Journal of Animal Research: v.13 n.01, p. 87-92. February 2023

DOI: 10.30954/2277-940X.01.2023.11

# Effect of Heat Stress on Water Deficit Markers in *Nali* Sheep

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**Received:** 16 Nov., 2022 **Revised:** 07 Dec., 2022 **Accepted:** 13 Jan., 2023

**ABSTRACT**

An exploration was launched to access the heat ambience associated alterations in water-deficit markers in sheep from western Rajasthan. Appraisal of environmental elements was carried out on the basis of recording of heat load index during intervening, dry-hot, humid-hot and cold Environmental periods (EPs) from Sri Ganganagar and Churu districts of Rajasthan. The mean values among EPs varied significantly ($p$<0.05) for minimum, maximum and average Temperature Humidity Index (THI). During humid-hot EP, the % variation in the values of plasma bicarbonate, urine bicarbonate, Fractional Excretion of Bicarbonate ions ($FE_{Bicarb)}$, plasma anion gap and urine anion gap were found to be maximum (+32.73%, +112.78%, +168.75%,-45.74% and +23.17), respectively. On the basis of study it was concluded that the humid hot was the most effective season among all ambiences. The female sheep were affected more than male sheep. Along with that it was also observed that 15- 19 months age group was affected the most among all 4 age groups.

**HIGHLIGHTS**

- Study focused on water-deficit markers in sheep from Rajasthan altered due to heat stress.
- Varying environmental periods can cause stress to the animals at different levels.
- Arid areas stand the trouble of seasonal change and the arid tracts of Rajasthan are the most dreadful victim of seasonal variations.

**Keywords:** Environmental periods, heat ambience, sheep, stress and water-deficit markers

The arid and semi arid tracts of Rajasthan are the most awful sufferer of seasonal changes. The sketch of physiological organization in the body of the animal during stress enunciates to amass proper tactics for the comfort and security of livestock. Comprehension of stress is crucial requiring befitting laboratory tools and as the first step of staircase (Kataria and Kataria, 2005; Kataria and Kataria, 2010). During study plasma and urine bicarbonate, fractional excretion of bicarbonate, plasma and urine anion gap were assessed as water deficit markers. Water stress is gaining significance in the explorations associated with homeostasis. According to Arora and Kataria (2021) high heat load index changes metabolic functions in body causing variation in metabolites production. Extreme environmental temperature has tremendous potential to lower down the hydration status, therefore producing lurid transformations in blood indices and glomerular filtration rate (Kataria *et al.,* 2001). The stress caused by ambient heat may be ameliorated by better nutritional management (Kishan pal *et al.,* 2020).

## MATERIALS AND METHODS

To accomplish the aim of the investigation, blood and urine samples were collected from the *Nali* sheep belonging to owners of private slaughter houses. Collection of blood samples was accomplished during the process of slaughtering. Non-invasive techniques were utilized to collect urine samples from the *Nali* sheep at the time of

**How to cite this article:** Singhal, S.S., Meena, M., Sharma, V.K., Meena, O.P., Kataria, N. and Kataria, A.K. (2023). Effect of Heat Stress on Water Deficit Markers in *Nali* Sheep. *J. Anim. Res.,* **13**(01): 87-92.

**Source of Support:** None; **Conflict of Interest:** None

voiding before slaughtering. The whole research work was executed with the permission of Institutional Animal Ethics Committee (IAEC), College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan. Total 1280 apparently healthy male and female *Nali* sheep of varying age groups were inspected. Collection of blood and urine samples was undertaken during intervening, dry-hot, humid-hot and cold periods (EPs). In each environmental period (EP), 320 blood and urine samples each were congregated in the morning hours from clinically healthy *Nali* sheep. Obtaining of the blood samples was done adding anticoagulant (dipotassium EDTA) for the whole blood and for plasma. During experiment intervening period comprised of months of October and November; dry-hot period comprised of months of April, May and June; humid-hot period consisted of months of July, August and September and cold environmental period consisted of months of December and January. Intervening period was considered as control period. In each EP, 320 *Nali* sheep were distinguished (160 males and 160 females) to collect samples of blood and urine. The male and female *Nali* sheep were classified 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) of age groups in each EP. In study plasma and urine bicarbonate, were determined as described by Varley (1988) method, fractional excretion of bicarbonate, plasma and urine anion gap were determined as described by Bagga *et al.* (2005). Special computer programmes were used to compute means and standard error (http://www.miniwebtool.com) and analyses of variance (www.danielsoper.com) to verify the significance of the effects. The changes in the means were evaluated by Duncan's new multiple ranges test (Duncan, 1955).

