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Effect of citric acid, herbal feed additive and their combination on the performance of broiler

M Tanzin[1], KMS Islam[2], MR Debi[*2], MR Islam[1]

[1]Rural Development Academy, Bogra; [2]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Abstract

The experiment was conducted with 108 day old straight-run Hubbard Classic broiler chicks for a period of 35 days to investigate the effects of citric acid, commercial herbal additive (Keqinling) and their combination on growth and carcass traits of broiler. The dietary treatments were control (T_0), 0.5% citric acid (T_1), 0.2% Keqinling (T_2) and combination of 0.5% citric acid +0.2% Keqinling (T_3). Final live weight was 1615, 1710, 1707 and 1795g in control, 0.5% citric acid, 0.2% Keqinling and their combination groups respectively. The highest live weight gain (1748g) was found in combination group followed by 0.5% citric acid (1664g), 0.2% Keqinling (1660g), and the lowest (1568g)in control group. The highest feed consumption and feed conversion efficiency was observed in T_3 and the lowest in group T_0. Significantly ($p<0.05$) the highest dressed yield (%) was found in 0.5% citric acid group (56.65) than combination (55.73) and Keqinling (55.18) and lowest in control group (54.59). Citric acid reduced the pH of the both feed and faces. The cost of production (Tk/kg broiler) was lowest in citric acid group (Tk. 76.22). Net profit per broiler production was found in 0.5% citric acid group (Tk. 10.03/broiler) followed by combination (Tk. 9.28), Keqinling (Tk. 7.31) and control group (Tk. 6.98) respectively. The addition of 0.5% citric acid and 0.2% Keqinling individually or their combination increase the performance of broiler but citric acid showed better response than Keqinling.

Key words: Citric acid, herbal feed additive, broiler and performance

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Introduction

Growth promoters are now recognized in broiler industry as feed additives for faster growth and economic meat production (Bhuyan et al. 1977). They also improve the efficiency of feed utilization (Milligan et al. 1955). There are several antibiotics which allowed to be used in poultry production (Jones and Ricket 2003) as growth promoter. Sub-therapeutic levels of antibiotics in broiler feed have increased feed efficiency but continuous use of these antibiotic growth promoters have residual effects on their products such as broiler meat. The antibiotic residue causes resistance and cross resistance to pathogens in animal body and also for human and therefore it is now considered as a public health hazard (Botsoglou and Fletouris 2001). Evidence exist that, antibiotic resistance genes can be transmitted from animal to human micro-biota (Greko 2001). Probiotics, prebiotics, organic acids, herbs and herbal products are some substitute approach of antibiotics in poultry production (Fuller 1989 and Chaveerach et al. 2004). Among other alternatives, organic acids work in poultry, not only as a growth promoter (Abdel-Azeem et al. 2000; Fushimi 2001 and Abdo 2004) but also as a meaningful tool of controlling all enteric bacteria, both pathogenic and non-pathogenic (Naidu, 2000 and Wolfenden et al. 2007). Citric acid is an organic acid decreased feed intake and increased daily weight gain and feed conversion efficiency of broiler. Considering these facts citric acid is safe for human and can be used as growth promoter in broiler production. Another alternative to antibiotic growth promoters (AGPs) is herbal feed additive. This can be used in poultry diet due to their antimicrobial properties (Dorman and Deans 2000). Many herbs and their bioactive constituents possess a broad antimicrobial activity (Lewis et al. 2003). The beneficial characters of herb are due to their chemical compounds which are effective against control of

