December to January and higher in April and May, which range from 39^0C - 40^0C (Aliyu, 2012).

Sourcing and Preparation of Bitter Cola

Bitter cola *(Garcinia kola)* was purchased in Hausari market in Maiduguri, the Borno state capital. It was visually inspected, and defective ones were removed and discarded. Healthy ones were selected, washed thoroughly in clean water, and dried at room temperature for a period of seven days before processing. The drying process reduced excess moisture content so as to prevent rancidity of the feed ingredients and the growth of moulds. The dried feed ingredients were then passed through a grinding machine to produce the required 2.00 mm-sized particles as shown in Figure 1.

Experimental Birds and Management

A total of two hundred (200) day-old broiler marshall chicks were purchased from ZARTECH hatchery were used for the study. The chicks were randomly allotted to five treatment groups: T1, T2, T3, T4, and T5. Each treatment was grouped into 40 birds and replicated four times with 10 birds per replicate in a completely randomized design (CRD). Bitter cola *(Garcinia kola)* powder was given at T1 (control), T2 (15g/kg), T3 (20g/kg), T4 (25g/kg), and T5 (30g/kg). The experiment lasted for 8 weeks. The brooding chamber was cleaned and disinfected before the arrival of birds, wood shavings were used as bedding material, and the vaccination schedule was observed for the well-being of the birds. Birds were given a commercial diet for the first week of brooding, while formulated diets, both starter and finisher, as shown in Tables 1 and 2, were given for seven weeks.

Data Collection

Feed Intake: Feed consumption from each treatment was measured daily by subtracting left over from the feed given per group, and adequate measures were taken to safeguard against spillage and related wastage. The mean daily feed intake was calculated every week by dividing the amount consumed by the number of birds in the group.

Weight Gain: The body weight gain of each of the treatment groups was obtained by calculating the difference between the mean live weight of the current week from the mean live weight of the preceding week, and dividing by seven (7) days in a week.

Feed Conversion Ratio: This was obtained daily. It was measured by dividing the mean feed intake per bird in grams by the mean live weight gain per bird. This was recorded for each replicate during the study period.

$$\text{Feed Conversion Ratio (FCR)} = \frac{Mean\ feed\ intake\ (g)}{Mean\ body\ weight\ gain\ (g)}$$

Carcass and Organs Measurements: Each carcass was divided into the following anatomical parts: head, neck, thorax, breast, wings, back, drumstick, thigh, and shank. The cutup parts were weighed using an electronic sensitive balance and expressed as a percentage (%) of the slaughter weight. The visceral organs, such as liver, crop, gizzard, proventriculus, heart, and abdominal fat, were also weighed and expressed as a percentage (%) of slaughter weight.

Statistical Analysis: All data collected were subjected to analysis of variance using the Statistical Analysis System (SAS, 2005). Significance differences among treatment means were compared using Duncan's multiple range tests (DMRT) (Duncan, 1955).

Results and Discussion

Growth Performance of Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola (Garcinia kola)

The growth performance of broiler chickens fed diets containing varying levels of bitter cola *(Garcinia kola)* is shown in Table 3. The initial weights of the chicks were balanced at the commencement of the experiment, which

