

## Electrolytes Supplementation through Drinking Water to Revive Broiler Production during Tropical Summer Stresses Management

### Research Article

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### ABSTRACT

This experiment was carried out for a period of 4 weeks with 240 day old straight- run broiler (Cobb-500) chicks to investigate the effects of administering electrolytes in drinking water on the productive performance (live weight, body weight gain, feed consumption, feed conversion and water consumption) and to determine the economic impact of using electrolytes. The chicks were randomly distributed into three different treatments: control (without electrolyte supplementation), continually supplemented electrolyte group and intermittently supplemented electrolyte group (when temperature rose to 30 °C or above). Statistically significant ( $P < 0.001$ ) differences in body weight and body weight gain were observed among treatments with the highest final body weight and body weight gain in birds that received electrolytes. Analysis of performance data showed significant difference in feed conversion ( $P < 0.05$ ) and also in water consumption ( $P < 0.01$ ). Birds of continuously supplemented electrolyte group and intermittently supplemented electrolyte groups showed significant improvement in feed conversion. Economic returns tended to be higher ( $P < 0.05$ ) in the continuously electrolyte supplemented group. Data suggest that both continuous and intermittent supplementations of electrolyte during summer improve the feed conversion in broilers. Thus electrolytes may be supplied to broilers during summer but additional feeding trial would be helpful to fully evaluate the impact of additional electrolytes.

**KEY WORDS** broiler management, broiler production, electrolytes, summer stress.

### INTRODUCTION

The broiler industry is growing rapidly in Bangladesh as an important part of commercial poultry enterprise and provides a large part of increasing demand for animal protein, cash income and creates employment opportunities. Poultry meat, especially chicken meat, is the most desirable animal protein and is acceptable for most of the people of all castes and religious. Broiler growers are interested in approaches that promote better growth and economic production. However, high ambient temperature is one of the most important

problems for poultry production in tropical countries (Fox, 1980) and modern fast growing broilers are facing difficulties in coping with heat stress (Bohren *et al.* 1982). The continuous selection for fast growth has been associated with increased susceptibility of broilers to heat stress (Geraert *et al.* 1993; Cahaner *et al.* 1995 and Berong and Washburn, 1998). High temperature is the major limiting factor in poultry production in many tropical areas of the world and the problem becomes severe when high temperature is accompanied by high humidity (Charles *et al.* 1978). The consequences of heat stress are reduction in feed in-

take, retardation of growth rate (Howlider and Rose, 1987) and mortality (Arjona *et al.* 1988) growth rate, feed efficiency. It is assumed that in summer mortality and reduced performance of flock cause BDT 1240 millions of loss to the poultry industry in Bangladesh. Teeter *et al.* (2000) reported that one of the best methods used to control heat stress is the chemical management of the acid base balance by supplementing feed or water with different electrolyte salts such as sodium bicarbonate ( $\text{NaHCO}_3$ ), potassium chloride (KCl), calcium chloride ( $\text{CaCl}_2$ ) and ammonium chloride ( $\text{NH}_4\text{Cl}$ ). These electrolytes in different amounts and proportions proved beneficial for broilers under different heat stress regimens. Supplementation of electrolytes in poultry diets is not normally practiced in Bangladesh. The application of electrolytes has captured the attention of poultry nutritionists in Bangladesh; however, it is not known what whether supplementing broiler drinking water with electrolytes during the summer would have both cost and performance benefits. The objective of this study was: to study the effects of administration of electrolytes in drinking water on production performance of broilers and assess the comparative cost, return and profitability of producing broilers during summer. Taking above significance, the present study was conducted.

