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Evaluation of the Effect of Plant Source feed additives and their combinations as Natural Growth Promoters on the Growth Performance, Carcass and Gut Characteristics of Broiler Chickens

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Abstract
The use of antibiotics in poultry feed at therapeutic or subtherapeutic levels as well as bacterial resistance to antibiotics, which impedes human health, are causing growing public concern. To ensure animal health, productivity, and carcass quality, livestock farmers must be given alternatives to antibiotic growth promoters. The main objective of this study is to evaluate the effect of supplementation of plant source growth promoters (Garlic, Ginger, Neem and Moringa leaves meal) and their combinations, as Natural Growth Promoters in broiler chickens. A total of 360-day-old Cobb-500 broiler chickens were purchased from Olam hatchery, Chukum. The chicks were fed commercial diets for seven (7) days. Thereafter, the birds were randomly allotted to six (6) dietary treatments with four (4) replicates each, 15 birds per replicate. The rations were labeled as Diets: T1=basal diet + Antibiotics, T2=basal diet + Garlic, T3=basal diet + Ginger, T4=basal diet + Neem leaf meal, T5=basal diet + Moringa leaf meal and T6=basal diet + mixture of natural growth-promoter herbs. The data was analyzed by One-way analysis of variance (ANOVA) using R-studio application software, LSD was used to compare significant difference among the treatments means at $P < 0.05$. The results revealed that there were no significant ($P > 0.05$) differences among the dietary treatment means for daily feed intake, weight gain, and feed conversion ratio in all the three phases (starter, finisher, and overall). the results for carcass and organs characteristics revealed that there were no significant difference ($P>0.05$) among the treatment means for live weight, plucked weight, evisceration weight, carcass weight, head weight, shank weight, neck weight, thigh weight, breast weight, wing weight, dressing percentage. While a significant difference ($P < 0.05$) was shown on the leg weight and drumstick weight where diets T3 and T2 were the highest. The weight of viscera organs; revealed a very high significant ($P < 0.001$) difference in kidney weight, and a high significance ($P < 0.01$) difference in spleen weight, Proventriculus weight, and small intestine weight, with a significant ($P < 0.05$) difference in lung weight. The results suggested that the natural herbal growth promoters are similar and had better output compared with commercial antibiotics growth promoters in most of the body cut parts. Therefore, these Natural Plant Growth Promoters will be used to replace Antibiotics Growth promoters without any adverse effects on broiler performance.

Keywords: Broiler chicken, Antibiotics, Natural Plant Growth Promoters, and Carcass

Introduction
Broiler chicks are one of the most effective and economical converters of vegetable food into animal protein and offer speedy results compared to the production of other proteins of animal origin. The chicken business continues to face significant concerns, including decreased weight gain, management issues, and infectious diseases. The majority of commercial poultry farmers use antibiotics as growth promoters and lower the incidence of diseases. A great Concern has been raised due to, the use of antibiotics therapeutics and for growth promotion which could lead to a problem of increasing resistance of human and animals origin, particularly regarding resistance to bacteria (*Salmonella spp*. and *Escherichia coli*).

It was recommended that the use of tetracycline, penicillin, sulfonamides, and tylosin as growth promoters be discontinued because of their residual effect in meat, which impaired human health. (Mahanta *et al*., 2017) [9]. Therefore, alternatives to Antibiotics Growth Promoters (AGP) need to be proposed to livestock producers in order to maintain effective animal productivity, health, and carcass quality. Animal scientists face a significant issue as the demand for human-safe food and animal protein that is free of antibiotics through the use of herbal feed resources rises. The need to decrease the use of antibiotics in livestock and poultry production has given the livestock industry a boost. (Anwar, *et al*., 2017; Cheng, *et al*., 2019) [6, 7]. However, the inclusion of dietary herbs and their extracts has growth-promoting roles in poultry (Movahhedkhah *et al*., 2019) [12]. Furthermore, in substitute for antibiotics in the poultry production, many natural therapeutic plants, and their extracts as feed supplements have been used. (Mahanta *et al*., 2017; Mahfuz *et al* 2018) [9, 10]. In addition, Mahfuz *et al*. (2018) [10] reported that, In order to improve the health and productivity of chickens, poultry scientists are required to apply novel natural feed supplements. These supplements may be key components of future therapies. Thus, poultry researchers are looking for potential natural feed resources that will be both environmentally friendly and safe for human society (Pourhossein *et al*., 2015; Mahfuz *et al* 2018) [15, 10]. The main objective of this study is to evaluate the effect of supplementation of natural plant products (Garlic, Ginger, Neem, and Moringa leaves meal) and their combination as natural growth promoters in broiler chickens.

