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Use of Some Methods for Amelioration Heat Stress in Friesian Calves

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ABSTRACT

Twenty Friesian calves of 3-4 months of age and 90 kg average body weight, were used to investigate the effect of hot climate (36 °C, 65% R.H.) and evaluate two methods of ameliorating heat stress, the first method was feed supplementation with urea and mineral mixture and the second was water sprinkling and supplying the heat stressed animals with cool water. Daily body gain (DBG) was calculated, while serum protein, urea N, cholesterol, creatine, alkaline phosphatese (Alk-P) and acid phosphatese (Ac-P) were determined in this study. The first and second treatments were carried out inside the climatic chamber and the third was undertaken outdoors (36.5 ± 2.5 °C, 62.5 ± 4.5% R.H.). Heat stress induced a significant decrease in DBG, serum protein, urea N, cholesterol, creatine and plasma aldosterone ($P<0.01$) and serum Alk-P ($P<0.05$), while the serum Ac-P decreased insignificantly. The nutritional treatment caused a significant increase in DBG serum protein And urea N ($P<0.01$) and serum creatine ($P<0.05$). Sprinkling and drinking cooled water caused an increase in serum cholesterol, plasma aldosterone ($P<0.01$), DBG, serum protein and creatine ($P<0.05$).

Key words: Heat stress, amelioration, aldosterone hormone.

INTRODUCTION

When the exotic European breeds of cattle are imported in tropical countries, they are faced with many problems related to hot climate particularly heat stress. The high environmental temperature increase the heat load on animals, thus depresses the feed intake1. Consequently, the production is significantly reduced. Different methods have been used to alleviate heat load in heat stressed animals to improve their production such as shading, water sprinkling, air conditioning, goitrogen and diaphoretics administration and drinking cool water2.

The present study was carried out to test the feasibility of some methods which may be utilized as tools for improving the performance and physiological conditions of Friesian calves in upper Egypt. These methods are nutritional (urea and minerals feed addition) and physical (Sprinkling and drinking cool water).

MATERIALS AND METHODS

Twenty Friesian calves which were 3-4 months old and of 90 kg average body weight, were used in this study. The animals belonged to the ARE USA-NSF Project Bovine Adaptation to the Sahara, which is located at the Atomic Energy Authority.

The calves were fed on pelleted concentrate mixture (35% umdecorticated cotton seed cake, 33% wheat bran, 22% yellow corn,4% rice bran, 2% lime stone, 1% sodium chloride and 3% molasses). The amount was given according to animals body weight and daily

gain, which was an overage 2.5 kg/day/head[3]. In addition, a mixture of vitamins A, D3, E and C (DEVIDREL) was offered. Rice straw was offered *ad libitum* after the concentrate was completely consumed. Water was provided *ad libitum* all the time.

In the first trial , the animals were subjected to mild climate (control) for 20 day (18°C, 65% R.H.) then to hot climate (36°C,65% R.H.) for 30 day (8 hrs daily from 9 a.m. to 5 p.m. and 21± 3°C, 65± 5% R.H. for the rest of the day).

In the second trial, the calves were given feed additives (urea and minerals) under the same above-mentioned conditions for 35 day. Urea of 46% nitrogen and mineral mixture were added to the concentrates of the rates of 1% and 0.1%, respectively. The mineral mixture consisted of 990 mg potassium chloride, 199 mg manganese sulphate, 100 mg zinc Oxide, 199 mg magnesium sulphate, 21 mg sodium borate and 63 mg cobalt chloride. At the end of 35 days, feed additives were with held for 20 day as a switch back design to correct for the advance in age, after which the animals were taken out of the climatic chamber.

In the third trial, the calves, which were grown to 5-6 months old and weighed 152.7 kg an average at that time, were maintained for 35 days during the summer in a semi-sheltered yard. The average air temperature and relative humidity of 35 day exposure period were 36.5 ±2.5 °C and 62.5±4.5%, respectively. The animals were divided randomly into two equal groups. One group was kept as control, whereas the other one was treated with water spraying (24.0 °C) and drinking *ad libitum* cool water (10 -15°C) for external and internal cooling. All calves spray five times daily at 11, 12, 13, 14, and 15 hrs. The duration of spraying was 2 minutes per calf.

