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PHYSIOLOGICAL RESPONSE AND ACID-BASE BALANCE OF EGYPTIAN BUFFALO AS RELATED TO SEASONAL CONDITIONS

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SUMMARY

Six buffalo heifers aging about 2.5 years and weighing 240-345kg at the beginning of the study were used to compare the physiological response (respiration rate, rectal temperature, serum bicarbonate and haemoglobin concentrations and haematocrit) in relation to acid-base balance under natural climatic conditions in winter and summer. All the previous parameters were measured twice daily at 08.00 morning and 12.00 noon during each season where blood samples were collected at that times. Ambient temperature and relative humidity were recorded simultaneously.

Haemoglobin concentration and haematocrit percentages were lower in summer than in winter (8.5 and 30.5 vs. 9.4 and 35.8, respectively). On the other hand a contradictory trend was observed concerning respiration rate, body temperature and serum bicarbonate, (38.3, 37.4 and 20.7 for winter vs. 42.6, 37.9 and 30.1 for summer, respectively). Bicarbonate concentration in the peripheral blood was 1.5 times higher in summer than in winter. The time of the day had an obvious effect on the physiological function since, body temperature and respiration rate were higher at 12.00 noon than the corresponding values of 08.00 morning in both seasons.

The difference between the morning and noon values of respiration rate, rectal temperature and serum bicarbonate was greater in summer than in winter. An opposite trend was observed for haemoglobin concentration and haematocrit percentage.

Keywords: Buffalo, seasons, acid-base, bicarbonate store.

INTRODUCTION

Maintenance of the acid-base balance in the body is an impressive illustration of homeostasis. Animal body is subjected to continuous acidic and basic stresses. Recovery of the optimal acid-base balance has a great importance due to its influence on the normal body biochemical reactions by intracellular enzymes which function optimally within narrow range of pH.

Maintenance of blood pH is controlled by many different systems of the body (e.g. respiratory, urinary and digestive systems). These systems have also a vital role in maintaining the normal cation-anion composition of the body (Habashy, 1985; Ashmawy, 1987 and 1994; and Shafie et al., 1994).

Stress of high ambient temperature and humidity cause a pronounced deviation of blood pH and body temperature out of the normal limits. These factors have a negative effect on acid-base balance due to the increase of respiration rate to maximize heat dissipation by water vaporization. Such stress has a great effect particularly on buffaloes which depend mainly on the activity of respiratory system (panting) for heat dissipation (Shafie, 1958). High pulmonary ventilation rate is accompained by depletion of large quantity of carbone dioxide and consequently results in an increase in blood pH (respiratory alkalosis). This leads to a modulation in body systems to keep the physiological functions in the proper level and to lessen the changes in the internal environmental elements.

The extent of the effect of high temperature, either due to season or day time change, on the acid-base balance is not still well known, particularly in buffaloes.
Accordingly, the present study was planned to compare the physiological response of buffaloes to climatic changes during winter and summer sesons.

MATERIALS AND METHODS

This work carried out in the Animal Physiology Laboratory, Animal Production Department, Faculty of Agriculture, Cairo University in winter (December and January) and summer (July and August) seasons.

Six Egyptian buffalo heifers weighing 240-345 kg and aging 2.5 years were used in this study. Heifers were fed on concentrate ration (6 kg/head/day), and roughage of an equal mixture of Egyptian clover (*Trifolium Alexandrinum*) hay and rice straw *ad libitum*. The concentrate ration was composed of, undecorticated cotton seed cake, rice bran, yellow corn, limestone and common salt plus molasses. The nutrients contents were approximatly 16% crude protein, 15% crude fiber and 3% crude fat. Animals were housed in a semi-open yard and kept were under shed all the day time . Blood samples were collected twice daily at 08.00 a.m and 12.00 at noon via the jugular vein. One hundred twenty blood samples were collected from the experimental animals in each season (6 heifers x 5 weeks x 2 times/wk x2 times/day).

Each sample was divided into two parts, the first was kept without adding any anticoagulant material under a layer of liquid paraffin oil to avoid any loss of CO_2. This portion of the sample was centrifuged at 3000 rpm/min for 30 minutes for serum separation . Serum bicarbonate was determined according to the titration method of Van Slyke (1922). The second part of the blood samples was collected in to heparinize tubes to determine the haemoglobin concentration (g/d) and haematocrit percentage. Haemoglobin (Hb) was determined colourimetrically according to the procedure described by Bauer (1970). Haematorit (Ht) was determined by microhaematocrit centrifuge at 1200 rpm for 5 minutes. Respiration rate (R.R., flank movement) and rectal temperature (R.T.,°C) were recorded simultaneously at the blood sampling time . Data were analyzed according to the factorial design considering season and time of the day as the main effects, by SAS package (1990). Differences among means were tested accoding to Duncan (1955).