## RESULTS AND DISCUSSION

The mean values among EPs varied significantly ($p<0.05$) for minimum, maximum and average THI. Humid-hot EP displayed maximum values of all the three elements of THI as compared to respective values during other EPs. During humid-hot EP, maximum THI range was 83- 96.11. Average THI mean values were 71.97± 0.14, 85.90± 0.16, 86.90± 0.18 and 62.98± 0.17, respectively during intervening, dry-hot, humid-hot and cold EPs from Churu and Sri Ganganagar districts of Rajasthan. The values among EPs varied significantly ($p<0.05$). Humid-hot showed maximum value. Average heat load index mean values were 70.99± 0.60, 76.95± 0.36, 83.86± 0.61 and 46.60± 0.64, respectively during intervening, dry-hot, humid-hot and cold EPs. It can be stated that intensity of environmental elements was maximum during humid-hot EP.

### Portrayal of changes in values of water-deficit markers during varying EPs

A highly significant ($p<0.01$) effect of extreme EPs i.e. dry-hot, humid-hot and cold was observed by analysis of variance. Level of plasma bicarbonate, urine bicarbonate, $FE_{Bicarb}$ were observed maximum during humid-hot EP. During humid-hot EP, the % variation in the values of plasma bicarbonate, urine bicarbonate and $FE_{Bicarb}$ were found to be maximum (+32.73), (+112.78) and (+168.75), respectively. In each EP, overall mean value of female sheep was significantly ($p<0.05$) higher than the respective overall mean value of male sheep. In male and female categories, in each group, the maximum mean values of urine bicarbonate wereas observed in humid-hot EP. In each gender, in each EP, minimum value was observed in 3-7 months age group and maximum value was observed in 15-19 months age group. All the changes were significant ($p<0.05$).

Chauhan *et al.* (2015) revealed the bang of heat load on balance of acid-base in sheep. Under heat stress, increase of blood pH and decrease of bicarbonate was noted. A study by Trefz *et al.* (2017) concluded that hyperkalemia is a regularly noticed imbalance of electrolyte in neonatal dehydrated calves having diarrhoea. Further advantages of infusions of hypertonic sodium bicarbonate wereas discussed. In a study, Joshi (2018) investigated effect of extreme ambiences in *Rathi* cattle; he observed the changes in plasma bicarbonate level due to heat stress. In a study, Promila (2018) estimated plasma bicarbonate as an indirect analyte of hydration status in sheep. A significant change was observed in the mean value during hot ambience reflecting bang of environmental temperature. A study by Singh (2018) revealed plasma bicarbonate as an indirect analyte of hydration status in goats. A significant change was observed in the mean value of bicarbonate during hot ambience shows the effect of heat stress on body physiology.

**Table 1:** Mean ± SEM values of plasma bicarbonate ($P_{Bicarb}$, $mmolL^{-1}$) in the *Nali* sheep during varying environmental periods (EPs)

| Sl. No. Effects | Mean ± SEM values during environmental periods | | | |
|---|---|---|---|---|
| | Intervening | Dry-hot | Humid-hot | Cold |
| Environmental period Overall values (320) | $22.18^{b}$ ±0.15 | $25.54^{b}$ ±0.18 | $29.44^{b}$ ±0.23 | $23.67^{b}$ ±0.17 |
| Overall mean values of males (160) | $19.68^{bc}$±0.02 | $22.68^{bd}$±0.01 | $25.74^{bd}$±0.04 | $20.96^{bd}$±0.01 |
| 3-7 months (40) | $18.15^{bd}$±0.016 | $21.17^{bd}$±0.016 | $23.49^{bd}$±0.139 | $19.17^{bd}$±0.016 |
| 7-11 months (40) | $19.17^{bd}$±0.016 | $22.19^{bd}$±0.014 | $25.20^{bd}$±0.016 | $20.18^{bd}$±0.015 |
| 11-15 months (40) | $20.21^{bd}$±0.034 | $23.17^{bd}$±0.018 | $26.14^{bd}$±0.011 | $21.22^{bd}$±0.010 |
| 15-19 months (40) | $21.21^{bd}$±0.014 | $24.19^{bd}$±0.018 | $28.16^{bd}$±0.016 | $22.19^{bd}$±0.015 |
| Overall mean values of females (160) | $26.01^{bc}$±0.010 | $28.18^{bc}$±0.010 | $32.12^{bc}$±0.012 | $26.21^{bc}$±0.010 |
| 3-7 months (40) | $24.10^{bd}$±0.001 | $26.16^{bd}$±0.006 | $30.11^{bd}$±0.009 | $25.20^{bd}$±0.006 |
| 7-11 months (40) | $25.24^{bd}$±0.001 | $27.16^{bd}$±0.004 | $32.17^{bd}$±0.003 | $26.16^{bd}$±0.006 |
| 11-15 months (40) | $26.10^{bd}$±0.001 | $29.14^{bd}$±0.003 | $34.10^{bd}$±0.002 | $27.14^{bd}$±0.006 |
| 15-19 months (40) | $28.02^{bd}$±0.001 | $31.16^{bd}$±0.005 | $36.14^{bd}$±0.006 | $28.97^{bd}$±0.007 |