Materials and Methods

Description of experimental sites

The research was conducted at research and teaching farm, Federal College of Education (Technical) Gombe, in Gombe State Nigeria. The State is located within the Northern Guinea Savannah region of North-Eastern geographical zone of Nigeria. It is located between latitude 10^0 to 10^0 $20^/$ N and longitude 11^0 $01^/$ E and 11^0 $19^/$ E with an average temperature of 26^0C (Abba *et al*., 2010) [1].

Experimental birds and their management

A total of 360-day old Cobb-500 broiler chickens were purchased from Olam hatchery, Chukum. The chicks were randomly allotted to six (6) dietary treatments with four (4) replicates each, 15 birds per replicate. The birds were kept under deep litter management system and timber shaving was used as litter materials to cover the floor. Veterinary services were rendered to ascertain the birds health condition, the birds were vaccinated with Gumboro (IBDV) at the 1st and 4th week and Lasota (NDV) at the 3rd week of age, anti-stress vitamins drugs were administered after each vaccination.

Experimental diets and treatments

There are six iso-nitrogenous and iso-caloric dietary treatments in both the starter (23% CP, 2800kcal/kg ME) and finisher rations (19% CP, 3000kcal/kg ME). The rations were labeled as Diets: T1=basal diet + Antibiotics, T2=basal diet + Garlic, T3=basal diet + Ginger, T4=basal diet + Neem leaf meal, T5=basal diet + Moringa leaf meal and T6=basal diet + mixture of natural growth-promoter herbs, for starter and the finisher; table 1. The birds were fed a starter experimental ration from 2nd - 4th weeks, while the finisher ration was fed at the 5th – 8th weeks, both feed and water are fed *ad-libitum*.

Table 1: Dietary Composition (%) and Calculated Analysis of Broiler Starter and Finisher Diets

Levels of Inclusion in % of Feed ingredients												
	Starter diet (2-4wks)						Finisher diet (5-8wks)					
Diets:	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Maize	50.24	50.24	50.24	49.49	49.49	45.64	58.30	58.30	58.30	58.31	58.31	45.64
GNC	30.06	30.06	30.06	29.31	29.31	28.66	22.00	22.00	22.00	20.49	20.49	28.66
Antibiotics	1	-	-	-	-	-	1	-	-	-	-	-
Garlic	-	1	-	-	-	1	-	1	-	-	-	1
Ginger	-	-	1	-	-	1	-	-	1	-	-	1
NLM	-	-	-	2.5	-	2.5	-	-	-	2.5	-	2.5
MOLM	-	-	-	-	2.5	2.5	-	-	-	-	2.5	2.5
Rice bran	10.00	10.00	10.00	10.00	10.00	10.00	12.00	12.00	12.00	12.00	12.00	12.00
Fish meal	5.00	5 .00	5.00	5 .00	5.00	5.00	3.00	3 .00	3.00	3.00	3.00	3.00
Bone Meal	2.00	2 .00	2.00	2.00	2.00	2.00	2.00	2 .00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	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	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Palm oil	0.42	0.42	0.42	0.42	0.42	0.42	0.36	0.36	0.36	0.36	0.36	0.36
Total	100	100	100	100	100	100	100	100	100	100	100	100
CP%:	23	23	23	23	23	23	19	19	19	19	19	19
ME kcal/kg	2800	2800	2800	2800	2800	2800	3000	3000	3000	3000	3000	3000

GNC= Groundnut cake, NLM= Neem leaves Meal, MOLM= Moringa oleifera leaves meal Antibiotics= Oxytetracycline, CP%= crude protein% ME= metabolizable energy: T1=basal diet + Antibiotics, T2=basal diet + Garlic, T3=basal diet + Ginger, T4=basal diet + Neem leaf meal, T5=basal diet + Moringa leaf meal and T6=basal diet + mixture of natural growth-promoter herbs

Statistical analysis: The data was analyzed by One-way analysis of variance (ANOVA) using R-studio application software, LSD was used to compare significant difference among the treatments means at $P < 0.05$.

