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Effects of Citric Acid, Antibiotic Growth Promoter and Probiotics on Growth Performance of Broiler

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Abstract: The experiment was conducted in Chittagong for 35 days long period to find out the performance of broilers fed with different feed additives by using 240 days old COBB-500 broiler chicks. The experimental chicks were reared with proper management including brooding, feeding, watering, housing and maintaining bio-security and data regarding performance were recorded weekly. The cumulative feed intake was the highest forcitric acidgroup (3028.0±1.5 g/bird) which varied significantly ($p<0.05$) among control (2940.50±5.1 g/bird), antibiotic (3004.75±2.9 g/bird) and probioticsgroup (3015.50±4.8 g/bird) for whole experimental period. Significantly ($p<0.05$) highest values were found with citric acid in live weight (1791.0±2.1 g/bird) and weight gain (1740.50±3.1 g/bird), followed by (1723.75±3.0 g/bird) and (1673.50±4.1 g/bird) in probiotics, respectively. The best Feed Conversion Ratio (FCR) was found in citric acid group (1.74±0.0) followed by probiotics (1.80±0.0), antibiotic (1.82±0.0) and control group (1.90±0.0). It may be concluded from the experiment that citric acid can be used as a better alternative growth promoter to antibiotics in poultry production.

Key words: Broilers, performance, antibiotic, probiotic, citric acid

INTRODUCTION

In Bangladesh, an agro-based, densely populated developing country (SPBB, 2008) 22.9% employment is provided by agriculture, forestry and fisheries. In GDP, agricultural contribution is close to 19.61% and livestock sub-sector 3.1% (BBS, 2006). Poultry sector, especially commercial poultry farming has been developing intensively every part and corner in the country in recent times. The development of the industry is associated with several areas such as nutrition, genetics, management to maximize the efficiency of growth performance and meat yield. Several constraints like disease, poor husbandry, low productivity, storage of feed affect the optimum performance of this industry. Enhanced bio-security of poultry farm (Tablante *et al*., 2002), genetic selection of poultry resistant to diseases (Gross *et al*., 2002) and vaccination against pathogenic microbes (Williams, 2002) have successfully protected poultry production from disease loss. Recently modern poultry scientists have been suggesting several feed supplements and feed additives such as antibiotic growth promoter, probiotics, prebiotics, various organic acids (citric acid, acetic acid and ascorbic acid) and so on to minimize these constraints.

Growth promoters are being used extensively in animal feed and water all over the world, especially in poultry industries to improve performance for therapeutic and prophylactic purpose by stabilizing intestinal microbial flora and to prevent some specific intestinal pathogens (Waldroup *et al*., 1995). There are several antibiotics which are allowed to be used in poultry production (Jones and Ricke, 2003) as growth promoters. Beneficial effects of antibiotic growth promoter on broiler performance were reported by several researchers (Aarestrup *et al*., 2000; Esteve-Gracia *et al*., 1997; JETACAR, 1999).

In poultry, growth promoters such as avilamycin, flavophospholipol, virginiamycin and avoparcin control *Clostridium perfringens* infection in addition to

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improving feed conversion efficiency (JETACAR, 1999). Avilamycin is also used in broiler for higher improvement of performance and feed efficiency. However, using antibiotics to establish a beneficial condition in GIT has some disadvantage as well. The use of antibiotic growth promoters becomes a health hazard problem (antibiotic resistance, allergy, toxicity, etc.). Linton (1977) stated that human exposure to animal products containing significant level of antibiotic residues may produce immunological response in susceptible individuals and cause disorder of intestinal flora. Chiew (2009) also mentioned toxicity of nitrofurans and chloramphenicol. Recent evidences from scientists around the world show that the link between the use of antibiotic growth promoters in food animals and antimicrobial resistance is increasing (Van de Bogaard and Stobberingh, 2000; Caprioli *et al*., 2000).

Moreover, this poultry industry has focused on addressing public health concern, environmental well being as well as food safety. Considering the above mentioned facts, the European Union banned the feeding of all antibiotics and related drugs to livestock for growth promotion purposes on January 1, 2006 (UCS, 2009).

