PHYSIOLOGICAL RESPONSES IN EGYPTIAN BUFFALO HEIFERS AND BUFFALO COWS EXPOSED TO SOLAR RADIATION

Mona A. El-Khashab
Faculty of Agriculture, Department of Animal Production, Fayoum University, Fayoum, Egypt.

ABSTRACT

Five buffalo heifers (1.5–2 years old) and 7 non lactating non pregnant buffalo cows (4 – 5 years old) weighed 214.7 ± 11.3 and 471.4 ± 12.8 Kg, respectively were exposed to direct solar radiation for a 5 hrs. period from 10.00 am. to 15.00 pm. day after day along August month. All the parameters under study were taken twice daily, in the morning at 8-9 am and after exposure to solar radiation for each animal.

Rectal temperature (RT), respiration rate (RR), pulse rate (PR), hematological parameters, serum total protein, Albumin, globulin, sodium (Na^+), potassium (K^+), chloride (Cl^-), liver enzymes (AST and ALT U/L), serum cortisol level, total body fluid (TBF), extracellular fluid (ECF), intracellular fluid (ICF), interstitial fluid (ISF), dry body weight (DBW), plasma volume (PV) and blood volume (BV) were determined.

Significant increase (P<0.01) in RT, RR and pulse rate, after exposure to sun ray, the increase of RR were 406.7% for heifers and 410.7% for buffalo cows. Pulse rate was increased by 32.62% for heifers and 35.37% for buffalo cows. Total protein and albumin significantly decrease in stressed animals. Exposure to sun ray caused increase in liver enzymes, Na, K, and Cl concentration in buffalo cows. Cortisol level was significantly increased (P<0.01) by 51.33% in buffalo heifers and by 44.19% in buffalo cows. Solar radiation caused a loss in DBW which was 28.56% in heifers and 30.05% in buffalo cows.

Exposure to solar radiation increased significantly (P<0.05 and P<0.01) absolute and relative total body fluids to body weight, extracellular fluid ml/ Kg BW, absolute and relative intracellular fluid and interstitial fluid ml/ Kg BW, while insignificant increase was found in ECF,L and ISF, L in both buffalo heifers and buffalo cows.

The absolute value of PV increased significantly (P < 0.01) by 68.82% after exposure to direct solar radiation in buffalo cows, while plasma volume insignificantly increase after heifers exposed to solar radiation. There is significantly (P < 0.05) increase of BV due to exposed to solar radiation by 7.88 % in buffalo cows.

Key words: Buffalo, Solar Radiation, Physiological Response, Body Fluids.

INTRODUCTION

The subtropical zone is characterized by intensive insulation. Direct solar radiation may reach up to 800KC/ m^2 /hr (**Kamal, *et al.*, 1993**). Due to the limited cultivated land of the Nile valley, which occupies 3% of the total territory of Egypt, the only available land for the expansion of animal production is the desert (**Kamal, *et al.*, 1993**). It was established that the solar radiation is an effective factor of climatic conditions which affect the animal productivity.

Buffaloes were more hyperthermic when exposed to direct solar radiation. The direct exposed of buffaloes to sun ray for two hours in August mid-day caused an increase of nearly 4% in body temperature, respiration rate was augmented to three folds and pulse rate rised by 30% (**Shafie 1993, Ashmawy 1998**). Exposure to solar radiation cause more deviation beyond normal limits, in certain blood constituents of animals. However the heat tolerant animals, show insignificant changes in the blood picture in the face of high ambient temperature and solar radiation stress (**Ashmawy 1998**). It is well known that the exposure to solar radiation exerts a marked influence on the metabolism, protein fraction, liver enzymes, body and vascular fluids of animals (**Ashour and Shafie 1993 and El- Masry *et al.*, 2001,**). A number of workers has demonstrated that buffaloes are adversely affected by direct solar radiation due to their blank or blackish color and sparse hair coat (**Alim and Ahmed, 1957 and Shafie 1993**). The mechanism responsible for the changes in body and vascular fluids during exposure to solar radiation has not been determined and the information about this mechanism specially about buffalo heifers is rare. The objectives of the present study were to determine the effects of direct exposure to solar radiation of hot summer conditions on some thermo-cardio respiratory parameters, haematocrite and hemoglobin, serum constituents, cortisol level, body and vascular fluids volume of buffalo heifers and non lactating non pregnant buffalo cows.