Blood samples in each trial collected during last 10 days from animals and were cooled immediately in ice. Serum was separated within one hour and stored at (- 20°C) until they were analyzed.

The serum total protein was determined by a colorimetric method using the biuret reagent as described by Armstrong and Carr[4]. Serum urea nitrogen was determined using the method described by Marach et al.[5] (BioMerieux Laboratory Reagents and Product, Marcy/ France). Serum total cholesterol and creatine were measured using a colorimetric method as described by [6,7]. Serum Alk-P and Ac-P were determined calorimetrically using the method of King and King[8]. Plasma aldosterone hormone level was estimate using RIA technique.

The differences between the averages of the treatments were tested by means of the"t" test of significance[9] .

RESULTS AND DISCUSSION

Effect of heat stress on Friesian calves:

The effect of heat stress on DBG, serum total protein, serum urea, cholesterol, creatine, Alk-P, Ac-P, and plasma aldosterone are given in Table 1. It could be noticed that subjecting animals to temperature caused significant decreases in DBG, serum total protein, urea, cholesterol, creatine and plasma aldosterone ($p<0.01$). Serum Alk-P decreased significantly ($P<0.05$), whereas Ac-P did not change significantly.

The decrease in DBG in heat stressed calves was attributed to the decline of anabolism that essentially caused by the decrease in voluntary feed intake of nutrients, metabolizable and net energy[10,11]. On the other hand, catabolism increases mainly in fat depots and lean body mass[12] and endogenous DNA and RNA catabolism[13] as a result of an increase in catecholamines and glucocorticoids[14].

The present work clearly showed that heat stress caused a decrease in serum protein and urea. These results are in agreement with Niles and Collier[15] . In this respect, Kamal et al.[16] reported that high environmental temperature decreased the concentration of some amino acids in the plasma. This decrease seems to be due to the direct effect of high ambient temperature on the catabolic process in the body. It was found that cattle exposed to high ambient temperature in the filed or in the climatic chambers showed significant tissue destruction as indicated by a decrease in nitrogen balance[17] , dry body weight[18], whole body 40k[19] and total body solids[12]. The decrease in protein may also be attributed to the decrease in feed nitrogen and mineral intake occurred under heat stress conditions[1,20].

The decrease in serum cholesterol may be due to a haemodilution effect where more water is transported in the circulatory system for evaporative cooling[21] or to the decrease in feed intake[1]. The decline in creatine in Friesian calves as a function of heat stress may be attributed to the reduction in feed consumption[1] and the increase in blood and plasma volume as a result of increase in water consumption under heat stress conditions[22].

The decrease in Alk-P activity when calves were subjected to heat stress may be attributed to the reduction in thyroid hormones, which takes place under heat stress[23,24]. These result are in agreement with those obtained by Roussel and Stallcup[25] and Hussein[26]. Serum level of Ac-P activity decrease insignificantly when animals were under heat stress. These results are in agreement with those obtained by Roussel and Stallcup[25].

Plasma aldosterone concentration decreased significantly under heat stress. Similar results were found as suggested earlier by Kamal et al[17] who found a decrease in urinary Na/K ratio in heat stressed heifers. The decrease in plasma aldosterone could be explained by the decrease in K intake due to decreased raphage intake in hot climate[27].

Effect of urea and mineral mixture supplementation to heat-stressed Friesian calves:

Increasing the quality of the feed with a nutritional supplement as Shown in Table 2, increased DBG, serum protein and urea. Such an increase was significant ($B<0.01$), while the serum creatine increase significantly at ($P<0.05$), serum cholesterol, Alk-P and Ac-P did not change significantly with such treatment. This treatment improved the appetite and feed intake. Thus leading to compensate the protein loss that occurs during the heat induced protein catabolism and consequently DBG was increased.

Effect of sprinkling and supplying the heat-stressed Friesian calves with cool water:

Table 3, shows that spraying and supplying the heat-stressed animals with cool water caused a significant increases ($p < 0.01$) in serum cholesterol and plasma aldosterone, while ($p<0.05$) in DBG, serum total protein and creatine. Serum urea, serum Alk-P and Ac-P activities, however, did not change significantly.

