EFFECT OF ELECTROLYTES IN DRINKING WATER ON THE PERFORMANCE OF BROILER DURING SUMMER SEASON

A Thesis

By

MD. ASHIKUR RAHMAN

Registration No. 1605474

Semester: January – June, 2018

MASTER OF SCIENCE (M.S.)

IN

POULTRY SCIENCE

DEPARTMENT OF DAIRY AND POULTRY SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR - 5200

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Dedicated to

My

Beloved Parents

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ABSTRACT

An experiment was carried out with commercial broilers to investigate the effects of administering electrolytes in drinking water on the productive performance (body weight gain, feed consumption, feed conversion ratio and water consumption) and carcass composition during summer and to determine the economic competence of using electrolytes. A total of 96 day-old Cobb 500 broiler chickens were considered for this experiment. The chicks were randomly distributed into 3 dietary treatments groups; control group (without electrolyte supplementation), 1gm electrolyte supplemented group and 1.5gm electrolyte supplemented group (Once daily). No significant differences in body weight and body weight gain were observed among treatments although the final body weight and body weight gain were highest in birds that received 1.5gm electrolytes once daily. Analysis of performance data showed significant difference for feed conversion ratio ($p<0.05$) and also in water consumption ($p<0.0l$). Birds of continuously 1 gm electrolyte supplied group and 1.5 gm electrolyte supplied groups showed significant improvement in feed conversion. The moisture, CP and EE contents of meat samples (breast, thigh and drumstick) of broilers of different treatments showed no significant differences. Economic returns tended to be higher ($p>0.05$) in continuously 1.5 gm electrolyte supplemented group. On the basis of the results of the study, it may be concluded that, both 1 gm continuous and 1.5 gm supplementation of electrolytes during summer improved the feed conversion of broilers. Thus electrolytes may be supplied to broilers during summer but further feeding trial.

Keyword: Electrolytes, drinking water and feed consumption on the performance of broiler.

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LIST OF ABBREVIATION AND SYMBOLS

Abbreviations		Elaborations
AM	=	Antemeridian
AOAC	=	Association of Official Analytical Chemistry
BAU	=	Bangladesh Agricultural University
^{0}C	=	Degree Celsius
cm	=	Centimeter
cm^2	=	Square centimeter
Contd.	=	Continued
CP	=	Crude protein
DEB	=	Dietary electrolyte balance
DM	=	Dry matter
EE	=	Ether extract
e.g	=	For example
et al.	=	Associates
FCR	=	Feed conversion ratio
g	=	Gram
i.e	=	That is
IU	=	International unit
kcal	=	Kilo-calorie
kg	=	Kilogram

Ltd.	=	Limited
Max	=	Maximum
ME	=	Metabolizable energy
mEq	=	Milicquivalent
mg	=	Milligram
ml	=	Milliliter
Mim	=	Minimum
NS	=	Non-significant
PM	=	Postmeridian
ppm	=	Parts per million
R	=	Replication
RH	=	Relative humidity
SD	=	Standard deviation
Tk	=	Taka
WS	=	Water soluble
>	=	Greater than
<	=	Less than
±	=	Plus-minus
*	=	Significant at 5% level of probability
**	=	Significant at 1% level of probability

CHAPTER-I

INTRODUCTION

Room temperature is a component of microclimate and has a significant effect on the productivity, health of broiler chickens and consequently on the profitability of poultry production. It is generally assumed that rearing temperature should be approximately 32°C on the first day and be gradually decreased to approximately 20°C at the 6 weeks of age (Leenstra and Cahaner, 1991; Zhou and Yamamoto, 1998). Too low or too high ambient temperature is highly undesirable during rearing of broiler chickens. Elevated temperature reduces the feed intake and body weight of broilers.

High temperature is a major limitation to growth and meat yield of broilers in tropical countries of the world (Arjona *et al.,* 1988). Reduced feed intake, growth rate, feed conversion, survivability, dressing yield, breast meat and total meat and increased abdominal fat are the immediate consequences of rearing broilers in a hot humid environment (Geraert, 1998). Depleted performance and decreased profitability of broiler are aggravated when high temperature is associated with high relative humidity (Charles *et al.,* 1978). Broiler with higher growth rate suffer more at elevated house temperature than that of slow growing broilers (Bohren *et al.,* 1982).

It is assumed that every year summer mortality and reduced performance of flock causes Tk. 1240 millions of loss to the poultry industry in Bangladesh (Miah, 2004). This situation demands an efficient means to economically improve the thermo-tolerance of broilers in hot climates without affecting their productivity. Different manage mental techniques and dietary modifications have been employed to overcome the adverse effects of heat stress. These strategies may often have proved beneficial but not all time. Some of them even increased the cost of production. Many of these techniques did not show promising results, especially at higher ambient temperatures. This is probably due to not considering the loss of electrolytes during the periods of heat stress when panting birds experience respiratory alkalosis.

During heat stress, the loss of carbon dioxide ($C0_2$) through respiration and bicarbonate ions coupled with monovalent eations (particularly sodium and potassium) through urine, disturbed the acid base balance (respiratory alkalosis). The corrections in blood acid base balance have been achieved by the supplementation of electrolytes either through drinking water or feed.

That nutritional modifications can be used to influence productivity, health and physiological processes occurring in the body of broilers reared in elevated ambient temperatures. Therefore, the aim of this investigation was to determine the effect of supplementing vitamins C and glucose in drinking water on productivity of broilers exposed to elevate ambient temperature (32 ± 2 °C) between 36 and 49 days of age (Sahina *et al*. 2003) and (Sabah *et al*. 2008). The addition of electrolyte salts to broiler chicken diets has been recommended as a way to minimize the deleterious effects of heat stress (Borges, 1997). Intestinal and renal homeostatic regulation attempt to maintain normal body content of electrolytes and this is generally affected by higher intestinal absorption of monovalent ions than divalent ions within the electrolyte supplements (Teeter, 1997).

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 ($NaHCO_3$), potassium chloride (KCl), calcium chloride ($CaCl_2$) and ammonium chloride (NH_4Cl). These electrolytes in different amounts and proportions proved beneficial for broilers under different heat stress regimens.

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. At high temperatures, which are characteristics of the tropical environment, chickens consume more water than feed. The reduced water intake is primarily behind the loss of production. According to NRC (1994), water intake of chickens increases by about 7% for each 1°C increase above 21°C.

Poultry production in Bangladesh is gaining popularity since more than two decades. Supplementation of electrolytes in poultry diet is not normally practiced in Bangladesh. The essentiality of electrolytes has received attention of the poultry nutritionist in Bangladesh very recently. But, it is not quite known as to whether significant benefits could be derived if broilers drinking water are supplemented with electrolytes during summer and whether such a supplementation is cost effective.

Therefore, this study was carried out with the following objectives:

1. To know the effects of electrolytes in drinking water on productive performance (body weight gain, feed consumption. feed conversion and survivability) of broilers during summer season.

2. To determine whether the administration of e1ectrolytes influence the composition of breast, thigh and drumstick meat.

3. To assess the profitability of producing broilers by supplying electrolytes.

CHAPTER-II
REVIEW OF LITERATURE

The broiler industry is growing rapidly in Bangladesh as an important part of commercial poultry enterprise and pro-vides 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. How-ever, 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).

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.

2.1 Electrolyte a matter of balance

High temperatures in the summer pose a considerable challenge to poultry industry, because they negatively affect feed intake, weight gain, carcass weight, and mortality (Teeter & Belay, 1996). Heat stress caused by high temperature increases respiratory rates, resulting in excessive CO_2 loss and respiratory alkalosis, with consequent increase of blood pH (Borges *et al.,* 2003b). In order to correct pH, birds excrete bicarbonate (HCO_3^-) through the kidneys. Bicarbonate is a negatively-charged ion that needs to bind to a positively-charged ion, such as Na^+or K^+, to be excreted in urine and these ions can be deficient when there is heat stress (Mushtaq *et al.,* 2005).

Vieites *et al.* (2005) evaluated diets with 0 to 350 mEq/kg of DEB and obtained the lowest litter moisture content at 138 and 147 mEq/kg, which corresponded to 26.17% and 2.57%, respectively. Oliveira *et al.* (2010) observed that diets with 200 mEq/kg of DEB for starter and grower broilers promote the best litter moisture and bone development.

