INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE & TECHNOLOGY
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www.vmsindia.org

Effect of Environmental Heat on Thyroid Hormones of Buffaloes

Shalini J. Chahande*, Ragini Chahande, A.H. Ansari and Jiwan Chahande
Seth Kesarimal Porwal College, Kamptee, District: Nagpur-441002, Maharashtra(INDIA).sdshalini89@gmail.com, Phone No (M)-9890364933

ABSTRACT
Present study included 80 buffaloes of Nagpuri breed. Buffaloes were under observation from Feb. to Jun. months during 2009 and 2010. Fortnightly observations on blood parameters were undertaken. Buffaloes were secured well with least disturbances. Blood samples were collected aseptically and analysed for thyroid hormones. Serum T3 and T4 were measured by RIA and microplate enzyme Immuno assay (ELISA technique). It is evident from the study that the Triiodothyronine values differ significantly due to treatments. T0 represented significantly lowest value as compared to cooling treatments. Within cooling treatments the numerical differences were observed. T4 group exhibited the highest value (1.69±0.05) followed by T3 (1.67±0.05), T1 (1.63±0.06) and T2 (1.61±0.06). The Thyroxin values differ significantly due to treatments. T0 represented significantly lowest value as compared to cooling treatments. Within cooling treatments also the significant differences were observed. T4 group exhibited the numerically highest value (51.43±0.95) than T3 (50.82±0.88) and T1 (50.04±0.93), whereas T2 (48.29±0.87) exhibited significantly lower value within treatment Group.
Key words: environmental heat, buffalo, thyrotropic hormone,T3, T4.

Heat stress is the state at which the mechanisms activate to maintain animal's body thermal balance, when exposure to elevated temperature. Exposure of buffaloes to the hot conditions evokes a series of drastic changes in the biological functions that include depression in feed intake, efficiency and utilization, disturbances in metabolism of water, protein, energy and mineral balances, enzymatic reactions, hormonal secretions and blood metabolites. Such changes result in impairment of reproduction and production performances. The effect of heat stress is aggravated when environmental heat stress is accompanied by high ambient humidity (Marai *et al.*, 2009, Marai and Habeeb, 2010).One of the greatest challenges facing producers and livestock around the world is environmental heat stress. Environmental heat stress strongly affects animal bioenergetics, with adverse effects on the performance and well being of buffaloes. Environmental factors such as ambient temperature, solar radiation, and humidity have direct and indirect effects on animals.

Buffaloes of Nagpuri breed spread over eastern Vidarbha providence of Maharashtra state. In its native tract these buffaloes principally used as milk producing animals. The race /tribe named as Gaoli posses these animals, in the form of big herds. However, with respect to improved managemental practices, no system as such has been established. Data on many aspects is meagre. Animals are generally kept inside fence or housed under ordinary sheds. Therefore, procurement of animals along with well constructed shed and incorporated managemental practises was problem. Under the scorching summer heat prevail in this region; these animals did not get much protection by mere shed structure. Additional cooling is must to sustain productivity of the buffaloes.

However the information of housing management of buffaloes is scarce overall and particularly in this region, is not available. Few farmers in recent years are seen to adopt newer technology in housing management; hence it was felt imperative to study the advancement in housing management, which would help in improvement of health conditions such as effects on thyroid hormones and hence productivity. Therefore it is felt necessary to carry out research in buffaloes with the objectives of studying the thyroid hormone profile of buffalo under environmental heat stress condition

MATERIAL AND METHODS

Present study was undertaken to estimate the effect of different cooling systems on the well being of buffaloes in the form of health most notably on thyroid function.The buffalo herds located in heavily populated area were under observations. The data thus generated was analyzed using RBD statistical design. Present study included 80 buffaloes of Nagpuri breed..Buffaloes were under observation from Feb. to Jun. months during 2009 and 2010. Fortnightly observations on blood parameters were undertaken.

Topographical and climatic situation of the Place of work:Nagpur is located on the latitude of 21^0 30' North and longitude of 79^0 03' East with a height of 310 Meters above mean sea level. Nagpur comes under the dry hot climatic zone of the tropical region. During summer season the maximum environmental temperature rises to 48 ^{0}C and humidity range from 14 to 16 %. The weather is hot during day time and warm but pleasant during night hours.The average rainfall is 950 to 1250 mm in 59 rainy days. Mean max and min temperatures are 32 to 37 ^{0}C and 15 to 24 ^{0}C. The mean humidity is 35 to 73 %.

Buffalo farming system is traditional in the region. Productivity of animals varies greatly. Grazing and feeding of dry grasses, straws, with little supplementation of concentrates is in vague.

Housing environment: All buffaloes were housed under shed. They were provided with identical diet. The diet included green and dry roughage as well as concentrate. The incorporation of concentrate and greens in the diet was limited and fixed. Rest of the dietary requirement was fulfilled by dry roughage. Ad libitum water was supplied to the animals.

