EFFECT OF VARYING DIETARY LEVELS OF BENZOIC ACID ON CARCASS CHARACTERISTICS AND INTESTINAL MICROBIOTA OF FINISHER BROILERS

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ABSTRACT

A four -week study was conducted to evaluate the effect of varying dietary levels of benzoic acid on carcass characteristics and intestinal microbiota of broiler birds. A total of 120 day-old unsexed "Arbor acre" strain of broiler chicks was randomly assigned to five treatment groups. Each treatment group contained 24 birds replicated three times with 8 birds per replicate in a completely randomized design (CRD). The five treatments were designated as follows: Treatment 1,0g benzoic acid; Treatment 2, 2.5g benzoic acid per kg of feed; Treatment 3, 5.0g benzoic acid per kg of feed; Treatment 4, 7.5g benzoic acid per kg of feed and Treatment 5, 10g benzoic acid per kg of feed. Feed and water were provided ad libitum to the birds. At the end of the feeding trial, 3 birds from each treatment were selected, starved overnight and slaughtered for carcass and gut microbiota evaluation. Results showed that dietary levels of benzoic acid had no significant ($p > 0.05$) effect on dressed weight, dressed percentage, back cut, spleen, and kidney of birds, but had significant ($p < 0.05$) increase in the live weight, weights of the breast, thigh, wing, shank, drumstick and heart. Dietary treatments also decreased Escherichia coli, Salmonella spp and Bifidobacteria and increased Lactobacillus significantly ($p < 0.05$). It was concluded that up to 10g of benzoic acid can be included in the diet of broiler birds for increase in live weight and carcass yield without any deleterious effect on birds.

Keywords: Broiler birds, diet, benzoic acid, carcass, gut microbiota.

INTRODUCTION

Poultry production plays a pivotal role in meeting the ever-increasing global demand for high-quality animal protein. Broiler meat production provides employment and regular income for entrepreneurs through its value chain activities. Traditionally, antimicrobials have been widely used for improving health and growth performance in poultry; however, increased public awareness about the risk of developing cross-resistance of pathogens to antibiotics has resulted in the gradual removal of antibiotics for therapeutic and prophylactic uses in food animals (Ricke *et al.,* 2020). Alternative feed additives such as a broad spectrum of essential oils and related compounds from botanical sources to organic acids (Zhai *et al.,* 2018), probiotics and prebiotics (Al-Khalaifah, 2018), bacteriophage (Li *et al.,* 2020), have been used in animal production. The inclusion of organic acids such as benzoic acid in the broiler feed has been shown to enhance feed intake, growth, and feed efficiency in broilers (Khan *et al.,* 2022). Benzoic acid which is explored in the present study is an organic acidifier, a colourless crystalline solid, and the simplest aromatic carboxylic acid. Benzoic acid plays an important role in lowering numbers of pathogenic bacteria like *Escherichia coli*, *Campylobacter jejuni,* and *Salmonella*, which competes with the host animal for nutrients (Józefiak *et al.,* 2016). Besides its bacteriostatic feature, benzoic acid helps reduce ammonia, thereby stimulates growth in broiler birds. It also helps to increase gastric proteolysis and improve digestibility of protein and amino acid in young broiler birds, thereby improving the feed efficiency and growth performance of broiler birds (Hassan and Raheem, 2016). Against this backdrop, the present study was designed to evaluate effect of varying dietary levels of benzoic acid on carcass characteristics and intestinal microbiota of broiler birds

MATERIALS AND METHODS

The study was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. All experimental procedures in the present study were performed according to the guidelines for the use of animals in biomedical research as described by the Ethical Research Committee of the University of Nigeria, Nsukka. The commercial finisher broiler feed used for the experiment contained 3150kcal metabolizable energy, 20% crude protein, 1.2% calcium, 0.5% phosphorus, 4% crude fibre, 1.15% lysine and 0.5% methionine. The feed and the benzoic acid used for the experiment were procured from commercial ventures in Nsukka town in Enugu State, Nigeria. A total of 120weeks old finisher broiler birds of mixed sexes were used for the study. The birds were randomly allotted to five treatment groups of 24 birds each, and assigned to five treatments using a completely randomized design (CRD). The treatments (1,2, 3, 4 and 5) contained 0g benzoic acid, 2.5g benzoic acid, 5.0g benzoic acid, 7.5g benzoic acid, and 10g benzoic acid per kg of feed, respectively. Each treatment group was replicated three times with 8 birds per replicate. Feed and water were provided to the birds *ad libitum*. At the end of the 4-week feeding trial, 3 birds from each treatment were selected, starved overnight and slaughtered for carcass evaluation. Immediately after slaughter, the feathers were plucked and the gastrointestinal tract (GIT) was removed. The carcass was weighed to obtain the carcass weight of the birds. For the measurement of carcass cuts, the shank was removed close to the skull and at hock joint, respectively. Wings were removed by cutting at the humeroscapular joint, the cuts were made through the rib head to the shoulder girdle, and the vertebrate was removed intact by pulling outwardly. The breast muscle, wing, shank, drumstick, thigh, back cut was weighed using a 0.1 kg precision weighing balance. For the intestinal microbiota evaluation, the abdominal cavity was opened and the entire gastro intestinal tract was removed aseptically. The digesta contents of the caecum were collected immediately under aseptic conditions into sterile glass bags and put on ice before they were immediately transported to the laboratory for enumeration of microbial population. Data collected were subjected to one-way analyses of variance (ANOVA) for completely randomized design (CRD) using a Stat Graphic Computer Package (SPSS, 2007) Model. Significantly different means were separated using Duncan's New Multiple Range Test (Duncan, 1955) option in SPSS.

