Acta Biomedica Scientia

e - ISSN - 2348 - 2168
Print ISSN - 2348 - 215X

www.mcmed.us/journal/abs

Research Article

ENVIRONMENTAL ELEMENTS *VIS-À-VIS* INTONATIONS IN METABOLIC CONTROLLERS OF *NALI* SHEEP FROM ARID TRACTS OF RAJASTHAN

Saurabh Singh Singhal[1] and Nalini Kataria[2*]

[1]Ph.D. scholar, Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner; Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India.
[2]Professor & Head, Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner; Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India.

ABSTRACT

For the appraisal of environmental elements *vis-à-vis* intonations in metabolic controllers of *Nali* sheep from arid tracts of Rajasthan, apparently healthy male and female *Nali* sheep of varying age groups from unorganized sector (Churu and Sri Ganganagar districts, Rajasthan) were examined. Collection of blood samples was made during different environmental periods (EPs) of the year incorporating intervening EP (October-November); dry-hot EP(April, May and June); humid-hot EP (July, August and September) and cold EP (December and January). Environmental elements incorporated temperature humidity index (THI) values from the areas of Churu and Sri Ganganagar districts, Rajasthan. The range of average THI values obtained during intervening or comfortable period was 60.00-77.00. Dry-hot and humid-hot periods revealed higher values of THI. Metabolic controllers comprised of serum hexokinase and serum aldolase enzymes of glycolytic pathway**.** The mean values of serum hexokinase and aldolase were observed to be significantly ($p \leq 0.05$) greater during dry-hot, humid-hot and cold EPs as compared to intervening or control mean value. However, both the enzymes illustrated maximum activity during cold EP and the maximum per cent change in the mean value of serum HK was found to be +25.93, whereas maximum per cent change in the mean value of aldolase was established to be +85.83, as compared to corresponding intervening EP values. Upshot made the impact of cold EP obvious as compared to other EPs regarding glycolytic cycle. This explained a physiological intonation in order to bestow a metabolic support to *Nali* sheep during extreme cold period.

Keywords :- Aldolase, environmental period, hexokinase, *Nali* sheep, THI

Access this article online	
Home page: http://www.mcmed.us/journal/abs DOI: http://dx.doi.org/10.21276/abs.2019.6.2.13	**Quick Response code**

Received:25.09.19	**Revised**:12.10.19	**Accepted**:15.10.19

INTRODUCTION

Solicitous deliberation of the physiological adjustments of animals to their close environment includes exploration of the different physiological edifice that tends to hold up biological life. This is encouraged by assessing and comparing several animal species from conflicting ambiences. It is more and more domineering to realize animal function in their native and inborn environments since peril of climatic variation is sweeping. Animals flourish within an ambience multifaceted by a congregation of tribulations integrating various concerns of the areas and tracts. A long-lasting goal for animal researchers has been to raise the biological strength of animals based on growing production.Animal edge with the environment takes in

Corresponding Author **Nalini Kataria** Email: - nalinikataria@rediffmail.com

physiological changes due to stress factors instigating by virtue of the environment. Hence, it is suitable to realize elements of homeokinesis which may assist in imparting the structure for assembling of the manoeuvre to reduce stress impinging on the animals. Animal welfare requires scientific attention on the ways by which animals counter to their atmosphere via physiological gears like haematological and biochemical quality, enzymes, hydration phase, metabolic issues, adaptive rejoinders, psycho-physiological reactions, endocrine gambits, oxidative stress indicators etc. [1-14]

Metabolic changes during extreme environmental periods can be measured efficiently by using metabolic controllers. Carbohydrate pathways are altered by a set of enzymes and blood levels latter can be examined by laboratory tools and tempo of pathways can be appraised. Environmental temperature of higher magnitude can affect nutrient use in sheep [15]. It has been observed that metabolicpathways can be squabbled by thephysiological states of the animals, being governed by endocrines mainly thyroid and adrenal glands. An approach to these pathways is vital to observe the physiology of ruminants, who stipulate enormous metabolic whack to thump into ecological confronts in addition to bear their physiological production system. Energy precondition is accomplished by several basic metabolic pathways like gluconeogenesis. Provisions vary as per the communication with physiological states and other features of physiological remodelling [16-21]. To establish above forethoughts and planning and in vision of the paucity of research work in this dome in *Nali* breed of sheep from Rajasthan, the present exploration was sketched for the evaluation of environmental elements *vis-à-vis* intonations in metabolic controllers of *Nali* sheep from arid tracts of Rajasthan.

