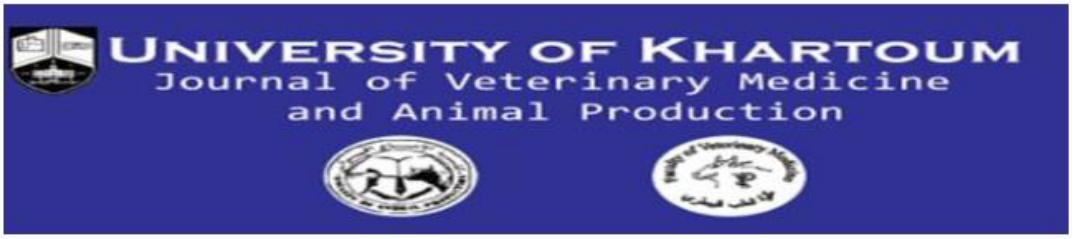
U. of K. J. Vet. Med. Anim. Prod., Vol.10, Issue 1&2 (2019) page 213 - 221
ISSN: 243456



Effect of Potassium Chloride and Sodium Bicarbonate in drinking water on heat stressed Broiler performance and blood profile

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Abstract

This study was conducted to investigate the effect of adding Potassium Chloride and Sodium Bicarbonate in drinking water on growth performance and blood haematological and biochemical parameters of broiler chicks reared during summer (April-May).The experiment consisted of four treatments (T): treatment A (control)water with no salt supplement, treatment B water was supplemented with 0.7% Potassium Chloride, (T) C 0.7% Sodium bicarbonate was added,(T)D combination of 0.7% KCl and 0.7% $NaHCO_3$was added. A total of 96 one-day unsexed broiler chicks (ROSS) were used. Birds were allocated into 4×3×8 completely randomized design. Feed intake, live body weight, weight gain and Feed conversion ratio (FCR) were measured. Blood haematological parameters (packed cell volume PCV, Red blood cells and white blood cells) and biochemical parameters (total protein, phosphorus, potassium and sodium) were measured. The results showed numerical increase (p0>.05) in weight gain and live body weight and carcass weight when a combination of KCl and $NaHco_3$ was supplemented in drinking water. Feed intake and feed conversion ratio were not affected (p>0.05) by the different treatments. Water consumption was increased (p< 0.05) when electrolytes were added. There was no significant effect (P>0.05) observed in (Total white blood cells, heterophils, Neutrophil, Basophill). However, Lymphocyte decreased significantly (p<0.0) by adding sodium bicarbonate. Monocytes were increased (p< 0.05) by adding mixture of potassium chloride with sodium bicarbonate. PCV was significantly (P<0.05) decreased by supplementing mixture of the KCl and $NaHCO_3$. The red blood cell decreased significantly (p< 0.05) by adding electrolytes. Total protein, potassium and sodium level were not significantly (p≥0.05) affected by electrolytes. It is concluded that the use of sodium bicarbonate and potassium chloride and their mixture during heat stress had no significant effect on parameters measured.

