

SOME PHYSIOLOGICAL TRAITS OF HISEX BROWN LAYERS FED WITH SUPPLEMENTAL SODIUM BICARBONATE DURING HEAT STRESS

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ABSTRACT

This experiment was carried out at the Poultry Farm of the College of Agriculture, University of Baghdad, utilizing 160 Hisex Brown layers. Four diets containing 0, 0.5, 1 and 1.5 % sodium bicarbonate (NaHCO_3) represent T1, T2, T3 and T4, respectively, were fed *ad libitum* for 4 weeks at 50 wk old (40 birds for each diet) reared under high environmental temperatures. The effect of NaHCO_3 supplementation on RBC, PCV, Hb, H/L ratio, plasma glucose, total protein and uric acid was evaluated.

A marked reduction ($p<0.05$) in RBC count was observed by NaHCO_3 inclusion in the diets. NaHCO_3 failed to influence ($p<0.05$) PCV, Hb and plasma total protein when provided at 1 and 1.5% levels (T3 and T4), whereas, they are significantly ($p<0.05$) increased at 0.5% level (T2) as compared with control (T1).

Significant ($p<0.05$) differences were noted in the H/L ratio among the four treatments. The lowest H/L ratio occurred in T2 birds while control birds (T1) experienced the highest H/L ratio. Apart from its level, NaHCO_3 inclusion caused a significant ($p<0.05$) reduction in plasma glucose accompanied by a significant ($p<0.05$) reduction in the concentrations of plasma uric acid.

Data suggest that Hisex Brown layers reared under high environmental temperatures respond positively to NaHCO_3 addition with regard to physiological adjustments.

Key words: sodium bicarbonate, physiological parameters, layers, high temperatures.

دراسة بعض الصفات الفسلجية لدجاج الهايسكس براون المغذى بعلائق مجهزة بمستويات مختلفة من بيكربونات الصوديوم تحت ظروف الإجهاد الحراري

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المستخلص

أجريت هذه التجربة في حقل الطيور الداجنة التابع لكلية الزراعة جامعة بغداد باستخدام 160 من دجاج الهايسكس براون بعمر 50 أسبوع. غذيت بصورة حرة باربع علائق حاوية على 0، 0.5، 1 و 1.5 % بيكربونات الصوديوم (NaHCO_3) لمدة اربعة اسابيع (بواقع 40 طير لكل عليقة) تحت ظروف درجات الحرارة العالية. تمت دراسة تأثير تجهيز بيكربونات الصوديوم للعليقة في اعداد خلايا الدم الحمر (RBC)، حجم خلايا الدم المضغوط (PCV)، تركيز الهيموغلوبين (Hb)، نسبة الخلايا المتغايرة الى اللمفية (H/L)، تركيز الكلوكوز في البلازما، تركيز البروتين الكلي في البلازما وتركيز حامض البوليك في البلازما.

حصل انخفاض معنوي ($p<0.05$) في اعداد خلايا الدم الحمر نتيجة اضافة بيكربونات الصوديوم للعلائق. لم يكن لاضافة بيكربونات الصوديوم تأثير معنوي في قيم حجم خلايا الدم المضغوط، تركيز الهيموغلوبين وتركيز البروتين الكلي في البلازما عند اضافتها بمستويات 1 و 1.5 % (المعاملتين T3 و T4) في حين ارتفعت هذه القيم معنويا عند مستوى 0.5 % بيكربونات الصوديوم (المعاملة T2) مقارنة بمعاملة السيطرة (T1).

لوحظت فروق معنوية بين المعاملات الاربعة فيما يتعلق بنسب الخلايا المتغايرة الى اللمفية (H/L) ولوحظت اقل نسبة للخلايا المتغايرة الى اللمفية في طيور المعاملة T2 في حين اظهرت طيور معاملة السيطرة (T1) اعلى نسبة للخلايا المتغايرة الى اللمفية. وبصرف النظر عن مستوى بيكربونات الصوديوم، ادى ادخالها الى العليقة الى حصول انخفاض معنوي ($p<0.05$) في تركيز الكلوكوز في البلازما مصحوب بانخفاض معنوي ($p<0.05$) في تركيز حامض البوليك في البلازما.