Data collection procedure

Feed intake: The daily feed consumption per bird is the difference between the supplied feed and the leaf over per day during the estimated production period. While the daily feed intake is computed as feed consumption (g/day/bird)

Weight gain

Initial body weights of the birds were taken during the commencement of the study and thereafter, at the end of every week; the bird's weight gain was determined by the differences between the current and the previous weights. While the daily weight gain is computed as weight gain (g/day/bird)

Feed conversion ratio

The Feed Conversion Ratio (F.C.R.) was calculated by dividing total feed intake (g) by total weight gain (g) as shown from the expression below:

$$\text{F.C.R. (Broiler)} = \frac{\text{Total Feed Intake (g)}}{\text{Total Weight Gain (g)}}$$

Determination of the mortality rate

This is the ratio between the number of the dead birds and the initial total number of birds in the batch multiplied by 100.

$$\text{Mortality (\%)} = \frac{\text{Number of subjects dead}}{\text{Total number of initial subjects}} \times \frac{100}{1}$$

Carcass measurement for broilers

At the end of the feeding trial two (2) birds (male and female) from each replicate were randomly selected and starved overnight (12 hours). Each bird was weighed (Live weight) and Slaughtered. The slaughtering was done by slitting the throat and jugular veins with a sharp knife for proper bleeding. Thereafter, the birds were scalded in warm water for about a minute, de-feathered, eviscerated and dressed to determine carcass characteristics. The Plucked Weight (PW), Eviscerated Weight, and Carcass Weight were taken, the intestinal and caeca lengths and weights were measured while the gizzard, spleen, thigh, shank, breast, wings, neck, lung, drum stick, pancreas, heart, liver and kidney were removed and grossly examined for any pathological changes. Each cut-up parts and organs were separately weighed using a sensitive electronic scale, lengths were measured using measuring tape and each part is expressed as a percentage of dressed weight. The weight of the carcass and internal organs were taken to determine the effects of the experimental diets on the organs. The dressing percentage was calculated using the mathematical relationship below:

$$\text{Dressing Percentage} = \frac{\text{Carcass Weight}}{\text{Live weight}} \times \frac{100}{1}$$

Results and Discussion

The results of daily feed intake, weight gain, and feed conversion ratio of broilers fed with Supplemented Natural Plant Growth Promoters diets at the starter, finisher and overall phases were presented in tables; 2,3, and 4 respectively. The results revealed that there were no significant ($P > 0.05$) differences among the dietary treatment means in all the three phases although, the diet containing Ginger meal (T3) shows the best numerical feed conversion ratio at all the feeding phases (1.38, 2.67, and 2.12). The lower the value of FCR the more efficient the birds convert feed to live weight (Ampode *et al*., 2020) [5]. Several studies have demonstrated the potency of these natural herbs as antimicrobial agents that enhance broiler chicken development, digestion, and health status. (Pourali *et al*., 2010; Onu and Aja; 2011) [14, 13]. This is in agreement with the findings of [Demir *et al*., 2003; Ademola *et al*., 2009; Aji *et al*., 2011; Mansoub *et al*., 2011] [8, 3, 4, 11] who reported non-significant effect of ginger and garlic on FCR. These results might be due to the chemical composition of the herbs which improves good health status of the birds (Reuter, 1995) [16]. This indicate that all the Natural Growth Promoters diets (T2,T3, T4, T5 and T6) are comparable with the Antibiotics Growth promoters diet (T1), Therefore, these Natural Plant Growth Promoters will be used to replace Antibiotics Growth promoters without any adverse effects on broiler performance.

