



Research Article

Dietary Citric Acid on Broiler Diet: Production Efficiency, Carcass Characteristics and Economic Viability

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Abstract | The feeding trial was undertaken to examine the responses of broiler chicken feeding citric acid (CA) on the diet of broiler chicken. The experiment was conducted with eighty four (84) day old broiler chicks (DOC) with four dietary treatment groups having three replication (7 birds per replication) where; T₀=basal diet (control group), T₁= 0.50% Citric Acid, T₂= 0.750% Citric Acid, and T₃= 1.00% Citric Acid. Formulated diet was supplied to the every dietary group on optimum basis. During experimental periods strict biosecurity protocol was maintained. Performances of birds were recorded every week to calculate and analyze the data. Finally the average live weights recorded were 1844.33, 2008.00, 2113.33, and 1895.00 (g/broiler) per broiler in groups T₀, T₁, T₂, and T₃ groups respectively. The 0.750% CA groups achieved a markedly superior live weight of 2113.33g compared to the other treatment groups. A significant effect was also noted in live weight gain, which reached 2073.00g in T₂ groups. Furthermore, the total average feed intake was significantly elevated in 0.75% CA, at 3036.34 g per broiler, where the most favorable feed conversion ratio (FCR) was also attained at 1.46. A higher dressing percentage was observed in 0.750% CA, which stood at 70%. The overall cost per bird for T₀, T₁, T₂, and T₃ were BDT 270.84, 277.61, 282.32, and 274.07, respectively, while the overall profit per bird was BDT 35.84, 56.78, 70.09, and 41.11, with the highest profit recorded was BDT 73.43 in 0.750% CA groups. It can be summarized that the supplementation of 0.750% citric acid incorporation in diet significantly enhances the production performance of broiler chicken.

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Introduction

The increasing use of antibiotic in broiler diet is a major concern in recent times. The application

of antibiotic in the diet for broiler chickens is controversial to consumers. In spite of the numerous advantages associated with broiler meat, which is abundant in high-quality protein, low in fat content,

and rich in essential vitamins such as B, as well as iron and selenium. Broiler meat also enhances muscle growth and repair, assists in effective weight management, and significantly contributes to cardiovascular and skeletal health. Young children and seniors effortlessly digest the broiler meat. But consumers still scared to consumes broiler meat due to incorporation of antibiotic growth promoters. Poultry Scientist is thinking alternatives of antibiotic growth promoter. Gunal *et al.* (2006), stated that citric acid (CA) are thought to be substitutes for antibiotic growth promoter.

It is widely recognized that citric acid acts as an alternative to antibiotic, enhancing nutrient digestibility, being rich in antioxidants, and significantly contributing to body weight gain. Several studies have indicated that citric acid included into broiler diet improve feed efficiency, production performances and immune responses (Chowdhury *et al.*, 2009). Citric acid has been incorporated in diets improved growth rate and resistant against diseases (Islam *et al.*, 2008). Among different organic acid citric acid is one of them which enhance growth rate, lower FCR, improve immunity and gut health of broiler. But more studies are needed to established to determine the inclusion level of citric acid in broiler ration. This study aimed to determine the effect of different dietary inclusion levels of citric acid on growth performance, feed conversion ratio (FCR), gut health markers, and economic consideration in broiler chickens.

Materials and Methods

The feeding trail was conducted at the Mirsarai Upazila of Chittagong district in Bangladesh.

Experimental design and bird's management

Eighty four (84) day old chicks (DOC) of Ross 308 have been reared for 35 days to find out the result. The experiment was allocated with four (4) dietary treatments with three replication having seven (7) birds per replication with 21 birds per treatment groups. The treatments were indicated as T_0 = Control or basal diet (without CA supplementation) T_1 = 0.50% Citric Acid, T_2 = 0.75% Citric Acid and T_3 = 1.00% citric acid supplementation.

Experimental diet

Table 1 showed the formulated diet for the experimental birds. Raw materials of the diets were supplied from a renowned company CP Bangladesh

Company limited. Diets were formulated in C.P. Bangladesh Company Limited Laboratory and Animal Health and Technical Services Office (AHTSO) Laboratories according to treatment wise where nutrient density will lower in accordance with increase the percentage of citric acid. Feeds were stored in plastic buckets in treatment wise in cool, dry place. Citric acid was supplied with drinking water (liquid form) according to experimental design.

