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ORIGINAL RESEARCH ARTICLE

Growth Performance and Nutrients Digestibility of Broiler Starter Chicks fed Diets Supplemented with Ginger Meal (*Zingiber officinale*) and Organic Acid

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ABSTRACT

This study investigated the effect of diets containing ginger root meal (GRM) supplemented with and without organic acid (OA) on growth performance and nutrients digestibility of broiler chicks. A total of two hundred and fifty-two (252) day old broiler chicks in a 4 - week feeding trial were allocated to seven dietary treatments replicated three times with 12 birds per replicate in a Completely Randomized Design. The diets formulated included T1 (0 % GRM and OA) which served as control and other diets 2, 3, 4, 5, 6 and 7 respectively which contained GRM at 15g (T2), 30g (T3) and 45g (T4) with and without OA supplementation. Feed and water were given ad libitum. Results showed that there were no significant (P>0.05) differences in final weight, weight gain, and feed conversion ratio of birds across all the treatment groups. However, total feed intake and daily feed intake were significantly (P<0.05) higher in birds fed the control diet (988.23g, 35.39g) but were similar to those fed GRM based diets T2, T3and T4 without OA when compared to those supplemented diets. Higher dry matter, crude protein and crude fibre digestibility were observed in birds fed diets without OA compared to the group supplemented with OA. Ether extract and ash digestibility were significantly (P<0.05) lower in diets T3 and T4 without OA compared to those in other treatment groups. However, NFE digestibility was statistically (P>0.05) similar in birds fed un-supplemented diets T1, T2 and T3 as well as T6 supplemented with OA. However, diets T4, T5 and T7, respectively had the least values; (71.29, 70.97 and 69.31%), respectively. It was therefore concluded that diets containing GRM without organic acid improved performance and nutrients digestibility of broiler chickens without any threat to their health status.

Keywords: Broiler, performance, ginger meal, organic acid

INTRODUCTION

Research has shown globally that poultry is the fastest growing livestock sector especially in developing countries; most especially, because of sustainable and rapid production of high-quality protein as well as its ability to meet the ever-increasing demand of the Nigerian teeming populace due to its short generation interval (Chang, 2007; Nkwocha, *et al.*, 2014). However, expansion of the poultry industry in Nigeria and most developing countries of Africa has been hampered due to acute shortage and high cost of feed ingredients especially protein and energy sources among many other challenges (Fasuyi, 2005). Researchers are therefore looking for cheap, available and safe alternative sources of protein and energy.

In addition, the poultry production sectors are also faced with the problem of antibiotic resistant pathogens due to unwise and excessive use of antibiotics. Consequently, removal of antibiotics has led to poultry performance problems, feed conversion increases and a rise in the incidence of certain animal diseases, such as subclinical necrotic enteritis (Dibner and Richards, 2005). Hence, scientists are exploring the use of phytobiotics as well as other natural antimicrobial ingredients such as organic acids, enzymes, probiotics, prebiotics, herbs, essemtial oils and immune-stimulants as feed additives in poultry production.

Phytobiotics (PFAs) are plant derived products added to feed in order to enhance the performance of livestock through the

improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut (Balunas and Kinghorn, 2005). The positive effects of these feed supplements on broiler performance, carcass characteristics and meat quality have been demonstrated **(**Safa and Eltazi, 2014). Evidence also showed that gram positive and gram-negative food borne bacteria, yeast and mould could be inhibited by garlic, ginger, onion, cinnamon, cloves, thyme and other spices (Igbokwe *et al.,* 2013).

Ginger (*Zingiber officinale Roscoe*) is a perennial plant, and is found throughout most of the tropics. It contains several bioactive components that have anti-oxidant, anti-inflammatory, anti-carcinogenic and antibacterial property (Susdarashan *et al.*, 2010). Herbs (2011) reported that ginger contains volatile oils like borneol, camphene, citral, eucalyptol, linalool, phenllandrene, zingiberine, zingiberol (gingerol, zingirone and shogaol) and resin. Some gingers' medicinal properties are contained in the chemicals responsible for the taste; the most noteworthy being gingerol and shogaol. Organic acids are also used in poultry to lower the pH of intestinal tract which favours the proliferation of beneficial microbes and suppresses pathogenic microbes thus eliminating the need for antibiotics.