MATERIALS AND METHODS

Experimental Animals and Procedure:

The experimental work was carried out in the Experimental Station of the Department of Animal Science, Faculty of Agriculture at El-Fayoum University, on 5 buffalo heifers and 7 non lactating non pregnant buffalo cows. Heifers were 1.5 – 2 years old and were 214.7 ± 11.3 Kg body weight, while the buffalo cows were 4-5 years and were 471.4± 12.8 Kg body weight. The experiment was conducted during the summer season in August month. Relative humidity and air temperature during the experimental period averaged 68.2 ± 4.9 % and 35.1 ± 4.5 °C respectively in shade condition and 61.9 ± 5.4 % and 40.1 ± 3.4 °C respectively under solar radiation condition. The animals were exposed to sever hot conditions of direct solar radiation for a 5 hrs. period from 10:00 am to 15:00 pm. during day after day to avoid the effect of the pervious exposure on the next exposure. The animals were kept during the rest day under shade. All the parameters under study were taken twice daily within the day of exposure, in the morning at 8-9 am and after exposure to solar radiation for each animal.

Feeding Animals:

The daily feed requirement was calculated for animals according to the body weight in reference to **NRC (1988)**. The animals were fed on clover hay along with concentrate mixture and wheat straw. The water provide three times daily.

Methods of Determinations:

Thermo- cardio- respiratory parameters were recorded for each animal. Rectal temperature (RT°C) was measured using a standard clinical thermometer inserted into the rectum approximately three inches after one minute the measurement was recorded to the nearest 0.1 °C. Respiration rate (RR/min) was counted from movements of flank in one minute using stop watch. Pulse rate (PR/min) was taken by placing the hand gently on the coccygeal artery and counting the pulse for a minute.

Blood samples were taken from the jugular vein for each animal after fasting 12 hr. in two test tube, one of them with anticoagulant and the other without it to obtain serum which was stored frozen at -20°C until analysis. Haematocrite ratio (Ht %) was determined according to Wintrobe method. Blood hemoglobin concentration (Hb, g / 100 ml) was determined according to **Makaren, (1974).**

The determination of serum total protein (g/dl) was performed by using test kits (STANBIO) according to **Cannon, (1974).** Albumin (g/dl) was measured by test kits (Diamond Diagnostics Egypt) according to Beng and Lim (1973). Globulin concentrations were calculated by the subtraction of albumin from total protein. Albumin / Globulin ratio was also calculated.

Aspartic-transaminase (AST U/L) and Alanine- transaminase (ALT U/L) activity in serum were measured calorimetrically using test kits provided by Diamond Diagnostics Egypt, according to **Reitman and Frankel (1957).**

Serum sodium (Na, mmol/L) and potassium (K, mmol/L) were measured colorimetrically using test kits provided by Biodiagnostic, according to **Sunderman and Sunderman (1958)** for potassium and **Trinder (1951)** for sodium. Chloride (Cl, mmol/L) was measured colorimetrically using test kits provided by SPINRE ACT, S.A. SPAIN according to **Burtis (1999).** Cortisol concentration in serum was measured by radioimmunoassay (RIA) kit of DSL-2100, Texas, USA according to **Kreiger, (1975) and Migeon and Lanes, (1990).**

Total body fluid (TBF, L) as absolute and relative value to body weight (TBF, ml/ Kg) were estimated using Antipyrine- space method as described by **Brodie, *et. al.*, (1949).** Extracellular fluid (ECF) was measured using sodium thiosulfate method according to **Cardozo and Edelman, (1952).** Intracellular fluid volume (ICF) calculated by deducting the ECF from TBF. Interstitial fluid volume (ISF) was calculated by deducting the PV from ECF.

Body weight (BW) was recorded for each animal and dry body weigh (DBW) or total body solid was calculated by the subtraction of TBF from BW. Total plasma volume (PV) was determined by the method of **Davis and Isenberg (1953)** using the Evan's blue dye (T-1824).Blood volume (BV) was calculated by the equation of **Pandy and Roy (1969)** where: BV (ml) = PV (ml) X 100 / (100 – Ht).

Statistical analysis:

Analysis of variance was conducted according to **SPSS, (1997).**

RESULTS AND DISCUSSION

Thermo- cardio- respiratory parameters:

Exposure of both buffalo heifers and cows to direct solar radiation significantly increased ($P \leq 0.01$) RT, RR and PR (Table, 1). The increase in rectal temperature amounted 7.38% and 6.75% in heifers and cows, respectively; the increase of RR amounted 406.7% and 410.07% in heifers and cows, respectively, meanwhile, the increase in PR amounted 32.62% and 35.37% in heifers and cows, respectively (Table, 1).

Table (1): Effect of direct exposure to solar radiation on thermo-cardio- respiratory parameters and haematocrite and hemoglobin in buffalo heifers and cows.