Two thirds of the body is water. Water is found inside and surrounding of each cell. The body fluids carry oxygen and carbon dioxide, move nutrients to the tissues, remove waste and distribute enzymes and hormones to their target tissues to function efficiently, the body cells must have a constant balanced environment, which is provided by the fluids surrounding them. These fluids must be maintained m balance.

2.2 Acid-base balance in broilers

High ambient temperature could result in numerous physiological and metabolic changes in broilers that adversely impact broiler performance and immune response. In addition to environmental control techniques that have been frequently used to reduce the negative impact of heat stress on birds' performance, other measures have been studied. Lately, proper nutritional management has shown to be effect as a preventive measure against heat stress because the function of the thermo regulating system of broilers (heat production, evaporative and non evaporative routes for heat dissipation) can be influenced by diet. This applies particularly to the establishment of proper electrolyte balances due to their physiological importance in the heat stress mechanism. Thus, nutritional mechanisms should be reassessed as a tool to control this metabolic dysfunction in birds (Borges *et al.,* 2007).

Chemical reactions occur all the time inside the body using up energy and producing waste. Under normal conditions balance is achieved through buffering when acids are neutralized by bases. Bicarbonate is the main buffer. However, abnormal conditions lead to a rise in the deep body (internal) temperature, the normal control system begins to break down and measures needed to be taken to assist it (Murakami *et al.,* 2001).

2.3 Electrolyte imbalance

Electrolyte imbalance produced by thermal stress, is the most important factors in animal production in tropical and subtropical areas.

When birds are being raised under stressful conditions the margin between balance and imbalance is often very small. Ions of the key electrolytes are involved in metabolic pathways and if the diets supplies less than required or losses occur through stress, cell functions such as manufacture of proteins, carbohydrates and fats are reduced. Appetite is affected immediately. Metabolic rate rises. While in emergency mode, the body marshals its resources to try to restore balance. In doing this, resources are not directed to productivity and efficiency is lost. A good example of a situation leading quickly to electrolyte imbalance is panting in birds. In higher temperature more water is drunk. With the additional urine excreted, more electrolytes are lost and a steady replacement is called for.

Arantes *et al.,* (2013). The aim of this study was to evaluate the performance of broilers fed diets with different levels of dietary electrolyte balances. Two experiments were carried out: during the starter phase (7 to 21 days of age, 960 broilers) and during the growe phase (22 to 38 days of age, 816 broilers). In both experiments, a completely randomized design with four treatments based on dietary electrolyte balance values (200, 240, 280 and 320 mEq/kg of diet) with four replicates was applied. Birds and diets were weighed when birds were seven, 14 and 21 days of age in the first experiment, and 22 and 38 days of age in the second experiment in order to determine weight gain, feed intake and feed conversion. Final body weight, weight gain, feed intake and feed conversion and mortality rate were evaluated. On days 21 and 38, the left tibia of two birds per replicate was collected to determine bone density and the serum was used for Na and K analysis. Litter dry matter content was also determined on days 21 and 38 . There was no effect of dietary electrolyte balance values on broilers performance between 7 and 14, 7 and 21, or 22 and 38 days of age, tibial bone density and mineral content, or on Na, K and Cl serum levels. Litter dry matter was linearly reduced as dietary electrolyte balance value increased. Diets with 200 mEq/kg may be recommended for broilers from 7 to 38 days of age with no negative influence on the evaluated parameters.

2. 4 Key dietary electrolytes

2 .4. 1 Sodium (Na^+)

Sodium makes up about 2% of the total body weight. It mostly occurs in the fluids around the cells where it maintains the osmotic pressure. It is vitally involved in the control of the viscosity of the blood. It is responsible for water regulations. The control of the viscosity of the blood. It is responsible for water regulations. Sodium is involved in the electrical charges along the nerve fibers which regulate neuromuscular functions. Sodium also activates certain enzyme system and facilitates the absorption of glucose and other nutrients from the gut and kidney. Although kidneys are remarkably competent in maintaining sodium homeostasis there are certain conditions where sodium is lost to the body. They must be recognized and corrective action should be taken immediately.

2.4.2 Potassium (K^+)

High environmental temperature is one of the most serious factors affecting production performance of broilers by reducing their feed intake, lowering BW, increasing mortality, and disturbing acid-base balance (Mushtaq *et al.,* 2005; Ahmad and Sarwar, 2006). There are certain behavioral and physiological mechanisms by which the birds try to dissipate their body heat. Birds can increase their effective surface area by lifting their wings or lose heat through conduction by spreading out on the ground. During respiratory alkalosis, naturally birds attempt to correct blood pH by excreting negatively charged bicarbonate ions. The bicarbonate ions must be coupled with positively charged ions, such as sodium (Na^+) or potassium (K^+), before being excreted through urine. Ultimately, the losses of Na^+ or K^+, or both, in urine result in acid-base imbalance.

Potassium, the most abundant intracellular cation, is involved in many metabolic processes, including nerve conduction, excitation-contraction in muscles, and regulation of cell volume. Consequently, changes in K^+ homeostasis profoundly affect cellular functions (Their, 1986). The thermo tolerance of chickens exposed to acute heat stress could be improved by supplementing either diet with K salts (Ahmad *et al.,* 2005) or drinking water with KCl (Smith and Teeter, 1987). Similarly, a daily potassium intake of 1.8 to 2.3 g has been recommended for maximum BW gain in broilers under hot conditions (Rao *et al.,* 2002). However, providing K^+ as potassium bicarbonate exaggerated respiratory alkalosis (Borges *et al.,* 2003), and it failed to influence either body temperature or plasma electrolytes at high temperature. Based on these findings, it has been postulated that drinking an electrolyte solution rich in K^+ might elicit favorable changes in the physiological adjustments to heat-stressed broilers. The present study, therefore, was conducted to determine the effects of 2 levels KCl supplementation (i.e., 0.3 and 0.6%) through drinking water on the performance of broiler chickens under heat stress conditions.

2 4.3 Chlorine (Cl^-)

Chlorine occurs everywhere m the body of the cells and in the extracellular fluids It is stored in the skin and subcutaneous tissue. Chlorine is absolutely critical to the maintenance of acid base balance without which no animal system can survive. An excess of chlorine has frequently been shown to be responsible for disturbing this balance. The relationship between sodium, potassium, and chlorine and the need to maintain close control over the ions is critical for the maintenance of the acid: base balances.

The minerals K^+, Na^+ and Cl^-, in particular, play essential roles in metabolism due to their participation in the osmotic balance, in the acid-base balance, and in the integrity of mechanisms that regulate the transport of substances across the cell membranes. Imbalances among those minerals have a direct effect on acid-base balance, affecting many metabolic functions, and therefore, broiler performance (Judice *et al.*, 2002).The environment and the diet influence the acid-base balance. Maintaining this balance is essential to improve the performance of broilers reared under high temperatures and to overcome the damaging effects of respiratory alkalosis produced by heat stress (Teeter & Belay, 1996).

Mongin (1981) also emphasizes that diets should contain not only an adequate electrolyte balance, given by the difference (Na^++K^+-Cl^-), but also adequate electrolyte ratio [(K^++Cl^-) /Na^+]. Therefore, the adequate ratio between K^+, Na^+ and Cl^- needs to be considered in addition to the calculation of the difference between the total concentration of anions and cations (Talbolt, 1978). The present experiment was carried out to experiment was carried out to evaluate the effect of the manipulations of dietary electrolyte balance based on combinations of different electrolyte balances and electrolyte ratios on the performance, mortality, and carcass traits of broilers submitted to heat stress.

