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Effects of dietary intake of bitter kola (*Garcinia kola*) on growth response and blood indices of starter broiler chicks

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Abstract

Antibiotic resistance is one of today's most pressing global public health threats which could become the primary cause of human deaths. Efficacy of Garcinia kola as antibiotic growth promoter was evaluated in assessing growth response and blood profile of broiler chicks. A total of 240, one day-old broiler chicks were used in four weeks feeding trial to assess the effect of dietary intake of bitter kola (Garcinia kola) on growth performance and blood indices of broiler chicks. Six experimental diets were formulated such that diet T1 (Control) contains no bitter kola (BK) while diets T2, T3, T4, T5 and T6 contained varying levels of BK at 10g/kg, 20g/kg, 30g/kg, 40g/kg and 50g/kg, respectively. The broiler chicks were weighed and allotted to six dietary treatments of 40 birds each. The groups were replicated four times in a completely randomized design of 10 birds per replicate. The parameters determined for growth performance were final weight (g), weight gain (g/bird), daily weight gain (g/bird), feed intake (g/bird), daily feed intake (g/bird) and feed conversion ratio (FCR).Supplementation of graded levels of bitter kola had significant (p<0.05) influence on all parameters measured. Birds fed diet containing 0g/kg bitter kola (T1) showed least (P<0.05) value of 1220.00g for final weight. Though not statistically difference, birds fed 20g/kg diet (T3) showed highest numerical value 1403.67g at comparative level across dietary treatments. With the exception of birds feed 0g/kg bitter kola (T1) similar statistical values were recorded for feed conversion ratio (FCR). Dietary treatments had significant (P<0.05) effect on haematological parameters determined. Diets with bitter kola supplementation up to 20g/kg diet could be fed to starter broiler chicks for improved growth performance without adverse effect.

Keywords: Bitter kola, growth response, blood indices, antibiotics, broiler

Effets de l'apport alimentaire de cola amer (Garcinia kola) sur la réponse de croissance et les indices sanguins des poussins de chair starter

Résumé

La résistance aux antibiotiques est l'une des menaces mondiales les plus urgentes pour la santé publique et pourrait devenir la principale cause de décès chez l'homme. L'efficacité de Garcinia kola en tant que promoteur de croissance antibiotique a été évaluée dans l'évaluation de la réponse de croissance et du profil sanguin des poussins de chair. Un total de 240 poussins de chair âgés d'un jour ont été utilisés dans un essai d'alimentation de quatre semaines pour évaluer l'effet de l'apport alimentaire de cola amer (Garcinia kola) sur les performances de croissance et les indices sanguins des poussins de chair. Six régimes expérimentaux ont été formulés de sorte que le régime T1 (témoin) ne contienne pas de cola amer (CA) tandis que les régimes T2, T3, T4, T5 et T6 contenaient des niveaux variables de CA à 10g/kg, 20g/kg, 30g/kg, 40g/ kg et 50g/kg, respectivement. Les poussins de chair ont été pesés et répartis en six traitements diététiques de 40 oiseaux chacun. Les groupes ont été répétés quatre fois dans une conception entièrement randomisée de 10 oiseaux par répétition. Les paramètres déterminés pour les performances de croissance étaient le poids *final (g), le gain de poids (g/oiseau), le gain de poids quotidien (g/oiseau), l'apport alimentaire (g/oiseau), l'apport alimentaire quotidien (g/oiseau) et le taux de conversion alimentaire. (TCA). La supplémentation des niveaux gradués de cola amer a eu une influence significative (p<0,05) sur tous les paramètres mesurés. Les oiseaux nourris avec un régime contenant 0 g/kg de cola amer (T1) ont montré la valeur la plus faible (P < 0,05) de 1220,00 g pour le poids final. Bien qu'il n'y ait pas de différence statistique, les oiseaux nourris avec un régime de 20 g/kg (T3) ont montré la valeur numérique la plus élevée de 1403,67 g au niveau comparatif entre les traitements diététiques. À l'exception des oiseaux nourrissant 0 g/kg de colaamer (T1), des valeurs statistiques similaires ont été enregistrées pour le taux de conversion alimentaire (TCA). Les traitements diététiques ont eu un effet significatif (P<0,05) sur les paramètres hématologiques déterminés. Des régimes avec une supplémentation en cola amer jusqu'à 20 g/kg de régime pourraient être donnés aux poussins de chair de démarrage pour améliorer les performances de croissance sans effet indésirable.*