Materials and methods

For the evaluation of environmental elements *vis-à-vis* intonations in metabolic controllers of *Nali* sheep from arid tracts, 1280 apparently healthy male and female *Nali* sheep of varying age groups belonging to unorganized sector in and around Churu and Sri Ganganagar districts, Rajasthan were examined. Collection of blood samples was made during the process of slaughtering from the *Nali* sheep with the permission of Institutional Animal Ethics Committee (IAEC), College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan. Collection of blood samples was made to harvest serum during different environmental periods (EPs) of the year incorporating intervening EP (October-November); dry-hot EP(April, May and June); humid-hot EP (July, August and September) and cold EP (December and January). In each environmental period (EP), animals were classified as male (160) and female(160). According to age, animals were grouped as 3-7 months (40 male and 40 female); 7-11months (40 male and 40 female); 11-15 months (40 male and 40 female) and 15-19 months (40 male and 40 female) in each EP.

Environmental elements of the study encompassed temperature humidity index values from the areas of Churu and Sri Ganganagar districts, Rajasthan. Computation of temperature humidity index (THI) was carried out as given by Gantner*et al.* [22] using environmental temperature and relative humidity. Metabolic controllers included serum hexokinase and aldolase, enzymes of glycolytic pathway. Serum **h**exokinase was measured by technique described in Worthington enzyme manual [23] with modifications [24]. Serum aldolase was measured by colorimetric process (Sibley and Lehninger) with little modifications [23,25]. Preliminary parameters of present study involved environmental elements and metabolic controllers. Institution of the main effects were as overall values of environmental period, male overall mean values and female overall mean values. Classification according to age was also there. For each parameter, values were collected from *Nali* sheep during intervening, dry-hot, humid-hot and cold environmental periods. Sub groups included were males, females and according to age (3-7 months, 7-11 months, 11-15 months and 15-19 months). Data were expressed as mean ± SE of mean and significance of the effects was determined [26].

RESULTS AND DISCUSSION

For the appraisal of environmental elements *vis-à-vis* intonations in metabolic controllers of *Nali* sheep from arid tracts of Rajasthan, computation of THI values was carried out along with determination of serum hexokinase and serum aldolase.

Temperature humidity index (THI)

Temperature humidity index (THI) values obtained at maximum environmental temperature were 76.90± 0.25, 87.90± 0.28, 89.90± 0.19 and 63.90± 0.27, respectively during intervening, dry-hot, humid-hot and cold EPs from Churu and Sri Ganganagar districts of Rajasthan. Temperature humidity index (THI) values were acquired by computing essential environmental elements incorporating environmental temperatures and relative humidities. In the present study, mean values of environmental elements collected from Churu and Sri Ganganagar districts, Rajasthan during intervening, dry-hot, humid-hot and cold environmental periods (EPs) substantiated the corresponding values from Bikaner region collected by earlier researchers in previous years [27-32]. The constituents of relative humidity (%) incorporated were minimum, maximum and average. The values among EPs mottled extensively ($p \leq 0.05$). In the study, humid-hot EP verified utmost values of all the three elements of relative humidity as compared to

corresponding values during intervening, dry- hot and cold EPs. It can be discoursed that intervening or congenial months of the Churu and Sri Ganganagar districts, Rajasthan on an average encountered a range of THI as 53.90-74.71;60.00-77.00 and70.00-78.80 related to minimum, average and maximum, respectively.