Key words: Broiler, Potassium, Sodium, heat stress, weight gain, blood

المستخلص

أجريت هذه التجربة لدراسة تاثير إضافة كلوريد البوتاسيوم وبيكربونات الصوديوم فى الماء على أداء النمو لفراخ اللاحم ومكونات الدم والمكونات الكيمائية فى فترة الصيف. تتكون التجربة من أربعة معاملات : المعاملة الضابطة يخلوالماء من أى إضافة، المعاملة ب مضاف إليها 0.7% كلوريد البوتاسيوم، المعاملة ج مضاف 0.7% بيكربونات الصوديوم والمعاملة د مضاف اليها مزيج من 0.7% بيكربونات الصوديوم و0.7% من كلوريد البوتاسيوم. إستخدم فى هذه التجربة 96 كتكوت غير مجنس عمر يوم واحد سلالة روس و تم توزيع الكتاكيت بتصميم كامل العشوائية 4×3×8.تم قياس المأكول الطوعى، الوزن الحى، الزيادة الوزنية والكفاءة التحويلية. كما تم قياس مكونات الدم (مكداس الدم، كريات الدم الحمراء، كريات الدم البيضاء) و مكونات الدم الكيميائية (البروتين الكلى، البوتاسيوم، والصوديوم). كان هنالك زيادة غير معنوية ($P\geq0.01$) فى الزيادة الوزنية والوزن الحى ولكن المأكول الطوعى والكفاءة التحويلية لم تتأثرمعنويا بإضافة الإلكتروليتات إلى الماء.كان هنالك زيادة معنوية ($p<0.05$) فى إستهلاك الماء عند إضافة الإلكتروليتات. لم يلحظ هنالك تأثير معنوي على كريات الدم البيضاء المتعادلة والقاعدية. إلا أناللليمفوسايت كانت أقل ($p<0.05$) عند إضافة بيكربونات الصوديوم. إضافة خليط كلوريد البوتاسيوم وبيكربونات الصوديوم أدى إلى زيادة معنوية ($p<0.05$) فى الخلايا وحيدة النوية. إنخفض مكداس الدم بدرجة معنوية($p<0.05$)عند إضافة خليط كلوريد البوتاسيوم و بيكربونات الصوديوم، و لوحظ إنخفاض معنوى فى كريات الدم الحمراء عند اضافة الإلكتروليتات. لم يتأثر البروتين الكلى والكلوستيرول ومستويات الفسفور والبوتاسيوم والصوديوم فى الدم بإضافة الإلكتروليات. خلصت الدراسة إلى أن إستخدام كلوريد البوتاسيوم وبيكربونات الصوديوم والخليط منهم لم يؤثر معنويا على الصفات التى تم قياسها.

الكلمات المفتاحية: فراخ اللاحم، البوتاسيوم ، الصوديوم، الاجهاد الحرارى، الزيادة الوزنية, الدم

Introduction

Broilers are the most efficient converter of feed into animal protein. These birds are often reared under adverse heat stress associated with low levels of relative humidity as in most tropical countries. Intensive genetic selection leads to the production of strains that are more susceptible to heat stress (Brossi *et al*., 2009). In addition to various viral, bacterial, and fungal diseases, parasitic infestation, poultry farming is confronted with various noninfectious problems such as extreme environment, poor management and poor feed quality. One of the major hazards challenging poultry industry is the ambient temperature, which persists for about 8 months of the year in most agro-ecological zones of Sudan. Heat stress often causes negative impact on poultry production, reproduction, growth and development (Liu and Peng, 2001). Poultry are highly affected by high temperature as a result of the absence of sweat glands especially when they are young (Li *et al*., 2015). Heat stress limits the feed intake and growth potential of the chicken. High environmental temperature is one of the most serious factors affecting production performance of broilers by reducing their feed intake, lowering body weight, increasing mortality, and disturbing acid-base balance (Mushtaq *et al*., 2005; Ahmad *et al.*, 2006). Commercial broilers after 3 weeks of age reach their maximum weight at 18^{o}C to 20^{o}C and progressively decline in warmer conditions (Yahav *et al*., 1996). In addition to reduced growth rates under warm climates increased mortality can occur at times when the ambient temperature increases for the short periods i.e. 5^{o}C to 10^{o}C above the regular levels (Picard *et al*., 1993). The negative effects of high and low temperatures on poultry performance can be minimized by appropriate housing design, installation of cooling systems, feed formulation according to feed intake and weather conditions and use of electrolytes, vitamin C or aspirin in drinking water of birds (Yahav and Planik, 1999). The National Research Council for starter phase recommended 0.20% sodium, chloride, 0.30% potassium and lower doses of sodium and chloride for the finisher phase.

However, under heat stress conditions, these requirements are increased for better performance, maintaining a DEB of preferably 250 mEq/kg. (Mushtaq *et al*., 2013). 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). Heat stress results in increased excretion of potassium through urine resulting in decreased plasma potassium. Therefore, dietary potassium level should be increased for birds reared in heat stressed environment (Keskin and Durgan, 1997). Ahmed *et al* (2008) and Ait- Boulahsen *et al* (1995) reported an improvement in heat tolerance of chicken that drank water supplemented with 0.6% KCL. It is suggested that water will reduce body temperature and most of the energy will diverted to improve weight gain.

The objective of this study is to investigate the effect of adding Potassium Chloride and Sodium Bicarbonate in drinking water during Summer on growth performance and blood profile traits of broiler chicks.