Mots-clés: Cola amer, réponse de croissance, indices sanguins, antibiotiques, poulet à griller

Introduction

Feed-additive antibiotic usage was an integral part of the revolution in animal-production technology. The mode of action of antibiotic growth promoters (AGPs) is mainly related to an inhibiting effect on certain intestinal bacteria that produce toxins. The inhibition of different species of bacteria that may depress dietary fat absorption due to bile acid de-conjugation may further explain the working mechanism of AGPs (Feighner and Dashkevicz, 1987). Antibiotics are used to fight bacterial infections. Ingestion of antibiotics results in the development of resistance in bacteria such as in the *Escherichia coli* and *Salmonella species*. Antibiotic resistance is one of today's most pressing global public health threats. Unchecked, antibiotic resistance could become the primary cause of human deaths. The severity of this problem has drawn global attention to the use and overuse of antibiotics in livestock production and the potential implications for antibiotic resistance in humans and animals. Using antibiotics for the growth promotion or prevention and treatment of infectious diseases can result in resistance among both resident bacterial pathogens and commensal organisms (Harbottle *et al*., 2006; Javandel *et al*., 2019). Some of the newly-emerging resistant bacteria in animals are transmitted to humans mainly via meat and other food of animal origin or through direct contact with farm animals. Consequently, the animal feed industry, exposed to increasing consumer pressure to reduce the use of AGPs in poultry diets, has to find alternative feed additives (Humphrey *et al*., 2002; Botsoglou *et al*., 2004). Much research has been carried out to look for natural agents with similar beneficial effects of growth promoters. Herbs could be used as alternatives to AGPs in poultry nutrition due to their antimicrobial properties. Many herbs and their bio-active constituents possess a broad antimicrobial activity (Dorman and Deans, 2000; Kamel, 2001; Tucker, 2002; Cross *et al*., 2003; Lewis *et al*., 2003). Scientific evidence exists that herbs and plant extracts stimulate the growth of beneficial bacteria and minimize pathogenic bacterial activity in the gastrointestinal tract of poultry (Gill, 1999; Langhout, 2000; Wenk, 2000). Organic products or phytogenic feed additives may be a viable substitute to increase the profitability of animal industry (Flint and Garner, 2009). 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 antibiotic has been banned completely from use as additive in livestock feeds since 2006, because of a suspected risk of generating microbiota with increase resistance to the antibiotic used for therapy in human and animals (Windisch *et al*., 2008). Phytogenic feed additives are plant extracts or materials which may have beneficial effect on animal production and health. A large variety of the plants materials have properties which could potentially improve feed intake, digestion, feed conversion and body weight gain (Lovkova *et al*., 2001; Williams and Losa, 2001; Ertas *et al*., 2005). They have antimicrobial, antiviral, antioxidant and many other biological activities (Ertas *et al*., 2005; Cross *et al*., 2007). They act as digestibility enhancers, stimulating the secretion of endogenous digestive enzymes (Williams and Losa, 2001; Lee *et al*., 2003). Satisfying the consumer's preference is of paramount importance in any production line. There is good reason to reduce antibiotic use in poultry production. Beyond addressing the antibiotic resistance risk and maintaining the efficacy of antibiotics for both humans and animals, reducing antibiotic use can add value to the end product and increase profitability. Hence, potency of Garcinia kola as antibiotic growth promoter was evaluated in assessing growth response and blood profile of broiler chicks.

Materials and methods

Experimental site

The study was conducted at the poultry unit of the Teaching and Research Farm of Taraba State University, Jalingo located between latitude 6° 30' and 9° 30' N and longitude 9° 00' and 12° 00' E in Guinea Savannah Zone of Northern Nigeria (Kefas *et al*., 2020). It has an annual rainfall range of 1000mm – 1500mm, the ambient temperature of the area ranged between 30 – 38°C with an average of 29°C.

