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The Effect of Different Intervention Strategies to Alleviate Heat Stress on Behavior, Performance and Some Blood Parameters of Growing Muscovy Ducks

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Key words: Heat stress, Muscovy ducks, Behavior, Welfare.

ABSTRACT

An experiment was conducted to investigate the effect of heat stress on growing Muscovy ducks during summer season and some strategies to alleviate its adverse effect. Nutrition strategies as addition of ascorbic acid and sodium bicarbonate to feed and welfare improvements as swimming access were assed against heat stress. Forty eight (seven week old) Muscovy ducks randomly allotted into four equal groups; heat stressed group (HS) without any supplementation, ascorbic acid (AA), sodium bicarbonate (NaHCO3) group and swimming access (SWIM). The results revealed that the swimming access significantly improved Muscovy duck welfare by improving body care behavior (preening, head shake, body shake and ruffling) and significantly increased the standing behavior and reduced crouching percent. Results also showed significant reduction in blood corticosterone level and (heterophils/ lymphocyte) H/L ratio for swimming access than other groups. While, swimming access group had significant reduction in relative growth rate than control one.

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1. INTRODUCTION

Thermal stress is one of the most important environmental stressors challenging the poultry production worldwide, as continuous change in global climate lengthens of hot season and increase the geographic area affected by high temperature **(Hansen et al. 2010) .** Also continuous selection for high production will generate more heat which needs to be dissipated.

Thermo neutral zone is the temperature at which the birds can loss heat in controlled rate using normal behavior and body temperature is constant. The optimal room temperature of ducks ranged from 10 to 15ºC (Huang et al. 2008). Birds will suffer from heat stress when heat production becomes greater than the maximum heat loss and birds cannot control their body temperature, thus a welfare problems exists and birds may die (Emery, 2004).

Heat stress had a negative impact on animal behavior and welfare, that bird under heat stress has more laying time to reduce the heat generated from movement, less preening and increased frequency of panting and spread of wing (Pereira et al. 2007 and Ma et al., 2014). Panting is one of heat loss mechanisms by evaporative cooling resulted in loss of carbon dioxide and respiratory alkalosis, which can be prevented by 0.25-0.5 % $NaHCO_3$. Water supply is necessary for ducks for water directed behavior also to thermorgulate their body and fulfillment of their welfare (Suswoyo and Sulistyawan, 2014: Van Der Meulen and Den Dikken, 2004).

Nutritional strategies aimed to alleviate the negative effect of heat stress by maintaining feed intake and water balance or by supplementing micronutrient such as vitamins (A, C & E) and mineral (Sodium bicarbonate, ammonium chloride & sodium carbonate) to satisfy the special needs during heat stress (Lin et al. 2006)

The aim of this work was assess ascorbic acid and sodium bicarbonate supplementation as well as swimming access to overcome heat stress effect on behavioral patterns, production performance, Serum Corticosterone level and heterophil lymphocyte ratio

2. MATERIAL AND METHODS

All the procedures of this study were carried out using the facilities belonging to Department of Animal Husbandry and Animal Wealth Development ,

Faculty of Veterinary Medicine, Alexandria University during summer season from August to September (maximum temperature was 33ºC ± 0.5 and the minimum temperature was 25ºC ± 0.5) with relative humidity 50-70 % for the three weeks of the experiment.

2.1. Birds

Forty eight (seven weeks old) Muscovy ducks were randomly allotted into four equal groups. HS group that exposed to heat stress condition, AA group was supplied by 500 mg/kg diet ascorbic acid, NaHCO3 group was supplied by 250 mg/kg diet sodium bicarbonate and SWIM group was supplied by swimming pool of 2×0.5m

2.2. Management and cleaning

The birds were housed in a clean and well-ventilated house. Day to day management was carried out for keeping facilities clean. Water and feed were supplied *ad-libitum* throughout the experiment. Crude protein and metabolizable energy was 19 % and 2900 kcal. All birds were apparently healthy and were vaccinated against Avian Influenza with a 0.5 ml subcutaneous at the 9th day old.

