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PHYSIOLOGICAL RESPONSES OF WATER BUFFALOES TO COOL AMBIENT TEMPERATURE AND HOUSING PRACTICE

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SUMMARY

The objective of this study was to determine if the cold season and housing practice have any effect on the physiological responses of lactating water buffaloes under winter and spring conditions in upper Egypt conditions. Fifteen lactating buffaloes were assigned to three groups balanced for age, days in milk and milk yield at the beginning of the study period (3 weeks): 1 st group (G1) housed indoors during the day (air temperature (AT) at 12-14 h =15.7 °C) and outdoors during the night (AT at 23-24 h =7.3 °C), 2 nd group (G2) housed outdoors during the day (AT=17.5 °C) and indoors during the night (AT=10.5 °C) in winter season, and 3 rd group (G3) housed outdoors during the day (AT=29.4 °C) and night (AT=11.3 °C) in spring season. Some blood constituents were determined; heamoglobin (Hb) and PCV, % and serum glucose, urea-nitrogen, total protein, albumin, globulin and bilirubin concentrations. Rectal and skin temperatures were recorded alongsides respiration rate. A significant increase in serum; glucose ($P<0.01$), urea-nitrogen ($P<0.05$), total protein ($P<0.01$), albumin ($P<0.01$), globulin ($P<0.01$) and bilirubin ($P<0.05$) occurred during winter season. Winter cool ambient temperature increased ($P<0.01$) PCV,% and Hb concentration (in G2 only). G1-animals had lower ($P<0.01$) PCV,% and Hb concentration than that of G2.There was no difference between the two winter groups,G1 &G2 in the concentrations of serum; glucose, urea-nitrogen, bilirubin, total protein, globulin and albumin . Winter cool temperature decreased respiration rate and rectal and skin temperatures than that in spring.Respiration rate and rectal temperature were lower at midnight than that at midday. In coclusion, serum; constituents, rectal temperature ,skin temperature and respiration rate were significantly affected by cool winter temperature in Egypt, particulary when housed outdoors during night.

Keywords: Buffaloes, blood, respiration, temperature, housing practise, cool environment

INTRODUCTION

The animal homeostasis mechanism is involved in better thriftyness and productivity. Milk, growth and reproductive performance, then can be affected by heat or cold stress (Kobeisy, 1983; Lee *et al.*, 1975; Shafie, 1985 & 1993). Cold stressed animals reduce their rate of heat loss through passive morphological modification, and active insulation effeciency by enhanced subcutaneous fat deposition and reduced blood flow in peripheral tissues through effective vasoconstrictive response, alongside changes in tissue metabolic capacities (Webster, 1974; Slee, 1985 & 1987; Balsbaugh *et al.* 1986; Young *et al*, 1989). Despite that air temperature frequently decreases to 1°C in winter season, particularly during the night in upper Egypt, there is limited data on the effect of cool ambient temperature on physiological responses of water buffaloes.

This study was designed to investigate the specific influence of natural climatic environment during cool season on physiological and metabolic reactions of buffaloes compared to that in hot spring season. Also, the effect of housing practise during winter season on same parameters to evaluate the need for environmental accomodation.

MATERIALS AND METHODS

This study was conducted during winter (January) and spring (April) seasons in Animal Production Experimental farm of the Faculty of Agriculture, Assiut University. Meteriological data of Assiut Province obtained from the Meteriological Department is shown in Table 1.

Table 1. Meterological data of Assiut Province in January and April.

Month	Air temperature, °C		Relative humidity, %		Wind speed KTS*
	night	day	max.	min.	mean
January	7.62±0.33	11.36±0.26	90.5±.16	38.0±1.05	5.26±.48
April	16.50±0.80	20.90±0.74	76.5±2.1	21.7±1.11	6.73±..42

* KTS= 1.15 mile/h or 1.85 km/h.