Organic acids are used in poultry to lower the pH of intestinal tract which favours the proliferation of beneficial microbes and suppresses pathogenic microbes, thus eliminating the need for antibiotics. Antibiotics removal has led to poultry performance problems, feed conversion increases and a rise in the incidence of certain animal diseases, such as (subclinical) necrotic enteritis (Dibner and Richards, 2005). Such a situation has compelled the researchers to explore the utility of other non-therapeutic alternatives like organic acids, enzymes, probiotics, prebiotics, herbs, essential oils and immune-stimulants as feed additives in poultry production. Several studies have demonstrated that organic acids could stimulate the natural immune response in poultry. The present research therefore aims at determining the effect of feeding diets supplemented with ginger Meal (*Zingiber officinale*) and organic acids on growth performance and nutrients digestibility of broiler starter chicks.

MATERIALS AND METHODS

The research was carried out at the Poultry Unit of the Teaching and Research Farm, Taraba State University, Jalingo and it lasted for a period of four weeks. Jalingo city is located within the Northern Guinea Savannah zone of Nigeria. It lies between latitude 80 500 N and longitude 110 310 E of the equator with anelevation of 364m above sea level. The area is characterized by a rainfall period of April - October and a dry season period of November - March. The annual rainfall is between 1000 – 1500 mm with an average minimum temperature of 38^{o}c and maximum of 41^{o}c depending on the season (Taraba State Dairy, 2008).

A total of two hundred and fifty two (252) day old unsexed broiler chicks of commercial strain (Marshall Broiler) were purchased from a reputable hatchery. The chicks were weighed and allotted to seven dietary treatment groups of three replicates each in a completely randomized design. Each replicate consists of 12 chicks and 36 birds per treatment group. The birds were brooded for two weeks. Birds were reared on deep litter housing system. Routine vaccinations and medications were strictly followed. Feed and water were supplied *ad libitum*. Ginger root used for this study was purchased from commercial dealers at Kasuwa mata main market Jalingo while the organic acid was purchased from Nutrivitas Limited, 27 Morrison Crescent Oregun Ikeja Lagos. Organic acid is supplemented in broiler diets at recommended rate of 2.5 kg/ton of feed. The fresh ginger roots procured were washed and sliced for effective drying. The ginger roots undergone air drying for 10 days in an open ventilated space away from sunlight. The air-dried ginger roots were then milled into fine particles using a local milling machine. The ground ginger meal was stored in an air tight container at room temperature (23.1^{0}C – 24.6^{0}C). The experimental diets were formulated to meet the NRC (1994) minimum

nutrient requirements. The diets consisted of maize-based diet T1 (control), while other diets designated as T2, T3, T4, T5, T6 and T7 supplemented with 15, 30 and 45g of ginger with and without organic acid supplementation. The organic acid was included at the rate of 2.5 kg/ton of feed for the supplemented diets (T5, T6 and T7). The composition of experimental diets is presented in Table 1.

Data Collection

Performance characteristics

The initial weight of the birds was taken on arrival. The live weight of the birds as well as the feed consumption of each replicate was measured weekly. Feed conversion ratio for each replicate was determined by dividing the feed intake by the weight gain.

$$\text{Feed intake/bird (g)} = \frac{\text{Quantity of feed fed} - \text{Quantity of feed left over}}{\text{Number of birds} \times 28 \text{ days}}$$

$$\text{Daily weight gain (g)} = \frac{\text{Final live weight} - \text{Initial weight}}{\text{Number of birds} \times 28 \text{ days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$$

