# Original Research Article

# Effects of Using Organic Acids to Substitute Antibiotic Growth Promoter on the Growth Performance of Broiler Chickens



**ABSTRAC**

Antibiotic growth promoters (AGP) are still widely used to improve gut health and growth performance in the global poultry industry. The continuous and excessive use of AGP has been thought to decrease the efficacy of AGP and threaten public health by spreading antibiotic resistant bacteria. The study was conducted to investigate the effect of organic acids to substitute AGP on the growth performance parameters of broiler chickens. A total of 150 unsexed day old broiler chicks (Cobb 500) were randomly allocated into five watery treatments with three replicates containing 10 chicks each. Group $T_0$ served as control while the groups $T_1$, $T_2$ and $T_3$ were supplemented with different organic acids (citric acid, formic acid and acetic acid). However, the group $T_4$ received AGP (oxytetracycline hydrochloride) at the appropriate dosage. The feeding trial was lasted for 28 days. The results of the experiment revealed that OAs and AGP supplementation significantly ($p<0.01$) improved feed conversion ratio (FCR) than control group. Besides, birds from $T_1$, $T_2$ and $T_3$ groups had significantly higher ($p<0.05$) body weight gain (BWG) compared to control and AGP groups. Considering the whole experimental period, $T_1$ and $T_3$ groups had a significantly ($p<0.01$) FCR than $T_0$, $T_2$ and $T_4$ groups. In conclusion, OAs are more efficient than AGP in improving broiler growth performance and could be successfully used to substitute AGP in broiler diets, though the effect of all OA mixtures were not same on performance.

*Keywords: Organic acids, Antibiotics, Body weight, Feed consumption, Feed conversion Ratio, Broilers*

## 1. INTRODUCTION

The poultry industry plays an important role in fulfilling the protein demand of humans in Bangladesh [1]. It is considered the farmers' first investment in the livestock ladder as a way of income generation. Poultry meat supplies by oneself a considerable 37% of the total meat production in Bangladesh [2]. Similarly, there is a need for high levels of production and efficient feed conversion in the modern poultry industry, which can be achieved by the use of specific feed additives [3]. Feed additives have long been part of feed and play substantial roles in success of poultry production [4]. Specifically, organic acid has been incorporated in feed or water for the benefit with prevention of intestinal tract disease, immunity, digestibility of nutrients, and effect on growth performance [5]. In addition to organic acids, probiotics, prebiotics, extract from medicinal herbs, and exogenous enzymes are some of the other frequently used feed additives. They are used as antimicrobials, antioxidants, emulsifiers, binders, pH control agents, and enzymes in the poultry diet [4].

But continuous misuses of antibiotics in livestock production, especially in the poultry industry have resulted in many problems like the development of antimicrobial-resistant bacteria [6]. To minimize health risks, consumers have great preferences for conventional broiler meat, resulting in shift to antibiotic-free broiler meat production around the globe [7]. However, discrete use of antibiotics is not encouraged and the European Union (EU) has already banned the use of antibiotics, considering their harmful effect on human or animal health [8]. The ban on antibiotic use, combined with consumers' preferences, provoked scholars to look for antibiotic alternatives [9].

In order to find substitutes for antibiotic growth promoter (AGP), different natural additives have been evaluated. Blended natural additives aiming to improve intestinal health are commercially available and previous studies have shown that they may modulate gut microflora [10]. Optimal intestinal health is important for gut barrier function, microflora, and digestion and absorption of nutrients, contributing to improved growth performance. Therefore, it is necessary to develop novel feed additives substituting antibiotics to maintain intestinal health in the poultry production [11]. Among alternatives, organic acids and essential oils have been used extensively for broiler chickens in different countries [12]. Organic acids or acidifiers, which are considered to be weak carboxylic acids (R-COOH) such as acetic, propionic, formic, fumaric, lactic, and sorbic acids. It was reported that the inclusion of organic acids had a positive impact on growth performance, feed efficiency, and digestibility of nutrients [13, 14].

