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Response of broiler chickens to administration of water containing different concentrations of Hydrochloric acid at two age groups

***Jiya, E.Z, Ayanwale, B.A, Adegboye, E. A. and Alabi, O. J.**

Department of Animal Production, Federal University of Technology Minna

Abstract

An eight weeks (56 days) experiment was conducted to evaluate the response of broiler chickens to water treated with different concentrations of hydrochloric acid (HCl) at two age groups (5 to 56 days and 21 to 56 days). Two hundred and forty Abor-Acre broiler chicks were used and randomly allotted to two age groups (5 to 56 days and 21 to 56 days) and four treatments which were replicated three times with 10 birds per replicate. Treatments 1, 2, 3 and 4 contained HCl concentrations of 0 ppm, 1500 ppm, 2500 ppm and 3500 ppm, respectively, in drinking water. The birds were managed on deep litre system and fed *ad libitum*. The results from group 1 (day 5 to 56 days of different concentrations of HCl inclusion in water) showed no significant ($P>0.05$) difference in feed intake and feed conversion ratio at the starter phase. However, final body weight and body weight gain were significantly ($p<0.05$) different. At the finisher phase all the parameters measured were significantly ($p<0.05$) affected. The results from group two (day 21 to 56 days of different concentrations HCl inclusion in water), final body weight, body weight gain and weekly feed intake were significantly ($p<0.05$) different. In finisher phase, there was no significant ($p<0.05$) difference in feed intake. However, there were significant ($p<0.05$) difference in final body weight, body weight gain, weekly hydrochloric acid treated water intake and feed conversion ratio. The results of the nutrient digestibility showed significant differences ($p<0.05$) in all the parameters measured in the phases (days 5-56 and 21-56) respectively. It is therefore recommended that lower concentrations of hydrochloric acid of 1500ppm given from younger stage holds the potential to be used as growth promoter supplement in broiler chickens.

Keywords: Response; Broiler chickens; Water; Concentrations; Hydrochloric acid
*Corresponding Author jiya.elisha@futminna.edu.ng/ez_jiya@yahoo.com

Introduction

In Nigeria, broilers hold a prospect for improving the daily required protein of an individual which has for long being very low (FAO, 2001). Broilers are more excellent in feed-meat conversion ratio than many livestock (Daryll and Harwood, 2013). Broiler chicken meat is highly palatable, highly nutritious (20% protein) and relatively less fat content (11 %) (Baymen, 1984). Based on this high-value protein content, readily available fats, a low cholesterol, tender and fine-fibre meat content (Grabowski and Kijowski, 2004), chicken meat is far better than the likes of turkey, veal, beef, lamb, and pork. Efforts have been developed to increase broiler chickens' growth rate; feed conversion efficiency and reduce the quantity of feed required to produce kilogram of broiler chickens' meat. Some antibiotics have proven effective in this area but are restricted due to health challenges (Mead, 2003). Until July 2011, arsenic was a popular additive to chicken diets – enhancing growth, promoting pinker meat and combating parasites. Today, sales of Roxarsone (an organic form of arsenic) have been advocated to be halted due to its health-risk residual effect, not only in chicken waste but also its meat (United States Food and Drug Administration 2015). Hence there is a need for a safe and a better alternative, Hydrochloric acid maybe the answer.

Hydrochloric acid (HCl) is an important substance that helps in the process of digestion. It is an intestinal juice which is

secreted in the stomach by the parietal cells under the stimulation of the hormone "gastrin" that is being produced by gastric mucosa immediately after the entry of food into the stomach from the oesophagus. It serves as antiseptic, killing most bacterial and other foreign cells, and a denaturing agent against unfolding globular proteins and rendering their internal peptide bonds more accessible to enzymatic hydrolysis (Rob, 2009). The enzymes that are present in the intestine which digest the food require lower acidic pH to function properly. This is where hydrochloric acid also comes into play. Hydrochloric acid provides an optimum pH for normal functioning of the enzymes present in the gastro-intestinal tract. For example, hydrochloric acid helps convert pepsinogen to pepsin, which is responsible for breaking down of proteins in the intestine (Sumaiya, 2010). Inclusions of hydrochloric acid in the intestine of broiler chicken have been shown in study to work well for anticoccidial activity against *Eimeria tenella* (Rao *et al.*, 2011). But it was believed it can play more roles in the intestine of broiler chickens by aiding better digestion and improved growth performance. Therefore this study was designed to evaluate the response of broiler chickens to water containing different concentrations of hydrochloric acid at two age groups

Materials and Methods

Experimental Site

The experiment was carried out at the Animal Production Teaching and Research Farm of the Federal University of Technology, Minna, Niger State. Minna, lies between latitude 9° 28' N to 9° 37' N and longitude 6° to 23' E to 6° to 33' E, with temperature range of 38° to 42° C, lowest temperature in August and highest in March. Mean annual rainfall ranges between 1000mm – 1500mm and located in Southern Guinea Savannah Zone (FUTMIN, 2012).

