Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2013, 3(1):592-595

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Effects of high environmental temperature on plasma sodium and potassium concentrations in commercial layers

Amin Allahverdi[1], Adel Feizi[1], Mohammad Ashrafzadeh Takhtfooladi[2*] and Saeed Shabani[1]

[1]*Faculty of Veterinary Medicine, Islamic Azad University of Tabriz, Iran*
[2] *Department of Surgery, Faculty of Veterinary Medicine, Science and Research Branch, Islamic Azad University, Tehran, Iran*

ABSTRACT

High environmental temperature can influence the acid-base balance in poultry. Among sodium (Na) and potassium (K), the monovalent ions are the key minerals involved in acid-base balance of the body fluids. The aim of this study was to determine the effect of high environmental temperature on plasma Na and K concentration in commercial layers. In this study two hundred laying hens (Hy-Line) 40 weeks age were divided randomly into two groups, each group contains 100 hens (control group and purpose group). Every 4 hens were kept in a cage with water and same basal and supplemental diets ad libitum. During the experiments hen houses received 16h of light per day. Hen house's temperature was measured four times a day (06.00, 12.00, 18.00 and 24.00). The average minimum and maximum daily temperature respectively were 22°C and 36°C that recorded in hot season of year. The length of the experiment was 90 days. The control group was kept in the same experimental situation and average minimum and maximum temperature were 20°C and 26°C respectively. Blood samples were taken weekly, concentration of plasma Na and K measured by the flame photometer. Differences between groups were evaluated by t-tests. P-values <0.05 were considered statistically significant. Average Na concentration in purpose and control groups was 140 mmol/L and 123 mmol/L respectively. Average k concentration in purpose and control groups was 6.53 mmol/L and 8.61 mmol/L respectively. Results of present study showed significant (P = 0.001) changes in Na and K plasma concentrations during heat stress period. Our results can be recommended that dietary minerals supplementation be helpful for maximum performance in laying hen under hot climate conditions, especially during the summer months when birds are most susceptible to heat stress.

Key words: Heat stress, Laying hens, Sodium concentration, Potassium concentration.

INTRODUCTION

Diet and high environmental temperature can influence the physiological blood parameters in poultry. At heat stress, bird's body temperature rises and respiratory rate increases to decompose extra heat, therefore, partial pressure of CO_2 decreases in the blood. In turn, the bicarbonate buffer system decreases the concentration of carbonic acid (H_2CO_3) and hydrogen (H^+), causing rise in plasma pH [1]. In response to that kidneys increase HCO_3^- excretion and reduce H^+ excretion as an attempt to keep bird's acid-base balance within the normal range. Excretion of negatively

charged bicarbonate in the urine requires coupling with positively charged sodium (Na) or potassium (K) ions; thus, respiratory alkalosis has been related to negative mineral balance for K and Na ions [2]. Also, Borges *et al* [3] showed that electrolyte balance is essential for maintenance of intracellular and extracellular homeostasis and electric potential cell membranes, acid-base balance, enzymatic reactions and osmotic pressure. The aim of this study was to determine the effect of high environmental temperature on plasma Na and K concentrations in commercial layers.

MATERIALS AND METHODS

This experimental study was performed in Hy-Line laying hens at the age of 40 weeks. The animals were obtained from commercial company and divided randomly into two groups, one as control and the other as purpose, each group contains 100 hens.

Every 4 hens were kept in a cage with water and same diets ad libitum. During the experiments hen houses received 16h of light per day. Hen house's temperature was measured four times a day (06.00, 12.00, 18.00 and 24.00). The average minimum and maximum daily temperature respectively were 22°C and 36°C that recorded in hot season of year. The length of the experiment was 90 days. The control group was kept in the same experimental situation and average minimum and maximum temperature were 20°C and 30°C respectively.

Blood samples were obtained weekly in heparinized tubes from the brachial vein of birds and transferred to laboratory. Blood samples were centrifuged at 3000 rpm for 15 minutes to separate clear plasma which was stored at –20°C to determine Na and K concentrations using the flame photometer (Jenway PFP 7, UK).