Individual or blends of several organic acids have been found to perform antimicrobial activities in poultry diet similar to antibiotics [15]. In addition to the antimicrobial activity of organic acids, they possess some other biological activities as well such as better intestinal health for efficient utilization and absorption of nutrients, hence improving broiler’s overall health and performance. For intestinal villi, organic acids are considered readily accessible cause of energy and stimulate their differentiation and multiplication, and consequently escalate feed efficiency [16].

Furthermore, studies demonstrate that supplementation of organic acids to broiler diets has been reported enhancement of growth performance along with carcass characteristics in broiler chickens [17]. The EU now allows the use of organic acids and their salts in poultry production as these are considered as safe [16]. Since the use of in-feed antibiotics will be restricted all over the world in future, there will be growing interest for using suitable feed additives (organic acids) as a bioactive compound for improving gut health and better growth performance of poultry. The antimicrobial activity of organic acid may decrease the incidence of disease caused by different microorganisms or mold and yeast in broilers. Use of organic acid may not only alleviate the fear of antibiotic residues but also the effect of antibiotic resistance. Moreover, their capacity to increase nutrient digestibility by improving utilization of different mineral particles may lead to livestock production in a positive way. For these reasons, the present study was designed to find out the effects of organic acids on growth performance parameters of broiler chickens.

## 2. MATERIAL AND METHODS

According to the Bangladesh veterinary council act 2019, Birds care and use regulations established by institutions and countries have been fulfilled. All precautions were taken to reduce pain and discomfort to animals during the experimental period. No animals were killed for the scientific purpose of this study.

### 2.1 Area and Duration of the Study

The experiment was carried out at the poultry research shed of the Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal

Sciences University (CVASU), Khulshi-4225, Chattogram, Bangladesh from July 2022 to December 2022.

## 2.2 Study Population and Design

In the present study, a total of 150 unsexed day old chicks (DOC) of broiler (Cobb-500) with an average weight of 38.75 g were used in a 4 week watery treatment. A completely randomized design (CRD) was used to randomly assign the birds into five watery treatments of 30 birds per group. Each treatment was divided into three replicates of 10 birds each. Birds had ad libitum access to water and feeds. The drinking water pH of group $T_0$ (control) was 7 while the pH of others was kept at 4.5 by administering specified doses of citric acid ($T_1$ =1.25 ml/L), formic acid ($T_2$= 0.5 ml/L) and acetic acid ($T_3$= 2 ml/L) in drinking water. Group $T_4$ received antibiotics at the appropriate dosage (oxytetracycline hydrochloride at 1 gm/L drinking water). The design of the experiment is displayed in Figure 1. All of the groups consumed typical diets.