ranged from 185.00 – 192.43 g/b. There was a significant (P<0.05) effect of varying levels of bitter kola diets on final weight, total feed intake, daily feed intake, weight gain, daily weight gain, and feed conversion ratio. Higher (P<0.05) final weight, weight gain and daily weight gain were recorded for birds fed 25 g/kg bitter kola while lower (P<0.05) values were obtained for birds fed 20 g/kg bitter kola which was at par with birds fed 0, 15 and 30 g/kg bitter cola *(Garcinia kola)*. Total feed intake was higher (P<0.05) in birds fed 15 g/kg bitter kola which was similar with birds fed 0 and 20 g/kg bitter cola *(Garcinia kola)*, followed by birds fed 25 g/kg bitter kola while lower (P<0.05) total feed intake was observed in birds fed 30 g/kg bitter kola. Similarly, higher (P<0.05) daily feed intake was recorded in birds fed 15 g/kg bitter cola *(Garcinia kola)* which was at par with birds fed 20 g/kg, followed by birds fed 0 g/kg which was also similar with birds fed 20 g/kg bitter kola while lower (P<0.05) daily feed intake was obtained in birds fed 30 g/kg bitter kola. Feed conversion ratio was better (P<0.05) in birds fed 25 g/kg bitter cola *(Garcinia kola)*, followed by birds fed 30 g/kg bitter kola which was then followed by birds fed 0 g/kg while poor (P<0.05) feed conversion ratio was recorded in birds fed 20 g/kg which was at par with birds fed 15 g/kg bitter cola *(Garcinia kola)*. The results of this study indicated that broilers had better growth performance potentials in terms of final weight, feed intake, daily weight gain, weight gain, daily weight gain and feed conversion ratio when dried bitter kola was added to the feed at 25g/kg level over other dietary treatments for 56 days (8 weeks). Jamroz *et al*. (2003) and Edacha *et al.* (2009) suggested that plant materials enhance the secretion of endogenous digestive enzymes, which activate the immune response and antioxidant activities in animals. This led to the development of commercial additives of plant origin as possible replacements for synthetic antibiotics (Williams and Losa 2001, Kocabagli *et al*. 2002, Lee *et al*, 2003; Aregheore *et al.,* 1998). Of these, significant attention has been placed on herbs, spices, and their by-products as either single compounds or mixtures (Gill, 1999; Alaje *et al.,* 2014; Aletor *et al.,* 2002; Cabuk *et al*., 2006), which have phytobiotic advantages on growth response and prevent microbial, fungal, bacterial, and viral multiplication and reduce their damaging effects on the intestinal wall (Hossain, 2009). The better growth performance recorded for broiler chickens fed 25g/kg diet bitter kola agrees with the findings of Adedeji *et al*. (2006); Mohammed and AbdulMalik (2013); Owen *et al*. (2022); and Oguntoye and Mafindi (2022), who reported better growth performance for broilers fed 25g, 10g, 15g, and 20g per kg diets, respectively. The values for final weight, feed intake, daily feed intake, weight gain, daily weight gain, and feed conversion ratio were lower than the values reported by Adedeji *et al*. (2006), Mohammed and AbdulMalik (2013), Owen *et al*. (2022), and Oguntoye and Mafindi (2022). Similar results were reported by Oguntoye and Mafindi (2022), in which final weight, weight gain, and daily weight increased when bitter kola was added from 0 to 20g/kg diet, but declined as bitter kola was added beyond 20g/kg diet. The parameters measured declined as bitter kola was added beyond 25g/ kg diet.

Apparent Nutrient Digestibility by Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola (Garcinia kola)

Apparent nutrient digestibility by broiler chickens fed diets containing varying levels of bitter cola *(Garcinia kola)* is presented in Table 4. There was a significant (P<0.05) effect of varying levels of bitter kola on dry matter, crude protein, crude fibre, ether extract, and nitrogen-free extract digestibility coefficients. Dry matter, crude fibre, ether extract and

nitrogen free extract digestibility coefficients were higher (P<0.05) by birds fed 25 g/kg bitter kola, followed by birds fed 0 g/kg, which was then followed by birds fed 15 g/kg while lower (P<0.05) digestibility coefficients values were recorded by birds fed 30 g/kg bitter kola. Similarly, higher (P<0.05) crude protein digestibility value was obtained by birds fed 25 g/kg bitter kola, followed by birds fed 0 g/kg, which was then followed by birds fed 30 g/kg while lower (P<0.05) digestibility coefficient was observed by birds fed 20 g/kg which was at par with birds fed 15 g/kg bitter cola *(Garcinia kola)*. The nutrient digestibilities of the diets were good since the values of the digestibility coefficients were above 60%.