Experimental birds and management

A total number of 240 day-old unsexed broiler chicks of commercial strain (cobb500) were purchased from a reputable hatchery. The chicks were weighed and allotted to six dietary treatment groups of four replicates each in a Completely Randomized Experimental Design. Each replicate consists of 10 chicks, to have a total of 40 birds per treatment group. The birds were brooded for two weeks. Birds were reared on deep litter housing system. Routine vaccinations was strictly followed and feed and water given *ad libitum*.

Source and processing of test ingredient

The bitter kola seeds were purchased from local market in Ondo, Ondo State. The seeds were sliced into small sizes, spread on a concrete floor and air dried until they became crispy. The air dried sliced seeds were pull together and milled in a 2mm sieve harmer mill.

Experimental diets

The experimental diets were formulated to meet NRC (1994) minimum nutrient requirement. The diets consist of T1 (Control) contains no bitter kola (BK) while diets T2, T3, T4, T5 and T6 contained varying levels of bitter kola at 10g/kg, 20g/kg, 30g/kg, 40g/kg and 50g/kg respectively as presented in Table 1.

Data collection

Performance characteristics

The initial weights of the birds were taken before commencement of the feeding trial. The live weights of the birds as well as the feed consumption of each replicate were measured weekly. Feed conversion ratio for each replicate were determined by dividing the feed intake by the weight gain.

Table 1: Percentage composition of broiler starter diets (1-4 weeks)

	Bitter Kola Levels (g/kg)					
	0	**10**	**20**	**30**	**40**	**50**
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Ingredients:						
Maize	51.50	51.50	51.50	51.50	51.50	51.50
Soy bean meal	30.00	30.00	30.00	30.00	30.00	30.00
Groundnut cake	6.70	6.70	6.70	6.70	6.70	6.70
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Maize offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00	1.00
DL-Methionine	0.2	0.2	0.2	0.2	0.2	0.2
L-Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Bitter kola (g/kg)	0.00	10.00	20.00	30.00	40.00	50.00
Calculated analysis:						
ME (kcal/kg)	2920.83	2920.83	2920.83	2920.83	2920.83	2920.83
Crude protein (%)	23.15	23.15	23.15	23.15	23.15	23.15
Crude fibre (%)	4.01	4.01	4.01	4.01	4.01	4.01
Ether extract (%)	3.74	3.74	3.74	3.74	3.74	3.74
Ca (%)	1.07	1.07	1.07	1.07	1.07	1.07
P (%)	0.55	0.55	0.55	0.55	0.55	0.55
L-Lysine (%)	1.26	1.26	1.26	1.26	1.26	1.26
DL-Methionine (%)	0.54	0.54	0.54	0.54	0.54	0.54

Feed intake/bird (g) =

$$\frac{\text{Quantity of feed fed} - \text{Quantity of feed left over}}{\text{Number of birds x 28 days}}$$

Daily weight gain (g) =

$$\frac{\text{Final live weight} - \text{Initial weight}}{\text{Number of birds x 28 days}}$$

Feed conversion ratio (g) =

$$\frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$$

Haematological analysis

At the end of 28th day feeding trial, blood samples were drawn from the wing vein of four birds per treatments that is one from each replicate. About 2mL of blood sample was transferred into a bottle containing ethylene diamine tetra acetic acid anticoagulant for haematological analyses. Haematological procedure were carried out according to Kelly (1979) and Jain (1986) in determining the following parameters: Packed cell volume (PCV), white blood cell (WBC), haemoglobin (Hb), red blood cell (RBC), mean cell haemoglobin concentration (MCHC), mean ell haemoglobin (MCH) and mean cell volume (MCV).

Statistical analysis

Data collected were subjected to One–way Analysis of Variance (ANOVA) in a Completely Randomized Design using SAS (2000) while significant means were separated using Duncan's Multiple Range Test at 5% level of significance.