2.3. Behavioral observation

Behavioral observations were started when the birds were seven weeks old and extended up to ten weeks old with infrared digital cameras using scan system (Mahrous, 1993). Day / Night period (24hrs.) was divided into four periods 6hr. each. Recording the number of birds performing a particular behavioral pattern was determined into a check sheet. For every behavior pattern, data was expressed as percentages (number of individual birds performing the behavior)

2.4. Productive performance

2.4.a. Live body weight & Relative weight gain

Ducks were identified by leg band and weighted individually every week from 7th to the 10th week of age. The relative weight gain (RGR%) was calculated with the following formula for both male and female according to **Broody cited Lopez et al. (2000)**

$$RGR\% = \frac{w2 - w1}{(w1 + w2)/2} \times 100 = \ \%$$

2.4.b. Blood parameter

At the 2^{nd}, 4^{th}, 10^{th} and 21st days from the onset of the experiment, four blood samples were collected from wing vein from each group in clean weatherman tube then centrifuged at 3000 rpm for 10 minute to separate serum and preserved under (-20ºc) for analysis of corticosterone hormone. Plasma corticosterone concentration was measured on the principle of photometric detection using a commercial corticosterone enzyme Immunoassay Kits. At the end of the experiment another blood sample were collected from 6 birds from each group (3 male and 3 female) via slaughtering in clean sterile heparinized tube in order to measure heterophilis / lymphocyte (H/L) count. The blood smears were prepared by Giemsa stain.

2.5. Statistical analysis

The results in this experiment were expressed as means ± SE. the difference between group means was assessed by analysis of variance (ANOVA) and DUNCAN test by SAS, Software 2004.

Statistical model $X_{ij} = \mu + t_i + e_{ij}$

Where:

X_{ij} = observed data μ = population mean

t_i = treatment effect (HS,AA, $NaHCO_3$ and SWIM)

e_{ij} = random error.

3. RESULTS AND DISCUSSION

3.1. Behavioral observation

Results in Figure (1, 2a,b) showed the effects of HS, AA, NaHCO3, SWIM on Muscovy duck behavior; Feeding behavior non-significantly affected by such strategies. However, NaHCO3 group showed significant increased drinking behavior (9.95%) than HS one (6.97%). There was shifting in feeding behavior to be maximum during night and morning than afternoon. In contrast, drinking behavior was the maximum during evening. These results supported by the finding of Mahmoud, (2010); Lara and Rostagno (2013) who found that electrolytes supplementation in diet stimulate water consumption, also agreed with Suswoyo and Sulistyawan, (2014) whoes found that there was no effect of swimming access on feeding behavior during heat stress. On the other hand; Ahmed and Sarwar (2005); Kutlu and Forbes (1993) concluded that 250mgeq/ kg from dietary electrolytes base sodium bi carbonate and ascorbic acid supplementation increased feed intake.

SWIM had significant increase in standing behavior and significant decrease in crouching behavior (6.67 & 67.04%) than HS (3.47 & 75.35 %) while AA had non-significant increase in walking activity (4.66%) than HS (4.34%). Meanwhile, NaHCO3 significantly

decrease walking and standing and significant increase crouching percentage (2.95, 3.03 & 75.60%, respectively). These results are in agreement with Bonzakova et al. (2012); Mack et al. (2013) who concluded that heat stressed birds spend less time walking and standing with more time crouching.