تشير نتائج هذه الدراسة الى ان دجاج الهايسكس براون المربي تحت ظروف درجات الحرارة العالية كانت استجابته ايجابية لاضافة بيكربونات الصوديوم للعليقة فيما يتعلق بالصفات الفسلجية المدروسة.

INTRODUCTION

Birds use evaporative cooling through panting as an important avenue in heat dissipation under high ambient temperature. However, this hyperthermic panting precipitates respiratory alkalosis (13), which has been negatively correlated with performance and survivability (20).

On the other hand, earlier work by Cohen *et al* (8) reported in laying hens that the interaction between dietary sodium and chloride affect acid-base parameters. Also, high temperature stress causes a decrease in plasma sodium and increase in plasma chloride (4). This alteration in sodium:chloride ratio resulted in blood alkalosis (12), which also has a detrimental effect on performance (18).

As mentioned above, blood alkalosis has been noted in chickens not only during episodes of thermal stress but also subsequent to decreasing Na:Cl ratio. Therefore, the balance between sodium and chloride ions can only be achieved using a non-chloride containing sodium source such as sodium bicarbonate.

Numerous studies have been directed towards supplementation of feed and water

with sodium bicarbonate in attempts to help to alleviate the adverse effects of heat stress (5, 6, 22).

The objective of this study was to evaluate dietary NaHCO₃ supplementation effects on some physiological parameters in Hisex Brown layers reared under high environmental temperatures.

MATERIALS AND METHODS

Birds and Housing:

A total of 160 laying hens of Hisex Brown layers, 50 weeks of age were used. All hens were selected randomly (as a group) from a population of birds and housed (2 birds per cage) and divided into four treatment groups, each group contain of 40 birds (20 cages per treatment), and all birds remained in their original cage position, within a closed house with controlled ventilation and lighting. The experiment was carried out from 50 to 54-wk-old hens. The cages unit was fitted with a single feed trough. Water was supplied by shared nipple drinkers. During the experimental period, maximum and minimum house temperatures were recorded daily (Fig.1).

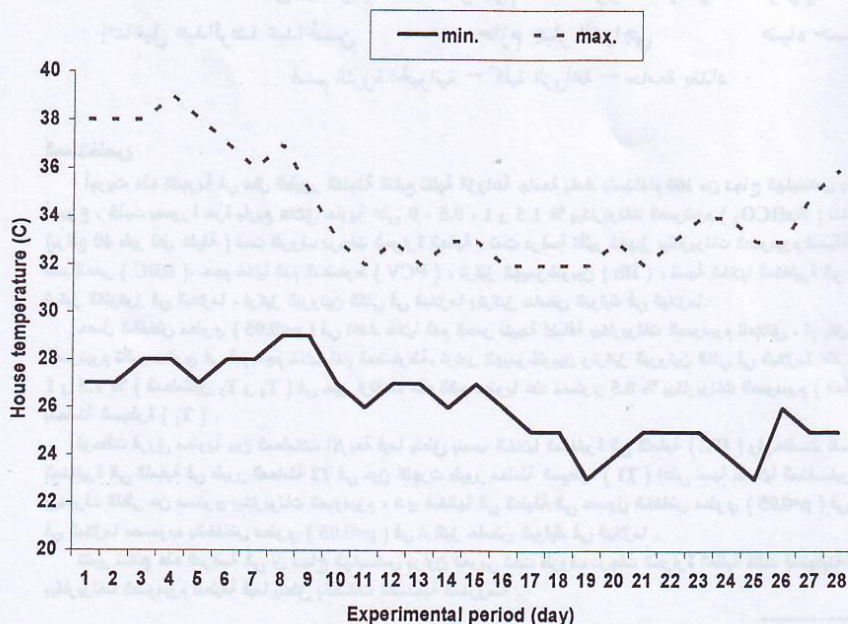


Fig.1. Minimum and maximum house temperatures during the experimental period.

