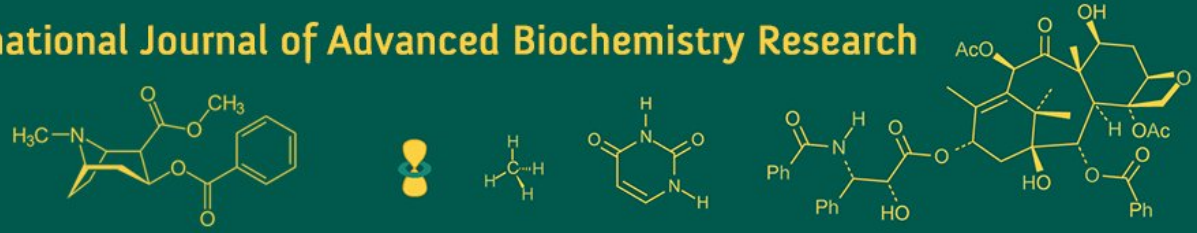
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(1): 40-46
www.biochemjournal.com
Received: 15-11-2023
Accepted: 20-12-2023

Prachi Dhaka
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

GS Gottam
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

Barkha Gupta
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

Smeer Meharania
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

Sushila Maida
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

Corresponding Author:
Prachi Dhaka
Department of Veterinary Physiology and Biochemistry, Post Graduate Institute of Veterinary Education and Research (PGIVER), Jaipur, Rajasthan, India

Seasonal variations in biochemical parameters of diarrheic cattle calves: Implications for gaushala health management

Prachi Dhaka, GS Gottam, Barkha Gupta, Smeer Meharania and Sushila Maida

DOI: https://doi.org/10.33545/26174693.2024.v8.i1a.303

Abstract
The primary objective of this investigation was to discern variations in biochemical parameters associated with diarrhea in cattle calves across different seasons, specifically the rainy, autumn, and winter periods. A total of 90 diarrheic cattle calves, with 30 representing each season, were meticulously chosen based on their diarrheic condition. The biochemical profile of the diarrheic calves revealed noteworthy distinctions among the seasons. During the rainy season, levels of ALT, AST, total protein, glucose, magnesium, and phosphorus were markedly higher (p<0.05) compared to the autumn and winter seasons. Conversely, levels of albumin, urea, and creatinine exhibited a significant increase (p<0.05) in the winter season when juxtaposed with those in the autumn season. Notably, cholesterol and calcium levels demonstrated a comparable pattern across all three seasons. The study underscores the intricate interplay between environmental conditions, diarrheal incidents, and the physiological responses of calves in a gaushala. The observed variations in blood serum parameters provide valuable insights for understanding and managing the health of cattle in such settings. These findings emphasize the importance of considering seasonal factors and implementing targeted interventions for effective herd management and health maintenance within a gaushala environment.

Keywords: Calves, diarrhoea, gaushala, Rajasthan seasons

Introduction
Diarrhoea in cattle, is a complex issue influenced by various factors, both infectious and non-infectious. Research indicates that the interplay of pathogen exposure, environmental conditions, management practices, nutritional status, and immunological factors contributes to the occurrence of diarrhoea in calves (Svensson *et al*., 2003; Trotz-Williams *et al*., 2007; Wudu *et al*., 2008) [31, 34, 36]. Calves and their dams, the calf's environment, and infectious agents all play crucial roles in the dynamics of diarrhoea. Alarmingly, diarrhoea accounts for a significant portion (80-85%) of total mortality in the first month of a calf's life, with a particularly high incidence in the third week (Singh *et al*., 2009) [29]. Understanding the factors contributing to diarrhoea is essential for effective management and prevention strategies. Seasonal variations emerge as significant determinants affecting the incidence of calf diarrhoea. Studies reveal that the prevalence of diarrheal pathogens peaks during the winter season, possibly due to optimized survival and infectivity of certain viruses in colder temperatures (Brenner *et al*., 1993) [5]. Interestingly, the specific pathogens involved exhibit varied seasonal patterns; for instance, rotavirus infections are more prominent in the cold months of winter, Cryptosporidium spp. show increased prevalence after the rainy season, and Enterotoxigenic *Escherichia coli* (ETEC) strains are more prevalent during the summer season (Chao *et al*., 2019) [6].
Given the unique conditions of cow gaushalas in India, where multiple factors such as climate, hygiene practices, and animal density come into play, addressing the seasonal variations in diarrhoea incidence becomes crucial. Implementing targeted management practices, seasonal adjustments, and preventive measures can be essential to reduce the impact of diarrhoea on calf mortality in cow gaushalas. These efforts may include adapting strategies based on the prevalent pathogens during specific seasons and enhancing overall health and hygiene practices within the gaushala environment.