RESULTS AND DISCUSSION

The average of ambient temperature and relative humidity during winter and summer at day time of testing are presnted in table (1).

1) Physiological reactions of heifers:

a) Body temperature and respiration rate:

Body temperature and respiration rate were increased significantly ($P<0.01$) in summer than in winter (Table 2 and Figur 1). Such trend was also obserbed at noon of each season compared to the morning time. However, the difference in respiration rate between noon and morning was more pronounced in summer than in winter (10.2vs. 3.3 breath/min)., the difference in body temperature was simlar (0.6°C). Shebaita et al. (1993) noted that when the Egyptian buffaloes were exposed to ambient temperature above the thermoneutral zone, the respiration rate was the first reaction occurred. Also, Igono and Aliu (1982) indicated that respiratory rate was significantly increased in Friesian crosses during the hot-humid season than in Zebu while rectal temperature did not differ significantly between seasons in both genotypes. On the other hand, Chikamune (1968) found that the rectal temperature of the buffaloes and Holsteins remained almost constant at an ambient temperature ranging between 20 and 35°C. Above 35°C, the increase of ambient

Table (1): Means ± S.E. of ambient temperature and relative humidity at time of testing the physiological response of the animals.

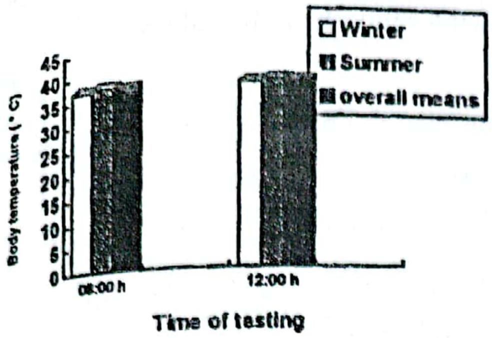
Item \ Time	08.00 h		12.00 h	
	Winter	Summer	Winter	Summer
Relative humidity (%)	68.1±0.09	69.4±0.09	68.6±0.06	69.2±0.11
Ambient temperature (°C)	15.8±0.25	25.5±0.24	19.8±0.18	31.4±0.54

Table (2): Season effects mean ± S.E. on physiological and haematological reactions of Egyptian buffaloes.

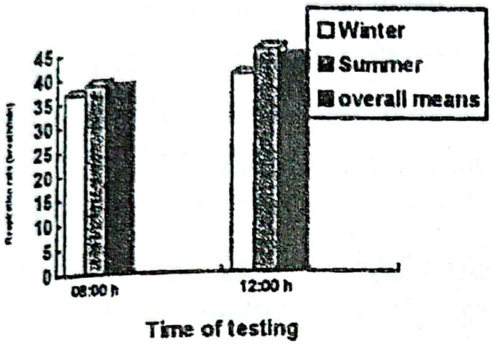
Seasaon	Item \ Diurnal time	08.00h	12.00h	Overall mean ± S.E.
Winter	**Physiological reaction**			
	Body temperature (°C)	37.1±0.07 [a]	37.7±0.017 [b]	37.4±0.06 *
	Respiration rate (breath/min).	36.6±0.65 [a]	39.9±0.64 [b]	38.3±0.48**
	Bicarbonate (m.mol/l)	20.5±0.24	20.9±0.21	20.7±0.16**
	Haematological reaction			
	Haematocrit (%)	37.0±0.41 [a]	34.7±0.52 [b]	35.8±0.35**
	Haemoglobin (mg/dl)	9.6±0.16 [a]	9.1±0.16 [b]	9.4±0.12**
Summer	**Physiological reaction**			
	Body temperature (°C)	37.6±0.12 [a]	38.2±0.15 [b]	37.9±0.07*
	Respiration rate (breath/min)	38.5±0.82 [a]	46.7±1.12 [b]	42.6±0.79
	Bicarbonate (m.mol/l)	30.8±0.50	29.5±0.62	30.1±0.40
	Haematological reaction			
	Haematocrit (%)	31.4±0.48 [a]	29.6±0.48 [b]	30.5±0.35
	Haemoglobin (mg/dl)	8.7±0.13 [a]	8.3±0.14 [b]	8.5±0.10

* Each mean represents 60 observations (10 for each animal).
** Difference between the corresponding values within each column is significant at 1% level.
a,b: Difference between the corresponding values within each row is significant at 1% level.