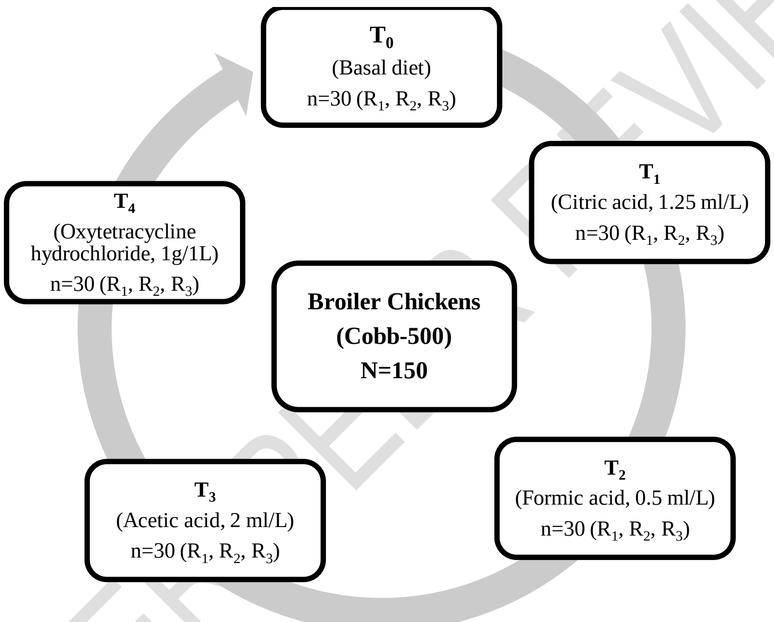


**Fig. 1.** The design of the experiment

## 2.3 Chicks Management

The chicks were housed in a room and reared under cage system housing. Each pen was furnished with a feeder and drinker. Feeders were cleaned before supplying diets, and drinkers were washed regularly to maintain hygienic conditions. For the first two days, the birds were provided with an initial temperature of 33°C. The temperature was then gradually reduced by 1 or 2°C every 1 or 2 days until the chicks were 19 days old and then maintained at 24°C for the remainder of the experiment. A lightening period of 23 h. per day was provided for the birds throughout the experiment.

## 2.4 Feeding and Watering of Chicks

The experimental period included 2 feeding phases, i.e. starting phase and growing phase. Corn-soybean meal based basal diet was supplied to the birds in two different growth stages. The starter ration was offered from 0 to 2 weeks and the grower ration from 3 to 4 weeks. Rations for all treatment groups were iso-energetic and iso-nitrogenous. Nutrient compositions of basal diets are presented in Table 1. Chicks were allowed to have free access to both feed and water in pellet form and by drinkers, respectively throughout the experimental period.

**Table 1. Nutrient compositions of basal diets**

| Ingredients, % | Starter (day 0-14) | Grower (day 15-28) |
|---|---|---|
| **Calculated composition, %** | | |
| CP | 22.00 | 21.00 |
| CF | 4.50 | 4.50 |
| EE | 4.50 | 5.00 |
| Ash | 6.00 | 6.00 |
| Lysine | 1.32 | 1.18 |
| Methionine | 0.55 | 0.52 |
| Calcium | 1.05 | 1.00 |
| Available phosphorus | 0.50 | 0.50 |
| ME (kcal/kg) | 3000 | 3100 |

**CP=Crude protein; CF= Crude fiber; EE= Ether extract; ME= Metabolizable energy*

### 2.5 Growth Performance of Chicks

Performance data were recorded weekly in the periods from 1 to 28 days of age. Feed intake (FI) was determined for each replicate as the difference between the amount of feed supplied and the remaining feed at the end of each experimental period. Body weight (BW) and body weight gain (BWG) were calculated as the difference between the final and initial bird weights. Feed conversion ratio (FCR) was calculated as the ratio between feed intake and body weight gain during each phase of the experimental period.

### 2.6 Statistical Analysis

All the data of performance were entered into a spreadsheet program of Microsoft Office Excel 2010. Data management and analysis were done in one way ANOVA (Analysis of Variance), using Statistical Package for the Social Sciences (SPSS) version 16.0. Means showing significant differences were compared with the Duncan's Multiple Range Test (DMRT). The *P* value of <0.05, <0.01 or <0.001 was considered statistically significant.

## 3. RESULTS AND DISCUSSION

The effect of organic acids on the growth performance parameters of broiler chickens which were recorded weekly throughout the experimental period are presented in Table 1. Results indicated that weekly average BW differed highly significant ($P$<0.001) and significant ($P$<0.01) at 3$^{rd}$ and 4$^{th}$ weeks respectively but insignificant at 1$^{st}$ and the 2$^{nd}$ week of age. The highest weekly average live weight was recorded in the group $T_1$ than other treatment and control groups at 4$^{th}$ week of age. However, our results are similar to the findings of Pesti et al. [18] indicated that acidified drinking water increased live body weight in comparison to normal drinking water. The findings in the current research trial regarding BWG and FCR agreed with Kamal and Ragaa [19] who reported that organic acids (butyric, formic, and lactic acid) supplementation showed a significantly higher weight gain in contrast to control. Besides, BW in the antibiotic-treated group ($T_4$) increased significantly at 4$^{th}$