Table 1: *Experimental diets ingredients composition.*

Feed component	Amount in kg/100 kg			
	T_0	T_1	T_2	T_3
Maize	62.00	62.00	62.75	63.00
Protein concentrate	6.25	5.50	5.00	5.00
Soya meal	27.00	25.50	25.00	24.45
Limestone	0.70	0.60	0.60	0.60
di calcium phosphate	1.30	1.20	1.20	1.25
Oil	4.00	4.00	4.00	4.00
Vit-Min premix	0.20	0.15	0.15	0.15
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Enzyme	0.05	0.05	0.05	0.05
Citric acid	0.00	0.5	0.75	1.00
Salt	0.30	0.30	0.30	0.30
Total	100	100	100	100
Analyzed nutrient composition				
Feed ingredients				
ME(Kcal/kg)	3007	3005	3005	3001
CP %	22.0	21.0	21.0	21.0
Calcium %	0.9	0.93	0.95	0.95
Available P%	0.45	0.45	0.45	0.45
Lysine %	1.00	0.9	0.9	0.9
Methionine%	0.42	0.39	0.39	0.39
Crude Fiber	4.03	5.00	5.1	5.3

Bird's management

Treatment wise formulated feed was supplied each bird on every replicated group. During the whole experimental periods. Water was added with percentage of different ratio of dietary supplementation of citric acid. A strict bio-security was maintained during experimental period. On the day of 4th birds were vaccinated against ND and Gumboro on 11th day. A booster vaccination against ND was done at 20th days of age.

Data collection and record keeping

All data like body weight, body weight gain, feed

conversion ratio (FCR), feed intake were recorded weekly except carcass characteristics (dressed weight, breast weight, thigh weight etc.) which were recorded at the end day of trial to statistically analyze. After completing the experiment economic analysis was done to calculate the cost benefit ratio.

Statistical analysis

All measurable data were recorded and analyzed statistically using IBM SPSS version 20. Completely Randomized Design (CRD) Design was used with Duncan multiple range test to analyze the differences

among the treatments. Means and standard error was calculated where $p < 0.05$ is indicated the level of significances.

Results and Discussion

Tables 2, 3, 4, and 5 indicates body weight, body weight gain, feed intake and FCR of the broiler. The result showed significance differences among the dietary treatments groups.

Table 2: Weekly body weight of broiler chicken.

Age in days	T ₀	T ₁	T ₂	T ₃	LS
Day 01	40.33±0.58 ^a	40.33±0.47 ^a	40.33±1.00 ^a	40.33±0.47 ^a	NS
Day 07	161±1.00 ^a	162 ±2.00 ^a	163.00±2.00 ^a	162.00 ±14.00 ^a	NS
Day 14	421.67±2.89 ^a	454.67±3.00 ^b	465.00±5.00 ^b	435.67±7.50 ^a	*
Day 21	850.67±4.04 ^a	895.0±3.00 ^b	925.67±3.00 ^b	862.33±2.52 ^a	*
Day 28	1393.0±3.61 ^a	1452.67±4.00 ^b	1515±5.00 ^b	1434.33±2.52 ^a	*
Day 35	1844.33±6.43 ^a	2008.00±7.00 ^b	2113.33±10.00 ^c	1895.00±10.00 ^a	*

LS= Level of significances. Superscripts (^{a,b}) indicate the significance.

Table 3: Body weight gain of broiler chicken.

Age in days	T ₀	T ₁	T ₂	T ₃	LS
Day 7	120.67±1.53 ^a	121.67±2.52 ^a	122.33±1.15 ^a	121.67±4.62 ^a	*
Day 14	260.67±3.06 ^a	292.67±4.73 ^b	302.00±4.16 ^b	273.67±10.02 ^a	*
Day 21	429.00±2.52 ^a	440.33±7.64 ^a	460.00±1.15 ^b	426.67±7.64 ^a	*
Day 28	542.33±2.52 ^a	574.33±14.57 ^b	589.33±4.16 ^b	572.00±3.42 ^b	*
Day 35	451.33±2.89 ^a	539.00±5.29 ^b	601.67±7.64 ^c	460.67±11.93 ^a	*
Total body weight gain	1804.00±12.0 ^a	1967.67±15.0 ^a	2073.00±10.0 ^b	1854.67±18.0 ^a	*

LS= Level of significances. Superscripts (^{a,b}) indicate the significance.

Table 4: Feed intake (g) of broiler chicken.

Age in days	T ₀	T ₁	T ₂	T ₃	LS
Day 7	183.67±2.08 ^a	188.67±5.51 ^a	183.00±2.65 ^a	183.67±4.73 ^a	NS
Day 14	347.67±4.16 ^a	368.67±7.57 ^a	352.67±2.52 ^b	355.67±0.58 ^b	*
Day 21	606.67±13.65 ^a	596.00±4.36 ^a	622.67±8.14 ^b	599.00±9.54 ^a	*
Day 28	850.00±12.91 ^a	885.00±12.58 ^a	890.00±12.25 ^a	888.33±14.43 ^a	NS
Day 35	870.00±10.00 ^a	925.00±5.00 ^a	988.33±20.41 ^b	881.67±2.89 ^c	*
Total feed intake	2858.01±36.23 ^a	2963.34±35.02 ^a	3036.34±40.00 ^b	2908.14±28.17 ^c	*

LS= Level of significances. Superscripts (^{a,b}) indicate the significance.

Table 5: FCR of broiler chicken.

Age in days	T ₀	T ₁	T ₂	T ₃	LS
Day 35	1.93±0.05 ^a	1.72±0.04 ^b	1.64±0.04 ^c	1.91±0.03 ^d	*
Final FCR	1.58±0.03 ^a	1.51±0.02 ^b	1.46±0.02 ^c	1.57±0.04 ^b	*

LS= Level of significances.

