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Comparing the Effect of Diets Treated with Different Organic Acids on Growth and Economic Performance of Broiler Chickens

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Target Audience: Animal nutritionists, feed millers, poultry farmers, researchers.

Abstract

An experiment was conducted to compare the growth and economics of adding organic acids to diets of broiler chickens. The organic acids were sorbic benzoic lactic and propionic acids. 150 day old Hubbard chicks were used. There were five treatments. Diet 1 which served as control contained no organic acid. Diets 2, 3, 4 and 5 respectively contained 0.25% sorbic benzoic lactic and propionic acids. There were three replicates per treatment each having 10 birds. Completely randomized design (CRD) was used. Feed and water were provided ad libitum for eight weeks the experiment lasted. Live weight was significantly (P<0.05) improved at starter phase by propionic acid. Live weight and feed intake were significantly reduced by benzoic acid. Propionic acid significantly (P<0.05) improved feed: gain ratio. At the finisher phase Sorbic lactic and propionic acids gave better live weight than control and benzoic acid. Total feed intake was improved by lactic and propionic acids. Weight gain and feed: gain ratio were not significant (P>0.05). Cost/kg feed was increased by organic acids. Feed cost per bird was significantly (P<0.05) increased by sorbic lactic and propionic acids. Benzoic acid significantly (P<0.05) reduced gross margin. Other organic acids posted similar gross margin as control. In conclusion propionic lactic and sorbic acids could be used in diets for broilers in terms of growth performance

Keywords: broiler chickens, economics, growth, organic acids.

Description of Problem

Poultry farmers are in need of quality feed to optimize their broiler performance and at the same time achieve a better gross margin. Production of quality feed can only be achieved by using high digestible feedstuffs such as maize and soya bean meal which are expensive, thereby, leading to expensive feed. Nutritionists are therefore faced with the task of striking a balance between quality and cost of feed to achieve both economic and production targets. Ukachukwu and

Anugwa (1) had advocated the need to produce least cost feed rather than low cost feed. Least cost feed means producing feed of good quality at a reasonable cost which would translate into better productivity and profit maximization (2).

Even when quality feed is fed, the performance of the bird depends among other factors on how well the feed is utilized by the bird. According to (3) better utilization of feed should go beyond provision of quality feed. The authors opined that what happened in the gut after feed is ingested is important. To adequately utilize quality feeds it has been suggested that the gut be modulated (4, 5, 6). Feed utilization is principally initiated by the gut and the gut must be healthy to be able to perform this duty (5). In recognition of this, feed additives are used to modulate the gut ecosystem. These include; probiotics (4); prebiotic (7); yeast culture (8); essential oils (9); spices (5) and organic acids (10, 11). Organic acids are able to do this because of their antibacterial properties and their ability to reduce the pH of the stomach which aids protein digestion in young monogastric animals (12, 13, and 11). 0.25% of formic acid has been recommended by (14) because of its positive impact on broilers.

Though, organic acids were reported to improve protein digestibility and promoted growth (15, 16), it is also necessary to determine the economic viability of using them. Therefore, the objective of this research was to determine the growth performance and economic implications of treating broiler diets with organic acids.

Materials and Methods

Site of Experiment

The experiment was carried out at the Poultry unit of Teaching and Research Farm of University of Uyo, Akwa Ibom State, Nigeria. The mean rainfall during the experiment was 2500mm, with relative humidity of 80%.

Experimental Design

Completely randomized design (CRD) was used. One hundred and fifty (150) day old chicks of AborAcre - plus strain were used. They were divided into five treatments replicated three times with 10 birds per replicate. The treatment groups received sorbic acid-group one, benzoic acid-group two, lactic acid-group three or propionic acid-group four at 0.25% level of their diet, while the control group-group five received non of the organic acids. Organic acids were introduced from the first week and lasted for eight weeks.

Experimental diets.

Five diets were formulated each for starter and finisher diets. The diets were iso-nitrogenous (22.20%) and isocaloric (11.76MJME/kg) for the starter diet table 1. and 20.14% 11.92 MJME/kg for the finisher diet (Table 2). The five diets contain the same proportion of feed ingredients except diets containing organic acids where 0.25% palm kernel cake was replaced by the organic acids. Trial and error method according to (17) was used to formulate the diets.

Management of Birds

From the second day, vitamin-mineral complex was added to their drinking water for five days. Feed and water were supplied free choice. They were brooded for three weeks, vaccinated against

Newcastle disease at day old-intraocular and lasota on the 18th day through the drinking water. Infectious bursal (gumboro) disease vaccine was administered on the 10th and 17th day.

The birds were fed formulated starter diet for four weeks. At the end of the fourth week, finisher diet was offered to the end of the experiment (eight weeks). The birds were managed in an open sided deep litter house with wood shavings as bedding materials.