Parameters	Buffalo heifers			Buffalo cows		
	Before exposure	After exposure	Percent of change	Before exposure	After exposure	Percent of change
RT °C	37.93±0.040[B]	40.73±0.069[A]	+7.38	37.80±0.033[B]	40.35±0.057[A]	+ 6.75
RR / min	24.53±0.267[B]	124.30±1.301[A]	+406.7	23.13±0.183[B]	117.98±1.556[A]	+ 410.07
PR / min	62.04±0.442[B]	82.28±0.546[A]	+32.62	58.07±0.540[B]	78.61±0.561[A]	+ 35.37
Ht %	33.32±0.312[A]	27.92±0.273[B]	- 16.21	35.86±0.344[A]	29.96±0.421[B]	- 16.45
Hb, g %	9.96±0.161[a]	9.40±0.165[b]	- 5.62	11.35±0.122[A]	10.89±0.118[B]	- 4.05

Average in the same row for each age having different superscripts differ significantly, $P < 0.05$ for **a,b** $P < 0.01$ for A,B.

RT: rectal temperature; RR: respiration rate; PR: pulse rate; Ht%: haematocrite; Hb: hemoglobin.

Similar results were also reported by **Das, *et al.*, (1999)**. who found in Murrah male buffalo calves exposed to solar radiation during summer that, when ambient temperature and solar radiation was maximum, buffaloes were not able to maintain their normal rectal temperature and increased pulmonary frequency by 5-6 times, protruded tongue, and increased salivary activity. The changes in RT and RR were observed to be related with discomfort and it was noticed that their increase was mainly due to exposure to greater intensity of solar radiation. They indicated also that a rise in skin temperature led to a greater heat storage in the body of calves due to direct solar radiation exposure during summer. The average heat stored in buffalo calves in their study was estimated to be about 1850 KJ with mean RT of 40.57°C and surface temperature of 42.60°C. Heat stress symptoms of buffalo heifers in the present study indicated that young buffaloes were not able to maintain constant body temperature under exposure to solar radiation. This was similar to the mechanism employed by other adult mammals **(Taylor, 1981)**. Inability to eliminate excess heat leads to a rise in body temperature of buffalo heifers and mechanisms associated with hyperthermia were observed primarily due to under developed hypothermic functions and lower thermostability in buffalo **(Bianca, 1968)**. In the process of thermoregulation, heat loss from the skin usually occurs by radiation, convection and evaporation **(Chaiyabutr, 1993)**. The skin sweat glands of buffalo have a low blood supply **(Yousef and Johnson, 1985)**. The number of sweat glands per unit area of skin is about one-third of cattle and the thickness of epidermis about double of the cattle **(Shafie, 1993)**. The thickness and the black pigment of the buffalo skin help in absorbing more heat and leads to disproportionate convective and radiative heat losses from the extremities during exposure to solar radiation **(Chaiyabutr, 1993)**.

In the present study, common observations on buffalo heifers were tongue protrusion and enhanced salivary secretion. These mechanisms were mainly achieved to facilitate greater heat dissipation from buccal surfaces. These observations confirmed the results of **Chikamune (1986)** who reported that the respiratory frequency increased enormously when the air temperature exceeds 30°C and the animal began to pant. This panting is thought to be initiated by thermal stimulation of peripheral receptors and unaccompanied by a rise in rectal temperature.

Haematocrite and Hemoglobin:

It is clear from Table (1) that direct exposure to sun ray caused significantly decrease in Ht % (P<0.01) and Hb,g % (P<0.05 and P<0.01). The decrease in haematocrite value after exposure to direct solar radiation may be due to a hemodilution effect where more water is transported in the circulatory system for evaporative cooling, also this decrease in Ht % was a hemodilution effect of the greater increased in blood volume usually associated with high environmental temperature **(Ashour 1990).** The decrease in Ht value is thus not only due to change in plasma volume but also due to change in circulation, most probably increasing storage in spleen **(Beltagy 1990).** It is interesting that solar radiation induced reduction in the concentration of RBCs circulation in the blood, an attempt to reduce O_2 carriage to depress the metabolic rate in this case of heat stress **(Ashmawy 1998).**

Serum Constituents:

Blood serum total protein and albumin were significantly decreased (P<0.01) after exposure to direct solar radiation in both heifers and buffalo cows. Globulin was significantly decreased (P <0.01) by 9. 58% in buffalo heifers and insignificantly with buffalo cows (Table 2). With regard to the increase in globulin level in stressed buffalo cows than stressed heifers, this may be pointed to that immune response of buffalo cows is better than that in young ones. A/G ratio was not significantly affected by exposure to sun ray. Reduction in serum protein fractions may be attributed to hemodilution effect, because of the increase of water consumption, blood and plasma volume **(Kamal, and Shebaita, 1972)** and body water content **(Kamal, et al., 1993)** mainly increased in heat stressed animals. Moreover, the increase of cortisol level which enhancing tissue destruction may be involved in such decrease of blood protein in heat stressed animals **(El-Nouty, *et al.*, 1978; El-Fouly and Kamal, 1979).**

Table (2): Effect of direct exposure to solar radiation on serum constituents and cortisol level in buffalo heifers and cows.

