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Effect of Citric Acid, Acetic Acid and their Combination on Growth and Meat Yield Performance of Broiler Chicken

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Abstract:

A study was conducted to investigate the effects of feeding citric acid and acetic acid on live weight gain, feed consumption, FCR, meat yield traits of commercial broilers. A total of 108 day old broiler chicks (Cobb 500) fed diets T0, T1, T2 and T3 having three replications in each.T0 (Basal diet with no supplemental acid), T1 (Basal diet with 0.75% citric acid), T2 (Basal diet with 0.75% acetic acid) and T3 (Basal diet with 0.75% citric acid and 0.75% acetic acid).The birds were reared in cage management system. Body weight gains, feed conversion ratio (FCR), mortality and meat yield traits were recorded and analyzed in CRD by using the SPSS software. Feed intake (g/bird) was almost similar (P>0.05) among the dietary groups. Body weight gain (gm) and FCR were significantly (P<0.05) different among the dietary groups. The highest body weight gain (gm) was (P<0.05) in T1 (1512.37gm), followed by T3 (1496.30gm) and T2 (1470.40gm) and T0 (1325.47gm) respectively. The lowest FCR was found in T1 (1.40) and the highest FCR in T0 (1.52), the intermediate in T2 (1.43) and T3 (1.41) respectively. It was found that there was significant (P<0.05) difference among the dietary groups in case of carcass weight (gm).live weight (gm),thigh weight (gm), breast weight(gm) but there was almost similar(P>0.05) among the dietary groups for heart weight (gm), spleen weight(gm), gizzard weight(gm), head weight(gm) and intestine weight (gm). Carcass weight in T1 (905gm) and live weight T1 (1496.67gm) were significantly (P<0.05) different compared to control T0 (668gm) and T0 (1160.67gm) respectively. No mortality was found among the dietary groups during experimental period. It was concluded from this experiment that supplementation of 0.75% citric acid in the diet had positive effect on the performance of broiler production.

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INTRODUCTION

Poultry sector is one of the most important sector of livestock in Bangladesh which supplies the cheapest animal protein (nutritious egg and meat) for human consumption within the shortest period of time. Broiler meat is an important source of quality proteins, minerals and vitamins to balance the human diet and superior to other meat available for human consumption for its tenderness, palatability and digestibility. People of modern times are very much conscious about their health and quality of food items that they will consume. Bangladesh provides a very fertile virgin field for the development of broiler industries. Broiler production has become a profitable and most popular income generating activity at present time for the people of the country. Developed breeds of chicken meat (broiler) are now available with the ability of quick growth and high feed conversion efficiency. Poultry production system has triggered the discovery and widespread use of a number of "feed additives". The main objective of adding feed additives are increasing their growth rate, better-feed conversion efficiency, greater livability and lowered mortality in poultry birds. These feed additives are termed as "growth promoters" and often called as non-nutritive feed additives (Singh and Panda, 1992).Growth promoters can play a vital role to shorten the time period required for attaining the market weight by stimulating growth (Bunyan et al.1977). The growth promoters have given positive responses in respect to growth improve feed efficiency and survivality of broilers (Dash et al., 2001). The feed additives have a number of beneficial effects like control of pathogenic microorganisms and enhance the growth of beneficial microorganisms (Shane, 1999). Antibiotics possess these beneficial effects but their use in the poultry industry has been intensively controversial because of the development of bacterial resistance and potential consequences on the human health. So, the alternatives to antibiotics are researched. Among these compounds, organic acids are promising alternatives (Hyden, 2000). Health of the gut is one of the major factors governing the performance of birds and thus, the economics of poultry production (Samik *et al*., 2007) and the profile of intestinal micro flora play an important role in gut health. Dietary organic acids and their salts are able to inhibit microbial growth in the food and consequently to preserve the microbial balance in the gastrointestinal tract. In addition, by modifying intestinal pH, organic acids also improve the solubility of the feed ingredients, digestion and absorption of the nutrients (Patten and Waldroup, 1988).Poultry performance and feed efficiency are closely interrelated with the qualitative and quantitative microbial load of the host animal, including the load in the alimentary tract and in the environment. Organic acids like citric acid and acetic acid have been used in diets due to their positive effect on health and growth of bird. More recently, the ban on antibiotics as a growth promoter in the European Union and the resulting pressures on meat exporters around the world, have increased interest in organic acids to attain performance improvements in growing swine and poultry. As the uses of organic acids are becoming more acceptable to feed manufacturers poultry producers and consumers, there is a growing interest in substituting them for antibiotic as growth promoters (Callsen, 1999). Citric acid and acetic acid are used as the substitute of antibiotic growth promoters in many countries of the world (Estieve *et al*., 1997). But use of citric acid and acetic acid as substitute of antibiotic growth promoter in Bangladesh is a new phenomenon. The effects of citric acid and acetic acid as substitute of antibiotic have not yet been evaluated much under Bangladesh condition.