Experimental Birds and management

Two hundred and forty (240) day old broiler chicks purchased from Courage Farm, Ibadan, Oyo State were used for the experiment. The birds were randomly and equally allocated into four experimental treatments of HCl concentration at two age groups (HCl inclusion from day five and HCl inclusion from day twenty-one) using a completely randomized experimental design. The experiment consists of two age groups of 5to 56 days (Group I) and 21 to 56 days (Group II). Each of the group had four treatments with three (3) replicates each. The first age group birds were given hydrochloric acid (HCl) treated water from 5 to 56 days and the second age group birds were given HCl treated water from 21 to 56 days (a modified method of Rao *et al.*, 2011 was adopted). Hydrochloric acid was included in the experimental birds' drinking water at different treatment concentrations of T_1, T_2, T_3 and T_4 with respective HCl concentration of 0, 1500, 2500 and 3500 ppm. The HCl included and water was carefully measured with the use of pipette and measuring cylinder respectively. Volume of HCl treated water given was measured with measuring cylinder and the left over was also measured and subtracted from HCl treated water given to obtain HCl treated water intake Hydrochloric acid of 70% concentrations was purchased from Panlac Chemical Store, Minna, Niger State. Before the arrival of the broiler chicks the pens were washed with water and detergents, disinfected with formaldehyde solution to get rid of harmful organisms. The birds, on arrival were randomly apportioned into brooding pens of two groups, four treatments with three replicates each. Glucose was given to the chicks through clean drinking water for quick energy recovery on arrival. Broad spectrum antibiotics (oxytetracycline®) was given together with multivitamin (vitalyte®) through the drinking water for the first 4 days for prophylactic reasons which was also the experimental bird adjustment period. All the chicks were placed on broiler starter ration (Table 1) up to 4 weeks of age after which they were fed a broiler finisher diet (Table 1). Fresh feeds and clean water were provided *ad libitum*. The temperature was maintained at 32.5°C during the first week of age and was reduced on weekly basis. Lighting was provided for 24 hours throughout the experimental period with the use of rechargeable lamps. After brooding, the birds were raised on deep litter system with wood shavings used as the beddings. Foot-bath containing Lysol solution was provided at the entrance of the poultry house. All the equipment used were rinsed and sterilized

with Lysol and 100% concentrated methylated spirit for prevention of the introduction of harmful organisms. Cleaning of feeders, drinkers, provision of non-mouldy feed and clean water were routinely done on daily basis. At the first seven days, all the birds were vaccinated for Infectious Bursal (gumboro) disease. On 14th day, the birds were vaccinated against New Castle disease. Gumboro vaccine was repeated on day 21, and second Newcastle vaccination on 28th day of age.

Feed intake

The feed given was weighed daily in grams(g) before giving to the chickens and quantity consumed for the day was obtained by taking the difference between the quantity supplied to the chickens and the left over at the end of each day and these were recorded as daily feed intake per replicate. The daily feed intakes were added up at the end of each week to give weekly intake values. These weekly feed intake values were further divided by the number of chickens per replicate to obtain the average weekly feed intake per chicken in individual replicate. The feeding trial took the duration of fifty-six days.

Body weight gain

Weight gain was obtained by collectively weighing the birds per each replicate by the use of top-pan balance of 20kg weighing capacity. The initial-weight of the birds are recorded at the beginning of the experiment and at the end of every week of the feeding trial. Body weight measured at the end of the previous week was deducted from that of the current week to obtain the weight gained per week, and dividing the weight obtained by the number of the chickens in each replicate to obtain average body weight gain per week.

Feed conversion ratio

The feed conversion ratio was determined by dividing the quantity of feed consumed weekly by the weekly body weight gain of the birds in each replicate in grams.

Digestibility trial

Digestibility trial was conducted by the seventh week of age using total collection method. Two (2) birds were randomly picked from each replicate to determine the nutrient digestibility. Metabolic cage was used for this process, and the birds were kept in the cage for seven (7) days, out of which three (3) days were for adjustable period before data collection started. Total droppings voided were collected for four (4) days. Feed was allocated to all the birds on equal basis. The feed rejected was weighed before giving another fresh feed every day of the trial. Faecal samples collected separately per day for each replicate as adopted by Ayanwale and Aya (2006). Proximate composition of faecal samples collected was determined by A.O.A.C. (1990).