Data collection and Analysis

Live weight and feed intake were measured weekly and used to calculate feed: gain ratio. Economic analysis was performed using parameters as calculated and reported by (18, 19, 2, 15, and 16) as shown below;

Cost/kg feed =

$$\frac{\Sigma \text{Proportion of each feed ingredient x cost per kg}}{100}$$

i.e. Cost/kg feed =

$$\frac{PF_1 \text{ x } CF_1}{100} + \frac{PF_2 \text{ x } CF_2}{100} + \ldots\ldots + \frac{PFn \text{ x } CFn}{100}$$

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

Feed cost/weight gain =Cost/kg feed x feed: gain ratio

Feed cost/bird =cost/kg feed x total feed intake.

Total feed cost/bird= feed cost/ bird of starter + feed cost/ bird of finisher.

Cost Differential:=

Feed Cost/weight gain of control group

Feed Cost/weight gain of each of other groups.

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

Gross margin = Revenue/bird – Feed cost/bird.

Revenue/bird: = Average final weight x price/kg live weight at time of experiment.

Revenue: feed cost ratio = Revenue/bird ÷ Feed cost/bird

Gross margin: feed cost ratio = Gross margin/bird ÷ Feed cost/bird

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Test (DNMRT) according to (20).

Results and Discussion

Experimental Diets

Tables 1 and 2 show the ingredient and nutrient composition of the experimental diets. There were iso-nitrogenous and isocaloric and conformed to *the* requirements of broilers raised in the tropical environment (17, 21). Other nutrients (lysine, methionine, calcium, phosphorus, ether extract and fibre) content of the diets were similar to that recommended by (22)

Table 1: Ingredients and Nutrients Composition of Starter Diets

Ingredients (%)	CON	SA	BA	LA	PA
Maize	53.00	53.00	53.00	5.00	5.00
Soya bean meal	30.00	30.00	30.00	30.00	30.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	10.30	10.05	10.05	10.05	10.05
Bone meal	3.00	3.00	3.00	3.00	3.00
Organic acid	-	0.25	0.25	0.25	0.25
Salt {NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Analyzed values (%)					
Crude protein	22.21	22.20	22.00	22.20	22.20
Energy (MJME/kg)**	11.79	11.76	11.76	11.76	11.76
Ether extract	3.78	3.76	3.76	3.76	3.76
Crude fibre	4.38	4.36	4.36	4.36	4.36
Ash	7.80	7.80	7.80	7.80	7.80
Calcium	1.11	1.11	1.11	1.11	1.11
Phosphorous	0.86	0.84	0.84	0.84	0.84
Lysine**	1.13	1.12	1.12	1.12	1.12
Methionine**	0.58	0.57	0.57	0.57	0.57

* premix supplied per kg starter 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, SA = Sorbic acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid. **Calculated

Table: 2 Ingredients and Nutrients Composition of Finisher Diets.

Ingredients	CON	SA	BA	LA	PA
Maize	53.00	53.00	53.00	53.00	53.00
Soya bean meal	27.00	27.00	27.00	27.00	27.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Palm kernel cake	14.30	14.05	14.05	14.05	14.05
Bone meal	3.00	3.00	3.00	3.00	3.00
Organic acid	-	0.25	0.25	0.25	0.25
Salt {NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Analyzed values (%)					
Crude protein	20.15	20.14	20.14	20.14	20.14
Energy (MJME/kg)**	11.97	11.92	11.92	11.92	11.92
Ether extract	5.00	5.02	5.02	5.02	5.02
Crude fibre	5.60	5.58	5.58	5.58	5.58
Ash	7.50	7.51	7.51	7.51	7.51
Calcium	1.10	1.10	1.10	1.10	1.10
Phosphorous	0.80	0.76	0.76	0.76	0.76
Lysine**	1.03	1.01	1.01	1.01	1.01
Methionine**	0.45	0.44	0.44	0.44	0.44

Per kg finisher 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, pyr idoxine 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, Coper 0.006g, Iodine 0.0014g, Selenium 0.24g, cobalt 0.25g and antioxidant 0.125g CON = Control, SA = Sorbc acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid. **Calculated.

Growth Performance

The growth performance of starter broilers is shown in Table 3.Daily gain was not significant. Propionic acid significantly (P<0.05) gave better final live weight compared to control, sorbic and benzoic acids. Benzoic acid negatively affected the final live weight. Feed intake was also negatively affected by benzoic acid as against other acids and control which were similar. This underscores the relationship between feed intake and body growth as reported by (21). At early stage of live there is positive relationship between feed intake and muscle development (21). Poor feed intake generated by benzoic acid could have affected growth. Propionic acid posted the best feed: gain ratio compared to other treatment groups which were similar. This could be linked to the better performance of propionic acid in terms of final live weight resulting from its ability to improve conversion of feed to meat

Table 3: Effect of Organic Acid Treated Diets on Growth Performance of Starter Broilers.