Parameters	Buffalo heifers			Buffalo cows		
	Before exposure	After exposure	Percent of change	Before exposure	After exposure	Percent of change
T.protein,g/dl	7.11±0.083[A]	6.46±0.075[B]	- 9.14	7.95±0.069[A]	7.24±0.096[B]	- 8.93
Albumin,g/dl	3.56±0.048[A]	3.25±0.050[B]	- 8.71	3.95±0.051[A]	3.50±0.053[B]	- 11.39
Globulin,g/dl	3.55±0.054[A]	3.21±0.066[B]	- 9.58	4.00±0.088	3.74±0.101	- 6.5
A/G	1.01±0.017	1.02±0.031	+ 0.99	1.01±0.031	0.96±0.035	- 4.95
AST U/L	84.43±5.140	94.79±6.640	+ 12.27	99.33±3.566	101.68±4.041	+ 2.36
ALT U/L	15.29±0.985	17.62±1.562	+ 15.24	16.30±0.586	17.29±0.576	+ 6.07
Na mmol/L	141.12±1.960[b]	148.19±2.126[a]	+ 5.00	139.83±1.761[B]	148.28±1.790[A]	+ 6.04
K mmol/L	7.22±0.477	8.62±0.740	+ 19.39	5.46±0.105[B]	8.25±0.484[A]	+51.09
Cl mmol/L	118.31±2.623[B]	133.34±3.381[A]	+ 12.70	117.73±2.063[B]	130.96±2.540[A]	+11.24
Cortisol ng / ml	10.93±0.054[B]	16.54±0.151[A]	+ 51.33	11.29±0.164[B]	16.28±0.232[A]	+ 44.19

Average in the same row for each age having different superscripts differ significantly, P < 0.05 for a,b P < 0.01 for A,B.

A/G: albumin globulin ratio; AST and ALT: aspartic and alanine transaminase; Na: serum sodium; K: serum potassium; Cl: serum chloride.

There are non significant increase in AST and ALT due to exposure to direct solar radiation by 12.27% and 15.24 % respectively than before exposure in buffalo heifers. Also insignificantly increase was observed in stressed buffalo cows by 2.36% for AST and 6.07% for ALT. This increasing in AST and ALT may be due to the heat stress during the summer hot climate of Egypt.

Direct exposure to sun ray caused a significantly increased ($P<0.01$) in Na^+, K^+ and Cl concentration in buffalo cows but caused a significantly increased ($P<0.05$ and $P<0.01$) in Na^+ and Cl for buffalo heifers. **Ghosal, *et. al.*, (1975)** stated that, in camels, the values of both the Na^+ and K^+ increased with heat stress, and this seems to have a relevance to increased plasma osmolarity resulting in drainage of water from intracellular and interstitial space which may help to maintain the body temperature. **Mehta and Gangwar., (1985)** suggested that the increase in K^+ concentration may be due to the increase in break down and leakage of RBCs during hot conditions.

Cortisol Level:

There was significantly increase ($P<0.01$) in cortisol level due to exposed to solar radiation by 51.33 % in buffalo heifers and by 44.19 % in buffalo cows (Table 2). Adaptation reaction or stress reaction represent a modification of a going physiological mechanism that allows an animal to respond to stress stimuli with minimum alteration in homeostasis. The major stress alterations involve enhanced secretion of glucocorticoids and increased sympathetic nervous system activity. Stress increased secretion of cortisol from the adrenal cortex in cattle one of the most important benefits of increased glucocorticoids secretion in stress concerns the maintenance of flight response with essential metabolites by diverting glucose metabolism from muscle to the brain and other tissues **(Khalil., 2002 and Mudron, *et al.*, 2005).**

Dry Body Weight and Body Fluid Compartments:

Exposure to solar radiation caused a loss in DBW, Kg and DBW, Kg % BW which were significantly ($P<0.01$) in both buffalo heifers and cows (Table 3), the decrease of DBW indicating a destruction in either one or more of fat, lean mass and bone tissues **(Kamal, *et al.*, 1993).** The reduction of DBW due to solar radiation was 28.56% in buffalo heifers and 30.05% in buffalo cows.