weeks of age as compared to the control group but decreased as compared to the citric acid-treated group ($T_1$). Previous studies indicated that the addition of OA as substitutes for AGP to the broilers' diet obviously improved the growth performance [20, 21, 22]. Furthermore, the results of our investigation complement the findings of Hassan et al. [3], which showed that gallic acid was better to biacid or enramycin. Gallic acid and biacid were commercial organic acids, while enramycin was a commercial antibiotic used as a growth stimulant. Similarly, Fathi et al. [23] also observed that broilers treated with formic and propionic acid presented better BWG and FCR. Various researchers also reported that the supplementation of organic acids to the diet of broilers chickens had beneficial effects on BWG [24] and FCR [25].

**Table 2. Effect of organic acids on the growth performance of broiler chickens**

| **Performance parameters** | **Experimental treatments** | | | | | **SEM** | **Level of Significance** |
|---|---|---|---|---|---|---|---|
| | **$T_0$** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | | |
| **Body weight (g)** | | | | | | | |
| 1st week | 197.70 | 201.00 | 202.00 | 200.75 | 201.25 | 0.89 | NS |
| 2nd week | 522.00 | 542.15 | 511.05 | 541.90 | 515.50 | 6.56 | NS |
| 3rd week | 982.50$^{bc}$ | 978.90$^{bc}$ | 810.70$^{a}$ | 950.00$^{b}$ | 1024.35$^{c}$ | 36.62 | *** |
| 4th week | 1581.50$^{b}$ | 1666.50$^{c}$ | 1497.00$^{a}$ | 1619.00$^{bc}$ | 1632.00$^{bc}$ | 28.94 | ** |
| **Body weight gain (g)** | | | | | | | |
| 1st week | 149.55$^{a}$ | 153.90$^{bc}$ | 154.75$^{b}$ | 153.90$^{bc}$ | 153.45$^{bc}$ | 0.91 | * |
| 2nd week | 324.50 | 341.15 | 309.05 | 341.80 | 314.25 | 6.70 | NS |
| 3rd week | 459.95$^{bc}$ | 437.10$^{b}$ | 299.15$^{a}$ | 409.85$^{b}$ | 508.85$^{c}$ | 34.96 | ** |
| 4th week | 604.25$^{a}$ | 687.60$^{b}$ | 686.30$^{b}$ | 669.00$^{b}$ | 587.55$^{a}$ | 21.25 | ** |
| **Feed intake (g)** | | | | | | | |
| 1st week | 175.70 | 175.10 | 175.20 | 174.60 | 178.50 | 0.89 | NS |
| 2nd week | 448.70 | 430.45 | 418.60 | 426.30 | 439.00 | 6.33 | NS |
| 3rd week | 809.00$^{cd}$ | 687.05$^{bc}$ | 549.95$^{a}$ | 650.05$^{ab}$ | 839.45$^{d}$ | 52.88 | ** |
| 4th week | 1071.05$^{b}$ | 1075.70$^{b}$ | 1086.95$^{b}$ | 1077.30$^{b}$ | 1013.05$^{a}$ | 14.55 | * |
| **Feed conversion ratio (g/g)** | | | | | | | |
| 1st week | 1.174$^{b}$ | 1.137$^{a}$ | 1.132$^{a}$ | 1.134$^{a}$ | 1.163$^{b}$ | 0.01 | ** |
| 2nd week | 1.290$^{a}$ | 1.300$^{a}$ | 1.350$^{b}$ | 1.311$^{a}$ | 1.390$^{b}$ | 0.01 | * |
| 3rd week | 1.750$^{b}$ | 1.590$^{a}$ | 1.830$^{b}$ | 1.580$^{a}$ | 1.640$^{a}$ | 0.04 | ** |
| 4th week | 1.770$^{b}$ | 1.590$^{a}$ | 1.580$^{a}$ | 1.610$^{a}$ | 1.720$^{b}$ | 0.04 | * |
| 0-4th week | 1.500$^{b}$ | 1.400$^{a}$ | 1.470$^{b}$ | 1.400$^{a}$ | 1.470$^{b}$ | 0.02 | ** |