Serum hexokinase

Mean± SEM values of serum hexokinase are presented in table 1. The overall mean values of serum hexokinase were notably ($p \leq 0.05$) higher as compared to intervening overall mean value during extreme EPs i.e. dry-hot, humid-hot and cold. It was observed that per cent change in the value of serum HK was maximum (+25.93) during cold EP. In each EP, it was observed that overall mean value of female sheep has shown significant ($p \leq 0.05$) rise when compared to corresponding overall mean value of male sheep. In the categories of male and female, the maximum ($p \leq 0.05$) mean value was acquired in cold EP. Again, minimum ($p \leq 0.05$) value was observed in 3-7 months age group whereas, maximum ($p \leq 0.05$) value was observed in 15-19 months age group. These changes revealed an increasing prototype of the mean values which were instituted to be minimum in 3-7 months and maximum in 15-19 months.

Transfer of phosphate from ATP to glucose is catalyzed by hexokinase to produce glucose 6-phosphate. This reaction is considered to be the first rate-limiting step in glucose metabolism. This enzyme alsoworks as the glucose sensor in the beta cell by controlling the tempo of access of glucose into the glycolytic pathway and its consecutive metabolism [15].

The range and overall mean value of serum hexokinase acquired in present exploration during intervening EP substantiated the previous findings [15,33]. Explorations related to serum hexokinase in sheep are scanty. Scientists are of the opinion that serum HK level may rise owing to various metabolic activities [15]. It can be proposed that greater values of serum HK pinpointed intonations in metabolic activities. Previous workers have advocated changes in serum HK owing to physiological states [15,34]. Bhartendu *et al.* [35] in an investigation in goats revealed atmospheric temperature reliance of glycolytic cycle enzymes.

The outcome of present study regarding HK status divulged its function as one of the issues in the expansion of oxidative stress [15]. Upshot of present investigation suggested that force of cold EP was greatest in terms of HK intonations followed by in humid-hot and dry- hot EPs. Among three extreme EPs, it can be opined that cold EP was competent enough to intonate HK activity efficiently as compared to other EPs, perhaps for the requirement of energy to sustain thermoregulation.

Serum aldolase

Mean± SEM values of serum aldolase are presented in table 2. The overall mean values of serum aldolase were notably ($p \leq 0.05$) higher as compared to intervening overall mean value during extreme EPs i.e. dry-hot, humid-hot and cold. It was observed that per cent change in the value of serum HK was maximum (+85.83) during cold EP. In each EP, it was observed that overall mean value of female sheep has shown significant ($p \leq 0.05$) rise when compared to corresponding overall mean value of male sheep. In the categories of male and female, the maximum ($p \leq 0.05$) mean value was acquired in cold EP. Again, minimum ($p \leq 0.05$) value was observed in 3-7 months age group whereas, maximum ($p \leq 0.05$) value was observed in 15-19 months age group. These changes revealed an increasing prototype of the mean values which were instituted to be minimum in 3-7 months and maximum in 15-19 months.

The range and overall mean value of serum aldolase acquired during intervening EP verified the earlier research [36-38]. In a study in sheep, serum aldolase was observed to be one of the enzymes of clinical use of liver origin and found higher activity in affected animals [36].

Raised values of serum aldolase has marked intonations in metabolic activities. The outcome of present investigation about ALD activity related its significance as an oxidative stress marker [15]. Impact of cold EP was found maximum followed by humid-hot and dry- hot EPs. Energy requirement of the animals during cold EP probably tended to intonate serum ALD activities. Increased levels of aldolase showed the higher rate of glycolysis as well as of gluconeogenesis [15]. In an investigation, Kour and Kataria [38] measured serum aldolase in goat during moderate, hot and cold environments and the value was found to be increased noticeably during extreme hot and cold conditions indicating liver stimulation. Raised aldolase during cold EP denoted towards liver intonation to raise energy metabolism to assist the physiological reactions of the sheep related with thermoregulation and metabolic adjustments [37].

It can be affirmed that animals native to arid tracts of Rajasthan existing under native husbandry circumstances are persistent prey of pitiless environment resulting in huge economical losses to poor sheep raisers. The data acquired through this investigation will help in producing reference values for upcoming research in the arena of Veterinary Clinical Physiology bequeathing diagnostic pragmatism for this native breed of sheep.