2.4.4 Bicarbonate (HCO_3^-)

The evolution of poultry production has resulted in an young broiler with a high efficiency in converting different types of feed into animal protein. In spite of this, a number of metabolic and management problems have emerged, among them heat stress. The susceptibility of birds to heat stress increases as both relative humidity and ambient temperature exceed the thermal comfort zone, thus making heat dissipation difficult and, as a consequence, increasing the bird's body temperature, adversely impacting performance. Some measures can be taken in order to minimize losses due to heat stress, including the use of fans and nebulisers, management of protein and energy in the diet, acclimatization of birds, use of anti-thermal agents, ascorbic acid, electrolytes, feeding management and management of drinking water. One of the consequences of stress is the change in the acid-base balance with the occurrence of respiratory alkalosis. Therefore, one of the methods used to control heat stress is the chemical management of the acid-base balance in birds by compounds such as sodium bicarbonate ($NaHCO_3^-$), potassium chloride (KCl), calcium chloride ($CaCl_2$) and ammonia chloride (NH_4Cl) in water and/or feed (Borges, 1997). The object of this paper is to discuss the detrimental effects of heat stress on birds and some techniques that minimize them.

The bicarbonate ion acts as a buffer to maintain the normal levels of acidity (pH) in blood and other fluids in the body. Bicarbonate levels are measured to monitor the acidity of the blood and body fluids. The chemical notation for bicarbonate is HCO_3. Although other minerals are essential for well being of birds, calcium, magnesium, phosphorus and sulfur are less important dietary minerals in the calculation of electrolyte balance (Mongin, 2006).

Heat stress is one of the major stressors in poultry production and produces a wide range of physiological changes. The nature and magnitude of these changes depend upon the degree of heat stress imposed. Summer stress in open houses is unavoidable detriments in tropical region. Many workers have shown possibility to alleviate depressive effect of heat stress by dietary antistress treatment. Use of electrolytes improves economic performance of broiler during hot season. The present work attempts to control adverse effect of hot weather on production performance of broiler by administermg electrolytes in drinking water. However, some of the available literatures pertinent to this study are reviewed in the follow sections.

2.5 Dietary requirements of electrolytes of broiler

Mushtaq *et al.,* (2013). Electrolytes (sodium, potassium and chloride) are compounds that dissolve into positive and negative particles in solution. The relationship between these compounds, known as the 'dietary electrolyte balance' (DEB), is affected by either electrolyte or its supplemental salt source. The National Research Council recommended 0.20% sodium, chloride, and 0.30% potassium for starter phase and lower doses of sodium and chloride for the finisher phase of broilers. However, these requirements are increased under heat stress conditions, and birds perform better when increasing levels of these electrolytes are offered, maintaining a DEB of preferably 250 mEq/kg. Increased levels of these electrolytes, especially sodium, were found effective for growth but caused increased water consumption and ultimately higher litter moisture in summer. Potassium and chloride were found effective in the diets of heat-stressed broilers. Sodium bicarbonate and potassium chloride have been recognised as the best choice in salt selection for broiler diets, particularly under hot summer conditions. In conclusion, a combination of the electrolytes with higher levels of cations and lower level of anions is recommended. Furthermore, the requirements of these electrolytes should be explored, with reference to current poultry housing systems and modern genetics.

Ahmad and Sarwar, (2006). Modern fast-growing meat-type broiler chickens are facing difficulties in coping with heat stress. The increase in broiler growth rate increases their body heat production. The global environmental temperature is also showing an upward trend. This situation demands an efficient means to economically improve the thermo tolerance of broiler chickens in hot climates without affecting their productivity. Different anagemental techniques and dietary modifications have been employed to overcome the adverse effects of heat stress. These strategies may often have proved beneficial but not all the time. Some of them even increased the cost of production. Many of these techniques did not show promising results, especially at higher ambient temperatures. This is probably due to not considering the loss of electrolytes during the periods of heat stress when panting birds are experiencing respiratory alkalosis. During heat stress, the loss of carbon dioxide (CO2) through respiration and bicarbonate ions coupled with monovalent cations (particularly sodium and potassium) through urine, disturbed the acid-base balance (respiratory alkalosis). The corrections in blood acid-base balance have been achieved by electrolyte supplementation, either through drinking water or feed. These electrolytes, in different amounts and proportions, proved beneficial for broilers under different heat stress regimens. The proportions of sodium, potassium and chloride in diets determine the dietary electrolyte balance (DEB = sodium plus potassium minus chloride, milliequivalents per kg). The discrepancies exist among different research workers about an appropriate DEB for heat-stressed broilers. Different environmental conditions in which broilers are reared; heat stress regimens (cyclic, acute, chronic), feeding regimens, source of electrolyte salts, combination of different electrolyte sources and the bird's genotype itself are factors that influence the requirements of a particular electrolyte as well as their balance in the diet. This review considers the usefulness and limitations of DEB equation, and the impact of different DEB on live performance, carcass characteristics, mortality and blood parameters in broilers reared under heat stress environments.

Borges *et al.,* (2003). Ross male broiler chicks (n = 480) on new litter were used in a randomized block design with two blocks (environmental rooms) and four treatments having four replicate pens (1.0 × 2.5 m; 15 chicks) each to evaluate dietary electrolyte balance (DEB; $P < 0.05$). Two rooms were 1) thermoneutral (Weeks 1 through 6, with decreasing maximum from 32 to 25°C and minimum from 28 to 19°C; relative humidity 49 to 58%) and 2) cyclic daily heat stress (Weeks 1 and 2, thermoneutral; Weeks 2 through 6, maximum temperatures 35, 35, 33, and 33°C, respectively; and minimum temperatures 23, 20, 19, and 19°C, respectively; relative humidity 51 to 54%). The DEB treatments (0, 140, 240, or 340 mEq Na + K − Cl/kg) had NaHCO3 plus NH4Cl, or KHCO3, or both added to corn-soybean meal mash basal diets with 0.30% salt (NaCl). In the thermo-neutral room, DEB 240 increased 42-d weight gain and 44-d lymphocyte percentage and decreased heterophil percentage and heterophil to lymphocyte ratio compared to the DEB 40 treatment. The DEB 240 diets had 0.35 and 0.35% Na and 0.37% and 0.29% Cl in starter (0.75% K) and grower (0.67% K) diets, respectively. No DEB treatment differences were found in the heat stress room. For combined rooms, 42-d feed intake was higher for DEB 240 than for DEB 40. The 21-d weight gain was higher for DEB 240 than for DEB 40 or 140; and 21-d feed/gain was lower for DEB 40 than for DEB 340. The predicted maximum point of inflection for 21- and 42-d weight gains were DEB 250 and 201, with highest 42-d feed intake at 220.

2. 6 Effects of electrolyte supplementation on growth and weight gain

Belal *et al.,* (2013). 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.

Kadim *et al.,* (2008).The efficacy of ascorbic acid in drinking water on performance of broiler chickens under closed and open-sided houses during hot (ambient temperature 36^{o}C) and cool (ambient temperature 23^{o}C) seasons were studied. The temperatures inside the poultry houses were 26^{o}C (closed), 29^{o}C (open-sided), 32^{o}C (closed) and 37^{o}C (open-sided) for cool and hot seasons, respectively. One-day-old chicks (432 birds) were housed in each closed and open-sided environment for each season. Birds were maintained under 23 hrs light and 1 hr dark cycle and offered *ad libitum* access water and feed. Broilers in both houses were randomly subjected to four drinking water treatments (9 birds in each 6 replicates/treatment): 0, 100, 200 and 300 ppm ascorbic acid. Feed intake, body weight gain, feed conversion ratio and rectal temperatures were recorded weekly. Ascorbic acid supplementation at 200-300 ppm was associated with a reduction in rectal temperatures during the hot season. Open-sided house depressed body weight gain and feed conversion ratio ($P < 0.05$) during hot season. Compared to the control group, ascorbic acid improved feed intake, body weight gain and feed conversion ratio by 6%, 9% and 3% (cool season) and 8%, 11% and 5% (hot season). Birds supplemented with 200 ppm ascorbic acid had ($P < 0.05$) higher feed intake, body weight gain and feed conversion ratio than the control group during the cool season, while 300 ppm ($P < 0.05$)

improved broiler performance including feed intake, body weight gain and feed conversion ratio during the hot season.

Bird's rectal temperature was higher ($P < 0.05$) during hot season in open-sided house and ($P < 0.05$) reduced by supplementing 200-300 ppm ascorbic acid. This study demonstrated that seasonal temperatures had a significant effect on broiler performance in open-sided house. Supplementation of drinking water with 200-300 ppm ascorbic acid ameliorated broiler performance in open-sided housing at high ambient temperatures.