Hence, poultry producers are trying to find out better alternate to antibiotic growth promoters for their well being. Several ways have been suggested as strategies to limit the antibiotic usage, notably, use of prebiotics, probiotics, organic acids, etc. By consequence, probiotics and organic acids became other alternatives of antibiotic in poultry production. Kim *et al.* (1988) observed that supplementation of a commercial probiotic (*Lactobacillus sporogens*) increased the weight gain of chicken. Erdogan (1999) stated that the probiotics treated groups were higher in live weight gains, feed consumption and feed efficiency. Probiotic (Fuller, 1989) with defined bacteria and prebiotic with ability to aid growth of beneficial bacteria have been reported to enhance poultry growth (Jernigan *et al*., 1985; Fernandez *et al*., 2002). Organic acids, enzymes and mycotoxin binding agents also have positive effects on poultry growth (Chaveerach *et al*., 2004; Raju and Devegowda, 2000). Among these compounds, organic acids are promising alternatives (Hyden, 2000).

Addition of dietary organic acids (citric, acetic and lactic acids) improved the live body weight and body weight gain of broilers as compared to those of un-supplemented diet (Abdel-Fattah *et al*., 2008). Mairoka *et al.* (2004) found that the mixture of organic acids namely fumaric, lactic, citric and ascorbic acids improved the broilers performance even in the absence of antibiotics. In addition, lowering the pH by organic acids reduces the pathogenic microbes from GIT and improves nutrient absorption (Boling-Frankenbach *et al*., 2001).

Organic acids (genex 0.2%) treatments was found to significantly decrease total bacterial count, especially gram negative bacteria in broiler than those fed only basal diet (Gunal *et al*., 2006).

While probiotics and organic acids are being used as alternatives to antibiotic growth promoters in poultry feed in Bangladesh, their effects on production performance is yet to evaluate extensively. Therefore, the present study was aimed to observe and compare feed intake, live weight, weight gain, feed conversion ratio with different dietary supplementations.

MATERIALS AND METHODS

The experiment was carried out in a trial farm managed on rent basis from July 2009 to October 2009. A total of 240 days old COBB-500 broiler chicks were procured from a reputed hatchery in Chittagong. All chicks were reared in the farm maintaining similar environment and with litter system.

Citric acid (crystal); Surmax (avilamycin), a product of Elanco animal health, USA and Protexin (a probiotic) manufactured by Probiotic International, Ltd. UK were purchased from a local shop. Each 1 kg Surmax contained 100 g avilamycin. The probiotic (Protexin) contained 7 species of bacteria, 1 species of mold and 1 species of yeast. To conduct the experiment in a Completely Randomized Design (CRD) the chicks were divided into 4 treatment groups with 60 birds in each group (group A, B, C and D). Again each group (Table 1) was subdivided into 4 subgroups considering four replicates having 15 birds each. Group A was fed with basal diet, group B with 0.001% avilamycin supplemented diet, group C with 0.5% citric acid supplemented diet and group D with probiotic supplemented diet at the rate of 1 g/4 L water.

Experimental diet contained DM 88.46%, CP 22.71%, CF 4.23%, ether extract 2.48%, nitrogen free extract 48.45%, ash 10.59%, calcium 0.98%, total phosphate 0.74% and ME (kcal kg^{-1}) 3278.63. Standard management practice, proper light, temperature (1st week 95°F, 2nd week 90°F, 3rd week 85°F, 4th week 80°F and 5th week 75°F) and ventilation were maintained. Feeds and water were offered *ad lib* to the experimental chicks. All the experimental chicks were vaccinated against Infectious

Table 1: Grouping of experimental chicks

	Dietary treatment group				
Replication	Control (G-A)	Antibiotic (G-B)	Citric acid (G-C)	Probiotics (G-D)	Total (60)
R1	15	15	15	15	60
R2	15	15	15	15	60
R3	15	15	15	15	60
R4	15	15	15	15	60
Total	60	60	60	60	240

Table 2: Schedule of vaccination in experimental chicks

Age (days)	Disease	Name of vaccine	Route of administration and dose
3	New castle (ND)	Cevac New L®	One drop in each eye
9	Infectious Bursal Disease (IBD)	Cevac IBDL®	One drop in each eye
17	Infectious Bursal Disease (IBD)	Cevac IBDL®	One drop in each eye
19	New Castle (ND)	Cevac New L®	One drop in each eye

Bursal Disease (IBD) and New Castle Disease (ND) as per recommendation of manufacturer (Table 2). Strict bio-security program was maintained during whole experimental period. Feed consumption (g/chick), live weight gain (g/bird) and Feed Conversion Ratio (FCR) was calculated at the age of 7, 14, 21, 28 and 35 days. Final body weight gain was also calculated. Data were analyzed by using SPSS (11.5) Statistical Program.