**Table 2:** Mean ± SEM values of urine bicarbonate ($U_{Bicarb}$, $mmolL^{-1}$) in the *Nali* sheep during varying environmental periods (EPs)

| Sl. No. Effects | Mean ± SEM values during environmental periods | | | |
|---|---|---|---|---|
| | Intervening | Dry-hot | Humid-hot | Cold |
| Environmental period Overall values (320) | $27.84^{b}$ ±0.15 | $47.12^{b}$ ±0.15 | $59.24^{b}$ ±0.16 | $36.62^{b}$ ±0.13 |
| Overall mean values of males (160) | $26.86^{bc}$±0.00 | $45.62^{bd}$±0.00 | $57.62^{bd}$±0.00 | $27.37^{bd}$±0.00 |
| 3-7 months (40) | $23.58^{bd}$±0.02 | $42.61^{bd}$±0.01 | $54.62^{bd}$±0.00 | $32.60^{bd}$±0.01 |
| 7-11 months (40) | $25.6^{bd}$±0.01 | $44.62^{bd}$±0.00 | $56.61^{bd}$±0.00 | $34.62^{bd}$±0.00 |
| 11-15 months (40) | $27.64^{bd}$±0.00 | $46.62^{bd}$±0.00 | $58.64^{bd}$±0.00 | $36.62^{bd}$±0.02 |
| 15-19 months (40) | $30.62^{bd}$±0.00 | $48.64^{bd}$±0.00 | $60.63^{bd}$±0.00 | $38.64^{bd}$±0.00 |
| Overall mean values of females (160) | $28.83^{bc}$±0.01 | $48.60^{bc}$±0.00 | $60.86^{bc}$±0.00 | $37.63^{bc}$±0.00 |
| 3-7 months (40) | $25.6^{bd}$±0.01 | $45.64^{bd}$±0.00 | $57.63^{bd}$±0.00 | $34.62^{bd}$±0.00 |
| 7-11 months (40) | $27.64^{d}$±0.00 | $47.64^{bd}$±0.00 | $59.62^{bd}$±0.00 | $36.62^{bd}$±0.00 |
| 11-15 months (40) | $29.50^{bd}$±0.02 | $49.54^{bd}$±0.02 | $61.56^{bd}$±0.01 | $38.64^{bd}$±0.00 |
| 15-19 months (40) | $32.60^{bd}$±0.01 | $51.61^{bd}$±0.01 | $64.64^{bd}$±0.00 | $40.64^{bd}$±0.00 |

**Table 3:** Mean ± SEM values of fractional excretion of bicarbonate ($FE_{HCO3}$,%) in the *Nali* sheep during varying environmental periods (EPs)