Statistical analysis was performed using the SPSS statistics software package version 16. Differences between groups were evaluated by t- tests. P-values <0.05 were considered statistically significant.

RESULTS

Average Na concentration in purpose and control groups was 140 mmol/L and 123 mmol/L respectively (table 1). Average k concentration in purpose and control groups was 6.53 mmol/L and 8.61 mmol/L respectively (table 2). Results of study showed significant (P=0.001) changes in Na and K plasma concentrations during heat stress period (chart 1 and 2).

TABLE 1- Plasma Na concentration (mmol/L).

	Group	N	Mean	Std. Deviation	Std. Error Mean
Na concentration	purpose	100	140.7879	10.58229	1.84214
	control	100	123.0000	6.09645	1.69085

TABLE 2- Plasma K concentration (mmol/L).

	Group	N	Mean	Std. Deviation	Std. Error Mean
K concentration	purpose	100	6.5376	0.94219	0.16401
	control	100	8.6154	1.75777	0.48752

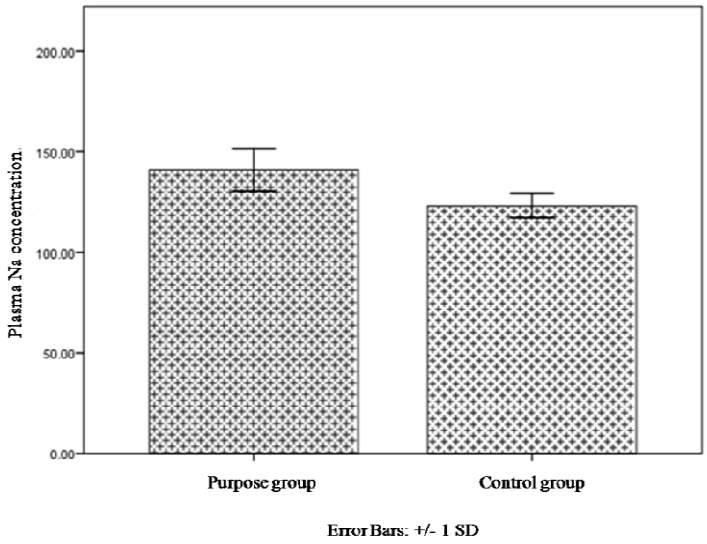

Chart 1- Plasma sodium concentration (mmol/L). P = 0.001.

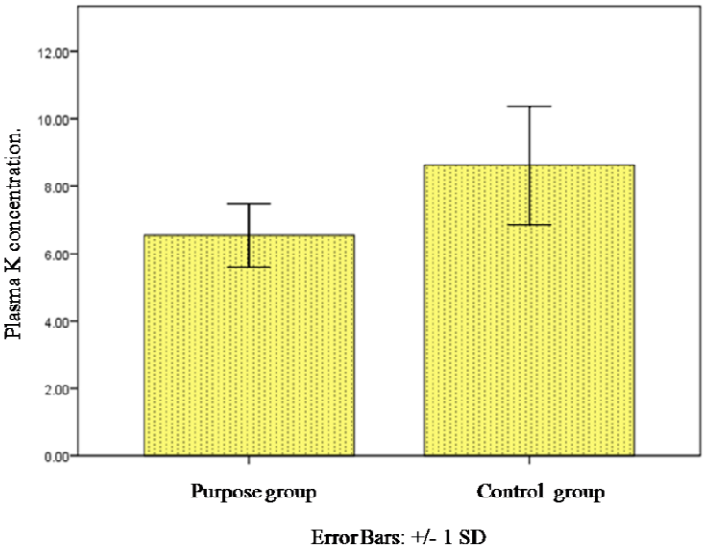

Chart 2- Plasma sodium concentration (mmol/L). P = 0.001.

