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Effects of water acidification on growth response and serum biochemical indices of broiler chicken

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Target Audience: Poultry farmers, nutritionist, researchers, extension officers

Abstract

An experiment was conducted with 180 unsexed day-old Arbor acre breed of broilers to evaluate the effects of water acidification on the growth response and serum biochemical indices of broiler chicken in a 49 days feeding trial. The birds were randomly distributed into 5 dietary treatments of 36 birds per treatment which were further distributed into 3 replicates in a Completely Randomized Design (CRD). The birds in control (T_1) were served with ordinary water (i.e water without any organic acid), while other groups were served with acidified water containing 4% Acetic acid (T_2), 4% Citric acid (T_3), 4% Formic acid (T_4) and 4% Lactic acid (T_5) respectively. All birds were vaccinated while only the control group (T_1) was medicated with antibiotics. Data were collected on weight gain, feed intake, and water intake, while blood sample were collected for serum biochemical assay. The results of growth response revealed significant differences ($P<0.05$) in the values obtained for final weight, weight gain, feed intake and average daily water consumption, while all other parameters were not significant ($P>0.05$). Final weight ranged (1.90 – 1.56kg/bird), weight gain (1.79 – 1.42kg/bird), Feed intake (4.16-4.70kg), daily water intake (87.10-129.22ml/bird/day). Among the serum biochemical indices evaluated only Alanine amino transferase (ALT), glucose, cholesterol and uric acid were significantly influenced by the dietary treatment. It can therefore be concluded that serving broiler chicken with water containing 4% citric acid compared favourably with the control in terms of growth response. Also serving broilers with acidified water does not have any detrimental effects on their serum biochemical indices.

Key words: Growth response, Serum, water acidification, organic acid.

Description of Problem

The practice of feeding livestock with sub-therapeutic levels of antibiotics for improving performance, reducing some pathogenic microorganisms in the intestinal tract has been in used for over fifty years (1). However, antibiotics used as growth promoter in animal feeds have been banned recently due to possible development of both drug resistance, cross resistance and multiple resistances (2). With the removal of antibiotic growth promoters from livestock diets in different parts of the world, numerous additives are now being used or proposed as means to reduce or eliminate pathogens or to improve growth (3). They include

Probiotics(4), Organic acids (5), Enzymes (6) and Phytogenics (7).

Organic acids are weak acids, which modulate the intestinal pH when these compounds are used correctly along with good nutritional management and Biosecurity measures. They could be a powerful tool in maintaining the health of the Gastro Intestinal Tract (GIT) in poultry thus improving the performance (8).

In the guts there are pathogenic bacteria, but the balance between pathogenic and beneficial bacteria determines whether or not disease will occur. The acids considered beneficial to the guts, including lactic acids which prevent proliferation of pathogens, such as *Salmonella spps*, through competitive exclusion for nutrients and for receptor sites on the guts wall (9). Apart from the antimicrobial activity they reduce the pH of digesta, increase the pancreatic secretion and have trophic effects on the mucosa of gastro-intestinal tract (10). (11) suggested that the reduction in gastric pH which occurs following feeding organic acids may increase pepsin activity. Moreover, feeding organic acids is thought to have several positive effects such as improving protein digestion (12), feed conversion ratio (FCR), growth performance, immunity (13;14) and enhancing mineral absorption (15; 16) Citric acid (CA) and Acetic acid (AA) have been used in diets due to their positive effect on bird's health and growth (17). Broiler chicken fed diets supplemented with 2% butyric acid, 3% butyric acid , 2% fumaric acid,3% fumaric acid, 2% lactic acid, and 3% lactic acid improved body weight gains and feed conversion ratio irrespective of type and level of acid used (Sheikh et al.,2010)

Organic acid treatments composed of individual acids and blends of several acids that have been found to process antimicrobial activities similar to those of antibiotics (18). Currently, drinking water acidification is another implementation in the broiler industry used for improving performance (19). Addition of organic acid to the drinking water helps to reduce the level of pathogens in the water and the crop/ proventiculus to regulate gut microflora, to increase the digestion of feed and to improve growth performance.

Materials and Methods

Experimental location

The research was carried out at the Poultry research unit of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Nigeria. The site is located in the rain forest zone of South-western Nigeria on longitude 7^0 23^1 and latitude 4^0 53^1 E and 76m above sea level. The climate is humid with a mean annual rainfall of 1037mm and mean temperature of 34.7^0C, respectively. (20).