Timely and accurate diagnosis of diarrhea is of paramount importance as it enhances the efficacy of treatments and prevents potential long-term complications in affected animals (Muktar *et al*., 2009) [39]. Previous studies have consistently highlighted the elevation of Aspartate aminotransferase, Alanine aminotransferase, Urea, Creatinine, Total Protein, and Albumin levels in calves experiencing diarrhea (El-sheikh *et al*., 2012; Malik *et al*., 2013; Singh *et al*., 2014; El-Seadawy *et al*., 2020; Kumar and Jakhar, 2020; Torche *et al*., 2020; Kumar and Kumar, 2021) [9, 19, 30, 8, 17, 33, 16]. However, there is a paucity of information regarding the diverse biochemical and blood mineral profiles of diarrheic calves across different seasons.

The primary goal of our investigation was to analyze the fluctuations in blood serum biochemical and mineral profiles in diarrheic calves, particularly within the gaushala. Our study aimed to explore these changes across different seasons to provide a comprehensive understanding of the seasonal variations in diarrheic calves.

Materials and Methods

In this research study, a cohort of 90 diarrhoeic calves, all below 2 months of age, was chosen from the Cow Rehabilitation Centre situated in Hingoniya, Jaipur, Rajasthan. Centre is positioned in the hot semi-arid zone of northern India, with geographical coordinates of 26.82°N latitude and 75.94°E longitude. The investigation aimed to explore seasonal variations (rainy, autumn, and winter seasons) in various biochemical markers, including Aspartate aminotransferase, Alanine aminotransferase, Urea, Creatinine, Total Protein, Albumin, Glucose, and Cholesterol, as well as essential minerals such as Calcium, Magnesium, and Phosphorus.

A total of 90 blood samples were collected, with 30 samples obtained during each of the three seasons: rainy, autumn, and winter. Calves were randomly selected, and inclusion criteria involved a history of diarrhoea in each respective season. The sampling procedure involved delicately guiding the calves into a holding pen equipped with a squeeze chute facility, allowing for minimal restraint during blood collection. All blood samples were obtained by the same skilled operator in a consistent manner, with the time taken for each blood collection event being less than 60 seconds per calf.

Blood samples, amounting to 10 mL, were collected via jugular venepuncture directly into serum separating tubes (SST) without EDTA. The serum obtained was subsequently stored in a deep freezer at -20 °C until further analysis. The estimation of blood biochemical parameters was performed using an automated Turbo Chem 100 Blood Biochemistry Analyzer, employing Jeev Diagnostic Kits for accurate measurements. This standardized approach ensured consistency and reliability in the assessment of the selected biochemical markers and minerals across all seasons for a comprehensive understanding of their seasonal alterations in diarrhoeic calves

Biochemical parameters were assessed across three distinct seasons using one-way analysis of variance (ANOVA) and Duncan's multiple range test in SPSS computer software version 24. Statistical significance was determined at $p<0.05$. The outcomes are expressed as least square (LS) means with standard error of the mean (SEM).

The relation between different biochemical and physiological variables were assessed by Pearson's correlation coefficient. The correlations between the variables were classified as weak (r<0.35), moderate (r–0.36-0.67) or strong (r – 0.68-1.00) as per Taylor, 1990. Significance was set at 95%. Data analysis was done with SPSS software version 24.

