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Impact of ginger (*Zingiber officinale*) on intestinal, caeca microbial loads and growth performance of broilers

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Abstract

A study using ninety-nine day old Marshal Broiler chicks was conducted to investigate the effect of ginger root meal on growth, carcass and microbial population of broiler birds. The birds were randomly assigned to three treatments replicated three times in a Completely Randomized Design (CRD). Each treatment consisted of 33 birds with 11 birds per replicate. The birds were fed ginger root meals supplemented at 0%, 1.5% and 3.0% representing diets 1, 2 and 3 respectively, with diet 1 as the control. Data collected on feed intake, final body weight, weight gain, feed conversion ratio, different carcass parts and microbial load of intestines, caeca and mortality were subjected to analysis of variance (ANOVA). Results showed significant decrease (P<0.05) in abdominal fat for birds fed 1.5% and 3.0% ginger supplemented diets, while the other carcass parts were not influenced. There were also significant decreases (P<0.05) in weight gain, final live weight and caeca microbial loads for birds fed 1.5% and 3.0% ginger supplemented diets compared to the control. Significant increases (P<0.05) were observed in feed conversion ratios and feed intake with resultant decrease in weight gain on diets 2 and 3, while mortality increased significantly in diet 3. Furthermore, the results also showed that ginger did not have any detrimental effect on the intestinal micro flora, but supported the activities of micro-organisms that aid digestion in the gastro-intestinal tract. The intestinal and caeca microbial loads examination confirmed the antimicrobial properties of ginger.

Keywords: *Antibiotics, Broilers, Ginger, Growth performance, Microbial load, Probiotics.*

Description of Problem

Organic poultry is a new technology based on the use or supplementation of organic substances from plants, animals and other natural products in poultry production. This method focuses on the avoidance or usage of chemical compounds in poultry diets or its use in a very low level for the sake of consumers [1]. These growth promoters or feed additives are primarily included to improve the efficiency of growth and laying capacity of birds. It is also used to prevent disease and improve feed utilization. Some growth promoters act as natural antibiotics and probiotics because of the physiological and biochemical activities in the enhancement of functional gut health leading to promotion of growth performance and disease prevention [2]. This has generated increasing interest in the use of phytogenic plants due to their lesser side effects, low cost and easy availability of their products compared to the synthetically produced growth promoters and antibiotics. Many active ingredients from plants are considered as pro-nutrients and have recently been tried in animal nutrition and animal physiology. As a result, organic and plant products are continually being harnessed, screened and explored for their beneficial properties [3,

4]. Poultry industry is moving towards minimizing the use of synthetic antibiotics as growth promoters in animal diets. There have been pressures on producers in many parts of the world to produce antibiotic free birds which arose from health challenges that were observed when synthetic antibiotics were overused both in human and animal [5]. Therefore, there is an increasing interest in other alternative substances and strategies for animal growth promotion and disease prevention. Phytogenic and herbal products have received increased attention since they have acquired more acceptability among consumers as natural antibiotics, and many have shown significant results [6]. One of such products is ginger (*Zingiber officinale).*

Zingiber officinale is a perennial flowering plant widely known as ginger. It belongs to the family *Zingiberacae* whose rhizome serves as the storage organ. Ginger contains more than 140 phytochemicals as well as volatile oils, vitamins and minerals [7, 8, 9]. Ginger has medicinal, anti-inflammatory, antimicrobial properties, speeds up digestion and widely used as preservatives, spice or condiment and for many other medicinal purposes in many homes [10, 11, 12, 13]. It has also been recommended for chronic skin diseases, muscular pains, obesity, abnormal bleeding after child-birth, alleviating mild-to-moderate nausea and vomiting during pregnancy [14, 15, 16, 17]. Ginger rhizome is known to lower blood cholesterol level in man [18, 19].

If biological properties of ginger are proved to enhance growth and regulate intestinal and caeca microbial population in broilers fed the experimental diets without deleterious effects on the physiological characteristics of birds, its potentials as growth promoter and antibiotic probiotics will impact positively on animal production. Therefore, this study was aimed at investigating the effects of ginger on the growth performance, carcass cut-up parts and microbial population in broiler chickens.

Materials and Methods

Location of experimental site

This study was conducted at the Poultry Unit of the Teaching and Research Farm of the College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is located at latitude $05^{0}29^{1}$ North and longitude $07^{0}31^{1}$ East; and at an altitude of 122 meters above sea level. It lies within the tropical rainforest zone of South-Eastern Nigeria. The location is characterized by average annual rainfall of 2,177mm in 148-155 rain days. The average ambient temperature is 25.5^{0}C with minimum and maximum tempera-ture of 22^{0}C and 29^{0}C respectively. Relative humidity ranged from 57-91% [20].