Results and discussion

Growth response

The results of growth response of starter broiler chicks fed diet containing graded levels of bitter kola supplementation are shown in Table 2. Dietary treatments had significant ($p<0.05$) effects on growth response of starter broiler chicks. Supplementation of graded levels of bitter kola had significant ($p<0.05$) influence on all parameters measured. Birds fed diet containing 0g/kg bitter kola (T1) showed least (P<0.05) value of 1220.00g for final weight. Higher values of 1346.67g, 1403.67g and 1386.67g recorded for birds fed diets containing 10g/kg (T2), 20g/kg (T3) and 30g/kg (T4) respectively were not statistically difference. Total weight gain followed similar trend with final weight. Birds fed control diet had least (P<0.05) value of 1049.00g for weight gain. Birds fed diet containing 10g/kg, 20g/kg and 30g/kg revealed similar statistical values 1176.00g, 1232.67g and 1216.00g respectively. Daily weight gain followed the same trend of T3>T4>T2>T5>T6>T1. This observed trend showed that inclusion of bitter kola enhanced better feed utilization as such favoured tissue build up. This observation could be attributed to efficient nutrient digestibility and utilization. Major constituents of bitter kola (alkaloids and flavonoid) stimulate an increase in gastric acid secretion (Oluwole and Obatomi, 1991). Birds feed control diet (T1) and birds on 50g/kg bitter kola (T6) recorded least (P<0.05) similar statistical values 1545.33g/bird and 1580.00g/bird respectively for total feed intake. Birds fed diets containing 10g/kg, 20g/kg, 30g/kg and 40g/kg bitter kola showed similar higher statistical values 1631.00g.1669.33g, 1667.00g and 1581.33g respectively. Numerical trend of T3>T4>T5>T6>T1 as observed in this study for feed intake showed the ability of the birds to tolerate bitterness in bitter kola though depressed feed intake was observed at highest level of 40g/kg and 50g/kg. This observation corroborate the report in literature (Adedeji *et al*., 2008) who reported progressive increase in feed intake by starter broiler chicks fed diets containing bitter kola followed by declined in feed intake at higher level of supplementation. With the exception of birds feed 0g/kg bitter kola (T1) similar statistical values were recorded for feed conversion ratio (FCR). Supplementation of biter kola showed improved FCR. This could be attributed to ability of the birds to better utilize quantity of feed consumed and may be due to antibacterial or growth promoting tendency of bitter kola (Adedeji *et al*., 2008) mortality did not follow any definite pattern as one mortality was recorded for birds on 20g/kg (T3).

Table 2: Growth response of starter broiler chicks fed diet containin g graded levels of bitter kola supplementation (1-4 weeks)

	Bitter Kola Levels (g/kg)						
	0	10	20	30	40	50	
	T1	T2	T3	T4	T5	T6	SEM
Parameters:							
Initial weight (g)	171.00	170.66	171.00	170.66	170.33	171.00	0.19
Final weight (g)	1220.00^{c}	1346.67^{ab}	1403.67^{a}	1386.67^{ab}	1323.33^{abc}	1290.00^{bc}	18.56
Total weight gain (g/bird)	1049.00^{c}	1176.00^{ab}	1232.67^{a}	1216.00^{ab}	1153.00^{ab}	1119.00^{bc}	18.56
Daily weight gain (g/bird)	49.95^{c}	55.99^{ab}	58.69^{a}	57.90 ^{ab}	54.90^{ab}	53.28^{bc}	0.88
Total feed intake (g/bird)	1545.33^{b}	1631.00^{ab}	1669.33^{a}	1667.00^{a}	1581.33^{ab}	1580.00^{b}	15.44
Daily feed intake (g/bird)	73.58^{b}	77.66^{ab}	79.49^{a}	79.38^{a}	75.30^{ab}	75.23^{ab}	0.74
FCR	1.47^{a}	1.38^{b}	1.35^{b}	1.37^{b}	1.37^{b}	1.41^{b}	0.01
Mortality (number)	0.00	0.00	1.00	0.00	0.00	0.00	

