Dietary Effect of Yellow and White Ginger (*Zingiber officinale*) on Growth Performance, Nutrient Utilization and Production Cost of Broiler Chicks

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Abstract

The study was conducted to evaluate the dietary effect of yellow and white ginger (Z*ingiber officinale*) on growth performance, nutrient utilization and production cost of broiler chicks. Four (4) week feeding trial was carried out using day-old *Abor Acre plus* strain of broiler chicks. Four groups of 36 birds each were fed diets that contained 0.25 and 0.30 % yellow and white ginger in a 2x2 factorial design consists of two inclusion levels (0.25 and 0.30 %) and two ginger varieties (yellow and white ginger powder). Data were collected on growth performance, nutrient utilization and economic of production. Significant ($p<0.05$) increased was observed in average final weight (815.19 to 846.23 g) and average daily weight gain (27.72 to 28.83 g) when white ginger increased from 0.25 % - 0.30 % in the diets. While for yellow ginger; the effect was not significantly ($p>0.05$) different as the levels increased from 0.25 % - 0.30 %. Except for nitrogen free extract; neither yellow nor white ginger had a significant effect on all the parameter observed while the increased levels of both yellow and white ginger from 0.25 % to 0.30 % significantly ($p<0.05$) improved the utilization of crude fibre and ether extract. Both yellow and white gingers usage in chicks' diet had no detrimental effect on the growth performance and production cost. It is concluded that supplementation of yellow and white ginger at 0.25 % improves the performance of broiler chicks but white ginger showed more superiority when added up to 0.30 % level as feed additives in broiler chicks.

Keywords: yellow and white ginger, growth, digestibility, cost, broiler chicks

Introduction

Feed additives are natural or synthetic products used in animal nutrition for purposes of improving the quality of feed or to improve the animal's performance and health (Hashemi and Davoodi, 2010). Beneficial properties of bioactive plant constituents in animal nutrition may comprise the stimulation of appetite and feed intake and enhancement of endogenous digestive enzyme secretion, stimulation of immune response and antibacterial, antiviral and antioxidants (Zhang *et al.,* 2016). Ginger as natural growth promoters can be used as an alternative to common artificial growth promoters like an antibiotic.

Ginger contains about 12 antioxidant constituents, the combined actions of which have been regarded as being more powerful

than vitamin C (Davies, 2011). The nutrients found in ginger include lipids, amino acids, minerals and vitamins especially phosphorus, potassium, riboflavin and vitamin C. Ginger also contains anti-nutritional factors especially tannin, phytic acid and cyanide, but the low level at which they occur makes ginger safe for consumption by animals (Adanlawo and Dairo, 2017). Ginger has been shown to have several biological effects, exhibiting anti-inflammatory, anti-oxidant and hypolipidaemic activities (Igbal *et al.,* 2003).

Onu (2010) reported that the addition of ginger at 0.25 % in the basal diet of broiler chicks resulted in improved weight gain and feed conversion ratio. Zhao *et al.* (2011) reported that ginger enhances animal nutrient digestion and absorption because of its positive effect on gastric secretion and digestive enzyme activities. Al-Homidan (2005) observed a reduced growth rate in starter broilers (1 to 4 wk) when ginger was fed at the rate of 6 g/kg diet and at the 6th week of age (Moorthy *et al.,* 2009) which was attributed to the toxic effect of this compound (Zhang *et al.,* 2009).

Worldwide over 25 varieties of ginger are grown (FAO, 2014). Most varieties have not been properly characterized. Varieties differ in the size of the rhizome, flavour, aroma, colour and fibre content (Greathead, 2003). In Nigeria, white and yellow gingers are readily and cheaply available, however, yellow ginger effects had only been extensively investigated with respect to broiler chicken (FAO, 2010); there is a paucity of information on the use of white ginger as a feed additive in broiler chickens. Therefore, there is a need to investigate the potential effect of white ginger and yellow ginger on the performance of broiler chickens hence, the need for this study

Materials and methods

Experimental site

The study was intensively conducted at the Poultry House of the Livestock unit, Teaching and Research Farm, Federal University of Agriculture, Makurdi, Benue State, Nigeria. Makurdi is located between latitude 7^{o}44′N and longitude 8^{o}21′E in the Guinea Savanna Zone of West Africa. The area has an annual rainfall season between 6 - 8 months (March - October) ranging from 508 to 1016mm with minimum temperatures of 22.8^{o}C and maximum temperature of 40.03^{o}C respectively. The relative humidity ranges between 37.30 % and 59.20 % (TAC, 2021).