Results

Blood Serum concentration of ALT and AST

The data pertaining to the mean concentration of ALT (U/L) and AST (U/L) in blood serum of diarrhoeic calves is presented in the Table 1. Analysis of variance indicated a significant difference ($p<0.05$) in blood serum ALT concentrations across the three seasons, with the highest levels observed during the rainy season, followed by autumn and winter. This variation may be attributed to the severity of diarrhea in calves during the winter season. The mean blood serum AST levels were also significantly higher ($p<0.05$) in the rainy and autumn seasons compared to the winter season.

Blood Serum concentration of total protein and albumin

The mean data of total protein (g/dl) concentrations and albumin (g/dl) concentrations in diarrheic calves during three seasons have been tabulated in Table 1. The average total protein concentrations were significantly ($p<0.05$) higher in rainy (10.29±0.48) than in winter (8.52±0.43) season. The analysis of variance revealed a statistically significant increase ($p<0.05$) in total protein concentrations during the rainy season compared to the winter season. Interestingly, no statistically significant differences were observed between the autumn and winter seasons, as well as between the rainy and autumn seasons. This nuanced variation in total protein levels across different seasons provides insights into the dynamic relationship between environmental conditions and the health status of calves. The average albumin concentrations were significantly ($p<0.05$) higher in winter (4.31±0.26) than those of autumn (3.42±0.25) and rainy (2.77±0.25) seasons. While, it was statistically similar in rainy and autumn seasons.

Blood Serum concentration of urea and creatinine

The average urea levels (Table 2) exhibited statistically significant differences ($p<0.05$) across various seasons, with higher concentrations observed during the rainy season (39.30±0.85) and winter (39.19±0.88) compared to the autumn season (34.67±0.51). Interestingly, no significant disparity was found between urea levels in the rainy and winter seasons. The average creatinine levels (Table 2) exhibited a noteworthy seasonal variation, with a significant increase ($p<0.05$) observed during the winter compared to the autumn season. Interestingly, there was no statistical distinction between the rainy and winter seasons in terms of creatinine levels.

Blood Serum concentration of glucose and cholesterol

During the rainy season, a noteworthy reduction in mean glucose levels (mg/dl) was observed when compared to the autumn and winter seasons ($p<0.05$) (Table 1). Interestingly, there was no statistically significant difference between the glucose levels in autumn and winter. This intriguing phenomenon prompts an exploration into potential physiological mechanisms underlying the observed variations. The analysis of variances revealed that the Mean ± SEM cholesterol levels (mg/dl) exhibited a remarkable similarity among different seasons, specifically in the rainy season (83.8±1.56), autumn (83.8±1.72), and winter (84.7±1.57).

Table 1: Mean ± SE of biochemical liver function parameters of diarrheal calves during different seasons

Parameters	Rainy	Autumn	Winter
ALT (U/L)	37.06±1.38^{c}	24.12±1.03^{b}	16.17±0.92^{a}
AST(U/L)	76.43±1.53^{b}	76.2±1.82^{b}	71.36±1.58^{a}
Total protein (g/dl)	10.29±0.48^{b}	9.76±0.44^{ab}	8.52±0.43^{a}
Albumin (g/dl)	2.77±0.25^{a}	3.42±0.25^{a}	4.31±0.26^{b}
Glucose (mg/dl)	39.21±1.85^{b}	45.60±1.85^{a}	49.73±1.39^{a}

Values with different superscript differ significantly (*P<0.05*) in a row

Table 2: Mean ± SE of biochemical Kidney function parameters of diarrheal calves during different seasons

Urea (mg/dl)	39.30±0.85^{b}	34.67±0.51^{a}	39.19±0.88^{b}
Creatinine (mg/dl)	2.71±0.17^{ab}	2.39±0.13^{a}	2.96±0.16^{b}

Blood Serum concentration of Calcium, Phosphorus and Magnesium

The graphical representation in Figure 1 illustrates the blood serum concentrations of calcium (mg/dl), phosphorus (mg/dl), and magnesium (mg/dl) across three distinct seasons: rainy, autumn, and winter. The analysis of blood serum magnesium levels revealed significant seasonal variations ($p<0.05$). Specifically, during the winter season (2.55±0.15) and autumn (2.55±0.12), the average magnesium concentrations were significantly lower compared to the rainy season (2.97±0.13). The investigation into blood serum phosphorus concentrations unveiled noteworthy seasonal variations ($p<0.05$). Specifically, during the winter season (5.61±0.26) and autumn (5.62±0.26), the average phosphorus levels were significantly lower compared to the rainy season (6.41±0.26). Intriguingly, statistical similarity was observed between autumn and winter seasons.