Carcass Characteristics of Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola (Garcinia kola)

The carcass characteristics of broiler chicken fed with diets containing varying levels of bitter cola *(Garcinia kola)* are presented in Table 5. There was a significant (P<0.05) effect of bitter cola *(Garcinia kola)* on the carcass characteristics of broiler chickens. The live weight obtained in the study was inferior to the 2495g/bird reported by Olumo (1995). The slaughter weights obtained for all the birds were higher than the recommended minimum slaughter weight of about 1.25kg (USDA, 2018). The values of carcass weight observed in this study were within the range 1.20 – 1.80kg of carcass weight reported by USDA (2018) and National Chicken Council (2021). The dressed weight reported is superior to the recommended minimum dressed weight of 1.25kg of dressed weight, USDA (2018). The dressing percentages obtained in this study were higher than 70.77% reported by Ranvindran and Savankanessan (1996). According to Peter *et al*. (1997), the proportion of meat in valuable parts of the carcass is usually influenced by diets as reported. The head weight reported in this study is higher than the values reported by Dongmo *et al*. (2000). The slightly lower shank weight obtained contradicts the report of Kitalyi (1998) that shank weight can range from 20 to 40 grams depending on the breed and age of the chicken. The thigh weight reported is lower than the 18.87 – 21.28% reported by Oluyemi and Robert (2000). Wing weight obtained in this study is higher than the value reported by Tůmová *et al*. (2012) that the average wing percentage of broiler chickens at slaughter age (42 days) ranged from 2.3% to 2.8% depending on the breed. The back weights obtained in this study are slightly below the range 9.90-10.14% reported by Teimour *et al.* (2005) and were superior to the values reported by Tůmová *et al.* (2012). The breast weight obtained in this research was slightly lower (26.32 to 27.13%) than values reported by Onu and Nwankwo (2001). While drumstick weights were superior to the range (9.31-10.25%) reported by Zeitler (2007). Gizzard weights reported were lower than the values (3.77 - 4.37%) reported by Oladunjoye and Ojebiyi (2010). The liver weights recorded in this study are slightly below the values reported by Hetland *et al*. (2002). Heart and crop weights obtained are greater than the values reported by Tůmová *et al*. (2012), while kidney weights concur with the values reported by Tůmová *et al*. (2012). The intestine weights obtained in this study were lower than (6.12 - 7.82%) reported by Togun *et al*. (2009) for mature broiler chicken. The results for abdominal fat contradict the report of Adebayo *et al.* (2016) that bitter kola in the diet lessened the abdominal fat of broiler chicken. The variations observed in this study for all carcass parameters might be attributed to the strain of the birds and the environmental conditions in which the birds were raised.

Conclusion

The results of the study showed that the inclusion of bitter cola *(Garcinia kola)* at 25g/kg and 30g/kg has significantly improved growth performance, nutrient digestibility, and carcass characteristics of broiler chickens. It is recommended that similar studies be conducted to investigate the effect of higher inclusion of bitter cola (*Garcinia kola*)