Dressing percentage of broiler

Table 6: Dressed weight of broiler from different dietary treatment groups.

Points (g)	T ₀	T ₁	T ₂	T ₃	LS
Dressed weight	1226.80±15.0 ^a	1288±15.5 ^a	1452.50±12.3 ^b	1279±14.2 ^a	*
Blood weight	90.20±2.1 ^a	93.40±2.2 ^a	103.75±1.8 ^b	92.70±2.3 ^a	*
Viscera weight	180.40±5.5 ^a	186±6.0 ^a	207.50±4.0 ^b	185.40±5.8 ^a	*
Shank weight	72.16±2.0 ^a	74.72±2.1 ^a	83.00±1.9 ^b	74.16±2.1 ^a	*
Gizzard weight	36.08±1.3 ^a	37.36±1.4 ^a	41.50±1.2 ^b	37.08±1.4 ^a	*
Liver weight	54.24±1.5 ^a	56.04±1.6 ^a	62.25±1.3 ^b	55.62±1.5 ^a	*
Dressing percentage (%)	68±0.5 ^a	69±0.5 ^a	70±0.5 ^a	69±0.5 ^a	NS

LS= Level of significances.

Cost benefit analysis of using different level of citric acid

Table 7: Economic consideration of broiler chicken in different treatment groups.

Points	T ₀	T ₁	T ₂	T ₃	LS
Value /Kg feed	64.5	64.5	64.5	64.5	NS
Chick value	41.50	41.50	41.50	41.50	NS
Feed intake Kg/bird	2.858	2.963	3.036	2.908	NS
Cost (feed/bird)	184.34	191.11	195.82	187.57	NS
Cost (feed+chick)/bird	225.84	232.61	237.32	229.07	NS
Miscellaneous cost	45	45	45	45	NS
Total cost/bird	270.84	277.61	282.32	274.07	NS
Sale (BDT 170/Kg Live Bird)	306.68	334.39	352.41	315.18	NS
Profit/bird	35.84	56.78	70.09	41.11	*

LS= Level of significances. ^{NS} indicates no significant difference.

The result is agreed with [Abdel-Fattah et al. \(2008\)](#) who demonstrated that citric acid included in diet improved the live body weight and body weight gain of broiler. [Islam et al. \(2008\)](#) showed that feed consumption of birds was higher due to incorporation of citric acid in broiler diet. [Chowdhury et al. \(2009\)](#) found that citric acid and avilamycin supplementation can individually increase feed intake of broiler chicken. [Afsharmanesh et al. \(2005\)](#) found higher feed conversion of birds with feeding dietary citric acid in poultry. [Denil et al. \(2003\)](#) found better feed conversion in broiler supplementing acidifier diet. [Hassan et al. \(2010\)](#) stated that organic acids improved feed conversion ratio of broiler.

The dressing percentage of broilers with different supplements groups are shown in [Table 6](#). All dietary treatments groups showed significance differences among the parameter. The dressing results showed significance performances than other dietary groups.

This findings is comparable with the results of [Sohail et al. \(2015\)](#) who find that dressing percentage of birds were improve due to addition of citric acid on diet.

[Table 7](#) demonstrated that the profit of production per kg broiler was found most cost effective in 0.750% supplemented groups. [Tanzin et al. \(2015\)](#) was found more profit in 0.50% citric acid group. But in current the study 0.750% citric acid on diet showed profit per birds. The result indicates that incorporation of citric acid in diet of broiler is profitable business and ensuring better performances of birds. From the above results and discussion it can be concluded that diet containing low protein and energy than standard with addition of 0.750% citric acid can be profitable for broiler rearing.

Conclusion

After completing the study showed that 0.750% citric acid supplementation group showed better result than other groups. Finally it can be it may be concluded that 0.750% citric acid diet can improve the production performance of broiler. Therefore, it may be recommended to use 0.750% citric acid on broiler diet for better growth, production performances and carcass quality.

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Novelty Statement

Although citric acid has been investigated as a feed additive in broiler chickens, previous several studies have reported variable effects on growth performances, carcass characteristics, and economic outcomes, but limited information is available on its practical application under local production conditions. The novelty of the present study lies in the evaluation of dietary citric acid in broilers by simultaneously assessing production efficiency, carcass characteristics, and economic viability. By examine the responses within a practical broiler production system, this study provides evidence not only on the biological effects of citric acid supplementation but also on its potential economic value as a dietary feed additive.

Authors' Contribution

Rakibul Hasan conducted the experiment, analyzed the data, and wrote the draft of the manuscript. Faisal Kabir supervised and critically reviewed. Mahbuba Sultana wrote the final draft, reviewed and edited the manuscript.

Ethical consideration

The experimental procedures of this study were approved by the university of Patuakhali Science and Technology University. The approval number was PSTU/IEC/2025/30(i) Dated 25/09/2025.

Generative AI and AI assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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