Correlation between biochemical and physiological parameters

The association between biological and physiological parameters during different seasons is presented in Table 3. A moderate negative correlation between total protein and rectal temperature, creatinine and respiration rate during the autumn season, and creatinine and heart rate during the rainy season was found. Urea and eye temperature had a strong positive correlation; however, an overall weak correlation was observed between all other biochemical and physiological parameters.

Table 3: Correlation of biochemical and physiological parameters of diarrhoeal calves during different seasons

Parameters	Rainy	Autumn	Winter	Overall
Total protein and Rectal temperature	-0.109 (P=0.567)	-0.391* (P=0.033)	-0.142 (P=0.456)	-0.177 (P=0.095)
Total protein and Eye temperature	-0.229 (P=0.224)	0.086 (P=0.652)	-0.353 (P=0.056)	-0.027 (P=0.798)
Total protein and Heart rate	0.101 (P=0.596)	-0.131 (P=0.490)	0.040 (P=0.832)	0.145 (P=0.172)
Total protein and Respiration rate	0.265 (P=0.158)	-0.016 (P=0.935)	0.120 (P=0.528)	0.222* (P=0.036)
Albumin and Rectal temperature	-0.400* (P=0.029)	0.036 (P=0.849)	0.102 (P=0.592)	-0.084 (P=0.430)
Albumin and Eye temperature	0.508** (P=0.004)	-0.025 (P=0.896)	-0.118 (P=0.535)	-0.082 (P=0.442)
Albumin and Heart rate	0.423* (P=0.020)	0.023 (P=0.905)	-0.040 (P=0.832)	-0.115 (P=0.281)
Albumin and Respiration rate	-0.161 (P=0.394)	-0.216 (P=0.251)	0.002 (P=0.993)	-0.250* (P=0.018)
Urea and Rectal temperature	-0.050 (P=0.793)	-0.012 (P=0.952)	0.323 (P=0.082)	-0.106 (P=0.318)
Urea and Eye temperature	0.382* (P=0.037)	0.133 (P=0.484)	0.199 (P=0.291)	0.173 (P=0.103)
Urea and Heart rate	0.038 (P=0.841)	-0.007 (P=0.972)	-0.075 (P=0.693)	-0.049 (P=0.643)
Urea and Respiration rate	0.048 (P=0.800)	-0.072 (P=0.706)	-0.140 (P=0.462)	-0.107 (P=0.315)
Creatinine and Rectal temperature	-0.159 (P=0.400)	0.183 (P=0.334)	-0.304 (P=0.102)	-0.106 (P=0.318)
Creatinine and Eye temperature	0.97 (P=0.612)	-0.024 (P=0.898)	-0.244 (P=0.193)	-0.123 (P=0.247)
Creatinine and Heart rate	-0.36 (P=0.852)	0.010 (P=0.959)	-0.121 (P=0.523)	-0.166 (P=0.118)
Creatinine and Respiration rate	0.230 (P=0.222)	-0.64 (P=0.735)	0.322 (P=0.083)	0.104 (P=0.328)

* and ** indicate correlation co-efficient (r) significance at 0.05 and 0.01 levels, respectively (2-tailed)