SWIM was significantly improved body care behavior (preening, head shake, body shake, ruffling and tail wag) (18.58, 3.00, 1.93, 1.51 & 6.94%, respectively) than HS (16.96, 1.96, 1.14, 0.77 and 6.40%, respectively). In contrary, the NaHCO3 supplementation had the lowest percent of body care behavior (13.47, 1.09, 0.94, 0.74 & 4.86%, respectively) while AA group had nonsignificant increase in body care behavior (17.34, 1.96, 1.46, 1.19 & 7.07%, respectively). Panting behavior was not significantly affected by different strategies; however, it was maximum during afternoon (15.33%) and minimum during night (0.1%). These results are in agreement with Nikolova, (2010); Ma et al. (2014); Suswoyo and Sulistyawan (2014) who conclude that the swimming access during heat stress improved the body care behavior and heat stressed bird show less body care behavior.

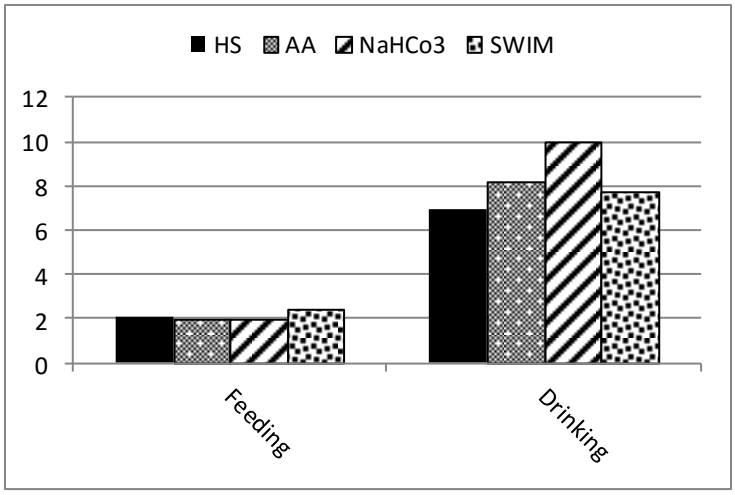

Fig. (1) Effect of heat stress (HS), ascorbic acid (AA) sodium bicarbonate ($NaHCO_3$) and swimming access on ingestive behavior of Muscovy ducks.

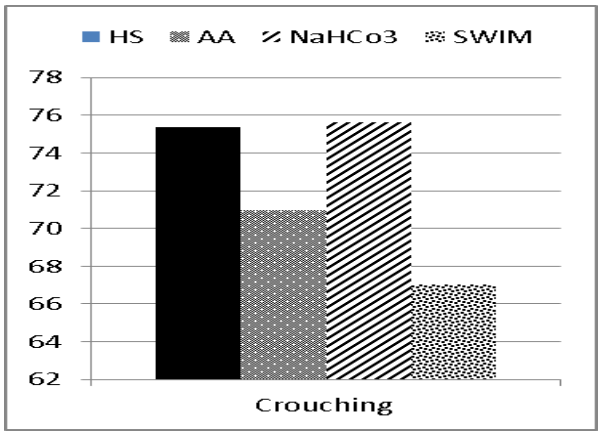

Fig. (2a) Effect of heat stress (HS), ascorbic acid (AA), sodium bicarbonate ($NaHCO_3$) and swimming access on resting behavior of Muscovy ducks

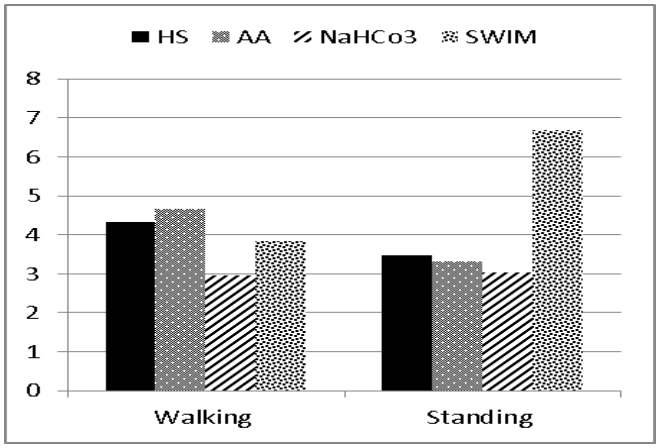

Fig. (2) Effect of heat stress (HS), ascorbic acid (AA), sodium bicarbonate ($NaHCO_3$) and swimming access on movements activity of Muscovy ducks

