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PHYSIOLOGICAL RESPONSES OF BUFFALO CALVES TO HOUSING PRACTICES DURING COOL WINTER TEMPERATURE

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SUMMARY

The effect of housing practices on growth performance, some blood constituents and thermo-respiratory responses were studied on 18 buffalo calves of about one year of age during the period from December to February under Upper Egypt conditions. Average maximum and minimum air temperatures during the study were 21.9 and 2.0° C, respectively. Animals were assigned at random to two groups, the 1 st group (A) was housed indoors during the night and outdoors during the day, and the 2 nd group (B) was housed outdoors during the night and indoors during the day. Each group was examined for growth performance, some blood constituents, rectal and skin temperatures and respiration rate during a 12-week experimental period. The average body weight and daily gain in group B were 6 % ($P<0.10$) and 30% ($P<0.01$), lower than in group A (149.9 kg and 374.3 g/d; 159.6 kg and 535.7 g/d, respectively). Animals exposed to low air temperature (group B) had significantly lower hemoglobin and packed cell volume, PCV,%. Group B also had lower concentrations of serum total protein, globulin, and total lipids. Exposure to cold temperature (group B) increased concentrations of serum glucose by about 24% ($P<0.01$), at the 4 th week of exposure, total bilirubin by 56% ($P <0.05$), and AST by 23%. Serum ALT and urea nitrogen were not significantly different between groups. Respiration rate, and rectal and skin temperatures were lower at 6.00h than at 12.00 h, and in group B than in group A at either periods. It is concluded that, cold exposure during the night of winter in upper Egypt decreased growth performance of buffalo calves.

Keywords: Buffalo calves, housing practice, cold, blood, growth, physiological parameters

INTRODUCTION

Young animals are very susceptible to environmental stressors such as heat (Kobeisy, 1983) or cold exposure (Scott *et al.*, 1993). It has become clear

that cold exposure interferes with the availability of nutrients for animal production and that feed are directed toward providing substrates for use in thermogenesis rather than milk (Kobeisy and Ibrahim, 1996), or growth (Scott *et al.*, 1993).

In addition to low air temperature, which may reach 1° C during the night in Upper Egypt, maximum wind speed may reach 10 knots, KT (KT=1.25 mile/h). So, lactating buffaloes could become physiologically stressed by the cold in Upper Egypt (Kobeisy, 1996), but milk performance was less affected (Kobeisy and Ibrahim, 1996). Buffalo calves were not examined for growth performance under such conditions, therefore, the study reported here was conducted to identify the effects of cold environment (housing practices) on growth performance, blood constituents and thermo-respiratory response of buffalo calves.

MATERIAL AND METHODS

This study was carried out during the cold months of winter (December to Februry) in the Animal Production Experimental Farm of the Faculty of Agriculture, Assiut University. Meteriological data of Assiut Province obtained from the Meteriological Department are presented in Table 1.

Table 1. Meterological data of Assiut Province during the study

Month	Air temperature, °C		Relative humidity, %		Wind speed
	max.	min.	max.	min.	KTS *
December	23.0 ± 0.30	2.6± 0.31	91.6 ± 0.54	41.4 ± 1.00	3.4 ± 0.33
January	22.0 ± 0.59	2.2± 0.28	85.5 ± 1.36	40.5 ± 1.61	3.8 ± 0.39
February	20.8 ± 0.45	1.1± 0.15	85.3 ± 1.04	34.7 ± 0.79	5.4 ± 0.34

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

Animals and mangement: Eighteen buffalo calves of about one year of age, were divided into two groups, similar in body weight (averaging 139.1 ± 12.8 and 137.7 ± 12.1 kg for group A and group B, respectively), age and sex of animals. The 1*st* group (group A) was housed indoors during the night and outdoors during the day. However, the 2*nd* group (group B) was housed outdoors during the night and indoors during the day. The building was a semi-closed barn which had aspestus roof and a side wall of cement bricks. The height, width and length of the building were 2.5, 4.2 and 7.4 m, respectively. The height of windows, base from the ground was 1.5 m, but, plastic sheets were used to close the windows and door. The outside yard was 11.7 m in length and 7.4 m in width and the side wall was about 1 m. The trial lasted for 12 weeks. The animals were fed on a ration consisted of 60% concentrate and 40% roughage (rice straw and berseem, 3:1) to cover their requirements as calculated according to Ghoneim (1967). The concentrate diet consisted of

corn (40%), cottonseed meal (25%), wheat bran (32%), limestone (2%) and sodium chloride (1%). Diets were offered to the animals twice daily, at 8.00 h and at 15.00 h, and water was freely available.

Animal performance : Body weight measurement was carried out early in the morning before access to feed and water. It was recorded every two weeks and daily gain was calculated.