*Corresponding author: **mdebi10@yahoo.com**

pathogen (Cowan 1999), antioxidant activity (Botsoglou et al. 2002, 2004), digestion aid by stimulation of endogenous enzyme activity and absorption of nitrogen (Gill 2001) and inhibition of odor and ammonia control (Varel 2002). Keqinling is a natural feed additive of herbal extract made from various natural botanic efficacious contents, such as flavonoids, alkaloid, organic acid, polysaccharide, volatile oil etc. which can improve immunity, promote growth, restrain virus, and help in removing stagnated food (Yongxue et al. 2004). Although, there is significant literature on growth promoting effects of organic acid, the number of published studies on the effects of herbal additives on broiler performance is still limited. Citric acid works by reducing the intestinal pH caused lowering pathogenic microbial burden. On other hand, herbal feed additive (Keqinling) increases the beneficial microorganisms in the digestive tract. It seems that, the modes of action of these two substances are synergistic. So the use of citric acid and its combination with the herbal feed additives (keqinling) is important to study for finding out the fact. Keeping in mind the above considerations and ideas, the present research work was focused to investigate the effect of citric acid, herbal feed additive (Keqinling) and their combination on the performance of broiler and to determine the economic competence of using citric acids or Keqinling and/ or their combination.

Materials and Methods

The research work was carried out in the poultry rearing unit of Shahjalal Animal Nutrition Field Laboratory of the Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh.

There were two test substances used in this study such as citric acid and Keqinling. Citric acid is an organic acid purchased from the local market in Mymensingh and Keqinling, a natural feed additive of herbal extract produced by Guangdong VTR Bio-tech Co. Ltd. China and marketed by Advance Animal Science Co. Ltd. from where it was collected.

One hundred and eight day-old straight-run broiler chicks (Hubbard classic) were used for this experiment. The chicks were purchased from Aftab Bahumukhi Farms Ltd., Bhagalpur, Bajitpur, Kishoregonj. All birds were reared in the cages maintaining similar environment.

Day old chicks were randomly divided into 4 equal groups with 3 replications each having 9 broilers (27 broilers per treatments). The four dietary treatments were control (T_0), 0.5% citric acid (T_1), 0.2% Keqinling (T_2) and their combination 0.5% citric acid + 0.2% keqinling (T_3). Treatments were distributed among the cages following completely randomized design (CRD). Ingredient composition and chemical composition of ration are presented in Table 1 and 2, respectively.

The experimental house, cages were properly cleaned and washed by forced water using a hose-pipe and then disinfected by bleaching powder and Virkon S solution (50 ppm). At the same time, all feeders, plastic buckets, waterers and other necessary equipment's were properly cleaned, washed and disinfected with bleaching powder solution subsequently dried and left them empty for a week before the arrival of chicks. After arrival of chicks in the experimental house, they were supplied adequate glucose solution to prevent transport stress and dehydration. Proper light, temperature and ventilation were maintained. Previously prepared mash feed was supplied treatment-wise twice a day (7.00 am and 5.00 pm) on *ad libitum* basis. Fresh, clean drinking water was made available all the time. In each cage, one feeder and one round waterer were provided for supplying feed and water. The experimental birds were vaccinated against Infectious Bursal Disease (IBD) and Newcastle Disease (ND). Vaccines were administrated as per recommendation of the manufacturer. Birds for each treatment were weighed by using electric balance in a group during onset of the trial and then every week at the age of 7, 14, 21, 28, 35 days. Feed offered was recorded when supplied in cages and refusal at the end of each week. Feed intake, feed conversion efficiency and feed conversion ratio was calculated. After 35 days of trial, three birds from each treatment were slaughtered to find out the dressing yield. The cost of broiler production for each treatment group was calculated based on the market price of feed ingredients, cost of chicks, citric acid and keqinling and management cost.

Table 1. Ingredient composition of the dietary treatments (g/100g)

Feed Ingredients	Dietary treatments			
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2K)
Maize	42.95	41.95	42.75	41.25
Rice polish	12.00	12.50	12.00	13.00
Soyabean meal	31.00	31.00	31.00	31.00
Meat and bone meal	7.00	7.00	7.00	7.00
Soyabean Oil	3.00	3.00	3.00	3.00
Oyster shell	0.10	0.10	0.10	0.10
DL-Methionine	0.30	0.30	0.30	0.30
DCP	2.00	2.00	2.00	2.00
L-Lysine	0.10	0.10	0.10	0.10
Vit-Min premix[@]	1.00	1.00	1.00	1.00
Common salt	0.50	0.50	0.50	0.50
Choline chloride	0.05	0.05	0.05	0.05
Citric acid	0.00	0.50	0.00	0.50
Keqinling (Herbal)	0.00	0.00	0.20	0.20
Total	100	100	100	100

