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Antimicrobial Effect Induced by Fresh Ginger Root Extracts in Broilers

Ruth T. S. Ofongo-Abule[1] and Elijah I. Ohimain[2*]

[1]Department of Animal Science, Faculty of Agriculture, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.
[2]Agricultural and Veterinary Microbiology Research Unit, Department of Biological Sciences, Faculty of Science Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the experiment. Author RTSO-A was carry out the statistical analysis. Author EIO wrote the first draft of the manuscript and manage literatures searches. Both authors read and approved the final manuscript.

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ABSTRACT

Poultry is challenged by microbial infection owing to the restrictions in the use of synthetic antibiotic growth promoters. This study investigated the use of ginger, *Zingiber officinale* Roscoe (family *Zingiberaceae)* for the control of infections in poultry. Aqueous extracts of fresh ginger was administered to the birds by dispersing in water. A completely randomized experimental design using 100 day old broiler chicks distributed to two treatments having five replicate per treatment. The ginger extract was given to a set of 50 day old birds (ginger treatment 2) and was not added in a second set, which served as the control. The population of microbes (*Lactobacillus*, *Salmonella, E. coli* and coliforms) in the crop, ileum and caecum of the birds were determined 7 days before and 7 days after the administration of the fresh ginger extract. Before the administration of ginger, *Salmonella* population was highest at the crop 1.852 Log cfu/g and decreased afterwards being 1.744 Log cfu/g at the ileum and 1.710 Log cfu/g at the caecum. *E. coli* was 1.789, 1.821 and 1.727 Log cfu/g at the crop, ileum and caecum respectively. *E. coli* accounted for over 90% of the coliform population, hence they exhibited the same pattern was observed. *Lactobacillus* was highest at the crop (1.933 Log cfu/g) and declined through the ileum (1.842 Log cfu/g) to the caecum (1.705 Log cfu/g). The administration of aqueous extract of ginger resulted in a significant

**Corresponding author: Email: eohimain@yahoo.com;*

decline of all microbial species analyzed over the control (P<0.05). Hence, it is recommended that the use of ginger for the control of infection is plausible but its use must be modified to prevent killing of beneficial microbes in the broiler GIT. The proximate composition of the fresh ginger rhizome used in the study was also presented.

Keywords: Alternative drugs; aqueous extracts; botanicals; coliforms; E. coli; lactobacillus; poultry infection; Salmonella; veterinary microbiology.

1. INTRODUCTION

One of the major challenges of poultry is microbial infections particularly *Eimeria* infection [1,2] and bacterial infections mainly *clostridia, Salmonella* and *E. coli* [3,4]. A variety of microbes have been associated with different poultry diseases including Colibacillosis, Salmonelosis, Poultry Cholera, Clostridiosis, Crysipelas, Pasteurellosis, Mycobacteriosis and Spirochetosis [5,6]. Moreover, the emergence of bird flu has had damaging effect on the poultry industry within the last ten years.

Typically, antibiotics growth promoter (AGP) are used to control infections and enhance performance in the poultry sector. Recently, due to the problem of antibiotics resistance, the use of AGP is increasing being restricted in many countries including Europe, US and Japan [4,5,7]. Hence, poultry farmers are now faced with the challenge of control infections while boosting performance. Many alternative substances have been considered such as the use of prebiotics and probiotics [4,5,7], mushroom based products [1,2,8–11] and botanicals [12].

It has been discovered that some botanicals particularly spices have antimicrobial properties e.g garlic, ginger and pepper [13-16]. The medicinal properties of ginger (*Zingiber officinale* Rosecoe), rhizome is well documented in literature. It has been well demonstrated that ginger have several pharmacological properties including anti-inflammatory, antibiotic, antiviral, and antinauseant, hypolipidemic, chemo-preventive, antidiabetic and antirheumatic [17-26]. Ginger also has insecticidal properties [27]. Hence, the aim of this study is to investigate the use of ginger for the control of bacterial infection in poultry.

2. MATERIALS AND METHODS

2.1 Source of Experimental Birds and Preparation of Brooder House

One hundred day old (ANAK 2000) commercial broilers were purchased at CHI farm, Ibadan, Nigeria and transported to Niger Delta University Teaching and Research Farm where the experiment was carried out. Vittalyte was administered to the birds due to stress resulting from transportation. The brooder house and it environment was cleaned with detergent and disinfectant (Z-germicide) two weeks prior to the arrival of the birds. Electric bulb (200 Watts) was used at the brooding stage as a source of heat and light. The feeders and drinkers were properly washed prior to brooding.