Experimental Animals and Management

Fifteen lactating water buffaloes in early lactation were used in this study. They were assigned to three treatment groups balanced for age, days in milk and milk yield at the begining of the experimental period. Treatments were distributed as follows: 1 st group (G1) of animals housed indoors during the day (average air temperature (AT) at 12-14 h = 15.7 °C) and outdoors during the night (AT at 23-24 h=7.3 °C), 2 nd group (G2) of animals housed outdopors during the day (AT=17.5°C) and indoors during the night (AT=10.5 °C) in winter season, and 3 rd group (G3) of animals housed outdoors during the day (AT=27.3 °C) and night (AT= 11.3 °C) in spring season. The building is a semi-closed barn which had cement floors and roofs, and side walls of cement bricks. The hight, width and length of bulding are 5.0, 22.5 and 37.5 m, respectively. The hight of windows base from ground is 2.25 m. Bales of rice straw were used to closed the windows during winter season. The trial included 2 wk preliminary (adapting) period and three weeks as test period during winter and spring seasons.

During the study all animals were fed rations consisting of 60 % concentrate and 40% roughage (rice straw and berseem) to cover their requirements calculated according to Ghoneim (1967). The concentrate diet was consisted of corn (40%), cottonseed meal (25%), wheat bran (32%), limestone (2%) and sodium chloride

(1%). The concentrate diet was offered twice daily just before milking and water was offered to the animals four times daily.

Experimental Procedure

Respiration rate and Rectal and Skin temperatures, assesments.

Respiration rate (RR, breaths/min.) was determined by counting the flank movements for 1 min weekly at 12:00-14:00 h and at 23:00-24:00 h during winter and at 12:00-14:00 h only during spring. Rectal temperature (RT) and skin temperature (ST) of six skin regions (neck, shoulder, mid-dorsal, mid-side, abdomen and flank) were tested (±0.1°C) in all animals after recording the respiration rate. Ambient temperature and relative humidity were recorded at the same time of measurements of RR and RT during the two seasons (Table 2).

Table 2. Air temperature and relative humidity during the experiment

Item	Air temperature, °C		Relative humidity, %	
	12 -14h	23-24 h	12-14 h	23-24 h
Winter, indoor	15.6±1.92	10.5±1.32	68.0±2.31	69.6±2.33
Winter, outdoor	17.5±2.18	7.3±0.88	62.6±2.91	73.0±5.13
Spring, outdoor	27.3±0.88	-	55.3±1.86	-

Relative humidity was within medium levels,thus with no siginificant interaction with the effect of air temperature

Blood Sampling and Analytical Methods.

Blood samples were collected weekly at 10.00 h from all animals, during the three weeks study period, immediatly into two vials, one dry clean and sterilized while the other contained EDTA. Serum was then separated by centrifugation at 3000 rpm for 15 min and stored at -20 °C until analyzed. Serum glucose, bilirubin and urea-nitrogen concentrations were determined using kits supplied by Diamond Diagnostics (Egypt). Serum total protein concentration was determined using kits supplied by bio Merieux (France). Serum albumin concentration was determined using kits supplied by Bio-Analyticus (USA) and serum globulin was obtained by difference.

Hemoglobin concentration (Hb, g/dl) was determined using kits supplied by Diamond Diagnostics (Egypt). Packed cell volume (PCV, %) was estimated according to the standard methods of hematology (Schalm, 1986).

Statistical analysis of data was done according to Harvey (1987) computer program.

RESULTS AND DISCUSSION

Thermo - respiratory responses

Rectal temperature and respiration rate of animals exposed to winter cool temperature (G1 & G2) were lower than that of animals exposed to spring warm temperature (G3). Animals housed outdoors during the night of winter season (G1),exposed to the coldest condition, had slightly lower rectal temperature and respiration rate (Figs. 1&2). This effect of cold climate on both rectal temperature and respiration rate is similar to observations in sheep kept at low ambient temperature (Morris *et al.*, 1962; Bennett, 1972; Stott and Slee, 1985). The decreases in rectal temperatures and respiration rates for lactating buffaloes exposed to winter cool air temperature indicate that surrender to cold condition, most probably due to its tropical origin. On the contrary temprate zone cattle, steers exposed to 4 °C were probably not stressed by the cold environment becouse rectal temperatures and respiratory rates of the steers were similar on day 0 and 3 of treatment as reported by Pratt and Wettemann (1986). This might be due in part to increased heat production of steers during exposure to cold temperature as stated by Blaxter and Wainman (1961).

