Comparative effects of fresh and dry ginger as nutritional supplements on live-weight gain, carcass characteristics and meat quality of broiler chicken

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Abstract

Fresh and sundried ginger was given to broilers to compare the effect of sun drying on their efficacy as nutritional supplements. 180 broiler chicks of Abor-acre strain were divided into three dietary groups comprising of 60 chicks which were further subdivided into four replicates of 15 chicks per replicate. Three experimental broiler starter diets were formulated such that diet 1 (T_1, control diet) and diet 3 (T_3) contained no ginger. Diet 2 (T_2) contained 0.5% sundried ginger meal. However, broilers placed on diet 3 (T_3) were also offered a fresh equivalent of 0.5% sundried ginger through the drinking water. Feed and water were fed *ad-libitum*. Result showed that final live-weight, weight gain, feed intake and feed conversion ratio were not affected ($P > 0.05$) in the starter phase but cost feed consumed was significantly ($P < 0.05$) higher in the ginger groups compared to the control group. In the finisher phase, live-weight, weight gain and cost per kilogram weight gain were significantly ($P < 0.05$) higher in the fresh ginger group compared to dry ginger and control groups, and cost of total feed intakes were significantly ($P < 0.05$) higher in the ginger groups compared to the control group. Carcass and meat quality parameters were not affected ($P > 0.05$) by fresh or dry ginger treatment. Therefore, supplementation of broilers with fresh ginger rhizomes through the drinking water was more efficacious in promoting growth performance than inclusion of sundried ginger in the feed.

Introduction

The growing awareness concerning healthy diets have resulted to increasing investigations of phytogenic feed additives (PFAs) for the enhancement of poultry productivity. Phytogenic feed additives otherwise called phytobiotics or botanicals are products derived from plants and added to feeds to enhance livestock and poultry performance. PFAs improve feed digestibility, nutrient absorption and eliminate pathogens residing in the guts of animals (Balunas and Kinghorn, 2005; Athanasiadou et al., 2007). Schleicher et al. (1998) reported that phytogenic feed additives have positive effects on broiler performance, carcass characteristics and meat quality. The use of ginger as a phytogenic feed additive in broiler production has yielded positive results. Over 50 bioactive compounds have been identified in ginger (Ding et al., 2012); and the most potent ones responsible for its pharmacological effects and pungency are gingerol, shagaol, zingerone (Yu, et al., 2007). Higher carcass weights and dressing percentages and improved carcass quality have been reported in broiler chickens fed ginger (Zhang et al., 2009).

Broiler chickens fed ginger meal had higher lean growth resulting in overall improvement in carcass weight with increases in meat tenderness compared to broilers with 0.0% ginger content in their diet (Agu et al., 2017). Feed conversion ratio (FCR) was reduced when broilers were fed a diet with 0.25% level of ginger, but feed intake was not affected (Onu, 2010). Zhao et al. (2011) reported that 5, 10, 15 and 20 g/kg inclusion levels of dried ginger in the diet of laying hens had no significant effect on feed intake and feed conversion ratio. Supplementation of ginger in broiler diets up to 2% level (Onimisi et al., 2005; Ademola et al., 2009) and 2% – 6% level (Al-Hormidan, 2005) increased body weight. The body weight, weight gain and feed conversion ratio were significantly improved whereas feed intake depressed in

broilers fed ginger diets at levels of 0.1 and 0.2% from three to six weeks of age (Mohamed et al., 2012). Malekizadeh et al. (2012) reported that the addition of ginger root powder at level of 1% in the diet of laying hens improved egg production, feed intake and feed conversion ratio. Dooley et al. (2009) did not observe any difference in feed intake in broilers fed ginger extract for a period of six weeks, while Herawati (2010) reported that ginger extracts had a depressing ($P < 0.05$) effect on feed intake. Turkey poults fed ginger powder at levels of 0.2, 0.4 and 0.6% from 14–56 days of age had improved final weight, weight gain and feed conversion ratio compared to the control group (Daramola et al., 2020).

