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# Response of Starter Broiler Chickens to Feed Diets Treated with Organic Acids

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## Abstract

**Background:** Organic acids contain one or more carboxylic acid groups which are linked with covalent bond and have acidic properties that can enhance the reservation of protein and some other nutrients in birds. Antibiotic growth promoters have been banned due to their residues that remain in the meat and effects the human beings. Therefore, the organic acids are used as their alternatives. The present study is aimed to inspect the outcome of organic acids on uptake of feed, feed gain ratio, and live weight gain in broiler chickens.

**Methods:** A total of 150 unsexed broiler chickens were used for this experiment which were having five categories of treatment as $T_1$, $T_2$, $T_3$, $T_4$, and $T_5$. Each category had thirty birds. $T_1$ was treated with a standard diet, $T_2$was treated with acetic acid, $T_3$ with butyric acid, $T_4$ with citric acid and $T_5$ with formic acid. The duration of this experiment was 28 days. After the specified time of this experiment, the data of uptake of feed and body weight was gathered on weekly basis. Comparison of all the five treatments was done by using the Duncan's multiple range test.

**Results:** Feed Conversion Ratio (FCR) was found lower in $T_5$ than other treatments. $T_5$ group showed the highest average value of final body weight of broilers in contrast to the $T_3$ group which showed the lowest final body weight. Feed intake was found significantly different within the treatments. $T_3$ showed significantly lower value as compared to other treatments. The lowest value of average regular uptake of grains was found in $T_3$ treatment group. Broilers fed on formic acid have shown a better protein efficiency ratio than that of butyric acid and citric acid. Broilers treated with citric acid have a significant difference which indicates more water consumption as compared to other treatments.

**Conclusion:** Organic acids have a productive effect on the growth of animals and broiler chickens. Organic acids including butyric acid, acetic, citric, formic, fumaric, and propionic acid vary in their biochemical actions in the system of animals. Organic acid affects the final weight gain, average regular gain in weight, total uptake of feed, and feed to gain ratio, daily intake of protein, protein efficiency ratio, total water uptake, average water intake, and water feed ratio. Based on the present study, further analysis is required to look over the impacts of addition of organic acid on the growth accomplishment of broiler chicks.

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## Introduction

From years in poultry diet, AGPs, (antibiotic growth promoters) have been used broadly. The usage of antibiotic growth promoters has been prohibited due to the general interest of people regarding the development of antibiotic-resistant bacteria and possible antibiotic residual problems [1]. Many researches showed that the organic acids, bacteriophages, organic minerals prebiotics, and probiotics are possible substitutes to AGPs. These have been recommended as an appropriate dietary source for balancing the loss in effective performance when AGPs are eliminated from the diets of animals [2,3]. Livestock production remains low and nutrition is the utmost limitation for its development in the tropics [4]. Therefore, the inclusion of organic acids is also applicable and useful in animal feeds.

Numerous trials have shown that organic acids are essential in animal or poultry nutrition [5]. According to an earlier study, for more than 25 years', the organic acids have been used in pig fabrications [5]. These organic acids inhibit the bacteria by changing internal pH, thus urging such conditions that are responsible for stopping its growth [6]. Animal protein is essential for the normal physical, physiological and mental development of an individual [7], and its consumption in Nigeria is still very low. Federal Ministry of Agriculture and Rural Development [8] estimated animal protein intake in Nigeria in 2000 at 18 g/caput/day, which is lower than the suggested level of minimum value, which is 35 g. Therefore, increased broiler production is necessary if protein supply and consumption of animal would increase.

The purpose of this study is (A) To learn the impact of these organic acids on the feed intake of broilers (B) To learn the impact of the organic acids on feed to gain ratio (C) To learn the effect of the organic acids on the live weight and live weight gain. In poultry production, further research is required to look over the impacts of the addition of organic acids on the growth accomplishment of broiler chicks.

## Methods

### Experimental Site

At the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, this study had been performed. The area is situated within the tropical rainforest zone of Nigeria. The experimental site bears the coordinates of $5^0$ $28^1$ North and $7^0$ $32^1$ East and lies at an altitude of 122 meters above sea level. The area is characterized by 7-10 months of rainfall and a short period of the dry season. The average rainfall is 2169.8 mm in 148-155 rain days. The relative humidity during the rainy season is over 72% and monthly ambient temperature ranges between $17^0$C and $36^0$C with an average of $26^0$C.