Table 1: Mean ± SEM values of serum hexokinase (HK, UL^{-1}) in the *Nali* sheep during varying environmental periods (EPs)

S. No.	Effects	Mean ± SEM values during environmental periods (EPs)			
		Intervening	Dry-hot	Humid-hot	Cold
1.	Environmental period Overall values(320)	49.58^{b} ±0.21	53.88^{b} ±0.22	56.82^{b} ±0.20	62.44^{b} ±0.23
2.	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)	48.60^{bc}±0.020	53.21^{bd}±0.040	56.12^{bd}±0.058	60.06^{bd}±0.030
a.	3-7 months (40)	43.14^{bd}±0.005	49.11^{bd}±0.007	52.11^{bd}±0.006	56.21^{bd}±0.025
b.	7-11 months (40)	47.34^{bd}±0.042	53.38^{bd}±0.038	55.68^{bd}±0.163	58.35^{bd}±0.030
c.	11-15months(40)	50.31^{bd}±0.029	54.30^{bd}±0.028	57.29^{bd}±0.030	61.26^{bd}±0.026
d.	15-19 months (40)	53.64^{bd}±0.026	56.08^{bd}±0.110	59.41^{bd}±0.033	64.42^{bd}±0.040
II.	Female (160), categorization according to gender specific age groups as a, b, c & d				
	Overall mean values of females(160)	50.05^{bc}±0.022	54.55^{bc}±0.021	57.53^{bc}±0.020	64.83^{bc}±0.023
a.	3-7 months (40)	45.32^{bd}±0.022	48.29^{bd}±0.027	52.28^{bd}±0.028	60.30^{bd}±0.029
b.	7-11 months(40)	49.31^{bd}±0.025	52.36^{bd}±0.029	55.28^{bd}±0.014	63.32^{bd}±0.019
c.	11-15months (40)	50.30^{bd}±0.016	57.25^{bd}±0.021	59.27^{bd}±0.024	65.35^{bd}±0.023
d.	15-19 months (40)	55.29^{bd}±0.019	60.30^{bd}±0.018	63.31^{bd}±0.017	70.35^{bd}±0.025
3.	Categorization according to age as a, b, c & d irrespective of gender				
a.	3-7 months (80)	44.22^{be}±0.121	48.70^{be}±0.048	52.19^{be}±0.017	58.25^{be}±0.231
b.	7-11 months(80)	48.32^{be}±0.113	52.87^{be}±0.062	55.48^{be}±0.084	60.83^{be}±0.280
c.	11-15months (80)	51.34^{be}±0.115	55.77^{be}±0.166	58.28^{be}±0.113	63.31^{be}±0.132
d.	15-19 months (80)	54.47^{be}±0.095	58.19^{be}±0.243	61.36^{be}±0.220	67.38^{be}±0.334

Figures in the parenthesis = Number of *Nali* sheep

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

'e'= Significant ($p \leq 0.05$) differences among mean values of different age groups for an EP irrespective of gender

Table 2: Mean ± SEM values of serum aldolase (ALD, UL^{-1}) in the *Nali* sheep during varying environmental periods (EPs)

S. No.	Effects	Mean ± SEM values during environmental periods			
		Intervening	Dry-hot	Humid-hot	Cold
1.	Environmental period Overall values (320)	15.81^{b} ±0.20	18.81^{b} ±0.20	22.61^{b} ±0.21	29.38^{b} ±0.32
2.	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)	13.70^{bc}±0.28	16.64^{bd}±0.30	20.22^{bd}±0.31	24.72^{bd}±0.29
a.	3-7 months (40)	10.26^{bd}±0.02	13.33^{bd}±0.03	16.51^{bd}±0.03	20.51^{bd}±0.03
b.	7-11 months (40)	12.55^{bd}±0.03	15.44^{bd}±0.03	19.44^{bd}±0.02	24.39^{bd}±0.02
c.	11-15months (40)	14.48^{bd}±0.03	17.37^{bd}±0.03	21.48^{bd}±0.02	25.49^{bd}±0.03
d.	15-19 months (40)	17.52^{bd}±0.02	20.42^{bd}±0.02	23.45^{bd}±0.02	28.51^{bd}±0.02
II.	Female (160), categorization according to gender specific age groups as a, b, c & d				
	Overall mean values of females	17.95^{bc}±0.36	20.96^{bc}±0.38	25.01^{bc}±0.40	34.03^{bc}±0.27

