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Effect of Dietary Inclusion of Ginger *(Zingiber officinale)* Dried with Different Methods on Performance and Gut Microbial Population of Broiler Chicks

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Authors' contributions

This work was carried out in collaboration between all authors. Author GOA designed the study, wrote the protocol, reviewed the experimental design and read all drafts of the manuscript. Author IJO wrote the first draft of the manuscript, managed the analyses of the study and performed the statistical analysis. Author OGL gave the idea that led to this study. All authors read and approved the final manuscript.

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ABSTRACT

Effect of dietary inclusion of differently processed ginger on performance and microbial population of broiler chicks were investigated in a 52-days feeding trial. A total of three hundred one-day old (arbor acre) broiler chicks were used for the experiment, the birds were allotted into ten dietary treatments of five replicates and six birds per replicate in a 3x3 factorial arrangement of completely randomized design. Weights of the birds were taken weekly throughout the experimental period. Birds were fed *ad-libitum* such that diet 1 was the basal diet (BD) without ginger, diets 2, 3 and 4 were BD+ sundried ginger at 1, 1.5, 2% inclusion levels respectively, diets 5, 6 and 7 were BD+ air-dried ginger at 1, 1.5 and 2% inclusion levels respectively, diets 8, 9 and 10 were BD+ oven-dried ginger at 1, 1.5 and 2% inclusion level respectively. On day 52 of the experiment, the birds were slaughtered. Sections of the ileum was cut and aseptically emptied into a sterile bottle for microbial analysis.

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Broilers fed diets containing ginger had no significant (P> 0.05) differences on the average initial body weight, average final body weight and average daily feed intake. Although the birds fed with diet containing oven-dried ginger at 2% inclusion level had the least (P>0.05) numerical difference of the average daily feed intake. The average body weight gain and feed conversion ratio (FCR) were not significant across the dietary treatments. Birds fed diet without ginger had higher body weight gain and best feed conversion ratio (P<0.05).
The total Aerobic and coliform microbial counts of broilers were not significantly (P>0.05) affected by the dietary treatments. Although the total aerobic microbial count was reduced in birds fed diets containing ginger when compared with the control.

Keywords: Ginger; drying methods; microbial population; performance; broilers.

1. INTRODUCTION

Numerous studies have been done to improve the efficiency of poultry products. Considering the importance of broiler growth, proper development of the gastrointestinal tract is necessary to make optimal use of feeds and to provide appropriate conditions to actualize the genetic potential of birds [1]. Thus, appropriate supplements should be added to their feed given the nature of metabolism and digestive system. Given the possible adverse effects in poultry caused by the use of antibiotic growth promoters (AGP) and bacteria resistance, careful selection and use of appropriate non-antibiotic additives in poultry nutrition is very important [2]. The alternative feed additives used in livestock and poultry nutrition include probiotics, prebiotics, symbiotics, organic acids and medicinal plants [3].

Feed additives are added in animal feeds to improve their nutritive value, boost animal performance by increasing their growth rate, better feed conversion efficiency, greater livability and lowered mortality in poultry birds [4].

Herbs could be expected to serve as feed additives due to their suitability and preference, lower cost of production, reduced risk of toxicity, minimum health hazards and they are also environmentally friendly [5]. Recent research works on herbal formulations as feed additives have shown encouraging results as regards weight gain, feed efficiency, lowered mortality and increased livability in poultry birds [6-10].

2. MATERIALS AND METHODS

Ginger root was purchased from a local market in Ibadan, Nigeria. The ginger used was observed for any physical defect, it was surface cleaned and washed in running tap water to remove adhering debris after which the samples was divided into three portions. The first portion was oven dried at 60℃ for 72 hours; the second and third portions were sundried and air-dried at an average temperature of 32.4℃ and 30.9℃ respectively. After drying, the dried ginger was ground into powder using commercial blender. The powdered ginger samples were stored in an airtight container until needed for use. The samples were analysed for chemical composition according to Association of Official Analytical Chemists [11] at the University of Ibadan, Nigeria.

Table 1. Proximate composition of processed ginger

Parameters	Sundried ginger	Airdried ginger	Ovendried ginger
Crude protein	11.53	13.33	11.01
Crude fibre	15.35	9.88	14.87
Ether extract	4.12	4.46	3.97
Dry matter	88.90	89.36	92.42
Ash	6.80	7.20	6.51
Gross energy	3.38	3.39	3.38

2.1 Diets Formulation

Ten experimental diets were formulated such that diet 1 served as the control diet which contained no ginger. Sun dried ginger was included in diets 2, 3 and 4 at 1.0%, 1.5% and 2.0% respectively. Diets in 5, 6 and 7 contained 1.0%, 1.5% and 2.0% air dried ginger respectively. Diets 8, 9 and 10 contained 1.0%, 1.5% and 2% oven dried ginger respectively. The composition of the experimental diets is shown in Table 2.