Table 2. Chemical composition of the dietary treatments (g/100g on fresh basis)

Nutrients	Dietary treatments			
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2K)
Dry matter	88.40	88.00	88.40	88.00
Crude protein	22.23	22.13	22.15	22.97
Crude fiber	4.92	5.15	4.93	5.20
Ether extract	2.69	2.55	2.80	2.89
Nitrogen free extract	46.96	47.25	47.64	46.38
Ash	11.60	10.92	10.88	10.56
ME (Kcal/kgDM)[@]	3188	3187	3222	3216

[@]Calculated from Wiseman (1987); CA= Citric acid; K= Keqinling

Samples of diets were analyzed to determine dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE) and total ash following the method of AOAC (1990).

Data were analyzed using statistical SPSS (11.5) program for one way ANOVA. DMRT (Duncan 1955) was done to know the difference among the treatment means according to Steel and Torrie (1980).

Results and Discussion

The initial live weights of different treatments were almost similar. At the end of the trial, combination of CA and Keqinling group attained the highest 1795g live weight ($p<0.05$) followed by 1710, 1707 and 1615g in 0.5% citric acid (T_1), 0.2% Keqinling (T_2) and control (T_0) group respectively (Table 3). The final live weight increased to 6%, 6% and 11% of the birds fed diet containing in the birds feed diet 0.5% citric acid, 0.2% Keqinling and their combination, respectively over that of the birds of the control (T_0) group. It can be seen from the table 3 that the final weight gain at 5th week of age was 1568, 1664, 1660 and 1748g in T_0, T_1, T_2 and T_3 groups respectively, where the highest weight gain observed in combination (T_3) and lowest in control (T_0) group at 5th week of age. The findings coincide with Abdel-Fattah *et al*. (2008) who reported that dietary citric acid, acetic acid and lactic acid improved the live weight of broilers ($p<0.05$). The beneficial effect of citric acid on the weight gain of broilers was also reported by Shen-HuiFang et al. (2005) Moghadam et al. (2006) and Nezhad et al. (2007).

Many herbs and their bioactive constituent's possess broad antimicrobial activity (Tucker 2002; Cross et al. 2003 and Lewis et al. 2003). Scientific evidence suggests that herbs and plant extract stimulate growth of beneficial bacteria and minimize pathogenic bacterial activity in gastrointestinal tract of poultry (Gill 1999 and Langhout 2000). Positive result of herbs and their products on broiler growth performance in the present study was observed which agreed with the previous reports of Dickens et al. (2000), Yongxue et al. (2004) and Hassan et al. (2004). The highest weekly live weight gain found in the present experiment due to the combined effect of citric acid and Keqinling on live weight was probably due to their synergistic activity. Increasing acidic condition for adding citric acid and probably reduced the activity of the harmful microorganisms present in the Keqinling.

At the end of trial, the combination (T_3) group showed numerically higher feed intake than other groups (T_0, T_1 and T_2). Total feed intake was also shown in Table 3. Numerically higher final feed intake was found in combination (T_3) group followed by 0.5% citric acid (T_1), Keqinling (T_2) and control (T_0) group at 1 to 5th week of age. Moghadam et al. (2006) demonstrated a significant a positive effect of CA on feed consumption of broilers and similar results was found by Atapattu and Nelligaswatta (2005). However, the observation did not agree with Nezhad et al. (2007) who found no changes in feed intake of broilers that could be explained by the supplementation of citric acid.

Numerically higher FCE was observed in combination (T_3) group at 5th week of age (table 3). The FCE differed significantly ($p<0.05$) among the treatment diets. Feed conversion efficiency (FCE) and feed conversion ratio (FCR) are literally same but the way of expression is different. Best FCR was observed in combination (T_3) group compared to control (T_0) group (Table 3). This result agrees with Nezhad *et al.* (2007) and Abdel-Fattah et al. (2008). They observed profound positive effect of citric acid on feed conversion. However, Atapathu and Nelligaswatta (2005); Gong-YiFeng et al. (2006) and Moghadam et al. (2006) did not observe any significant effect of CA on feed conversion of broilers.

