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Environmental conditions versus cellular metabolic regulators of Krebs cycle in Sirohi Goat from Southern Rajasthan

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Abstract
Hot environmental conditions can put immense stress to animals touching health and production. Therefore, a study was embarked on Sirohi goat from un-organized sector from Semi-arid tracts of southern Rajasthan to assess the effect of moderate, humid-hot, dry-hot and cold environmental conditions. Bang of environment on animals was assessed by determining heat load index and the values obtained were 67.82, 81.70, 83.80 and 54.80, respectively during the moderate, dry-hot, humid-hot and cold environmental conditions. Serum is citrate dehydrogenase (ICDH) and malate dehydrogenase (MDH) were determined by the standard protocol as representatives of cellular metabolic regulators. Serum enzymatic activities divulged remarkable changes during dry-hot and humid-hot environmental conditions. Maximum activity of serum ICDH was noted during cold EP. During cold, the percent variation in the value of serum ICDH was found to be maximum (+ 21.69), While during humid-hot, the per cent variation in the value of serum MDH was found to be maximum (+ 75.25). The model of changes expounded the lilt of cellular activities in animals of different age groups during dry-hot and humid-hot ambiences. The snarl of the effects was higher during humid-hot than dry-hot. Animals of female group and older age group were observed to be more affected.

Keywords: sirohi goat, metabolic regulators and krebs cycle

Introduction
Ambient stress can produce outsized modifications in the physiological mechanism of animals thereby influencing health, reproduction and production of the animals. With this perception an exploration was conducted in *Sirohi* goats from semi arid tracts of Southern Rajasthan to evaluate cellular enzymatic activity of Kreb cycle during different seasons of the year with the pretense of stress to animals. ICDH and MDH are key enzymes in Kreb cycle, influenced by seasonal variations. The samples were collected from unorganized farms to evaluate the true effect of environmental stress on metabolism of animals. The goats included in the study were of different age groups

Material and Methods
To achieve the goal, 1280 apparently healthy male and female Sirohi goats of varying age groups were inspected kept by impoverished farmers and animals owners from unorganized sector in and around Udaipur district, Rajasthan, India for the milk and meat purpose. To undertake the goals of the study, blood samples were collected from the Sirohi goats during cold (December and January), dry hot (April, May and June), humid hot (July, August and September) and moderate (October and November) environmental periods (EPs). In each environmental period (EP), 320 clinically healthy Sirohi goats were screened (160 males and 160 females) to collect the samples of blood for harvesting serum. ICDH enzyme was determined by colorimetric procedure as described by Bell and Baron (Varley, 1988) [12] with little alterations (Anonymous, 2010) [2]. MDH was determined by spectrophotometric procedure (King, 1965) [10] with slight modifications (Anonymous, 2010) [2].

Results and Discussion
For the assessment of variation in cellular metabolism in response to environmental stress of Sirohi goat from semi-arid tracts of Rajasthan, computation of HLI values was conducted along with measurement of serum is citrate dehydrogenase and malate dehydrogenase

enzymes of Krebs cycle.

Heat load index (HLI)

The average Heat load Index (THI) values were 67.82, 81.70, 83.80 and 54.80, respectively at the time of moderate, dry-hot, humid-hot and cold EPs from Udaipur district of Rajasthan. Heat load index (THI) values were acquired by computing fundamental environmental elements. The values among various EPs mottled significantly ($p \leq 0.05$). Humid-hot EP exhibited maximum values of HLI as compared to corresponding values during moderate, dry-hot and cold EPs. (Arora and Kataria, 2021) [1] explored the similar physiological effect of abiotic stressors in female non-descript indigenous cattle from arid tracts of Rajasthan The heat load index (HLI) can be employed as a tool to appraise the environmental heat load which is transferred to goat. The working out of HLI needs black globe temperature which exhibits radiation influences in addition to air temperature. Therefore, HLI is considered as a marker of physiological stress to the animals (Kataria and Kataria, 2012) [8]. Scientists (Ganter *et al.* 2011) [3] explained that revelation of animals to enormously high environmental temperatures and supercilious relative humidity for protracted periods can reduce the ability to disperse heat. Hence, unjustified heat load can give rise to significant reduction in production thereby affecting animal wellbeing. (Kataria *et al.*, 2017) [4] Observed the impact of environmental stress factors on vultures. Towering heat loads are generated when animal's heat production and higher environmental temperature combine together considerably influences dissipation of heat from animal. During dry-hot EP, the mean value of maximum HLI substantiated the earlier observations from the other regions of Rajasthan (Kataria and Kataria, 2016) [9].

