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ANALYSIS OF ABIOTIC STRESSOR *VIS-À-VIS* STRESS IN FEMALE NON- DESCRIPT INDIGENOUS CATTLE FROM ARID TRACTS OF RAJASTHAN

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ABSTRACT

An exploration was carried out to analyze effect of abiotic stressor on the development of stress in female non-descript indigenous calves, heifers and cows from arid tracts of Rajasthan during extreme environmental temperature periods. Abiotic stressor was appraised on the basis of temperature humidity index and heat load index values. Stress was assessed on the basis of serum cortisol and plasma catalase. Ostensibly healthy animals were monitored during comfortable, extreme hot-dry, extreme hot-humid and extreme cold environmental temperature periods. The overall mean values of serum cortisol and plasma catalase were significantly ($p \leq 0.05$) higher during extreme hot-humid, extreme hot-dry and extreme cold environmental temperature periods as compared to respective comfortable mean overall value. During extreme hot-humid, the per cent variation was found to be maximum for serum cortisol and plasma catalase. Based on the findings of serum cortisol, it can be construed that calves were found to be impinged on maximally by the effect of stress followed by heifers and cows. Among calves, calf-yearling transition exhibited higher influence of all the extreme environmental temperature periods. Between heifers, pre-pubertals expressed elevated effect of extreme environmental temperature periods. Amongst cows, non-pregnant milch and primipara divulged higher shove of extreme environmental temperature periods. Changes in plasma catalase exhibited the presence of oxidative stress in all the animals and the impact was maximum during extreme hot-humid. The epitome of the present exploration was that extreme hot-humid period caused the development of higher degree of stress in the cattle with fine-tuning in the physiological gambits to an extent which can establish distress to health of animals. Abiotic stressor produced stress to all the animals from calves to cows in all the three extreme environmental temperature periods with peak outcome in hot-humid. Hot-humid period exhibited maximum values of heat load index and temperature humidity index revealing maximum impact of abiotic stressor. Results of present exploration tended to suggest that animals must be supplemented with ample antioxidants. Additionally, marginal farmers must be encouraged to screen the health of non-descript indigenous cattle on a regular basis.

KEYWORDS: Catalase, cold, cortisol, environmental temperature periods, hot-dry, hot-humid.

INTRODUCTION

Abiotic stress is defined as the off-putting bang of non-living features on the living organisms in an explicit environment. The abiotic wavering can critically affect the animal performance or physiology in a sequence. The most common abiotic stressor is intimidating environmental temperature period. Negative impact of non-living factors on living organisms in an explicit ambience has become a global issue now. Chief abiotic factors in arid tract of Rajasthan are extremely high or low temperatures, drought, salinity and other environmental extremes. These factors together affect livestock and agriculture jointly.

Arid tracts of Rajasthan can be divided into moderate, hot-dry, hot-humid and extreme cold periods incorporating the months of October-November; April-May-June; July-August-September and December-January, respectively with some superseding period including February-March months. Researchers believe that extreme environmental temperatures and humidities can influence physiological tactics to a larger extent.[1,2,3] Stress in the animals can be assessed by evaluating the levels of serum cortisol. The animals native to arid region of Rajasthan living under natural husbandry situations are frequently pestered due to rutheless environment resulting in massive economical thrashing to marginal farmers. It becomes mandatory to manage the stress responses and first point of strategy is timely detection of stress. Hence, scientists from time to time have attempted the appraisal of stress by measuring cortisol hormone.[4,5,6,7,8,9] However, there is scarcity of research on this aspect in animals especially non-descript animals. For the execution of all the physiological tactics to combat stress, antioxidants are important. There are many endogenous antioxidants present in the body taking care for the elimination of oxidative stress. Catalase is one of the biomarkers of oxidative stress. There are many causes of oxidative stress ranging from abiotic to biotic stressors.[10,11,12,13,14,15,16,17] Abiotic stressors can be evaluated on the basis of temperature humidity index and heat load index.[18,19,20,21] Non-descript cattle are also considered as backbone of marginal farmers, however, measly scientific attention has been given to them. Therefore, the present study was executed to assess impact of abiotic stressor on the development of stress in non-descript cattle. The data generated in the exploration will assist as edifice for future research.

MATERIALS AND METHODS

Ostensibly healthy non-descript indigenous female cattle (1200) incorporating calves, heifers and cows ageing two weeks old to 11 years of age were monitored from private dairies situated in and around Bikaner district, Rajasthan, India under the permission of Institutional Animal Ethics Committee, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan. Collection of three hundred blood samples was made to harvest serum and plasma each during comfortable (October-November), extreme hot-dry (April-May-June), extreme hot-humid (July-August-September) and extreme cold (December-January) environmental temperature periods. Category of female calves included preruminant, transitional, preweaning, post weaning and calf-yearling transition, each having 30 animals. Category of heifers included pre-pubertal and pos-tpubertal, each encompassing 30 animals. Cows were grouped as A and B. Sub-group A comprised of non-pregnant milch (30); pregnant milch (30) and pregnant dry (30) cows. Sub-group B incorporated primipara (45) and multipara (45) cows. Serum cortisol was determined by chemiluminescence assay. Plasma catalase was determined by standard method.[22] Temperature humidity index values was calculated by standard equation.[23] Heat load index was computed using standard protocol.[24] Data were expressed as mean±SE of mean and special computer programmes were used to calculate means and standard error (http://www.miniwebtool.com). The significance of the impacts was also calculated.[25]

