APRW -64

Effect of Graded Level of Dietary Supplementation of Citric Acid on Performance and Serum Biochemistry of Broiler Chickens

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Abstract
This study was conducted to evaluate the effects of antibiotics and graded levels of citric acid as growth promoting agent on growth performance, carcass attributes and serum lipid profile of broiler chickens. 300 day-old arbor acre broiler chicks were allocated to five treatments; each treatment had six replicates with ten birds per replicate. The experimental diets are as follows: Treatment 1- basal diet + oxytetracycline (positive control), Treatment 2- basal diet (negative control), Treatment 3- basal diet + 1% citric acid, Treatment 4- basal diet + 2% citric acid, Treatment 5- basal diet + 3%citric acid. There were no significant differences in weight gains and FCR of birds fed a basal diet with antibiotics, and. a basal diets with citric acid. However, basal diets with 1% citric acid had highest weight gain. Birds fed basal diet only had the least weight gain which is significantly different from other treatments. The result of triglyceride, cholesterol, HDLc, LDLc and VLDLc values were not significantly different across the treatments ($p>0.05$). From this study, we can infer that antibiotics as a growth promoting agent may conveniently be replaced with citric acid to enhance broiler chickens performance.

Keywords: Antibiotics, citric acid, serum lipid profile, antibiotic resistant, broiler chickens

Introduction

The broiler chickens industry has been one of the most dynamic, ever expanding and an important economic activity in many countries, Nigeria inclusive. Broiler chickens performance and feed efficiency are closely interrelated with the qualitative and quantitative microbial load of the broiler chicken gut, the morphological structure of the intestinal wall (Bellaver and Scheuermann, 2004). The broiler chicken producers and researchers are increasingly searching for feed additives in order to improve the gut health and feed efficiency. Antimicrobial compounds have been used in broiler chickens industry to improve health status and performance of broilers by reduction or correction of the population of the bacteria present in the gastrointestinal tract (Bellaver and Scheuermann, 2004). Although antibiotics possess beneficial effects, their use as growth promoters in the poultry industry has been intensively controversial because of the development of bacterial resistance and potential consequences on human health.

Consequently, the focus in research has shifted to natural feed additives as alternatives to antibiotics in poultry diets, primarily to ensure good gut health. The alternative feed additives include products such as enzymes, herbal products, microflora enhancers, immunomodulators, organic acids, probiotics, prebiotics or combinations of these products. Among these, the organic acids (citric acid, acetic acid, propionic acid, formic acid) may be the most promising alternatives for poultry (Gunal *et al*., 2006).

The benefits of the use of citric acids in animal feeding may be explained by several mechanisms, including pH reduction, bacteriostatic properties, and metabolic effects of the anionic portion of the acids after their dissociation (Bellaver and Scheuermann, 2004). These properties may potentially improve broiler intestinal integrity and eventually performance. The use of citric acid creates an acidic environment (pH 3.5 to 4.0) in the gut, which favors the development of lactobacilli and inhibits the replication of *Escherichia coli*, *Salmonella*, and other gram-negative bacteria. It also decreases pH of cecal digesta, crop and gizzard and intestine (Denli *et al.,* 2003) in broiler chicks. Feeding citric acids is thought to have several positive effects such as improving protein digestion (Emami *et al*., 2013), feed conversion ratio (FCR), growth performance, immunity (Chowdhury *et al*., 2009; Khan and Iqbal, 2016) and enhancing mineral absorption (Nourmohammadi *et al*., 2012; Wickramasinghe *et al.,* 2014).

Therefore this study was planned towards investigating the potential of citric acid as a substitute for antibiotics as growth promoters in broiler chicken production especially in areas of performance, carcass attributes and serum biochemistry.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm, University of Ibadan, Nigeria, and lasted for a period of 6 weeks. Birds were allocated to five treatments; each treatment had six replicates with ten birds per replicate making a total of 300 birds. The experimental diets are as follows: Treatment 1- basal diet + oxytetracycline (positive control), Treatment 2- basal diet (negative control), Treatment 3- basal diet + 1% citric acid, Treatment 4- basal diet + 2% citric acid, Treatment 5- basal diet + 3%citric acid.