Materials and methods

Experimental site and housing:

The experiment was conducted at poultry farm of the College of Animal Production Sudan University of Science and Technology for six weeks during the period between April and May which are considered as the hottest months in Sudan, the average temperature range between (32-43C°). The experiment was conducted in an open sided deep litter house; the house was partitioned into twelve experimental pens (replicates) of equal size ($1m^2$) area.The experimental house and equipment were thoroughly cleaned disinfected a week before arrival of the experimental birds, fresh wood shaving litters was spread in the pens at a depth of 3cm and each replicate was provided with one tubular feeder and one drinker before the arrival of the chicks.

Experimental plan

A total of 96 one-day unsexed broiler chicks (ROSS) were purchased from commercial company. The rearing period extended for 21days during which 24 hours of lighting was provided. Feed and water were provided ad libitum. The birds were weighed and randomly assigned into four groups, designated as A, B, C and D. Each group was further subdivided into three replicates of 8 birds each.

Basal starter (1 to 21 d) and finisher (22 to 42 d) diets were formulated according to the nutrient requirement recommended by National Research Council (NRC, 1994) for broiler chicks. Table (1) shows the composition and calculated analysis of the experimental diets. After 21 d the water was supplemented with 0.7% of potassium chloride and 0.7% sodium bicarbonate per liter of drinking water for group B and C, respectively, while group D was provided with a combination of 0.7% potassium chloride and 0.7% sodium bicarbonate, the control group (A) received tap water without addition of electrolytes throughout the experimental period.

Performance parameters

Data on feed intake, feed conversion ratio (FCR), body weight (BW) and weight gain were recorded on weekly basis whereas water consumption was recorded daily. Feed intake was measured weekly by offering the

prescribed diet. Then the residue of the food was measured using an electronic digital balance. The body weight was recorded on day 21 and thereafter on weekly basis up to the termination of the experiment (42 d). Feed conversion ratio was calculated from the recorded feed intake and body weight gain.

Feed conversion ratio (FCR) =Total feed consumed/Total weight gain

Blood Parameters

Collection of blood sample

Blood samples from two birds were collected on day 42, from each pen. The blood samples of four ml were taken from the wing vein using sterile disposable syringe. The blood was transferred immediately into 2ml collection tubes with anticoagulant (Lethem heparin) for blood cell examination. The other 2ml were put in tubes without anticoagulant for serum separation for chemical blood evaluation. The white blood cells were counted in heamocytometer using Natt and Herrick as a dilution fluid. The differential leukocyte count was determined by examining whole blood smears. The count includes relative percentage of Lymphocytes, Heterophils, Monocytes, Basophil and Esinophil.

Biochemical estimations: Serum samples have been collected at 42 day of age for the estimation of total protein, albumin, sodium and potassium. The serum total protein concentration was determined using biuret reagent method as described by Cannon *et al*. (1974). The serum albumin concentration was determined using modified bromocresol green colorimetric method as described by Doumas *et al*. (1971). Sodium and potassium level were determined by flame photometer technique described by Wootton (1974).

Statistical Analysis:

The data were analyzed statistically using the General Linear Models procedure of SPPS. Significant differences between treatment means were separated using Duncan's multiple range tests.

Table (1) Composition of the Basal Diet:

Ingredients	Starter	Finisher
Sorghum	63	71
Groundnut meal	30	22
Concentrate	5	5
Lime stone	1	1
Di calcium phosphate	0.3	0.3
Lysine	0.1	0.1
Methionine	0.1	0.1
Anti-fungi	0.1	0.1
Premix	0.1	0.1
Salt	0.3	0.3
CALCULATED ANALYSIS		
ME(k/cal)	3103	13.2
Crude protein%	23.88	21.34
Crude fiber%	3.77	3.42
Calcium%	1.8	1
Available phosphorus%	0.46	0.41
Lysine	1.3	1.19
Methionine	0.54	0.52

Super concentrate (Provimi) provided the following per kilogram diet ME 2000kcal , CP 40%,Ca 10% , AV.P 5.8%, Lysine 12%, Methionine 3.7% and CF 3% .