The average values of pH were 5.71, 5.22, 5.25 and 5.15 in the control (T_0), 0.5% CA (T_1), 0.2% K (T_2) and combination (T_3) diets respectively. The values indicated that addition of citric acid in diet reduces the pH of the feed. The pH of faces were 5.68, 5.63, 5.65 and 5.60 for T_0, T_1, T_2 and T_3 group respectively which was remained almost same in all groups. However, significant differences were observed among the treatment groups (Table 4). This observation is similar with the findings of Jozefiak and Rutkowski (2005) who found that acidification especially with CA decreased pH of gastric and duodenal contents and inhibited coliform and anaerobic flora. In the entire research period, the overall mortality was 2.77% which is lower than the accepted level of commercial broilers.

Table 3. Growth performances, feed intake, feed conversion efficiency and feed conversion ratio of broilers receiving different dietary treatment

Parameter	Dietary Treatments[#]				SEM
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2 K)	
Initial weight (g)	47.22±1.06	46.30±0.84	47.30 ±0.57	47.00±0.51	0.23
Final weight (g)	1615.19^{c}±23.93	1710.09^{b}± 28.80	1706.76^{b}± 29.33	1794.54^{a}±9.44	20.04
Final weight gain (g)	1567.96^{c}±23.60	1663.80^{b}±27.96	1659.46^{b}±29.60	1747.54^{a}±9.03	20.04
Total feed intake (g)	3571.03±16.48	3582.53±13.36	3575.75±15.49	3602.08±45.17	7.35
Final FCE	439.10c±8.61	464.44b±9.47	464.12b±10.26	485.19a±5.81	5.37
Final FCR	2.28a±0.05	2.15b±0.04	2.16b±0.05	2.06c±0.02	0.025

*abc. Means with dissimilar superscripts differ significantly (p<0.05); LS= Level of significance; # = Values indicated Mean±SE (Standard error); SEM= Standard error of mean; *= Significant at 5% level (p<0.05); NS= Non significant; CA= Citric acid; K= Keqinling*

It is evident from Table 5 that the dressing percentage (without skin) of broilers belonging to control (T_0), 0.5% CA (T_1), 0.2% K (T_2) and combination (T_3) were 54.59, 56.65, 55.18 and 55.73% respectively. Significantly ($p<0.05$) higher dressing yield was observed in 0.5% CA group. No significant ($p>0.05$) differences were observed among the groups of birds in terms of head weight and giblet weight. Killed weight (%) of different groups were 95.88, 96.03, 95.96, 95.95% in control, 0.5% CA, 0.2% K

and combination groups respectively ($p>0.05$). But the skin weight differed significantly among the treatment groups ($p<0.05$). The result is in harmony with Atapattu and Nelligaswatta (2005). They reported increased dressed yield for supplementation of citric acid, but the results contradict with the findings of Nezhad et al. (2007) and Abdel-Fattah *et al*. (2008). They observed no effect ($p>0.05$) of citric acid on carcass yield of broilers.

It was revealed that, the percent weight of blood, shank and viscera did not differ significantly among the treatments groups. The highest visceral weight (table 5) was observed in control group and lowest in 0.5% CA group ($p>0.05$).

Production cost was calculated considering the cost of broiler, feed, citric acid and Keqinling, excluding electricity and other management cost (Table 6). The cost per kilogram feed was the highest (Tk. 30.27) in combination group (T_3). Addition of CA and Keqinling created a progressive increase in feed cost in all the treatments in comparison to control.