Exposure to solar radiation increased significantly ($P<0.05$ and $P<0.01$) absolute and relative total body fluids to body weight, extracellular fluid ml/ Kg BW, absolute and relative intracellular fluid and interstitial fluid ml/ Kg BW, while non significant increase was found in ECF,L and ISF, L in both buffalo heifers and buffalo cows.

The increase in TBF in hot climate may be an adaptive mechanism for heat tolerance, since it will allow the animal to store a great amount of heat because of the high specific heat of water during the hot part of the day and dissipate it during the cool hours **(Yousef and Johnson, 1985).**

Moreover, **Parker, *et al.*, (2004)** determined the total water content in *Bos indicus* steers and reported that the replacement of water from the gastrointestinal tract may have been responsible for maintenance of body water in stressed animals. The water pools in the ruminant body are dynamic, moving freely from the lumen of the gastrointestinal tract to the extracellular fluid. This flux has resulted in considerable variation in the determination of body water loss from stressors **(Cole, 1995).**

Table (3): Effect of direct exposure to solar radiation on dry body weight and body fluids compartment in buffalo heifers and cows.

Parameters	Buffalo heifers			Buffalo cows		
	Before exposure	After exposure	Percent of change	Before exposure	After exposure	Percent of change
DBW Kg	67.30±4.880[A]	48.08±3.681[B]	- 28.56	152.83±4.208[A]	106.90±5.518[B]	- 30.05
DBW,Kg%BW	30.79±0.733[A]	21.71±0.829[B]	- 29.49	32.58±0.585[A]	22.95±1.579[B]	- 29.55
TBF, L	147.45±6.613[b]	169.77±8.247[a]	+15.13	318.54±10.018[B]	369.19±14.007[A]	+15.90
TBF,mL/Kg BW	692.10±7.333[B]	782.87±8.291[A]	+13.12	674.19±5.851[B]	770.54±15.788[A]	+14.29
ECF,L	64.99±4.211	70.16±4.221	+7.95	152.44±4.520	163.87±4.919	+7.49
ECF,mL/Kg BW	299.14±3.725[B]	319.71±2.850[A]	+ 6.88	322.82±2.329[B]	343.57±2.403[A]	+6.43
ICF, L	82.46±2.635[B]	99.61±4.181[A]	+20.79	166.10±6.120[B]	205.32±9.860[A]	+23.61
ICF,mL/Kg BW	392.96±10.694[B]	463.16±9.161[A]	+17.86	351.37±6.503[B]	426.97±15.753[A]	+21.52
ISF, L	52.86±3.723	56.53±3.650	+ 6.94	132.91±4.301	140.86±4.539	+ 5.98
ISF,mL/Kg BW	241.87±4.318[b]	256.42±3.263[a]	+ 6.02	280.85±2.784[B]	294.76±2.611[A]	+ 4.95

Average in the same row for each age having different superscripts differ significantly, $P < 0.05$ for a,b $P < 0.01$ for A,B.

DBW: dry body weight; TBF: total body fluids; ECF: extracellular fluid; ICF: intracellular fluid; ISF: interstitial fluid.

Ashour, *et al.*, (2001) found that buffaloes had higher values of rumen characteristics during the hottest month of summer than in the coldest month of winter, larger rumen fluid volume, rapid turnover time, higher turnover constant rate, the absolute value of rumen fluid volume and relative to metabolic body weight were two and four times in hot summer than in cold winter. This could be adaptive reservoir to supply blood by water to contract excess of water output by increased vaporization cooling of the body temperature in hot conditions. This means that buffaloes used their rumen as a good container of water in hot condition.

In addition, **Shebaita and El-Banna, (1982)** pointed out that high environmental temperature stimulates the drinking center in hypothalamus. This might contributed to the water turnover rate as adaptive mechanism. Moreover, heat increased ADH secretion in cattle **(El-Nouty, *et al.*, 1980)** which may be contributed to the increase in total body fluid.

Moreover the mechanism of water balance under hot conditions could be discussed on the basis of osmolarity of body fluids. However, under hot conditions, a temporary water deficit develops as a result of increased water vaporization from skin and lungs **(Bianca, *et al.*, 1965)** and water loss in urine **(Kamal, *et al.*, 1972)** Furthermore, as environmental temperature increases the blood reaching hypothalamus, causing an increase in hypothalamic temperature **(Carlson, 1962)** this increase in hypothalamic temperature may stimulates other hypothalamic areas controlling water intake.

With regard to the changes in ISF volume may be attributed to its elasticity of the interstitial space which permits it to absorb much of the fluctuating body water.