Haematological indices

The result of hematological parameters of starter broiler chicks fed diets containing graded levels of bitter kola is presented in Table 3. With the exception of mean corpuscular hemoglobin concentration (MCHC), dietary treatments had significant (P<0.05) effect on the parameters determined. Values recorded for parameters across dietary treatment did not follow any definite trend. Ranged values 24.00 % - 28.00 % were recorded for PCV. Birds fed diets containing 20g/kg bitter kola T3 and 40g/kg T5 had least

($P<0.05$) values 24.00% and 24.33% respectively. Values recorded were within the range obtained in the literature (Adedeji *et al*., 2008) who reported 20.00 % - 28.00 % for PCV in broiler starter chicks fed diet with bitter kola supplementation. Haemoglobin revealed ranged values 7.93g/dl – 9.23g/dl which is a close range to 9.80g/dl reported for experimental birds in literature (Miturka and Rawnsely, 1977). This observation showed that the birds had improved value for efficient oxygen carrying capacity. Ranged values 20.00 $\times10^9$/L -30.40 $\times10^9$/L were recorded for white blood cell (WBC). This elevated range value recorded for WBC were slightly higher than 18.90 reported for experimental animal in literature (Miturka and Rawnsely, 1977). However, the ranged values observed in this study were slightly below the values 30.00-80.00 $\times10^9$/L reported in literature (Adedeji *et al*., 2008) when starter broiler chicks were fed diets containing varying levels of bitter kola supplementation. WBC differentials; lymphocytes and neutrophil showed ranged values 43.66 – 67.33% and 33.66 – 53.33% respectively. The elevated values obtained for WBC differentials were slightly above 12.1 – 64.2% and 4.57 – 24.2% reported for lymphocyte and neutrophil for experimental birds in the literature (Miturka and Rawnsely, 1977). This observation could be attributed to response of the birds to foreign substance such as phenolic compounds including bioflavonoids, xanthones and benzophenones.

Table 3: Haematological indices of starter broiler chicks fed diet containin g graded levels of bitter kola supplementation (1 - 4 weeks)

	Bitter Kola Levels (g/kg)						
	0	10	20	30	40	50	
	T1	T2	T3	T4	T5	T6	SEM
Parameters:							
Packed cell volume (%)	26.64^{a}	27.00^{a}	24.00^{b}	28.00^{a}	24.33^{b}	26.00^{ab}	0.41
Haemoglobin (g/dL)	8.76^{ab}	8.90^{ab}	7.96^{b}	9.23^{a}	7.93^{b}	8.63^{ab}	0.16
White blood cell ($\times10^9$/L)	26.66^{ab}	20.00^{b}	30.40^{a}	19.43^{b}	28.26^{ab}	26.00^{ab}	1.35
Red blood cell ($\times10^{12}$/L)	2.50^{ab}	2.50^{ab}	2.36^{b}	2.63^{a}	2.46^{ab}	2.56^{a}	0.02
Mean corpuscular volume (fl)	108.16^{a}	103.66^{abc}	101.43^{bc}	106.30^{ab}	98.60^{c}	102.60^{abc}	0.95
Mean corpuscular haemoglobin (pg)	36.03^{a}	35.13^{ab}	33.64^{ab}	35.06^{ab}	32.15^{b}	33.32^{ab}	0.50
Mean corpuscular haemoglobin concentration (g/dL)	33.32	33.09	33.18	32.96	32.61	33.12	0.26
Lymphocyte (%)	55.00^{abc}	67.33^{a}	61.66^{ab}	51.66^{bc}	66.33^{a}	43.66^{c}	2.48
Neutrophil (%)	41.00^{ab}	33.66^{b}	35.33^{b}	44.66^{ab}	33.66^{b}	53.33^{a}	2.32

Conclusion

The study revealed that graded levels of bitter kola supplementation had effect on growth response parameters of starter broiler chicks. Supplementation of graded levels of bitter kola had effect on haematological indices. Diets with bitter kola supplementation up to 20g/kg diet could be fed to starter broiler chicks without any adverse effect on starter broiler chicks.

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