Blood sampling and analytical methods: Blood samples were taken from each animal at selected weeks (4, 7 and 9) during the experiment. Samples were collected before feeding at 9.00 h in two clean vials, one for serum collection, and the other contained EDTA. Serum was separated by centrifugation at 3000 rpm for 15 min and was stored at -20° C until analysis. Serum total protein concentration was determined using kits supplied by Bio merieux (France). Serum albumin , urea-nitrogen, glucose, total bilirubin, aspartic aminotransferase (AST), alanine aminotrasferase (ALT) and total lipid concentrations were determined using kits supplied by Diamond Diagnostic (Egypt). Serum globulin concentration was determined by difference between serum total protein and serum albumin. Hemoglobin concentration (Hb, g/dl) was determined using kits supplied by Diamond Diagnostics. Packed cell volume (PCV) % was determined using standard procedures as described by Schalm (1986).

Thermo-respiratory assessments: Respiration rate (RR, breath/min.) was determined by counting the flank movements for 1 min. It was carried out every two weeks at 6.0 to 8.00 h and at 12.00 to 14.00 h during the experimental period. Rectal temperature (RT) and skin temperature (ST) of six skin regions, neck, shoulder, mid-dorsal, mid-side, abdomen and flank, were measured using clinical thermometer and digital telethermometer (± 0.1° C). They were performed in all animals after recording the respiration rate. Air temperature and relative humidity were recorded at the same time of measurments.

The data were subjected to least-squares analysis of variance using Harvey (1987) computer program.

RESULTS AND DISCUSSION

Growth performance: Animals housed outdoors during the night (group B) had lower final body weight and gained more slowly ($P < 0.01$) than those housed indoors (group A). Exposure of animals to cold environment (group B) decreased average daily gain by 30 % ($P < .01$, Table 2). The decrease in daily gain of animals in cold environment may be attributed to: (1) cold exposure decreases growth hormone secretion (Sano *et al.*, 1995). (2) cold

exposure decreases the apparent digestibilities of feed nutrients (Christopherson, 1989). This could be attributed to the reduction in retention time of particulate and fluid digesta in the ruminoreticular due to increased reticular motality during cold exposure (Christensen *et al.*, 1991), and consequently, reduced fermentation and nutrients available for absorption. The decrease of feed nutrients available for absorption during cold exposure is amplified by the decrease of blood flow to the reticulo-rumen (Schaefer and Young, 1981). (3) cold exposure increases blood concentrations of cortisol (Godfrey *et al.*, 1991), epinephrine and norepinepherine (Fukuhara *et al.*, 1996), which stimulate catabolic processes (Hadley, 1984). In fact during cold environment muscle and skin have lower priority for nutrients than other organs and tissues due to the cold-induced alteration in the endocrine system. Such physiological response to cold is very important to provide glucose and other substrates for use in thermogenesis rather than growth (Scott *et al.*, 1993).

Table 2. Animal performance as influenced by housing practices during cool winter temperature

Item	Group A*	Group B*
Number of animals	9	9
Initial weight (kg)	139.1± 12.8	137.6 ± 12.1
Final weight (kg)	184.1 ± 12.8	169.4 ± 12.1
Daily gain (g/d)	533.7 ± 43.2^{c}	374.3 ± 40.7^{d}

* group (A) housed indoors during the night and outdoors during the day, group (B) housed outdoors during the night and indoors during the day
Values are least squares means ± standard error of LSM, c,d ($P<0.01$)

Hematological Response: Animals exposed to cold air temperature (group B) had significantly ($P< 0.01$) lower concentrations of hemoglobin (Hb) and packed cell volume (PCV,%). The decreases in Hb and PCV were about 6 and 9%, respectively (Table 3). It may be expected that both blood Hb and PCV concentrations will increase during cold exposure due to the reduction in plasma volume as reported by Degen and Young (1980). However the decline in these hematological parameters in animals exposed to cold were possibly brought about by elevations in the circulating cortisol levels (Godfrey *et al.*, 1991), increased the rate of red blood cell destruction and/or decreased the new red blood cell formation (Lee *et al.*, 1975). When erythrocytes are hemolyzed, the heme is produced and converted to biliverdin and then reduced to bilirubin (Reece, 1997). For this reason, serum total bilirubin was increased by about 56% after cold exposure (group B, Table 3). Similarly, high serum bilirubin concentration during cold season was found in sheep (Degen and Young, 1980) and in lactating buffaloes (Kobeisy, 1996).