Vascular Fluid

The absolute value of PV increased significantly ($P < 0.01$) by 68.82% after exposure to direct solar radiation in buffalo cows (Table 4), while plasma volume insignificantly increase after heifers exposed to solar radiation. The relative value of PV ml/kg BW was also increased after exposure to direct solar radiation and this increase in buffalo cows was greater than in the buffalo heifers. This biological increase of PV in hot summer conditions a mean to combat the effect of high environmental temperature on body temperature by supplying enough source of water for skin and respiratory vaporization **(Ashour, 1990).**

Table (4): Effect of direct exposure to solar radiation on plasma and blood volume in buffalo heifers and cows.

Parameters	Buffalo heifers			Buffalo cows		
	Before exposure	After exposure	Percent of change	Before exposure	After exposure	Percent of change
PV, L	12.13±0.528	19.53±0.368	+ 61.00	13.63±0.623^{B}	23.01±0.557^{A}	+ 68.82
PV, mL/KgBW	57.27±1.419^{B}	63.28±0.928^{A}	+ 10.49	41.96±1.458^{B}	48.81±1.086^{A}	+ 16.33
BV, L	18.25±0.850	18.92±0.887	+ 3.67	30.45±0.517^{b}	32.85±0.762^{a}	+ 7.88
BV,mL/KgBW	85.91±2.086	87.78±1.941	+ 2.18	65.44±1.407^{b}	69.70±1.510^{a}	+ 6.51

Average in the same row for each age having different superscripts differ significantly, $P < 0.05$ for a,b $P < 0.01$ for A,B.
PV: plasma volume; BV: blood volume.

There is significantly ($P < 0.05$) increase of BV, L due to exposed to solar radiation by 7.88 % in buffalo cows (Table 4). The increase of vascular fluids due to heat stress was to transfer more heat from body core to the skin to be dissipated by evaporative and non evaporative cooling mechanisms **(Ashour and Shafie, 1993 and Kamal, *et al.*, 1993).**

It can be concluded from the results of the present study that buffalo cows followed by buffalo heifers undergo the severe heat stress which cause by solar radiation via significant changes in physiological responses. Results point out to aid buffalo heifers and cows by artificial means to alleviate imposed stress of exposure to solar radiation in desert hot conditions.

REFERENCES

Alim, K.A. and Ahmed, I.A. (1957): Studies on the body temperature and respiration rate of buffalo cows under normal conditions. Canadian J. Anim. Sci., 37 : 130.

Ashour,G. (1990): Water balance in Bovine as related to heat regulation. Ph.D. Thesis. Fac. of. Agric. Cairo. Universty. Egypt.

Ashour,G. and Shafie, M.M. (1993): Water balance in riverine buffaloes.1-Mobilization of body fluids under heat and dehydration stresses. Proc.Inter.Symp.,Cairo,Egypt,9-12-Nov., EAAP Pub.62: 194.

Ashour.G; Shafie M.M. and Morad H.M. (2001): The significance of rumen fluid volume in sodium and potassium balance in buffaloes. Egyptian.J.Nutrition and Feeds : Proc. Canf. Anim. Nutrition., Sharm El-Sheik, 23-26 Oct, 4: 473.

Beltagy,.H.G.M.,(1990): Effect of some environmental and heamatological factors on blood biochemical and heamatological characteristics of pure-breed Friesian cows. M.Sc. Thesis, Alexandria Univ., Egypt.

Beng,C.G.and Lim,K.L. (1973): Colorimetric determination of albumin in serum. Amer. J.Clin.Path.,59:14.

Bianca, W.; Findlay J.D. and Maclean, J.A. (1965): Responses of stress to water restriction. Res.Vet Sci. 6: 38.

Bianca, W.W., (1968): Thermoregulation. In Hafeze, E.S.E. (Ed), Adaptation of Domestic Animals, Lea & Febiger, Philadelphia: 97.

Brodie,B.B.; Axelord,J.; Soberman, R. and B.Levy, B. (1949): The estimation of Antipyrine in biological materials. J.Biol. Chem., 179: 25.

Burtis, A., (1999): Text Book of clinical chemistry. 3rd Ed, AACC,Press.

Cannon, D.C., (1974): Assessment of total protein in clinical chemistry-principles and techniques. 2nd Ed. RJ Henry,et.al.,Eds. Harper and Row, Hagerstown, MD, 411.

Cardozo, R.H., and Edelman I.S. (1952): The volume distribution of sodium thiosulfate as a measure of the extracellular fluid space. J. Clin . Invest. 31: 280.

Carlson, L.D. (1962): Temperature . Annu. Rev. Physiol. 24: 85.