Results

The effect of supplementing of potassium chloride, sodium bicarbonate and their mixture on overall growth performance of heat stressed chicks is presented in table (2). Weight gain and live body weights were not significantly (p≥ 0.05) affected but numerical increased was noticed when a combination of KCl and NaHco3 was supplemented in drinking water. Feed intake and feed conversion ratio were not significantly (p≥ 0.05) affected by the different treatments.

Statistically there was significant increase (p<0.05) in water consumption was noticed when electrolytes were supplemented. The lowest mean (2.330 L) was noticed in the control group with no electrolyte supplementation.

Table (2) Effect of water supplementation of potassium chloride and sodium bicarbonate on the overall performance of heat stressed broiler chicks

Parameters	Control	$NaHCO_3$	KCL	$NaHCO_3$+KCL
Final life Body weight (g/bird)	1216.33±73.36	1115±159.29	1239±44.83	1277.67±77.11
Weight gain(g/bird)	300.45±16	319±34.43	317.11±31.43	345.11±48.26
Feed in take (g/bird)	822.78±38.71	753.89±30.70	829±157.80	793±22.88
FCR	2.78±0.18	2.42±0.31	2.71±0.34	2.34±0.30
Water consumption (lit/bird)	2.33±0.09[b]	3.04±0.24[a]	3.11±0.26[a]	2.97±0.03[a]

[a, b]*Means with different superscript letters within the same row are significantly different at P<0.05.*

The effect of supplementing potassium chloride, sodium bicarbonate and their mixture on blood profile was presented in table (3). There were no significant differences (P≥0.05) observed between treatments in (Total white blood cells, Basophill and heterophils). However, PCV was significantly (P<0.05) decreased in the group treated with the mixture of the KCl and $NaHCO_3$. The red blood cell was decreased significantly (P<0.05) when electrolytes were added to the different groups compared to control.

Lymphocyte decreased significantly (p< 0.05) in the group treated with sodium bicarbonate compared to control group, but other treatments were not significantly different from control group. The monocytes were increased significantly (p< 0.05) in the group supplemented with the combination of KCl and $NaHCo_3$ compared to control. Esinophill decreased significantly in the group treated with $NaHco_3$ and the combination of the KCl and $NaHco_3$ compared to the control group. Basophill were not affected by the different treatments.

The biochemical blood profile was presented on table (4). It was observed that there was no significant difference (P<0.05) between the different treatments in total protein but numerical decrease was noticed in Sodium- Potassium level. However, there was significance decreased (P<0.05) in albumin value compared to control group.

Table (3) Effect of potassium chloride and sodium bicarbonate in drinking water on blood profile of heat stress broiler

Parameters	Control	$NaHCO_3$	KCL	$NaHCO_3$+KCL
PCV%	22.33±0.58[a]	22.00±0.00[a]	22.33±1.53[a]	15.33±1.53[b]
TWBCs ×10³	2.17±0.21	1.93±0.12	2.37±0.32	2.13±0.23
TRBCs ×10⁶	1.80±0[a]	1.50±0.10[b]	1.40±0.10[b]	1.20±0.10[c]
Lymphocytes %	58.00±1.00[a]	54.00±2.00[b]	57.67±1.16[a]	57.67±0.58[a]
Heterophil%	26.67±1.53	25.33±1.53	26.00±1.00	26.00±1.00
Monocytes%	5.00±0.00[c]	6.67±0.58[bc]	6.33±1.53[c]	8.67±0.58[a]
Esionphil%	9.67±0.58[a]	10.00±0.00[a]	7.67±1.53[b]	5.33±0.58[c]
Basophil%	1.33±0.58	3.00±0.00	3.00±1.00	2.00±1.00

[a, b]*Means with different superscript letters within the same row are significantly different at P<0.05.*

Table (4) Blood Biochemical parameter of heat stressed broiler chicks supplemented with electrolytes in drinking water

Parameters	Control	$NaHCO_3$	KCL	$NaHCO_3$+KCL
Total protein (g/dl)	2.83±0.49	2.80±0.35	2.67±0.42	3.13±0.95
Albumin (g/dl)	1.77±0.06[a]	1.33±0.15[b]	1.43±0.15[b]	1.33±0.15[b]
Sodium (mmol/L)	114.67±4.73	111.00±2.65	108.33±3.06	112.00±1.00
Potassium (mmol/L)	3.50±0.44	2.73±0.06	2.87±0.51	3.20±0.10