Diets

During the pre-experimental period, hens were fed a laying diet containing 17.5 % protein and 2862 Kcal/kg ME (diet A). Diet A was also included in this experiment as a control diet. The

experimental diets (Table 1) were fed to the treatment groups at random from 50 weeks of age until the termination of the experiment at 54 weeks of age. Three diets (B, C and D) were formulated to

Table 1 . Composition of the experimental diets .

Diets	A	B	C	D
Ingredients, %				
Corn	36	36	36	36
Wheat	36	35.5	35	34.5
Soybean meal (44% protein)	15	15	15	15
Protein concentrate (45% protein)	9	9	9	9
Salt	0.5	0.5	0.5	0.5
Limestone	3.5	3.5	3.5	3.5
Sodium bicarbonate	0	0.5	1	1.5
Total	100	100	100	100
Calculated composition				
Metabolizable energy (kcal /kg)	2862	2846	2831	2815
Crude protein (%)	17.49	17.44	17.39	17.33
Calcium (%)	2.2	2.2	2.2	2.2
Available phosphorus (%)	0.41	0.41	0.41	0.41
Methionine (%)	0.39	0.39	0.39	0.39
Lysine (%)	0.88	0.88	0.88	0.87

contain 0.5, 1 and 1.5% NaHCO₃, respectively. The four treatments: T₁, T₂, T₃ and T₄ were represents A, B, C and D diets, respectively. Feed and water were provided *ad libitum*.

Blood sampling and analytical procedures

Blood samples were taken from the brachial vein of 10 birds from each treatment and were collected into test tubes containing anti-coagulant agent (Potassium EDTA). Blood collection was carried out at 52 weeks of age and repeated at 54 weeks of age. Blood samples were treated as follows: red blood cells (RBC) count, packed cell volume (PCV), hemoglobin (Hb), and heterophil to lymphocyte (H/L) ratio determination were made on subsamples of whole blood, and plasma was separated by centrifuging blood samples for 10 min at 3000 r.p.m. using a Beckman centrifuge. The plasma samples were then stored at -20 C until required for analysis.

RBC counts were determined with the aid of a haemocytometer using the Natt and Herrick diluent (15). The values of PCV and Hb were obtained according to Archer (2) and Varley *et al* (21), respectively. The number of heterophils and lymphocytes was determined by

examining a blood smears which stained with Wright-Giemsa stain according to Shen and Patterson (17) and examined according to Burton and Guion (7). Glucose concentrations (3), total protein (23), and uric acid (11) were measured in plasma.

Statistical Analysis :

Data were analyzed as a completely randomized design based upon four dietary treatments: T₁, T₂, T₃ and T₄. Analysis was performed using the SAS GLM procedure (16). Duncan's new multiple range test was used to determine significant differences between means (19).

RESULTS AND DISCUSSION

Blood picture parameters for the birds of experimental treatments are presented in Table 2. RBC of T₁ birds was significantly (p<0.05) lower than those of other treatments. Also, birds consuming 0.5 % NaHCO₃ (T₂) showed

Table 2. Blood picture traits of Hisex brown layers fed different NaHCO₃ levels under high temperatures (mean ± SE).

Measurements	Treatments			
	T ₁	T ₂	T ₃	T ₄
Red blood cell count, RBC (10 ⁶ /mm ³)	2.45 ± 0.02 ^c	2.74 ± 0.03 ^a	2.53 ± 0.02 ^b	2.53 ± 0.04 ^b
Packed cell volume, PCV (%)	29.78 ± 1.04 ^b	36.50 ± 0.87 ^a	30.39 ± 0.96 ^b	31.22 ± 0.88 ^b
Hemoglobin, Hb (g/100 ml)	8.0 ± 0.41 ^b	11.83 ± 0.58 ^a	9.17 ± 0.47 ^b	9.06 ± 0.65 ^b
Heterophil / lymphocysts, H/L ratio	0.34 ± 0.01 ^a	0.26 ± 0.01 ^d	0.30 ± 0.01 ^b	0.28 ± 0.01 ^c

Values in the same rows having different superscripts are significantly different (p<0.05).