Bilal *et al.,* (2017). The study was designed to investigate the effect of feeding different levels of dietary electrolyte by adding sodium bicarbonate ($NaHCO_3$) on the performance of broilers. Experiment was conducted in two phases. In first phase (0-4 weeks), six broiler starter rations were formulated; a ration without $NaHCO_3$ was served as control whereas other five rations had 0.15-0.73% $NaHCO_3$ in the rations. In this way six dietary treatments resulted in dietary electrolyte balance (DEB) and sodium levels of 245, 262, 279, 297, 314, 331 meq/kg and 0.166, 0.206, 0.246, 0.286, 0.326, 0.336%, respectively. Feed consumption, weight gain and feed conversion ratio (FCR) were significantly ($P<0.05$) improved in broilers fed all the experimental diets as compared to control during starter and finisher phases. At 28 day of age percent thigh meat yield, breast meat yield and abdominal fat yield were significantly better in broilers fed experimental rations as compared to those fed control ration however non-significant ($P>0.05$) differences were observed in dressing percentage. But at 42 day age dressing percentage, percent thigh meat yield, breast meat yield and abdominal fat yield did not show any treatment effect. The electrolyte contents (Na+, K+, and Cl-) of thigh and breast meat were also significantly higher in broilers fed experimental rations as compared to control. Similarly, significantly better Na+, K+, and Cl- contents of thigh and breast meat were observed ($P<0.05$) among all the treatments. The results of present study depict that to support optimal performance of broilers, DEB levels between 250-300 and sodium levels of 0.28% is required.

2.7 Effects of electrolytes on feed consumption

Sayed and Downing (2015).The effects of dietary electrolyte balance (DEB) and electrolyte-betaine (El-Be) supplements on heat-stressed broiler performance, acid-base balance and water retention were evaluated during the period 31-40 d of age in a 2×3 factorial arrangement of treatments. A total of 240 broilers were assigned to 6 treatment groups each with 8 replicates of 5 birds per cage and were exposed to cyclic high temperature (32 - 24 ± 1°C). Birds were provided with diets having DEB of either 180 or 220 mEq/kg. El-Be supplements were either added to the diet, water or not added to either of them to complete the array of 6 treatment groups. An additional 80 birds were kept at thermoneutral temperature (20 ± 1°C) and were provided with tap water and diets with DEB of either 180 or 220 mEq/kg to serve as negative controls. Exposure to high temperature depressed growth performance, increased rectal temperature and decreased potassium (K(+)) retention. In high-temperature room, birds fed on diets with DEB of 220 mEq/kg tended to increase BW from 35-40 d of age. However, at thermoneutral temperature, broilers fed on diets with DEB of 220 mEq/kg increased K(+) retention. Adding El-Be supplements in feed or water improved feed conversion ratio (FCR), enhanced water consumption and increased K(+) and sodium (Na(+)) retention. Interactions between DEB and El-Be supplements tended to affect body weight gain and FCR during the periods 35-40 and 31-40 d of age, respectively. It is suggested that when using a diet with DEB of 180 mEq/kg, adding the El-Be supplements in drinking water was more beneficial than in feed. Adding the supplements in feed or water was equally useful when using DEB of 220 mEq/kg.

2.8 Effects of electrolytes on feed conversion

Mirshamsollahi *et al.*, (2003) observed the effects of electrolyte supplement in drinking water on broiler performance during heat stress. In order to determine the effect of different electrolyte supplements on broiler performance, four electrolytes: KC1, Na_2CO_3, NH_4C1 and K_2C0_3 with four levels 0.0%, 0.15%, 0.3% and 0 45% were used in drmlung water The study was conducted by using 780 days old chicks (Arian) They were reared under normal conditions till 36 days of ages. Then they were exposed to heat stress until 56 days of age. Results of the study indicated that generally electrolytes had a beneficial effect on broiler performance and mortality rate as compared to control group. Feed conversions were improved to 20.1, 18.8, 13.6 and 18.07% by using 0.15 KC1, 0.15 Na_2CO_3, 0.45 NH_4C1 and 0.3% K_2CO_3 respectively.

Gongruttananun *et al.,* (1999) reported that birds given sodium bicarbonate through drinking water had better feed efficiency than those supplied potassium chloride.

Shapira *et al.,* (1999) conducted two experiments to study the effect of electrolytes in drinking water on performance and feed to gain in broilers. In two experiments, 144 day-old broilers had been orally dosed with an electrolyte solution up to 3 weeks of age. The result supported that compensatory growth was most apparent in the chick provided with electrolyte solution and feed conversion was improved ($P<0.05$).

2.9 Effects of electrolytes on water consumption

Branton *et al.,* (1985) investigated the effect of ammonium chloride and sodium bicarbonate in acute heat exposure of broilers. He added amnionium chloride (NH_4C1) and sodium bicarbonate ($NaHCO_3$) to the drinking water (DW) of 42 to 52 day old broilers. NH_4C1 and $NaHCO_3$ were supplied at the rate of 6.25 g/litre (0.63%) of drinking water (DW) and 3.15 g/litre (0.32%) DW respectively. Experimental results showed that water intake was increased by approximately 20% in birds given water containing 3.15g of $NaHCO_3$/litre (0.32%) DW, while both feed and water intake were severely limited by NH_4CI at 6.25gllitre (0.63%) DW.

2.10 Effects of electrolytes on carcass composition

Bonsimbinate *et al.,* (2002) observed the effects of different sodium bicarbonate dietary contents on the productive performance and meat quality of broilers. He used male broilers (369 birds) belonging to the Cobb 500 genotype. Throughout 28 days of trial, birds were fed 4 different diets based on maize and soybean meal which conmined 0 (C group), 0.3 (B1 group), 0.6 (B2 group) and 0.9% (B3 group) sodium carbonate and the dietary sodium contents were 0.13, 0.20, 0.30 and O.37% respectively. The experiment was performed throughout the summer months. The results revealed that the diets did not affect growth rate of birds (68.8 g/day). At slaughter, dietary sodium bicarbonate content did not influence normal composition (moisture and CP %) of carcass.

Hale and stadelman (1992) provided a commercially available electrolyte pack to broilers via their drinking water and reported an increase in carcass weight gain during wet chilling.

Whiting *et al.,* (1990) conducted two broiler trials to investigate the effect on postmortem carcass and meat quality of $NaHCO_3$ and KCI drinking water supplementation under thermo-neutral and cyclic heat stress climatic condition. Experimental results suggested that broilers given 0.5% NaI-1$C0_3$ from 5 to 8 week of age had no effect (P>0.05) on carcass composition or meat quality.

2.11 Effects of electrolytes on survivability

Borges *et al.,* (2003) used Cobb male broilers to evaluate the effects of dietary electrolyte balance on survivability under tropical summer conditions. Corn soybean meal based mash diets had salt (NaCl) alone or in combination with one or more supplements: sodium bicarbonate, ammonium chloride or potassium bicarbonate. A completely randomized design, with 5 starter and grower feed treatments (control: 145, then 130 mEq/kg or 0, 120, 240 or 360 mEq/kg throughout) and 4 replicates per treatment was used. There were no significant effects of treatment on survivability or processing parameters of broilers shown.

2.12 Effects of electrolyte supplementation on overall performance

Tanveer *et al.,* (2005) conducted an experiment to investigate the relativc efficacies of three sodium ($NaHCO_3$, Na_2CO_3, Na_2SO_4) and potassium ($KHCO_3$, K_2CO_3 K_2SO_4) supplements and two chloride supplements ($CaC1_2$ and NH_4CI) on broiler performance. Results indicated that the growth performances in K supplements, except $KHCO_3$, were poorer than those of Na supplements. The $NaHCO_3$, Na_2CO_3 and NH_4C1 increased body weight gain, feed intake and improved feed to gain than those of K_2CO_3 and K_2SO_4 after 42 days of age. Better performance was noted with bicarbonate than that with carbonate and sulfate sources.