RESULTS AND DISCUSSION

Evaluation of abiotic stressor was carried out by obtaining mean ± SEM values of temperature humidity index and heat load index by collecting data of environmental variables from Bikaner district, Rajasthan during varying environmental temperature periods (ETPs). The mean ± SEM values of temperature humidity index and heat load index are presented in table 1. The mean value of each obtained during comfortable environmental temperature periods was considered as control value.

The elements of temperature humidity index (THI) were minimum, maximum and average. They were classified due to incorporation of minimum, maximum and average required environmental correlates for the computation of THI. The values among environmental temperature periods varied significantly ($p \leq 0.05$). Extreme hot-humid environmental temperature period demonstrated maximum values of all the three components of temperature humidity index as compared to respective values during comfortable, extreme hot-dry and extreme cold ETPs.

The components of heat load index (HLI) were minimum, maximum and average. The values among environmental temperature periods varied significantly ($p \leq 0.05$). Extreme hot-humid environmental temperature period displayed maximum values of all the three components of HLI as compared to respective values during comfortable, extreme hot-dry and extreme cold environmental temperature periods.

Months of starting from April to September generally face high environmental temperature in arid part of Rajasthan. Researchers have divulged impacts of higher and lower environmental temperatures on various physiological aspects of the animals.[24,26,27,28,29] In present investigation, maximum THI of comfortable period showed greater and higher extent in range, however, earlier researchers have reported THI values as 71-72 during comfortable ETP from Bikaner district.[30,31] Researchers[32] have observed THI value as 72 or less during November month from arid tracts of Rajasthan. The THI values obtained during extreme hot-humid ETP in present investigation were higher than those reported previously from the same areas.[31]

Tolerance of the animals to THI depends upon their acclimatization. In the arid tracts of Rajasthan, especially Bikaner district, comfortable months of climate on an average have THI range from 63 to 77 observed by computing the basic average data provided by earlier researchers over and over a long period of time.[24,26] On the basis of these computed facts and data collected in the present investigation, it can be reiterated that comfortable months of the Bikaner district, Rajasthan on an average experienced a higher range of THI in terms of minimum, average and maximum, respectively. Per cent increment in the respective values of THI as minimum, maximum and average was found to be maximum during extreme hot-humid ETP followed by extreme hot-dry ETP as compared to respective comfortable ETP mean value.

The heat load index (HLI) can be instituted as a measure of the environmental heat load which is relegated to cattle. The computation of HLI needs black globe tempertaure which indicates radiation effects in addition to air temperature. The HLI is a marker of physiological stress to the animals.Therefore, HLI in addition to THI has been considered as an important environmental index affecting growth in cattle[32] and physiology of animals.[33,34] Exposure of cattle to extremely high ambient temperatures and high relative humidity for prolonged periods can decline the ability to dissipate heat. The unwarrnted heat load in cattle can give rise to momentous decline in production thereby affecting animal wellbeing. High heat loads are generated when animal's heat production and higher environmental temperature couple together.This drastically affects dissipation of heat from animal. Initial signs are decline in feed intake followed by loss in production. Extended rise in body temperature can cause tissue and organ insults. In present investigation, during extreme hot ETP, the mean value of maximum HLI corroborated the earlier finding from the Bikaner district, Rajasthan.[30]

Parameters of abiotic stressor related with environment incorporating temperature and relative humidity can be grouped into alert, danger and emergency conditions. Various temperature-humidity indexes have been employed to measure the extent of thermal stress faced by cows. THI explains the joint influences of environmental temperature and relative humidity.[24] The need of the hour is to rethink about the critical levels of various environmental elements associated to combine the impact of environment on the animal thermal comfort. India is a great country with different geographical and environmental characteristics. It is mandatory to set up comfort zone of each area having a variety of characteristics. Animals native to these areas are acclimatized with their separate thermal zones. It is not wise to extrapolate ranges of ambient temperatures and humidities applicable to animals of other geographical areas. Comfort experienced by an animal can be gauged by the temperature and analogous heat load index. Different animal species have varying level of sensitivities to temperature and relative humidity, therefore, the heat stress computation is unique for a particular species.[18]

The one of the objectives of the present investigation was to institute the values of comfort index of non-descript animals belonging to area in and around Bikaner district, Rajasthan based upon the environmental variables and analytes for detection of sterss. Animal population in arid tracts experience higher environmental temperatures. They need higehr extent of comfort. Scientists feel that sorting of comfort level has to be appropriate to the area under investigation, hence, data collected in the present study will help in formulating management gambits for micro environments of the animals. Most of the earlier literature available fails to classify the THI values according to minimum, maximum and average ambient temperatures. The comprehensive data obtained in the present investigation will help in redefining the comfort zones of animals according to arid tracts and outlook of the physiological gambits.