Table 2: Performance of Broilers Fed with Supplemented Natural Growth Promoters Diets at Starter Phase (2-4 Weeks)

Parameters	T1	T2	T_3	T_4	T_5	T_6	SEM
Initial body wgt	43.00	40.00	42.50	40.67	41.00	43.00	2.34 ^{NS}
Final weight	2250.00	2210.00	2270.00	2225.00	2125.00	2200.00	200.81 ^{NS}
DFI (g)	35.75	36.51	35.04	37.97	36.23	40.24	2.04^{NS}
DWG (g)	25.60	25.35	25.74	23.33	25.83	28.45	2.46 ^{NS}
FCR	1.44	1.45	1.38	1..63	1.40	1.42	0.10 ^{NS}
Mortality (No)	0	0	0	0	0	0	-

Table 3: Performance of Broilers Fed with Supplemented Natural Growth Promoters Diets at Finisher Phase (5-8 Weeks)

Parameters	T1	T2	T_3	T_4	T_5	T_6	SEM
DFI (g)	96.22	96.34	99.63	89.43	94.09	102.41	4.95^{NS}
DWG (g)	33.69	32.01	37.88	31.55	31.99	29.58	3.77 ^{NS}
FCR	2.89	3.02	2.67	2.89	2.95	3.52	0.34^{NS}
Mortality (No)	0	0	0	0	0	0	-

Table 4: Performance of Broilers Fed with Supplemented Natural Growth Promoters Diets at Overall Phase (2-8 Weeks)

Parameters	T1	T2	T_3	T_4	T_5	T_6	SEM
DFI (g)	65.98	66.43	67.34	63.70	65.16	71.33	2.04^{NS}
DWG (g)	29.65	28.68	31.82	27.44	28.92	29.02	2.46^{NS}
FCR	2.25	2.33	2.12	2.34	2.25	2.46	0.10^{NS}
Mortality (No)	0	0	0	0	0	0	-

NS = not significant SEM = Standard Error of the mean DFI = Daily Feed Intake DWG= Daily Weight Gain FCR = Feed Conversion Ratio T1=basal diet + Antibiotics, T2=basal diet + Garlic, T3=basal diet + Ginger, T4=basal diet + Neem leaf meal, T5=basal diet + Moringa leaf meal and T6=basal diet + mixture of natural growth-promoter herbs

The results of carcass and organs characteristics of Broilers Fed with Supplemented Natural Plant Growth Promoters diets were presented in Table 5: the results revealed that there was no significant difference (P>0.05) among the treatment means for live weight, plucked weight, evisceration weight, carcass weight, head weight, shank weight, neck weight, thigh weight, breast weight, wing weight, dressing percentage. While a significant difference (P < 0.05) was shown on the leg weight and drumstick weight where diets T3 and T2 were the highest, followed by diets T4, T6, and T1 while diet T5 was the least. The weight of viscera organs; revealed a very high significant difference (P < 0.001) obtained in kidney weight, and high significance (P < 0.01) in spleen weight, Proventriculus weight, and small intestine weight, with a significant difference (P < 0.05) in lung weight. The carcass results suggested that the natural herbal growth promoters are similar and had better output compared with commercial antibiotics in most of the body cut parts. The highest legs and drumstick weights in diets T2 and T3 shows their superiority as compared to other diets, this result is similar to the findings of Abonyi *et al*. (2019) [2].

Table 5: Carcass and Organs Characteristics of Broilers Fed with Supplemented Natural Growth Promoters