## MATERIALS AND METHODS

A feeding trial was conducted on 240 day old straight run broilers (Cobb 500) for a period of 28 days (from 14<sup>th</sup> March to 10<sup>th</sup> April, 2011) at Alutola Poultry Farm, Sylhet to investigate the effects of supplementation of electrolytes on the production performance of broilers during tropical summer stress. Birds were fed *ad libitum* on a basal starter diet (containing 11% moisture, 245 g/kg crude protein, 50 g/kg fat, 40 g/kg crude fibre, 14 g/kg lysine, 6.5 g/kg methionine, 12 g/kg calcium, 7.5 g/kg available phosphorus and 15.11 MJ metabolizable energy) up to 10 days of age. Thereafter, they were fed on a grower diet (containing 11% moisture, 240 g/kg crude protein, 50 g/kg fat, 40 g/kg crude fibre, 14 g/kg lysine, 6 g/kg methionine, 12 g/kg calcium, 7.5 g/kg available phosphorus and 14.65 MJ metabolizable energy) for 11-21 days and the rest of the days (22-28 days) with broiler finisher diet (containing 11% moisture, 240 g/kg crude protein, 50 g/kg fat, 40 g/kg crude fibre, 13 g/kg lysine, 6 g/kg methionine, 12 g/kg calcium, 7.5 g/kg available phosphorus and 14.65 MJ metabolizable energy) on *at libitum* basis. The day of age broilers were divided into 3 treatment groups; each group contained 80 chicks and 4 replications in each, with 20 chicks per replicate. One group of chicks was maintained as a control (without electrolytes), the second group received electrolytes continuously, and the third group received intermittent electrolytes when the temperature was at ambient tempera-

ture of 30 °C or above in a Completely Randomized Design. Data recorded comprised body weight, feed consumption, water consumption and survivability for each replication. Temperature and relative humidity were recorded every 4 hours. The body weight gains, water consumption and feed conversion of broilers in each replication were calculated. Responses of birds to electrolyte supplementation in the drinking water were subjected to ANOVA to analyze if significant differences were present between the treatment groups (SAS, 1986).

## RESULTS AND DISCUSSION

### Final body weight

The data is presented in table 1 showing the differences in final body weight and weight gain of the birds. It appears that the differences in final body weight (g/bird) and body weight gain (g/bird) of birds receiving electrolytes in drinking water were higher ( $P < 0.001$ ) than in controls ( $T_2$ ) and than the intermittently electrolyte ( $T_3$ ) group. Initial body weight of day old broilers was higher ( $P < 0.05$ ) in the control group. The continuous electrolyte group displayed the highest body weight (1599.96 g;  $P < 0.05$ ) and were followed by the intermittent electrolyte group (1535.93 g). The birds of the control group had the lowest final body weight (1528.54 g). The significant effect of electrolytes on body weight gain did not agree with Nessa (2008) and Rondon *et al.* (2000) who did not find any beneficial effects of dietary electrolyte balances (DEB) of 300 mEq/kg diets in broilers. The present findings did also not agreed with Borges *et al.* (2004a) used colostomized male broiler chickens and reported no significant effect of the DEB treatments (140, 240, or 340 mEq/kg) on body weight gain in birds exposed daily to cyclic heat stress ( $22.5 \pm 3.5$  °C for 14 h and  $33 \pm 2.0$  °C for 10 h). Improvements in growth performance recorded with KCl supplementation agree with those reported by Teeter and Smith (1986), Smith and Teeter (1987), Deyhim and Teeter (1992) and Osman (2000) who reported that KCl managed to improve growth performance of thermally stressed broilers. They attributed the beneficial effect of supplemental KCl to increased water consumption over the control which work as heat sink for broiler body heat, hence could combat heat stress. On the other hand, Ait-Boulahsen *et al.* (1995) suggested that the beneficial effect of KCl on growth rate may not be attributed to  $\text{K}^+$  alone due to severely depletion under heat stress, may be involved. Hurwitz *et al.* (1973) while studying the impact of cation / anion ratio ( $\text{Na}^+\text{K}^+/\text{Cl}^-$ ) noticed that broiler growth rate was the greatest when blood pH was 7.28 and it reduced when pH values were greater than 7.30 or lower than 7.20. However, it is still to be defined whether the response was totally due to change in pH or to other electrolyte or metabolic effects.