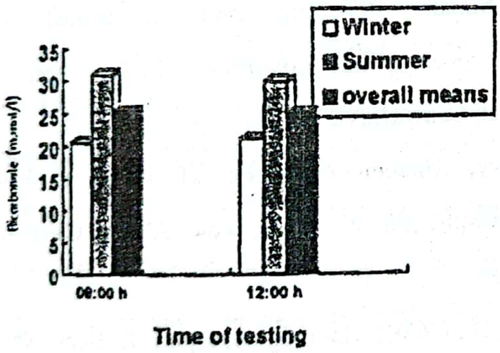
temperature was positively correlated with the rectal temperature in both species. The change in respiration volume of the buffaloes was affected at ≥30°C ambient temperature reaching the maximum value (98.5 1/min) at 40°C. He also observed a similar pattern for the respiration volume of the Holstins which reached a value of 149 1/min at 40°C. In the present study, respiration rate was insignificatly greater in summer than in winter (Table 2). Which agrees with the finding reported by Vercor et al. (1985) in buffaloes.



(a)

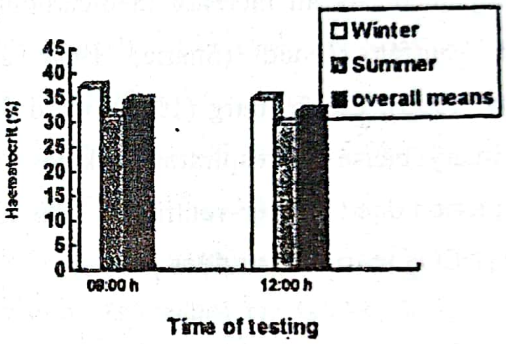


(b)

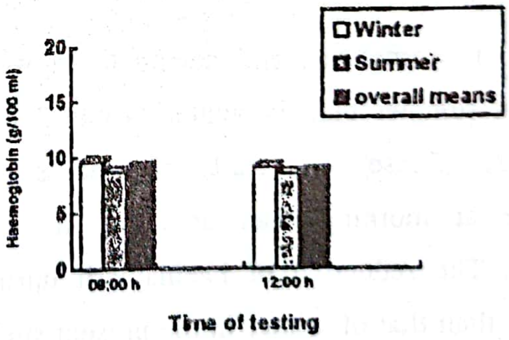


(c)

Fig.(1) Physiological reactions of heifers a) Body temperature, b) Respiratory rate and c) Serum bicarbonate as affected by season of the year and time of the day.



(a)



(b)

Fig. (2): Haematological reactions of heifers a) Haematocrit and b) Haemoglobin as affected by season of the year and time of the day.

B) Serum bicarbonate:

Serum bicarbonate concentration was affected by season. The change was more obvious in summer than in winter (Table 2) and this pattern of response coincided with the increase in ambient temperature (Figure 1). This causes a reduction in haemoglobin and haematocrit, thus leading to a comparable increase in plasma bicarbonate. The higher values of bicarbonate during summer than those of winter could be attributed to the elevated ambient temperature which induced decrease in respiration rate. This is accompained by an increase in bicarbonate store in buffalo blood (Shafie, 1958 and Upadhay, 1993). Clearenburg (1992) noted that the primary cause of respiratory alkalosis is CO_2 depletion due to hyper-ventilation. The rate of HCO_3 / CO_2 increase, as does pH.

2) Haematological reactions:

Values of haematocrit and haemoglobin were lower in summer than in winter (Table 2 and Figur 2). These two traits showed slight increase at morning than at noon in both seasons. The reduction of haematocrit during summer than that of winter in the present study might be due to a haemodilution effect by the consumption of large amount of water in order to supply water for evaporative cooling of the body. Moustafa et al. (1977) reported a reduction in circulating erythrocytes during summer, while a higher count was recorded during winter months in buffaloes.

From the results obtained it could be concluded that there were seasonal variations for the studied physiological and haematological parameters, which suggest that high ambient temperature causes more deviation beyond normal limits in certain blood constituents (HCO_3, haemoglobin and haematocrit) and in thermo-respiratory response (body temperature and respiration rate) which cause disturbances is acid-base balance in the body.

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