Serum cortisol

Mean ± SEM values of serum cortisol are presented in table 1.The overall mean value of serum cortisol (comfortable) was close to the values recorded by researchers in native animals from arid tracts.[4,7,8,12,24,35,36]

Changes in values of serum cortisol during varying ETPs

The overall mean values of serum cortisol were significantly ($p \leq 0.05$) higher during extreme hot, extreme hot-humid and extreme cold ETPs in comparison to comfortable mean overall value. During extreme hot-humid ETP, the per cent variation in the value of serum cortisol was found to be maximum. Researchers are of the view that cortisol level may increase due to various stress factors and a doubling of serum cortisol can be taken as the rise essential for the development of stress.[7,24] Present exploration marked more rise in extreme hot-humid ETP than extreme hot-dry ETP. Hot ambience related rise in the serum cortisol levels has been observed by earlier workers in animals from arid tracts.[4,7,8,24,35]

Stress is a significant incentive for the secretion of CRH and hence the secretion of ACTH. Its high increase during extreme hot-humid ETP founded the progression of stress owing to hot-humid condition. Heat stress can cause a tumble of changes in the physiological mechanisms to combat the stress. Greater cortisol level authenticated the importance in encountering the energy catastrophe during stress.[4]

Cortisol modulates glucose supply by the glucogenolytic and gluconeogenetic features. Researchers advocated that the higher cortisol assists the animals by initiating stress responses. Cortisol augments the reaction of an animal to an intensely stressful happening which have the probable destabilizing feature in terms of psychobiological buoyancy to oxidative insult. This aspect depends upon the length of exposure.[4,7, 24]

The observationsof present study regarding cortisol status are also indicating towards its role as one of the causative factors in the development of oxidative stress. It is appealing to be aware of the role of cortisol in this direction. Results of present study demonstrated that impact of extreme hot-humid ETP was maximum in terms of cortisol modulations followed by extreme hot and cold ETPs. Out of these three extreme ETPs, it can be stated that extreme hot-humid and extreme hot ETPs were able to modulate cortisol systems effectively as compared to cold ETP, which though showed a rise but magnitude was lower.

Effect of physiological states on serum cortisol

Statistical analysis denoted significant ($p \leq 0.05$) changes among all the three overall mean values (calves, heifers and cows) in each environmental temperature period. Overall mean values of calves was minimum and of cows was maximum significantly ($p \leq 0.05$). This pattern was akin for all the environmental temperature periods. Per cent change in the overall mean values of calves was maximum and was least in cows and drift was similar for all the environmental temperature periods. Extreme hot-humid marked maximum per cent variation in each category.This pattern remained similar in extreme hot and cold environmental temperature periods. Mean values were also compared within each category. In each environmental temperature period, variations among all the type of calves were significant ($p \leq 0.05$). Pre-ruminants revealed maximum serum cortisol value and calf-yearling transition showed minimum value in each environmental temperature period. All the types of calves revealed maximum per cent variation during extreme hot-humid environmental temperature period as compared to respective comfortable mean value.

This exhibited that effect of extreme hot-humid was greatest on all the calves followed by hot-dry and cold. Per cent variation in calf-yearling transition group was maximum in extreme hot-humid.In heifers category, post-pubertal had significantly ($p \leq 0.05$) higher values of serum cortisol in each ETP in comparison to pre-pubertal. In both the types, maximum mean values were observed in extreme hot-humid as compared to comfortable environmental temperature period followed by extreme hot and extreme cold environmental temperature periods. In comparative terms,both the groups exhibited higher per cent variations during extreme hot-humid. However, maximum per cent variation was exhibited by pre-pubertal animals.In cows category, among group A animals, pregnant-dry had significantly ($p \leq 0.05$) higher values of serum cortisol in each environmental temperature period in comparison to others. In all the three types, maximum mean values were observed in extreme hot-humid as compared to comfortable environmental temperature period followed by extreme hot and extreme cold ETPs. In comparative terms, all the types exhibited higher per cent variations during extreme hot-humid. Maximum per cent variations were exhibited by non-pregnant milch as compared to pregnant milch and pregnant dry. This pattern was changed in extreme cold, wherein, pregnant-milch revealed maximum variation in comparison to other two types.

In group B animals, multipara had significantly ($p \leq 0.05$) higher values of serum cortisol in each environmental temperature period in comparison to primipara. In both the types, maximum mean values were observed in extreme hot-humid as compared to comfortable environmental temperature period followed by extreme hot and extreme cold. Primipara animals showed higher per cent variations in extreme hot, extreme hot-humid and extreme cold as compared to multipara animals. Previous research has shown the elevated cortisol values in calves at the time of birth. It was divulged that the high cortisol had a tyrannical action with respect to the absorption of colostral gamma-globulins. Weaning stress can rise cortisol in calves. Variations in serum cortisol due to physiological states have been reported.[24] Higher values of serum cortisol could be attributed to stress in calves. Raised cortisol is required for energy homeostasis due to its metabolic role as an energy regulator through gluconeogenesis and lipolysis.[24,26]

Plasma catalase (CAT)

Mean ± SEM values of plasma catalase are presented in table 3.The overall mean value of comfortable period was close to the values recorded by researchers in native animals from arid tracts.[10,11,12,13,24] Catalase is an important biomarker of oxidative stress.