Ginger supplementation in poultry diets has largely been in dry milled forms. Drying and milling ginger into powder is an additional cost for farmers. Worse still, many of the bioactive compounds is suspected to be lost during drying and milling as sost of these compounds are volatile in nature. An et al. (2016) found that gingerol content of ginger powder increased while the shagaol contents tended to increase with drying. Ding et al. (2012) found that most bioactive compounds in ginger decreased with drying irrespective of methods. The free radical scavenging ability (a measure of antioxidation capacity) was lower in dried ginger (An et al., 2016). It is therefore likely that fresh or dried ginger would have varied physiological effect on broiler chickens whole physiological functions are largely dependent on interplay of several antioxidants and hormones. This study was designed to determine the effect of dietary inclusion of sundried ginger versus ground fresh ginger administered through the drinking water on the performance of broiler chickens.

Materials And Method

Source and processing of ginger

The ginger used in this study was sourced from a local market in Owerri. The fresh ginger rhizomes were washed, thinly sliced (about 5 mm thickness), sundried to a constant weight (within 5–7 days) and milled using a hammer mill fitted with a 0.01 mm sieve. The meal was stored in a plastic air-tight container until needed during feed formulation. During the feeding trial, an equivalent weight of fresh ginger rhizomes was cut into thin slices and then ground into ginger paste using kitchen type blender (Molino Tolva Alta, model 121; Landers, Medellin, Colombia). The paste was mixed with water, sieved with cheese cloth and the filtrate recovered. The volume of water used in the extraction was limited to the amount the birds would finish before late afternoon each day.

Experimental diets

Three experimental broiler chicken diets were formulated as shown in Table 1. Diets 1 contain no ginger and served as the control diet while Diets 2 contained 0.5% of the sundried dry ginger meal. Diets 3 did not contain ginger, but the birds that received the diet were offered the aqueous fresh ginger extract in the drinking water every morning. The quantity of sundried ginger birds in T_2 would consume each day was estimated and used to determine the quantity of fresh aqueous ginger extract as described above.

Experimental birds

One hundred and eighty broilers of Abor-acre strain were weighed on arrival and allotted to three treatment groups of 60 each. Each group was subdivided into four replicates of fifteen 15 birds each in a completely randomized design. Each replicate was reared on deep litter in a pen measuring 1m x 1m. The starter diet was fed from 1–27 days while the finisher was fed from 28–56 days of age. feed and water were provided *ad libitum* throughout the feeding trial.

Table 1
Ingredient and calculated nutrient composition of the experimental broiler diets

	Starter			**finisher**		
Diet (ginger level)	1 (0.00)	2 (0.50)	3 (0.00)	1 (0.00)	2 (0.50)	3 (0.00)
Maize	49.50	49.00	49.50	58.00	57.50	58.00
Ginger	0.00	0.50	0.00 [a]	0.00	0.50	0.00 [a]
Soybean meal	22.50	22.50	22.50	17.00	17.00	17.00
Blood meal	2.00	2.00	2.00	2.00	2.00	2.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Palm kernel cake	10.00	10.00	10.00	10.00	10.00	10.00
Spent grain	5.00	5.00	5.00			
Wheat offal	2.00	2.00	2.00	4.00	4.00	4.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin and mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	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
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated values						
Crude protein (%)	23.05	23.04	23.04	20.40	20.40	20.40
Calcium (%)	1.33	1.34	1.34	1.31	1.31	1.31
Phosphorus (%)	1.07	1.07	1.07	1.00	1.00	1.00
Crude fibre (%)	5.78	5.78	5.78	5.32	5.32	5.32
Metabolizable energy (kcal/kg)	2868.97	2868.91	2868.91	2927.74	2927.14	2927.74

[a] fresh aqueous ginger equivalent to ginger content of Diet 2

*Agrited® Formulated to provide per kg feed: Vitamin A: 8,000,000 IU, Vitamin D_3: 1,800,000IU, Vitamin E: 20,000 IU, Vitamin K: 2,200mg, Vitamin B1: 1,600mg, Vitamin B2: 5000mg, Vitamin B6: 2,4000mg, Vitamin B12: 13mg, Niacin: 23,500mg, Folic acid: 700mg, Pantothenic acid: 6,500mg, biotine:42mg, antioxidant:13,300mg, manganese: 85,000mg, Cobalt: 220mg, Copper: 6,000mg, Iodine: 1,100mg, Iron: 25,000mg, Manganese: 1800mg, Selenium: 120mg and zinc: 50,000mg, Choline chloride: 15,000mg

Data collection

Birds were weighed on arrival at day-old to get the initial weight, and thereafter weekly till the 8th week of age when the feeding trial was terminated. The difference between the final weight and the initial weight was recorded as the weight gain. Feed intake was determined daily on replicate basis as the difference between weight of the feed offered daily and the weight of left-over feed the next morning. Feed conversion ratio was calculated by dividing the average daily feed intake by the average daily weight gain. Cost of feed consumed per bird was calculated by multiplying the unit cost of feed by quantity of feed consumed per bird. Feed cost per kilogram weight gain was calculated by dividing the cost of feed by the feed conversion ratio.