**Table 1** Productive performance of broilers receiving electrolytes in drinking water (0-28 days)

Variables	Control (T <sub>1</sub> )	Continuously electrolyte (T <sub>2</sub> )	Intermittently electrolyte (T <sub>3</sub> )	Level of significance
	Mean±SD	Mean±SD	Mean±SD	
Initial body weight (g/bird)	39.00±0.14 <sup>a</sup>	38.30±0.28 <sup>b</sup>	38.41±0.46 <sup>b</sup>	*
Final body weight (g/bird)	1528.54±47.79 <sup>b</sup>	1599.96±15.38 <sup>a</sup>	1535.93±52.42 <sup>ab</sup>	***
Body weight gain (g/bird)	1489.55±47.66 <sup>b</sup>	1561.66±15.33 <sup>a</sup>	1497.52±52.63 <sup>ab</sup>	***
Feed consumption (g/bird)	2130.60±86.79	2113.93±22.29	2057.45±60.04	NS
FCR (g feed/g gain)	1.39±0.02 <sup>a</sup>	1.32±0.01 <sup>c</sup>	1.34±0.05 <sup>b</sup>	*
Survivability (%)	97.92±2.41	97.92±2.41	98.96±2.09	NS
Water consumption (mL/bird)	4335.17±86.46 <sup>c</sup>	4739.95±20.06 <sup>a</sup>	4556.70±72.60 <sup>b</sup>	**

The means within the same row with at least one common letter, do not have significant difference ( $P>0.001$ ;  $P>0.01$  and  $P>0.05$ ).  
 \*\*\*  $P<0.001$ ; \*\*  $P<0.01$ ; \*  $P<0.05$  and NS: non significant.

Cohen and Hurwitz (1974) indicated that the dietary addition of Na<sup>+</sup> (without Cl<sup>-</sup>) increased plasma HCO<sub>3</sub><sup>-</sup> and pH, while Cl<sup>-</sup> addition (without Na<sup>+</sup>) reduced plasma HCO<sub>3</sub><sup>-</sup> and pH, whereas the addition of both as NaCl (salt) caused a little change in plasma HCO<sub>3</sub><sup>-</sup> and pH.

Rondon *et al.* (2001) and Murakami *et al.* (2001) established with modern broiler strains and practical diets, an optimal DEB for the starter phase between 246 and 315 mEq/kg and for the grower one between 249 and 257 mEq/kg. Fixter *et al.* (1987) mentioned that optimal DEB for growing broilers varied with ambient temperature, at 250 mEq/kg for moderate temperatures (18 to 26 °C) and 350 mEq/kg for higher temperatures (25 to 35 °C).

### Feed consumption

The highest feed intake was for the broilers in the control group ( $P>0.05$ ) 2130.60 g and this was followed by continuously supplied electrolyte (T<sub>2</sub>) group (2113.93 g) and intermittently supplied (T<sub>3</sub>) electrolyte group (2057.45 g) respectively.

This result concur with those of Nessa (2008), who concluded that use of dietary electrolyte balance (DEB) of 300 mEq/kg could not affect feed intake. The present findings also agree with Borges *et al.* (2004a) used colostomized male broiler chickens and reported no significant effect of the DEB treatments (140, 240, or 340 mEq/kg) on feed intake in birds exposed daily to cyclic heat stress (22.5±3.5 °C for 14 h and 33±2.0 °C for 10 h).

Borges *et al.* (2004b) noted that in growing (21-42 d) broilers the DEB 40 mEq/kg reduced feed intake and weight gain.

Rondon *et al.* (2000) observed the best EB as 250 mEq/kg when Na<sup>+</sup> levels varied and 319 mEq/kg when K<sup>+</sup> was manipulated. Similarly, in growing (21-42 d) broilers maximum feed intake was noted by Borges *et al.* (2004b) in DEB 264 mEq/kg treatment, when Na<sup>+</sup> level was increased in the diet, and 213 mEq/kg, when K<sup>+</sup> and Na<sup>+</sup> levels were concurrently increased in the diet. This indicates that there is a limit over which feed intake is depressed as a function of excessive Na<sup>+</sup> and / or K<sup>+</sup>.

### Feed conversion ratio

The results of feed conversion showed significant ( $P<0.05$ ) differences between electrolyte supplemented and control groups.