### Experimental Birds

A total of 150 unsexed day-old broiler chicks were used for this experiment. On the very first day, the chicks were weighed to determine their initial weight.

### Experimental Diets

The experimental diet was on five inclusive levels as treatment T1 (Control diet), T2 (fumaric acid), T3 (Butyric acid), T4 (Citric acid), and T5(Formic acid) with the inclusion of 0.25% of T2, T3, T4, T5 and each was replicated 3 times with 30 birds per replicate.

### Management of Experimental Birds

The chicks used for this experiment were one hundred and fifty days old and were unsexed broiler chicks. Day old chicks were weighed to determine their initial weight. The birds were hatched in Owerri Imo State.

They were brooded three weeks at the University Teaching and Research Farm in a deep litter (wood shaving) pen of a tropical type. Open-sided poultry house were used whose sides and demarcations between pens were covered with wire gauze. Birds were raised in this poultry house during the brooding stage where water and feeders were being supplied ad libitum. Kerosene stoves, Lanterns were used for brooding or giving heat to the birds under galvanized metal hooves [9]. Antibiotics were given as prophylactic measures to the birds and the Newcastle disease vaccine and Gumboro disease vaccine were given at day-old intraocular (I/O) and 21 days and 10 and 17 days of age respectively, while broad-spectrum antibiotics named as coccidiostats were administered to the chickens through drinking water.

Additional medications administered to the broilers were Taradox$^R$ for Chronic Respiratory Disease (CRD) which lasted for 4 days and Bidox$^R$ was also given for 4 days.

The diets were developed with different amounts of insertion of organic acids. The sample diets used were butyric acid, fumaric acid, formic acid, and citric acid at a 0.25 percent level of inclusion. The organic acids were sourced from mid-Century Agro Services. The experiment lasted 28 days.

### Data Collection

The data gathered were about the weight of the body and feed intake. The body weight was measured on weekly based with a capacity scale of 20 kg and they were weighed according to their replicates. The number of birds per replication was used to divide the total weight of the same replicate to estimate the average weekly body weight per bird. Data on nutriments consumption were collected daily. The gain in weight and Daily nutrient uptake was measured on daily basis.

### Experimental Design and Statistical Analysis

The gathered data were examined by ANOVA (One Way Analysis of Variance). By using the Duncan Multiple Range Test treatment methods were compared [10].

## Results

### Performance of Starter Broilers Fed Diet Treated with Organic Acids

The weight of broilers at the start, that was treated with organic acids were not significant ($P>0.05$). There were remarkable ($P<0.050$) contrasts in the final body weight

(FWT) of the broiler with $T_5$ given the highest average value of 637 g. $T_3$ recorded the lowest value of FBWT.

| Parameters | Control$T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | P-Value |
|---|---|---|---|---|---|---|
| Body weight at beginning (g) | 72.00$^{d}$ | 76.00$^{b}$ | 77.00$^{a}$ | 74.00$^{c}$ | 74.67$^{c}$ | (P>0.05) |
| Body weight at end (g) | 560$^{c}$ | 580b$^{c}$ | 500$^{d}$ | 598$^{b}$ | 637$^{a}$ | (P<0.050) |
| Overall weight gain (g) | 488$^{c}$ | 504b$^{c}$ | 423$^{d}$ | 524$^{b}$ | 562.33$^{a}$ | (P<0.05) |
| Av. regular gain in weight (g) | 23.24$^{c}$ | 24.00b$^{c}$ | 20.14$^{d}$ | 24.97$^{b}$ | 26.78$^{a}$ | (P<0.050) |
| Total grain uptake (g) | 1132$^{a}$ | 1160$^{a}$ | 1023$^{b}$ | 1228$^{a}$ | 1178$^{a}$ | (P <0.05) |
| Av. regular uptake of grain (g) | 53.90$^{a}$ | 55.25$^{a}$ | 48.70$^{b}$ | 58.49$^{a}$ | 56.11$^{a}$ | (P<0.05) |
| Feed: gain ratio | 2.35$^{a}$ | 2.31$^{a}$ | 2.43$^{a}$ | 2.34$^{a}$ | 2.09$^{b}$ | (P<0.05) |
| Daily uptake of protein (g) | 11.53$^{ab}$ | 11.80$^{ab}$ | 10.42$^{b}$ | 12.51$^{a}$ | 12.01$^{a}$ | (P<0.05) |
| Protein efficiency ratio | 2.00$^{b}$ | 2.30$^{b}$ | 1.92$^{b}$ | 1.99$^{b}$ | 2.25$^{a}$ | (P<0.05) |
| Total uptake of water (ml) | 1511$^{c}$ | 1588$^{c}$ | 1371$^{d}$ | 1803$^{a}$ | 11691$^{b}$ | (P<0.05) |
| Av. Daily uptake of water (ml) | 71.97$^{c}$ | 75.60$^{c}$ | 65.27$^{d}$ | 85.87$^{a}$ | 80.54$^{b}$ | (P>0.050) |
| Water: feed ratio | 1.30$^{b}$ | 1.35$^{ab}$ | 1.32$^{ab}$ | 1.44$^{a}$ | 1.40$^{ab}$ | (P<0.05) |

