ECONOMICS OF FEEDING DRINKING WATER CONTAINING ORGANIC ACIDS TO BROILER CHICKENS

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ABSTRACT
A feeding trial was conducted to determine the economic effect of acidifying drinking water of broiler chickens with organic acids. The organic acids were acetic, butyric, citric and formic acids, each offered at 0.25%. The control did not contain any of the acids. One hundred and fifty (150) day old AborAcre - plus chicks were used. There were five treatments. Each treatment was replicated three times with 10 birds per replicate, arranged in completely randomized design (CRD). Feed and water were offered *ad libitum.* At the starter phase cost/weight gain was significantly ($P<0.05$) higher in control than in acetic, citric and formic acids, while cost/bird and cost/kg live weight were higher ($P<0.05$) in all the organic acid groups. At the finisher phase feed cost/weight gain was significantly ($P<0.05$) higher in control than in all the organic acid groups while cost/bird was higher in all the organic acid groups. Both revenue and gross margin were significantly improved by all the organic acids except butyric acid whose values were statistically ($P>0.05$) the same with the control. Cost differential and cost benefit showed that inclusion of acetic, citric or formic acid in the drinking water resulted to improvement in feed cost/weight gain.

Keywords: Acidifying, broiler chickens, drinking water and organic acids

INTRODUCTION
For years, animal nutritionists have adopted nutritional measures to improve the performance of broiler chickens even when adequate feed and feeding is assured in order to meet the aspiration of farmers which is input minimization, output maximization and profit actualization. This is due to competitive pressure posed by the major feed ingredients which are maize and soya whose cost is a major factor in determining the cost per kilogramme feed. Hence, the most economical feed formulation for meat production in monogastric animals seeks to optimize ingredients and processing for most efficient lean tissue deposition (Firman, 2006). One of the strategies being adopted is addition of feed additives to the feed or drinking water. Use of feed additives to better nutrient utilization for improved performance has been in use for decades (Patterson and Burkholder, 2003) such as pharmaceutical antibiotics (Maynard *et al*., 1981; MacDonald *et al*., 2000). Recently, the use of antibiotics has been under scrutiny necessitating either their restriction or ban in animal feeds due to reported antibiotic resistance in both man and farm animals Dibner (2004). Nutritionists therefore seek for alternative feed additives to optimize growth. Some dietary products are therefore being evaluated to replace antibiotics in poultry diets. These products include probiotics (Cheeson, 1994), prebiotic (Patterson and Burkholder, 2003), yeast culture (Gao *et al.*, 2008; Oyede *et al*., 2008), essential oils (Lee *et al*., 2004a), spices (Lee *et al*., 2004b; Windisch *et al*., 2007), herbs (Botsoglou *et al*., 2004) and organic acids (Leeson *et al.,* 2005: Ndelekwute *et al*., 2010a: Ndelekwute *et al*., 2011).).

The conventional way of feeding organic acids has been through the feed hence it has been suggested that drinking water for birds should be sanitized with organic acids for better performance (Oviedo, 2006; Marco, 2008; Islam *et al*., 2008). The objective of this research was to determine the effect of organic acids fed through the drinking water on economic performance of broiler chickens.

MATERIALS AND METHODS

Site of Experiment

The experiment was conducted at the Teaching and Research Farm of Department of Nutrition and Forage Science of the Michael Okpara University of Agriculture Umudike; Abia State, Nigeria. Umudike is situated on latitude 5^o 28^1N and longitude 7^o 32^1E and lies at an altitude of 122 metres above sea level, with average rainfall of 2000 mm. The average relative humidity during the experiment was over 72% and average ambient temperature of 28^{oC}.