Carcass analysis

At the end of the feeding trial, two birds in the weight range of 2000–2300 g were selected from each replicate, tagged and starved of feed overnight (18) hours, but allowed unlimited access to water. The birds were reweighed and bled to death by severing the carotid arteries to assure effective blood drainage. They were scalded by immersion in hot water ($60^{o}C$) for 30 seconds and de-feathered. Evisceration was accomplished manually, followed by decapitation and the removal of necks and shanks. Carcass weights were subsequently determined. Weights of organs, internal fat and carcass parts (drumsticks, thighs, breast, wings) were also determined. All weights were expressed as percentages of live weight.

Organoleptic quality analysis

One drumstick from each bird was separated and labelled for organoleptic quality assessment. The drumsticks were kept in the refrigerator overnight. The following morning, each drumstick was halved giving 48 meat samples were assessment. Meat samples were individually immersed in brine for a few seconds, removed and placed in labelled transparent polythene bags. Bags were tied tightly to disallow entry of water while boiling. Samples were cooked for thirty minutes in boiling water, cooled to room temperature and distributed equally among sixteen trained taste panelists. Each panelist received three samples, one from each treatment. Meat quality parameters assessed included juiciness, tenderness, flavour intensity, amount of connective tissue and hedonic rating using the 9-point rating scale (AMSA, 1978). After assessing one sample, each panelist cleared the buccal cavity by eating cabin biscuits and drinking water before assessing another sample.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) for the completely randomized design according to Steel and Torie (1980). Significant differences among treatment means were determined using least significant difference (LSD) at 5% level of probability as described by Onuh and Igwemma (2000).

Results

The performance of the broiler chicks at the starter fed ginger diets is presented in Table 2 while that of the finisher phase is presented in Table 3. The cumulative performance (starter – finisher) data of the feeding trial is presented in Table 4. None of the performance parameters measured in the starter phase showed diet related significant differences ($P > 0.05$), though cost of total feed intake was significantly ($P < 0.05$) higher in the ginger groups compared to the control group. In the finisher phase, final live-weight, total weight gain and average daily weight gain were significantly ($P < 0.05$) higher in the fresh ginger group compared to the groups fed dry ginger and control diet. Cost of total feed intake was significantly ($P < 0.05$) higher in the ginger groups compared to the control group, while feed cost/kg gain was significantly ($P < 0.05$) higher in the dry ginger group compared to fresh ginger and control groups.

In the whole trial period, final live-weight and total weight gain were significantly ($P < 0.05$) higher in the fresh ginger group compared to dry ginger and control groups. The sundried ginger group had similar final live-weight and weight gain with the control group, though values were numerically higher in the dry ginger group compared to the control group. Cost of feed consumed was significantly ($P < 0.05$) higher in the ginger groups compared to control group while feed cost/kg gain was significantly higher in the dry ginger compared to fresh ginger and control groups. Average daily feed intake and feed conversion ratio were not affected by ginger treatment ($P > 0.05$) throughout the period of experiment.

Table 2
Performance and economic of feed utilization of the starter broiler chickens fed fresh and dry ginger

Parameters	**0.0% ginger**	**0.5% dry ginger**	**0.5% fresh ginger**	**SEM**
Av. initial live weight (g)	36.24	35.24	37.83	1.38
Av. final live weight (g)	784.00	829.82	849.52	23.77
Av. total weight gain (g)	747.76	794.59	811.69	23.33
Av. daily weight gain (g/day)	26.71	28.38	28.99	0.83
Av. daily feed intake (g)	52.18	53.36	53.88	1.46
Feed conversion ratio	1.96	1.88	1.87	0.06
Economic analysis				
Cost of feed (₦/kg)	144.93	170.63	160.33	-
Total feed intake/bird (kg)	1.461	1.494	1.509	-
Cost feed consumed bird (₦)	211.73^{b}	254.94^{a}	241.87^{a}	6.51
Feed cost (₦)/kg gain	284.06	320.78	299.82	9.78
$^{a, b}$ Means within a row with different superscripts are significantly different ($P < 0.05$).				