Skin temperatures of G1-animals were lower than that of G2-animals (Figs. 3&4). This effect was mainly due to the difference in air temperature between the two housing practises. Cool winter temperature decreased skin temperature of all regions, the drop was the greatest on the neck and the lowest on the flank, particularly in G1-animals. The still higher temperature of the flank skin is due to that thin body chell on this region facilitate heat transport to the skin surface. The decrease of skin temperature at low environmental temperature is mainly due to cold exposure stimulates peripheral vasomotor mechanisms to decrease heat flow from the body (Bligh, 1974). Functionly, vasoconstriction of peripheral blood vessels reduced blood flow in peripheral tissues, consequently reduced rate of heat loss due to cooler surface temperatures (Webster,1974;Slee,1985& 1987; Young *et al.*, 1989).

Hematological response

Winter cool ambient temperature increased ($P<0.01$) PCV,% and Hb concentration (in G2-animals only). G1-animals had lower ($P<0.01$) PCV,% and Hb concentration than that of G2-animals (Table 3). The increase of PCV, % and Hb concentration during winter, probably related to increase O_2 uptake and consequently metabolic heat production during cold environment. Young (1985) stated that concomitant with the increase in metabolic activity with cold adaptation there is an increases in hematocrit concentration. Also, Patel *et al.* (1971) found that the total of erythrocyte count was high during winter in Surti buffaloes. The drop of both PCV and Hb concentration in G1, that exposed to the coldest condition, than the other two groups in another sign of surrender to cold condition which denotes long lasting cold stress.

Blood serum metabolites and proteins

Some blood constituents of these lactating buffaloes during winter (G1&G2 animals) and spring (G3-animals) seasons are shown in Tables 3, 4 and 5. Serum glucose concentration during winter cool ambient temperature, (G1 & G2) was significantly ($P<0.01$) higher by about 17 and 20 % for G1 and G2, respectively than during spring (G3). Housing practise during winter season had no effect ($P>0.10$) on serum blood glucose. High blood glucose in animals exposed to cool ambient temperature indicates involvment of hormonal actions of catecholamines, cortisol, glucagon and growth hormones, however this needs further investigations. High blood glucose, as a result of cold exposure (Austin and Young, 1977; Stott and Slee, 1985; Young *et al.* 1989) is a normal physiological response due to the increase of the catecholamines (adrenalin and noradrenaline) and corticoid hormone (cortisol) during cold exposure (Panaretto and Vickery, 1970; Webster, 1974; Thompson *et al.*, 1978; Samson *et al.*, 1983; Slee, 1985 and Young *et al.*, 1989), to increase energy supply and availability for tissue use. In addition, Weekes *et al.* (1983) found that plasma glucose concentration and basal glucose flux increased in adult sheep exposed to 0 °C. This may be due to a higher glucagon concentration (Sasaki *et al.* 1982). In fact, the high (P<0.05) basal concentration of insulin in the cold environment found by Scott and Christopherson (1993) in Holstein heifers may be a result of high blood glucose during cold exposure.

Table 3. Hematological response; Packed cell volume (PCV,%) and hemoglobin (Hb) concentrations in buffaloes as influenced by cool winter temperature and housing practice.

Sampling week	PCV, %				Hb g/dl			
	Winter		Spring	S.E	Winter		Spring	S.E
	G1	G2	G3		G1	G2	G3	
1	29.80	33.20^{a}	27.40^{b}	0.31	13.04	13.89	14.56	0.59
2	29.40^{c}	33.80^{da}	26.20^{b}	0.31	13.34^{g}	14.92^{ah}	12.21^{b}	0.59
3	30.00^{c}	34.00^{da}	26.80^{b}	0.31	10.57^{a}	12.04	13.39^{b}	0.59
Mean	29.73^{a}	33.67^{be}	28.80^{bf}	0.76	12.31^{ac}	13.62^{b}	13.39^{d}	0.34

Values are least square means, SE= standard error; a,b ;e,f (P<0.01); c,d (P<0.05), g,h (P<0.06).
-G1, animals housed indoors during the day and outdoors during the night in winter; G2, animals housed outdoors during the day and indoors during the night in winter; G3, animals housed outdoors during the day and night in spring season.