Feed conversion was best in the continuously electrolyte supplied group (1.32), intermediate in the intermittent group (1.34) and worst in the control group (1.39). The results of feed conversion almost agreed with the findings of Nessa (2008), who showed significant ( $P<0.05$ ) differences between electrolyte supplemented and control groups but did agree with the findings of Vieites *et al.* (2004). They reported that supplementation of electrolytes (KCl and NaHCO<sub>3</sub>) in drinking water to male Ross chicks from 1 to 21 days of age at a constant DEB (dietary electrolyte balance) of 250 mEq/kg diet during the extreme summer stress may improve the feed conversion of broiler. In contrast, the findings of Flemming *et al.* (2001) differed from those reported here, their comparison of three different DEB (Na<sup>+</sup>K<sup>+</sup>Cl<sup>-</sup>) levels i.e., high, medium and low, in male broilers during the summer season found that feed conversion was not affected by the DEB. Borges *et al.* (2003a) noticed that DEB 240 mEq/kg gave the best body weight gain and feed conversion ratio versus DEB 0, 120, and 360 mEq/kg, in broiler rose during summer season (max. 31 °C, min. 23 °C; RH 75.5%). The DEB 340 mEq/kg resulted in worse feed conversion that may be due to excess Na<sup>+</sup> (0.45%) in the diet (Ahmad and Sarwar, 2006).

### Survivability

There was no significant variation ( $P>0.05$ ) in survivability among treatments and control groups. During the experimental period, two birds died from *Colibacillosis* infection in continuous electrolyte supplied group for *Colibacillosis*, another two birds died in control group due to heat stroke and only one bird died in intermittent electrolyte supplemented group due to heat stroke. This results of survivability showed that supplementation of electrolytes had no effect on mortality. The results of survivability almost agreed with the findings of Nessa (2008) who showed that sup-

plementation of electrolytes had no effect on survivability ( $P>0.05$ ).

The present findings also agree with [Borges et al. \(2003a\)](#) who observed non-significant effects of DEB treatments (0, 120, 240, 360 mEq/kg) on mortality in broilers reared under moderately high ambient temperature and relative humidity's, in both starter (0-21 d) and finisher (21-42 d) phases. Similarly, [Deyhim and Teeter \(1995\)](#), showed that supplementing drinking water with isomolar (0.067 mol/L) KCl or NaCl did not affect survivability of broilers reared in thermo neutral and cycling heat stressing environments. [Borges et al. \(2004b\)](#) did not notice any significant effect of DEB (40, 140, 240 and 340 mEq/kg) on the livability of growing (21-42 d) broilers reared in mild environment.

[Musthaq et al. \(2005\)](#) reported non-significant effect of increasing levels of dietary Na (0.20, 0.25, and 0.30%) and Cl (0.30, 0.40, and 0.50%) on mortality (0 to 2.78%) in heat stressed (32-39 °C) 28-days-old broilers.

### Water consumption

Water consumption was highest ( $P<0.01$ ) in the continuously electrolyte ( $T_2$ ) supplied group (4739.95 mL), intermediate in intermittently electrolyte ( $T_3$ ) supplied group (4556.70 mL) and lowest in the control ( $T_1$ ) group (4335.17 mL). Water consumption showed an apparently linear increasing trend with the supplementation of electrolyte during heat stress period.

The results of water intake almost agreed with the findings of [Nessa \(2008\)](#), who showed an apparently linear increasing trend with the supplementation of electrolyte during heat stress period. The present findings agreed with [Borges et al. \(2004a\)](#) reported increased water consumption in colostomized male broiler chickens by 22.4% from 254 to 300 mL/kg0.75 in heat stress (22.5±3.5 °C for 14 h and 33±2.0 °C for 10 h) compared to thermo neutral environment.

These results also agreed with the [Borges \(2001\)](#). He showed that any increase in the dietary intake of electrolyte (Na, K and Cl) enhance the water consumption and excreta moisture. According to him water intake depends directly on bird's age and on the  $Na^+ + K^+ Cl$  ratio in the feed. The present findings did not agreed with [Ahmad and Sarwar \(2006\)](#), who reported in either environment no effect of DEB levels (140, 240, or 340 mEq/kg) was observed on water consumption, excretion and other water related parameters. The present findings also agreed with [Borges et al. \(2003a\)](#) observed linear increase in water intake of heat stressed broilers with increasing DEB levels (increased  $Na^+$  and  $K^+$  intake) in the diet and with bird's age. He also reported that water intake increased linearly as the DEB increased and the increase of water intake was also reflected in a progressive increase in litter moisture in broilers reared under tropical summer conditions. The increase in water intake cools the birds and reduces mortality in broilers exposed to heat stress ([Branton et al. 1985](#); [Ahmad et al. 2005](#)). Among several factors, water consumption depends upon the bird's age, physiological state, ambient temperature, water temperature and pH, dietary protein levels, and amount and types of salts added in feed and water ([Yousef, 1985](#); [Borges, 1997](#)). The increase in water consumption benefits the bird by acting as a heat receptor as well as increasing the amount of heat dissipated per breath ([Teeter and Smith, 1987](#); [Smith and Teeter, 1988](#); [Belay and Teeter, 1993](#)). The increase in water consumption by 20% over basal levels can increase heat loss per breath by as much as 30% ([Belay and Teeter, 1993](#)).