Experimental Design

Completely randomized design (CRD) was used. One hundred and fifty (150) day old chicks of AborAcre-plus strain were used. There were divided into five treatments replicated three times with 10 birds per replicate. Each treatment group were fed acetic acid, butyric acid, citric acid or formic acid at 0.25% level of the drinking water, while the control group was fed neither of the organic acids in the drinking water. Birds were fed both feed and water *ad libitum.*

Experimental Diets and Management of Birds

Starter and finisher diets were formulated (Table 1). Trial and error method according to Olomu (1995) using Microsoft Excel package was used to formulate the diets. At day old, the chicks were weighed, after which they were transferred into the brooding room. Glucose was added to their drinking water on the first day to cushion the effect of stress due to transportation and heat from the sun. From the second day, vitamin was added to their drinking water for five days. Feed and water were supplied free choice. They were stabilized for one week in the brooding room. Heat was supplied using kerosene stove placed under a metal hover. At the end of the one week stabilization period the birds were transferred to a rearing house, into a portion of the house that was covered with water proof material. Brooding continued to the third week of age.

They were randomly separated into treatment groups and weighed. Feeding of organic acids through the drinking water started from the second week. The birds were vaccinated against Newcastle disease at day old intraocularly and lasota at the 18th day through the drinking water. Infectious bursal (gumboro) disease vaccine was administered twice on the 9th and 16th day. The birds were fed the same formulated starter diet to the fourth week. At the end of the fourth week, they were fed the same finisher diet to the end of the experiment. The birds were managed in a deep litter having wood shavings as bedding materials in an open sided wire mesh building.

Feed Cost Benefit Analysis.

At the end of the feeding experiment, economic analysis was performed to determine the economic viability of inclusion of the organic acids in water. Cost per kilogramme feed was calculated. Economic parameters used to assess performance of birds were cost per kilogramme feed, cost per bird (cost of feed + cost of acid in water consumed), cost per live weight, cost per weight gain, revenue per bird, gross margin, cost differential and relative cost benefit. They were calculated as shown below;

Calculation of Economic Parameters

$$\text{Cost/kg feed} = \frac{\text{Summation of Proportion of each feed ingredient x cost per kg}}{100}$$

$$\text{i.e. Cost/kg feed} = \frac{PF_1 \times CF_1}{100} + \frac{PF_2 \times CF_2}{100} + \ldots\ldots\ldots \frac{PFn \times CFn}{100}$$

Where:

PF = Proportion of each feed ingredient in the diet
CF = Cost/kg of the feed ingredient in the diet
N = the last feed ingredient in the feed formula
cost/weight gain = Cost/kg feed x feed: gain ratio (Ukachukwu and Anugwa, 1995).
Cost/ bird = total feed consumed x cost/kg feed + cost of acid consumed.
Cost Differential: = Cost/weight gain of control group -

Cost/weight gain of each of other groups. (Akpodiete and Inoni. 2000)

$$\text{Relative Cost benefit} = \frac{\text{Cost Differential of each group}}{\text{Feed Cost/weight gain of Control}} \times 100$$

(Akpodiete and Inoni., 2000)

Revenue/bird: = Average final weight x price/kg live weight at time of experiment.
Gross margin: = Revenue/bird – total cost/bird

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Test (Steel and Torrie 1980).

RESULTS AND DISCUSSION

Table 1 shows the ingredient and nutrient composition of the experimental diets.

Table 1: Experimental Diets

Ingredients	Starter	Finisher
Maize	55.00	55.00
Soya bean meal	28.00	26.00
Palm kernel cake	10.30	13.30
Fish meal	3.00	2.00
Bone meal	3.00	3.00
Salt (Nacl)	0.25	0.25
Lysine	0.10	0.10
Methionine	0.10	0.10
Premix*	0.25	0.25
Total	100.00	100.00
Calculated composition (%)		
Crude protein	22.10	20.65
Energy (MJME/kg)	11.99	12.03
Ether extract	3.92	6.16
Crude fibre	5.01	6.00
Ash	7.04	6.80
Calcium	1.2	1.11
Phosphorus	1.01	0.88
Lysine	1.12	1.05
Methionine	0.55	0.50

*Starter Premix supplied per kg diet: vitamin A 15,000 I.U, vitamin D_3 13000 iu, thiamin 2mg, Riboflavin 6mg, pyridoxine 4mg, Niancin 40mg, cobalamine 0.05g, Biotin 0.08mg, chooline chloride 0.05g, Manganese 0.096g, Zinc 0.06g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and Antioxidant 0.125g. CON = control, AA = acetic acid, BA = butyric acid, CA = citric acid, FA = formic acid.