Table1: Composition of Broiler Starter Chicks Fed Ginger Root Meal Supplemented Diets With and Without Organic Acid (0-4 weeks)

Ingredients	1 Control	2 15g GRM	3 30g GRM	4 45g GRM	5 15g GRM + OA	6 30g GRM + OA	7 45g GRM + OA
Maize	52.50	52.50	52.50	52.50	52.50	52.50	52.50
Maize offal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Soybean meal	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Groundnut cake	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Common Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Vit. Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total (%)	100	100	100	100	100	100	100
Organic Acids	-	-	-	-	+	+	+
Calculated Analysis							
ME (kCal/kg)	2916.21	2916.21	2916.21	2916.21	2916.21	2916.21	2916.21
Crude protein (%)	23.05	23.05	23.05	23.05	23.05	23.05	23.05
Crude Fibre (%)	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Ether Extract (%)	4.65	4.65	4.65	4.65	4.65	4.65	4.65
Calcium (%)	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Avail Phosphorus (%)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Lysine (%)	1.22	1.22	1.22	1.22	1.22	1.22	1.22
Methionine (%)	0.56	0.56	0.56	0.56	0.56	0.56	0.56

Biomix chick premix provided per kg of diet: Vit A. 10,000 I.U; Vit D_3 32,000 I.U; Vit E 23,000 mg; Vit K 2,000mg; Vit. B_1 1,800 mg; Vit. B_2 5,000mg; Pantothenic acid 7,500mg; Vit.B_{12} 150mg; Folic acid 750mg; Biotin 100mg; Choline chloride; 300,000mg; Cobalt 3,000mg; Iodine 1,000mg; Iron 20,000mg; Manganese 40,000mg; Selenium 200mg; Zinc 30,000mg; Antioxidant 1250mg. ME = Metabolizable Energy

Nutrients Digestibility

Metabolic trial was conducted at the 4th week of the study. A bird per replicate was randomly selected and housed separately in appropriate metabolic cage fitted with feeder and drinker. The birds were allowed to acclimatize for two days before the commencement of 5 days feeding and excreta collection. A known weight of feed was offered and excreta collected were oven dried at 60°C and used for analysis. The feeds and dried excreta were analyzed for dry matter, crude protein, ether extract, crude fibre and ash using standard method of AOAC (2000).

Statistical Analysis

Data obtained were subjected to analysis of variance using General Linear Procedure of Statistical Analytical System, SAS (2008). Significant treatment means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The result of effect of supplemental ginger root meal (GRM) with and without organic acid (OA) on growth performance of broiler starter chicks is presented in Table 2. From the result, no significant effect (P>0.05) of dietary treatments were observed in all the parameters measured except total feed intake, daily feed intake and mortality (%). The final weight (FW), total weight gain (TWG) and daily weight gain (DWG) of birds were statistically (P>0.05) similar across all the treatments, although those on diet T4 containing 45g GRM without OA supplementation were numerically higher in terms of FW (944.63 g), TWG (590.50 g) and DWG (21.09 g) compared to those in other treatment groups. The lack of significant effect of treatments observed among birds may suggest that ginger root meal supplemented with and without organic acid in the diets of broilers did not adversely affect the development and performance of birds. This agrees with Onu (2010) and Habibollah (2013) who reported no detrimental effect of ginger powder on the performance of broilers.

On the other hand, total feed intake (TFI) and daily feed intake (DFI), respectively differed significantly (P<0.05) and followed similar trend across all the treatment groups. However, no significant (P>0.05) effect of ginger supplementation up to 45g/kg was observed in feed intake of birds fed the control diet (988.23, 35.39 g) and those in T2 containing 15 g GRM (901.93, 32.21 g), T3 containing 30 g GRM (968.91, 34.60 g) and T4 containing 45 g GRM (920.73, 32.88 g) without OA supplementation when compared to those on supplemented diets. The increased daily feed consumption observed in birds fed diets T1, T2, T3 and T4 not supplemented with organic acids stimulate appetite and has digestive properties, enhancing feed intake. Platel and Scrinivasan (2000) in their findings reported that ginger increased appetite by stimulating digestive juices such as bile, salivary, gastric, pancreatic and internal secretions.