Experimental Plan

A total of one hundred and eighty day old chicks of Arbor Acre stain were randomly allotted five treatment groups of 30 birds per treatment which were further divided into 3 replicates of 12 birds per replicate in a Completely Randomized Design. The birds were brooded together for 7 days before the commencement of the experiment. Treatment 1 served as the control and contained 0% Organic acid, while T_2, T_3, T_4, and T_5 were served with water containing 4% acetic, citric, formic and Lactic acids respectively. The dose of the organic acids were determined according to (Sheikh et al.,2010)21 who found that Broiler chicken fed diets supplemented with 2% butyric acid, 3% butyric acid , 2% fumaric acid,3% fumaric acid, 2% lactic acid, and 3% lactic acid improved body weight gains and feed conversion ratio irrespective of type and level of acid used.

All the treatments except the control were not medicated with antibiotic throughout the experimental period. However, vaccination programme were strictly adhere to.

Experimental birds were offered 2 rations (starter from 1-21days of age and finisher from 22-56 days of age). Both the diets were formulated to meet the nutrients requirements of broiler chicken according to (22).

Table1: Gross composition of broiler starter and finisher diets

Parameters (%)	Starter	Finisher
Maize	53.80	63.50
Soybean meal	26.50	16.80
Full fat soybean meal	15.00	15.00
Bone	2.00	2.5
Limestone	1.50	1.5
Lysine	0.10	0.10
Methionine	0.10	0.10
Salt	0.25	0.25
Premix	0.25	0.25
Total	**100.00**	**100.00**
Crude protein	22.21	20.52
Metabolisable energy	2975.59	3012.64
Crude fibre	3.74	2.86
Ether extract	3.64	3.49

Data collection

Blood collection and evaluation: At the end of the feeding trial, blood samples were collected from experimental birds through the wing web vein into a well labeled sterile bottle without EDTA, immediately covered and centrifuged, Serum separated out, decanted, deep-frozen for serum biochemical analysis as outlined by (23)

Statistical analysis

Data generated were subjected to analysis of variance using SAS statistical package (24). The mean where significant, was separated using Duncan's multiple range tests (25).

Results and Discussion

The result of effects of water acidification on the growth response of broiler chicken is as presented in Table 2. All parameters evaluated were significantly ($P<0.05$) influenced by the dietary treatments. Birds on 0% organic acid had the highest value for final weight (1.90kg/bird), while those served with 4% acetic acid had the lowest (1.42kg/bird). Birds served with citric acid and Lactic acid had significantly similar weight which were lower than what was obtained for birds on control, but higher than those served with acetic and formic acid.

Table 2: Growth Response of Broiler Chicken Serve Acidified Water

Parameters	T1	T2	T3	T4	T5	SEM±
	Control (0%)	Acetic (4%)	Citric (4%)	Formic (4%)	Lactic (4%)	
Initial weight (kg/bird)	0.12	0.11	0.12	0.14	0.12	0.01
Final weight (kg/bird)	1.90^{a}	1.56^{d}	1.82^{b}	1.64^{c}	1.76^{b}	0.03
Weight gain	1.79^{a}	1.42^{d}	1.70^{b}	1.53^{c}	1.64^{b}	0.04
Feed intake	4.70^{a}	4.16^{b}	4.66^{a}	4.35^{ab}	4.28^{ab}	0.08
Feed conversion ratio	2.63	2.94	2.75	2.86	2.63	0.05
Water intake (ml/bird/day)	129.22^{a}	91.37^{b}	135.57^{a}	87.10^{b}	118.64^{b}	6.02
Mortality %	9.14	9.14	9.76	9.17	10.18	0.27

$^{a, b, c}$ *Means along the row with different superscript significantly different ($P<0.05$)*
SEM: Standard Error of Mean

However, birds on 4% formic acid consumed the lowest quantity of water (87.10 ml/bird/day), while those on 0% organic acid consumed the highest quantity of water (135.57 ml/bird/day). In this study, citric acid supplementation increased body weight and feed intake of broiler chicken. Improvements in the growth performance are frequently

attributed to the composition and activity of the gut microflora which regulate nutrient utilization (26). Supplementation of organic acids in drinking water helps to reduce the level of pathogens in water, crops and the proventiculus, regulate the gut microflora, increase feed digestion and improve growth performance of birds (27). Furthermore, it has been reported that dietary organic acids such as citric acid increase body weight (11, 28, and 29), feed consumption (30. 19; 31) of broilers. However, other studies reported that supplementation of butyric acid, lactic acid, acetic acid or formic acid to feed or water has no effect on performance of chickens (14; 32).