Serum urea-nitrogen concentration of animals exposed to winter cool temperature was higher (P<0.05) than that exposed to spring warm temperature. No significant differences of serum urea-nitrogen concentrations were observed between G1 and G2 animals. The concentration of serum bilirubin of G1 and G2-animals was higher (P<0.05) than that of G3-animals, while, housing practise had no significant effect. Similarly, serum total protein, globulin and albumin concentrations of animals exposed to cool winter temperature (G1 & G2) were higher (P<0.01) than that exposed to warm spring temperature (G3). Housing practise had no significant (P>0.10) effect on serum protein and its fractions (Table 5). High serum total proteins of animals exposed to cool ambient temperatures may be due to either the decrease of proteins uptake as a result of a decrease in protein synthesis, or muscle protein breakdown, or both of them. Panaretto and Vickery (1970) and Samson *et al.* (1983) stated that high cortisol secretion as a response to cool ambient temperature may be a cause of a high serum protein and their fractions in cold environment . In this context, Rosen *et al.* (1958) found that hydrocortisone treatment decreased protein synthesis. Halliday *et al.* (1969) reported higher plasma total protein in ewes under 8 °C than under 30 °C for two weeks.

In conclusion, serum constituents, respiration rate and rectal and skin temperatures were significantly affected by winter cool temperature, however housing practise under this level of ambient temperature, had slight , no significant, effect on physiological responses .This study is a preliminary test which denotes for exteensive studies under different system of housing particularly for the more sensitive young calves.

Table 4. Serum glucose, Biliruloin and urea-nitrogen in buffaloes as influenced by cool winter temperature and housing practise.

Sampling	Glucose, mg/dl				Bilirubin, mg/dl				Urea-nitrogen, mg/dl			
week	Winter		Spring	S.E	Winter		Spring	S.E	Winter		Spring	S.E
	G1	G2	G3		G1	G2	G3		G1	G2	G3	
1	65.59	67.13c	55.95d	4.00	0.38c	0.40a	0.14bd	0.07	25.88	27.57e	20.88f	2.51
2	65.91a	66.60a	43.10b	4.00	0.29	0.37	0.40	0.07	26.06	26.21	23.88	2.51
3	70.69	69.10	73.48	4.00	0.44c	0.39	0.22d	0.07	24.18	24.74	19.23	2.51
Mean	67.39a	67.61a	57.51b	2.30	0.37c	0.39c	0.25d	0.04	25.37c	26.17c	21.06d	1.45

Values are least square means, SE= standard error; a,b ($P<0.01$); c,d ($P<0.05$); e,f ($P<0.07$).
G1, animals housed indoors during the day and outdoors during the night in winter; G2, animals housed outdoors during the day and indoors during the night in winter; G3, animals housed outdoors during the day and night in spring season.

Table 5. Serum total protein, albumin and globulin in buffaloes as influenced by cool winter temperature and housing practice.

Sampling	Total protein, g/dl				Albumin, g/dl				Globulin, g/dl			
week	Winter		Spring	S.E	Winter		Spring	S.E	Winter		Spring	S.E
	G1	G2	G3		G1	G2	G3		G1	G2	G3	
1	9.73a	9.52a	7.29b	0.29	4.27a	4.31a	3.62b	0.15	6.56	6.71c	5.60d	1.00
2	9.55a	9.83a	8.15b	0.29	4.31c	4.27c	3.82d	0.15	6.59	6.66a	4.31b	1.00
3	8.93a.	9.44a	7.87b	0.29	3.97e	4.06c	3.57df	0.15	7.07	6.91	7.33	1.00
Mean	9.40a	9.59a	7.77b	0.17	4.18a	4.21a	3.67b	0.09	6.74	6.77a	5.75b	2.32

Values are least square means, SE= standard error; a,b ($P<0.01$); c,d ($P<0.05$); e,f ($P<0.07$).
G1, animals housed indoors during the day and outdoors during the night in winter; G2, animals housed outdoors during the day and indoors during the night in winter; G3, animals housed outdoors during the day and night in spring season.