Serum is citrate dehydrogenase (ICDH)

Mean ± SEM values of serum MDH of male and female Sirohi goat of different age groups i.e. 3-7 months, 7-11 months, 11-15 months and 15-19 months during moderate, dry- hot, humid-hot and cold environmental periods (EPs) are presented in table 1. The overall mean values of serum ICDH were significantly ($p \leq 0.05$) higher during cold and lower during dry-hot and humid-hot as compared to moderate EP mean overall value. Maximum activity of serum ICDH was noted during cold EP. During cold, the per cent variation in the value of serum ICDH was found to be maximum (+ 21. 69). Higher values of serum ICDH were indicative of modulation of metabolic activities and stress.

(Kataria and Bhatia, 1991) [6] Divulged the decreasing trend of is citrate dehydrogenase during extreme hot than in period of extreme cold environment. A note by (Kataria *et al.*, 1991) [6] revealed the reduced activity in dromedary camel of serum ICDH during hot condition as compared to moderate condition. They found that the mean values of serum is citrate dehydrogenase were noticeably lower during extreme hot and rainy ambiences and significantly higher during extreme cold ambience when compared to moderate mean overall value. (Kataria and Kataria, 2006) [7] Reported the effect of age, sex and extreme ambiences on serum dehydrogenases in Tharparkar cattle. The enzymes of pathways of carbohydrate were assessed. Raised serum ICDH during extreme cold ambience indicated the gambits of animals to generate heat in the body along with ATPs. In each EP, overall mean value of female goat was significantly ($p \leq 0.05$) higher than the respective overall mean value of male goat. Impact of cold EP was enormous on serum ICDH value. In general, in each category, percent change in the mean value was maximum during cold, revealing it as a potent manipulator of metabolism. It can be opined that female goat developed greater degree of modulation in physiology than male goat.

Table 1: Mean ± SEM values of serum is citrate dehydrogenase (ICDH, UL^{-1}) in the Sirohi goat during varying environmental periods (EPs)

S. No.	Effects	Mean ± SEM values during environmental periods			
		Moderate	Dry-hot	Humid-hot	Cold
	Environmental period Overall values (320)	$17.63^{b} \pm 0.13$	$16.61^{b} \pm 0.12$	$13.63^{b} \pm 0.06$	$21.16^{b} \pm 0.13$
	Categorization as male and female (I & II categories)				
I.	**Male (160), categorization according to gender specific age groups as a, b, c& d**				
	Overall mean values of males (160)	$15.60^{bc} \pm 0.008$	$14.62^{bd} \pm 0.01$	$13.62^{bd} \pm 0.02$	$19.58^{bd} \pm 0.02$
	3-7 months (40)	$14.07^{bd} \pm 0.007$	$13.11^{bd} \pm 0.01$	$12.11^{bd} \pm 0.01$	$17.08^{bd} \pm 0.01$
	7-11 months (40)	$15.10^{bd} \pm 0.01$	$14.10^{bd} \pm 0.01$	$13.12^{bd} \pm 0.02$	$18.09^{bd} \pm 0.02$
	11-15months (40)	$16.08^{bd} \pm 0.007$	$15.16^{bd} \pm 0.02$	$14.13^{bd} \pm 0.04$	$20.11^{bd} \pm 0.04$
	15-19 months (40)	$17.15^{bd} \pm 0.01$	$16.12^{bd} \pm 0.03$	$15.15^{bd} \pm 0.03$	$21.05^{bd} \pm 0.007$
II.	**Female (160), categorization according to gender specific age groups as a, b, c & d**				
	Overall mean values of females (160)	$19.65^{bc} \pm 0.01$	$18.59^{bc} \pm 0.01$	$13.64^{bc} \pm 0.02$	$22.74^{bc} \pm 0.02$
	3-7 months (40)	$18.11^{bd} \pm 0.01$	$17.10^{bd} \pm 0.008$	$12.10^{bd} \pm 0.01$	$21.12^{bd} \pm 0.01$
	7-11 months (40)	$19.09^{bd} \pm 0.01$	$18.08^{bd} \pm 0.01$	$13.15^{bd} \pm 0.02$	$22.28^{bd} \pm 0.04$
	11-15months (40)	$20.11^{bd} \pm 0.02$	$19.09^{bd} \pm 0.01$	$14.85^{bd} \pm 0.02$	$23.13^{bd} \pm 0.01$
	15-19 months (40)	$21.30^{bd} \pm 0.03$	$20.11^{bd} \pm 0.02$	$15.28^{bd} \pm 0.04$	$24.43^{bd} \pm 0.03$

Malate dehydrogenase (MDH)