*Finisher Premix supplied per kg diet vitamin 10, 0001.u., vitamin D_3 12,0001.u. Vitamin E 201.U., Vitamin K 2.5mg, thiamine 2.0mg, Riboflavin 3.0mg, pyridoxine 4.0mg, Niacin 20mg, cobalamin 0.05mg, pantthemic acid 5.0mg, Folic acid 0.5mg, Biotin 0.08mg, choline chloride 0.2mg, Manganese 0.006g, Zinc 0.03g, Copper 0.006g, Iodine 0.0014g, Selenium 0.24g, cobalt 0.25g and antioxidant 0.125g

They conformed to the requirements of broilers raised in the tropical environment (Oluyemi and Roberts, 2000). Other nutrients (lysine, methionine, calcium, phosphorus, ether extract and fibre) content of the diets were similar to that recommended by NRC. (1994)

Feed Cost – Benefit of Starter Broilers

Effect of feeding organic acids through drinking water on starter broilers is shown in Table 2. Except butyric acid all the organic acids significantly improved final weight, feed intake and feed: gain ratio. Cost per kilogramme of feed was the same because the organic acids were not added to the diets. Cost per weight gain was significantly ($P<0.05$) higher in group that fed the control drinking water and butyric acid water than those that were offered acetic, citric and formic acids. Birds fed the acetic acid had the best cost per weight gain followed by the groups that consumed citric and formic acids. This was because of their improved feed: gain ratio. However, both cost per bird and cost per kilogramme live weight were significantly higher in birds that fed organic acids due to extra cost of organic acid consumed through the drinking water. Cost differential and relative cost benefit were positive and higher in organic acid groups indicating that it cost less to produce a unit gain in weight using organic acid in the drinking water especially acetic, citric and formic acids. Though feed cost per bird at the starter phase was higher in broilers fed organic acids, yet they generated higher revenue because of the better feed cost per weight gain especially citric and formic acids.

Table 2: Effect of Organic Acid Treated Drinking Water on Economic Parameters of Starter Broilers.

Parameters	CON	AA	BA	CA	FA	SEM
Final live weight (g)	730.09^{c}	869.07^{a}	747.22^{c}	807.41^{b}	803.70^{b}	14.11
Feed intake (g)	1176.84^{b}	1203.51^{a}	1203.72^{a}	1211.91^{a}	1201.41^{a}	25.54
Feed: gain ratio	1.91^{a}	1.06^{b}	1.90^{a}	1.75^{b}	1.75^{b}	0.08
Cost/kg feed (N)	71.11	71.11	71.11	71.11	71.11	-
cost/weight gain (N)	135.82^{a}	113.78^{c}	135.12^{a}	124.44^{b}	124.44^{b}	17.97
cost/bird* (N)	83.91^{c}	104.68^{a}	102.28^{a}	104.67^{a}	103.84^{a}	19.09
cost/kg live weight (N)	114.95^{c}	120.46^{b}	136.92^{a}	129.70^{b}	129.15^{b}	14.71
Cost differential	-	22.04	0.70	11. 38	11.38	-
Relative cost difference	-	16.23	0.52	8.34	8.34	-

abcd : Means along the same row with different superscript are significantly ($P < 0.05$) different. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid. *Cost / bird = Cost of feed consumed + cost of organic acid consumed through the drinking water. (N) = Nigerian currency