Results of serum biochemical indices (Table 3) indicated revealed that Glucose, Cholesterol, Uric acid and Alanine aminotransferase (ALT) were significantly ($P<0.05$) influenced by the organic acids, while all other parameters measured were not significant. The value obtained for Glucose ranged (140.24 – 181.70 mg/dl), cholesterol (44.85 – 84.31mg/dl), urea (3.48 – 6.64 mg/dl) and ALT (8.52 – 11.85 u/L). Serum biochemical indices may provide useful information for the evaluation of the health status of birds and reflect many metabolic alterations of organs and tissue (33). Total protein and albumin tests are usually used to evaluate the health status of the animal. These tests are often used in diagnosing diseases and in monitoring changes in health status of farm animals. The total protein is a composition of albumin and globulin content in the blood and is a reflection of nutritional status of the birds, low level of albumin indicates incidence of diseases related to the liver and kidney. It could also be associated with the presence of infections (34). The non significant ($P>0.05$) difference recorded in these parameter is an indication that the organic acids were well tolerated by the animals.

Table 3: Serum Biochemical Indices of Broiler Chicken Served Acidified Water

Parameters	T1	T2	T3	T4	T5	SEM±
	Control(0 %)	Acetic (4%)	Citric (4%)	Formic(4%)	Lactic (4%)	
Total Protein (g/dl)	3.79	4.10	4.04	4.04	4.10	0.09
Albumin (g/dl)	2.38	2.41	2.31	2.46	2.00	0.09
Globulin (g/dl)	1.41	1.69	1.73	1.58	2.10	0.11
Albumin: Globulin	1.78	1.53	1.38	1.60	1.04	0.13
Glucose (mg/dl)	181.70^{a}	165.23^{ab}	140.24^{b}	154.83^{ab}	160.72^{ab}	5.75
Cholesterol (mg/dl)	48.50^{b}	55.71^{b}	44.85^{b}	59.27^{b}	84.31^{a}	4.48
Uric acid (mg/dl)	4.64^{b}	4.62^{b}	4.61^{b}	6.64^{a}	3.48^{b}	0.34
AST (u/L)	42.83	38.38	40.76	50.51	47.16	2.60
ALT (u/L)	8.52^{b}	11.44^{a}	10.02^{ab}	11.75^{a}	11.85^{a}	0.41
Creatinine (mg/dl)	1.19	1.40	1.40	1.10	1.10	0.07

^{a,b,c} means along the same row with different subscript are significantly different ($p<0.05$).
AST: Aspartate Amino Transferase
-ALT: Alanine Amino Transferase

A significant ($P<0.05$) difference was observed in ALT activity, but they were lower than the physiological values reported for normal chicken by (35). Since liver is reported to contain enzymes like ALT and AST, it releases these enzymes to the blood when damage (36). Elevation of ALT and AST can occur with state of altered hepatocellular membrane,

permeability due to circulatory hypoxia, exposure to toxins and toxemia, inflammation, metabolic disorders or proliferation of hepatocytes (37). Hence the non-significant ($P>0.05$) difference among the treatments in serum AST in the present study may reflect normal liver function of the birds served with 4% organic acids. Birds served with 4% formic acid had significantly ($P<0.05$) higher uric acid value than those served other organic acids. The findings of uric acid are coincide with (38) who revealed that dietary addition of organic acid slightly reduced serum concentration of uric acid. This result could be referred to the better utilization of protein and amino acid digestibility. As uric acid is the major end product of protein metabolism.

Conclusion and Applications

1. Organic acids improved the performance of broiler chicken and also resulted into comparable feed conversion ratio with the control.
2. The serum biochemical indices revealed that organic acids do not have any negative effects serum biochemical parameters.
3. Farmers can include organic acids in the water of their broilers for improved performance and health status.

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