**SEM = Standard Error of Mean; NS = Not Significant; * = Significant ($p<0.05$); ** = Significant ($p<0.01$); *** = Significant ($p<0.001$). a, b and c = Means having different superscript in the same row differ significantly.*

In this investigation, the BWG of the experimental birds revealed that a significant ($P$<0.05) level of variations was found during the 1st, 3rd, and 4th weeks. Considering the data on 2nd week, weight gains differed insignificantly ($P$>0.05) among the treatment groups. In terms of body weight gain, the group $T_1$ performed better than other groups, and finally, the highest BWG was observed in the treatments supplemented with citric acid ($T_1$ group). It was found that the body weight gain of the group $T_2$ was lowest at 3rd week of age. Regarding the effect of organic acid supplementation on productive traits during the experimental period, it was evident that BW and BWG were significantly increased ($P$<0.05) by citric and acetic acid supplementation as compared with the control group (**Table 2**). At the present study, there was no significant variation in BW and BWG during the first two weeks but a statistically significant ($P$<0.05) result was found during 3rd and 4th week of age. At a later stage, the significant positive effect on growth performance was reported in the acidifier group due to the stimulating role on enzymatic secretion, specifically on the synthesis of gastric and pancreatic lipase [26], and because of the reduction of the growth depressing metabolites produced by microorganism in the gut [27]. Better BWG was observed because feed utilization by dietary acidification becomes more efficient [28].

There was no significant difference in feed consumption across treatments over the periods 01 to 07 and 08 to 14 days of age. However, FI of birds also showed significant differences at 3rd ($P$<0.01) and 4th ($P$<0.05) week of age within all the water treatment groups. The highest feed intake was recorded in group $T_2$ (formic acid) while the lowest was reported in $T_4$ (antibiotic treatment) group at 4th week of age. From our findings, it is evident that average FI was higher in the organic acid-treated group as compared to the control and antibiotic supplemented group and differed statistically ($P$<0.05) only at 3rd and 4th week of age (**Table 2**). During the entire experimental period, FCR of the birds varied in irregular fashion. It was revealed that FCR differed significantly ($P$<0.05) at 2nd week of age within the treatment group. The results of the experiment showed that FCR increased gradually and varied significantly ($P$<0.01) and ($P$<0.05) at 3rd and 4th week of age respectively. Considering the whole experimental period, highest FCR was recorded 1.50 in $T_0$ group (control) while the lowest 1.40 and 1.40 observed in $T_1$ (citric acid) and $T_3$ (acetic acid) treatment group, respectively. Similarly, feed conversion ratio of the antibiotic-treated group ($T_4$) showed significantly ($P$<0.01) better FCR as compared to the control group (**Table 2**). The FCR was improved in broilers by supplementing their water with organic acids. The better FCR in organic acid-treated groups could be attributed to lowering the pH of the digestive organ, resulting in improved digestion, absorption, and nutrient utilization [29]. This could account for the higher FCR in these groups. In a recent study conducted by Brzoska et al. [30] found that broiler feed efficiency was enhanced by adding 0.1% acidifier to water. According to Adil et al. [16], supplementing 0.3% acidifier increased BWG and FCR in chickens. This finding is in similar to our study.

## 4. CONCLUSION

The results of the study revealed that organic acid supplementation responded positively as a result of increased feed intake, body weight and better FCR. Therefore this study suggests organic acid as a potential growth promoter to substitute antibiotic growth promoter for commercial broiler farming.

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