RESULTS AND DISCUSSION

Table 1 shows the effects of varying dietary levels of benzoic acid on carcass characteristics, weights of internal organs and gut microbiota of broiler chickens. Dietary levels of benzoic acid had no significant ($p > 0.05$) effect on dressed weight, dressed percentage, back cut, spleen, and kidney of birds. However, dietary inclusion of benzoic acid significantly ($p < 0.05$) increased the live weight, weights of the breast, thigh, wing, shank, drumstick and heart. Birds fed diets containing 2.5g benzoic acid per kg of feed and 5.0g benzoic acid per kg of feed (T2 and T3, respectively) had similar liveweights (3211 g and 3252 g, respectively), breast weights (901.50 g and 1006.50 g, respectively), and shank weights(77.5 g and 78.00g, respectively) and these were significantly($p < 0.05$) higher than the live weight, breast weight, and shank weight((2631.50 g, 664.5 g and 48.50g, respectively) recorded for birds fed the control diet(0g benzoic acid per kg of feed).

Table 1: Effects of benzoic acid on the carcass characteristics, weights of internal organs and gut microbiota of broiler chickens

Treatments*/Parameters	T1	T2	T3	T4	T5	SEM
Live weight (g)	2631.50^{b}	3211.50^{a}	3252.00^{a}	2877.00^{ab}	2743.50^{ab}	96.56
Dressed weight (g)	2058.50	2628.50	2640.50	2219.00	2144.00	98.52
Dressed percentage (%)	78.20	81.84	81.07	77.15	78.06	1.02
Breast (g)	664.50^{c}	901.50^{ab}	1006.50^{a}	845.00^{abc}	760.00^{bc}	42.23
Thigh (g)	147.00^{c}	201.00^{b}	235.50^{a}	184.00^{b}	171.00^{bc}	10.34
Wing (g)	111.50^{b}	132.00^{ab}	150.00^{a}	136.00^{ab}	129.00^{ab}	4.82
Shank (g)	48.50^{b}	77.50^{a}	78.00^{a}	67.50^{ab}	59.00^{ab}	4.23
Back cut (g)	316.00	452.50	460.50	409.00	414.00	23.12
Drumstick (g)	137.50^{c}	178.50^{ab}	200.50^{a}	165.00^{b}	161.50^{bc}	7.33
Heart (g)	10.00^{b}	14.50^{a}	12.50^{ab}	12.00^{ab}	11.50^{ab}	0.50
Spleen (g)	2.50	4.00	4.00	2.50	2.00	0.37
Kidney (g)	10.50	13.00	12.00	11.00	10.50	0.50
Escherichia coli	9.55^{a}	1.70^{c}	1.75^{c}	6.95^{b}	6.40^{b}	1.04
Salmonella	8.25^{a}	6.65^{b}	5.75^{c}	2.20^{d}	1.45^{e}	0.87
Lactobacillus	5.35^{c}	6.80^{b}	7.10^{ab}	8.15^{a}	7.45 ^{ab}	0.43
Bifidobacteria	4.20^{a}	3.45^{b}	3.80^{b}	2.85^{d}	2.50^{c}	0.21

Means in the same row different superscripts (^{abc}) are significantly different.
*Treatments 1,2, 3, 4 and 5 contained 0g benzoic acid, 2.5g benzoic acid, 5.0g benzoic acid, 7.5g benzoic acid, and 10g benzoic acid per kg of feed, respectively.

thigh, wing, shank, drumstick and heart of birds. The observed increase tends to suggest that benzoic acid is a desirable feed additive in broiler nutrition. Increase in body weight of broilers fed diets supplemented with benzoic The heart weight (14.5 g) of birds fed diet containing 2.5g benzoic acid per kg of feed(T2) was significantly ($p < 0.05$) higher than that (10.00 g) recorded for birds fed the control diet. All the intestinal flora (*Escherichia coli, Salmonella, Lactobacillus, and Bifidobacterium*) examined in the study were significantly ($p < 0.05$) affected by treatments. Birds fed the control diet had significantly ($p < 0.05$) higher gut populations of *Escherichia coli, Salmonella and Bifidobacterium* and lower gut population of *Lactobacillus* than those fed diets containing benzoic acid. As shown in Table 2, dietary inclusion of benzoic acid significantly ($p < 0.05$) increased live weight, acid had been reported (Gong *et al*., 2021; Seifi *et al.,* 2015). The putative mechanism underlying the observed increase may be related to benzoic acid's potential to stimulate appetite and enhance feed utilization efficiency (Seifi *et al.,* 2015). The present observation is consistent with previous observations of increased carcass yield in broilers fed diets supplemented with organic acids (Kaya *et al.,* 2014). Mechanistically, organic acid additives such as benzoic increase carcass yield by stimulating nutrient digestion and absorption, as well as protein synthesis, resulting in increased muscular and tissue development (Nourmohammadi *et al*. 2011; Saleem *et al*., 2020; Dauksiene *et al*., 2021; Ogwuegbu *et al*., 2021). As presented in Table 3, dietary treatments decreased *Escherichia coli*, *Salmonella spp* and *Bifidobacteria* and increased *Lactobacillu*s significantly ($p < 0.05$). According to Ogwuegbu *et al*. (2021) dietary organic acids improved intraluminal digestibility of mineral, protein and energy by reducing microbial competition with the host for nutrients and endogenous nitrogen losses, by lowering the incidence of subclinical infections and secretion of immune mediators, by reducing the production of ammonia and other growth depressing microbial metabolites. Vinus and Tewatia (2017) had also reported that benzoic acid possesses antimicrobial and antioxidant attributes which could enhance enteric absorption of amino acids.

CONCLUSION

It is evident from the results obtained in the present study that up to 10g of benzoic acid can be included in the diet of broiler birds for increase in live weight and carcass yield without any deleterious effect on birds.

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