| Sl. No. Effects | Mean ± SEM values during environmental periods | | | |
|---|---|---|---|---|
| | Intervening | Dry-hot | Humid-hot | Cold |
| Environmental period Overall values (320) | $0.032^{b}$ ±0.040 | $0.081^{b}$ ±0.043 | $0.084^{b}$ ±0.045 | $0.058^{b}$ ±0.041 |
| Overall mean values of males (160) | $0.029^{bc}$±0.010 | $0.078^{bc}$±0.010 | $0.082^{bc}$±0.012 | $0.057^{bc}$±0.010 |
| 3-7 months (40) | $0.026^{bd}$±0.0005 | $0.076^{bd}$±0.0006 | $0.080^{bd}$±0.0006 | $0.051^{bd}$±0.0006 |
| 7-11 months(40) | $0.030^{bd}$±0.0004 | $0.079^{bd}$±0.0005 | $0.082^{bd}$±0.0005 | $0.054^{bd}$±0.0006 |
| 11-15 months (40) | $0.033^{bd}$±0.0005 | $0.078^{bd}$±0.0004 | $0.083^{bd}$±0.0005 | $0.058^{bd}$±0.0005 |
| 15-19 months (40) | $0.035^{bd}$±0.0004 | $0.079^{bd}$±0.0005 | $0.084^{bd}$±0.0005 | $0.059^{bd}$±0.0005 |
| Overall mean values of females (160) | $0.035^{bc}$±0.011 | $0.084^{bd}$±0.011 | $0.086^{bd}$±0.011 | $0.059^{bd}$±0.011 |
| 3-7 months (40) | $0.031^{bd}$±0.0005 | $0.078^{bd}$±0.0006 | $0.082^{bd}$±0.0006 | $0.055^{bd}$±0.0006 |
| 7-11 months (40) | $0.034^{bd}$±0.0004 | $0.081^{bd}$±0.0005 | $0.083^{bd}$±0.0005 | $0.056^{bd}$±0.0006 |
| 11-15 months (40) | $0.036^{bd}$±0.0005 | $0.085^{bd}$±0.0004 | $0.085^{bd}$±0.0005 | $0.059^{bd}$±0.0005 |
| 15-19 months (40) | $0.038^{bd}$±0.0004 | $0.086^{bd}$±0.0005 | $0.088^{bd}$±0.0005 | $0.063^{bd}$±0.0005 |

**Portrayal of changes in values of plasma anion gap and urine anion gap during varying EPs**

During humid-hot EP plasma anion gap level was observed minimum while urine anion gap was observed maximum during same period. During humid-hot EP, the % variation in the values of plasma anion gap and urine anion gap were found to be maximum (-45.74) and (+23.17), respectively, while during in each EP, overall mean value of female sheep was significantly ($p$<0.05) higher than the respective overall mean value of male sheep. All the changes were significant ($p$<0.05). In each gender, in each EP, minimum value was observed in 3-7 months age group and maximum value was observed in 15-19 months age group. The changes according to age groups, irrespective of gender, divulged an increasing pattern of the mean values which were found to be minimum in 3-7 months age group and maximum in 15-19 months age group. Analysis of variance also indicated significant ($p$<0.05) differences. A study by Mellor (1970) attempted to investigate sheep and goat for exploring ion distribution. A study by Kutas (1965) attempted to explore

**Table 4:** Mean ± SEM values of plasma anion gap ($P_{AG}$, mmol$L^{-1}$) in the *Nali* sheep during varying environmental periods (EPs)

| Sl. No. Effects | Mean ± SEM values during environmental periods | | | |
|---|---|---|---|---|
| | **Intervening** | **Dry-hot** | **Humid-hot** | **Cold** |
| Environmental period Overall values (320) | $22.96^{b}\pm0.40$ | $16.03^{b}\pm0.43$ | $13.05^{b}\pm0.45$ | $20.96^{b}\pm0.41$ |
| Overall mean values of males (160) | $21.33^{bc}\pm0.10$ | $13.73^{bc}\pm0.10$ | $11.42^{bc}\pm0.12$ | $18.45^{bc}\pm0.10$ |
| 3-7 months (40) | $19.94^{bd}\pm0.05$ | $10.37^{bd}\pm0.06$ | $8.64^{bd}\pm0.06$ | $13.16^{bd}\pm0.06$ |
| 7-11 months (40) | $20.60^{bd}\pm0.04$ | $12.48^{bd}\pm0.05$ | $9.73^{bd}\pm0.05$ | $17.36^{bd}\pm0.06$ |
| 11-15 months (40) | $21.50^{bd}\pm0.05$ | $14.73^{bd}\pm0.04$ | $10.04^{bd}\pm0.05$ | $18.62^{bd}\pm0.05$ |
| 15-19 months (40) | $25.73^{bd}\pm0.04$ | $16.90^{bd}\pm0.05$ | $13.20^{bd}\pm0.05$ | $19.07^{bd}\pm0.05$ |
| Overall mean values of females (160) | $24.60^{bc}\pm0.10$ | $20.48^{bd}\pm0.11$ | $17.54^{bd}\pm0.12$ | $23.88^{bd}\pm0.10$ |
| 3-7 months (40) | $23.44^{bd}\pm0.05$ | $18.89^{bd}\pm0.06$ | $15.63^{bd}\pm0.06$ | $22.61^{bd}\pm0.06$ |
| 7-11 months (40) | $24.60^{bd}\pm0.04$ | $19.97^{bd}\pm0.05$ | $17.01^{bd}\pm0.05$ | $23.84^{bd}\pm0.06$ |
| 11-15 months (40) | $25.55^{bd}\pm0.05$ | $20.50^{bd}\pm0.04$ | $18.18^{bd}\pm0.05$ | $24.90^{bd}\pm0.05$ |
| 15-19 months (40) | $26.82^{bd}\pm0.04$ | $22.11^{bd}\pm0.05$ | $19.34^{bd}\pm0.05$ | $25.02^{bd}\pm0.05$ |