Organic acids are weak acids, which modulate the intestinal pH.When these compounds are used correctly along with good nutritional, management and biosecurity measures. They could be a powerful tool in maintaining the health of the gastrointestinal tract (GIT) in

poultry thus improving the performance (Huyghebaert *et al.,* 2011). Moreover feeding organic acids is thought to have several positive effects such as improving protein digestion (Emami *et al.,* 2013), feed conversion ratio (FCR), growth performance, immunity (Chowdhury *et al.,* 2009; Khan and Iqbal, 2016) and enhancing mineral absorption (Nourmohammadi *et al.,* 2012; Wickramasinghe *et al.,* 2014). Citric acid (CA)and acetic acid (AA) have been used in diets due to the positive effect on birds' health and growth (Islam *et al.,* 2008).Currently, drinking water acidification is another implementation in the broiler industry used for improving performance Cornelison *et al.,* (2005). Organic acids are widely accepted as an alternative to in-feed antibiotics in poultry production, the addition of organic acid to the drinking water helps to reduce the level of pathogens in the water crop and proventriculus to regulate gut microflora to increase the digestion of feed and to improve growth performance Philipsen, (2006), and used for dual purposes-as feed preservatives as well as growth promoters. Reducing the pH of the feed organic acids can decrease bacterial contamination of feeds prior to consumption by birds, making them useful as feed preservatives Mroz *et al., (*1997). Hudha *et al.,*(2010) showed the supplementation of acetic acid in drinking water might improved growth, feed conversion and meat yield of broilers, such an improvement in biological performance would be counteracted by the cost of acetic acid making poultry rearing non-profitable. Supplementing layer feed with acetic acid may provide an effective, cost efficient method of achieving significant reductions in the negative effects of heat-stress, resulting in major improvements in egg production and quality, according to Anitox, a world-leader in pathogen elimination and mould control products for the feed milling and primary meat, egg and fish production industries, Acetic acid is an organic acid which is used primarily to control mold and reduce bacterial growth in feed, but it can also inhibit the growth of micro-organisms in the gastrointestinal tract, modify pH levels and improve feed utilization (Cooksley , 2011).This study was taken to investigate the effects of feeding citric acid and acetic acid on live weight gain, feed consumption, FCR, meat yield traits of commercial broilers.

MATERIALS AND METHODS

The study was conducted with a total of 108 day-old broiler chicks (Cobb 500) for 28 days. The day-old chicks were reared at brooder house to adjust with the environmental condition up to 7 days. After 7 days, chicks were randomly allocated in four dietary treatment groups having three (3) replications in each and 9 birds per replications. The dietary treatment groups were T0 (Control without acid),T1(Control+0.75% citric acid),T2(Control+0.75%citric acid+0.75% acetic acid),T3(Control+0.75%citric acid+0.75% acetic acid) with drinking water. Pure drinking water was provided to the birds at all times. Dry mash feed was given on adlibitum basis. The birds were reared in cage management system. Brooding temperature was regulated properly. During the experimental period the birds were reared on rice husk littered floor having a depth of 4 cm and removed it after 7 days. All birds were exposed to continuous lighting of 23 hours and one hour dark period per day throughout the experimental period. Sufficient sanitary measures were taken during experimental period. All birds were vaccinated at the age of 4th and 21th day against Ranikhet Disease and at 10th and 16th day against Infectious Bursal (Gumboro) diseases. To determine effects of acid, live weight ,feed consumption. feed conversion ratio ,mortality and Dressing yield were taken and calculated. At the end of experiment, two birds from every treatment were selected randomly to record the dressing yield and organs weight. All collected and calculated data were analysed by Complete Randomized Design (CRD) (Steel and Torrie, 1980). The significant

differences between the treatment means were calculated from analysis of variance (ANOVA) table. All analyses were performed by using "IBM SPSS statistics 20" Program.