Parameters	CON	SA	BA	LA	PA	Sem
Mean initial live weight (g)	40.00	40.00	40.00	40.00	40.00	3.05
Mean final live weight (g)	702.00^{c}	722.00^{bc}	642.00^{d}	740.00^{b}	779.00^{a}	35.46
Mean daily gain (g)	25.07	25.79	23.93	26.43	27.82	4.11
Mean total feed intake (g)	1400^{a}	1438^{a}	1284^{b}	1529^{a}	1463^{a}	165.32
Mean daily feed intake (g)	50.00^{a}	51.35^{a}	44.80^{b}	54.59^{a}	52.21^{a}	5.06
Feed: gain ratio	1.99^{a}	1.99^{a}	1.95^{a}	2.07^{a}	1.88^{b}	0.08

abcd Means along the same row with different superscripts are significantly different (P < 0.05). SEM = Standard error mean. CON = Control, SA = Sorbic acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid

During finisher phase (Table 4), all the organic acids except benzoic acid significantly (P<0.05) improved final live weight compare to the control group. Benzoic acid deteriorated the final live weight. Better final live weight posted by lactic and sorbic acids over control was an indication of cross over effect because all were similar during the starter phase. This is an indication that feeding of these organic acids except benzoic acid beyond starter phase could be positive. This observation concurred with earlier result by (14). Total feed intake was significantly (P<0.05) higher in propionic and lactic acid groups compared to control and benzoic acid. The same trend (P>0.05) was observed in benzoic acid and control groups. This result clearly showed that there was improvement in feed intake due to presence of benzoic, lactic and propionic acid over control group as opposed to what was observed in the starter phase. According to (14) prolong feeding of butyric, formic and acetic acids resulted to improved feed consumption. This was attributed to strong taste and bad odour exhibited by some organic acids which birds could be accustomed with as feeding progressed. There were no significant differences in daily gain, daily feed intake and feed: gain ratio.

Feed Cost - Benefit of Starter Broilers

The economic implications of including

organic acids in diets for starter broiler chicks are shown in Table 5. Cost/kg feed of acid treated diets was significantly (P<0.05) higher by 8.52% than the control. This was due to added cost of organic acids. Application of organic acids to the diets significantly (P<0.05) increased cost of production in terms of cost of feed consumed. Feed cost/bird was significantly (P<0.05) higher in all the acid treated groups except benzoic acid whose cost was similar to that of the control. The benzoic acid group was able to achieve this because of its lower feed intake. The trend was not the same for feed cost/ weight gain. Sorbic, benzoic and lactic acid groups had higher values of feed cost/gain those of the control and propionic acid which were similar. Propionic acid group posted lower feed cost/gain because of its lower feed: gain ratio. This cannot be said of the control group. The control group had lower feed cost/gain not because of its feed: gain ratio, but because of its lower cost/kg feed. Feed cost/ kg live weight was the least in benzoic acid group than the other organic acid groups. This was because of its lower feed intake. The value was similar to that of the control. The value of the control was statistically the same with that of sorbic acid but significantly lower than the lactic and propionic acids.

Cost differential was negative in all the organic acid groups showing that feed cost/gain of control was smaller than the organic acids in relation to the numerical values. Relative cost benefit indicates that it cost more by 2.52 – 12.88% to treat broiler diets with the organic acids at starter phase. But judging from the growth performance of propionic acid group the economic implication could mean that a broiler producer could make substantial economic gain by treating starter broiler diets with formic acid with the full realization of the benefits (higher revenue due to heavier live weight) expected at the finisher phase (Table 4).

Table 4: Effect of Organic Acid Treated Diets on Growth Performance of Finisher Broilers

Parameters	CON	SA	BA	LA	PA	Sem
Mean initial live weight (g)	702^{b}	722^{b}	642^{c}	$740a^{b}$	779^{a}	35.46
Mean final live weight (g)	2205^{b}	2275^{a}	2089^{c}	2289^{a}	2331^{a}	69.45
Mean daily gain (g)	53.68	55.46	51.67	55.32	55.43	6.14
Mean total feed intake (g)	3508^{bc}	3677^{ab}	3425^{c}	3774^{a}	3720^{a}	185.01
Mean daily feed intake (g)	125.30	131.32	122.32	134.77	132.86	10.21
Feed: gain ratio	2.33	2,36	2.37	2.44	2.40	0.12

abc. Means along the same row with different super scripts are significantly different (P < 0.05). SEM = Standard error mean. CON = Control, SA = Sorbic acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid

Feed Cost - Benefit of Finisher Broilers

The effect of organic acids on different economic parameters of finisher broiler chickens is shown in Table 6. The cost/kg feed of diets treated with organic acids was significantly (P<0.05) higher by 8.89% than that of the control. Significant differences (P< 0.05) were also recorded in other parameters. It was significantly more expensive in terms of feed cost/bird in of using the organic acids except benzoic acid. Within the acid group, feed cost/bird was better in benzoic acid than others. Better feed cost/bird posted by benzoic acid over other acids was due to its lower feed intake, considering the fact that all the acid groups had the same cost/ kg feed. However, the control was able to achieve lower feed cost/bird because of its lower cost/ kg feed. Both feed cost/gain and feed cost/kg live weight of organic acid groups followed similar trend and were significantly (P<0.05) higher than that of the control. This arose from the high cost of feed and feed intake of organic acid treated groups of birds. There were no significant differences (P>0.05) within the acid treated groups

Table 5: Effect of Organic Acid Treated Diets on Economic Performance of Starter Broilers.

Parameters	CON	SA	BA	LA	PA	Sem
Cost /kg feed (N)	88.00[b]	95.50[a]	95.50[a]	95.5[a]	95.5[a]	5.43
Feed cost/ bird (N)	123.20[b]	137.33[a]	119.76[b]	146.02[a]	139.72[a]	11.05
Feed cost/weight gain (N)	175.12	190.25	186.23	197.69	179.54	30.11
Feed cost/kg live wt (N)	86.40[bc]	99.15[ab]	76.78[c]	108.04[a]	108.84[a]	20.14
Cost differential	-	- 14.94	- 11.11	- 22.57	- 4.42	
Relative cost benefit (%)	-	8.02	6.34	12.88	2.52	

abc. Means along the same row with different superscripts are significantly different (P < 0.05). SEM = Standard error mean. CON = Control, SA = Sorbic acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid

The revenue (N) accrued was significantly different (P<0.05). Birds raised with diets containing benzoic acid had the least revenue and propionic acid had the highest. There were no differences between those of sorbic acid, lactic acid and the control. The better revenue generated by propionic acid was due to its better live weight which negatively affected benzoic acid. Dietary inclusion of organic acids significantly (P<0.05) influenced the gross margin. Benzoic acid gave the least gross margin compared to other groups which similar. Further investigations, revealed that for a unit cost of feed, revenue and cross margin realized were numerically higher in propionic acid and

Table 6: Effect of Organic Acid Treated Diets on Economic Performance of Finisher Broilers

Parameters	CON	SA	BA	LA	PA	Sem
Cost /kg feed (N)	84.32[b]	91.82[a]	91.82[a]	91.82[a]	91.82[a]	5.99
Feed cost/ bird (N)	295.79[b]	337.62[a]	314.48[b]	346.53[a]	341.57[a]	22.00
Total feed cost/bird (N)	418.99[b]	474.95[a]	434.24[b]	492.55[a]	481.44[a]	51.22
Feed cost/weight gain (N)	196.47[b]	216.70[a]	217.61[a]	224.04[a]	220.37[a]	18.01
Feed cost/kg live Wt. (N)	194.37[b]	213.35[a]	212.90[a]	219.73[a]	210.90[a]	15.56
Revenue/bird (N)	1030[b]	1068[ab]	964[c]	1074[ab]	1096[a]	65.04
Gross margin/ bird (N)	611.01[a]	593.25[a]	529.76[b]	581.45[a]	614.56[a]	50.45
Revenue: feed cost ratio	2.46	2.25	2.22	2.18	2.78	
Gross margin: feed cost ratio	1.46	1,25	1.22	1.18	1.28	
Cost differential	-	- 20.23	- 21. 14	- 27.57	- 23.90	
Relative cost benefit (%)	-	10.30	10.76	27.57	12.16	

abc. Means along the same row with different superscripts are significantly different (P < 0.05). SEM = Standard error mean. CON = Control, SA = Sorbic acid, BA = Benzoic acid, LA = Lactic acid, PA = Propionic acid control respectively. This result did agree with former reports that addition of feed additives to broiler diets could improve economic performance of broiler chickens (4, 11).

Cost differential shows that feed cost/weight gain of organic acid groups were higher than the control judging from their numerical values. This translated to between 10.30 – 27.57%.

Conclusion and Application

1. Propionic acid was adjudged the best test organic acid for growth and is recommended for use.
2. Incorporation of benzoic acid into the diet significantly reduced feed intake, growth and the amount of revenue generated and is therefore not recommended for use in broiler diets.
3. Non maximization of profit observed in this work could be attributed to the cost of the organic acids which raised cost of the feed. In Nigeria organic acids are imported and thus scarce. With abundant hydrocarbon in Nigeria it is expected that local production could bring down the prices.

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