Feed Cost – Benefit of Finisher Broilers

Effect of inclusion of organic acids in drinking water for broilers on economic indices of finisher broiler chickens as shown in Table 3 indicated that acetic, citric and formic acids gave higher final weight, feed intake and better feed: gain ratio. Cost per kg feed was the same. This was because the acids were not added to the feed but to the drinking water. All the groups that were fed organic acids had better cost per weight gain than the control, indicating that cost per gain of birds that fed butyric acid improved over the control compared to the starter phase. This could be as result of better utilization of butyric acid at finisher phase. Costs per bird at finisher phase, total cost per bird and cost per kg live weight were significantly higher in birds fed organic acids except those that consumed acetic acid whose cost per kg live weight was similar to that of the control. This indicated improvement over the control considering the result of the starter period. Better feed: gain ratio contributed to the improved cost per weight gain, while high feed intake and cost of the acid consumed through the drinking water were the reason for higher cost per bird and cost per kg live weight.

Table 3: Effect of Organic Acid Treated Drinking Water on Economic Parameters of Finisher Broilers

Parameters	CON	AA	BA	CA	FA	SEM
Final live weight (g)	1762.32^{c}	2050.96^{a}	1851.55^{bc}	1969.52^{ab}	1956.41^{ab}	66.76
Feed intake (g)	3650.36^{b}	3743.04^{a}	3642.80^{b}	3754.52^{a}	3737.72^{a}	87.67
Feed: gain ratio	2.65^{a}	2.38^{b}	2.47^{b}	2.42^{b}	2.43^{b}	0.16
Cost/kg feed (N)	67.54	67.54	67.54	67.54	67.54	-
cost/weight gain (N)	178.98^{a}	162.42^{b}	166.82^{b}	163.45	164.12^{b}	14.05
cost/bird* (N)	185.06^{c}	238.54^{a}	225.42^{b}	240.08^{a}	237.35^{a}	11.87
Total cost/bird**	268.97^{c}	343.22^{a}	327.48^{b}	344.75^{a}	341.19^{a}	20.22
cost/kg live weight (N)	105.03^{c}	116.30^{bc}	121.72^{ab}	121.87^{ab}	121.34^{ab}	7.98
Revenue/bird (N)	968.00^{b}	1127.83^{a}	1017.83^{b}	1083.50^{a}	1078.00^{a}	54.87
Gross margin/bird (N)	699.03^{c}	780.65^{a}	690.35^{c}	738.75^{b}	736.81^{b}	42.21
Cost differential	-	16.56	12.16	15.53	14.86	-
Relative cost benefit (%)	-	9.25	6.79	8.68	8.30	-

abc means along the same row with different superscript are significantly ($p<0.05$) different. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid. *Cost / bird = Cost of feed consumed + cost of organic acid consumed through the drinking water, ** cost/bird of starter + cost/bird of finisher. (N) = Nigerian currency.

Revenue realized was significantly ($P<0.05$) higher in all the groups that fed organic acids than the control except that fed butyric acid. The revenue realized from birds fed butyric acid and that of the control were statistically similar. Acetic, citric and formic acid groups were able to achieve this because of their improved live weight. Birds that consumed acetic acid produced the best gross margin followed by those that consumed citric and formic acids. The gross margin of birds that fed butyric acid and the control were statistically the same. Both cost differential which was positive and the relative cost benefit which was more than 5% indicate that inclusion of organic acids in drinking water for broilers was economically beneficial. This result is in agreement with Alciceck *et al*. (2004). Oviedo (2006) and Marco (2008) had reported the economic importance of acidifying drinking water for broiler chickens

CONCLUSION

Addition of the organic acids except butyric acid in the drinking water for broiler chickens gave better economic advantage by at least N11.38 (8.34 %) at the starter phase and N14.86 (8.30 %) at the finisher phase. Going by this, addition of 0.25% of acetic, citric and formic acids in drinking water could be adopted for better economic benefit.

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