Collection and processing of gingers

Fresh yellow and white gingers rhizomes were separately procured from the local market within Makurdi town, Benue State, Nigeria. The fresh rhizomes were washed in water to remove adhering soil and chopped into smaller pieces using sharp knives. The chopped rhizomes were sun-dried on a flat and clean concrete floor to the saved moisture content. It was ground using a hammer mill of 2mm to obtain ginger powder. The samples were airtight for subsequent laboratory analysis and feed mixing as additive.

Management and disease control

The poultry house and all other equipment were thoroughly washed and disinfected 12 days before the arrival of the chicks. The litter material (wood shavings) was mould free and placed in the experimental pen before the arrival of the chicks while the whole house was fumigated to avoid any forms of contamination. The pen was kept warm 24 hours before the chicks' arrived to maintain a temperature of 85 to 90 ^{o}F. The brooder temperature was

adjusted according to the needs and their behaviours of the chicks. The birds were kept intensively and stocked at 12 birds/ m^2. They were fed on formulated experimental starter (0-4 weeks) diets. Feed and water were supplied *ad-libitum* throughout the experimental period.

Experimental diets and design

One hundred and forty-four (144) unsexed day-old *Abor acre plus* broiler strain chicks purchased from a reputable hatchery in Ibadan, Oyo State, Nigeria were used for this experiment. The birds were randomly distributed into four dietary treatments in a 2 x 2 factorial arrangement with two levels of ginger inclusion (0.25 % and 0.30 %) and two ginger varieties (yellow and white) with each having three replicates with 12 chicks per replicate. All the diets were iso-nitrogenous and iso-caloric as shown in Table 1 and were formulated to meet standard nutrient requirements of broiler chicks according to NRC (1994) from day 1 to 28 (Starter phase).

Growth performance data collection

Data were collected weekly on feed intake, body weight and weight gain. Feed intake was calculated as quantity difference of feed given and leftover after 24 hours. Weight gain was determined as the difference in the weight of the birds after 28 days period. Feed: weight gain ratio was calculated as the feed intake per weight gain.

Production cost

The cost of feed was calculated from the cost of ingredients used in feed preparation. Feed cost per weight gain was calculated by multiplying the feed cost per kg by total feed intake divided by total weight gain. Feed cost/chick was calculated by multiplying feed intake per day by the number of days multiplied by feed cost per kilogram. Feed cost per weight gain was calculated by multiplying the feed cost per kg diet by feed conversion ratio. Operational cost per bird was calculated by adding all other expenses except expenses on feed and broiler chicks. The total cost of production was calculated by adding the cost of day-old chick, feed cost per chick and operational cost. Feed cost as a percentage of total production cost was calculated by dividing the cost of feed per kg by the total cost of production multiplied by a hundred.

Nutrient digestibility

Nutrient digestibility evaluation was done at the end of week three (3) and terminated at the end of week four (4). Two birds per replicate group were selected and transferred into metabolic cages. A 3 days acclimatization period was allowed for the birds, and the respective diets were offered to the birds. Daily feed intake and daily faecal output were recorded for 4 days. The droppings were collected per replicate once daily at 8:00 am, weighed and dried in an oven at 70 °C to constant weight. Dried excreta were bulked and ground, experimental diets and faecal samples were used to determine their respective proximate constituent according to AOAC (2006), while the metabolizable energy was calculated using the equation; 37 x % CP + 81.1 x % EE + 35.5 x % NFE (Pauzenga, 1985).

Table 1. Gross composition of the experimental broiler chicks' diets

Ginger varieties	Yellow ginger		White ginger	
Inclusion levels (%)	0.25	0.30	0.25	0.30
Ingredients (kg)				
Yellow maize	53.00	53.00	53.00	53.00
Soya bean meal	30.30	30.30	30.30	30.30
Groundnut cake	4.00	4.00	4.00	4.00
BDG	2.50	2.50	2.50	2.50
Rice bran	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Blood meal	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00
L-Lysine	0.25	0.25	0.25	0.25
Herbo-Methionine	0.20	0.20	0.20	0.20
Vitamin/mineral premix*	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Rhizomes	0.25	0.30	0.25	0.30
Total	100	100	100	100
Calculated analysis				
ME (Kcal/kg)	2943	2943	2943	2943
Crude protein (%)	23.24	23.24	23.24	23.24
Crude fibre (%)	4.00	4.00	4.00	4.00
Ether extract (%)	4.84	4.84	4.84	4.84
Lysine (%)	1.48	1.48	1.48	1.48
Methionine (%)	0.54	0.54	0.54	0.54
Calcium (%)	1.29	1.29	1.29	1.29
Available Ph (%)	0.71	0.71	0.71	0.71