Parameters	Broilers Fed with Supplemented Natural Growth Promoters						
	T1	T2	T3	T4	T5	T6	SEM
Weight of Body (g)							
Live Weight	2250	2210	2270	2225	2125	2200	200.81^{NS}
Plucked Weight	2150	2125	2180	2150	1975	2100	191.12^{NS}
Evisceration Weight	1675	1675	1726	1550	1625	1750	174.01^{NS}
Carcass Weight	1275	1300	1440	1349	1250	1350	81.12^{NS}
Head Weight	55.65	51.65	42.55	49.40	44.85	51.35	4.83^{NS}
Shank Weight	105.80	103.45	89.55	108.85	87.55	94.65	7.34^{NS}
Neck Weight	99.20	104.45	76.25	96.50	86.30	111.20	12.52^{NS}
Leg Weight	217.65^{ab}	244.15^{a}	251.90^{a}	223.80^{ab}	198.35^{c}	222.42^{ab}	17.26*
Drumstick Weight	90.10^{ab}	104.75^{a}	109.80^{a}	100.65^{ab}	89.65^{ab}	92.60^{ab}	6.62*
Thigh Weight	127.45	139.40	142.10	123.15	108.70	133.15	12.96^{NS}
Breast Weight	351.15	365.55	308.37	363.00	362.90	340.05	40.00^{NS}
Wing Weight	74.15	76.05	73.90	89.10	89.07	76.00	194.69^{NS}
Dressing Percentage	56.67	58.82	56.76	60.63	58.82	61.36	4.24^{NS}
Weight Viscera Organs	**(g)**						
Gizzard	60.15	60.65	47.20	52.55	55.40	59.75	6.43^{NS}
Lung weight	10.75^{a}	8.35^{a}	8.30^{a}	10.25^{a}	7.50^{a}	9.95^{a}	1.02*
Kidney weight	13.30^{a}	8.25^{bc}	5.55^{c}	10.75^{ab}	8.80^{b}	10.85^{ab}	0.87***
Spleen weight	2.05^{ab}	1.65^{bc}	1.80^{abc}	1.95^{abc}	1.20^{c}	2.50^{a}	0.25**
Heart weight	8.60	8.80	8.20	8.60	7.40	9.70	8.03^{NS}
Proventriculus wgt	9.00^{ab}	6.45^{abc}	4.95^{c}	5.80^{bc}	5.55^{bc}	10.05^{a}	1.09**
Abdominal fat wgt	46.95	66.45	17.90	24.55	40.20	51.15	3.46^{NS}
Large intestine wgt	4.05	4.85	5.65	3.35	3.55	5.10	0.85^{NS}
Caecal weight	20.00	12.50	11.85	13.33	11.35	16.4	2.80^{NS}
Small intestine wgt	132.05	104.55	114.05	97.50	88.05	131.70	10.96**
Liver weight	42.32	39.60	39.35	39.80	38.20	45.60	6.54^{NS}
Pancreatic weight	5.92	5.72	5.50	5.92	5.74	5.96	3.46^{NS}
Length of Gastro Intestinal Tract (GIT) Components (cm)3							
Large intestine length	10.15	10.20	5.90	10.20	10.50	10.40	1.67^{NS}
Small intestine length	260.40	235.60	250.60	235.45	240.70	265.35	12.79^{NS}
Caeca length	15.65	10.80	15.45	15.35	15.45	15.50	3.50^{NS}

^{abc} Means bearing different superscripts within the same row differ significantly, * = (P < 0.05), ** = (P < 0.01), *** = (P < 0.001), NS = not significant , SEM = standard Error of the mean. T1 – Basal diet + Antibiotics T2 - Basal diet + Garlic T3- Basal diet + Ginger T4 - Basal diet + Neem leaves Meal T5- Basal diet + Moringa oleifera leaves meal T6 - Combination of the various natural growth promoters

Conclusions

In this study, better growth performances, and carcass characteristics, were observed in the treatment groups of diets supplemented with natural growth promoters (Garlic, Ginger, Neem, and Moringa leaves meal). The use of these natural growth promoters revealed beneficial effects towards improving the health, growth, carcass, and gut characteristics quality of broiler chickens. In addition to that, natural growth promoters are safe, available, and affordable, therefore, they can effectively be used as an alternative to the antibiotic growth promoter in the poultry industry.

Recommendations

1. The use of natural growth promoters (Garlic, Ginger, Neem, and Moringa leaves meal) should be encouraged as alternatives to Antibiotics Growth Promoter to maintain the health, productivity, and carcass quality of broiler chickens
2. Farmers and poultry feed industries should supplement feed production with natural growth promoters for better weight gain and feed conversion ratio in broiler chickens
3. To ensure the health of the birds and to avoid antibiotics' potentially harmful long-term side effects, the government should promote the use of natural growth promoters in place of antibiotic growth promoters in the feed industry.
4. The production of healthy organic poultry meat can be achieved through feed supplementation with natural growth promoter in broiler chickens
5. Further investigation is required into the use of these natural growth promoters for other classes of poultry at various levels of inclusion.

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