$^{a-d}$ Means in the same row with different superscripts are significantly (P<0.05) different.

**Table 1:** Performance of starter broilers fed diet treated with organic acids (Mean ± SEM).

Final weight gain was remarkably (P<0.05) higher with T5 than others in the ranking of $T_5$>$T_4$> $T_3$>$T_2$>$T_1$. T1 showed that the average daily weight gain (AVWG) of the broilers was remarkably (P<0.050) highest with T5 and this organic acid at 0.25 percent level of inclusion may be recommended for starter broilers. Total feed intake (TFI) was highly significant in the treatments. However, T3 (Butyric acid) has significantly different (P <0.05) in TFI as compared to others at a 0.25% level of inclusion. There was remarkable contrast (P<0.05) in the average regular uptake (ADFI) of the broilers with T3 (Butyric) given the lowest value. The TFI, as well as ADFI and DPI, were not significantly (P<0.05) influenced by citric acid. The report that have been followed by [17] shows that the performance of chicks has not been affected by the supplementation of citric acid and ascorbic acid. Feed: gain ratio was remarkably (P<0.05) lower in the birds that were placed on T5 (formic acid) and was influenced in other treatments. However, other treatments did not differ remarkably (P<0.05). There were remarkable (P<0.05) contrasts in daily protein intake DFI of the birds with those on citric acid and formic acid being similar and remarkably (P<0.05) giant than DPI of birds on acetic acid, butyric acid, and even of the standard. Although, regarding protein efficiency ratio, broilers that were fed on nutriments containing formic acids had significantly better results (P<0.05) than those fed either of acetic, butyric, citric acid and even the control diet (Table 1). Although, regarding protein efficiency ratio, broilers nourished better results (P<0.050) than those fed either of acetic, butyric, citric acid, and even the control diet (Table 1). The total water intake (TWI) was affected (P<0.05) by the organic acids. But the birds took more of water containing citric acid as compared to that of others.

The birds consumed remarkably lower (P<0.05) water containing butyric acid and no remarkable (P>0.050) contrast existed between the total and average daily water consumption of broilers on acetic acid water and the control (T1) (Table 1). Water utilization to include water: Feed ratio was significantly (P<0.05) highest with the birds that are fed with citric acid diets. This indicates that citric acid encourages increased water consumption in broiler starters.

### EFFECT OF ORGANIC ACID ON ECONOMIC PERFORMANCE OF BROILER STARTER CHICKS

| Cost | Control T1 | T2 | T3 | T4 | T5 | SEM |
|---|---|---|---|---|---|---|
| Price/kg nutriment (N) | 71.11$^{b}$ | 78.61$^{a}$ | 78.61$^{a}$ | 78.61$^{a}$ | 78.61$^{a}$ | 2.56 |
| Nutriment price/bird (N) | 80.50$^{b}$ | 91.19$^{a}$ | 80.42$^{a}$ | 96.53$^{a}$ | 92.60$^{a}$ | 4.11 |
| Nutriment cost/weight gain (N) | 167.11$^{c}$ | 181.59$^{a}$ | 191.02$^{a}$ | 183.95$^{b}$ | 164.29$^{c}$ | 7.12 |
| Feed cost/live weight (N) | 45.08$^{c}$ | 52.89$^{b}$ | 40.21$^{d}$ | 57.72$^{a}$ | 58.99$^{c}$ | 3.01 |

$^{a-d}$ Means in the same row with different superscripts are significantly different (P<0.05), while means along the same row with similar superscripts are not remarkably (P>0.05). SEM = Standard error of the means.