*To provide the following per kg of diet vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E- 30,000IU, Vitamin K3,000mg, Vitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B6- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg, Folic acid 2,000mg, choline 300,000mg, Iron 60,000mg, manganese 80,000mg, copper 25,000mg, Zinc 80,000mg cobalt 150mg, Iodine 500mg. (feed formulation was done using the feedwin software application) ME – metabolizable energy; BDG - Brewer dried grain; Ph - Phosphorus

Statistical analysis

All generated data were subjected to 2 – way analysis of variance (ANOVA) using the SAS (2008) software package and the means of the parameters which were significantly different ($P<0.05$) were separated using Duncan's Multiple Range Test (DMRT).

Results and discussions

The effect of yellow and white ginger on growth performance of broiler chicks is presented in Table 2. All groups of broiler chicks had an initial weight of 39.00 g.

Table 2. Effect of yellow and white ginger on growth performance of broiler chicks

Parameter (g)	AIW	AFW	ADWG	ADFI	FCR	Mortality (%)
Ginger varieties						
YG	39.00	821.77[b]	27.96[b]	45.59	1.64	3.33
WG	39.00	839.65[a]	28.60[a]	45.34	1.59	0.00
Inclusion levels (%)						
0.25	39.00	815.19[b]	27.72[b]	44.67	1.62	0.33
0.30	39.00	846.23[a]	28.83[a]	46.26	1.61	0.00
Interaction (YG*WG)	NS	*	*	NS	NS	NS
SEM	0.00	18.58	0.66	0.92	0.04	1.67

[ab]Means within each column with different superscripts are significantly different ($p < 0.05$). ns – not Significantly different ($P>0.05$); * Significantly different ($P<0.05$). AIW = average initial weight; AFW = average final weight; ADWG = average daily weight gain; ADFI = average daily feed intake; FCR = feed conversion ratio; SEM = standard error of mean; YG = Yellow ginger; WG = White ginger

Average daily feed intake, feed conversion ratio and percentage mortality were not affected by the ginger varieties ($P>0.005$). This may indicate that the addition of white and yellow ginger in the diet of broiler chicks had no adverse effect on palatability, acceptability and survivability. The non-significance differences observed in this study confirmed the findings of Ahmed *et al.* (2014); Al-Khalifa *et al.* (2018); Duwa *et al. (*2020) who observed that inclusion of ginger powder in the diet of broiler chickens did not have significant effect on average daily feed intake, FCR and mortality. However, Thejanuo *et al*. (2019), Karanguja *et al*. (2016), Oleforuh *et al*. (2014) reported significant differences on feed intake and feed conversion ratio when broiler chickens were fed diets supplemented ginger powder. White ginger powder significantly improved average final weight and daily weight gain when inclusion levels increased from 0.25 – 0.30 %, this suggests that inclusion level at 0.30 % may be appropriate for optimal performance in broiler chick diet. The improvement observed in average final weight and daily weight gain may be attributed to the beneficial properties of the ginger materials which influence the secretion of digestive fluids. Also, the possible mechanisms of action of ginger for growth promotion include changes in the intestinal microbiota, increased digestibility and nutrient absorption; enhanced nitrogen absorption, improvement of the immune response, morphological and histological modifications of the gastrointestinal tract and antioxidant activity (Zhang *et al.*, 2016). The increase in average final weight and daily weight gain with increased in inclusion levels of ginger in the diet of broiler chickens confirmed the reported of Thejanuo *et al*. (2019). Onu (2010) observed that ginger at 0.25 % in the diet of broiler chicks improved the weight gain.