2.2 Source of *Zingiber officinale* and Its Preparation Methods

Ginger*, Zingiber officinale* used in this experiment were obtained from Swali market in Yenagoa Local Government Area of Bayelsa State, Nigeria. The *Zingiber officinale* was washed with clean water and peeled. Five hundred gram (500 g) was blended in 1.5 liters of distilled water, hence the concentration of ginger used in the experiment is therefore 111 mg/l. The solution was filtered with cheese cloth, and further diluted with 3.0 liters of distilled water then divided into five equal portions. The extract was offered to the birds via drinking (oral route) for three hours before they were given clean drinking water. This was repeated two days after to ensure the birds consumed adequate amount of the aqueous ginger extract dispersed in water.

2.3 Proximate Analysis

A hundred gram of each experimental diet was collected and set aside for proximate analysis. Proximate analysis of dry matter, crude protein, ash, ether extract concentration was analyzed in the diets according to AOAC [28].

The proximate composition of poultry feed and fresh ginger rhizome used in the study is presented in Table 1. The fresh ginger rhizome used in the study is composed of crude protein (2.30%), fat (0.90%), mineral (1.20%), crude fibre (2.40%), carbohydrate (12.30 %) and moisture (80.9%). Ajayi et al. [24] reported the proximate

composition of white ginger as follows; 4.95% ash, 3.95% moisture, 17.11% fat, 21.90% crude protein and 39.70% carbohydrates. Otunola et al. [14] presented the proximate composition of white ginger as follows; 6.30% ash, 6.36% moisture, 5.35% fat, 8.58% crude protein, 3.25 % crude fibre and 68.15% carbohydrates. The result from our study differed from these values, which analyzed for dry ginger, whereas our analysis was based on fresh ginger.

Table 1. Proximate composition of dried ginger used in the study

Constituent	Fresh ginger rhizome
Moisture, %	80.9
Crude protein, %	2.30
Fat, %	0.90
Mineral, %	1.20
Crude fibre, %	2.40
Carbohydrate, %	12.30

2.4 Experimental Design and Digesta Collection

The experiment was design as a complete randomized design. The birds were fed commercial broiler starter diet. The birds were divided into 2 sets; one set was administered with fresh ginger extracts (treatment) and the other without ginger (control). Each treatment had five replicates with ten birds per replicates. The birds were brooded for seven days. Digesta was collected from the crop, ileum and caecum 7 days before the extracts were administered and 7 days after they have been administered (ginger treatment) and from the control i.e. without ginger treatment. The samples were collected into sterile McCathney bottles for microbial enumeration for coliforms, *E. coli, Salmonella and Lactobacillus*.

2.5 Enumeration of Microorganisms from the Gastrointestinal Tract of Birds

The populations of microorganisms in the different samples were enumerated using serial dilution pour plate method of Pepper and Gerba [29]. About 1g of the sample was serially diluted in sterile distilled/deionized water and aliquots of the dilutions were ascetically plated into growth media; MRS Agar supplemented with cycloheximide to enumerate total *lactobacillus* species. The medium were anaerobically incubated at 30ºC for 7 days. For the isolation of E. coli, EMB Agar was employed and it was incubated aerobically at 30ºC for 24 hours. *Salmonella-Shigella* Agar was used to enumerate total *Salmonella* population. The medium was incubated aerobically at 30ºC for 24 hours; however, presence of black colonies indicated *salmonella* species. After incubation, the colonies that grew on the medium were counted and expressed as colony forming units (cfu)/g of the samples

2.6 Statistical Analysis

Bacterial counts were log transformed before subjecting the results to general linear model using SPSS version 16 (SPSS Inc, Chicago, USA). Mean separation was carried out using Least Significant Differences (LSD).