2.2 Management of Experimental Broiler Chicks

The chicks were offered experimental diets and water *ad libitum*. The feed intake was determined as the differential between the quantity of feed served and left over. The weight gain was

determined by weighing chicks initially and thereafter on a weekly basis until termination of the experiment.

2.3 Microbial Analysis

Thirty broilers were sacrificed and eviscerated. The ileum was separated aseptically and the digesta within the 2/3rd caudal area of the ileum was collected aseptically into sterile universal bottles. Microbial assay was carried out using methods describe by [12]. Media used were prepared according to manufacturers' specification. The standard plate count technique was used in the microbial load determination. One millimeter of the digesta described above was used for serial dilution in sterile 15 ml test tubes, containing 9 ml 0.1% sterile peptone water and vortex. Serial dilution of digesta was made to 10^{-3} dilution level. 1ml of the dilution was pipette and inoculated on Plate count agar and Mac Conkey agar and was incubated at 37℃ for 18 – 24 hours. Discrete colonies on plates were counted using colony counter and estimated in log10 CFU/ml.

2.4 Experimental Design and Statistical Analysis

The experimental design was 3 x 3 factorial arrangements in a completely randomized design (CRD) and the data obtained were subjected to analysis of variance (ANOVA) using SAS [13] and difference among treatments means were separated using SAS macro [14].

Table 2. Gross composition of experimental basal diets

Ingredients	Starter (kg/100 kg)	Finisher (kg/100 kg)
Maize	55.00	56.50
Soybean	33.00	---
Wheat Offal	---	10.00
Fish meal (72%)	0.50	0.30
GNC	4.60	9.50
FF soya	3.00	20.00
Oyster shell	0.50	1.00
L-lysine	0.15	0.10
Dl-methionine	0.25	0.15
B.Premix	0.25	0.25
Salt	0.25	0.25
DCP	2.50	1.95
Total	**100.00**	**100.00**
Calculated nutrients		
Crude protein (%)	23.11	19.72
Metabolizable Energy (Kcal/kg)	3005.31	3000.39
Crude fibre (%)	3.82	3.79
Ether extracts (%)	3.86	5.51
Calcium (%)	1.02	1.12
Available phosphorus (%)	0.55	0.45

GNC- Groundnut Cake; FF Soya- Full Fat Soya; DCP- Dicalcium Phosphate
B. Premix- Broiler Premix

Table 3. Effect of different processing methods of ginger on growth performance characteristics of broiler chicks

Parameters	Control	Methods			SEM
		Sundried	Airdried	Ovendried	
AIBW/bird (g)	38.62	44.44	43.33	47.63	1.02
AFBW/bird (g)	1941.43	1801.11	1893.33	1862.06	70.06
ADFI/bird/day (g)	94.07	93.18	95.13	93.25	1.38
ABWG/bird/day(g)	38.80^{a}	35.85^{b}	37.76^{ab}	37.01^{ab}	1.42
FCR/bird/day	2.43	2.61	2.54	2.53	0.10

Means with different superscript are significantly different from each other (P<0.05)
AIBW: Average Initial Body Weight, AFBW: Average Final Body Weight, ADFI: Average Daily Feed Intake, ABWG: Average Body Weight Gain, FCR: Feed Conversion Ratio

Table 4. Effect of graded inclusion levels of ginger on growth performance characteristics of broiler chicks

Parameters	Inclusion level				SEM
	0%	1%	1.5%	2%	
AIBW/bird (g)	38.62	47.16	42.22	46.03	1.02
AFBW/bird (g)	1941.43	1876.19	1837.78	1842.54	70.06
ADFI/bird/day(g)	94.07	94.66	95.35	91.54	1.38
ABWG/bird/day(g)	38.80	37.31	36.64	36.65	1.42
FCR/bird/day	2.43^{b}	2.55^{ab}	2.63^{a}	2.51^{ab}	0.10

Means with different superscript are significantly different from each other (P<0.05)
AIBW: Average Initial Body Weight, AFBW: Average Final Body Weight, ADFI: Average Daily Feed Intake, ABWG: Average Body Weight Gain, FCR: Feed Conversion Ratio

Table 5. Interaction effect of processing methods and inclusion levels of ginger on growth performance characteristics of broiler chicks