Changes in values of plasma CAT during varying ETPs

The overall mean values of plasma catalase were significantly ($p \leq 0.05$) higher during extreme cold, hot and extreme hot-humid as compared to comfortable mean overall value. During extreme hot-humid, the per cent variation in the value of plasma catalase was found to be maximum. Among extreme environmental temperature periods, the overall mean value of extreme hot-humid was maximum and that of extreme cold was minimum.

Previous researchers have associated extreme environmental temperatures with the greater production of free radicals leading to production of oxidative stress in animals.[10,11,12,13,24] Higher value of plasma catalase in present study demonstrated the impact of extreme environmental temperature periods. It is worth mentioning that higher environmental temperature period was found to be associated with greater generation of free radicals since values of catalase were utmost. Plasma catalase is an important part of antioxidant defense system of the body and a potent endogenous free radical scavenger.

Effect of physiological states on plasma CAT values

Non-descript indigenous female cattle were divided into three major groups (calves, heifers and cows) in all the four environmental temperature periods. The comfortable mean value in each case was considered as control. The variations due to extreme environmental temperature periods were significant ($p \leq 0.05$). Overall mean values of cows were maximum and of calves were minimum significantly ($p \leq 0.05$). This prototype was parallel for all the environmental temperature periods. Per cent shifts were highest in each environmental temperature period in cows. In each environmental temperature period, variations among all the type of calves were significant ($p \leq 0.05$). Pre-ruminant group revealed maximum plasma catalase value in each environmental temperature period. All the types of calves revealed maximum per cent variation during extreme hot-humid as compared to respective comfortable environmental temperature period mean value. This exhibited that effect of extreme hot-humid was greatest on all the calves followed by extreme hot and cold environmental temperature periods. Per cent variation was maximum in pre-ruminant in each environmental temperature period.

Between heifers, post- pubertal had significantly ($p \leq 0.05$) lofty values of plasma CAT in each environmental temperature period as compared to pre-pubertal. In both the types, towering mean values were observed in extreme hot-humid as compared to comfortable and lowest values in extreme cold environmental temperature period. Both the groups exhibited elevated per cent variations during extreme hot-humid. Post-pubertal heifers marked higher per cent variation in each environmental temperature period. Among cows, in group A animals, pregnant- dry had significantly ($p \leq 0.05$) higher values of plasma CAT in each environmental temperature period. In all the three types, utmost mean values were observed in extreme hot-humid and lowest values in extreme cold as compared to comfortable. Highest per cent change was displayed by non-pregnant milch during all environmental temperature periods. In group B animals, multipara had significantly ($p \leq 0.05$) higher values of plasma catalase in each environmental temperature period as compared to primipara. In both the types, maximum mean values were observed in extreme hot-humid as compared to comfortable environmental temperature period. Multipara tended to reveal higher per cent variations in each environmental temperature period. Alterations in plasma catalase due to physiological states have been reported.[24]

In the present study, abiotic stressor was measured by determining temperature humidity index and heat load index. Stress was gauged by using serum cortisol. Oxidative stress was assessed by measuring plasma catalase. Extreme hot-humid appeared to be the most callous environmental temperature period and all the animals were found stressed with a variation in magnitude.

Table 1: Mean ± SEM values of environmental variables (EV_s) for abiotic stressor evaluation of Bikaner district, Rajasthan during varying environmental temperature periods (ETPs) of sampling period (N=40).

S.No.	Environmental variables	Mean ± SEM values during varying ETPs			
		Comfortable	Extreme Hot-dry	Extreme Hot-humid	Extreme Cold
1.	THI_{MinET}	$65.29^{b} \pm 0.12$ (53.90-74.70)	$80.29^{b} \pm 0.12$ (67.70-88.10)	$82.38^{b} \pm 0.13$ (73.01-90.02)	$50.37^{b} \pm 0.13$ (40.00-68.08)
2.	THI_{MaxET}	$76.49^{b} \pm 0.21$ (70.00-78.80)	$87.29^{bd} \pm 0.21$ (79.00-92.00)	$89.39^{b} \pm 0.11$ (82.10-96.20)	$63.39^{b} \pm 0.21$ (46.00-71.00)
3.	THI_{AET}	$71.38^{b} \pm 0.11$ (60.00-77.00)	$85.48^{b} \pm 0.11$ (72.00-92.4)	$86.20^{b} \pm 0.12$ (82.20-93.08)	$62.58^{b} \pm 0.12$ (50.00-69.08)
4.	HLI_{MaxET}	$76.35^{b} \pm 0.40$ (61.08-89.99)	$81.13^{b} \pm 0.30$ (64.00-87.09)	$92.48^{b} \pm 0.37$ (70.10-96.09)	$52.18^{b} \pm 0.58$ (34.20-75.09)
5.	HLI_{MinET}	$65.05^{b} \pm 0.10$ (54.08-78.98)	$67.22^{b} \pm 0.13$ (58.02-73.95)	$70.85^{b} \pm 0.13$ (60.00-83.94)	$34.00^{b} \pm 0.13$ (22.44-43.88)
6.	HLI_{AET}	$70.07^{b} \pm 0.60$ (61.05-83.09)	$76.05^{b} \pm 0.36$ (63.09-79.79)	$83.06^{b} \pm 0.33$ (63.00-89.19)	$46.00^{b} \pm 0.33$ (30.00-61.91)