3. RESULTS AND DISCUSSION

The population of microbes in the gastrointestinal tract (GIT) of the chicken before and after the administration of ginger extract is presented in Table 2. Before the administration of ginger, *Salmonella* population was highest at the crop 1.852 Log cfu/g and decreased afterwards being 1.744 Log cfu/g at the ileum and 1.710 Log cfu/g at the caecum. *E. coli* was 1.789, 1.821 and 1.727 Log cfu/g at the crop, ileum and caecum respectively. *E. coli* accounted for over 90% of the coliform population, hence they exhibited the same pattern. Lactobacillus was highest at the crop (1.933 Log cfu/g) and declined through the ileum (1.842 Log cfu/g) to the caecum (1.705 Log cfu/g). This pattern is unusual because microbial population tend to increase from the proximal portion of the GIT to the distal [5]. The reason for this unusual pattern is unknown. The population of microbes in the GIT obtained in this study is comparable to what Ohimain and Ofongo [5] reported on the population of coliform in the crop (7.10 Log cfu/g), ileum (7.20 Log cfu/g) and caecum (7.05 Log cfu/g), *E. coli* in the crop (7.05 Log cfu/g), ileum (7.02 Log cfu/g) and caecum (6.98 Log cfu/g), and *Lactobacillus* in the crop (6.63 Log cfu/g), ileum (6.66 Log cfu/g) and caecum (6.73 Log cfu/g) of broiler chickens.

One week after the application of ginger extract, the population of microbes in the GIT declined with respect to the control. In the crop, ileum and Caecum, *Salmonella* population was significantly lower ($P<0.05$) with respect to the control (Table 2) and samples obtained before ginger treatment (Table 3) except at the ileum where the difference was insignificant ($P>0.05$). Coliforms, *E. coli* and Lactobacillus are beneficial organisms [5] Hence, the ginger didn't discriminate,

Table 2. Microbial population in the gastrointestinal tracts of the birds before and after administration of aqueous ginger (log cfu/g)

Bacterial species	Before Treatment, cfu/g Log	After treatment			P. value
		Treatment with ginger, cfu/g Log	Control, cfu/g Log	SEM	
CROP					
Salmonella	1.852	1.778[b]	1.853[a]	0.032	0.056ns
Escherichia coli	1.780	1.794[b]	1.860[a]	0.000	0.001***
Coliform	1.796	1.797[b]	1.908[a]	0.045	0.002***
Lactobacillus	1.933	1.740[b]	1.988[a]	0.057	0.032***
ILEUM					
Salmonella	1.744	1.744[b]	1.842[a]	0.020	0.001***
Escherichia coli	1.821	1.725[b]	1.739	0.028	0.280[ns]
Coliform	1.844	1.762	1.835[a]	0.020	0.000***
Lactobacillus	1.842	1.809[b]	1.906[a]	0.045	0.053***
CEACUM					
Salmonella	1.710	1.740	1.815	0.092	0.438ns
Escherichia coli	1.727	1.750[b]	1.836[a]	0.000	0.000***
Coliform	1.851	1.774	1.890	0.045	0.037[ns]
Lactobacillus	1.705	1.755[b]	1.885[a]	0.045	0.017***

abc: means along the same row with different subscripts are significantly ($p<0.05$) while ns means not significant ($p>0.05$).

Table 3. Comparison of the population of microbes before and after ginger treatment

Bacterial species	*Salmonella*	*E. coli*	Coliform	*Lactobacillus*
CROP				
Before	1.852e	1.780d	1.796c	1.933f
After	1.778d	1.794e	1.797c	1.740b
ILEUM				
Before	1.744c	1.821f	1.844d	1.842e
After	1.745c	1.725a	1.762a	1.809d
CEACUM				
Before	1.710a	1.727b	1.851e	1.705a
After	1.740b	1.750c	1.774b	1.755c

but resulted in the decline of both beneficial and detrimental microbes, unlike mushroom based products that have been demonstrated to eliminate detrimental microbes particularly *Eimeria*, *Salmonella* and *E. coli*, while enhancing beneficial microbes particularly Bifidobacteria and Lactobacillus [3,30,31]. Ginger have been demonstrated to be effective against pathogenic bacteria particularly *Salmonella* [29] and *E. coli* [16,19,20,23].

4. CONCLUSION

The use of antibiotic growth promoter is restricted in many countries due to the problem of antibiotic resistance. Farmers and the scientific community have intensified research into the development of alternative products for the control of infection in poultry. Botanicals have received considerable attention for use both in humans' health and livestock. Hence, this study focused on the use of aqueous extracts of ginger for the control of pathogenic bacteria. Results obtained show that ginger extract cause the decline of pathogenic (*Salmonella, E. coli* and coliforms) and beneficial microbes (*Lactobacillus*). Hence, it is recommended that the use of ginger for the control of infection is plausible but its use must be modified to prevent killing of beneficial microbes in the broiler GIT.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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