SHORT COMMUNICATION

Serum Enzyme Activity in Murrah Buffalo under Hot-Humid and Cold Seasonal Conditions

Mohan Singh*, Barkha Gupta, Pavan Kumar Mittal, Govind Sahay Gottam, Bhagat Singh Saini

Abstract

The present study was conducted to evaluate the effect of seasonal variation, specifically the hot-humid (June to September) and cold period (December to February), on selected serum enzyme activity in adult female Murrah buffalo (n=10). Blood samples were aseptically collected from the jugular vein, and serum was separated for biochemical analysis. Hepatic enzyme activities were quantified using an automated Turbo Chem 100 blood biochemistry analyzer. Seasonal variation had no significant effect on serum levels of alanine aminotransferase (ALT), lactate dehydrogenase (LDH), or alkaline phosphatase (ALP). However, aspartate amino-transferase (AST) concentrations showed a highly significant decrease ($p<0.01$) during the cold season. These findings suggest that while most serum enzyme levels remain relatively stable across seasonal conditions, AST is sensitive to ambient temperature changes and may serve as a potential indicator of thermal stress in Murrah buffaloes.

Key words: Hot-humid and cold climate, Murrah buffalo, Seasonal variation, Serum enzymes.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.22.1.40

Introduction

The domestic water buffalo (*Bubalus bubalis*) plays a pivotal role in the livestock economy of tropical and subtropical regions, particularly in Asia, which accounts for nearly 97% of the global buffalo population, estimated at approximately 204 million heads as of 2023 (FAO, 2023). India leads globally with a buffalo population exceeding 110 million, and the Murrah breed is renowned for its high milk yield, adaptability, and economic significance. However, buffaloes are frequently exposed to seasonal variation, especially in arid and semi-arid regions, where thermal stress from extreme summer heat or winter cold can disrupt their physiological and biochemical homeostasis. Serum enzymes serve as sensitive indicators of such stress, reflecting the functional status of vital organs, particularly the liver and muscles. Enzymes such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT) are markers of hepatic function; alkaline phosphatase (ALP) indicates hepatobiliary and bone activity; and lactate dehydrogenase (LDH) is associated with tissue damage and muscular stress (Kaneko *et al.,* 2008). Seasonal stress, particularly during summer, has been linked to elevated AST, ALT, and LDH levels, suggesting hepatic strain and muscle injury. In contrast, cold stress may alter enzyme profiles due to suppressed metabolism and peripheral vasoconstriction (Kumar *et al.,* 2011).

Monitoring seasonal fluctuations in these enzyme activities provides valuable insights into the physiological adaptability of buffalo and can serve as a diagnostic tool for assessing metabolic stress. Therefore, the present study was undertaken to investigate the seasonal modulation of serum AST, ALT, ALP, and LDH activity in Murrah buffaloes, with the aim of understanding their adaptive responses under varying environmental conditions and guiding appropriate management strategies.

Department of Veterinary Physiology & Biochemistry, Post Graduate Institute of Veterinary Education and Research, Jaipur-302031, RAJUVAS, Rajasthan, India

Corresponding Author: Dr. Mohan Singh, Department of Veterinary Physiology & Biochemistry, Post Graduate Institute of Veterinary Education and Research, Jaipur-302031, RAJUVAS, Rajasthan, India. e-mail: mohanfaujdar1994@gmail.com

How to cite this article: Singh, M., Gupta, B., Mittal, P. K., Gottam, G. S., & Saini, B. S. (2026). Serum Enzyme Activity in Murrah Buffalo under Hot-Humid and Cold Seasonal Conditions. Ind J Vet Sci and Biotech, 22(1), 197-199.

Source of support: Nil

Conflict of interest: None

Submitted 08/10/2025 **Accepted** 29/10/2025 **Published** 10/01/2026

Materials and Methods

The present study was conducted to assess the seasonal influence, specifically during the hot-humid (June to September) and cold period (December to February) on enzyme activity of adult female Murrah buffalo (n=10). Blood samples were collected from the same individuals in both seasonal conditions to ensure consistency in the data. For each sampling, approximately 10 mL of blood was drawn aseptically from the jugular vein with minimal stress to the animals. The blood was collected in plain (non-EDTA) vials for serum biochemical evaluation.

To obtain serum, the plain tubes were kept undisturbed at an approximate 45° angle for 15-30 min at ambient temperature to allow clot formation. The clotted samples were then centrifuged at approximately 1500 × g for 15 min, and the clear supernatant (serum) was carefully harvested and was stored at –20°C for biochemical analysis. Enzyme activities were measured using an automated Turbo Chem 100 blood biochemistry analyzer, employing commercially available diagnostic kits from Jeva Diagnostics. The serum enzyme activity analyzed in the study included aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and lactate dehydrogenase (LDH). The mean values of these enzyme activities were statistically compared between the hot-humid and cold seasonal conditions to evaluate the impact of seasonal variation on the physiological status of Murrah buffalo.