DISCUSSION

Electrolytes have a great importance in maintaining acid-base balance, osmotic pressure and electrical potential of cell membranes; and are also essential for cellular homeostasis [4]. Among these electrolytes, the monovalent ions are the key minerals involved in acid-base balance of the body fluids [5], because they have a higher permeability and have greater absorption than divalent ions [6]. Hyperventilation during heat stress results in increased CO_2 loss and respiratory alkalosis develops [7]. The kidney attempts to correct this condition by renal exchange of bicarbonate with Cl [5]. As a consequence Cl concentrations increase in plasma [8]. Bicarbonates were negatively charged ions that were coupled by positively charged ions such as K and Na and both are excreted in urine [9]. During heat stress, Belay *et al* [10] and Belay and Teeter [8] reported increased K and Na excretion in urine and faeces. As Na and K are alkalogenic ions, their loss can lead to body fluid acidification. The changes in systemic pH in response to heat stress are therefore complex involving an initial respiratory response phase, which can produce a systemic alkaloidosis and then a compensatory phenomenon involving homeostatic mechanisms that can produce

systemic acidosis. Predicting the length and duration of these phenomena and how they interact with diet, and management remains problematical. These changes in acid-base balance are responsible for growth retardation and poor performance under heat stress [1,11].

Our results demonstrate that the high environmental temperature had significant influence on the blood plasma mineral profile in laying hens. The plasma k levels significantly decreased during this experiment, which correspond with finding of strakova *et al* [12]. On the other hand, koelkebeck [13] reported no significant changes in plasma k levels. Mean values found in current study correspond with the range of values reported by suchy *et al* [14,15], Gezen *et al* [16]. The potassium and sodium levels in present study indicated towards efficient handling of salt and water by the birds during conditions of heat stress.

CONCLUSION

This present study was designed to assess the effect of heat stress on Na and K concentrations in commercial layers. In conclusion, results can be recommended that dietary minerals supplementation be helpful for maximum performance in laying hen under hot climate conditions, especially during the summer months when birds are most susceptible to heat stress.

Acknowledgment
The present research is a part of project financed by Faculty of Veterinary Medicine, Islamic Azad University of Tabriz, Iran.

REFERENCES

[1] R.G. Teeter, M.O. Smith, F.N. Owens, *Poult. Sci.*, **1985**, 64, 1060-1064.
[2] T. Belay, R.G. Teeter, *Br. Poult. Sci.*, **1996,** 37, 423-433.
[3] S.A. Borges, A.V. Fischer da Silva, J. Ariki, D.M. Hooge, K.R. Cummings, *Poult. Sci.*, **2003 a**, 82,301–308.
[4] S.A. Borges, A.V. Fischer da Silva, J. Ariki, D.M. Hooge, K.R. Cummings, *Poult. Sci.*, **2003**, 82: 428-435.
[5] P. Mongin, *Proceedings of the Nutrition Society*, **1981**, 40, 285-294.
[6] S.A. Borges, A.V. Fischer da Silva, A. Majorka, D.M. Hooge, K.R. Cummings, *Poult. Sci.*, **2004**, 83, 1551-1558.
[7] M. Toyomizu, M. Tokuda, M. Ahmad, Y. Akiba, *J. Poult. Sci.*, **2005**, 42, 110-118.
[8] T. Belay, R.G. Teeter, *Br. Poult. Sci.*, **1996**, 37, 423-433.
[9] J. Remus, *Feedstuffs*, **2002**, 74, 11-13.
[10] T. Belay, C.J. Wiernusz, R.G. Teeter, *Poult. Sci.*, **1992**, 71, 1043-1047.
[11] Z. Arad, J. Marder, U. Eylath, *Comparative Biochemistry and Physiology*, **1983**, A, 74, 449-453.
[12] E. Strakova, P. suchy, D. Klecker, J. Illek, *Zivocisna vyroba*, **1994**, 39, 409-420.
[13] K.W. Koelkebeck, *Comp Biochem physiol A-physiol*, **1995**, 112, 119-122.
[14] P. Suchy, S. Jerabek, S. Stanek, J. Zelenka, *Zivocisna Vyroba*, **1989**, 34, 741-450.
[15] P. Suchy, E. Strakova, V. Vecerek, P. Sterc, *Czech J Anin Sci*, **2001**, 46, 383-387.
[16] S.S. Gezen, M. Even, G. Deniz, *Rev Med Vet*, **2005**, 156, 491-497.