N= Number of observations
$M_{in}ET$ = Minimum environmental temperature
$M_{ax}ET$ = Maximum environmental temperature
AET = Average environmental temperature
Min = Minimum Max = Maximum
THI = Temperature humidity index
ET = Environmental temperature
HLI = Heat load index
'b' marks significant ($p \leq 0.05$) differences among mean values for a row.
Figures in the parentheses are ranges.

Table 2: Mean ± SEM values of serum cortisol (nmol L^{-1}) in the female non-descript cattle during varying environmental temperature periods (ETPs)

S. No.	Effects	Mean ± SEM values during ETPs Comfortable	Extreme Hot-dry	Extreme Hot-humid	Extreme cold
1.	Overall ETP(300)	$32.00^{b} \pm 0.39$	$72.20^{b} \pm 0.60$	$91.00^{b} \pm 0.70$	$42.00^{b} \pm 0.49$
2.	Age group categorization (I, II & III categories)				
I.	Calves, 2-48 weeks (150),categorization as a,b,c,d&e				
	Overall value of calves(150)	$30.00^{bg} \pm 0.08$	$70.20^{bg} \pm 0.08$	$88.00^{bg} \pm 0.08$	$40.00^{bg} \pm 0.07$
	Pre-ruminant (30)	$31.00^{bc} \pm 0.04$	$71.30^{bc} \pm 0.02$	$89.00^{bc} \pm 0.03$	$41.00^{bc} 0.03$
	Transitional (30)	$30.00^{bc} \pm 0.02$	$70.10^{bc} \pm 0.02$	$88.00^{bc} \pm 0.03$	$40.00^{bc} \pm 0.02$
	Pre-weaning(30)	$29.00^{bc} \pm 0.03$	$69.20^{bc} \pm 0.02$	$87.00^{bc} \pm 0.02$	$39.00^{bc} \pm 0.02$
	Post -weaning (30)	$28.00^{bc} \pm 0.02$	$68.30^{bc} \pm 0.03$	$86.00^{bc} \pm 0.03$	$38.00^{bc} \pm 0.02$
	Calf-yearling transition (30)	$27.00^{bc} \pm 0.03$	$67.10^{bc} \pm 0.02$	$85.00^{bc} \pm 0.03$	$37.00^{bc} \pm 0.02$
II.	Heifers, 1-3.5 years (60), categorization as a&b				
	Overall value of heifers (60)	$31.00^{bg} \pm 0.08$	$71.20^{bg} \pm 0.07$	$90.00^{bg} \pm 0.08$	$41.00^{bg} \pm 0.07$
	Pre-pubertal(30)	$30.00^{bd} \pm 0.03$	$70.10^{bd} \pm 0.02$	$89.00^{bd} \pm 0.03$	$40.00^{bd} \pm 0.03$
	Post-pubertal (30)	$32.00^{bd} \pm 0.02$	$72.30^{bd} \pm 0.02$	$91.00^{bd} \pm 0.03$	$42.00^{bd} \pm 0.02$
III.	Cows, 3.5-11 years (90), categorization as group A & B				
	Overall value of cows (90)	$33.00^{bg} \pm 0.08$	$73.20^{bg} \pm 0.08$	$93.00^{bg} \pm 0.07$	$43.00^{bg} \pm 0.08$
	Group A (90), Physiological states: Pregnancy and milch status				
	Non-pregnant milch (30)	$32.00^{be} \pm 0.03$	$72.10^{be} \pm 0.03$	$92.10^{be} \pm 0.02$	$40.90^{be} \pm 0.02$
	Pregnant milch(30)	$33.00^{be} \pm 0.01$	$73.30^{be} \pm 0.02$	$93.00^{be} \pm 0.03$	$43.00^{be} \pm 0.01$
	Pregnant dry (30)	$34.00^{be} \pm 0.03$	$74.10^{be} \pm 0.03$	$93.90^{be} \pm 0.03$	$44.10^{be} \pm 0.02$
	Group B (90), Physiological states: Parity				
	Primipara (45)	$32.00^{bf} \pm 0.03$	$72.10^{bf} \pm 0.02$	$92.10^{bf} \pm 0.02$	$42.10^{bf} \pm 0.03$
	Multipara(45)	$34.00^{bf} \pm 0.02$	$74.30^{bf} \pm 0.03$	$93.90^{bf} \pm 0.02$	$43.90^{bf} \pm 0.02$

i. Figures in the parenthesis = Number of non-descript indigenous animals
ii. 'b' =Significant ($p \leq 0.05$) differences among mean values for a row.
iii. 'c'=Significant ($p \leq 0.05$) differences among mean values of calves for an ETP
iv. 'd'=Significant ($p \leq 0.05$) differences between mean values of heifers for anETP
v. 'e'=Significant ($p \leq 0.05$) differences among mean values of Group A for an ETP
vi. 'f'=Significant ($p \leq 0.05$) differences between mean values of Group B for an ETP
vii. 'g'=Significant ($p \leq 0.05$) differences amongoverall values of calves, heifers and cows for an ETP