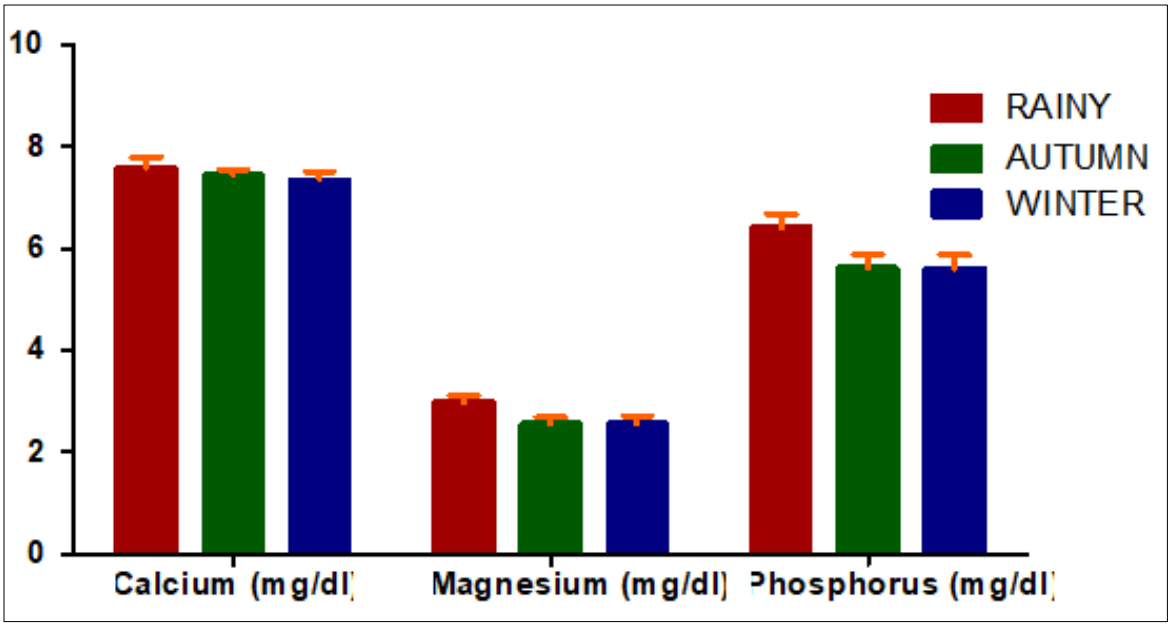


Fig 1: Mean ± SE of Calcium (mg/dl), Magnesium (mg/dl) and Phosphorus (mg/dl) during different seasons in diarrheal calves

Discussion

Analysis of variance indicated a significant difference (p<0.05) in blood serum ALT concentrations across the three seasons, with the highest levels observed during the rainy season, followed by autumn and winter. The elevated serum ALT and AST levels in diarrheic calves may be linked to chronic inflammation of the gastrointestinal tract (GIT) and pathological lesions, such as cell necrosis, damage to cell membranes, changes in membrane permeability of the liver and intestine cells, damage to the intestinal lining and muscle fibers, increased activity of osteoclasts and osteoblasts, and cardiac muscle tissues. These factors can lead to the leakage of intracellular enzymes into the bloodstream (Benjamin, 2013; Kaneko, 1997) [37, 15]. The increased serum ALT and AST activities in diarrheic cattle calves suggest cellular injury in vital organs like the liver, heart, kidney, and muscles. This finding aligns with previous studies by El-Seadawy *et al*., 2020 [8], and Kumar and Jakhar, 2020 [17], which reported elevated ALT and AST activities in diarrheic cattle calves. However, our results contradict those of Shekhar *et al*., 2017 [26], who found a non-significant (p>0.05) change in ALT and AST activities in diarrheic calves, as well as Singh *et al*., 2014 [30], who observed no variation in ALT and AST activities in similar conditions. These discrepancies could be attributed to differences in study populations, environmental conditions, or specific factors influencing the health status of the calves.

The notable elevation in total protein during the rainy season can be attributed to a higher incidence of diarrhea in calves during this specific period. The rainy season is often associated with environmental conditions conducive to the proliferation of pathogens and, consequently, an increased likelihood of diarrheal episodes in vulnerable populations, such as young calves. The stress and challenges posed by the environmental factors during the rainy season might contribute to the observed higher total protein concentrations. Additionally, the phenomenon of haemoconcentration, presumably induced by dehydration, could further explain the hyperproteinemia observed during the rainy season. The increased total protein levels may be a reflection of the calf's physiological response to dehydration, wherein the concentration of proteins in the blood increases due to reduced plasma volume. These findings align with various authors, including Walker *et al*., 1998 [35]; Guzelbektes *et al*., 2007 [13]; Leal *et al*., 2008 [18]; El-sheikh *et al*., 2012 [9], who have reported significantly higher total protein concentrations in diarrheic calves. However, it's important to note that discrepancies exist in the literature, as demonstrated by the study of Roy *et al*., 2009 [24], which observed higher total protein levels in diarrheic calves during October and November. These variations could be attributed to regional differences, specific environmental conditions during different seasons, or other factors influencing the prevalence and severity of diarrhea in calf populations. In summary, the specific analysis of total protein concentrations across distinct seasons underscores the intricate interplay between environmental factors, diarrheal incidents, and the physiological responses of calves, providing valuable insights for understanding and managing the health of these animals.