Results and Discussion

Mean ±SE values of serum enzyme activity in hot-humid and cold seasonal conditions are presented in Table 1.

Table 1: Effect of hot-humid and cold seasonal conditions on Mean ±SE values of serum AST, ALT, ALP & LDH in Murrah buffalo (n=10)

Parameters	Season	Mean ± SE
AST (IU/L)	Hot- humid	146.88±8.56*
	Cold	97.91±6.71
ALT (IU/L)	Hot- humid	78.97±5.18
	Cold	70.2±5.75
ALP (IU/L)	Hot- humid	181.71±49.73
	Cold	181.04±46.45
LDH (U/L)	Hot- humid	618.41±40.15
	Cold	1565.07±938.61

*p<0.05 between season

Aspartate Aminotransferase (AST/SGOT)

The present study revealed a significantly higher (p<0.01) serum aspartate aminotransferase (AST) level during the hot-humid compared to the cold season in adult Murrah buffaloes. These findings aligned with the observations of Rasooli *et al.* (2004), Al-Saeed *et al.* (2009), and Bhan *et al.* (2012) in cattle, who reported elevated AST levels during summer relative to winter. Similarly, Aggarwal *et al.* (2016) found increased AST levels under hot-humid conditions in Murrah buffaloes, while Rathwa *et al.* (2017) reported a comparable trend in indigenous sheep. Mengwei *et al.* (2020) observed seasonal variation in Nili-Ravi buffaloes, with AST activity highest in spring, followed by autumn, summer, and winter. Elevated AST levels are indicative of hepato-cellular damage and may reflect metabolic adaptations, such as increased gluconeogenesis under thermal stress. However, contrasting results were reported by Banerjee *et al.* (2015) and Abdou *et al.* (2017), who observed higher AST concentrations during winter in goats and buffaloes, respectively. Urwat *et al.* (2015) also documented significantly higher AST activity in winter in Pashmina goats, suggesting a possible down regulation of hepatic metabolic function rather than cellular injury during warmer periods.

Alanine Aminotransferase (ALT/SGPT)

A marginal but non-significant increase in serum ALT levels was observed during the hot-humid condition. These findings are in agreement with those of Aggarwal *et al.* (2016), Bhan *et al.* (2012), and Rathwa *et al.* (2017), who reported higher ALT activity during warmer months in buffaloes, cattle, and sheep, respectively. Mengwei *et al.* (2020) also found higher ALT activity during autumn than winter in Nili-Ravi buffaloes. Conversely, Abdou *et al.* (2017) and Urwat *et al.* (2015) reported elevated ALT levels in winter in Egyptian buffaloes and Pashmina goats, respectively. Variations in ALT levels across seasons may be attributed to shifts in gluconeogenic activity, as ALT catalyzes the conversion of alanine to pyruvate, a crucial step in glucose synthesis under stress-induced metabolic demands.

Alkaline Phosphatase (ALP)

Although not statistically significant, a slight increase in serum ALP activity was noted during the hot-humid condition. Similar seasonal patterns were reported by Aggarwal *et al.* (2016) in Murrah buffaloes, Bhan *et al.* (2012) in Sahiwal cattle, and Giri *et al.* (2017) in dairy cows, all of whom documented elevated ALP levels during summer. This rise may be associated with enhanced secretion of adreno-corticotropic hormone (ACTH) under thermal stress, which can influence hepatic metabolism and ALP synthesis (Sejian *et al.,* 2010). In contrast, Urwat *et al.* (2015) recorded higher ALP activity during winter in Pashmina goats. ALP is considered a sensitive biomarker for heat stress and seasonal metabolic alterations in ruminants (Juma and Alkass, 2005), with fluctuations attributed to changes in hepatic function, bone metabolism, and growth-related physiological processes.

Lactate Dehydrogenase (LDH)

An elevated but statistically non-significant increase in serum LDH levels was recorded during the cold season. These findings are in line with Gottam (2020), who observed increased LDH concentrations in Pugal sheep during winter. Variability in LDH activity may reflect species differences, environmental conditions, and individual physiological status. In contrast, Aggarwal *et al.* (2016) and Bhan *et al.* (2012) reported higher LDH activity during the hot-humid season in Murrah buffaloes and Sahiwal cattle, respectively. Elevated LDH is generally indicative of tissue damage, particularly of hepatic or muscular origin, and may result from cellular leakage under climatic stress. De Coen *et al.* (2001) described LDH as a terminal enzyme in anaerobic glycolysis, playing a pivotal role in energy production during physiological stress. Interspecies differences in LDH activity can also be influenced by factors such as age, breed, sex, and metabolic adaptability.

The findings of this study indicate a significant influence of seasonal conditions on hepatic enzyme activity in adult Murrah buffalo. A highly significant ($p<0.01$) increase in the mean serum activity of AST was observed during the hot-humid compared to the cold condition, suggesting a marked effect of environmental heat stress on hepato-cellular function. However, the seasonal differences in ALT, ALP, and LDH levels were not statistically significant. These enzymes, being key indicators of liver function, demonstrate that thermal stress may modulate hepatic metabolism and integrity. Therefore, it can be concluded that seasonal environmental conditions can have varying impacts on biochemical markers of liver function, with AST being particularly responsive to heat stress in Murrah buffaloes.