	(160)				
a.	**3-7 months (40)**	**13.34^{bd}±0.02**	**16.52^{bd}±0.02**	**20.43^{bd}±0.02**	**28.43^{bd}±0.20**
b.	**7-11 months (40)**	**16.56^{bd}±0.02**	**19.39^{bd}±0.01**	**24.53^{bd}±0.02**	**32.62^{bd}±0.03**
c.	**11-15months (40)**	**19.51^{bd}±0.03**	**22.47^{bd}±0.02**	**25.63^{bd}±0.03**	**35.59^{bd}±0.02**
d.	**15-19 months (40)**	**22.40^{bd}±0.32**	**25.49^{bd}±0.03**	**29.46^{bd}±0.02**	**39.49^{bd}±0.03**
3.	**Categorization according to age as a, b, c & d irrespective of gender**				
a.	**3-7 months (80)**	**11.80^{be}±0.17**	**14.92^{be}±0.18**	**18.47^{be}±0.22**	**24.47^{be}±0.44**
b.	**7-11 months (80)**	**14.50^{be}±0.23**	**17.41^{be}±0.22**	**21.69^{be}±0.28**	**28.50^{be}±0.46**
c.	**11-15months (80)**	**16.99^{be}±0.28**	**19.92^{be}±0.28**	**23.55^{be}±0.23**	**30.50^{be}±0.56**
d.	**15-19 months (80)**	**19.96^{be}±0.27**	**22.99^{be}±0.28**	**26.45^{be}±0.33**	**34.00^{be}±0.61**

Figures in the parenthesis = Number of *Nali* sheep

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

'e'= Significant ($p \leq 0.05$) differences among mean values of different age groupsfor an EP irrespective of gender

CONCLUSION

It can be concluded that dry-hot, humid-hot and cold environmental periods affected male, female, 3-7 months ,7-11 months, 11-15 months and 15-19 months old age groups of the *Nali* sheep from Churu and Sri Ganganagar districts of Rajasthan. Though the intensity of dry-hot and humid-hot environmental periods was greater as reflected by THI values, but maximum intonation in metabolic controllers i.e. hexokinase and aldolase was observed during cold environmental period. Possibly, this was to provide metabolic support to animals for thermoregulation as well as stress mitigation. In the present study, effect was observed to be higher on female *Nali* sheep and 15-19 months old group. The data acquired through this investigation will help in producing reference values for upcoming research in the arena of Veterinary Clinical Physiology bequeathing diagnostic pragmatism for this native breed of sheep.