The increase in feed intake observed in this study agreed with the findings of Ademola *et al.* (2009) who reported increase in feed intake of broilers fed diets containing ginger. This increased feed consumption may be attributed to the improved palatability of the diets. This observation agrees with the findings of Nidaulah *et al*. (2010) who reported that smell and taste were critical traits in food selection. Feed conversion ratio (FCR) differed non-significantly (P>0.05) across all the treatments. The similarity observed in FCR of birds across the dietary treatments could be attributed to balance and improved rate of utilization of the dietary nutrients and conversion to gains. This observation agrees with the findings of Gebhart and Kabanov (2001) who reported that better feed conversion ratio signified that more feed was retained in the animals and less waste to the environment. Mortality (%) was observed in birds across all the dietary treatments except those in the control group (T1). However, the mortality was mild and may not possibly have been as a result of the ginger.

Nutrients Digestibility

The result of the apparent nutrients digestibility trials of birds fed diets containing ginger root meal (GRM) supplemented with and without organic acid (OA) is presented in Table 3. The result showed significant effect (P<0.05) of dietary inclusion of GRM with and without OA

on the apparent nutrients digestibility by broiler chickens. Percentage dry matter and crude protein digestibility by birds fed diets T1 (control), T2 (15 g GRM) and T3 (30 g GRM) without organic acid (OA) were comparable but significantly (P<0.050) higher than those on supplemented diets. It was observed that the dry matter digestibility of birds fed diets T1 (84.29 %) T2 (82.77 %) and T3 (81.00 %), respectively without OA supplementation were statistically (P<0.05) better compared to those on OA supplemented diets. The observed similarity and higher percentage dry matter digestibility observed in birds across treatments T1 (control), T2 and T3 compared to those of other dietary treatments may be attributed to improved feed intake and enhanced taste.

Percentage digestibility of crude protein by birds was statistically higher (P<0.05) in diets T2 (93.55 %) and T3 (92.07 %) but similar to those in T1 (91.83 %), T5 (91.52 %) and T6 (91.40 %). However, birds on T4 and T7 had the least CP digestibility values (85.99 % and 88.57%) respectively. The higher similarity in CP digestibility by birds fed T1, T2, T3, T5 and T6 compared to those in other treatment groups may be an indication of equal and balanced nutrients utilization by the birds.

Crude fibre (CF) digestibility by birds fed diet T2 (88.69 %) was similar to those on diet T1 (87.34 %), T3 (84.75 %), T4 (86.00 %) and T6 (85.98 %) but significantly (P<0.05) higher compared to those in other treatment groups. The CF digestibility values observed in birds fed diets T1, T3, T4 and T6 this is an indication of improved nutritional value of the diets. However, the ether extract digestibility by birds were statistically (P>0.05) similar across all the dietary treatments except those in T3 group (46.00%) which had the lowest value. This may also suggest balanced nutrients utilization. The percentage ash digestibility was similar but significantly (P<0.05) higher in birds across all the treatment groups except those on T4 which had the least value (80.57 %). The higher digestibility of ash observed in birds fed the diets T1, T2, T3, T5, T6, T7 and T8 compared to those in T4 group was an indication of balanced utilization of mineral nutrients across the dietary treatments.

Nitrogen free extract digestibility by birds was significantly (P<0.05) higher in birds fed diets T1 (76.88 %), T2 (74.72 %), T3 (75.22 %) and T6 (80.70 %) compared to those in other treatments. This observation may suggest that ginger meal produced more soluble fraction in the diets and also enhanced the digestibility of the soluble carbohydrates for improved production.