Table 3: Mean ± SEM values of plasma catalase (CAT, kU L^{-1}) in the female non-descript indigenous cattle during varying environmental temperature periods (ETPs)

S. No.	Effects	Mean ± SEM values during ETPs Comfortable	Extreme Hot-dry	Extreme Hot-humid	Extreme cold
1.	ETP Overall values (300)	$79.00^{b} \pm 0.49$	$101.00^{b} \pm 0.52$	$112.00^{b} \pm 0.54$	$91.00^{b} \pm 0.49$
2.	Age group categorization (I, II & III categories)				
I.	Calves, 2-48 weeks (150), categorization as a, b, c, d & e				
	Overall values of calves (150)	$77.00^{bg} \pm 0.10$	$96.00^{bg} \pm 0.15$	$107.00^{bg} \pm 0.15$	$87.00^{bg} \pm 0.18$
	Pre-ruminant (30)	$79.00^{bc} \pm 0.05$	$102.00^{bc} \pm 0.05$	$113.00^{bc} \pm 0.05$	$91.60^{bc} \pm 0.05$
	Transitional (30)	$78.00^{bc} \pm 0.05$	$99.00^{bc} \pm 0.04$	$110.00^{bc} \pm 0.04$	$89.00^{bc} \pm 0.05$
	Pre-weaning (30)	$77.00^{bc} \pm 0.04$	$96.00^{bc} \pm 0.04$	$107.00^{bc} \pm 0.04$	$87.00^{bc} \pm 0.04$
	Post -weaning (30)	$76.00^{bc} \pm 0.04$	$93.00^{bc} \pm 0.04$	$104.00^{bc} \pm 0.04$	$85.00^{bc} \pm 0.04$
	Calf-yearling transition (30)	$75.00^{bc} \pm 0.04$	$90.00^{bc} \pm 0.04$	$101.00^{bc} \pm 0.04$	$83.00^{bc} \pm 0.03$
II.	Heifers, 1-3.5 years (60), categorization as a & b				
	Overall values of heifers (60)	$79.00^{bg} \pm 0.09$	$101.00^{bg} \pm 0.09$	$112.00^{bg} \pm 0.11$	$91.00^{bg} \pm 0.10$

	Pre-pubertal (30)	$78.00^{bd} \pm 0.08$	$99.00^{bd} \pm 0.07$	$110.00^{bd} \pm 0.07$	$89.00^{bd} \pm 0.08$
	Post-pubertal (30)	$80.00^{bd} \pm 0.07$	$103.00^{bd} \pm 0.07$	$114.00^{bd} \pm 0.07$	$93.00^{bd} \pm 0.08$
III.	Cows, 3.5-11 years (90), categorization as group A & B				
	Overall values of cows (90)	$81.00^{bg} \pm 0.11$	$106.00^{bg} \pm 0.09$	$117.00^{bg} \pm 0.09$	$95.00^{bg} \pm 0.12$
	Group A (90), Physiological states: Pregnancy and milch status				
	Non-pregnant milch (30)	$79.00^{be} \pm 0.07$	$104.80^{be} \pm 0.08$	$115.80^{be} \pm 0.08$	$93.00^{be} \pm 0.07$
	Pregnant milch (30)	$81.00^{be} \pm 0.07$	$106.00^{be} \pm 0.07$	$117.00^{be} \pm 0.07$	$95.00^{be} \pm 0.07$
	Pregnant dry (30)	$83.00^{be} \pm 0.08$	$107.20^{be} \pm 0.08$	$118.20^{be} \pm 0.08$	$97.00^{be} \pm 0.06$
	Group B (90), Physiological states: Parity				
	Primipara (45)	$80.00^{bf} \pm 0.08$	$104.00^{bf} \pm 0.07$	$115.00^{bf} \pm 0.07$	$93.00^{bf} \pm 0.08$
	Multipara (45)	$82.00^{bf} \pm 0.08$	$108.00^{bf} \pm 0.06$	$119.00^{bf} \pm 0.06$	$97.00^{bf} \pm 0.08$

i. Figures in the parenthesis = Number of non-descript indigenous animals
ii. 'b' = Significant ($p \leq 0.05$) differences among mean values for a row.
iii. 'c' = Significant ($p \leq 0.05$) differences among mean values of calves for an ETP
iv. 'd' = Significant ($p \leq 0.05$) differences between mean values of heifers for an ETP
v. 'e' = Significant ($p \leq 0.05$) differences among mean values of Group A for an ETP
vi. 'f' = Significant ($p \leq 0.05$) differences between mean values of Group B for an ETP
vii. 'g' = Significant ($p \leq 0.05$) differences among overall values of calves, heifers and cows for an ETP