REFERENCES

1. Kataria, N. and Bhatia, J.S. (1991). Activity of some enzymes in the serum of dromedary camels. Res. Vet. Sci. 51 (9) : 174-176.
2. Kataria, A.K.; Kataria, N.; Bhatia, J.S. and Ghosal, A.K. (1993). Blood metabolic profile of *Marwari* goats in relation to seasons. Indian Vet. J. 70 (8) : 761-762.
3. Kataria, N.; Kataria, A.K.; Agarwal, V.K.; Garg, S.L. and Sahani, M.S. (2002a). Effect of long term dehydration on serum constituents in extreme climatic conditions in camel (*Camelusdromedarius*) . Indian J. Physio.Pharmacol. 46 (2) : 218-222.
4. Kataria, N.; Kataria, A.K.; Agarwal, V.K.; Garg, S.L. and Sahani, M.S. (2002b). Effect of seasonal water restriction on erythrocytic and leucocytic indices in camel. Indian J. Anim. Hlth. 41 (1) : 24-28.
5. Kataria, N. and Kataria, A.K. (2004a). Serum calcitonin levels in dromedaries. J. Camel Prac. Res. 11(1): 35-38.
6. Kataria, N. and Kataria,A. K.(2004b). Use of blood analytes in assessment of stress due to drought in camel. J. Camel Prac. Res. 11 (2): 129-133.
7. Kataria, N.; Kataria, A.K.; Maan, R. and Gahlot, A.K. (2010a). Evaluation of oxidative stress in brucella infected cows. J. Stress Physiol. Biochem. 6 (2):19-31.
8. Kataria, N.; Kataria, A.K. and Maan, R. (2010b). Evaluation of oxidative stress due to hot environmental condition in healthy *Marwari* goats from arid tract in India. Philipp. J. Vet. Anim. Sci. 36(2):175-184.
9. Kataria,N.; Kataria, A.K.; Pandey, N. and Gupta, P. (2010c). Serum biomarkers of physiological defense against reactive oxygen species during environmental stress in Indian dromedaries. HVM Bioflux. 2 (2):55-60.
10. Kataria,N.; Kataria, A.K.; Maan, R. and Gahlot, A.K. (2010d). Evaluation of clinical utility of serum enzymes of hepatic origin in clinically affected Marwari sheep of arid tract in India. ABAH Bioflux. 2 (2):71-75.
11. Kataria, N.; Kataria, A.K. and Joshi, A. (2010e). Fuelling of TCA cycle in hepatic cells of Marwari goat during ambient temperature associated stress. J. Stress Physiol. Biochem. 6 (4): 5-11.
12. Kataria, N.; Abhimanu; Arora, S.; Sharma, A.; Maan, R.; Soren, S.; Kataria, A.K.; Mohammad, N.; Pilania, P.K.; Sankhala, L.N.; Thori, M.K.; Gaur, J.S. and Meena, A. (2013a). Status of free radical scavenging enzymes in heat stressed Rathi calves. Vet. Res. 6(1):19-22.
13. Kataria,N.; Kataria, A.K. and Shaukat, Khan (2013b). Heat stress induced changes in serum antioxidants of pregnant and non pregnant*Murrah* buffaloes (*Bubalusbubalis*) in India. Philippine J. Vet. Med. 50 (1):47-50.