Chaiyabutr, N., (1993): Buffalo physiological responses to high environmental temperature and consequences for DAP. In Pryor, W.G. (Ed). Draught Animal Power in the Asian – Australasian region. Anim. Prod. Soc. Congress, 23-28 Nov., 46: 100.

Chikamune, T., (1986): Effect of environmental temperature on thermoregulatory responses and oxygen consumption in swamp buffalo and Holstein cattle. Buffalo J. 2:151.

Cole, N.A. (1995): Influence of a three – day feed water deprivation period on gut fill, tissue weights, and tissue composition in mature wethers. J. Anim. Sci. 73: 2548.

Das, S.K.; Mpadhyay R.C. and Madan. M.L. (1999): Heat stressing Murrah buffalo calves. Livestock production scince, 61: 71.

Davis, H.A.; and Isenberg, L., (1953): An improved blood volume method (Evan's blue dye) utilizable even in the presence of hemolysis and lipemia. J. Lab. and Clin.Med.41: 789.

El-Fouly,H.A. and Kamal, T.H. (1979): Effect of short-term heat exposure on urinary allantoin –N in Freisian calves. World Review of animal production, 15:12.

El-Masry, K.A.; El-Fouly, H.A. and Gabr. S.A. (2001): Physiological action of chromium on some blood biochemical constituents and immune response in relation to growth performance of heat stressed calves. Egyptian, J. Nutrition and Feeds. 4: 453.

El-Nouty, F.D.; El-Banna, I.M. and Johnson H.D. (1978): Effect of adrenocorticotropic hormone on plasma glucocorticoids and antidiuretic hormone of cattle exposed to 20and 30 C°. J.Dairy Science, 61: 189.

El-Nouty,F.D.; El-Banna, I.M.; Davis, I.P. and Johnson, H.D., (1980): Aldosterone and ADH response to heat and dehydration in cattle. J.Appl.Physiol.,48: 249.

Ghosal, A.K.; Dwarkmath, P.K. and. Appanna, T.C (1975): A study on the changes in blood electrolytes of camel (*camelus dormedarius*) during water deprivation. Indian J. Anim. Health, 14: 113.

Kamal T.H.; Shebaita, M.K. and Ibrahim, I.I. (1993): Seasonal variations in different Physiological parameters in water buffaloes and Friesians. Proc. Inter. Symp., Cairo .Egypt, 9-12 Nov., EAAP Pub. 62:201.

Kamal, T.H. and Shebaita M.K. (1972): Natural and Controlled hot climatic effects on blood volume and plasma total solids in Friesian and water buffaloes. FAOIAEA, Symp. On (Isotope Studies on the Physiology of Domestic Animals., Athens Greece, Proc Series, IAEA, Vienna 20-24 March, 103.

Kamal,T.H.; Shebaita, M.K. and El-Banna, I.M., (1972): Effect of heat and water restriction on water metabolism and body fluid compartments in farm animals. Proc.Series, IAEA, Vienna, 95.

Khalil, M.H., (2002): Endocrinology. ISBN: 977- 224-146-3. Book House. Emirates. El- Aeen.

Kreiger,D.T. (1975): Rhythms of ACTH and corticosteroid secretion in health and disease and their experimental modification. J. Steroid Biochem 6: 785.

Makaren, A. (1974): Hemoglobins, myoglobins and haptoglobins. In: Clinical Chemistry. 2nd Ed., Edited by Henry, R.J., Cannon, D.C.and Winkelman, J. W. Harper & Row, Publishers, Hagerstown, Maryland, New York, USA, 1131.

Mehta, S.N. and Gangwar, P.C. (1985): Seasonal variations in plasma electrolytes of lactating buffaloes (*bubalus bubalis*). Indian. J. Dairy. Sci., 38:327.

Migeon, C.J. and Lanes, R.L. (1990): Adrenal cortex : hypo and hyper function. IN Lifshitz F(Ed): Pediatric Endocrinology, A clinical Guide, Second Edition. Marcel Dekker, INC., New Yourk, 333.

Mudron, R; Rehage, J; Sallmann, H. P.; Holtershinken, M. and Sochlz, H. (2005): Stress response in dairy cows related to blood glucose. ACTA Vet. Brno, 74:37.

Ashmawy, Neama, A. (1998): Acid-Base balance in buffalo heifers as affected by heat stress.Egyptian.J.Anim.Prod. 35:29.

NRC (1988): Nutrient Requirements of Dairy cattle. National Research Council. 6th Revised Ed. Washington, D.C. USA.