Takahashi and Akiba (2002) conducted an experiment to determine the effects of oral administration of different electrolytes through drinking water on growth performance and some physiological responses in male broilers reared in high temperature. A 2x3 factorial arrangement test of 2 temperatures (24°C and 36°C) and 3 levels of oral administration of the electrolytes (0.5 gm/liter, 1 gm/liter and 1.5 gm/liter) were applied in the experiment. Male broilers (2 weeks of age) were assigned to six groups and received dietary and temperature treatment for 7 days. The experimental results suggested that oral administration of the electrolytes prevented decreases in food intake and growth rates in broilers due to exposure of the hot environment.

Draslarova *et al.,* (2000) conducted an experiment to study the effect of electrolyte supplements on broiler performance under heat stress. He studied the effect of NaCI and $NaHCO_3$ on growth, feed consumption, feed conversion, slaughter value and meat quality of 400 broilers (Cobb 500) under heat stress. Broilers were exposed to constant ambient temperature (day average temperature 38°C and night average temperature 30°C) and average relative humidity 55%. Group I was used as a control. Group 2 obtained 0.3% NaCI/bird/day and group 3 had 0.5% $NaHCO_3$ Third/day. Broiler in group 2 reached significantly higher weight gains (males 17.55% higher and females 4.08% higher) and showed better feed conversion (males 5.26%) in comparison to the control group. Group 3 had higher weight gain (males 32.55%, females 26.28%) and showed better feed conversion (males 10.53%, females 3.76%), in comparison to the control group.

Dehim and Teeter (1995) conducted an experiment to evaluate the effects of supplementing drinking water with isomolar (0.067 mol/l) KCI or NaCI on mass gain, food and water consumption, rectal temperature, and survivality of broilers reared in thermo neutral and cycling heat stressing environments. Heat stress decreased ($P \leq 0.05$) mass gain, food consumption, and plasma concentrations of Na+ and K^+, while increased ($P \leq 0.05$) in plasma concentrations of aldosterone, rectal temperature, and water consumption were observed. Drinking water supplemented with either KCl or NaCl increased ($P \leq 0.05$) broiler mass gain and water consumption. The results of this study indicate that broilers in a heat stress environment are under osmotic stress and supplementing drinking water with 0.067 mol/l KC1 or NaC1 does not lessen this stress.

2.13 Research gap and the present study

Although results of a number of studies conducted in abroad mostly showed positive effects of electrolyte supplementation on broiler performance under summer stress, use of electrolytes are normally recommended in this country. Moreover, experimental results on this subject in Bangladesh poultry sector are lacking. Therefore it seemed worthwhile to investigate the effects of commonly available electrolytes on broiler production during summer in Bangladesh.

CHAPTER-III
MATERIALS AND METHODS

3.1 Statement of research work

The feeding trial on commercial broiler was conducted with 96 day old broilers (Cobb 500) for a period of 28 days at the Poultry Farm and chemical analyses were done in the Poultry Science laboratory of Hajee Mohammad Danesh Science and Technology University, Dinajpur.

3.2 Preparation of the experimental house and equipment

An experimental pen was divided into 12 small pens each of equal size measuring 274cm × 91cm for housing 8 broilers in each pen. Plastic hard board were used with a common alley along the middle of the pen. The experimental house was properly cleaned and washed by forced water using a hose-pipe. After 15 days, the room was disinfected with times zon Agro vet. All feeders, plastic buckets, waterers and other necessary equipments were also properly cleaned, washed and disinfected with bleaching powder solution, subsequently dried and left them empty for two weeks before the arrival of chicks. Fresh dried rice husk was used as litter at a depth of 4cm. The birds were kept separately in each pen under similar care and management.

3.3 Source of feed

Day old chicks were supplied broiler starter feed for the first 12 days and the rest of the days (13-28 days) with broiler grower. All feeds were procured from Sujala feeds Limited which was in the form of crumble and pellet respectively.

3.4 Collection of experimental birds

Ninety six day old broilers (Cobb 500) were procured from the hatchery of Kazi Farms Limited from a reported dealer of Goalabazar, Osmani nagor, Sylhet.

3.5 Layout of the experiment

The chicks were randomly distributed into 3 dietary treatment groups with four replications having 8 birds in is each. The layout of the experiment is shown in Table 3.1.

Table 3.1 Layout showing the distribution of experimental birds

Treatments	Number of birds in each replication				Total
	R_1	R_2	R_3	R_4	
Control (T_1)	8	8	8	8	32
Control + Continuous 1gm (Once Daily) electrolyte supply (T_2)	8	8	8	8	32
Control+Continuous 1.5gm (Once Daily) electrolyte supply (T_3)	8	8	8	8	32
Total	24	24	24	24	96

3.6 Composition of the industrial broiler feeds

The composition of the industrial broiler feeds that were used during the experimental period is shown in Table 3.2

Table 3.2 Composition of the industrial broiler feeds

Nutrients	Broiler starter (1-16 days) (g/100g)	Broiler grower (17-28 days) (g/l00g)
Moisture (Max)	12	12
Protein (Max)	21	20
Fiber (Max)	5	5
Calcium (Min)	1	0.95
Phosphorus available(Min)	0.45	0.45
Methionine (Min)	0.48	0.45
Lysine (Mm)	1.15	1.05
ME (kcal/kg)	2950	3000

Based on composition of the feed supplied by the manufacturer (sujala feeds Ltd.)

3. 7 Composition of electrolyte

The electrolyte considered in this study was “Eco-lyte” manufactured by Euro Gold Animal Health.

The composition is shown in Table 3.3

Table 3.3 Composition of the electrolytes (Eco-lyte**) (each 100 gm)**

Composition	per kg
Sodium chloride	270000 gm
Potassium chloride	500.00 gm
Sodium bicarbonate	50.00 gm
Dextrose anhydrous	1700.00gm
Vitamin A	20,00,000 gm
Vitamin C	580 gm

1 gram and 1.5 gm Eco-lyte was supplied with 1 litres of drinking water (Manufacture by: Euro Gold Animal Health).

1 gm Ecolyte and 1.5 gm Ecolyte once daily.

3.8 Management of experimental birds

The following management practices were followed during the experimental period and these management practices were identical for all treatment groups.

3.8.1 Housing

A group of 8 broilers were randomly allocated to each of 12 small pens. Each pen was 274 cm × 91 cm (24934cm^2). Therefore floor space for each bird was approximately 103× 8cm^2 to ensure comfort ability of birds during summer.

3.8.2 Feed and water management

For the first 7 days feeds were given on small trays. After 7 days of age, one round feeder and one round waterer were provided for each replication. At 18 days and onwards, one more feeder was provided for each replication to avoid competition for feed. The feeder and waterer were placed in such a way that the birds were able to eat and drink easily. Feeders were cleaned at the end of each week and waterers were cleaned two times daily.

Fig. 1. Feeding of broiler

Fig. 2. Watering of broiler

3.8.3 Litter management

Fresh, clean and dried rice husk was used as litter at a depth of about 4cm. The litter of every pen was well covered by clean newspaper up to the first 15 days. After first two weeks, total with droppings were removed and new litter was provided. The litter was disinfected with Fulclin soln (marketed by salfebio-products). Litter, when found wet for any reason, were removed and replaced by new litter to prevent any dampness.

3.8.4 Brooding

The experiment was conducted in summer season. During the experimental period, the environmental temperature was sometimes higher than the requirement. Brooding of chicks was done by using one 100-watt electric bulbs in each pen. The bulbs were hanged just above the birds' level at the centre of each pen. It was moved up and down to adjust temperature. Brooding temperature was kept 34°C at the beginning of the first week of age and decreased gradually. The room temperature and humidity were measured by an automatic digital thermo-hygrometer. Gunny bags were used on two sides of the house and in ventilators to protect cold, stormy wind and rain for maintaining actual brooding temperature during early period of growth (1-7 days). These bags were removed partly or completely particularly at the middle part of the day when room temperature became high.

 

Figure. 3. Brooder Preparation **Figure. 4.** Brooding Management

3.8.5 Vaccination

All birds were vaccinated against Ranikhet Disease (Newcastle disease) at 7^{th} days. One drop of Cevac vaccine was administered in one eye as per direction of the manufacturer ACI Animal Health Company. Then 12 days Gumbomade Vaccine and 19 days Gumbomade were admisterd throw drinking water manufacture by Incepta Pharmaceutical and 22 days cevae again throw drinking water.