Data analyses

All data generated were subjected to analysis of variance (ANOVA) according to standard procedures of Statistical Analysis System (SAS, 2002) version 9.0. Duncan's Multiple Range Test of the same software, was used to compare means where they occurred at $p<0.05$.

Table1. Composition and calculated values of experimental diets

Ingredients	Starter phase	Finisher Phase
Maize	37.44	55.76
Groundnut cake	24.61	24.81
Maize bran	20.43	9.74
Soy bean meal	11.13	3.30
Fish meal	2.00	2.00
Bone meal	2.50	2.50
Lime stone	0.74	0.74
Lysine	0.30	0.30
Methionine	0.30	0.30
Premix*	0.25	0.25
Salt	0.30	0.30
Calculated		
Energy MEKcal/Kg	2800	3000
Crude protein	23.00	20.00
Crude fibre	4.87	3.59
Lysine	1.32	1.30
Methionine	0.78	0.75
Calcium	1.00	1.70
Phosphorus	0.70	0.85

*Premix to supply per 2.5kg/tone contains: vit. A (7,500.00 iu), vit D (500,000iu), vit.E (1,000iu), vit B1 (375mg), vit. B2 (125mg), vit. B3 (500mg), vit. B6 (150mg), vit. B12 (2.5mg), vit. K (15mg), vit C (10mg) and folic acid (150mg), Ca (12.5mg), Cu (8.0mg), Fe (32mg), I (0.8mg), Se (100mg), Mg (0.25mg), Cl (250mg), Panthotenic Acid (14.4mg).

Results

The result of performance of broiler chickens given water containing different concentrations of HCl (Group I) at day 5 to 56 days of age at starter phase is shown (Table 2). The results showed no significant ($p>0.05$) difference in initial body weight, feed intake and feed conversion ratio among the treatments means. However, final body weight, body weight gain and hydrochloric acid treated water intake were significantly ($p<0.05$) affected. Higher values were significantly ($p<0.05$) recorded in treatment T_2 in the final body weight, body weight gain and hydrochloric acid treated water intake compare to treatments T_1 and T_4. The results of performance of broiler chickens given water containing different concentrations of hydrochloric acid (HCl) at day 5 to 56 days of age at finisher phase is shown in Table 3. The result shows significant ($p<0.05$) difference across all the parameters measured except the initial body weight. In the final body weight, T_2 (2166.67g) and T_1 (2266.67g) had higher weight and significantly differs ($p<0.05$) from T_3 (1833.33g) and T_4 (1960.00g) respectively. Likewise in body weight gain, the result showed that T_1 (1670.00g) was significantly different fromT_3 (1170.00g) and T_4 (1333.33g) but not statistically different from T_2 (1460.00g). Treatment T_2 (3331.67g) had a significantly ($p<0.05$) higher feed intake than T_3(3205.00g) and T_4 (3205.00g) respectively. The result in feed conversion ratio (FCR) showed that T_3 (2.78) differs significantly from others, however, the broiler chickens in T_1 (1.97) recorded a significantly ($p<0.05$) better FCR, this was followed by T_2 (1500 ppm) in the group. Similarly, treatment T_1(9004.67ml) and T_2(9231.32ml) differs significantly ($p<0.05$) from T_3(8024.00ml) and T_4(8309.67ml) respectively in HCL treated water intake.

Table 2. Performance of broiler chickens given water containing different concentrations of Hydrochloric acid (HCL) at day 5 to 56 days of age at starter phase (Group I)

Parameters	$T_{1\,(0PPM)}$	$T_{2\,(1500PPM)}$	$T_{3\,(2500PPM)}$	$T_{4\,(3500PPM)}$	SEM	LS
Initial body weight (g)	31.67	31.33	32.33	31.00	0.23	NS
Final body weight (g)	596.67^{b}	706.67^{a}	663.33^{ab}	626.67^{b}	15.42	*
Body weight gain(g)	565.00^{b}	675.33^{a}	631.00^{ab}	595.67^{b}	15.40	*
Feed intake (g)	1305.00	1378.33	1310.00	1341.67	18.98	NS
HCLTW intake(ml)	4924.45^{b}	5539.33^{a}	4659.17^{bc}	4408.84^{c}	134.04	*
FCR	2.31	2.04	2.09	2.26	0.52	NS
Mortality	0.00	0.00	0.00	0.00	0.00	NS

abc = Means with the same superscript in the same row are not significantly different ($p>0.05$).
SEM = Standard Error Mean NS = Not Significant LS = Level of Significance FCR = Feed Conversion Ratio *= Significant at $p<0.05$ HCLTW = Hydrochloric acid treated water