Table 3
Performance and economics of feed utilization of finisher broiler chickens fed fresh and dry ginger

Parameters	0.0% ginger	0.5% dry ginger	0.5% fresh ginger	SEM
Av. initial live weight (g)	784.00	829.82	849.52	23.77
Av. final live weight (g)	2255.19^{b}	2401.45^{b}	2631.77^{a}	58.84
Av. total weight gain (g)	1471.19^{b}	1571.62^{b}	1782.25^{a}	64.10
Av. daily weight gain (g/day)	52.54^{b}	56.13^{b}	63.65^{a}	2.29
Av. daily feed intake (g)	132.57	142.90	144.08	3.41
Feed conversion ratio	2.54	2.55	2.27	0.09
Economic analysis				
Cost (₦)/kg feed	148.58	174.28	163.98	-
Total feed intake/bird (kg)	3.712	4.001	4.034	-
Cost of feed consumed (₦/bird)	551.47^{b}	697.32^{a}	661.52^{a}	14.09
Feed cost (₦)/kg gain	377.39^{b}	444.41^{a}	372.23^{b}	16.10

$^{a, b}$ Means within a row with different superscripts are significantly different ($P < 0.05$).

Table 4
Performance and economics of feed utilization of the broiler chickens fed fresh and dry ginger from 1–8 weeks of age

Parameters	0.0% Ginger	0.5% Dry Ginger	0.5% Fresh Ginger	SEM
Av. initial live-weight (g)	36.24	35.24	37.83	1.38
Av. final live-weight (g)	2255.19^{b}	2401.45^{b}	2631.77^{a}	58.84
Av. total weight gain (g)	2218.95^{b}	2366.21^{b}	2593.94^{a}	58.84
Av. daily weight gain (g/day)	39.63	42.25	46.32	3.35
Av. daily feed intake (g)	92.37	98.13	98.98	2.07
Feed conversion ratio	2.34	2.32	2.14	0.05
Economic data				
Total feed intake/bird (kg)	5.17	5.50	5.54	0.11
Cost of feed consumed (₦)	763.20^{b}	952.26^{a}	903.39^{a}	19.77
Feed cost (₦)/ kg weight gain	345.23^{b}	403.34^{a}	348.81^{b}	8.91
Av.= Average				

Result from carcass analysis (Table 5) shows that percentages of carcass, wings, breast, thighs, drumstick, abdominal fat, heart and empty gizzard did not differ significantly between treatment means. However, abdominal fat was slightly reduced among the dry ginger group. Table 6 shows the result of ginger treatment on organoleptic quality of broiler meat. Neither sundried nor fresh ginger had no significant effect ($P > 0.05$) on all parameters assessed. All the meat samples tasted were moderately tender and juicy, slightly flavoured and moderately liked by panellists.

Discussion

The bioactive component (gingerol, shogaol, etc.) must have been responsible for the significantly ($P < 0.05$) higher final weight and weight gain of broilers fed diets containing ginger. A higher abundance of these bioactive components in fresh ginger compared to dry ginger (Yu et al., 2007). Gingerols and shagaols have been reported to be the most potent phenolic compounds of ginger responsible for its beneficial effects in animals and humans (Yu et al., 2007; Ding et al., 2012). Ginger and other spices such as pepper lose their pungency when milled and stored (Bartley and Jacobs, 2000). Though the sun-dried and milled ginger used in this study was stored in an air-tight container, loses in volatile components may have occurred during sun drying of fresh ginger and storage of compounded feed. Nonetheless, strong evidence exists in the literature supporting the positive influence of dry ginger on performance of broilers (Mohamed et al., 2012; Agu et al., 20) and egg production (Malekizadeh et al., 2012; Tchoffo et al., 2017).

Table 5
Carcass characteristics of broiler chickens fed ginger diets

Parameters	**0.0% ginger**	**0.5% dry ginger**	**0.5% fresh ginger**	**SEM**
Live weight (g)	2187.50	2155.00	2187.50	51.92
Dressed weight (g)	1555.00	1437.50	1543.75	70.94
Dressing percentage	70.75	66.75	70.50	3.16
Cut-up parts (%)				
Head	2.39	2.28	2.06	0.12
Neck	4.98	5.00	5.16	0.29
Wings	9.30	9.40	9.49	0.43
Breast	21.13	21.16	21.08	0.82
Thighs	10.99	11.13	12.05	0.39
Drumsticks	10.51	10.51	9.68	0.26
Shanks	4.29	4.15	3.91	0.38
Abdominal fat	1.16	0.83	1.47	0.43
Internal organs (%)				
Heart	0.41	0.45	0.42	0.03
Liver + gall bladder	2.38	1.82	2.18	0.16
Empty gizzard	1.96	2.01	1.87	0.17
Differences were not statistically significant ($P > 0.05$).				