Fig 1. Influence of cool winter temperature and housing practise on rectal temperature in buffaloes.

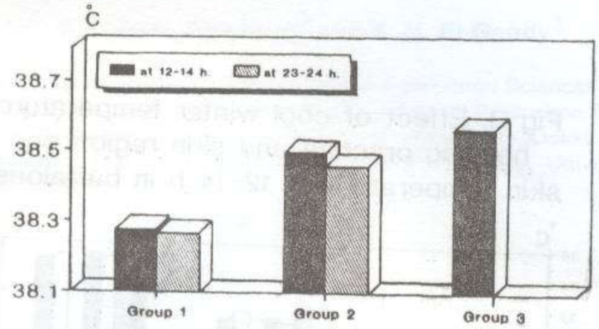


Fig 2. Influence of cool winter temperature and housing practise on respiration rate of buffaloes.

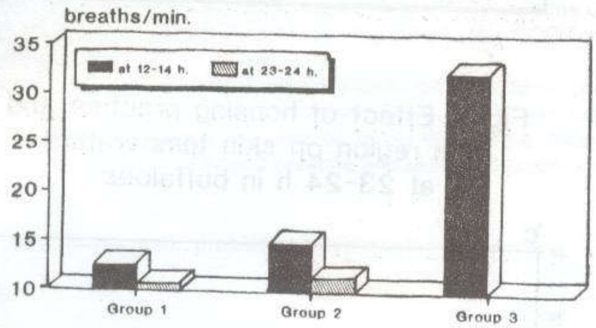


Fig 3. Effect of cool winter temperature housing practise and skin region on skin temperature at 12-14 h in buffaloes

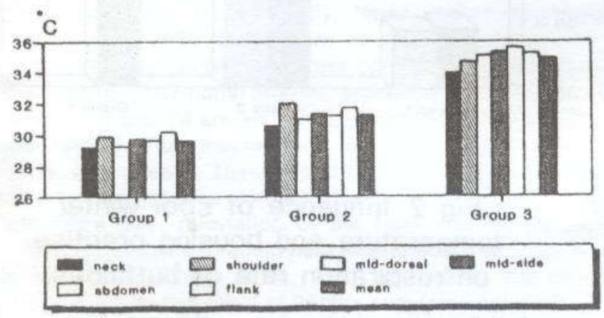
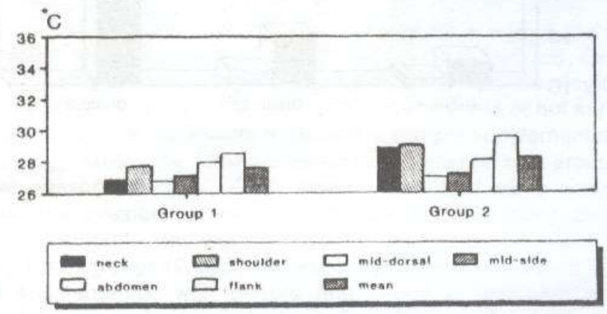


Fig 4. Effect of housing practise and skin region on skin temperature at 23-24 h in buffaloes.



REFERENCES

Austin, A. R. and N.E. Young, 1977. The effect of shearing pregnant ewes on lamb birth weights. Vet. Res. 100:527-529.

Balsbaugh, R. K., S. E. Curtis, R. C. Meyer and H. W. Norton. 1986. Cold resistance and environmental temperature performance in diarrhetic piglets. J. Anim. Sci.62:315-326.

Bennett, J. W., 1972. The maximum metabolic response of sheep to cold. Effects of rectal temperature, shearing, feed consumption, body posture and body weight. Aust. J. Agric. Res. 23:1045-1058.

Blaxter, K. L. and F.W. Wainman, 1961. Environmental temperature and the energy metabolism and heat emission of steers. J. Agric. Sci. 56:81-90.