Table 3 Performance of broiler chickens given water containing different concentrations of Hydrochloric acid (HCL) at day5 to56 days of age at finisher phase (Group I)

Parameters	$T_{1\,(0PPM)}$	$T_{2\,(1500PPM)}$	$T_{3\,(2500PPM)}$	$T_{4(3500PPM)}$	SEM	LS
Initial body weight(g)	696.67	706.67	663.33	626.67	15.42	NS
Final body weight (g)	2266.67^{a}	2166.67^{a}	1833.33^{b}	1960.00^{b}	57.20	*
Body weight gain(g)	1670.00^{a}	1460.00^{ab}	1170.00^{c}	1333.33^{bc}	62.00	*
Feed intake (g)	3285.00^{ab}	3331.67^{a}	3205.00^{b}	3205.00^{b}	21.09	*
HCLTW intake(ml)	9004.67^{a}	9231.32^{a}	8024.00^{b}	8309.67^{b}	97.35	*
FCR	1.97^{b}	2.29^{b}	2.78^{a}	2.40^{ab}	0.10	*
Mortality	0.00	0.00	0.00	0.00	0.00	NS

abc = Means with the same superscript in the same row are not significantly different ($p>0.05$).
SEM = Standard Error Mean NS = Not Significant LS = Level of Significance FCR = Feed Conversion Ratio *= Significant at $p<0.05$ HCLTW = Hydrochloric acid treated water

The result of performance of broiler chickens given water containing different concentrations of hydrochloric acid (HCl) at day 21 to 56 of age at starter phase is shown in Table 4. The results revealed that there was no significant ($p>0.05$) difference in initial body weight, feed intake and feed conversion ratio (FCR). However, in final body weight, body weight gain and hydrochloric acid treated water intake were significantly ($p<0.05$) different among the treatment means. T_1 recorded significantly ($p<0.05$) higher values than T_4 which recorded the lowest values in final body weight and body weight gain. It was also observed that higher value was recorded by birds in T_1, which was significantly ($p<0.05$) different from T_3 and T_4, respectively, in hydrochloric acid treated water intake.

Table 4. Performance of broiler chickens given water containing different concentrations of Hydrochloric acid (HCL) at day 21 to 56 days of age at starter phase (Group II)

Parameters	$T_{1(0PPM)}$	$T_{2(1500PPM)}$	$T_{3(2500PPM)}$	$T_{4(3500PPM)}$	SEM	LS
Initial body weight(g)	32.00	32.00	31.33	32.00	0.24	NS
Final body weight (g)	710.00^{a}	686.67^{ab}	680.00^{b}	640.00^{b}	9.81	*
Body weight gain(g)	678.00^{a}	654.67^{ab}	648.67^{ab}	608.00^{b}	9.84	*
Feed intake (g)	1326.67	1338.33	1328.33	11328.33	17.35	NS
HCLTW intake (ml)	5368.84^{a}	5195.50^{ab}	4648.85^{b}	5019.67^{b}	102.81	*
FCR	1.96	2.06	2.05	2.19	0.05	NS
Mortality	0.00	0.00	0.00	0.00	0.00	NS

abc = Means with the same superscript in the same row are not significantly different ($p>0.05$).
SEM = Standard Error Mean NS = Not Significant LS = Level of Significance FCR = Feed Conversion Ratio *= Significant at $p<0.05$ HCLTW = Hydrochloric acid treated water

The result of performance of broiler chickens given water containing different concentrations of hydrochloric acid (HCL) at day 5 to 56 of age at finisher phase is shown in Table 5. The results showed no significant ($p>0.05$) difference in initial body. The final body weight and body weight gain per week, it showed that T_1 (control) recorded the highest value followed by T_2 (1500ppm) which differs significantly ($p<0.05$) from T_3 (2500ppm) and T_4 (3500ppm). However, feed intake showed no significant difference ($p>0.05$). In feed conversion ratio (FCR), T_1 (control) with 2.47 performed better, followed by T_2 (1500ppm) with 2.55 which differ significantly ($p<0.05$) from T_3 (2500ppm) with 2.97 and T_4 (3500ppm) with 2.98, respectively. Result also showed that in hydrochloric acid treated water intake, treatment T_2 recorded higher value and differs significantly ($p<0.05$) from other treatments.