Treatments: One group each of buffaloes was treated with physical measures of environmental heat stress management viz. splashing water(T1), covering body with wet gunny bags(T2), using water sprinklers(T3), and using foggers(T4).

Experimental control: one group of buffalo was kept under shed only(T0).

Blood sampling: Buffaloes were secured well with least disturbances. Blood samples were collected aseptically from the jugular vein puncture before initiation of treatment and at the end of experimental period, in plain vaccutainer tubes. Serum was separated by centrifugation at 3000 rpm for 15 min and stored in aliquots at -20^{0}c until analysed for biochemical parameters.

Hormone assay: Serum T3 and T4 were measured by RIA and microplate enzyme Immuno assay (ELISA technique).

RESULTS

Triiodothyronine: It is evident from the table 1 that the Triiodothyronine values differ significantly due to treatments. T0 represented significantly lowest value as compared to cooling treatments. Within cooling treatments the numerical differences were observed. T4 group exhibited the highest value (1.69±0.05) followed by T3 (1.67±0.05), T1 (1.63±0.06) and T2 (1.61±0.06).

Table 1: Mean ± SE of triiodothyronine (ng/ml) of buffaloes within treatment groups

Treatments	T0	T1	T2	T3	T4	Pooled	CD
Mean±SE	1.38±0.08^b	1.63±0.06^a	1.61±0.06^a	1.67±0.05^a	1.69±0.05^a	1.59±0.05	0.68

Different superscript letters indicate significant differences ($p < 0.05$) among means of the same raw; otherwise indicate similarity.

Thyroxin: It is evident from the table 2 that the Thyroxin values differ significantly due to treatments. T0 represented significantly lowest value as compared to cooling treatments. Within cooling treatments also the significant differences were observed. T4 group exhibited the numerically highest value (51.43±0.95) than T3 (50.82±0.88) and T1 (50.04±0.93), whereas T2 (48.29±0.87) exhibited significantly lower value within treatment Group.

Table 2: Mean ± SE of thyroxin (ug/ml) of buffaloes within treatment groups

Treatments	T0	T1	T2	T3	T4	Pooled	CD
Mean±SE	45.03±1.43^c	50.04±0.93^a	48.29±0.87^b	50.82±0.88^a	51.43±0.95^a	49.12±0.61	1.44

Different superscript letters indicate significant differences ($p < 0.05$) among means of the same raw; otherwise indicate similarity.

Analysis of variance for hormones Triiodothyronine and Thyroxin

Table 3: Analysis of variance to show the effect of replication and treatment on hormone profile

		Triiodothyronine		Thyroxin
SV	df	MSS	DF	MSS
Replication	43	0.15	43	20.92
Treatments	4	0.68**	4	291.60**
Error	172	0.02	172	9.79
Total	219		219	

Table 3 reveals that the Triiodothyronine and Thyroxin differs highly significantly within treatment groups. Significant variation in Triiodothyronine due to week of observation was also observed.

DISCUSSION

Both acute and chronic thermal stress requires metabolic adaptations to accommodate altered nutrient utilization caused by environmental stress. Due to the considerable involvement of the endocrine system in the coordination of hormone concentration of metabolism, it is not surprising that thermal stress results in alteration of hormone concentrations in the blood (Beede and Collier, 1986). Hormones involved in adaptation to thermal stress include thyroxin (T4) and triiodothyronine (T3).

A number of experimental conditions have been used to evaluate hormonal secretion during environmental heat stress including short-term temperature modification using environmental chamber, seasonal comparisons of hormonal-profiles and the use of micro climatic modification during period of environmental heat stress. Differences in experimental conditions have presumably contributed to the disparity of results that are found in the literature concerning hormonal secretions during environmental heat stress.

Thyroxin and triiodothyronine

It has also been recognized that thyroid hormones increase oxygen consumption of tissues and, as a result heat production. Thyroid activity is reduced under environmental heat stress conditions (Beede and Collier, 1986; Silanikove, 2000). The response of concentrations of T3 and T4 to environmental heat stress is slow and it takes several days for levels to reach a new steady-state (Silanikove, 2000). This is not an immediate response to acute heat stress, but instead is involved in the acclimatization of animals to a sustained heat load. A decrease in thyroid hormone level is correlated with a decrease metabolic rate and a reduction in cellular heat production (Beede and Collier, 1986). It is not clear whether the reduction in T3 and T4 is due to thermal inhibition of the hypothalamus or lower feed intake and metabolism (Johnson, 1985).Thyroid gland is one of the most sensitive organs to the ambient heat variation and it has been shown that thyroid hormones are important modulators of developmental processes and general metabolism, Kaneco (1989).

The concentrations of triiodothyronine and thyroxin in cold stress conditions were higher than in heat stress, as reported by the earlier researchers, Nazifi et al. 2005, indicated the stimulatory effect of low temperature on thyroid gland activity. Our study results are therefore in agreement with the previous reports. Scott et al. (1983) suggested initiation of night cooling at the time that rectal temperature was highest was most beneficial to maintain thermo-neutral plasma thyroxin concentration, and that strategically cooling the environmental heat stressed cow could enhance her metabolic potential.