Bligh, J. 1974. Temperature Regulation in Mammals and Other Vertebrates. North-Holland Publ. Co. Amsterdam.

Ghoneim, A. 1967. Ration of milking animals in Egypt. In: Animal Nutrition (1 st Ed., in Arabic). Anglo Library, Cairo, Egypt.

Halliday, R., A. R. Sykes, J. Slee. A. C. Field and A. J. F. Roussof, 1969. Cold exposure of South Downm and Welsh Muntain sheep: 4-change in concentrations of free fatty acids, glucose, acetone, protein-bound-iodine, protein and antibody in blood. Anim. Prod. (Brit.) II (Part. 4): 479-491.

Harvey, W. R., 1987. User' s guide for LSMLMW Pc-1 version. Polycopie Ohio State University.

Kobeisy, M. A., 1983. Adaptation of Friesian cattle in upper Egypt. M. Sc. Thesis, Assiut University, Egypt.

Lee, J. A., J. D. Roussel and J. F. Beatty, 1975. Effect of temperature on bovine adrenal function, blood cell profile and milk production. J. Dairy Sci. 59:104-108.

Morris, R. J. H., B. Howard and W. V. Macfarlane, 1962. Interaction of nutrition and air temperature with water metabolism of Merino wethers shorn in winter. Aust. J. Agric. Res. 13:320-334.

Panaretto, B. A. and P. Vickrey, 1970. The rates of plasma cortisol entry and clearance in sheep before and during their exposure to a cold, wet environment. J. Endocr. 47:273-285.

Patel, B. M., M. B. Vaidya, V. R. Thakore and P. C. Shukla, 1971. Seasonal variation in certain biochemical and haematological constituents in the blood of surti buffaloes. Indian J. Anim. Sci. 41:537-541.

Pratt, B. R. and R. P. Wettemann, 1986. The effect of environmental temperature on concentrations of thyroxine and triiodothyronine after thyrotropin releasing hormone in steers. J. Anim. Sci. 62:1346-1352.

Rosen, F., N R. Roberts, L. E. Budnick and C. A. Nichol, 1958. An enzymatic basis for the gluconeogenic action of hydrocortisone. Science, 127:278-288.

Samson, D. E., J. Slee, G. E. Thompson, J. A. Goode and A. P. F. Flint, 1983. Prolongation of gestation and changes in maternal steroid hormone concentrations during cold exposure of sheep in late pregnancy. Anim. Prod. 36:1-6.

Sasaki, Y., H. Takahashi, H. Aso, A. Ohneda and T. E. C. Weekes, 1982. Effects of cold exposure on insulin and glucagon secretion in sheep. Endocrinology, 111:2070-2076.

Shafie, M. M., 1993. Biological adaptation of buffaloes to climatic cond. Proc. Int. Symp. of Prospects of buffalo Production in the Mediterranean and the Middle East, pp.176-185, Cairo, 9-12 November, 1992.

Shafie, M. M., 1985. Physiological responses and adaptation of water buffalo. In: M. K. Yousef (Ed.) , Stress Physiology in Livestock. pp. 67 -80, CRC press Inc., Boca Raton, Florida.

Shalm, O. W., 1986. Veterinary Hematology (3 rd Edn.) Lee&Febiger, Philadelphia.

Scott, S. L. and R. J. Christopherson. 1993. The effect of cold adaptation on kinetics of insulin and growth hormone in heifers. Can. J. Anim. Sci. 73:3-47.

Stott, A. W. and J. Slee, 1985. The effect of environmental temperature during pregnancy on thermoregulation in the newborn lambs. Anim. Prod. 41:341-347.

Slee, J., 1987. Sheep. In: H. D. Johnson (Ed.) Bioclimatology and the Adaptation of Livestock. Elsever, Amsterdam.

Slee, J., 1985. Physiological responses and adaptations of sheep. In: M. K. Yousef, Ed., stress Physiology in Livestock, vol. 2, Ungulates, pp. 111-125. CRC Press. Inc., Boca Raton. Raton, Florida.