14. Joshi, A.; Kataria, N.; Asopa, S. And Kataria, A.K. (2017). Role of aldosterone in hot ambience associated oxidative stress in *Murrah* heifers. Vet. Pract. 18(1): 97-101.
15. Joshi, A. (2018). 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. 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.
16. Kataria, N. and Kataria A.K. (2012a). Heat stress induced changes in metabolic regulators of donkeys from arid tracts in India. J. Stress Physiol. Biochem. 8 (2) : 193-198.
17. Kataria, N. and Kataria, A.K. (2012b). Evaluation of health status by serum metabolic profiling in Rathi cows with some disorders. Ruminant Sci. 1(2):131-135.
18. Kataria, N. and Kataria A.K. (2012c). Use of serum gamma glutamyltransferase as a biomarker of stress and metabolic dysfunctions in Rathi cattle of arid tract in India. J. Stress Physiol. Biochem. 8(3): 23-29.
19. Kataria, A.K. and Kataria, N. (2012d) Assessment of Oxidative Stress in Goats affected with Peste des petits ruminants. Media Peternakan. 3:170-174.
20. Kataria, A.K. and Kataria, N. (2012e). Evaluation of oxidative stress in pigs affected with classical swine fever. Porcine Res. 2 (2) : 35-38.
21. Kataria, A.K. and Kataria, N. (2012f). Evaluation of oxidative stress in sheep affected with peste des petits ruminants. J. Stress Physiol. Biochem. 8(4): 72-77.
22. Ganter, M.; Bickhardt, K.; Stockhofe, N. and Kamphues, J. (1991).The diagnostic significance of different blood parameters and liver biopsy in chronic copper poisoning of sheep.Tierarztl.Prax. 19(2): 141-146.
23. Anonymous (2010a).Worthington Enzyme Manual. Worthington Biochemical Corporation. 730 Vassar Ave., Lakewood, NJ.08701. 1.800.445.9603. 1.732.942.1660.
24. Anonymous (2010b).Enzyme Manual.Ed. Kataria, N. and Kataria, A. K. Vet.Physiol., CVAS, Bikaner, Rajasthan. pp. 12-78.
25. Kour, G. (2010). Ambient temperature associated variations in serum enzymes and metabolites of hepatic functions in Marwari goat. M.V.Sc. thesis submitted to Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner, SKRAU, Bikaner, Rajasthan.
26. Kaps, M. and Lamberson, W.R. (2004). Biostatistics for animal science. CABI Publishing. Oxford shire. pp.36-270.
27. Meena, R.C. (2002). Effect of change in environment temperature on some renal function in sheep. M.V.Sc.thesis submitted to department of Veterinary Physiology,College of veterinary and animal science,BikanerRAU,Rajasthan.
28. Kataria, N.; Kataria, A.K.; Agarwal, V.K.; Garg, S.L. and Sahani, M.S. (2007). Solutes loads and transfer function of kidney in dromedary camel during dehydration and rehydration in winter and summer. *VeterinarskiArhiv*. 77 (3), 237-246.
29. Kour, G.; Kataria, N. and NinadSahebrao, L. (2014). Ambient temperature associated variations in serum urea and creatinine in Marwari goats. IOSR J.Agri. Vet. Sci. 7 (3): 15-18.
30. Kataria, A.K.; Kataria, N.; Kumawat, R.N. and Gahlot, A.K. (2016a). Temperature humidity index vis-à-vis black kite (*Milvusmigrans*) population and migration pattern in arid tracts in India. Ep. J. Environ. Ecol. 3 (2): 69-74.
31. Kataria, N.; Joshi, A.; Saurabh Singh Singhal; Asopa, S. and Kataria, A.K. (2016b). Evaluation of oxidative stress during hot dry and hot humid environmental periods in indigenous pigs from arid tracts in India. Porcine Res. 6(1): 16-23.
32. Kataria, A.K.; Kataria, N. and Kumawat, R.N. (2016c). An appraisal of spatio-temporal association between saker falcon migration and environmental correlates at Jorbeer conservation reserve, Bikaner, Rajasthan (India). Am. J. Biol. Pharma. Res. 3 (2): 69-74.
33. Thori, M. K. (2015). The physiological stress responses and oxidative stress biomarkers in Rathi calves during hot ambience. M.V.Sc. thesis submitted to Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner, Rajasthan, RAJUVAS, Bikaner, Rajasthan.
34. Thori, M.K.; Kataria, A.K. and Kataria, N. (2016). Heat stress assessment in preruminant calves. In: Compendium of national seminar on Mankind: Facing environmental challenges & tackling disasters, MFECTD, held at Jodhpur during 3rd -4th December, 2016.pp. 224.
35. Bhartendu, Joshi, A.; Kataria, N. and Kataria, A.K. (2016). Assessment of environmental temperature dependencies of glycolytic cycle enzymes in *Marwari* goat from arid tract. In: GSTF conference proceddings. Vet.Sci.15.28 .Doi: 10.5176/2382-5685.
36. Kataria, N.; Kataria, A.K.; Chaturvedi, M. and Sharma, A. (2011).Changes in serum enzymes levels associated with liver functions in stressed *Marwari* goat. J. Stress Physiol. Biochem. 7 (1): 13-19.

37. Kataria, N.; Bargujar, J.; Pilania, P.K.; Arya, N.; Bhati, T.; Mohammed, N.; Nathawat, P.; Mathur, M.; Choudhary, S.; Asopa, S.; Abhimanu and Kataria, A.K. (2013c). Evaluation of Stress and Metabolic Adjustments in Buffaloes with Post Parturient Haemoglobinuria. Vet Res.6 (2):43-47.
38. Kour, G. and Kataria N. (2011). Ambient temperature associated variations in serum arginase and aldolase in *Marwari* goat. Vet. Pract. 12: 124-127.

Cite this article:
Saurabh Singh Singhal and Nalini Kataria. Environmental Elements *Vis-À-Vis* Intonations In Metabolic Controllers of *Nali* Sheep From Arid Tracts of Rajasthan. ***Acta Biomedica Scientia***, 2019;6(2):116-122.
DOI:**http://dx.doi.org/10.21276/abs.2019.6.2.13**