Pandey, M.D. and Roy, A. (1969): Studies on the adaptability of buffaloes to tropical climate: seasonal changes in the water and electrolytes status of buffalo cows.Indian.J.Anim.Sci.,39: 307.

Parker, A.J.; Hamlin G.P.; Colmane G.J. and Fitzpartick. L.A., (2004): Excess cortisol interferes with a principal mechanism of resistance to dehydration in *Bos Indicus* Steers. J.Anim.Sci. 82: 1037.

Reitman, S. and Frankel, S. (1957): A clorimetric method for the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases J. Clin. Path., 28: 56.

Shafie, M.M. (1993): Biological adaptation of buffaloes to climatic conditions. Proc. Inter. Symp., Cairo, Egypt, 9-12- Nov., EAAP Pub. 62: 176.

Shebaita,. M.K.; and El-Banna. I.M., (1982): Heat load and heat dissipation in sheep and goats under environmental heat stress. 6th Int. Conf. Anim & Poult. Prod. Zagazig University. 459.

SPSS (1997): Statistical package for social science. Release 8.0, copyright © SPSS. INC., Chicago, U.S.A.

Sunderman, F.W. Jr. and Sunderman F.W. (1958): A turbidimetric method for potassium determination. Am. J. Clin. Pathol. 29:55.

Taylor, C. R., (1981): Response of large animals to heat and exercise. In: Horvath, S. M. Yousef, M. K. (Eds), environmental physiology, Ageing, Heat and Altitude, North Holland, Inc, New York: 79.

Trinder, P., (1951): A colorimetric method for sodium determination. Analyst, 76: 596.

Yousef, M.K. and Johnson, H.D., (1985): Stress Physiology in livestock. Vol. I, CRC Press, Inc, Florida.

استجابات فسيولوجية في عجلات وأبقار الجاموس المصري المعرضة للإشعاع الشمسي

منى عبد التواب الخشاب
قسم الإنتاج الحيواني – كلية الزراعة – جامعة الفيوم – الفيوم – مصر.

استخدم في هذه الدراسة ٥ من عجلات الجاموس يتراوح عمرها ١,٥ – ٢ سنة وكذلك ٧ من أبقار الجاموس الغير حلاب وغير حامل يتراوح عمرها ٤: ٥ سنوات وكان وزن الجسم ٢١٤,٧ كجم و٤٧١,٤ كجم على التوالى.

عرضت الحيوانات لاشعة الشمس المباشرة لمدة ٥ ساعات من الساعة العاشرة صباحا حتى الساعة الثالثة بعد الظهر يوم بعد يوم طوال شهر أغسطس. أخذت القياسات تحت الدراسة مرتين خلال يوم التعرض مرة قبل التعرض ومرة بعد التعرض.

تم قياس كل من درجات حرارة المستقيم، عدد مرات التنفس، معدل النبض وكذلك قياس نسبة الهيماتو كريت والهيموجلوبين. كما تم قياس البروتين الكلى والالبيومين وكذلك الجلوبيولين وأيضاً مستوى الصوديوم، البوتاسيوم، الكلوريد ومستوى هرمون الكورتيزول فى سيرم الدم. كما تم تقدير وزن الجسم الجاف وسوائل الجسم وكذلك حجم البلازما والدم.

أوضحت النتائج زيادة معنوية فى كل من درجة حرارة المستقيم، معدل التنفس وكذلك معدل النبض بالتعرض لآشعة الشمس المباشرة. وقدرت الزيادة في معدل التنفس بحوالى ٤٠٦,٧% فى عجلات الجاموس و ٤١٠,٧% فى ابقار الجاموس كما أن معدل النبض زاد بحوالى ٣٢,٦٢% فى العجلات مقابل ٣٥,٣٧% فى ابقار الجاموس.

كما أوضحت النتائج ايضاً تناقص معنوى فى البروتين الكلى، الالبيومين فى الحيوانات المعرضة لآشعة الشمس. كما زاد مستوى هرمون الكورتيزول زيادة معنوية وبدرجة كبيرة في العجلات تقدر بحوالى ٥١,٣٣% مقابل ٤٤,١٩% فى الجاموس المعرض لآشعة الشمس المباشرة.

التعرض لأشعة الشمس المباشرة سببت فقد فى وزن الجسم الجاف فى كلاً مجموعتى الجاموس.

كما أدى التعرض لآشعة الشمس المباشرة إلى زيادة فى سوائل الجسم أيضاً زيادة معنوية فى كل من حجم البلازما وحجم الدم، حيث كانت الزيادة فى حجم الدم حوالى ٣,٦٧%، ٧,٨٨% فى عجلات الجاموس وأبقار الجاموس على التوالي.