Thompson, J. R., R. J. Christopherson, V. A. Hammond and G. A. Hill, 1978. Effects of acute cold exposure on plasma concentrations of noradrenaline and adrenaline in sheep. Can. J. Anim. Sci. 58:23-28.

Webster, A. J. F., 1974. Adaptation to cold in: D. Robertshaw (Ed.), Environmental Physiology Series I., 7. University Park Press, Baltimore.

Weekes, T. E. C., Y. Sasaki and T. Tsuda, 1983. Enhanced responsiveness to insulin in sheep exposed to cold. Am. J. Physiol. 244:E335-E345.

Young, B. A., 1985. Physiological responses and adaptation of cattle in : M. K. Yousef (Ed.), Stress Physiology in Livestock. CRC press Inc. Florida, USA.

Young, B. A., B. Walker, A. E. Dixton and V. A. Walker, 1989. Physiological adaptation to the environment. J. Anim. Sci. 67:2426-2432.

الاستجابة الفسيولوجية فى الجاموس للحرارة البيئية المنخفضة ونظام الإيواء

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الهدف من الدراسة هو تحديد الاستجابة الفسيولوجية للموسم البارد وطريقة الايواء فى الجاموس الحلاب تحت ظروف مصر العليا. استخدم خمسة عشر من الجاموس الحلاب مقسمة إلى ثلاثة مجاميع متزنة بالنسبة للعمر وأيام الحليب وانتاج اللبن عند بداية فترة الدراسة (٣ اسابيع) : المجموعة الأولى تم ايواءها داخل الحظيرة نهاراً (درجة الحرارة الساعة ١٢-١٤ - ١٥,٧ °م) وخارج الحظيرة ليلاً (درجه الحرارة الساعة ٢٣-٢٤ - ٧,٣ °م) ، المجموعة الثانية تم ايواءها خارج الحظيرة نهاراً (درجة الحرارة ١٧,٥ °م) وداخل الحظيرة ليلا (درجة الحرارة ١٠,٥ °م) فى موسم الشتاء. المجموعة الثالثة تم ايواءها خارج الحظيرة ليلا (١١,٣ °م) ونهاراً (٢٩,٤ °م) فى موسم الربيع. تم تقدير تركيز الهيموجلوبين ونسبة المكونات الخلوية فى الدم ومحتوى السيرم من الجلوكوز ، اليوريا-نيتروجين ، البروتين الكلى ، الالبيومين ، الجلوبيولين والبليوروبين . كذلك تسجيل معدل التنفس ، حرارة الجلد والمستقيم.

خلال موسم الشتاء كانت هناك زيادة معنوية فى محتوى السيرم من الجلوكوز ($P<0.01$) ، اليوريا-نيتروجين ($P<0.05$) ، البروتين الكلى ($P<0.01$) ، الالبيومين ($P<0.01$) ، الجلوبيولين ($P<0.01$) والبليوروبين ($P<0.05$). درجة الحرارة الباردة فى الشتاء أدت الى زيادة ($P<0.01$) فى حجم المكونات الخلوية والهيموجلوبين فى الدم (فى المجموعة الثانية فقط) . المجموعة الأولى تملك تركيز أقل من المكونات الخلوية والهيموجلوبين بالدم بالمقارنة بالمجموعة الثانية . لاتوجد هناك فروق معنوية بين المجموعة الأولى والثانية فى محتوى السيرم من الجلوكوز ، اليوريا-نيتروجين ، البليوروبين ، البروتين الكلى ، الجلوبيولين والألبيومين. حرارة الشتاء المنخفضة أدت الى انخفاض معدل التنفس وحرارة المستقيم والجلد. هناك انخفاض فى حرارة المستقيم ومعدل التنفس عند منتصف الليل مقارنة بمنتصف النهار .

الخلاصة: حرارة الشتاء المنخفضة فى مصر لها تأثير معنوى على مكونات السيرم ، حرارة المستقيم ، معدل التنفس خاصة عند ايواء الحيوانات خارج الحظائر ليلا. وهذه الدراسة تحتاج الى دراسات أكثر تحت نظم الإيواء المختلفة خاصة فى العجول الصغيرة.