CONCLUSION

In view of the results obtained in this study, it was observed that organic acid supplementation of ginger meal based diets had no significant effect on the performance and nutrients digestibility of broiler chickens. In addition, feeding of diets supplemented with ginger meal had no adverse effect on the performance and nutrients utilization of broilers. It was therefore concluded that inclusion of ginger root meal without organic acid supplementation improved performance and nutrients digestibility of broilers. Hence, organic acid supplementation of broiler diets may not be necessary for economic reasons.

CONFLICT OF INTEREST

The authors declared that there was no conflict of interest in the course of this research.

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Table 2: Growth Performance of Starter Broiler Chicks Fed Ginger Root Meal Supplemented Diets With and Without Organic Acid (0 – 4 weeks)

Parameters	Dietary treatments							
	T1 (control)	T2 15g GRM	T3 30g GRM	T4 45g GRM	T5 15g GRM + OA	T6 30g GRM + OA	T7 45g GRM + OA	SEM
Initial Weight (g/bird)	153.89	152.43	153.86	154.13	152.63	154.13	154.13	0.00^{NS}
Final Weight (g/bird)	733.33	733.23	731.67	744.63	718.13	698.33	693.93	47.61^{NS}
Total Weight Gain (g/bird)	579.44	580.80	577.81	590.50	565.50	544.20	539.80	46.70^{NS}
Daily Weight Gain (g/bird/day)	20.69	20.75	20.64	21.09	20.19	19.44	19.28	1.67^{NS}
Total Feed Intake (g/bird)	988.23^{a}	901.93^{abc}	968.91^{a}	920.73^{abc}	823.50^{bc}	886.63^{bc}	772.73^{c}	79.60*
Daily Feed Intake (g/bird/day)	35.39^{a}	32.21^{abc}	34.60^{ab}	32.88^{abc}	29.40^{bc}	31.66^{bc}	27.59^{c}	2.31*
FCR	1.71	1.57	1.67`	1.55	1.45	1.62	1.42	0.66^{NS}
Mortality (%)	0.00^{b}	5.53^{ab}	2.77^{ab}	2.77^{ab}	10.99^{a}	11.13^{a}	2.77^{ab}	0.00*

[ab] Mean in the same row with different superscripts are significantly different (P<0.05), SEM= Standard Error of Mean, FCR= Feed Conversion Ratio, NS= Not Significant

Table 3: Effects of Ginger Root Meal Supplemented Diets with and without Organic Acid on Nutrients Digestibility by Broiler Chicks (0 – 4weeks).

Parameters (%)	T1 (Control)	T2 15g GRM	T3 30g GRM	T4 45g GRM	T5 15g GRM + OA	T6 30 GRM + OA	T7 45 GRM + OA	SEM
Dry Matter	84.29^{a}	82.77^{a}	81.00^{ab}	77.59^{b}	78.97^{b}	79.17^{b}	78.13^{b}	1.84*
Crude Protein	91.83^{ab}	93.55^{a}	92.07^{a}	85.99^{c}	91.52^{ab}	91.40^{ab}	88.57^{bc}	1.17*
Crude Fibre	87.34^{ab}	88.69^{a}	84.75^{ab}	86.00^{ab}	83.56^{b}	85.98^{ab}	82.56^{b}	1.83*
Ether Extract	70.20^{a}	62.00^{ab}	46.09^{b}	53.43^{ab}	59.54^{ab}	52.70^{ab}	58.07^{ab}	6.09*
Ash	83.53^{ab}	85.01^{ab}	86.29^{a}	80.57^{b}	85.68^{ab}	82.94^{ab}	86.68^{a}	3.36*
NFE	76.88^{ab}	74.72^{ab}	75.22^{ab}	71.29^{b}	70.97^{b}	80.70^{a}	69.31^{b}	2.61*

NFE = Nitrogen Free Extract, abc = Means with different superscripts are significantly different (P<0.05), SEM = Standard Error of Means, GRM = Ginger Root Meal, OA = Organic Acid

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