The increase in DBG, serum protein, cholesterol, creatine and plasma aldosterone by sprinkling and drinking cool water under hot climate may be attributed to the direct effect of cooling process which aided animals to reach a steady physiological state with respect hemodilution normally occurring in heat stressed cattle[22] . Such cooling processes apparently caused the animals to drink less water. Thus the heat-induced decrease in serum protein content caused by hemodilution resulted from increased total body water[28] and blood volume[22] was restored (7.53% Table 3) close to its normal level under mild climate (7.94% Table 1). It is also possible that this cooling treatment improved the appetite of animals thus causing an increase in protein intake, either from feed or from digested rumen microorganisms, and consequently an increase in serum protein content.

Conclusively, it seems that the sprinkling and drinking cool water technique is an ideal agent compared with nutritional technique

Table 1. Effect of heat-stress on some blood components in growing Friesian calves

Items	Mild climate (18°C 65% R.H.)	Hot climate (36°C, 65% R.H.)	Difference %	"t"
Daily body gain (kg)	0.751 ±0.03	0.497 ±0.03	33082	21.374**
Serum total protein (gm/100 ml)	7.94 ±0.16	6.86 ±0.08	13.60	6.108**
Serum urea (m mol/L)	4.78 ±0.32	3.45 ±0.26	27.82	5.308**
Serum cholesterol (mg/100 ml)	119.80±1.07	108.49 ±1.39	9.44	11.198**
Serum creatine (mg/100 ml)	1.18 ±0.03	0.94 ±0.03	20.34	6.167**
Serum alkaline phosphates (U/100 ml)	8.72 ±0.51	8.20 ±0.55	5.96	2.246*
Serum acid phosphates (U/100 ml)	5.20 ±0.18	5.11 ±0.17	1.73	0.911
Plasma aldosterone (Pg/ml)	77.36 ±0.89	63.33 ±1.79	18.14	8.222**

** P<0.01, P<0.05

Table 2. Effect of urea and mineral mixture addition on some Blood components in growing Friesian calves

Items	Control (36°C, 65% R.H.)	Treated (36°C, 65% R.H.)	Difference %	"t"
Daily body gain (kg)	0.479 ±0.03	0.644 ±0.05	29.60	4.744**
Serum total protein (gm/100 ml)	6.09 ±0.08	7.28±0.17	6.12	3.015**
Serum urea (m mol/L)	3.45±0.26	4.39 ±0.29	27.24	5.009**
Serum cholesterol (mg/100 ml)	108.5 ±1.39	108.0 ±1.90	0.42	0.828
Serum creatine (mg/100 ml)	0.94 ±0.03	1.11±0.07	18.08	2.790*
Serum alkaline phosphates (U/100 ml)	8.20 ±0.55	8.34 ±0.56	1.70	1.770
Serum acid phosphates (U/100 ml)	5.11 ±0.17	4.96 ±0.19	2.93	1.035
Plasma aldosterone (Pg/ml)	63.33 ±1.79	64.50 ±1.80	1.85	1.904

**P< 0.01, * P< 0.05

Table 3. Effect of sprinkling and drinking cooled water on some blood components in growing Friesian calves

Items	Control (36.5± 2.5°C, 62.5± 4.5% R.H.)	Treated (36.5± 2.5°C, 62.5± 4.5% R.H.)	Difference %	"t"
Daily body gain (kg)	0.563 ±5.03	0.700 ±0.04	14.33	2.727*
Serum total protein (gm/100 ml)	6.96 ±0.18	7.53 ±0.19	8.20	2.192*
Serum urea (m mol/L)	3.80 ±0.35	4.19 ±0.26	10.30	0.871
Serum cholesterol (mg/100 ml)	105.6 ±1.44	122.9 ±1.34	16.40	14.070**
Serum creatine (mg/100 ml)	0.83 ±0.03	0.97 ±0.04	16.90	2.284*
Serum alkaline phosphates(U/100 ml)	9.86 ±0.50	8.75 ±0.42	11.30	1.730
Serum acid phosphates (U/100 ml)	5.53 ±0.09	5.30 ±0.07	4.20	1.866
Plasma aldosterone (Pg/ml)	55.20 ±1.74	71.82 ±2.28	30.11	5.255**

** P< 0.01 * P< 0.05

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