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Ameliorative effect of zinc and manganese supplementation in buffalo calves during hot climatic conditions

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ABSTRACT

Ameliorative effect of zinc and manganese on buffaloes was studied during natural hot summer climate. Buffalo calves (18) of either sex in age group of 6–7 months were divided in groups A, B and C of 6 each. Group A was supplemented with zinc sulphate @500 mg/ animal/ day, group B was supplemented with zinc sulphate @500 mg/ animal/ day plus $MnCl_2$ @500 mg/ animal/day daily during the experimental period, while group C was kept as control. Respiration rate, pulse rate and rectal temperature increased significantly from morning to evening, while animals of zinc sulphate supplemented group had significantly lower respiration rate in the evening compared to other groups. The activity of alkaline phosphatase and concentration of glucose, cholesterol, triglyceride, calcium, magnesium, potassium, triiodothyronine (T_3) and thyroxine (T_4) did not vary significantly different among groups. However, in zinc sulphate supplemented group, the concentration of blood urea and aspartate aminotransferase decreased significantly compared to control and zinc sulphate plus manganese chloride supplemented group. The significantly higher plasma sodium concentration was observed in zinc sulphate and zinc sulphate plus manganese chloride supplemented group compared to control group. Our results indicated that supplementation of zinc sulphate during hot summer may ameliorate some effect of heat stress in buffalo calves.

Key words: Buffalo calves, Heat stress, Hot climate, Zinc

Heat stress due to coat color and less number of sweat glands is a major constraint for improving the buffalo productivity (Das *et al*. 1999). Heat stress can produce an imbalance between reactive oxygen species (ROS) and antioxidants, which lead to oxidative stress. Reactive oxygen species-induced damage of cells and molecules is one of the mechanisms responsible for the decline in an animal's performance during heat stress (Mujahid *et al*. 2007).

Zinc also has antioxidant role by contributing to the structure of the antioxidant enzyme as superoxide dismutase (Davis *et al*. 1998, Marklund 1992). This also retards oxidative process indirectly by various mechanisms (Powell 2000). Trace element, manganese is a component of the antioxidant enzyme manganese superoxide dismutase (MnSOD), which can neutralize free radicals and may reduce some of the free radicals damage.

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Therefore, this experiment was conducted to investigate the ameliorative effect of zinc and manganese supplementation during natural hot climatic conditions in buffalo calves.

MATERIALS AND METHODS

Buffalo (*Bubalus bubalis*) calves (18) of either sex in age group of 6–7 months maintained in experimental animals shed under good husbandry practices were used. They were provided 0.5 kg concentrate mixture with 1% salt and; wheat straw, green fodder and water *ad lib.* During the experiment (July and August), the animals were maintained in experimental animal shed, and the minimum and maximum THI (temperature humidity index) was calculated as 78.58 and 89.38, respectively. The animals were divided into 3 groups of 6 animals each. Group A was supplemented with zinc sulphate @500 mg/ animal/day, group B was supplemented with zinc sulphate and $MnCl_2$ @500 mg/ animal/day daily during the experimental period, while group C was kept as control.

The supplementation started 1 week before the start of experiment. The physiological responses (respiration rate, pulse rate and rectal temperature) were recorded weekly,

using standard techniques, at 07: 30 in the morning and at 02: 30 in the afternoon. The plasma and serum samples were collected at fortnightly interval for the estimation of biochemical and hormonal parameters. The plasma was stored at –20°C until analysis of biochemical and hormonal parameters. The biochemical estimations were done using kits whereas sodium and potassium were analyzed by flame photometer. The thyroid hormones were estimated by RIA technique using kits. The statistical analysis was done as per Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The respiration rate increased significantly (P<0.05) from morning to evening in all the experimental animal groups, however, it was significantly (P<0.05) lower in zinc supplemented group compared to control group (Table 1).