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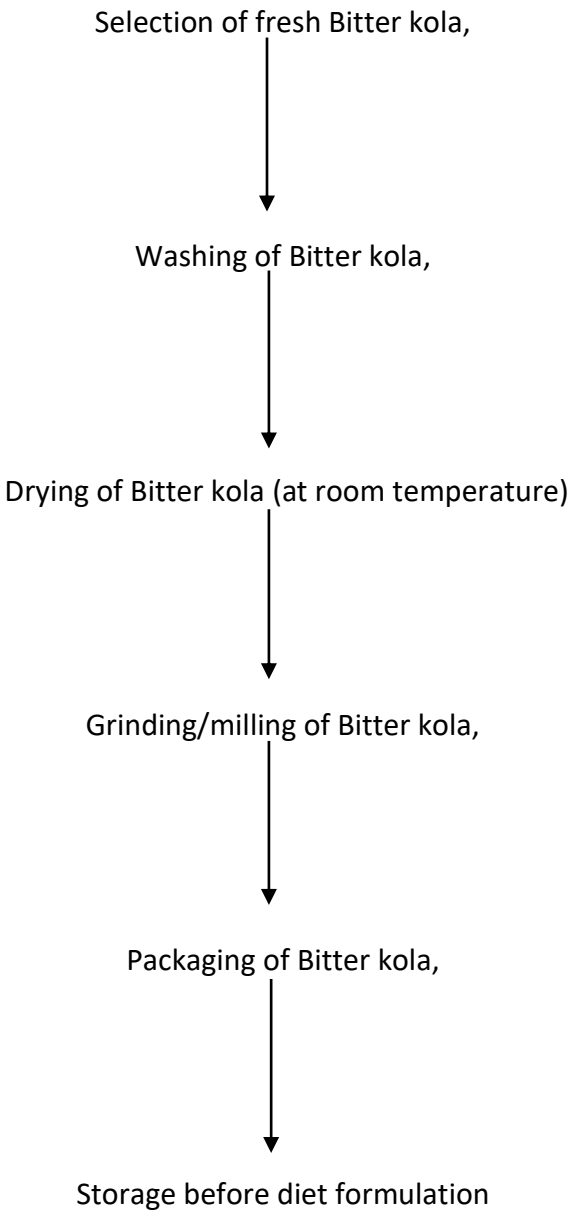

Figure 1: Flow Chart of how Bitter Cola (Garcinia kola) was processed

Table 1: Ingredient Composition of Experimental Broiler Starter Diets (%)

Ingredients	T1(0%)	T2(15g/kg)	T3(20g/kg)	T4(25g/kg)	T5(30g/kg)
Maize	43.30	41.70	41.20	40.70	40.20
Wheat Offal	10.80	10.40	10.30	10.20	10.00
GNC	40.90	41.40	41.50	41.60	41.80
Bone Meal	3.00	3.00	3.00	3.00	3.00
Lime Stone	1.00	1.00	1.00	1.00	1.00
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Sodium chloride	0.30	0.30	0.30	0.30	0.30
Bitter Cola	0.00	1.50	2.00	2.50	3.00
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
Crude Fibre (%)	3.83	3.75	3.76	3.75	3.74
Crude Protein	23.95	23.77	23.97	23.97	23.98
ME	2726.87	2677.18	2660.69	2644.20	2621.69
Calcium	0.09	0.09	0.09	0.09	0.09
Phosphorus	0.14	0.14	0.14	0.14	0.14
Methionine	0.28	0.28	0.29	0.28	0.09
Lysine	0.84	0.85	0.85	0.83	0.85
Ether Extract	5.58	4.50	4.49	4.46	4.45

***ME** = Metabolizable energy *composition of broiler finisher, premix supplying the following per kg of feed: Vitamin A = 3,400IU, Vitamin D_3 = 600IU, Vitamin E = 4000IU, Vitamin K3 600IU, Vitamin B1 = 640IU, Vitamin B2 = 1600mg, Niacin = 8000mg, Pantothenic = 2000mg, Vitamin B6 = 600mg, Vitamin B12 = 4mg, Folic acid = 200mg, Biotin H2 = 300mg, Chlorine + Chloride = 70,000mg, Cobalt = 80mg, C= 1,200mg, Iodine 400mg, Iron = 8000mg, Manganese = 16000mg, Selenium = 80mg, Zinc = 12000mg and Antioxidant = 500mg*

Table 2: Ingredient Composition of Experimental Broiler Finisher Diets (%)