Acknowledgments

The authors are thankful to the Vice-Chancellor, RAJUVAS, Bikaner, Rajasthan, India, and Dean, Post Graduate Institute of Veterinary Education and Research, Jaipur, Rajasthan, for providing the necessary facilities and financial support to carry out the research.

References

Abdou, A.A., El-Sayed, A.I.M., Soliman, A., Mokhles, E.M., & El-Regalati, H. (2017). Effect of season and parity on blood plasma metabolites, milk yield and milk components and somatic cell count in newly parturition Egyptian buffalo females. *Egyptian Journal of Nutrition and Feeds, 20*(1), 17-28.

Aggarwal, A., Singh, S.V., Badrealam, K.F., Renuka, A.K., & Anil, K. (2016). Haematological and hormonal profile of various breeds of cattle and buffalo under varied seasons and environmental conditions. ICAR-*National Dairy Research Institute, Karnal, Haryana, India Publication*, p. 1-47.

Banerjee, D., Upadhyay, R.C., Chaudhary, U.B., Kumar, R., Singh, S., Ashutosh, & De, S. (2015). Seasonal variations in physio-biochemical profiles of Indian goats in the paradigm of hot and cold climate. *Biological Rhythm Research, 46*(2), 221-236.

Bhan, C., Singh, S.V., Hooda, O.K., Upadhyay, R.C., Beenam, V.M., & Vaidya, M. (2012). Influence of temperature variability on physiological, hematological and biochemical profile of growing and adult Sahiwal cattle. *Journal of Environmental Research and Development, 7*(2), 986-994.

De Coen, W.M., Janssen, C.R., & Segner, H. (2001). The use of biomarkers in *Daphnia magna* toxicity testing V: *In vivo* alterations in the carbohydrate metabolism of *Daphnia magna* exposed to sublethal concentrations of mercury and lindane. *Ecotoxicology and Environmental Safety, 48*(3), 223-234.

FAO (2023). Food and Agriculture Organization of the United Nations. FAOSTAT: Live animals -Buffaloes. https://www.fao.org/faostat/en/#data/QA.

Giri, A., Bharti, V.K., Kalia, S., Ravindran, V., Ranjan, P., Kundan, T.R., & Kumar, B. (2017). Seasonal changes in haematological and biochemical profile of dairy cows in high altitude cold desert. *Indian Journal of Animal Sciences, 87*(6), 723-727.

Gottam, G.S. (2020). Perusal of varying environmental conditions versus physiological cadence in Pugal sheep from arid tracts subsuming serum cortisol and glutathione status. *Ph.D. Thesis.* Rajasthan University of Veterinary and Animal Sciences, Bikaner, India. pp. 1-724.

Juma, K.H., & Alkass, I.E. (2005). Native goats of Iraq: A review. *Dirasat: Agricultural Sciences, 32*(2), 180-188.

Kaneko, J.J., Harvey, J.W., & Bruss, M.L. (2008). *Clinical Biochemistry of Domestic Animals.* 6th edn., Academic Press.

Kumar, S., Dangi, S.S., Singh, G., & Upadhyay, R.C. (2011). Effect of heat stress in tropical livestock and strategies for its amelioration. *Journal of Animal Research, 1*(1), 1-9.

Mengwei, L., Hassan, F.U., Yanxia, G., Zhenhua, T., Xin, L., Fang, X., & Yang, C. (2020). Seasonal dynamics of physiological, oxidative and metabolic responses in non-lactating Nili-Ravi buffaloes under hot and humid climate. *Frontiers in Veterinary Science, 7*, Article 111.

Rasooli, A., Nouri, M., Khajeh, G.H., & Rasekh, A. (2004). The influences of seasonal variations on thyroid activity and some biochemical parameters of cattle. *Iranian Journal of Veterinary Science, 5*(2), 55-62.

Rathwa, S.D., Vasava, A.A., Pathan, M.M., Madhira, S.P., Patel, Y.G., & Pande, A.M. (2017). Effect of season on physiological, biochemical, hormonal and oxidative stress parameters of indigenous sheep. *Veterinary World, 10*(6), 650-654.

Sejian, V., Maurya, V.P., & Naqvi, S.M.K. (2010). Adaptive capability as indicated by the blood biochemical profile in Malpura ewes subjected to thermal and nutritional stress. *Tropical Animal Health and Production, 42*(8), 1763-1770.

Urwat, U., Fazili, I.S., Ruby, T.A., Shiekh, F., Naykoo, N.A., Malik, F.A., & Ganai, N.A. (2015). Sex and seasonal variations in the serum biochemical profile of Changthangi Pashmina goats. *Animal Science Reporter, 9*(4), 138-148.