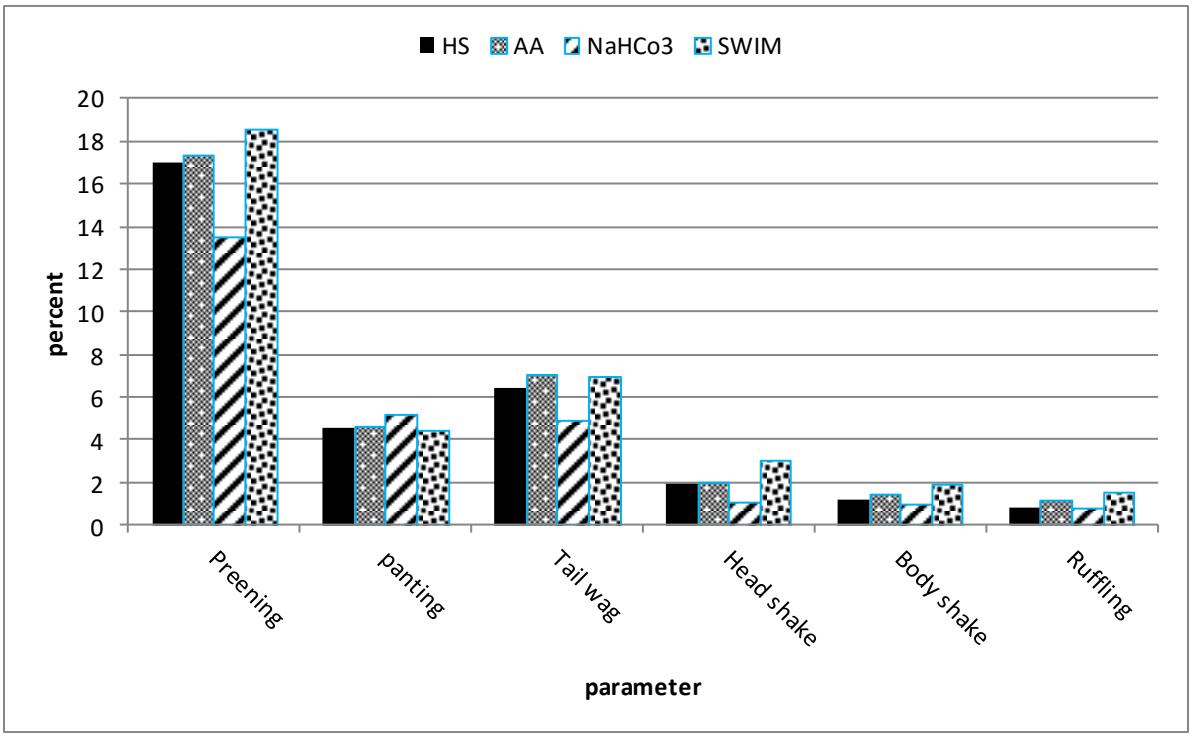

Fig (3). Effects of heat stress (HS), ascorbic acid (AA) sodium bicarbonate ($NaHCO_3$) and swimming access(SWIM) on body care behavior percent of Muscovy ducks

3.2. Production performance:

Table (1) showed that at the end of the experiment HS males showed significant increase in body weight (4.63 kg) than AA, NaHCO3 and SWIM (4.13, 4.04 & 4.15 Kg; respectively). However, the final body weight of female was higher in AA and NaHCO3 was the same (2.62kg) than HS and SWIM (2.54& 2.30 kg), On the other hand, mixed sex had no significant difference between treatments. The obtained results were supported by Lai et al. (2003) and Huang et al. (2008) who found that the body weight was significantly decreases during heat stress. Also, ascorbic acid supplementation did not increase the body weight of heat stressed birds. Moreover, Balnave and Gorman, (1993) reported that sodium bicarbonate supplementation improved body weight and did not appear to be related to water retention in the body.