Collection and preparation of ginger root meal

Fresh ginger rhizome was purchased from Ubani market, in Umuahia, Abia State, Nigeria. It was cleaned and washed in running tap water to remove adhering debris. It was later cut into small sizes of about 1 cm, after which they were air-dried under room temperature. It was ground to coarse powder using a mechanical blender (CF-158 Hammer Muhle 2,2 Kw 380 V-cissonius). The ground sample was used in formulating the experi-mental diets. The compositions of the experimental diets are presented in Table 1.

Table 1: Compositions of the experimental diets (%)

Ingredients	Diet 1	Diet 2	Diet 3
Maize	47.3	47.3	47.3
Soya bean meal	28.3	28.3	28.3
Palm kernel cake	17.7	17.7	17.7
Fish meal	3.0	3.0	3.0
Bone meal	3.0	3.0	3.0
Common salt	0.25	0.25	0.25
Lysine	0.10	0.10	0.10
Methionine	0.10	0.10	0.10
Premix	0.25	0.25	0.25
Total	100.0	100.0	100.0
Ginger Root, %	0	1.5	3.0
Calculated Crude protein	21.0	21.0	21.0
Calculated Energy (kcal/kg)	2840.0	2840.0	2840.0

Premix composition (per kg of diet): vitamin A, 12,500 IU; vitamin D3, 2500 IU; vitamin E, 50.00mg; vitamin K3, 2.50mg; vitamin B1, 3.00mg; vitamin B2, 6.00mg; vitamin B6, 6.00mg; niacin, 40mg; calcium pantothenate, 10mg; biotin, 0.08mg; vitamin B12, 0.25mg; folic acid, 1.00mg; chlorine chloride,300mg; manganese, 100mg; iron, 50mg; zinc, 45mg; copper, 2.00mg; iodine, 1.55mg; cobalt, 0.25mg; selenium, 0.10mg; antioxidant, 200mg.

Experimental design, birds and management

One hundred and fifty (150) day-old Marshal broiler chicks were purchased from a reputable hatchery in Ibadan, Oyo State, Nigeria. Two weeks pre-experimental period were used to acclimatize the broiler chicks to the experimental procedures. Thereafter, Ninety-nine (99) 2weeks old broilers were selected and randomly assigned to three treatments replicated three times with 11 birds per replicate in a completely randomized design feeding trial that lasted 56 days. They were managed on deep litter pens throughout the experimental period and were fed experimental diets with water supplied *ad libitum*. Routine management practices were also carried out appropriately. The 3 treatments consisted of 0%, 1.5%, and 3.0% ginger root meal supplemented diets, designated Diet 1, Diet 2 and Diet 3 respectively. Diet 1 served as the control. The experimental model is as follows:

$Y_{ij} = U + T_i + e_{ij}$

Where Y_{ij}= individual observation on the broiler characteristics.

μ= overall mean

T_i = treatment effect

e_{ij}= random error assumed to be independently, identically and normally distributed with zero means and constant variances.

Data collection

The initial body weights of the broilers were measured on arrival to the pen. Subsequently, body weights and other growth performance parameters were taken at weekly interval throughout the study. All weight measurements were done using electronic weighing scale (OHAUS Champ II). Weight gain was calculated from the difference between the final weight and initial weight. Feed intake and mortality were recorded while feed conversion ratio was calculated. At the end of the 56 days experiment, 3 birds were randomly sampled from each replicate and slaughtered. The internal organs,

abdominal fats, caeca, small intestines were collected and used for microbial load analysis. The carcass analyses were carried out immediately after dressing.

Microbial load determination

The method of serial dilution as described by [21] and [22] was used for microbial load determination. About 2.5g each of the caeca of the chicken samples were collected immediately after slaughter, cut into small sizes with a flame sterilized knife under aseptic conditions and transferred into well labeled sterile screw-capped bottles to which 22.5ml of sterile physiological saline solution was added. The bottles were shaken vigorously to homogenize its contents before being diluted in the serial dilution technique. Test ***Amaduruonye et al*** tubes of 9ml sterile physiological saline were set up and labeled from10^{-1} to$10^{-4.}$ Ten foto serial dilutions were performed by pipetting 1ml from the original bottle containing the respective samples into the tube labeled 10^{-1}. From this tube, 1ml was transferred to the next tube labeled 10^{-2} and mixed properly. This was repeated until the 4th tube for all the samples. After the dilutions, standard microbiological technique was used to spread the inoculums from each sample into freshly prepared nutrient agar. A sterile bent glass rod was used to spread out each inoculum. The plates were labeled accordingly and incubated at 37^0C for 48 hours. The colony count was performed after 48 hours of incubation. The total aerobic count was expressed as Colony Forming Unit per gram (CFU/g).