Mean ± SEM values of serum MDH of male and female Sirohi goat of different age groups during various environmental periods (EPs) are presented in table 2. The overall mean values of serum MDH were significantly ($p \leq 0.05$) higher during cold, dry-hot and humid-hot as compared to moderate EP mean overall value. Maximum activity of serum MDH was noted during humid-hot EP. During humid-hot, the per cent variation in the value of serum MDH was found to be maximum (+ 75.25). Higher values of serum MDH were indicative of modulation of metabolic activities and stress. Malate dehydrogenase is an enzyme of great importance in Krebs and urea cycles and its greater activity shows higher rate of gluconeogenesis. (Tanvi *et al.*, 2020) [11] Reported that humid-hot ambience doubtlessly worked as a persuasive stressor to alter the pathway of carbohydrate metabolism as an initiation of adaptive responses in least studied non-descript sheep. High NADP-malate dehydrogenase activity along with a higher concentration of plasma glucose after weaning suggested that this enzyme activity could be increased by high glucose availability in goat kids. NADP-malate dehydrogenase and

glucose-6-phosphate dehydrogenase in liver tissue were not influenced by weaning (Bas, 1992) [2]. In each EP, overall mean value of female goat was significantly ($p \leq 0.05$) higher than the respective overall mean value of male goat.

Table 2: Mean ± SEM values of serum malate dehydrogenase (MDH, UL^{-1}) in the Sirohi goat during varying environmental periods (EPs)

S. No.	Effects	Mean ± SEM values during environmental periods			
		Moderate	Dry-hot	Humid-hot	Cold
	Environmental period Overall values (320)	$130.96^{b} \pm 1.94$	$151.39^{b} \pm 1.96$	$166.38^{b} \pm 1.97$	$142.64^{b} \pm 1.94$
	Categorization as male and female (I & II categories)				
	Male (160), categorization according to gender specific age groups as a, b, c& d				
	Overall mean values of males (160)	$109.99^{bc} \pm 5.25$	$129.42^{bd} \pm 5.39$	$148.16^{bd} \pm 5.29$	$120.51^{bd} \pm 5.48$
	3-7 months (40)	$93.04^{bd} \pm 4.26$	$113.04^{bd} \pm 4.42$	$133.02^{bd} \pm 4.74$	$102.94^{bd} \pm 5.90$
	7-11 months (40)	$103.94^{bd} \pm 5.05$	$122.94^{bd} \pm 5.21$	$142.94^{bd} \pm 5.04$	$117.04^{bd} \pm 5.37$
	11-15months (40)	$115.94^{bd} \pm 5.53$	$135.67^{bd} \pm 5.69$	$153.63^{bd} \pm 5.85$	$126.04^{bd} \pm 6.00$
	15-19 months (40)	$127.04^{bd} \pm 6.16$	$146.04^{bd} \pm 6.32$	$163.05^{bd} \pm 6.48$	$136.04^{bd} \pm 6.64$
	Female (160), categorization according to gender specific age groups as a, b, c & d				
	Overall mean values of females (160)	$147.57^{bc} \pm 4.28$	$168.28^{bc} \pm 4.26$	$179.86^{bc} \pm 4.24$	$159.54^{bc} \pm 4.18$
	3-7 months (40)	$135.65^{bd} \pm 4.35$	$155.04^{bd} \pm 4.26$	$167.47^{bd} \pm 4.26$	$146.04^{bd} \pm 4.26$
	7-11 months (40)	$146.15^{bd} \pm 4.41$	$162.05^{bd} \pm 4.26$	$174.82^{bd} \pm 4.38$	$156.36^{bd} \pm 4.28$
	11-15months (40)	$147.46^{bd} \pm 4.01$	$174.04^{bd} \pm 4.26$	$186.04^{bd} \pm 4.26$	$165.04^{bd} \pm 4.26$
	15-19 months (40)	$161.05^{bd} \pm 4.27$	$182.01^{bd} \pm 4.27$	$191.13^{bd} \pm 4.32$	$170.73^{bd} \pm 4.05$

Figures in the parenthesis = Number of Sirohi goat
EP = Environmental period
'b' = Significant ($p \leq 0.05$) differences among mean values for a row.
'c' = Significant ($p \leq 0.05$) differences between overall mean values of males and females for an EP
'd' = Significant ($p \leq 0.05$) differences among mean values of different gender specific age groups for an EP

Conclusion

It can be concluded that Sirohi goat native to semi-arid tracts of Rajasthan living under native husbandry are badly affected during humid-hot ambience among all ambiences. It could also be concluded that the metabolism is also changed during various environmental conditions. The environmental force during cold and humid-hot tended to modulate the cellular activity maximally as observed by the changes in serum ICDH and MDH enzymes. The data collected through this study will assist in generating reference data for forthcoming research in the arena of Veterinary Clinical Physiology granting diagnostic matter-of-factness for this native breed of goat.

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