RESULTS AND DISCUSSION

Feed intake: The result for feed intake (Table 3) of different dietary groups varied significantly ($p<0.05$) till 2nd week of age. Citric acid group consumed significantly higher ($p<0.05$) amount of feed than all other groups up to 14 days. The cumulative feed intake was significantly ($p<0.05$) higher in citric acid group (3028.00±1.47 g/bird), probiotic group and antibiotic group compared to control group for 35 days from beginning to end of the experiment. This is in line with finding of Chowdhury *et al.* (2009), Moghadam *et al.* (2006) and with Atapattu and Nelligaswatta (2005) who demonstrated significant variation in feed consumption between citric acid and control and insignificant variation between citric acid and avilamycin group. This may be due to the fact that mild doses of citric acid enhances the palatability of feed leading to increase feed intake that is congruent with Rahmani and Speer (2005). Citric acid or weak acid has a low tendency to free H^+ and so tend to have a strong taste associated with them. But this result disagrees with several researchers. Nezhad *et al.* (2007) did not find any significant effect of citric acid on feed intake. Soltan (2008) reported feed intake of laying hen was not affected by organic acid added with feed. Yesilbag and Colpan (2006) indicated that dietary organic acid in laying hen did not significantly affect feed intake. But Paul *et al.* (2007) noticed that use of single organic acid salt (Ammonium formate or calcium propionate) in broiler diet lowered feed intake with control. Antibiotic growth promoter and probiotic had significant effect on feed intake compared to control. This finding is supported by Alwan *et al.* (1997) who reported that flavomycin significantly increased feed intake at 4 weeks. Erdogan (1999) supported the present finding that the probiotic group had higher feed intake. However, Ashayerizadeh *et al.* (2009) reported no effect on feed intake by probiotic and antibiotic as well as prebiotics.

Table 3: Feed intake (g/bird) of broilers with different dietary treatments

Age (weeks)	Control	Antibiotic	Citric acid	Probiotics
1st	135.25±0.63^{a}	140.00±0.82^{b}	148.00±1.08^{bc}	142.50±1.04^{b}
2nd	329.50±2.10^{a}	364.50±2.10^{b}	379.00±0.91^{bc}	370.25±2.32^{b}
3rd	568.75±3.15^{a}	582.00±1.96^{bc}	592.50±1.44^{b}	595.25±2.06^{b}
4th	787.00±2.65^{b}	787.25±2.29^{b}	780.00±1.78^{a}	781.25±1.31
5th	1120.00±2.04^{a}	1131.00±2.27^{b}	1128.50±1.71^{b}	1126.25±2.39
Initial 5th	2940.50±5.12^{a}	3004.75±2.87^{b}	3028.00±1.47^{bc}	3015.50±4.80^{b}

$^{a-d}$Means with different superscripts in the same row differ significantly at $p<0.05$. Mean±SE shows ±values

Live weight and weight gain: The final live weight was the significantly ($p<0.05$) highest in broilers having citric acid supplemented diet, intermediate in probiotic and antibiotic supplemented groups and lowest in control group (Table 4). Significant difference in weight gain was also observed among the groups. The highest weight gain was found in citric acid group, followed by probiotic, antibiotic group and lowest in control group. This finding is in agreement with Abdel-Fattah *et al.* (2008), Nezhad *et al.* (2007) and Ivanov (2005) who reported significantly ($p<0.05$) improved live body weight, weight gain of broilers with supplemental citric acid, acetic acid and lactic acid compared to control. This may be due to decreasing pH in gastrointestinal tract with organic acid and growth inhibition of potential pathogen bacteria, e.g., *E. coli* and *Salmonella* sp. in the feed and in gastrointestinal tract is of benefit with respect to animal health (Iba and Berchieri, 1995; Berchieri and Barrow, 1996; Thompson and Hinton, 1997). The improved final live weight, weight gain with antibiotic (avilamycin) is consistent with the findings by Onifade (1997) who reported feed additives (antibiotic and dried yeast) enhanced the nutritional value and/or utilization of feeds leading to improved performance. Better live weight of broiler due to citric acid supplementation observed by Moghadam *et al.* (2006) and Mairoka *et al.* (2004) is congruous with current findings. However, this finding is not in the agreement with Atapattu and Nelligaswatta (2005). They did not find any difference of growth performance sequel to citric acid supplementation. Probiotic group had better live weight and weight gain of broilers over control group. These present results are also in harmony with findings by Ham *et al.* (1999), Kim *et al.* (1988) and Erdogan (1999). Erdogan (1999) and Chowdhury *et al.* (2009) found highest live weight and weight gain with citric acid supplementation than all other groups. Report of Gama *et al.* (2000) and Soltan (2008) revealed that dietary organic acid modify live body weight