Table 4. Effect of citric acid and Keqinling on the pH of feed and faces of broilers in different treatment groups

Parameters	Dietary Treatments[#]				SEM
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2 K)	
Feed	5.71^{a} ± 0.015	5.22^{c} ± 0.012	5.24^{b} ± 0.010	5.16^{d} ± 0.010	0.0660
Faeces	5.68^{a} ± 0.015	5.63^{b} ± 0.015	5.65^{b} ± 0.025	5.60^{b} ± 0.020	0.0096

*abcd, Means with dissimilar superscripts differ significantly (p<0.05); LS= Level of significance; # = Values indicated Mean ± SE (Standard error); SEM= Standard error of mean; *= Significant at 5% level (p<0.05); NS= Non significant; CA= Citric acid; K= Keqinling*

Table 5. Carcass characteristic (% live weight) of broilers in different dietary treatment groups of broilers

Parameters	Dietary Treatments[#]				SEM
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2K)	
Live weight (g)	1650 ± 0.0	1770±0.0	1750±0.0	1850±*0.0*	0.02
Killed (%)	95.88±0.32	96.03±0.14	95.96±0.09	95.95±*0.43*	0.07
Blood (%)	4.12±0.32	3.97±0.14	4.04±0.09	4.05±*0.43*	0.07
Head (%)	2.61±0.10	2.73±0.25	2.63±0.29	2.61±*0.33*	0.08
Shank (%)	4.30±0.33	4.44±0.25	4.59±0.29	4.34±*0.39*	0.09
Skin (%)	7.47^{a}±0.13	6.33^{b}±0.84	7.37^{a}±0.25	7.23^{a}±*0.33*	0.18
Viscera (%)	8.99±1.89	7.53±0.43	8.53±0.31	7.69±*0.61*	0.31
Giblet (%)	6.69±0.31	6.33±0.20	6.63±0.63	6.34±*0.41*	0.11
Dressing (%)	54.59^{b}±1.02	56.65^{a}±0.85	55.18^{ab}±0.96	55.73^{ab}±*0.49*	0.31

*ab, Means with dissimilar superscripts differ significantly (P<0.05); LS= Level of significance; # = Values indicated Mean ± SE (Standard error); SEM= Standard error of mean; *= Significant at 5% level (p<0.05); NS= Non significant; CA= Citric acid; K= Keqinling*

Table 6. Analysis of cost /kg live weight (in Taka) of broilers in different dietary treatment groups

Parameters	Dietary Treatments[#]				SEM
	T_0 (Control)	T_1 (0.5 CA)	T_2 (0.2 K)	T_3 (0.5 CA+0.2 K)	
Cost per kg Feed	27.16 ± 0.00	28.34±0.00	29.08±0.00	30.27±0.00	0.34
Cost (feed/broiler)	96.99^{d}±0.45	101.53^{c}±0.38	103.98^{b}± 0.45	109.03^{a}±1.37	1.32
Cost (feed+chick)/broiler	122.24^{d}±0.45	126.78^{c}±0.38	129.23^{b}±0.45	134.28^{a}±1.37	1.32
Cost per kg live weight	77.98±1.47	76.22±1.51	77.90±1.67	76.84± 0.75	0.41
Market price (Tk./kg)	80.00± 0.0	80.00±0.0	80.00±0.0	80.00±0.0	0.00
Net profit/bird	6.98±2.36	10.03±2.67	7.31±2.80	9.28±1.30	0.69

*[abcd,] Means with dissimilar superscripts differ significantly (P<0.05); LS= Level of significance; [#] = Values indicated Mean ± SE (Standard error); SEM= Standard error of mean; *= Significant at 5% level (p<0.05); NS= Non significant; CA= Citric acid; K= Keqinling*

Cost per kilogram live weight of broiler was the lowest in 0.5% CA group (76.22) followed by combination (76.84), 0.2% Keqinling (77.90) and control group (76.98) respectively and no significant difference was found. The highest profit was found in 0.5% citric acid group followed by combination, 0.2% Keqinling and control group.

Conclusion

The addition of 0.5% citric acid and 0.2% Keqinling individually or their combination increase the performance of broiler but citric acid showed better response than Keqinling. Although citric acid and Keqinling have synergistic effect on the performance of broiler but economic study suggests the dietary inclusion of citric acid at 0.5% level in Bangladesh condition.

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