**Table 5:** Mean ± SEM values of urine anion gap ($U_{AG}$, mmol$L^{-1}$) in the *Nali* sheep during varying environmental periods (EPs)

| Sl. No. Effects | Mean ± SEM values during environmental periods | | | |
|---|---|---|---|---|
| | **Intervening** | **Dry-hot** | **Humid-hot** | **Cold** |
| Environmental period Overall values (320) | $28.01^{b}\pm0.040$ | $31.50^{b}\pm0.043$ | $34.59^{b}\pm0.045$ | $31.63^{b}\pm0.041$ |
| Overall mean values of males (160) | $27.75^{bc}\pm0.010$ | $28.51^{bd}\pm0.012$ | $32.82^{bd}\pm0.011$ | $28.67^{bd}\pm0.010$ |
| 3-7 months (40) | $23.34^{bd}\pm0.005$ | $26.35^{bd}\pm0.006$ | $31.36^{bd}\pm0.006$ | $25.27^{bd}\pm0.006$ |
| 7-11 months (40) | $27.19^{bd}\pm0.004$ | $28.28^{bd}\pm0.005$ | $32.30^{bd}\pm0.005$ | $27.16^{bd}\pm0.006$ |
| 11-15months (40) | $28.20^{bd}\pm0.005$ | $29.29^{bd}\pm0.005$ | $33.39^{bd}\pm0.004$ | $29.31^{bd}\pm0.005$ |
| 15-19 months (40) | $30.19^{bd}\pm0.004$ | $30.21^{bd}\pm0.005$ | $34.37^{bd}\pm0.005$ | $31.21^{bd}\pm0.005$ |
| Overall mean values of females (160) | $30.26^{bc}\pm0.10$ | $36.10^{bc}\pm0.10$ | $38.17^{bc}\pm0.12$ | $35.02^{bc}\pm0.10$ |
| 3-7 months (40) | $30.23^{bd}\pm0.005$ | $35.23^{bd}\pm0.006$ | $35.99^{bd}\pm0.006$ | $32.32^{bd}\pm0.006$ |
| 7-11 months (40) | $31.28^{bd}\pm0.004$ | $36.22^{bd}\pm0.005$ | $37.26^{bd}\pm0.005$ | $36.27^{bd}\pm0.006$ |
| 11-15 months (40) | $33.27^{bd}\pm0.005$ | $37.39^{bd}\pm0.004$ | $38.21^{bd}\pm0.005$ | $37.32^{bd}\pm0.005$ |
| 15-19 months (40) | $36.29^{bd}\pm0.004$ | $38.56^{bd}\pm0.005$ | $39.14^{bd}\pm0.005$ | $39.18^{bd}\pm0.005$ |

Figures in the parenthesis = Number of *Nali* sheep; EP = Environmental period; '[b]' = Significant ($p$<0.05) differences among mean values for a row.; '[c]' = Significant ($p$<0.05) differences between overall mean values of males andfemales for an EP; '[d]' = Significant ($p$<0.05) differences among mean values of different genderspecific age groups for an EP.

net acid base excretion in the urine of cattle. This study was for the estimation of acid base equilibrium. Screening of anionic salts influence on acid-base status and urinary calcium excretion in dairy cows were done by Oetzel *et al.* (1991). Sendag *et al.* (2011) determined net acid base excretions which are imperative markers the acid-base balance in ewes. Joshi (2018) investigated cattle to find effect of extreme ambiences on urine anion gap and significant changes were observed.