Table 1. Effect of zinc sulphate and zinc sulphate plus manganese chloride on physiological responses of buffalo calves under natural climatic stress

	Group A ($ZnSO_4$)	Group B ($ZnSO_4$ + $MnCl_2$)	Group C (control)
Respiration rate			
Morning	15.75 ± 0.48^{A}	15.66 ± 0.37^{A}	17.75 ± 0.55^{A}
Evening	28.41 ± 1.32^{aB}	30.64 ± 1.74^{abB}	33.05 ± 1.67^{bB}
Pulse rate			
Morning	51.16 ± 0.70^{A}	51.95 ± 0.63^{A}	53.25 ± 0.61^{A}
Evening	57.02 ± 1.13^{B}	58.16 ± 1.03^{B}	58.72 ± 0.94^{B}
Rectal temperature			
Morning	101.10 ± 0.80^{A}	101.22 ± 0.09^{A}	101.32 ± 0.07^{A}
Evening	102.16 ± 0.12^{B}	102.21 ± 0.13^{B}	101.96 ± 0.14^{B}

Means bearing different superscripts (a,b,c) are significantly (P<0.05) different in row. Means bearing different superscripts (A,B,C) are significantly (P<0.05) different in column.

The rise in respiration rate is a means to lose heat from the body as was observed in present study. Coppock *et al*. (1982) also reported that under high ambient temperatures the respiration rate increased as a part of physiological adjustments. Srikandakumar and Johnson (2004) observed a significantly increased respiratory rate in 3 cattle breeds during heat stress. Respiratory rates may be increased as an adaptive measure to maintain thermostability by evaporative cooling. In the present study, the lowered respiration rate in zinc supplemented group may be due to the ameliorative effect of zinc during heat stress.

The pulse rate and rectal temperature in all 3 groups increased significantly from morning to evening. However, no significant effects of supplementation have been recorded. The increase in both these parameters indicated that the animals were under heat stress during evening. According to McDowell *et al.* 1976 the body temperature is a sensitive indicator of physiological response to heat stress and even a small increase in rectal temperature is enough to reduce performance in most livestock species.

The biochemical and hormonal responses under natural climate are presented in Table 2. The concentration of plasma glucose was maintained fairly at constant level and no significant difference was observed among different groups.

The plasma urea concentration decreased significantly (P<0.05) in zinc supplemented groups as compared to control and zinc plus manganese supplemented groups. Srikandakumar and Johnson (2004) reported a decrease in blood urea nitrogen in response to heat stress in Holstein, Jersey and Australian Milking Zebu Cows. Houpt (1959) reported that the conversion of absorbed ammonia to blood urea by the liver and the recycling of urea to the rumen is valuable to protein cycle. Zn supplementation decreases ruminal NH_3 concentrations in sheep after feeding urea-supplemented, low quality roughage (Rodriguez *et al*. 1995).

Table 2. Effect of zinc sulphate and zinc sulphate plus manganese chloride on biochemical parameters of blood in buffalo calves under natural climatic stress

Parameters	Group A ($ZnSO_4$)	Group B ($ZnSO_4$ + $MnCl_2$)	Group C (control)
Glucose (m moles/L)	2.442±0.15832	2.444±0.19114	2.094±0.10107
Urea (m moles/L)	7.396±0.33973 ^{b}	9.318±0.55841 ^{a}	8.900±0.38947 ^{a}
Cholesterol (m moles/L)	2.892±0.08399	2.776±0.19557	2.910±0.23818
Triglycerides (m moles/L)	0.442±0.034	0.496±0.052	0.485±0.059
Alkaline phosphatase (U/L)	41.146±6.18539	40.914±4.42619	35.084±6.32901
Aspartate aminotransferase (U/L)	66.120±6.39612 ^{b}	87.744±6.34145 ^{a}	91.680±1.59198 ^{a}
Calcium (m moles/L)	2.164±0.29049	2.048±0.26895	2.010±0.19131
Magnesium (m moles/L)	0.526±0.106	1.188±0.127	0.613±0.082
Sodium (m moles/L)	120.7±1.65529 ^{a}	116.1±2.27706 ^{a}	109.5±3.02490 ^{b}
Potassium (m moles/L)	3.63±0.13096	3.51±0.11662	3.53±0.08307
T_3 (nmol/L)	1.28±0.03	1.29±0.05	1.41±0.04
T_4 (nmol/L)	25.65±1.40	23.04±2.09	24.13±1.18

Values with different superscript differ significantly (P<0.05) within row.