Table (2) revealed that by the end of experiment the body weight was decreased so that the relative growth rate (RGR) had negative value for all treatments (AA, NaHCO3 & SWIM) and recorded (-5.34, -8.64 & -5.24 %; respectively) except control group proceeded in their weight gain and RGR (6.08 %). RGR of male at the end of experiment was significantly higher in HS (36.86%) than NaHCO3 and SWIM (20.99 & 20.29%) while AA had non-significant decrease from HS. On the other hand RGR of females in SWIM significantly decreased (-0.73%) than HS, AA and NaHCO3 (12.24, 12.23, 12.66 %, respectively). Moreover, mixed sex recorded significant ($P < 0.05$) decrease in SWIM (9.78%) than these of HS and AA (22.50 & 19.94%) while NaHCO3 had nonsignificant decrease (16.82%) than HS and AA. These results disagreed with the finding of Ahmed and Sarwar, (2005); Mohammed et al. (2015) and Ali et al. (2010) the mentioned that ascorbic acid supplementation and sodium bicarbonate improved RGR of birds. Moreover, Puron et al. (1994); Bottje and Harrison, (1985) and Whinting et al. (1991) who found insignificant results due to ascorbic acid and sodium bicarbonate supplementation on feed efficiency, growth performance, weight gain, feed conversion and mortality rate. In contrast to Smith and teeter, (1987) who reported improvement in weight gain, feed conversion and survival due to sodium bicarbonate supplementation.

Table 1: Means and their stander error of the effect of heat stress on body weight of Muscovy ducks.

Items		W0	W1	W2	W3
Effect of treatments					
	Control	2.65b ± 0.15	3.11 ± 0.22	3.39b ± 0.26	3.41 ± 0.32
	Vit. C	2.72ab ± 0.14	3.12 ± 0.21	3.54ab ± 0.25	3.38 ± 0.24
	NaHCo3	2.78ab ± 0.15	3.21 ± 0.19	3.60a ± 0.25	3.33 ± 0.23
	Swimming	2.85a ± 0.16	3.20 ± 0.21	3.55ab ± 0.25	3.23 ± 0.29
effect of sex (treatments)					
Males	Control	3.21 ± 0.06	3.95 ± 0.08	4.36 ± 0.14	4.63a ± 0.15
	Vit. C	3.13 ± 0.11	3.77 ± 0.11	4.36 ± 0.1	4.13b ± 0.1
	NaHCo3	3.26 ± 0.09	3.84 ± 0.07	4.40 ± 0.08	4.04b ± 0.14
	Swimming	3.38 ± 0.07	3.89 ± 0.06	4.37 ± 0.06	4.15b ± 0.13
Females	Control	2.25 ± 0.04	2.51 ± 0.06	2.70 ± 0.07	2.54ab ± 0.06
	Vit. C	2.32 ± 0.05	2.47 ± 0.07	2.72 ± 0.06	2.62a ± 0.09
	NaHCo3	2.30 ± 0.06	2.58 ± 0.06	2.79 ± 0.05	2.62a ± 0.10
	Swimming	2.32 ± 0.04	2.51 ± 0.06	2.73 ± 0.04	2.30b ± 0.10

Means within the same column of the same category carrying different superscripts are significantly different ($p<0.05$).
W0= 7 weeks old Muscovy ducks. W1= 8 weeks old Muscovy ducks.
W2 = 9 weeks old Muscovy ducks. W3= 10 weeks old Muscovy duck.

Table (2) Means and their stander error of the effect of heat stress on relative growth rate (RGR) of Muscovy ducks.