Figure. 5. IB + ND Vaccination

3.8.6 Medication

During the course of experiment, multivitamins Megavit WS (Novartis Bangladesh Ltd.) was mixed in drinking water and supplied to birds to combat stress due to high environmental temperature (33°C to 37°C). At the age of 13 days of broiler, medication was done by antibiotic (Doxivet, manufactured by square, (Hameco P^H square) and lysovit (Ranata Narsingdi, Bangladesh) and vinegar for 5 days due to *Escherichia coli* infection. It was done for birds of all treatments.

3.8.7 Hygiene and sanitation

Adequate sanitary measures were taken during the experimental period. The entrance point and veranda were kept clean and solution of bleaching powder and potassium permanganate ($KNnO_4$) was kept in foot bath alternatively. The outside of the experimental house and the feed storage room were also kept clean.

3.8.8 Clinical observation

The birds were critically observed twice a day for clinical sign or abnormal symptoms, if any (slow movement, lack of appetite, significant changes of feathering, paralysis and other problems).

3.9 Post-mortem examination of birds

To find out the cause of death of birds post-mortem examination of the birds were performed at Microbiology. Reports were collected and evaluated.

The report of post-mortem examination is shown in Table 3.4

Table 3.4: Report of post mortem examination

Age (Days)	Total No. of dead birds	Groups affected	Cause of death
13^{th}	3	Control and continuously 1gm electrolyte supplemented group	E. coil infection
22^{nd}	2	Control group	Heat stroke
26^{th}	1	1.5 electrolyte supplemented group	Heat stroke

3.10 Collection of meat sample

Meat samples from 3 regions viz, breast, thigh and drumstick were made from each replication for chemical analysis. Twelve birds, one from each replicate were sacrificed for this purpose at the end of trail period.

Figure. 6. Post-mortem examination

3.11 Chemical analysis of meat sample

Meat samples were analyzed to determine moisture, crude protein (CP) and ether extract (EE). These proximate analyses were accomplished by following Official Methods of Analysis AOAC, (1990).

3.12 Data collection and record keeping

The chicks of each replication were weighed at the beginning of the experiment. Birds were weighed every week replication wise in the morning at 6:30 AM prior to feeding. The average body weight gain of birds in each replication was calculated by deducting initial body weight of birds from final body weight. The amounts of feed consumed by the experimental birds under different replications were calculated from the amount supplied at beginning of a week and the amount retained at the end of week. Feed intake was adjusted for dead birds. The feed conversion ratio was calculated by dividing the cumulative feed consumption by average both weight up to rearing.

Electrolytes were supplied in drinking water to the birds of T_2 and T_3 treatments from 7 to 28 days. From the 7 days the amount of water consumed by the experimental birds under different replication, were calculated from the amount supplied and the amount retained at the time of changing of water. Electrolyte was administered for 28 days 1 times daily.

In treatment 2 (T_2) electrolytes were supplied 1 gm during day time and in treatment 3 (T_3) 1.5 gm electrolytes were supplied.

Mortality was recorded replication-wise when death occurred. Survivability of chicks was recorded by subtracting the dead birds from the number of birds considered at the start of trial. Number of live birds were then divided by the initial number of live birds and expressed as per cent.

The cost of broiler production for each treatment was calculated considering the market price of feed ingredients and expense on chicks, electrolytes and management (labour, medicine, electricity and litter) to produce each kg live broiler at the time of trial. The incomes from each kg live broiler in different treatments were calculated considering the sale price of each kg live broiler.

Electricity failure when occurred was recorded during the course of the experiment During the experimental period, the temperature and relative humidity (RH) of the experimental house and pens at chick's levels were recorded four times a day at 6 AM, 12 PM. 6 PM and 12 AM with the help of an automatic digital thermo-hygrometer.

3.13. Statistical analysis

Responses of birds to electrolyte supplementation in the drinking water were statistically evaluated by 'SAS' statistical programme. Completely Randomized Design (CRD) was followed in analyzing data and analysis of variance (ANOVA) was performed to compare different variables among treatments. Least significant differences were calculated where ANOVA showed significant differences.

CHAPTER-IV
RESULTS AND DISCUSSION

4.1 Performance of broilers

The results of productive performance and chemical composition of meat as obtained due to application of electrolytes (Eco-lyte) in drinking water during summer are presented and discussed in the following sections. The performance data is shown in Table 4.1.

4.1.1 Final body weight

It appears from Table 4.1 that the differences in final body weight and body weight gain of birds receiving electrolytes in drinking water were not significant ($p>0.05$). Initial body weight of day old broilers was similar ($p>0.05$). The group that received 1.5 gm electrolytes continuously tended ($p>0.05$) to show the highest body weight (1389.6g) and followed by those birds that received 1 gm electrolytes only (1380.6g). The birds of the control group had the lowest final body weight 1313.75 g).

The non significant effect of electrolytes on body weight gain agreed with Rondor *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 also agreed with Borges *et al.* (2004) who reported that there were no differences of DEB treatments (140, 240 or 340 mEq/kg) on body weight gain and N balance in birds exposed daily to cyclic heat stress (22.5 ± 3.5°C for 14 hours and 33 + 2.0°C for 10 hours).

4.1.2 Feed consumption

Apparently, highest ($p>0.05$) feed intake of broilers in control group (T_1) as noted (1786.81g) and this was followed by continuously supplied 1 gm electrolyte (T_2) group (1774.56g) and 1.5 gm electrolyte supplied (T_3) group (1772g) respectively. But differences in feed intake among groups were not significant (Table 4.2).

The result partially agreed with Borges *et al.* (2004). They found that use of dietary electrolyte balance (DEB) of below 50 mEq/kg diets or above 270 mEq/kg could not affect feed intake.

Table: 4.1 Weight gain Weekly/bird. Productive receiving electrolytes in drinking water (0-28 days).

Treatment group				
Week	**T_1 (Control)**	**T_2 (1gm electrolyte)**	**T_3 (1.5 gm electrolyte)**	**Level of significance**
Initial body Wt.	39.98±1.10	40.25±1.18	40.02±0.41	NS
1st	187.50±2.06	188.56±0.90	192.00±1.08	NS
2nd	382.25 ± 2.17^a	399.75 ± 1.93^b	400.50 ± 2.10^b	*
3rd	781.00 ± 2.38^a	808.75 ± 1.25^b	804.75 ± 1.25^b	*
4th	1313.75 ± 1.75^a	1380.6 ± 0.087^b	1396.6 ± 0.025^b	*

NS means Non-significance.

* Means statistically significant at 5% level of significance.

Values are expressed as Mean ± SE

**Means statistically significant.

a, b means Values with different superscript in the same raw differs significantly

4.1.3 Feed efficiency

The results of feed conversion showed significant ($p<0.05$) differences between electrolyte supplemented and control groups. Feed conversion was best in continuously 1.5 gm electrolyte supplied group (1.40), 1 gm electrolyte group (1.43) and lowest in control group (1.56).This result agreed with the findings of Vieites *et al.* (2004). They reported that supplementation of electrolytes (KCI and $NaHCO_3$) 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 (Table 4.3).

4.1.4 Survivability

There was no variation ($p>0.05$) in survivability among treatments. During the experimental period three birds died from continuous 1 gm electrolyte supplied group for

E. Coil infection, another two birds in control group for heat stroke and only one bird in 1.5 gm electrolyte supplemented group for heat stroke. The results of survivability showed that supplementation of electrolytes had no effect on survivability ($p>0.05$). These results agreed with the findings of Dehim and Teeter (1995), who showed that supplementing drinking water with isomolar (0.067 mol/l) KCI or NaCI did not affect survivability of broilers reared in thermo neutral and cycling heat stressing environments.

4.1.5 Water consumption

Water consumption was highest ($p<0.00$) in the continuously 1.5 gm electrolyte (T_3) supplied group (200.10 ml), intermediate in 1 gm (T_2) supplied group (198.25) and lowest in the control (T_1) group (193.65). Water consumption showed an apparently linear increasing trend with the supplementation of electrolyte during heat stress period. This results agreed with the Borges (2001). He showed that any increase in the dietary intake of electrolyte (Na, K, 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.

4.2 Feed Consumption or Feed intake

Table: 4.2 Feed intake (gm)/bird/week.