This property of zinc in decreasing the ruminal ammonia concentration might be the cause of decreased plasma urea concentration in our study.

The cholesterol, triglyceride and alkaline phosphatase concentrations in plasma were comparable in all the groups and no significant change was recorded during natural climate heat stress in buffalo calves.

The aspartate aminotransferase activity decreased significantly ($P<0.05$) in zinc sulphate supplemented group compared to control and zinc sulphate plus manganese chloride groups. Srikandakumar and Johnson (2004) also reported lowered plasma aspartate aminotransferase activity in cows during heat stress. Our results are in agreement with Almeida and Barajas (2002) who reported a decrease in plasma aspartate aminotransferase activity in stressed calves supplemented with zinc-methionine.

The plasma sodium concentration decreased significantly ($P<0.05$) in control group as compared to zinc sulphate and zinc sulphate plus manganese chloride supplemented groups. Reffett *et al*. (1986) reported that zinc supplementation resulted in increased serum sodium in weaning beef calves during stress. The concentration of calcium, magnesium and potassium did not vary significantly ($P>0.05$) among groups.

In the present experiment, no significant difference was found in triiodothyronine and thyroxine levels. Bouraoui *et al*. (2002) found a negative correlation in THI and thyroxine in Holstein Friesian cows. The level of stress experienced by buffalo calves in our study may be low and unable to alter the thyroid status of these animals.

In conclusion, heat stress affects various physiological parameters as well as biochemical parameters and supplementation of zinc has some ameliorative effects and can be used in feeding programmes during the warmer months of the year.

REFERENCES

Almeida L and Barajas R. 2002. Effect of chromium methionine and zinc methionine supplementation on cortisol, glucose, aspartate amino transferase, and cratinin in blood of stressed feedlot calves. *Journal of Animal Science* **80** (Suppl. 1): (Abs 1458): 364.

Bouraoui R, Lahmar M, Majdoub A, Djemali M and Belyea R. 2002. The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. *Animal Research* **51**: 479–91.

Coppock C E, Grant P A, Portzer S J, Charles D A and Escobosa A. 1982. Lactating dairy cow responses to dietary sodium, chloride, and bicarbonate during hot weather. *Journal of Dairy Science* **65**: 566–76.

Das S K, Upadhyay R C and Madan M L. 1999. Heat stress in Murrah buffalo calves. *Livestock Production Science* **61**: 71–78.

Houpt J R. 1959. Utilization of blood urea in ruminants. *American Journal of Physiology* **197**: 115–20.

McDowell R E, Hooven N W and Camoens J K. 1976. Effects of climate on performance of Holsteins in first lactation. *Journal of Dairy Science* **59**: 965–73.

Mujahid A, Akiba Y and Toyomizu M. 2007. Acute heat stress induces oxidative stress and decreases adaptation in young White Leghorn cockerels by downregulation of avian uncoupling protein. *Poultry Science* **86**: 364–71.

Powell S R. 2000. Antioxidant properties of zinc. *Journal of Nutrition* **130**: 1447S – 1454S.

Reffett J K, Spears J W, Hatch P A and Brown T T. 1986. Influence of selenium and zinc on performance, blood constituents, and immune response in stressed calves. *Biological Trace Element Research* **9**: 139–49.

Rodriguez B T, Arelovich H M, Villaba J J and Laborde H E. 1995. Dietary supplementation with zinc and manganese improves the efficiency of nitrogen utilization by lambs. *Journal of Animal Science* **37** (Supp1.1): 1233.

Snedechor G W and Cochran W G. 1989. *Statistical Methods*. 8th edition. Iowa State University Press, Ames.

Srikandakumar A and Johnson E H. 2004. Effect of heat stress on milk production, rectal temperature, respiratory rate and blood chemistry in Holstein, Jersey and Australian milking Zebu cows. *Tropical Animal Health and Production* **36 (7)**: 685–92.