Table 1 Gross composition of starter diet for broiler chickens fed different levels of citric acid broiler starter and finishers

Ingredient	Starter	Finisher
Maize	56	61
Soybean meal	35	30
Soybean oil	2.7	35
Wheat bran	2.45	2.2
Dicalcium phosphate	1.5	1
Limestone	1.1	1.15
Di Methionine	0.10	0.10
Salt	0.30	0.30
Vitamin premix	0.25	0.25
L- Lysine	0.05	0.05
Total	100	100
Calculated nutrients (%)		
Crude protein	21.345	19.60
ME Kcal/kg	3001.39	3121.94
Crude fiber	3.245	3.645
Calcium	1.024	1.054
Total phosphorus	0.657	0.585
Ca:P	1.576	1.802
Energy: Protein	140.594	159.28

*ME=Metabolizable energy;

Composition of vitamin premix per kg of diet; vitamin A,12,500 I.U; vitamin D 2,500 I.U; vitamin E, 40 mg, vitamin K3, 2 mg; vitamin B13, mg; vitamin B2 5.5 mg; calcium panthothenate11.5 mg; vitamin B6, 5 mg; vitamin B12 0.025 mg; choline chloride, 500 mg; folic acid, 1 mg; Biotin 0.08 mg; manganese120 mg; iron 100 mg; zinc 80 mg; copper, 0.8 mg; iodine,1.5 mg; cobalt, 0.3 mg; selenium, 0.12 mg; antioxidant,120 mg.

Chickens were weighed on 42 days to determine average body weight (BW). Feed intake (FI) per cage was recorded on the same date and feed conversion ratio (FCR) was calculated for all periods. At 42 d of age, two birds of each replicate were killed to measure the relative weight of primal cut.

Data were analyzed as a completely randomized design using the ANOVA Procedures of Statistical Analysis System software (SAS, 2005) and means were compared using Duncan's multiple range tests. A single cage represented the experimental unit (replicate) for all measured parameters. The results were presented as means and SEM calculated by standard procedures. Differences among treatments were considered significant when $p<0.05$.

Results and Discussion

The results of citric acid on broiler chickens performance are presented in Table 2. This study confirmed that citric acid can enhance poultry performance as much as antibiotic can and so can serve as an alternative to antibiotics in poultry production. The observation of this study agrees with the findings of Galib and Aqeel (2009) who recorded improved weight gains in broiler birds fed formic acid. There was no significant difference in weight gains of birds fed a basal diet with antibiotics, and basal diet with citric acid. However, It is observed that birds supplemented with 1% citric acid has highest weight gain which is significantly different from other treatments while the birds fed with basal diet only has the least weight gain, intestinal pH effects raising pepsin activities and other pancreatic secretions for increased protein, energy and mineral digestion and absorption. This is also, in agreement with (Boling *et al*., 2000; Chowdhury *et al*., 2009) who observed higher weight gain in broiler chickens fed organic acids, and probiotics, respectively, compared with controls, considering the period between one and 42 days of age. The improved body weight in birds supplemented with citric acid may be due to improved utilization of nutrients.

Highest very low-density lipoprotein cholesterol was recorded for birds fed basal diet T2 (22.80) while lowest very low density lipoprotein cholesterol was recorded for birds fed basal diet with 2% citric acid (13.548). Lowest low-density lipoprotein was recorded for birds fed basal diet with 1% citric acid (21.361) while highest level low-density lipoprotein was observed in birds fed basal diet only (36.370).

Table 2: performance characteristics of broiler birds fed dietary supplementation of citric acid

Parameters	T1	T2	T3	T4	T5	SEM	F value	P value
Weight gain(g/bird)	1141.19^{b}	782.48^{c}	1290.16^{a}	1154.15^{b}	1152.29^{b}	34.035	37.95	<0.0001
Feed intake (g/bird)	2194.83^{a}	2022.17^{b}	2191.4^{a}	2194.83^{a}	2197.29^{a}	18.387	5.92	0.0017
FCR. (g/bird)	1.93^{b}	2.59^{a}	1.71^{c}	1.90^{b}	1.89^{b}	0.056	36.11	<0.0001
Mortality (g/bird)	2.22^{ab}	3.61^{b}	1.94^{b}	1.39^{b}	1.39^{b}	0.24	3.07	0.0347

Means with the same superscripts are not significantly different ($p<0.05$)

Treatment 1= basal diet with antibiotics (positive control)

Treatment 2= basal diet only (negative control)

Treatment 3= basal diet with 1% citric acid

Treatment 4= basal diet with 2% citric acid

Treatment 5= basal diet with 3% citric acid

Means with the same superscripts are not significantly different ($p<0.05$)

Conclusion

In conclusion, this study demonstrated, the outstanding effects of using citric acid as feed additives to improve the performance of broilers as a result of improved feed intake, good feed conversion ratio and improved body weight gain of the experimental birds.

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