RESULTS AND DISCUSSION

Body weight

The effect of citric acid and acetic acid on highest body weight gain is shown in table 1. The present study revealed that there was no significant (P>0.05) variation of initial body weight (g/broiler) among the dietary groups but final body weight (g/broiler) and body weight gain were significantly (P<0.05) differed among the dietary groups. The initial body weight (g/broiler) in T_0, T_1, T_2 and T_3 group was (38.00±0.03), (39.07±0.04), (41.00±0.09), (37.00±0.05). At 7 days of age, the body weight was almost similar in different dietary groups. Significant different (p<0.05) were found at 14 days, 21 days and 28 days of age on body weight gain. The highest body weight was found in T_1 (1512.37gm), followed by T_3 (1496.30gm), T_2 (1470.40gm), and T_0 (1325.47gm) respectively. Birds on dietary group T_2 showed the lowest (P<0.05) weight gain and dietary group T_1 showed the highest (P<0.05) weight gain between T_0, T_2 and T_3 dietary groups. Dietary groups T_3 showed improved growth when administration of both citric acid in diets and acetic acid in water was done. The lower growth rate of water administration containing acetic acid was evident in dietary groups T_2 throughout the trial and confirmed at the end of the trial. The growth reduction in treatment T_2 seemed to be a consequence of a depressed water intake induced by application of acetic acid in water. The result is in agreement with Schuhmacher *et al.,* (2006), who found lower weight gain. The chicks belonged to treatment T_2 showed highest weight gain which was significantly (P<0.05) higher compared to treatmentT_0, T_2 andT_3respectively. The results obtained in the study agreed with previous findings (Shen-HuiFang *et al.,* 2005; Deniletal. 2003; Stipkovits *et al.,* 1992) where improved weight gain was observed with administration of citric acid in diets at 0.3, 0.5 and 0.7%, respectively. The results contradict with the findings of previous researchers Pinchasov *et al.,* (2000) where depressed weight gain was observed with application of acetic acids in diets.

Feed intake

The feed intake of birds fed different diets are shown in Table 2. Feed intake (g/broiler) was almost similar among the dietary groups. The feed intake (g/broiler) in T_0 (2031.64gm), T_1 (2125.56gm) T_2 (2100.74gm) and T_3 (2110.88gm) respectively. Feed intake was lowest in dietary group T_0 (2031.64gm) and the highest in dietary group T_1 (2125.56gm) but difference was non significant(P≥0.05) .These results agreement with the finding of previous researchers (Darko *et al.,* 1991; Laczay *et al.,* 1990b; Frigg *et al.,* 1983 and Stipkovits *et al.,* 1992) where depressed feed intake was observed.

Feed conversion ratio

The feed conversion ratio (FCR) of the experimental birds is shown in Table 3. It was found that FCR differ significantly(P<0.05)among dietary groups. The lowest FCR was found in dietary group T_1 (1.40) and highest in dietary group T_0 (1.52) at 28th day (4 weeks) of age. From the table- 4, it was found that citric acid treated group (T_1) showed better FCR and control diet treated group (T_0) showed higher FCR but administration of acetic acid and citric acid treated group T_3(1.41) showed better FCR than treatment T_2(1.43).Administration of citric acid showed best feed conversion ratio as compared to other dietary group. The results are in well agreement with the findings of (Afshärmã Pesh *et al.,* 2005) where FCR was found with administration of citric acid in poultry diet

Meat Yield Traits

Edible meat weight

It is found from the Table-4 that highest live weight (1496.67gm) in group T_1 and lowest live weight (1160.67gm) in group T_0 and group T_2 weight (1340.67gm),other weight (1365gm)group T_3 respectively which are significant ($P<0.05$). Carcass weights were significant and highest weight (905.00gm) found dietary groups T_1 and lowest weight in dietary groups T_0 (668.00gm).The results are in well agreement with the previous findings (Kahraman *et al.*, 1997) where significant effect was observed.

Weight of inedible meat

It is observed from the Table-4 that weight of shank in all treatments did not differ significantly ($P>0.05$) among different groups. Head weight, gizzard weight and liver weight was non significantly ($P>0.05$) among different groups. Heart, spleen and intestine weight also did not differ significantly ($P>0.05$).

CONCLUSIONS

The study was carried out 108 day old Cobb 500 broiler chicks to evaluate the effect of supplementation of citric acid and acetic acid on growth, feed intake, feed conversion ratio and meat yield traits of broilers. The experimental birds were distributed randomly in 4 dietary groups T_0 (Basal diet) ,T_1(Basal diet + 0.75% citric acid) ,T_2 (Basal diet + 0.75% acetic acid) ,T_3(Basal diet + 0.75% citric acid + 0.75% acetic acid)each with 3 replications each having 9 broilers. Diets and fresh drinking water were provided to the chicks adlibitum during experimental period. Body weight, feed consumption, FCR, mortality and meat yield traits of broiler on different dietary groups were recorded and calculated and analyzed by using SPSS version 20 software. The highest body weight of broilers in dietary groupsT_1(1512.37 gm) among than T_3(1496.30 gm) ,T_2(1470.17gm) and lowest in T_0(1325.40gm) respectively at 28 days. Body weight gain was affected significantly ($P<0.05$) by using 0.75% citric acid and 0.75% acetic acid in the diet of broiler. Feed conversion ratio (FCR) was best in T_1 group and addition of 0.75% citric acid was the most effective and efficient followed by dietary groups T_0, T_2 and T_3 respectively. No mortality was found in all dietary groups. Carcass weight (gm) was the highest in dietary groups T_1 (905.00gm) and the lowest in T_0(668gm). Carcass weight was affected significantly ($P>0.05$) by using 0.75% citric acid.Therefore, addition of citric acid up to the level of 0.75% in broiler diet enhances productivity and feed conversion ratio (FCR).It may be concluded that supplementation of 0.75% citric acid in the diet had positive significant effect on live weight, feed intake and feed conversion ratio(FCR) with no detrimental effect on meat yield traits. Therefore, 0.75% citric acid may successfully be used in broiler diet