Treatment group				
Week	**T_1 (Control)**	**T_2 (1gm electrolyte)**	**T_3 (1.5gmelectrolyte)**	**Level of significance**
1st	158.00±2.86	158.25±2.36	161.75±1.65	NS
2nd	254.56±1.66	254±2.94	247.00±2.38	NS
3rd	546.25±2.39	541.75±1.81	539.75±1.55	NS
4th	828.00±2.71	820.00±2.04	824.25±2.17	NS

NS means Non-significance.

* Means statistically significant at 5% level of significance.

Values are expressed as Mean ± SE

**Means statistically significant.

a, b means Values with different superscript in the same raw differs significantly

It appears from Table 4.2 shows that the proximate composition (moisture, CP and EE) of breast meat, thigh meat and drumstick meat of different treatments could not be attributed to electrolyte supplementation.

This result indicates that supplementation of electrolytes did not alter meat quality or carcass quality ($p>0.05$).

The results of the proximate composition of meat (breast meat, thigh meat and drumstick meat) agreed with the results of Borgatti *et al.* (2004). They reported that the supplementation of electrolytes in broilers diet did not alter carcass characteristics ($p>0.05$).

Table 4.3 Feed Conversion Ratio (FCR) of different treatment groups

Treatment group				
Week	**T_1 (Control)**	**T_2 (1gm electrolyte)**	**T_3 (1.5gm electrolyte)**	**Level of significance**
1st	1.07±0.017	1.07±0.013	1.06±0.006	NS
2nd	$1.31±0.004^b$	$1.21±0.0021^a$	$1.18±0.0189^a$	*
3rd	$1.37±0.009^b$	$1.32±0.005^a$	$1.33±0.007^a$	*
4th	$1.56±0.007^b$	$1.43±0.002^a$	$1.40±0.007^a$	*

NS means Non-significance.

* Means statistically significant at 5% level of significance.

Values are expressed as Mean ± SE

**Means statistically significant.

a, b means Values with different superscript in the same raw differs significantly

4.3 Cost of production and net profit

Table 4.4 Cost of production and profitability of different treatment groups

Cost items	Control	Continuous 1gm electrolyte (day time)	Continuously 1.5gm electrolyte	Level of significance
	T_1	T_2	T_3	
Chick Cost (Tk/bird)	36.00±00.00	36.00±00	36.00±00	NS
Feed cost (Tk/bird)	64.33±0.515	63.88±0.54	63.79±0.2	NS
Maintenance cost (Tk/bird)	20.59±00	20.59±00	20.59±00	NS
Electrolyte cost (Tk/bird)	0.00±0.000	0.75±0.000	1.13±00	**
Total cost (Tk/bird)	120.92±0.515	121.22±0.9	121.51±0.9	NS
Total Cost (Tk/kg body weight)	92.04±0.186	87.8±0.02	87.4±0.0.042	NS
Sale price (Tk/kg body weight)	115.00±0.000	115.00±0.000	115.00±0.000	NS
Sale price (Tk/bird)	151.08±1.25	158.7±00	159.7±0.035	NS
Profit (Tk/Bird)	30.16±1.5	37.48±00	38.19±00	NS*
Profit (Tk/kg body weight)	22.96±0.71	27.14±0.15	27.48±0.003	NS
Increase in profit as compared to T_1 (Tk/bird)	00	7.32	8.03	**
(Tk/kg body wt.)	-	4.18	4.52	-

Values are expressed as Mean ± SE

The cost items included expenditures on chick, feed, litter, vitamin, electrolyte, vaccines, labour, electricity and miscellaneous items From Table 4.4, it is clear that net profit per bird and net profit per kg bird were similar in different treatments ($p>0.05$). Although net profit per bird and per kg was slightly higher ($p>0.05$) in the treatment 2 (Tk 37.48 and Tk 27.14 respectively) than treatment 3 (Tk 38.19 and Tk 27.48) and treatment 1 (Tk 30.16 and Tk 22.96 respectively). The cost involvement for electrolyte supplementation showed significant differences ($p<0.01$) between T_2 and T_3. It was only Tk 0.75, Tk 1.13/bird respectively. Increase in profit in T_2 and T_3 as compared toT_1 was Tk 7.32 and Tk 8.03 Tk/bird respectively and Tk 4.18 Tk and Tk 4.52/kg respectively.

4.4 Future work

The impetus behind the study was to investigate the effects of electrolytes on broiler performance during summer. From the results of the present study, it appeared that inclusion of electrolytes in drinking water during summer enhances the body weight and improves the feed conversion.

This is a preliminary work of its nature. To investigate the more effects of electrolytes on broiler performance, in depth study at DEB (Dietary Electrolyte Balance) level would be helpful. Of course this preliminary study would be foundation for future work.

CHAFFER-V

SUMMARY AND CONCLUSIONS

An experiment was carried out with 96 Cobb 500 broilers at Sylhet broiler-project, Sylhet in summer to investigate the effects of electrolytes in drinking water on broiler performance and carcass characteristics of broilers. The experiment was conducted from one-day old to 28 days. The chicks were randomly distributed to three different treatments namely control group (without electrolyte supplementation), continuous 1.5gm electrolyte supplied group and 1gm electrolyte supplied group. Each treatment had four replications and each replication contained 8 birds. Feeds and water were provided ad labium to all birds throughout the experimental period.

The cumulative body weight of different treatment groups were 1313.75, 1389.6g and 1380.60g in control, continuously 1.5gm and 1gm electrolytic supplied groups respectively. The highest body weight gain was achieved by the birds that received 1.5gm electrolyte continuously in drinking water (about 1390.00g) although no significant difference from the control 1321.50g) was found. Feed consumption of broilers in control (T_1), continuously electrolyte (T_2) and intermittently electrolytes (T_3) supplied groups were 1786.81, 1774.56g and 1772g/bird respectively. At the end of the experiment (28 days) feed conversion of the broiler were 1.56, 1.43 and 1.40 in T_1, T_2 and T_3 groups respectively, which indicated that supplementation of electrolytes both 1gm and 1.5gm may improve the feed conversion during summer stress.

Data on water consumption in different treatments were found to be statistically significant ($p>0.01$). Variation in water consumption gave a clear indication that supplementation of electrolyte increases water consumption significantly in heat stressed broilers. Water consumption was highest in the continuous 1.5gm and 1gm electrolyte supplied group (200.10 ml) and lowest in the control group 193.56ml).

Water consumption was highest in the continuous 1.5gm electrolyte supplied group (200.10 ml) and lowest in the control group (193.56ml). Meat samples (breast meat, thigh meat and drumstick meat) were collected from each of the replication at 28 days after slaughtering the birds to determine the moisture: crude protein and ether extract contents. The moisture, CP and EE of the meat samples of different body parts of the birds of different treatment groups were more or less similar and carcass characteristics of broilers of treated groups were unaffected by the electrolyte supplementation.

Feed cost, total cost and profit Tk/kg live weight showed no significant variation though same return was achieved both in continuous 1.5gm and 1gm electrolyte supplied group (Tk 7.32 more/bird than control). Supplementation of electrolytes also accounted little cost involvement. In continuous 1gm and1.5gm electrolyte group cost was only Tk. 0.75/bird and Tk. 1.13/bird respectively.

As the experiment was conducted in open house in summer season the temperature was very much higher than the requirement of birds. Most of the days the temperature rose to 33°C and even sometimes it rose to 35°C which was very much detrimental for the broilers. Electrolyte supplementation in drinking water in that situation has proved to be beneficial for broilers.

On the basis of the results of the study the followings are conclusions were made:

Supplementation of electrolytes in drinking water to broilers during summer improves feed conversion. Supplementation of electrolytes continuously (1.5gm and 1gm) does not alter the composition of breast meat, thigh meat and drumstick meat. Electrolyte supplementation involves very little cost and relative profit is tended to be higher in electrolytes supplemented broilers. 1.5 gm electrolyte gained significant weight than 1gm electrolyte supplied grouped. There is very small difference of money return/bird between 1gm and 1.5gm electrolyte supplied group.