Statistical analysis

Data collected on different parameters were subjected to Analysis of Variance (ANOVA) in accordance with the methods of Steel *et al*. [23]. Significant means were separated using Duncan's New Multiple Range test [24].

Results and Discussion

The results of ginger root meal on the growth performance of the broilers are presented in Table 2.

Table 2: Growth Performance of broilers fed ginger root meal supplemented diets

Parameters	Diet 1 (0%)	Diet 2 (1.5%)	Diet 3 (3.0%)	SEM	Sig.
Final live weight (g/bird)	2400.0^a	2133.3^b	2100.0^b	58.8	*
Total Weight gain (g/bird)	2000.0^a	1733.3^b	1700.0^b	64.2	*
Daily feed intake (g/bird)	157.8^b	159.8^{ab}	161.9^a	1.16	*
Daily weight gain (g)	47.6^a	41.3^b	40.5^b	2.32	*
Feed conversion ratio	3.31^b	3.87^a	4.00^a	0.14	*
Mortality (%)	0.00^b	3.03^b	12.1^a	0.39	*

^{a,b}: Means with different superscripts along rows are significantly different (P<0.05). NS=Non-significant difference (P>0.05). SEM = standard error of treatment means.

From the results, final weight, total weight gain and daily weight gain were significantly higher (P<0.05) in the control group than the ginger treated groups. These parameters decreased as the level of ginger supplementation increased. The reduction in weights could be as a result of the reduction in fat content and fat deposition in the carcass of the ginger treated group (Table 3). On the other hand, feed intake, feed conversion ratio and mortality rate of the ginger supplemented

groups were significantly higher (P<0.05) than the control group. From the foregoing, the birds fed ginger root meal supplemented diets showed poor growth performance and higher mortality than those on the control diet.

The daily feed consumption of birds in diet 2 (159.8g) and diet 3 (161.9g) was similar and significantly higher (P<0.05) than those fed the control diet (157.8g). It increased as the level of ginger supplementation in the diets increased. This indicates that ginger stimulate appetite and has digestive properties, enhancing feed intake and digestion. This is attributed to the active compounds - gingerol and shagaol- found in ginger, which has appetizing and digestive properties. Ginger increase appetite and digestion by stimulating digestive juices such as bile, salivary, gastric, pancreatic and intestinal secretions [25, 26, 27]. This means that ginger can be introduced into diets to aid digestion and prevent constipation. The increase in feed intake observed in this study concurred with the findings of Ademola *et al.* [28], Zomrawi *et al*. [29] and Igbokwe *et al.* [30].

Birds fed diets with 0% ginger root meal supplementation had a significant (P<0.05) better feed conversion ratio than those fed 1.5% and 3.0% supplementation. The increase in feed conversion ratio of the ginger treated birds agreed with the findings of the previous workers [30,31] and they reported significantly higher feed conversion ratio (P<0.05) in ginger fed groups of broilers compared to control. However, birds showing lower feed conversion ratio expectedly had higher final body weight and daily weight gain as observed in this study. This is attributable to the ginger supplementation. It is most probably that the level of ginger root meal supplemented in diet 3 was too high. Thus lower levels of ginger root meal supplements in the diets of broilers may give better results.

Similarly, the birds in diet 3 had higher mortality than those in diets 1 and 2. Therefore, the mortalities observed in diet 3 might be attributed to the undesirable effects of ginger when used in excess. Inhalation of dust from ginger may cause allergy and sneezing [32]. Excess consumption of ginger may cause heartburn, gastric irritation, stomach upset, dyspepsia, diarrhea and eructation [10, 11, 14, 15, 16, 33, 34]. Excess consumption of ginger may induce necrosis of the liver, kidney and intestine [35, 36, 37, 38, 39].

The results of ginger root meal on the carcass analysis of the broilers are presented in Table 3.

Table 3: Carcass parts of broilers fed ginger root meal supplemented diets.

Parameters (%)	Diet 1 (0%)	Diet 2 (1.5%)	Diet 3 (3.0%)	SEM	Sig.
Dressing percentage	82.77	77.87	81.93	1.90	NS
Wings	7.82	8.24	7.68	0.20	NS
Drum stick	19.37	19.31	19.83	0.74	NS
Breast	13.74	12.75	15.44	0.59	NS
Back cut	20.79	22.12	20.66	0.84	NS
Thigh	17.73	17.69	17.15	0.41	NS
Abdominal fat	0.43[a]	0.20[b]	0.10[b]	0.59	*

[a,b]: Means with different superscripts along rows are significantly different (P<0.05). NS=Non-significant difference (P>0.05). SEM = standard error of treatment means.