Parameters	Control	Methods									SEM
		Sundried			Air-dried			Oven-dried			
Inclusion level	0%	1%	1.5%	2%	1%	1.5%	2%	1%	1.5%	2%	
AIBW/bird (g)	38.62	46.66	40.00	46.66	43.33	40.00	46.66	51.48	46.66	44.76	1.02
AFBW/bird (g)	1941.43	1860.00	1693.37	1850.0	1886.67	1973.33	1820.00	1881.91	1846.67	1857.62	70.06
ADFI/bird/day(g)	94.07	95.85	91.36	92.31	96.33	97.62	91.23	91.61	97.06	91.09	1.38
ABWG/bird/day(g)	38.80^{a}	37.01^{ab}	33.74^{b}	36.80^{ab}	37.62^{ab}	39.46^{a}	36.19^{ab}	37.32^{ab}	36.73^{ab}	36.96^{ab}	1.42
FCR/bird/day	2.43^{b}	2.60^{ab}	2.73^{a}	2.52^{ab}	2.58^{ab}	2.51^{ab}	2.54^{ab}	2.47^{ab}	2.66^{ab}	2.47^{ab}	0.10

Means with different superscript are significantly different from each other (P<0.05)

AIBW: Average Initial Body Weight, AFBW: Average Final Body Weight, ADFI: Average Daily Feed Intake, ABWG: Average Body Weight Gain, FCR: Feed Conversion Ratio

3. RESULTS

There were no significant differences (P>0.05) in all the performance indices measured for the birds fed diet containing ginger from different drying methods, except for the average body weight which was significantly (P<0.05) influenced. Birds fed with dietary treatments without ginger had the highest body weight gain (38.80 g) while birds fed with sundried ginger had the lowest weight gain (35.76 g). The feed conversion ratio of broilers fed diet containing ginger from different processing methods throughout the experimental period showed no significant (P>0.05) difference. Although the best mean value was obtained from broilers fed diet without ginger.

The varying inclusion levels of ginger inclusion in the diet do not significantly (P>0.05) influence the performance of the broiler chicks. However, the feed conversion ratio was significantly (P<0.05) affected. Birds fed with diet with ginger at 1.5% inclusion level had the highest mean value (2.63) when compared with birds fed diet without ginger which had the lowest mean value (2.43).

The interaction effect of the different processing methods and inclusion levels of broilers fed dietary treatment showed no significant (P>0.05) difference in the average daily feed intake of the birds. Although birds fed oven-dried ginger at 1.5% inclusion level had the highest value (139.9 g) while birds fed with sun-dried ginger at 1.5% inclusion level recorded the lowest value (128.30 g).

There was significant (P<0.05) influence of both factors on the average body weight gain of the birds, with the highest value obtained from birds that consumed diet without ginger and Air-dried ginger at 1.5% inclusion level (38.80 g) and (39.46 g) respectively while those fed sun-dried ginger at 1.5% inclusion level had the lowest value (33.74 g). The FCR of birds fed diet without ginger recorded the least value (2.43) and significantly (P<0.05) differ from birds fed Sun-dried at 1.5% inclusion level which had the highest mean value (2.84).

The different processing methods of ginger had no significant (P>0.05) effect on the total aerobic count and total coliform count of the broiler chicken. However, birds fed with basal diet without ginger (control) had the highest mean value (3.76), while birds fed with oven-dried ginger had the lowest mean value (3.27). The mean values of total coliform count were not significantly (P>0.05) different across the birds fed the dietary treatments. Birds fed with diet containing air-dried ginger recorded the highest mean value (3.32), while those fed with diet containing oven-dried ginger recorded the lowest mean value (3.30).

There were no significant (P>0.05) variations observed for the total aerobic count and the total coliform count of the broilers fed dietary treatments. However, birds fed with basal diet without ginger (0%) level of inclusion were observed to have recorded the highest total aerobic count (3.76) compared to other birds fed diets containing ginger, while the lowest total aerobic value was observed in birds fed diet that contained 2% ginger. The mean values (3.32) of total coliform counts were highest on birds fed diet that contained 1% and 1.5% ginger and lowest (3.30) on birds fed diet that contained 2% ginger. Although no variation (P>0.05) was observed across the values for the graded inclusion levels, but it was observed that birds with 1% and 1.5% inclusion levels recorded higher total coliform counts.