## CONCLUSION

It could be concluded that, in each EP, overall mean value of all studied water deficit markers were observed significantly ($p$<0.05) higher in female sheep than the respective overall mean value in male sheep. In each gender, in each EP, minimum value of each water deficit marker was observed in 3-7 months age group and maximum value was observed in 15-19 months age group. It could be concluded that humid hot ambience was the harshest ambience causing bang on animal physiology. The one of the objectives of the present study was to set the reference values of wellbeing and contentment index of *Nali* sheep belonging to Churu and Sri Ganganagar districts, Rajasthan based upon the environmental elements and physiological analytes, since animal population greatly suffer the impact of higher environmental temperatures in arid tracts.

## FURTHER RESEARCH

In future the effect of heat stress could be extended on molecular level and the role of heat stress could be explored in sheep in same area.

## ACKNOWLEDGMENTS

The authors are thankful to Dr. Nalini Kataria, Prof. and Head, Dept. of Veterinary Physiology, RAJUVAS Bikaner for financial support and allowing to work in the laboratory during research work and for their continuous motivation and indispensable suggestions and counselling during the study and research period.

## REFERENCES

Arora, S. and Kataria, N. 2021. Heat load index vis-à-vis changes in metabolic functions of Sirohi goat from semi-arid tracts of Rajasthan**.** *J. Entomol. Zool Stud.,* **9**(3): 267-270.

Bagga, A., Bajpai, A. and Menon, S. 2005. Approach to renal tubular disorders. *Indian J. Paediatr.,* **72**(9): 771-776.

Chauhan, S.S., Celi, P., Leury, B.J. and Dunshea, F.R. 2015. High dietary selenium and vitamin E supplementation ameliorates the impacts of heat load on oxidative status and acid-base balance in sheep. *J. Anim. Sci.,* **93**(7): 3342-3354.

Duncan, D.B. 1955. Multiple range and multiple F test. *Biomet.,* **11**(1): 1-42.

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.

Kataria, N., Kataria A.K., Agarwal, V.K., Garg, S.L. and Sahani, M.S. 2001. Changes in certain blood indices due to long term seasonal dehydration and rehydration in dromedary camel. *Int. J. Animal Sci.,* **16**(2): 269-275.

Kataria, N. and Kataria, A.K. 2005. A psychophysiological approach to alleviate stress in cattle. *Indian Cow*, **2**(6): 2-5.

Kataria, N. and Kataria, A.K. 2010. Can prolactin be used as marker of stress in goat? *Vet. Prac.,* **11**(1): 48-49.

Kutas, F. 1965. Determination of net acid-base excretion in the urine of cattle. A method for the estimation of acid-base equilibrium. *Acta Vet. Acad. Sci. Hung.,* **15**: 147-153.

Mellor, C.S. 1970. First rank symptoms of schizophrenia: I. the frequency in schizophrenics on admission to hospital II. Differences between individual first rank symptoms. *Br. J. Psychiatry.,* **117**(536): 15-23.

Oetzel, G.R., Fettman, M.J., Hamar, D.W. and Olson, J.D. 1991. Screening of anionic salts for palatability, effects on acid-base status and urinary calcium excretion in dairy cows. *J. Dairy Sci.,* **74**(3): 965-971.

Promila. 2018. Hydration status *vis-à-vis* antioxidant level in non-descript sheep from arid tracts during extreme hot ambience. M.V.Sc. thesis submitted to Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner, RAJUVAS, Bikaner, Rajasthan.

Sendag, S., Cetin, Y., Failing, K. And Wehrend, A. 2011. Laboratory diagnostics in the urine of young and pregnant ewes. *Tierarztliche Praxis Ausg. G Grosstiere Nutztiere.,* **39**(2): 82-87.

Singh, A. 2018. Relationship of antioxidant status and water deficit markers in non-descript goat from arid tracts during extreme hot environmental temperature period. M.V.Sc. thesis submitted to Department of Veterinary Physiology, College of Veterinary and Animal Science, Bikaner, RAJUVAS, Bikaner, Rajasthan.

Tanwar, K.P., Arora, S., Shakhar, C. and Agarwal, M. 2020. Role of strategic mineral mixture supplementation against oxidative stress in cattle. *Livest. Res. Int.,* **8**(2): 44-47.

Trefz, F.M., Constable, P.D. and Lorenz, I. 2017. Effect of intravenous small-volume hypertonic sodium bicarbonate, sodium chloride, and glucose solutions in decreasing plasma potassium concentration in hyperkalemic neonatal calves with diarrhea. *J. Vet. Intern. Med.,* **31**(3): 907-921.

Varley, H. 1988. Practical Clinical Biochemistry. 4th Ed., CBS publishers and distributors, New Delhi, pp. 158-637.