RGR	Treatments	N	Male	N	Female	N	Over all
			$\overline{X}$ ± SE		$\overline{X}$ ± SE		$\overline{X}$ ± SE
RGR1	HS	5	20.72^{a} ± 1.82	7	11.22 ± 1.17	12	15.18 ± 1.71
	AA	6	18.87^{ab} ± 1.31	6	6.51 ± 4.08	12	12.69 ± 2.76
	NaHCO3	6	16.35^{ab} ± 1.98	6	11.69 ± 1.34	12	14.02 ± 1.34
	SWIM	6	14.28^{b} ± 0.71	6	8.17 ± 1.22	12	11.23 ± 1.14
RGR2	HS	5	9.70^{b} ± 1.41	7	6.98 ± 0.74	12	8.12^{b} ± 0.8
	AA	6	14.56^{a} ± 1.19	6	9.59 ± 1.38	12	12.08^{a} ± 1.15
	NaHCO3	6	13.65^{ab} ± 0.88	6	8.03 ± 0.77	12	10.84^{a} ± 1.01
	SWIM	6	11.47^{ab} ± 1.91	6	8.37 ± 1.37	12	9.92^{ab} ± 1.21
RGR3	HS	5	6.08^{a} ± 2.29	7	-5.85^{a} ± 3.14	12	-0.88^{a} ± 2.66
	AA	6	-5.37^{b} ± 3.35	6	-3.86^{a} ± 2.54	12	-4.61^{ab} ± 2.02
	NaHCO3	6	-8.64^{b} ± 3.67	6	-6.86^{a} ±2 .11	12	-7.75^{b} ± 2.04
	SWIM	6	-5.24^{b} ± 3.81	6	-17.44^{b} ± 3.83	12	-11.34^{b} ± 3.16
TRGR	HS	5	36.86^{a} ± 3.47	7	12.24^{a} ± 2.29	12	22.50^{a} ± 4.11
	AA	6	27.66^{ab} ± 4.12	6	12.23^{a} ± 5.01	12	19.94^{a} ± 3.87
	NaHCO3	6	20.99^{b} ± 4.98	6	12.66^{a} ± 2.64	12	16.82^{ab} ± 2.96
	SWIM	6	20.29^{b} ± 2.89	6	-0.73^{b} ± 3.74	12	9.78^{b} ± 3.89

Means within the same column of the same category carrying different superscripts are significantly different ($P < 0.05$).
RGR1 = the relative growth rate from 7^{th} to 8^{th} week old. RGR2= the relative growth rate from 8^{th} to 9^{th} week old.
RGR3= the relative growth rate from 9^{th} to 10^{th} week old. TRGR= Total relative growth rate from 7^{th} to 10^{th} week old.

Table (3): Means and their stander error of the effect of heat stress on body temperature of Muscovy ducks.

Treatments	Body temperature
HS	$41.37^{ab} \pm 0.12$
AA	$41.57^{a} \pm 0.12$
$NaHCo_3$	$41.59^{a} \pm 0.13$
SWIM	$41.16^{b} \pm 0.09$

Means within the same column carrying different superscripts are significantly different ($P < 0.05$).

3.3. Body temperature

Swimming access group had significantly decreased body temperature (41.16ºC) than control group (41.37 ºC) while the ascorbic acid and sodium bicarbonate had non-significant increased body temperature (41.57 & 41.59 ºC) than control (Table 3). these results agreed with Huang et al, (2008) & Suswoyo and Sulistyawan, (2014) who concluded that swimming access significantly decreased the body temperature. However, Ahmad and Sarwar, (2005) mentioned that sodium bicarbonate supplementation significantly decreased body temperature **.**

3.4. Blood parameters

3.4. a. Differential leukocytic count

the differential leukocytic count (fig. 4) had significant increase in heterophil/ lymphocyte (H/L) ratio in AA group of males, females and mixed sex (1.63, 1.48 & 1.57, respectively) than SWIM (0.15, 0.39 & 0.27, respectively), control group (0.21, 0.47 & 0.34, respectively) and NaHCO3 group (0.44, 0.38 & 0.41, respectively). These results disagreed with those of Minka and Ayo, (2008); Prieto and Compo, (2010) & Sayed and Downing, (2011) who found that AA & $NaHCO_3$ significantly decreased H/L ratio and significant increase in heat stressed group.