Table 6
Organoleptic quality of meat samples from broiler chickens fed ginger diets

Parameters	0.0% ginger	0.5% dry ginger	0.5% fresh ginger	SEM
Juiciness	6.50	7.50	6.38	0.47
Tenderness	7.38	7.38	6.88	0.34
Hedonic rating	6.25	6.38	6.50	0.27
Connective tissue	6.25	6.38	5.88	0.49
Flavour intensity	6.25	6.38	5.88	0.48
Off-flavour intensity	4.13	3.88	3.88	0.68
Differences in the same row without superscripts are similar (P > 0.05).				
9-Points Category Rating Scale used: Extremely tender/juicy/flavoured = 9; very tender/juicy/flavoured = 8; moderately tender/juicy/flavoured =7; slightly tender/juicy/flavoured = 6; neither tender/juicy/flavoured nor tough/dry/unflavoured = 5; slightly tough/dry/unflavoured = 4; moderately tough/dry/unflavoured = 3; very tough/dry/unflavoured = 2; extremely tough/dry/unflavoured =1. Hedonic Scoring: Extremely liked = 9; very liked = 8; moderately liked = 7; slightly liked = 6; neither liked nor disliked = 5; slightly disliked = 4; moderately disliked = 3; very disliked = 2; extremely disliked = 1.				

Results indicate that these significant improvements occurred during the finisher phase only, and not during the starter phase. This suggest that the effect of the bioactive ingredients might be age dependent or an additive in nature. This however needs to be further investigated. The significantly higher daily weight gain observed in the finisher phase was not observed in the whole trial result. Obviously, the non-significant daily weight gain in the starter phase diluted the significant effect achieved in the finisher phase. Close examination of the results shows that the difference between the means were quite high and statistical significance was almost achieved. Live weight was highest in the groups fed fresh ginger in the starter phase, and this trend continued into the finisher phase.

In this study, carcass characteristics were not affected by dietary inclusion of ginger. Onu (2010) reported similar findings when broiler chickens were diets containing ginger. However, Egenuka et al. (2021) reported significant influences ($P < 0.05$) on the neck and abdominal fat percentages in eight weeks old broiler chickens fed dietary inclusion of dry ginger at 0.0%, 0.5%, 1.0% and 1.5% with the 1.5% level having the lowest values while all other carcass parameters measured were similar ($P > 0.05$). This suggests that the effect of ginger on broiler carcasses is dose dependent. Results of the sensory/organoleptic assessment of the broilers revealed no diet related alteration in the eating quality. Agu et al. (2017) reported a significant increase in tenderness in broiler chickens fed ginger in their diets compared to the control (without ginger), but juiciness, flavour and hedonic score were not affected. It is to be expected that variable results are possible when feeding ingredients like ginger that change considerably during processing and storage.

Conclusion And Recommendations

Results from this study demonstrated that fresh ginger promotes broiler productivity better than sundried ginger. Doubtlessly, handling costs including labour costs are increased when fresh ginger extract had to be prepared every morning. To get around this problem, it may be necessary to extract the fresh ginger juice, and after adding an appropriate preservative, bottle it and store for daily usage. The efficacy of this product should be the subject of future research investigation.

Declarations

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Code availability: This does not apply

Data availability: The datasets generated during and/or analyzed during the current study are not publicly available due to data restrictions policy of the host institution, Federal University of Technology, Owerri. They can be made available from the corresponding author on reasonable request.

Ethics approval: The ethics governing the use and conduct of experiments on animals were strictly observed, and the experimental protocol was approved by the Research and Ethics Committee of the Department of Animal Science and Technology, Federal University of Technology, Owerri.

Consent to participate: Permission and informed consent of all persons involved in the sensory evaluation of samples was sought and freely given,

Consent for publication: This does not apply.

Conflict of interest: All authors certify that as of the time of this research, they had no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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