The result observed for nutrient utilisation (Table 3) showed that ginger varieties had no effect ($P>0.05$) on all the parameter observed except nitrogen free extract which was significantly ($P<0.05$) improved by addition of white ginger. The result also showed that inclusion level at 0.30 % significantly ($P<0.05$) improved the utilization of crude fibre and ether extract. Significant ($P<0.05$) effect recorded for crude fibre and ether extract with increased inclusion level up to 0.30 % indicates that

broiler chick can tolerate up to 0.30 % both ginger varieties in their diet thereby making the addition of 0.30 % of the two ginger varieties a potential option in broiler chick diet. Significant increased observed for ether extract with increased in the levels of inclusion may be associated presence of phenolic compounds, flavonoids and terpenoids which protect feed, tissues and cells against the deleterious effect of autoxidation reactions. Significant effect observed for nitrogen free extract could be attributed to the stimulation effect of digestive enzymes by bioactive compounds of ginger. Platel and Srinivasan (2000) reported that phytogenics enhanced the activity of amylase, trypsin and chymotrypsin by 32-51 %, 63-81 % and 12-38 % respectively. Ginger was reported to enhance pancreatic disaccharides, sucrose and maltase activities in rat (Platel and Srinivasan, 1996) which was reported to have favorable influence on gut function, which is the primary mode of action for growth promoting feed additives (Windisch e*t al*., 2008).

Economics of production of the broiler chicks fed diets containing yellow and white ginger powder (Table 4) showed that feed cost per kg increased with increased levels of ginger varieties from 0.25 % - 0.30 %. This was attributed to the additional cost of the ginger powder with increased in inclusion levels. Feed cost per chick increased with increased in inclusion levels from 0.25 to 0.30 % was as a result of palatability/acceptability of the two ginger varieties in the diets resulted in higher feed intake. Feed cost per weight gain was higher on chicks fed 0.25 % for both yellow and white ginger. This was attributed to higher feed consumed by the birds fed 0.25 % yellow and white ginger but less utilization efficiency compared to the birds fed 0.30 % yellow and white ginger. The major concern of the farmer is how well the animals utilised or convert the feed consumed into the body flesh. Therefore, the lower the feed cost per weight gain, the better it is in terms of profit maximization. Higher total cost of production recorded on chicks fed 0.30 % yellow ginger was as a result of higher feed intake resulted to the higher feed cost per chick. Higher feed intake and feed cost per kilogram observed on birds fed.

Table 3. Effect of yellow and white ginger on nutrient digestibility of broiler chicks

Treatments	DM (%)	CP (%)	CF (%)	EE (%)	NFE (%)
Ginger varieties					
YG	69.80	70.82	67.80	67.87	69.94[a]
WG	66.20	68.50	67.77	67.36	64.52[b]
Inclusion levels (%)					
0.25	67.84	68.70	65.16[b]	65.50[b]	67.85
0.30	68.17	70.63	70.16[a]	69.75[a]	66.62
Interaction (YG*WG)	NS	NS	NS	NS	NS
SEM	1.08	0.99	1.25	1.06	1.33

[a,b] Means within each column with different superscripts are significantly different (P< 0.05). ns – not Significantly different (P>0.05); * Significantly different (P<0.05). DM = Dry matter; CP = Crude protein; CF = Crude fibre; EE = Ether extract; NFE = Nitrogen free extract; SEM = standard error of mean; YG = Yellow ginger; WG = White ginger

Table 4. Production cost of broiler chicks fed yellow and white gingers powder

Ginger varieties		YG		WG	
Inclusion levels		0.25 %	0.30 %	0.25 %	0.30 %
Economic Indices					
C of DOC	($/chick)	0.44	0.44	0.44	0.44
FC	($/kg)	0.55	0.56	0.55	0.56
FC/chick	($/kg)	0.69	0.70	0.69	0.69
FC/WG	($/kg)	0.86	0.83	0.83	0.82
OPC	($/chick)	0.16	0.16	0.16	0.16
TCP	($/chick)	1.29	1.30	1.29	1.30
FC	(% TCP)	0.12	0.11	0.11	0.11

FC = feed cost; CS = Cost savings; DOC = Day old chicks; C = Cost; TCP = Total cost of production; FC = Feed cost; OPC = Operational cost;
0.25 % yellow ginger resulted to higher feed cost when expressed as a percentage of total cost of production.

Conclusion

On the basis of the results of this study, it is concluded that supplementation of yellow and white ginger improves the growth performance and had no harmful influence on broiler chicks when added at 0.25 %, however, when white ginger level increased up to 0.30 %, an improvement was observed in terms of average final weight (846.23 g) and daily weight gain (28.83 g). Production analysis showed that at 0.30 % inclusion level, yellow and white gingers were better in terms of feed cost per weight gain.

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