**Table 2:** Impact of organic acids on the economic performance of broiler starter chicks.

The impact of organic acids on the economic conduct of broiler starter chicks is given in Table 2. There was a remarkable contrast (P<0.05) in the feed cost per bird which were receiving a diet containing organic acids as compared to those containing Butyric acid diet that were given at the feed cost of N80.42. The economic implication of this is that feed prepared with butyric acid caused the reduced cost of production. Feed cost weight gain of the birds differed remarkably (P<0.05) with the lowest costs (N167.11) and (N164.29) obtained for diets containing control (standard) and formic acid respectively. This indicated that formic acid seems to have high weight gain with the lowest cost (cost-benefit analysis). This profit is maximized with formic acid diets. There was a remarkable contrast (P<0.05) in the nutriment price per live weight of birds with those placed on a diet containing butyric acid (N40.21).

## Discussion

The existence of significant differences in the final body weight of birds may be attributed to the influence the differences in the type of acid product as reported earlier [11]. The influence may be a result of the type of acid and level of bacterial load in the birds because the weight gains of host animals [12] were improved by acidification of nutrients which are helpful in preventing intestinal bacteria by contesting with the host for average daily weights. The improvement in the daily weight gain of broiler was done by the addition of fumaric acid in diet during the whole trial of almost 49 days [13]. The T3 (Butyric) may have shown to be active against microorganisms. Feed intake of the birds fed 0.4 percent butyric acid was reduced in contrast to birds fed the non-medicated diet throughout the starter period, whereas

birds fed 0.2 percent butyric acid had similar feed intake to the control birds [14]. In other words, the prevention of the growth of potentially pathogenic bacteria and zoonotic bacteria, e.g. *E. coli* and *Salmonella spp*, in the nutriments and the GIT tract is beneficial regarding the health of animals [15]. Nutrient uptake of these organic acids can only be retrieved from the foregut of chicks (Crop, gizzard, and proventriculus) [16]. The performance of chicks has not been affected by the supplementation of citric acid and ascorbic acid [17]. A positive impact on either FCR or growth performance of broiler chicks was found in fumaric acid, propionic acid, sorbic acid propionic acid [18]. In birds, a remarkable contrast was observed in rising of ADFI which may be ascribed because organic acids also put forth their antimicrobial action both in the nutriments as well as in the GIT tract of the birds and acid in the food endeavor as an antibacterial effect in the bird cane. Butyric, citric, and acetic acids in diet were responsible for increased gastric proteolysis and protein and amino acid digestibility in pigs as reported earlier [19]. This organic acid may have been found very succulent and acceptable by the birds for obvious advantages. [20] revealed that in young chicks these organic acids were responsible for making drinking water free from campylobacter infection. Also, it has been observed that in poultry production these organic acids have been supplemented in drinking water to hold on the watering system liberate from microbes and are used to reduce the impact of feed-borne salmonella species without damaging the birds or environment [21]. The lower feed cost for the live weight of birds on a butyric acid diet is an indication that a poultry farmer needs less amount of money to feed his bird using butyric acid diets than a feeding control diet [9].

Organic acid-treated diets have a remarkable effect on the growth performance of animals by including the broiler chickens that are often responsible for enduring the digestive problems which include bloody diarrhea and abdominal cramps due to *E. coli*. Organic acids which include acetic, butyric, citric, formic, fumaric, and propionic acids vary in their biochemical actions in the systems of animals. This situation has necessitated aggressive research work to improve the nutrition of broilers in Nigeria.

The present study showed that organic acids have a remarkable impact on the final weight gain, average regular weight gain, total feed intake, and feed: gain ratio, daily protein uptake, protein efficiency ratio, total water uptake, average water intake, and water: feed ratio. The encouraging results that were obtained from this study resulted in the expansion of a large number of commercial products. Although, a further broad and rigorous study is required to ameliorate their efficacy.

## Competing Interests

All authors read and approved the final version of the manuscript and declared that they have no conflict of interest.

## Author Contributions

Muhammad Hassan Saleem: Designed the study, Dozie Ndubisi Onunkwo: Conduct the research, Abdul Jabbar: Supervise the study and statistical analysis. Areej Rauf, Hamza Javed and Muhammad Hamza Javid: Write a primary draft. Muhammad Talha and Nimra Irm: Edit the manuscript.

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