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Table-1 :Body weight gain and mortality in different dietary groups at different ages of birds

Age in days /Parameters	Dietary groups				Level of Significance
	T_0	T_1	T_2	T_3	
Initial body weight	38.00±0.03	39.07±0.04	41.00±0.09	37.00±0.5	NS
7th	181.81±0.49	185.32±1.12	183.67±2.79	184.83±4.16	NS
14th	265.07±28.62	341.01±11.75	323.39±1.47	325.83±2.25	*
21th	385.56±57.53	467.28±19.51	437.64±1.90	444.01±9.84	*
28th	493.40±46.95	560.94±3.42	530.17±0.35	546.95±11.77	*
Highest body weight gain (1-28)th	1325.47±2.56	1512.37±11.32	1470.40±1.84	1496.30±4.61	*
Mortality (%)	00.00	00.00	00.00	00.00	NS

T_0= Control diet,T_1= Control diet + 0.75% citric acid,T_2= Control diet + 0.75% acetic acid,T_3= Control diet + 0.75% citric acid + 0.75% acetic acid,±= Standard error,^{abc}means having different superscript in the same row differed significantly (P<0.05),*= 5% level of significance NS= Non significant.

Table-2: Feed intakes (g) in different dietary groups at different ages of birds

Age in days /Parameters	Dietary groups				Level of Significance
	T_0	T_1	T_2	T_3	
7th	201.38±0.69	202.74±0.32	201.93±0.15	200.66±0.28	NS
14th	370.37±55.96	417±11.54	409.29±6.14	415.33±5.77	NS
21th	620.59±42.30	645±5.77	638±3.22	641.22±11.87	NS
28th	840.81±63.63	860.81±72.31	846.52±10.49	849.66±11.67	NS
(1-28)th	2031.64±47.17	2125.56±66.19	2100.74±15.78	2110.88±12.12	NS

Table 3: Feed conversion ratio (wt gain/feed intake) of different birds of different dietary groups.

Age in days	Dietary groups				Level of Significance
	T_0	T_1	T_2	T_3	
7th	1.10±0.002	1.09±0.006	1.01±0.16	1.08±0.02	NS
14th	1.39±0.08	1.21±0.02	1.26±0.02	1.27±0.01	*
21th	1.6±0.07	1.36±0.02	1.43±0.008	1.44±0.009	*
28th	1.7±0.03	1.50±0.09	1.55±0.01	1.53±0.01	*
(1-28)th	1.52	1.40	1.43	1.41	*

Table -4: Meat yield traits of broilers of different dietary groups (gm)

Parameter (gm)	Dietary groups				Level of Significance
	T_0	T_1	T_2	T_3	
Live weight	1160.67±22.26	1496.67±12.02	1340.67±110.33	1365.00±72.17	*
Carcass weight	668.00±9.87	905.00±7.64	799.33±67.22	847.33±70.83	*
Breast weight	266.67±9.56	391.33±34.84	321.00±9.64	381.33±42,78	*
Thigh weight	203.67±7.54	273.33±4.41	233.67±22.06	250.67±15.94	*
Head weight	33.33±2.33	38.33±3.28	36.00±2.52	41.00±1.73	NS
Shank weight	42.67±0.88	51.33±2.40	45.33±2.67	50.00±3.06	NS
Gizzard weight	43.33±3.33	40.67±7.4279	38.00±3.	39.67±6.17	NS
Liver weight	34.67±2.33	37.67±3.84	33.00±5.13	35.00±4.73	NS
Heart weight	5.00±0.00	6.67±0.33	5.67±0.67	7.00±0.58	NS
Spleen weight	2.00±0.00	2.33±0.33	2.00±0.00	2.33±0.33	NS
Intestine weight	133.33±8.82	115.67±8.84	103.33±6.57	99.67±13.30	NS

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