Table 6. Effect dietary inclusion of processed ginger on microbial population of broiler chicks

Parameters	Methods				SEM
log (cfu/ml)	Control	Sundried	Airdried	Ovendried	
Total Aerobic count	3.76	3.53	3.50	3.27	0.088
Total Coliform count	3.31	3.31	3.32	3.30	0.057

Table 7. Effect of graded dietary inclusion of ginger on microbial population of broiler chicks

Parameters	Inclusion level				SEM
Log (cfu/ml)	0%	1%	1.5%	2%	
Total Aerobic count	3.76	3.43	3.50	3.37	0.088
Total Coliform count	3.31	3.32	3.32	3.30	0.057

Table 8. Interaction effect of processing methods and inclusion levels of ginger on microbial population of broilers

Parameters	Control			Sundried			Air-dried			Oven-dried		SEM
Inclusion level	0%	1%	1.5%	2%	1%	1.5%	2%	1%	1.5%	2%		
Total Aerobic count	3.76	3.47	3.58	3.56	3.54	3.48	3.49	3.29	3.45	3.07	0.09	
Total Coliform count	3.31	3.27	3.35	3.31	3.28	3.25	3.43	3.41	3.35	3.31	0.06	

The result of the interaction effect of the processing methods and inclusion level showed that there was no interaction (P>0.05) observed in the processing methods and inclusion levels of ginger on the total aerobic count and the total coliform count of the birds. However a significant (P<0.05) reduction in the total aerobic count was observed in birds fed diet dietary treatment compared to the birds fed diets without ginger. Birds fed with diet that contained no ginger had the highest value (3.76) and the lowest value (3.29) was observed on birds fed oven-dried ginger at 1% inclusion level. There was no interaction observed in the processing methods and inclusion level of ginger on the total coliform count of the broiler chicks. However, the numerical value showed chicks fed with diet containing air-dried ginger at 2% inclusion level had the highest total coliform count (3.43) while the lowest value (3.25) was observed on birds fed diet containing air-dried ginger at 1.5% inclusion level.

4. DISCUSSION

The results of feed intake obtained in this study are in agreement with the submission of [15,16] that broiler birds fed 1.5-2% dried supplementary red ginger meal had significantly lower feed intake than those on the control diet while [17] reported no differences in feed intake for broilers fed with ginger extract over a period of 6 weeks period.

The findings in this study showed that neither the processing method nor the inclusion level was able to improve the daily weight gain of the birds above what was recorded by the birds that were fed with the control diet. This was contrary to the reports of [18] and [19] who observed an increase in weight gain of broiler fed 2% and 6% ginger.

However, the interaction of the processing methods and inclusion levels resulted in an increment in the total weight gain of birds fed diet that contained air-dried ginger at 1.5% inclusion level as compared with the control and other interaction effects. This can be attributed to the increase in their high feed intake which resulted in corresponding increase in body weight gain.

The findings in this study showed that birds fed with basal diet, without ginger (control) recorded the best value, regardless of the processing method adopted, the inclusion level or the interaction effect of the methods and inclusion level in the overall FCR. The result agree with findings of [20] who reported no significant difference among broiler birds that were fed 0.5%, 1% and 1.5% ginger root powder in feed conversion ratio. The result also compares well with the findings of [21] who reported no differences in feed intake, final weight, weight gain and feed conversion ratio when they fed supplemental ginger as a feed additive in broiler diets at 250 g, 500 g and 750 g inclusion per 100 kg diet.

The reports of earlier workers [22,23] that observed significant feed conversion ratio in

ginger fed groups of broilers compared to those fed control diet.

The different processing methods and the inclusion levels of ginger fed to the birds did not differ in the values of their total aerobic count respectively but were significantly reduced compared with the control. These findings were similar to [24-26] who demonstrated that the addition of lactic acid, formic acid and propionic acid to diets and drinking water efficiently controlled *Salmonella and Shigella* species, *Escherichia coli* and other Enterobacteria in poultry..

There was a reduction in the population of the total aerobic count as a result of the interaction of the different processing methods and inclusion levels of the ginger in the diet fed to the birds. This could be due to the presence of antibacterial compounds such as gingerols, shogaols, vitamin A and B, paradol and zingerine in ginger [27]. The antibacterial activities of the ginger extract are expected perhaps due to the presence of compounds like flavonoids and volatile oils which were dissolved in organic solvents. It was reported that sesquiterpenoids are the main component of ginger attributed to its antibacterial activity [28].

5. CONCLUSION

This study showed that the performance characteristics of the broiler chickens were not influenced by the processing methods and inclusion levels of ginger. However, the interaction effect of the processing methods and inclusion levels resulted in a higher weight gain of the birds when compared with the birds fed with basal diet without ginger.

Also ginger supplementation in broiler chickens diets considerably reduced and inhibited the growth of pathogenic microbes in broiler chickens.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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