3.4. b. Blood corticosteroids

Blood corticosterone level (fig. 5) during the 2nd and 4th day of experiment had no significant difference between treatments. But at the 10th day SWIM had significant decrease in blood corticosterone level (3.23 ng/ml) than HS (8.40 ng/ml). At the end of the experiment SWIM and NaHCO3 recorded significant decrease in blood corticosterone level (2.5 & 4.58 ng/ml) than control (12.48 ng/ ml) this results supported by Quinteiro-Filho et al. (2012); Ma et al. (2014) & Mohammed et al. (2015) who reported that heat stress significantly increased blood corticosterone level while swimming access significantly reduced blood corticosterone level.

It was concluded that swimming access significantly improved body care behavior (preening, head shake, body shake and ruffling) and increase the standing behavior but reduced crouching percentage with significant reduction in blood corticosterone level. However, it had significant reduction in relative weight gain than heat stressed group.

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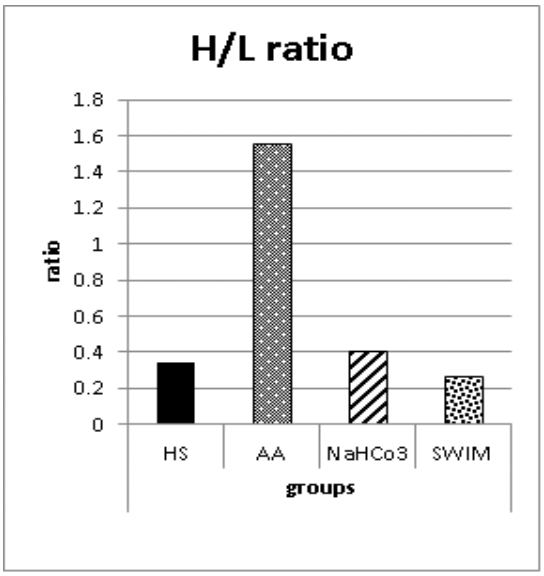

Fig (4) Heterophil / lymphocyte (H/L) ratio of Muscovy ducks under heat stress ascorbic acid (AA), sodium bicarbonate ($NaHCO_3$) and swimming access (SWIM) at the24th day of experiment (end of the experiment).

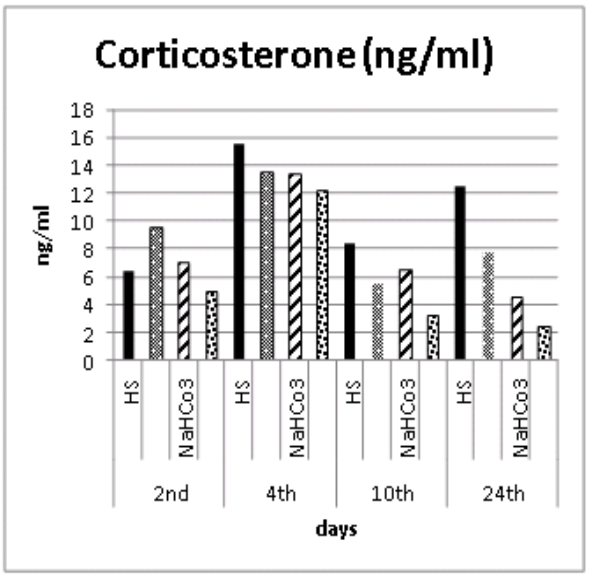

Fig (5) Serum corticosteron level of Muscovy ducks under heat stress, ascorbic acid (AA), sodium bicarbonate (NaHCO3) and swimming access at the 2nd , 4th , 10th and 24th day of experiment.

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