The dressing percentage, wings, drum stick, breast, back cut, and thigh of the broilers fed 0%, 1.5% and 3.0% ginger supplementation were statistically similar. Thus, there were no significant difference (P>0.05) between the 0%, 1.5% and 3.0% ginger root meal supplemented diets on dressing percentage and components of the carcass. Dietary increase in the ginger root meal supplementation did not have any adverse effects on the sizes of the carcass part of the broiler birds. These results agreed with those of [29] that reported no significant difference in carcass characteristics of broilers fed diets supplemented with ginger root powder at 0.5%, 1% and 1.5%, and [31] that fed varying levels of ginger extracts.

Furthermore, birds fed 1.5% and 3% ginger supplementations showed a significant reduction (P<0.05) on abdominal fat when compared with the control. This means that ginger root meal was able to reduce the abdominal fats and by implication lowering the cholesterol and triglyceride levels on the carcass of these broilers at 1.5% and 3.0% supplementation. The reduction on the weight (Table 2) is attributable to the reduction in fat content on the carcass of these broilers. Although there were reductions in weights from the supplementation of ginger root meal on the broiler diets, these birds produced better quality meat and carcass (meat that has less fat content, low cholesterol and triglyceride content). Due to the health implications associated with the consumption of meats that are high in fats, cholesterol and triglycerides, it will be healthier, preferable and encouraging consuming meats produced from ginger root meal.

These findings confirmed the anti-lipidimic and hypo-lipidimic properties of ginger. The result observed in this study agreed with the findings of Ademola *et al.* [28], Valiollahi *et al.* [40] and Safa and Eltazi, [41] who reported that the addition of ginger and its essential oils to broiler diets reduced significantly the abdominal fat of the chicken. The lowering of fat contents on the broiler carcass by ginger root meal may find useful application in improving the cardiovascular health in humans.

The results of ginger root meal on the microbial load of the broilers are presented in Table 4.

Table 4: Microbial load of broilers fed ginger root meal supplemented diets.

Parameters (CFU/g) x 10^3	Diet 1 (0%)	Diet 2 (1.5%)	Diet 3 (3.0%)	SEM	Sig.
Small Intestine	125.3	159.3	172.0	11.5	NS
Caeca	225.3[a]	151.3[ab]	124.3[b]	18.7	*

[a,b]: Means with different superscripts along rows are significantly different (P<0.05). NS=Non-significant difference (P>0.05). SEM = standard error of treatment means.*CFU = Colony Forming Unit.

The intestinal microbial load analysis of the birds use in the study showed no significant differences (P>0.05) between the different treatments. This showed that ginger did not have any detrimental effect on the small intestinal micro flora. Enzymes are protein. Ginger stimulates the production of digestive enzymes, pancreatic enzymes, intestinal secretions and juices. These increased secretions might have increased the protein content of the digesta. This might be responsible for

the numerical increase observed in the microbial load of the intestine.

Furthermore, there was a significant decrease ($P<0.05$) in the microbial load of the caeca of the 1.5% and 3% ginger supplemented groups compared to the control group. The decrease in the caeca microbial load indicates the antimicrobial property of ginger root meal which, might be attributed to the presence of alkaloids, camphene, glycosides, saponins, terpenoids, methoxymethyl, propionate, phenllandrene, gingerol, borneol, gingerdiol etc found in ginger-- phenolic compounds that have antiseptic, bactericidal and disinfectant properties [7, 8, 9]. This means that ginger can effectively be used in animal production to reduce the population of pathogenic microorganisms; thereby reducing the prevalence of disease occurrence.

The findings agreed with the documentation of previous workers [42, 43] that the addition of essential oil of ginger to poultry diets efficiently controlled *salmonella, E. coli, shigella* species and other bacteria in poultry. Furthermore, the efficacy of ginger as an effective antimicrobial agent against the growth of both gram-positive and gram-negative bacteria, such as *salmonella, E. coli, salmonella, shigella, typhinurium, proteus, vulgaris, Haemophilus influenzae, Pseudomonas aeruginosa and streptococcus* species were previously documented [44, 45, 46, 47].

Conclusion and Application

It could be concluded that:

1. Ginger stimulates appetite, increased feed intake, feed digestion and feed conversion ratio. This means that ginger can be introduced into diets to improve feed intake, digestion and to prevent constipation.
2. Ginger can be used as a natural antibiotic probiotics in animal production to reduce the population of pathogenic microorganisms; thereby reducing the prevalence of disease occurrence.
3. Ginger can be used to regulate excessive fat deposition, triglyceride and cholesterol levels in humans and animal.

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