Table 5. Performance of broiler chickens given water containing different concentrations of Hydrochloric acid (HCL) at day 21 to 56 days of age at finisher phase (Group II)

Parameters	$T_{1(0PPM)}$	$T_{2(1500PPM)}$	$T_{3(2500PPM)}$	$T_{4(3500PPM)}$	SEM	LS
Initial body weight(g)	690.00	686.67	680.00	640.00	4.81	NS
Final body weight (g)	2023.33^{a}	1933.33^{a}	1733.33^{b}	1700.00^{b}	45.04	*
Body weight gain(g)	1313.33^{a}	1246.67^{a}	1053.33^{b}	1060.00^{b}	40.11	*
Feed intake (g)	3223.33	3163.33	3121.67	3153.33	18.36	NS
HCLTW intake(ml)	8702.17^{b}	9226.34^{a}	7986.34^{c}	8598.12^{b}	142.23	*
FCR	2.47^{b}	2.55^{b}	2.97^{a}	2.98^{ab}	0.09	*
Mortality	0.00	0.00	0.00	0.00	0.00	NS

abc = Means with the same superscript in the same row are not significantly different ($p>0.05$).
SEM = Standard Error Mean NS = Not Significant LS = Level of Significance FCR = Feed Conversion Ratio *= Significant at $p<0.05$ HCLTW = Hydrochloric acid treated water

The results of apparent nutrient digestibility coefficient of broiler chickens on water containing different concentrations of hydrochloric (Group I) at day 5to 56 of age is shown in Table 6. The results showed significant differences ($p<0.05$) in all the parameters. Broiler chickens in T_4 (3500 ppm) recorded significantly ($p<0.05$) lower values in dry matter, crude protein and crude fibre and ether extract digestibility. The ash digestibility of broiler chickens in T_3were significantly ($p<0.05$) higher than all other treatments which are statistically similar. While in the nitrogen free extract (NFE) digestibility, broiler chickens on water containing 3500ppm of HCl recorded significantly ($p<0.05$) higher values compared to the other treatments which are also similar. The results of apparent nutrient digestibility coefficient of broiler chickens on water containing different

concentrations HCl performance of broiler chickens given 0 ppm and 1500 ppm of HCl treated water from day 5 to 56 days at the finisher phase which differs from the performance from the starter phase could be that HCl build up in the broiler chicken intestine is more than tolerant level. However, the values of total feed intake, final body weight and feed conversion efficiency from 0 ppm and 1500 ppm from 5 to 56 days recorded from this study at finisher phase are within the range of broiler chicken performance stated by Summers and Leeson (1985). The significant difference in the performance of broiler chickens given different concentrations of hydrochloric acid treated water from day 21 to 56 days could be attributed to the effect of the different concentrations of hydrochloric acid in the intestine. The significance ($p<0.05$) in the difference from 0ppm to 3500ppm introduced at day 21 to day 56 could be that broiler chicken could not tolerate additional drop in intestinal pH during digestion. Similarly (Freitag, 2007) suggested that the need for acidifier in the gastro intestinal tract of animals at adult stage may not be necessary because inadequacy of enough lower pH for proper digestion only occur mostly with the young animals. The supplementation of HCl at this stage may also pose a threat to their intestinal health. The HCl inclusion does not affect feed consumption significantly. Feed conversion ratio (FCR) which ranges from 2.47 (0 ppm) to 2.98 (3500ppm) reported in this study is higher than the 2.10 reported by Summers and Leeson (1985). The significant effects of hydrochloric acid treated water given to the broiler chicken in all the parameters measured on digestibility coefficient for both groups (group given HCL from day 5 to days 56 and group given from day 21 to day 56) reported in this study is similar to Foramoti *et al.* (2003 who reported that supplementing probiotic in monogastric animal feed positively affects digestion and absorption of the feed nutrient components. Aya *et al.* (2013), also observed in their study of performance and nutrient digestibility in broiler chicks as influenced by multi-enzyme addition to starter diets containing palm kernel meal, that there is positive nutrient digestibility in feed containing 10% palm kernel meal (PKM) with enzyme supplementation.

Conclusion

It was therefore concluded that hydrochloric acid addition to drinking water had little or no significant effects on feed intake. However, HCL included during starter phase improved weight gain with lower concentration (1500ppm). This study further revealed that increased HCL inclusion in drinking water from 1500 ppm to 3500 ppm at 21 to day 56 lowered weight gain in broiler chickens and also lowered feed conversion ratio at the finisher stage. It is therefore recommended that lower concentrations of hydrochloric acid (1500ppm) given at a younger stage for period of starter phase holds the potential to be used as a growth promoter supplement in broiler chickens which will serve as an alternative to antibiotics and arsenic based feed additives, with safe and no threat of adverse residual effects on humans.

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