CONCLUSION

It can be inferred that abiotic stressor produced stress in female non-descript indigenous cattle during extreme environmental temperature periods. Impact of abiotic stressor was found to be maximum during hot-humid based on higher temperature humidity index and heat load index values. Serum cortisol and catalase depicted changes during extreme hot-humid, extreme hot-dry and extreme cold environmental temperature periods. Maximum changes were found during extreme hot-humid environmental temperature period. Increased serum cortisol and plasma catalase lucidly exhibited the development of stress. Serum cortisol denoted stress whereas, plasma catalase exhibited the presence of oxidative stress. It can be recommended that special attention must be paid regarding supplementation of the animals with proper antioxidants during callous environmental temperature periods. Recommendations can be made that animal owners must be stimulated to check the health of non-descript indigenous cattle normally with the help of the clinicians so that all the animals can be kept in a stress free state.

REFERENCES

1. Kataria, N., Joshi, A., Singhal, S.S., Asopa, S. and Kataria, A.K., Evaluation of oxidative stress during hot dry and hot humid environmental periods in indigenous pigs from arid tracts in India, Porcine Res, 2016; 6(1): 16-23.
2. Joshi, A. and Kataria, N., Alterations in serum 5' nucleotidase activity of *Rathi* female calves, heifers and cows from arid tracts during extreme ambiences, Acta Biomedica Scientia, 2018a; 5(2): 43-50.
3. Joshi, A. and Kataria, N.,Modulations in serum pepsinogen activity of *Rathi* female calves, heifers and cows from arid tracts during various ambiences, European Journal of Environmental Ecology, 2018b; 5(1): 7-15.
4. Kataria N, Kataria AK Agarwal VK, Garg SL, Sahani MS and Singh R, Effect of water restriction on serum aldosterone and cortisol in dromedary camel during winter and summer., J. Camel Prac. Res, 2000; 7(1): 1-7.
5. Kataria N. and Kataria AK, Can prolactin be a measurable marker of stress in dromedaries?, Slovenian Veterinary Research, 2010; 47(3): 133-138.
6. Kataria,N.and Kataria,A.K., Can prolactin be used as marker of stress in goat?Vet Prac., 2010; 11(1):48-49.
7. Kataria, N. and Kataria A.K.,Use of prolactin as an indicator of stress in *Marwari* sheep from arid tracts in India., Comp. Clin.Pathol, 2011; 20: 333-336.
8. Kataria, N. and Kataria, A.K., Alterations in prolactin and cortisol levels in heat stressed pigs from arid tracts in India., Porcine Research, 2013; 3(1): 4-8.
9. Kataria, N. and Kataria, A.K., Relationship of inflammatory signals, cortisol and oxidative stress in sheep affected with *petide des petits ruminants.* J. Immunol. Immunopathol, 2013; 15(1): 69.
10. Kataria,N.; Kataria,A.K.;Pandey,N. and Gupta,P., Serum biomarkers of physiological defense against reactive oxygen species during environmental stress in Indian dromedaries, 2010a; HVM Bioflux. 2(2): 55-60.
11. Kataria, N.,Kataria,A.K., Maan, R. and Gahlot, A.K., Evaluation of oxidative stress in brucella infected cows., J. Stress Physiol. Biochem, 2010b; 6(2): 19-31.
12. Kataria N. and Kataria AK, Assessment of stress due to hot ambience in donkeys from arid tracts in India, Journal of Stress Physiology & Biochemistry, 2010; 6(4): 12-17.
13. Kataria, N., Kataria A.K. and Maan,R., Evaluation of oxidative stress due to hot environmental condition in healthy *Marwari* goats from arid tract in