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APPENDIX

Appendix Table: 1. Layout showing the distribution of experimental birds

Treatment	Number of birds in each replication				Total
	R_1	R_2	R_3	R_4	
Control (T_1)	8	8	8	8	32
Control+ Continuous 1gm (once daily) electrolyte supply (T_2)	8	8	8	8	32
Control + 1.5 gm (once daily) electrolyte supply (T_3)	8	8	8	8	32
Total	**24**	**24**	**24**	**24**	**96**

T_1, T_2, T_3 are treatment 1, 2, 3 respectively; R_1, R_2, R_3, R_4 are replication 1, 2, 3, 4 respectively

Appendix Table: 2. Productive performance of broilers (0-28 days) supplied electrolytes in drinking water (7-28 days)

Replication	Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Total feed consumption (g/bird)	FCR	Survivability (%)
T_1R_1	39	1310	1271	1855	1.459481	87.5
T_1 R_2	41	1318	1277	1862	1.458105	87.5
T_1 R_3	43	1312	1269	1845	1.453901	100
T_1 R_4	38	1315	1277	1865	1.460454	87.5
T_2 R_1	42	1378	1336	1848	1.383234	100
T_2 R_2	40	1382	1342	1843	1.373323	100
T_2R_3	37	1380.25	1343.25	1852	1.378746	87.5
T_2R_4	42	1382.5	1340.5	1833	1.3674	87.5
T_3 R_1	40	1388	1348	1836	1.362018	100
T_3R_2	40	1392	1352	1847	1.366124	100
T_3 R_3	41	1388.5	1347.5	1842	1.366976	87.5
T_3R_4	39	1390	1351	1834	1.357513	100

FCR, Feed Conversion Ratio; %, Percentage; g, Gram; T_1, T_2, T_3 are treatment 1, 2, 3 respectively, R_1, R_2, R_3, R_4 are replication 1,2, 3,4 respectively

Appendix Table:3. Water intake of the birds supplied electrolytes in drinking water (7-28 days) of different treatments

Replication	Water intake (ml/bird)			Total water intake
	7-14 days	14-2ldays	21-28 days	(7-28 days)
T_1 R_1	7480	15580	22836	45896
T_1 R_2	7500	15550	22840	45890
T1 R_3	7490	15600	22800	45890
T_1 R_4	7520	15610	22850	45980
T_2 R_1	7525	15520	22750	45795
T_2 R_2	7550	15800	22820	46170
T_2R_3	7510	15605	22850	45965
T_2R_4	7515	15650	22860	46025
T_3 R_1	7540	15665	22800	46005
T_3R_2	7520	15700	22921	46141
T_3 R_3	7530	15680	22810	46020
T_3R_4	7540	15610	22880	46030

ml, Milliliter, T_1, T_2, T_3 are treatment 1,2, 3 respectively, R_1, R_2, R_3 R_4 are replication 1, 2, 3, 4 respectively

Appendix Table: 4. Recorded temperature (°C) and relative humidity (%) during the experimental period (0-28 days)

Age	6A.M.		12P.M.		6 P.M.		12A.M.	
(days)	temperature	humidity	temperature	humidity	temperature	humidity	temperature	humidity
1	33	75	32	77	33	74	32	78
2	33	80	35	70	34	78	33	78
3	33	78	33	66	33	66	32	78
4	33	74	35	60	34	77	32	78
5	33	75	33	65	33	74	32	77
6	31	80	33	68	32	67	31	78
7	30	77	35	54	32	66	31	76
8	28	79	36	54	33	62	30	74
9	27	86	35	54	34	52	29	74
10	29	79	33	57	31	73	28	78
11	29	80	33	71	35	55	28	74
12	28	77	35	50	33	60	29	72
13	28	82	35	55	32	51	29	78
14	29	86	32	67	31	78	28	72
15	28	81	28	86	29	85	27	87
16	26	89	34	66	30	72	28	74
17	27	88	29	71	30	75	28	83
18	26	88	32	57	30	81	28	83
19	29	89	35	58	31	77	29	85
20	28	89	39	46	34	52	31	84
21	28	86	35	56	33	72	28	80
22	26	88	34	58	28	83	27	87
23	26	90	29	86	28	88	27	89
24	26	90	30	79	30	81	27	88
25	27	89	33	63	29	86	29	85
26	27	90	29	84	32	81	27	87
27	27	89	31	81	29	87	27	85
28	26	85	29	80	28	81	26	85

°C, Degree Celsius; %, Percentage; 6 A.M., Morning (6 O’clock); 12 P.M., Noon (12 O’clock); 6 P.M., Afternoon (6 O’clock); 12A.M., Night (12 O’clock)

Appendix Table: 5. Proximate composition (moisture, CP and EE) of meat samples (breast meat, thigh meat and drumstick meat) of different treatment groups

Replication	Breast meat			Thigh meat			Drumstick meat		
	Moisture (%)	CP (%)	EE (%)	Moisture (%)	CP (%)	EE (%)	Moisture (%)	CP (%)	EE (%)
T_1 R_1	72.50	21.06	1.00	68.82	18.06	2.39	70.29	19.99	2.70
T_1 R_2	73.12	23.08	1.30	75.32	19.07	3.05	72.61	17.39	2.41
T1 R_3	72.77	20.01	1.47	75.30	17.79	2.25	69.11	19.65	3.45
T_1 R_4	72.74	21.10	1.75	73.07	19.30	3.05	75.46	18.60	2.99
T_2 R_1	71.84	20.80	1.80	69.4	17.45	2.41	75.18	17.02	2.73
T_2 R_2	72.76	24.10	1.02	75.59	18.73	2.99	73.55	19.55	3.09
T_2R_3	70.68	22.90	1.35	73.99	19.43	2.70	70.93	18.75	3.43
T_2R_4	72.90	19.25	1.47	76.14	19.54	3.45	72.96	17.50	2.79
T_3 R_1	72.55	21.99	1.08	75.21	17.33	2.79	70.25	17.37	3.05
T_3R_2	73.06	24.50	1.39	74.15	18.94	3.09	69.53	18.20	2.39
T_3 R_3	74.09	20.75	1.37	76.6	19.45	3.43	74.05	17.30	2.25
T_3R_4	75.20	21.10	1.40	69.5	19.73	2.73	74.73	19.80	3.09

%, Percentage; CP, Crude protein; FE, Ether extract; T_1, T_2, T_3 are treatment 1, 2, 3 respectively, R_1, R_2, R_3, T_4 are replication 1, 2, 3, 4 respectively

Appendix Table: 6. Profitability of broiler of different treatment group

Replication	Chick cost (Tk/bird)	Feed cost (Tk/bird)	Electrolyte cost (Tk/bird)	Maintenance cost (Tk/bird)	Total cost (Tk/bird)	Total cost (Tk/kg bird)	Sale price (Tk/bird)	Stile price (Tk/kg)	Net profit (Tk/bird)	Net profit (Tk/kg)
T_1 R_1	38	54.66	0	23.59	116.25	79.93	167.25	115	51.00	35.06
T_1 R_2	38	51.63	0	23.59	116.22	78.71	169.78	115	53.56	36.27
T1 R_3	38	55.74	0	23.59	117.33	81.11	166.27	115	48.94	33.84
T_1 R_4	38	54.05	0	23.59	115.64	79.29	167.70	115	52.06	35.69
T_2 R_1	38	54.78	0.75	23.59	117.12	77.00	172.85	115	57.86	38.49
T_2 R_2	38	52.30	0.75	23.59	114.64	75.00	173.69	115	59.80	39.59
T_2R_3	38	55.21	0,75	23.59	116.55	76.42	175.37	115	60.73	39.82
T_2R_4	38	54.68	0.75	23.59	117.02	79.52	169.22	115	52.20	35.47
T_3 R_1	38	53.12	0.50	23.59	115.21	80.37	164.83	115	49.62	34.61
T_3R_2	38	53.88	0.50	23.59	115.97	76.04	175.37	115	59.40	38.95
T_3 R_3	38	54.98	0.50	23.59	117.07	79.48	169.28	115	52.21	35.44
T_3R_4	38	53.39	0.50	23.59	115.48	76.45	173.69	115	58.21	38.53

T_1, T_2, T_3 are treatment 1, 2, 3 respectively; R_1, R_2, R_3, R_4 are replication 1, 2, 3,4 respectively