Table 4: Live weight (g/bird) and weight gain (g/bird) of broilers having different dietary treatments

Age (weeks)	Control	Antibiotic	Citric acid	Probiotics
Initial	50.25±0.85	50.75±0.63	50.50±1.19	50.25±1.25
1st	124.00±1.29^{a}	138.00±2.58^{b}	161.00±1.29^{bc}	151.50±1.32^{bcd}
2nd	421.25±1.11^{a}	426.50±1.71^{a}	455.25±1.93^{b}	438.50±2.33^{bc}
3rd	774.00±1.29^{a}	785.25±2.63^{b}	813.25±2.02^{bc}	797.75±3.17^{bcd}
4th	1130.25±2.39^{a}	1155.75±1.55^{b}	1202.25±2.17^{bc}	1175.75±2.66^{bcd}
5th	1594.25±5.14^{a}	1698.75±1.75^{b}	1791.00±2.08^{bc}	1723.75±2.95^{bcd}
Wt. gain (Initial 5th week)	1544.00±5.43^{a}	1648.00±2.04^{b}	1740.50±3.12^{bc}	1673.50±4.11^{bcd}

Table 5: FCE and FCR of broilers having different dietary treatments

Age (weeks)	Control	Antibiotic	Citric acid	Probiotics
1st	545.33±6.380^{a}	623.43±19.4800^{b}	746.86±14.65^{bc}	710.63±14.28^{bc}
2nd	902.30±11.23^{a}	791.45±9.20000^{b}	776.39±8.010^{b}	775.28±11.04^{b}
3rd	620.26±4.480^{a}	616.38±4.89000	604.25±6.260^{b}	603.54±1.740^{b}
4th	452.66±2.440^{a}	470.64±2.96000^{bc}	498.73±4.140^{bcd}	483.83±5.160^{bcde}
5th	414.29±5.510^{a}	480.30±1.72000^{b}	521.70±2.550^{bc}	486.57±1.610^{b}
Initial 5th week	525.08±1.740^{a}	548.46±2.43000^{bc}	574.80±2.880^{bcd}	554.97±3.320^{bcde}
FCR	1.90±0.010^{a}	1.82±0.00352^{b}	1.74±0.000^{bc}	1.80±0.010^{bcd}

$^{a-d}$Means with different superscripts in the same row differ significantly at $p<0.05$. Mean±SE represents the ±values

compared to control supporting present findings and Tarakanov *et al.* (1999) reported increased body weight of broilers with probiotic supplementation.

Feed Conversion Ratio (FCR): The feed conversion ratio (feed intake in g/weight gain in g) of broilers having different dietary treatments is shown in Table 5. There was significant ($p<0.05$) variation in feed conversion efficiency (weight gain in g/feed intake in kg) and conversion ratio (feed intake in g/weight gain in g) of broilers having different dietary treatments. The highest feed conversion efficiency was observed in citric acid than control, avilamycin and probiotic. This finding is in agreement with Chowdhury *et al.* (2009), Abdel-Fattah *et al.* (2008) and Nezhad *et al.* (2007) who observed profound effect of citric acid on feed conversion efficiency. Ashayerizadeh *et al.* (2009) reported that the FCR was significantly improved in flavomycin in comparison to control. Rahmani and Speer (2005) found that and natural product had significant effect on FCR. Adding probiotic and symbiotic to the ration has been effective in FCR (Zulkifli *et al.*, 2000; Cavit, 2004). Soltan (2008) showed significant improvement in FCR on laying hen with dietary organic acid compared to control fed with basal diet. The improvement of feed efficiency has already been demonstrated in broiler and quail chicken by Patten and Waldroup (1988), Denli *et al.* (2003) and Versteegh and Jongbloed (1999).

CONCLUSION

The experiment revealed that performance of Broiler was better with supplementation of citric acid and probiotics in comparison to antibiotic and control. The final live weight, weight gain, feed intake, feed conversion efficiency and conversion ratio of broilers having different dietary treatments showed significant improvement with citric acid than other supplements.

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