Table 3. Hemoglobin (Hb), packed cell volume (PCV,%) and serum total bilirubin concentrations in buffalo calves as influenced by housing practice during cool winter temperature

Sampling	Hb, g/dl			PCV, %			T. bilirubin, mg/dl		
week	A *	B *	SE	A	B	SE	A	B	SE
4	11.33	10.69	0.25	32.78e	28.78f	1.20	.45e	1.14f	.23
7	8.36	7.89	0.25	33.11	31.62	1.20	.58	.25	.23
9	9.31	8.77	0.25	37.56c	33.33d	1.20	.26	.62	.23
mean	9.67c	9,12d	0.15	34.48c	31.24d	0.69	.43	.67	.13

* group (A) housed indoors during the night and outdoors during the day, group (B) housed outdoors during the night and indoors during the day
Values are least squares means , SE=standard error of LSM,
c,d (P<0.01), e,f (P<0.05).

Serum metabolities: Serum total protein concentration was lower in group B than that in group A, such decrease was mainly due to lower concentration of serum globulin rather than albumin (Table 4). One possible reason for the decrease of serum proteins in cold-exposed animals is that high cortisol secretion, due to cold environment (Godfrey *et al.*, 1991), stimulates the use of non-carbohydrate metabolities in thermogenesis. For this reason , Panaretto (1968) found higher level of protein catabolism in ewes exposed to 2-4° C than those exposed to 21°C. Serum urea-nitrogen concentration was not significantly affected by housing practices (Table 4). Sun *et al.* (1994) also found that there was no effect of ambient temperature (6 and 25° C) on clearance rates of urea in 7-month-old rams.

Table 4. Some serum metabolities in buffalo calves as influenced by housing practices during cool winter temperature

Item	Treatment*		
	Group A	Group B	SE
Total protein, g/dl	6.53	6.35	0.23
Albumin, g/dl	3.53	3.62	0.11
Globulin, g/dl	3.00	2.69	0.26
Urea-nitrogen, mg/dl	23.37	22.94	0.87
Glucose, mg/dl	67.32c	71.93d	2.16
AST, u/l	63.07	77.46	5.93
ALT, u/l	11.00	11.89	0.87
Total lipids, mg/dl	495.80	493.30	24.20

* group (A) housed indoors during the night and outdoors during the day, group (B) housed outdoors during the night and indoors during the day
Values are least squares means , SE=standard error of LSM, c,d (P< 0.10).

Animals housed outdoors during the night and exposed to low air temperature (group B) had higher serum glucose concentration than those

housed indoors (group A, Table 4). Exposure to cold environment (group B) increaed serum glucose concentration by about 24% ($P<0.01$) at the 4*th* week of exposure (73.6 v 59.4 mg/dl). High serum glucose in cold-exposed animals may be attributed to the high level of glucocorticoids (cortisol), which regulate glucose availability (Campbell, 1991). Other possible reasons for the high serum glucose concentration during cold exposure is due to the increase in molar proportion of propionate in the rumen (Kelly and Christopherson, 1989), which is the main precursor for glucose synthesis in ruminants (Reynolds, 1995). The increase of serum glucose during cold environment are, therefore, very important adjustments that help the ruminants to cope with the metabolic challenges of a cold environment. One would expect that the increase of blood glucose must be correlated with the increase in insulin secretion and, consequently, improved anabolism and growth (Kobeisy and Abd El-Ati, 1995). However during cold exposure, insulin response to glucose decreased in sheep (Christensen *et al.*, 1990). Serum total lipids concentration tended to be lower in group B, but these changes were not significant (Table 4). In cattle the decline in blood lipids occurring during exposure to cold supports the idea that fat is a fuel for heat production (Thompson, 1976), and that fat mobilization is enhanced by low environmental temperature. Christensen *et al.* (1990) found that chronic (32 h) cold exposure (-0.9° C) increased ($P<0.05$) plasma free fatty acids in sheep. Godfrey *et al.* (1991) also found an increase of nonesterified fatty acids in cold air temperature exposed calves.

Serum transaminases (AST and ALT) : Animals housed outdoors during the night (group B) had higher serum AST and ALT concentrations than those housed indoors, group A (Table 4). Serum AST concentration increased by 23% due to cold exposure, thus suggesting increased synthesis of this enzyme in response to an increased need for gluconeogenesis. Both enzymes, AST and ALT, are very important in glucose synthesis from noncarbohydrate metabolitie sources (Harper *et al.*, 1977). It is clear that high level of AST may increase protein catabolism, to synthesize glucose. This explains, at least partly, the poorer growth rate of animals exposed to cool winter temperature during the night, group B (Table 2).