[a, b]*Means with different superscript letters within the same row are significantly different at P<0.05.*

Discussion

The results of this study revealed that live body weight and weight gain were not significantly increased but numerical increase was noticed by supplementing electrolyte in drinking water at high temperature. Adeyemo *et al*., (2018) reported that under heat stress, supplementation 0.5% KCl and 0.5% Na Cl in water reduced rectal temperature, increased body weight, and improved FCR. Also Naseem *et al.* (2005) found when KCl and $NaCo_3$ supplemented at 1.5% and 0.5% improved weight gain and feed conversion ratio. Feed intake and feed conversion ratio were not affected by the different treatment. This result agrees with Ahmed *et al* (2008) who found no effect of supplementation of KCl on feed intake. Bottje and Harrison

(1985) reported that body weight is not significantly increased by dietary sodium bicarbonate supplementation during heat stress. In this study supplementation of drinking water with $NaHco_3$ and KCl up to0.7% was not effective to reduce effect of heat stress for broiler.

Water consumption was increased when electrolytes were added to drinking water. This result agreed with Borges *et al*. (2003 a,b) and Ahmed *et al*. (2006) who reported that supplementation of diet or drinking water with electrolytes (1.0%KCL) from 21d onward improved water consumption in birds reared under heat stress conditions, so the increased water intake helps the birds in maintaining deep body temperature. Ahmed *et al*. (2008) found increased live performance by 0.6% KCl supplementation was attributed to increase in water consumption which resulted in lowered body temperature and consequently, it is considered that energy is diverted towards body weight gain instead of decreasing heat load. Some researchers have attributed the survival rates of heat-stressed broilers receiving electrolytes such as potassium chloride and sodium bicarbonate to the increased water consumption not to the electrolytes.

The Results of this experiment revealed that there was no significant effect on total white blood cells count (TWB C) when the electrolytes were supplemented in drinking water at high temperature. The result showed that lymphocyte decreased significantly ($p<0.05$) in the group treated with sodium bicarbonate compared to control. However, there was no significant effect ($P\geq0.05$) of electrolyte supplementation on heterophil. This result was in line with a review of Zulkifli and Siegel (1995) indicated that stress can reduce the number of circulating lymphocytes and increase the number of heterophils in chickens. This concept was also confirmed by Borges *et al*. (2004) and he concluded that flocks susceptibility to the disease challenge at heat stress will increase as a result of decrease in immune response due to decrease in lymphocytes and increase in heterophils. Berne and Levy (1998) reported that exposure to stress lead to release of glucocorticoids, causing dissolution of lymphocytes in lymphoid tissues and leading to lymphopenia; an increase in heterophil release by the bone marrow, but their phagocytic and bactericidal activities are decreased.

The PCV (hematocrit) was decreased in the group supplemented with the combination of KCl and $NaHCo_3$. Yahav *et al*. (1996) and Dinu et al. (2004) found that blood hematocrit decreased with exposure to high temperature may be due to the decreased production of erythrocyte or the decreased erythrocytes number and size.

Monocyte was increased in group given the combination of the two electrolyte i.e it prevents the decrease of monocyte which is a consequence of heat stress as reported by Altan (2000) that heat stress resulted in decreased monocyte and lymphocyte proportions.

In this study sodium and potassium level in the blood was not affected by supplementation of KCl and Na HCo_3, but their values in general are lower than normal which implies the effect of heat stress. (Belay and Teeter, 1993; Ait-Boulahsen *et al*., 1995) found a reduction in plasma levels of K and Na due to heat stress, but they concluded that this may occur as a result of haemodilution following increased water consumption. In addition, Borges *et al.* (2004) reported that during heat stress haemodilution occurs as the body temperature rises; result in lowering of Na concentration.

It is concluded that supplementation of electrolytes in drinking water did not affect

broiler performance significantly; however numerical increase in body weight and live weight was noticed. The blood profile and biochemical parameters were decreased in response to high temperature but electrolytes did not alleviate the heat stress effect except combination of KCl and $NaHCo_3$ increase monocytes.

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