India., Philipp. J. Vet. Anim. Sci, 2010c; 36(2): 175-184.
14. Kataria, N.;Joshi,A.; Saini, B.S.; Arora, S.; Singla, B.; Mohammed, N.; Asopa, S. and Kataria, A.K., Relationship of aldosterone with electrolytes and oxidative stress during hot ambience in Marwari goats from arid tracts., Ruminant Science, 2014a; 3(2): 211-215.
15. Kataria, N.;Joshi,A.; Mohammed, N. and Kataria, A.K., Interrelation of aldosterone with oxidative stress and electrolytes in hot climate in pigs from arid tracts., Porcine Research, 2014b; 4(1): 7-14.
16. Joshi, A. and Kataria, N. Aldosterone assay to evaluate oxidative stress in Marwari lambs during extreme hot ambience, Applied Biological Research, 2015; 17(2): 195-199.
17. Joshi, A.; Kataria, N.; Asopa, S. And Kataria, A.K., Role of aldosterone in hot ambience associated oxidative stress in *Murrah* heifers, Veterinary Practitioner, 2017; 1,18,97-101.
18. Kataria, A.K.;Kataria, N.; Kumawat, R.N. and Gahlot, A.K., Temperature humidity index vis-à-vis black kite (*Milvus migrans*) population and migration pattern in arid tracts in India., European Journal of Environmental Ecology, 2016a; 3(2): 69-74.
19. Kataria, A.K.;Kataria, N. and Kumawat, R.N., An appraisal of spatio-temporal association between saker falcon migration and environmental correlates at Jorbeer conservation reserve, Bikaner, Rajasthan (India), American Journal of Biological and Pharmaceutical Research, 2016b; 3(2): 69-74.
20. Kataria, A.K.;Kataria, N.; Kumawat, R.N.and Sihag, A., Comparative exodus archetype of vultures in relation to environmental factors at Jorbeer conservation reserve, Bikaner, Rajasthan, India, Acta Biomedica Scientia, 2017; 4(1): 4-10.
21. Kataria, A.K.;Kataria, N. and Kumawat, R.N., Effect of environmental elements on migration pattern of eagles at Jorbeer conservation reserve, Bikaner, Rajasthan, India., Research Journal of Life Sciences, Bioinformatics, Pharmaceuticals and Chemical sciences, 2016c; 2(3): 90-101.
22. Goth, L., A simple method for determination of serum catalase activity and revision of reference range, 1991; *Clinica. Chimica. Acta*. 196: 143-152.
23. Gantner, V., Mijić, P., Kuterovac, K., Solić, D., and Gantner, R., Temperature-humidity index values and their significance on the daily production of dairy cattle. *Mljekarstvo: časopis za unaprjeđenje proizvodnje i prerade mlijeka*, 2011; 61(1), 56-63.
24. Joshi, A. Dynamics of environmental correlates *vis-à-vis* appraisal of physiological strategies in female *Rathi* cattle implying modulations in endocrine, organ and tissue functions, energy metabolism and cellular oxidative stress responses, 2018;Ph.D. thesis submitted to Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India.
25. Kaps, M. and Lamberson, W.R., Biostatistics for animal science. CABI Publishing, Oxford shire, 2004; 36-270.
26. Kataria, N., Hormonal and renal regulation of fluid retension in dromedary camel,2000; Ph.D. thesis submitted to department of Veterinary Physiology, CCSHAU. Hisar, Haryana.
27. Joshi, A.; Kataria, N.; Asopa, S. and Kataria, A.K., Role of aldosterone in hot ambience associated oxidative stress in *Murrah* heifers. Vet. Pract, 2017;18(1): 97-101.
28. Saini, M.; Singhal, S.S.; Joshi, A.; Pareek, S.; Saini, B.S. and Kataria, N., Archetype of variations in erythrocytic antioxidants of non-descript goat from arid tracts during hot and cold ambiences, Vet. Pract, 2018; 19(1): 18-20.
29. Singhal, S.S.; Pareek, S.; Saini, B.S.; Saini, M.; Budania, S.; Joshi, A.; Srivastava, A.; Promila.; Singh, A.; Kataria, N. and Kataria, A.K., Appraisal of endogenous antioxidant stature in pregnant sows from arid tract in India. Porcine Res, 2016; 6(1): 31-36.
30. Kataria, N. and Kataria, A.K., Heat load index *vis-à-vis* hormone *milieu* in non-descript heifers. In:Compendium of national seminar on mankind: facing environmental challenges & tackling disasters, MFECTD, held at Jodhpur during 3rd -4th December, 2016; 8-11.
31. Promila; Srivastava, A.; Singh, A.; Satyendra; Joshi, A.; Pareek, S. and Kataria, N., Hot ambience versus mineral profiling of sheep from arid tracts of Rajasthan. In:Compendium of national seminar on mankind: facing environmental challenges & tackling disasters, MFECTD, held at Jodhpur during 3rd -4th December, 2016; 221.
32. Saini, B.S. and Kataria, N., Dynamics of environmental components *versus* appraisal of physiological tactics in female non-descript cattle from arid tracts of Rajasthan. Paper published in compendium of national symposium on Holistic Approach in Veterinary Medicine for Better Animal Health to Meet Challenges of one Health Mission & 37th annual convention of Indian society for Veterinary Medicine from 1-3 February, 2019 held at Rajasthan University of Veterinary and Animal Science, Bikaner, 2019; 323.
33. Singhal S.S. and Kataria N., Environmental elements *vis-a vis* intonations and metabolic controls of *Nali* sheep from arid tract of Rajasthan. Acta Biomedica scienta, 2019a; 6(2): 116-122.
34. Singhal S.S. and Kataria N., Heat load index *vis-a vis* changes in liver functions of *Nali* sheep from arid tract of Rajasthan., Am. J. Biol. Pharm. Res, 2019b; 6(1): 1-5.
35. Kataria, N. and Kataria,A. K., Use of blood analytes in assessment of stress due to drought in camel., J. Camel Prac. Res, 2004; 11(2): 129-133.

36. Kataria, N. and Kataria, A. K., Endocrine and metabolic responses of *Marwari* sheep in arid tract. Slov. Vet. Res, 2006; 43(3): 135-142.