Thermo-respiratory response: Respiratin rate (RR), and rectal (RT) and skin (ST) temperatures were greater in the afternoon (12.00-14.00h) than in the morning (6.00-8.00h) in both groups. Animals of group B had lower respiration rate and rectal temperature than those of group A (Table 5). These effects of cold exposure on RR and RT was found in lactating buffaloes by Kobeisy (1996). Skin temperature was lower ($P<0.01$) in group B than in group A both at 6.00-8.00 h and at 12.00-14.00 h. The lowest skin temperature was neck temperature and the highest was flank temperature (Table 5). Similar results were found in lactating buffaloes by Kobeisy (1996). These results suggest

that animals housed outdoors during cool winter temperature modify the rate of heat exchange by vasomotor control of blood flow to superficial tissues, where the decrease of blood flow to skin is the main cause of low skin temperature. In other words, these animals are physiologically stressed by the cold environment during the winter of Upper Egypt. However, additional information of the mechanism(s) involved with endocrine system and skin characteristic functions and hemeostasis need further studies.

Table 5. Respiration rate (breath/min.) and rectal and skin temperatures (°C) of buffalo calves as influenced by housing practices during cool winter temperature

Item	At 6:00 - 8:00 h		At 12:00 - 14:00 h		SE
	Group A*	Group B*	Group A	Group B	
Respiration rate	12.70c	11.22d	18.59	17.63	0.41
Rectal temperature	37.69	37.57	38.70	38.59	0.21
Skin temperature					
Neck	30.87c	27.77d	33.73c	31.62d	0.39
Shoulder	31.84c	30.23d	35.08c	33.80d	0.28
Mid-dorsal	33.42c	30.94d	36.01c	32.81d	0.21
Mid-side	33.21c	31.04d	35.86c	34.81d	0.27
Abdomen	33.65c	30.95d	35.87	35.30	0.32
Flank	33.94c	32.35d	36.45e	35.68f	0.22
Mean	32.83c	30.56d	35.50c	34.32d	0.21

* group (A) housed indoors during the night (Air temperature, AT = 11.6 ± .7 °C and Relative humidity, RH % = 72.9 ± .4) and outdoors during the day (AT = 18.8 ± .9 and RH % = 65.0± 1.7), group (B) housed outdoors during the night (AT = 7.2 ± .3 and RH % = 77.4± .9) and indoors during the day (AT = 19.8 ± .8 and RH % = 63.8 ± 1.0).
Values are least squares means , SE=standard error of LSM
c,d ($P<0.01$); e,f ($P<0.05$).

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الاستجابة الفسيولوجية فى العجول الجاموسى لنظم الإيواء خلال درجة الحرارة الباردة فى الشتاء

مصطفى قبيصى

قسم الإنتاج الحيوانى – كلية الزراعة – أسيوط

تمت دراسة تأثير نظم الإيواء على النمو وبعض مكونات الدم والاستجابة الحرارية والتنفسية فى ١٨ من العجول الجاموسى عمر سنة خلال شهر ديسمبر الى فبراير تحت ظروف مصر العليا. كانت درجة الحرارة إلقصوى والصغرى للحرارة الجوية ٢١,٩ °م ، ٢°م على التوالى. قسمت الحيوانات الى مجموعتين ، المجموعة الأولى (A) تم إيواؤها داخل الحظيرة ليلا وخارج الحظيرة نهارا أما المجموعة الثانية (B) تم إيواؤها خارج الحظيرة ليلا وداخل الحظيرة نهاراً. تم إختبار كل الحيوانات بالنسبة لمعدلات النمو وبعض مكونات الدم ، درجة حرارة المستقيم والجلد ومعدل التنفس خلال ١٢ أسبوع فترة تجريبية .

إنخفض متوسط وزن الجسم ومعدل الزيادة اليومية فى المجموعة الثانية (B) بمعدل ٦٪ و ٣٠٪ (P<0.01) على التوالى مقارنة بالمجموعة الأولى (A) (١٤٩,٩ كجم ، ٣٧٤,٣ جم/يوم ، ١٥٩,٦ كجم و ٥٣٥,٧ جم/يوم). كان هناك انخفاض معنوى فى تركيز كل من الهيموجلوبين والمكونات الخلوية فى الدم فى الحيوانات المعرضة للحرارة الجوية المنخفضة (المجموعة B). كذلك المجموعة B تملك تركيز أقل من البروتين والجلوبيولين والليبيدات الكلية فى سيرم الدم. أدى التعرض للبرد(المجموعة B) إلى زيادة فى تركيز جلوكوز السيرم بواسطة ٢٤٪ (P <0.01) عند الأسبوع الرابع من التعرض ، البليوروبين الكلى بواسطة ٥٦٪ (P <0.03) وانزيم AST بواسطة ٢٣٪ . أما انزيم ALT واليوريا نيتروجين فى السيرم لم يختلف تركيزهما معنويا بين المجموعتين. كان معدل التنفس وحرارة الجسم والجلد أقل فى الساعة السادسة صباحا مقارنة بالساعة الثانية عشر ظهرا فى المجموعة B مقارنة بالمجموعة A .

الخلاصة: يُقلل التعرض للبرد خاصة خلال فصل الشتاء ليلا فى مصر من النمو فى العجول الجاموسى.