Ingredients	T1(0%)	T2(15g/kg)	T3(20g/kg)	T4(25g/kg)	T5(30g/kg)
Maize	57.10	55.60	55.00	54.60	54.00
Wheat Offal	14.30	13.90	13.80	13.60	13.50
GNC	23.60	24.00	24.20	24.30	24.50
Bone Meal	3.00	3. 00	3.00	3.00	3.00
Lime Stone	1.00	1. 00	1.00	1.00	1.00
Premix	0. 25	0. 25	0. 25	0. 25	0. 25
Lysine	0. 25	0. 25	0. 25	0. 25	0. 25
Methionine	0. 20	0. 20	0.20	0.20	0.20
Sodium chloride	0.30	0. 30	0.30	0.30	0.30
Bitter Cola	0.00	1.50	2.00	2.50	3.00
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
Crude fibre (%)	3.54	3.49	3.48	3.47	3.46
Crude Protein	17.99	17.97	18.00	17.98	18.00
Phosphorus	0.59	0.58	0.58	0.58	0.58
Calcium	1.52	1.52	1.52	1.52	1.49
Lysine	1.06	1.06	1.06	1.06	1.06
Methionine	0.28	0.27	0.27	0.27	0.27
ME	2826.52	2542.81	2760.34	2745.41	2729.89
Ether Extract	4.23	4.18	4.16	4.14	4.13

ME = Metabolizable energy *composition of broiler finisher, premix supplying the following per kg of feed: Vitamin A = 3,400IU, Vitamin D_3 = 600IU, Vitamin E = 4000IU, Vitamin K3 600IU, Vitamin B1 = 640IU, Vitamin B2 = 1600mg, Niacin = 8000mg, Pantothenic = 2000mg, Vitamin B6 = 600mg, Vitamin B12 = 4mg, Folic acid = 200mg, Biotin H2 = 300mg, Chlorine + Chloride = 70,000mg, Cobalt = 80mg, C= 1,200mg, Iodine 400mg, Iron = 8000mg, Manganese = 16000mg, Selenium = 80mg, Zinc = 12000mg and Antioxidant = 500mg

Table 3: Growth Performance of Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola *(Garcinia kola)* (8 weeks)

	Inclusion levels of Bitter cola in the diets					
Parameters	**T1(0g/kg)**	**T2(15g/kg)**	**T3(20g/kg)**	**T4(25g/kg)**	**T5(30g/kg)**	**SEM**
Initial Weight (g/b)	192.43	187.50	188.75	185.00	186.25	3.80^{NS}
Final Weight (g/b)	1772.30^{b}	1706.50^{b}	1676.30^{b}	2008.00^{a}	1713.30^{b}	63.37*
Total Feed Intake(g/b)	4561.71^{a}	4641.51^{a}	4613.01^{a}	4199.19^{b}	4001.40^{c}	53.20*
Daily Feed Intake (g/b/d)	80.03^{b}	81.43^{a}	80.93^{ab}	73.67^{c}	70.20^{d}	0.92*
Weight Gain (g/b)	1552.68^{b}	1492.83^{b}	1462.05^{b}	1791.51^{a}	1500.81^{b}	63.67*
Daily Weight Gain (g/b/d)	27.24^{b}	26.19^{b}	25.65^{b}	31.43^{a}	26.33^{b}	1.10*
Feed Conversion Ratio	2.93^{c}	3.10^{cd}	3.15^{d}	2.34^{a}	2.66^{b}	0.12*

^{abcd}Means with different superscript within row differ significantly (P<0.05), NS = Non-significant, NST = Not statistically tested SEM = Standard error of mean

Table 4: Apparent Nutrient Digestibility by Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola *(Garcinia kola)*