### Cost of production

The cost items included expenditures on chick, feed, litter, electrolyte, vaccines, labor, electricity and miscellaneous items. From Table 2, it is clear that net profit per bird and net profit per kg bird were different between treatments ( $P<0.05$ ).

**Table 2** Cost of production and profitability of different treatment groups

Cost items	Control ( $T_1$ )	Continuous electrolyte ( $T_2$ )	Intermittent electrolyte ( $T_3$ )	Level of significance
	Mean±SD	Mean±SD	Mean±SD	
Chick Cost (Tk/bird)	37.00±0.00	37.00±0.00	37.00±0.00	NS
Feed cost (Tk/bird)	72.44±2.95	71.87±0.76	69.95±2.04	NS
Maintenance cost (Tk/bird)	22.79±0.00	22.79±0.00	22.79±0.00	NS
Electrolyte cost (Tk/bird)	0.00±0.00 <sup>c</sup>	0.85±0.00 <sup>a</sup>	0.60±0.00 <sup>b</sup>	**
Total Cost (Tk/bird)	132.23±2.95	132.51±0.76	130.34±2.04	NS
Total Cost (Tk/kg BW)	86.52±1.06 <sup>a</sup>	82.82±0.72 <sup>c</sup>	84.92±2.69 <sup>b</sup>	*
Sale price (Tk/kg BW)	115.00±0.0	115.00±0.0	115.00±0.0	NS
Sale price (Tk/bird)	175.78±5.50 <sup>b</sup>	183.99±1.77 <sup>a</sup>	176.63±6.03 <sup>b</sup>	***
Profit (Tk/bird)	43.55±2.85 <sup>b</sup>	51.48±1.59 <sup>a</sup>	46.29±5.62 <sup>ab</sup>	*
Profit (Tk/kg BW)	28.47±1.07 <sup>b</sup>	32.17±0.72 <sup>a</sup>	30.07±2.69 <sup>ab</sup>	*
Increase in profit as compared to $T_1$ (Tk/bird)	-	7.93	2.74	-
Increase in profit as compared to $T_1$ (Tk/kg BW)	-	3.70	1.60	-

The means within the same row with at least one common letter, do not have significant difference ( $P>0.001$ ;  $P>0.01$  and  $P>0.05$ ).

\*\*\*  $P<0.001$ ; \*\*  $P<0.01$ ; \*  $P<0.05$  and NS: non significant.

BW: body weight.

Net profit per bird and per kg broiler was slightly higher ( $P < 0.05$ ) in the treatment  $T_2$  were Tk 51.48 and 32.17 respectively than treatment  $T_3$  Tk 46.29 and Tk 30.07 respectively but treatment  $T_2$  was significantly higher from the treatment  $T_1$  Tk 43.55 and Tk 28.47 respectively.

The cost involvement for electrolyte supplementation showed significant differences ( $P < 0.01$ ) between  $T_2$  and  $T_3$ . It was only Tk 0.85 and Tk 0.60/bird, respectively. Increase in profit in  $T_2$  and  $T_3$  as compared to  $T_1$  was Tk 7.93 and Tk 2.74/bird respectively and Tk 3.70 and Tk 1.60/kg respectively. The results of profit did not agree with the findings of Nessa (2008) who showed that net profit per bird and net profit per kg bird were similar in different treatments ( $P > 0.05$ ). The results of cost of electrolyte supplementation almost agreed with the findings of Nessa (2008) who showed significant differences ( $P < 0.01$ ) between  $T_2$  and  $T_3$  however here it was only Tk 0.75 and Tk 0.50/bird respectively.

## CONCLUSION

The result of the experiment indicated that the supplementation of continuous electrolytes in drinking water to broilers during summer improves highest body weight, feed conversion efficiency, increase water consumption and involves very little cost and relative profit.

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