T₁,T₂,T₃ and T₄ means supplementation of diet with 0, 0.5, 1 and 1.5 % sodium bicarbonate, respectively.

that highest RBC count as compared with T₃ and T₄ birds. The observed change in RBC can therefore be attributed directly to the addition of sodium bicarbonate apart from its inclusion rate in the diet. PCV and Hb values of T₂ birds were higher (p<0.05) than those of T₁,T₃ and T₄. PCV and Hb values returned to the control level once the inclusion rate of sodium bicarbonate in the diet increased up to 1 and 1.5%. This result in agreement with that reported by Krista *et al* (14) who demonstrated that a stress-related stimulus has no effect on hemoglobin and hematocrit values. However, the mode of action of sodium bicarbonate in the change of PCV and Hb values under present study conditions has no readily apparent explanation. Significant differences (p<0.05) were observed in the H/L ratio among the four treatments. The lowest H/L ratio occurred in T₂ birds, while T₁ birds experienced the highest H/L ratio (Table 2). The results from this study indicate that the addition of sodium bicarbonate to the diet of laying hens reared under high environmental temperatures at 0.5, 1 and 1.5% caused a reduction (p<0.05) in H/L

ratio. This result may be serve as an indicator on that sodium bicarbonate can help to alleviate the adverse effects of heat stress (10).

All diets except diet T₁ had the same effect on plasma glucose concentrations. They caused a significant (p<0.05) reduction in plasma glucose concentrations accompanied by a significant (p<0.05) reduction in the concentrations of plasma uric acid (Table 3) as compared with control diet. These results are in accordance with our previous laboratory findings on acute heat exposures (1). As presented in Table 3, there was no significant change in concentrations of plasma total protein when the birds were fed T₃ and T₄ diets, whereas, T₂ diet resulted only in a significant increase (p<0.05) in plasma total protein compared to other treatments. The changes in plasma total protein, in birds subjected to heat stress, are not easy to explain since plasma total protein contents are affected by many variables such as increased capillary permeability, increased catabolism or decreased synthesis of protein (9).

Table 3 . Concentrations of glucose, total protein and uric acid in plasma of Hisex brown layers fed different NaHCO₃ levels under high temperatures (mean ± SE).

Measurements	Treatments			
	T ₁	T ₂	T ₃	T ₄
Plasma glucose (mg/100ml)	194.22 ± 2.24 ^a	175.44 ± 2.46 ^b	180.44 ± 2.23 ^b	179.78 ± 2.44 ^b
Plasma protein (g/100ml)	2.68 ± 0.07 ^b	3.00 ± 0.03 ^a	2.76 ± 0.03 ^b	2.77 ± 0.03 ^b
Plasma uric acid (mg/100ml)	10.75 ± 0.28 ^a	7.28 ± 0.33 ^c	8.39 ± 0.33 ^b	8.22 ± 0.48 ^{bc}

Values in the same rows having different superscripts are significantly different (p<0.05).

T₁,T₂,T₃ and T₄ means supplementation of diet with 0, 0.5, 1 and 1.5 % sodium bicarbonate, respectively.

As a result of this study, the following conclusion can be drawn about Hisex Brown layers exposed to high temperatures : (1) under conditions of cyclic heat stress, Hisex Brown layers respond positively to sodium bicarbonate addition, with regard to physiological adjustments; and (2) the use of 0.5% NaHCO₃-containing diet was sufficient to induce a favorable abrupt change in all physiological parameters studied.

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