	Inclusion levels of Bitter cola in the diets					
Parameters (%)	**T1(0g/kg)**	**T2(15g/kg)**	**T3(20g/kg)**	**T4(25g/kg)**	**T5(30g/kg)**	**SEM**
Dry Matter	76.36^{b}	70.60^{c}	70.34^{cd}	77.32^{a}	69.99^{d}	0.25*
Crude Protein	78.89^{b}	77.19^{d}	77.09^{d}	80.35^{a}	77.87^{c}	0.22*
Crude Fibre	40.99^{b}	38.01^{c}	38.45^{c}	42.06^{a}	37.91^{d}	0.40*
Ether Extract	80.04^{b}	76.96^{c}	73.91^{d}	82.44^{a}	73.00^{d}	0.48*
Nitrogen Free Extract	73.26^{b}	66.38^{c}	65.83^{c}	75.01^{a}	60.32^{d}	0.30*

^{abcd}Means with different superscript within row differ significantly (P<0.05), NS = Non -significant, SEM = Standard error of mean

Table 5: Carcass Characteristics of Broiler Chickens Fed Diets Containing Varying Levels of Bitter Cola *(Garcinia kola)*

	Inclusion levels of Bitter cola in the diets					
Parameters	**T1 0g/kg**	**T2 15g/k**	**T3 20g/kg**	**T4 25g/kg**	**T5 30g/kg**	**SEM**
Live Weight(g)	1772.30^{b}	1706.50^{b}	1676.30^{b}	2008.00^{a}	1713.30^{b}	63.37*
Slaughter Weight (g)	1725.00^{b}	1632.00^{b}	1615.80^{b}	1927.30^{a}	1708.80^{b}	64.92*
Carcass Weight (g)	1471.80^{b}	1378.50^{b}	1487.50^{b}	1626.80^{a}	1389.80^{b}	60.99*
Dressed weight (g)	1533.00^{b}	1537.80^{b}	1519.50^{b}	1781.80^{a}	1582.30^{b}	65.12*
Dressing %	85.68^{c}	90.12^{ab}	90.65^{ab}	88.69^{b}	91.99^{a}	1.15*
Major Cuts (% Dress Weight)						
Head	3.07^{ab}	3.23^{a}	2.91^{b}	2.66^{c}	21.63^{c}	0.09*
Shank	5.23^{ab}	5.48^{a}	3.64^{d}	4.62^{c}	4.84^{bc}	0.20*
Thigh	12.93^{ab}	12.93^{ab}	13.04^{ab}	12.57^{b}	14.13^{a}	0.74*
Wing	8.96^{b}	8.55^{b}	9.97^{a}	8.41^{b}	8.50^{b}	0.41*
Back	8.92^{a}	8.69^{ab}	8.31^{b}	9.08^{a}	8.76^{ab}	0.24*
Neck	6.64^{bc}	6.32^{c}	7.70^{a}	6.16^{c}	7.11^{ab}	0.38*
Breast	22.10^{b}	19.96^{d}	23.46^{a}	21.62^{bc}	20.71^{cd}	0.51*
Drum stick	10.94^{b}	11.01^{b}	12.41^{a}	10.64^{b}	10.55^{b}	0.35*
Organs (% of Live Weight)						
Gizzard	2.68^{c}	2.84^{b}	2.66^{c}	2.60^{c}	3.09^{a}	0.06*
Liver	2.41^{b}	2.06^{d}	2.16^{d}	2.27^{c}	2.62^{a}	0.05*
Abdominal fat	0.52^{c}	0.51^{c}	0.73^{b}	0.93^{a}	0.75^{ab}	0.09*
Heart	0.62^{a}	0.56^{b}	0.56^{b}	0.51^{c}	0.62^{a}	0.02*
Crop	1.62^{b}	1.21^{c}	2.19^{a}	0.60^{d}	0.65^{d}	0.15*
Kidney	0.27^{a}	0.19^{c}	0.13^{d}	0.22^{b}	0.25^{a}	0.02*
Intestine	6.99^{a}	4.81^{d}	5.74^{bc}	5.15^{cd}	5.96^{b}	0.21*

^{abcd}Means with different superscript within row differs significantly (P<0.05), NS = Non-significant, SEM= standard error of mean