Functional activity of the thyroid gland and thereby caused a relatively lower concentration of thyroid hormones. Cold environment may be stimulus to increase the thyrotrophic hormone output thereby resulting in a higher concentration of thyroid hormones in serum. Although there are some evidences to suggest conversely, that thermal exposure acts directly on the hypothalamic pituitary axis and caused in the reduction in TSH secretion, Tal and Sulaman, 1973, El Nauty and Hassan, 1983. It has also been reported that in dogs, serum T3 and T4 levels are lowest in summer and their concentrations are higher in winter, Tuckova et al, 1995. In contrast to the above finding, Yagil et al 1978, Nazifi et al 1999, reported higher levels of serum T3 and T4 in summer in comparison to winter in the camel. Yagil et al 1978 believed that in summer in summer if enough water is provided to camel, thyroid function is stimulated but in the absence of water inhibition could be seen. Cold environment could be a stimulus to augment thyroid hormones secretion to increase basal metabolic rate in order to maintain body temperature which accompanies with high levels of blood metabolites, Prakash and Rathore, 1991 and Kataria et al. 1993.

The tendency for a decrease in thyroid hormone blood concentration was observed, which is supported by the earlier reports also. The absence of significant interactions between factors emphasize that thermal stress influenced all animals in the same way. This stresses the role of lower thyroid hormone concentration in the acclimatization process by reducing metabolic rate, Baccari et al 1988, Yousef et al 1988. T3 variation is more accurate in studies of thermal stress, Pratt 1986, O' Kelly 1987.

Seasonal variation in the concentration of T4 and T3 was reported by Yagil et al. 1978, Ingraham et al. 1979, Prakash and Rathore, 1991, Flisinska-Tuckova et al. 1995 and Nazifi et al. 1999 in different farm animals. During hot weather, plasma concentration of thyroid hormones (T3, T4) are depressed (El-Nouty and Hassan , 1983, Rasooli et al. (2004), Pereira et al.

(2008),). This appears to be related to the reduction in basal metabolism.

The thyroid gland secretes triiodothyronine (T3) and tetraiodothyronine/ thyroxine (T4). These hormones are the primary determinants of basal metabolic rate and have a positive correlation to weight gain or tissue production, Magdub, et al.1982. The response of T3 and T4 to heat stress is slow and it takes several days for levels to reach a new steady state Silanikove, 2000. A decline in the plasma concentrations of T3 from 2.2 to 1.16 ng/ml has been reported by Johnson et al.1988 whereas a reduced thyroid activity in thermal acclimated cattle has been reported by Gale, 1973. This decline in thyroid hormones along with decreased plasma GH level has a synergistic effect to reduce heat production, Yousef, and Johnson 1966.

The thyroid hormones, T4 and T3, provide a major mechanism important for acclimation and have received considerable research attention. It is well known that heat acclimation decreases endogenous levels of thyroid hormones (in an attempt to reduce endogenous heat production) and those mammals adapted to warmer climates follow this pattern, Johnson and Vanjonack, 1976; Horowitz, 2001.

Magdub et al.1982 reported that during heat stress there were significant reduction in concentrations of triiodothyronine (T3) and thyroxine (T4) in plasma and in milk of lactating cows. However, a significant increase in T3 but not in T4 level was observed during heat stress in crossbred cattle, Singh et al., 1984.

Hala et al. (2009) reported that the serum concentration of the thyroid hormone T3 were significantly (p, 0.056) increased in treated buffaloes with antioxidents and anti heat stress. Marai et al. (2009) reported mean values for T3 ng/dl as 94.2±10.48 & 39.0±10.5 during winter and summer season in rams.

The decrease in T3 by heat stress agreed with results of Marai et al. 1997. Thyroid hormones major role in regulation of overall heat production lies in the control of endothermic thermoregulation, although T3 is more concern with thermo genesis. The decrease in thyroid hormone is due to decrease in basal metabolic rate and muscle activity that decrease heat production during hot condition, Curtis, 1983. The increase in cortisol was similar to the results of Yousef et al. 1997. Activation of the hypothalamic pituitary adrenal axis and the consequent increase in plasma glucocorticoid concentration are perhaps the most important responses of animals to stressful conditions. Adrenal corticoids, mainly cortisol, elicit physiological adjustments that enable animals to tolerate stressful condition, Christison and Johnson, 1972.

Conclusion:

Serum T3 and T4 concentration were lower in environmental heat stressed buffaloes thus hormone concentrations were altered by environment. Serum thyroxin and triiodothyronine concentration were lower in control buffaloes, indicated altered thyroid hormone metabolism in environmental heat stressed buffaloes. In order to improve the thyroid function of the buffaloes which is in question it is necessary to provide proper environmental condition for the sustained living of the buffaloes.

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