During the winter season, we observed a statistically significant increase (p<0.05) in albumin concentrations compared to both autumn and rainy seasons. Conversely, no statistical difference was noted between albumin levels in the autumn and rainy seasons. This seasonal variation in albumin concentrations may be attributed to the heightened severity of calf diarrhoea during the winter, leading to potential extracellular fluid loss. The observed elevation in albumin levels aligns with the findings of Kumar and Jakhar, 2020 [17], who reported increased albumin levels in diarrhoeic calves and proposed a connection to haemoconcentration. This phenomenon was also consistent with the results of Malik *et al*., 2013 [19], Singh *et al*., 2014 [30], and Brar *et al*., 2015 [4], who similarly identified elevated albumin levels in diarrhoeic calves. Contrary to our findings, Jayalakshmi *et al*., 2018 [14] reported lower albumin levels in a similar context. The discrepancy in results could be attributed to diverse environmental and physiological factors, warranting further exploration. The observed seasonal fluctuations in albumin concentrations suggest a potential physiological response to the severity of diarrhoea, implicating haemoconcentration as a contributing factor. This underscores the importance of considering seasonal variations and the underlying mechanisms influencing albumin levels in understanding the health dynamics of calves.

It is noteworthy that the recorded urea levels surpassed the reference values (7-20 mg/dl) established by several authors (Guatteo, 2004; Navetat and Rizet, 2002; Navetat *et al*., 2007) [12, 38, 21]. This elevation in blood serum urea levels implies an escalated dietary intake of nitrogen compounds (Bouda and Jagos, 2014) [3]. Furthermore, the heightened urea levels are likely attributable to hypovolemia induced by dehydration (Grech-Aneglini, 2007; Freitas, 2009) [11, 10]. A parallel observation has been noted in previous studies involving calves with diarrhoea, corroborating increased blood serum urea levels (Guzelbektes *et al*., 2007; Ozkan *et al*., 2011; El-sheikh *et al*., 2012; Torche *et al*., 2020) [13, 23, 9, 33]. Considering the seasonal variations, the elevated urea levels in both rainy and winter seasons, as opposed to autumn, suggest a potential environmental influence. The rainy season, characterized by increased humidity and potential changes in dietary patterns, may contribute to higher urea levels. Likewise, winter conditions could impact the animals' diet and metabolism, leading to comparable urea levels. The absence of a significant difference between rainy and winter seasons may be attributed to overlapping factors affecting urea concentrations. The observed season-specific variations in urea levels underscore the influence of environmental and climatic factors on the metabolic profile of the studied calves. The results further emphasize the utility of monitoring blood urea levels for assessing dehydration and acid-base disturbances in calves with diarrhoea, providing valuable insights into their physiological status.

The average creatinine levels revealed a significant seasonal variation, with a significant increase (p<0.05) observed during the winter compared to the autumn season. Interestingly, there was no statistical difference between the rainy and winter seasons in terms of creatinine levels. This seasonal fluctuation in creatinine levels prompts a closer examination of the physiological factors influencing these variations. The findings of the present study align closely with those of Kumar and Kumar, 2021, who reported elevated mean values of serum creatinine levels across various treatment groups (A: 2.32±0.09 mg/dl, B: 2.30±0.08 mg/dl, C: 2.28±0.07 mg/dl) on day 0 (pre-treatment), in contrast to healthy control calves (1.32±0.14 mg/dl). This consistent observation suggests a potential influence of seasonal factors on renal function. Similarly, Singh *et al*.

(2014) [30] noted a significant (p<0.05) increase in mean creatinine values among diarrheic calves (1.68±0.03 mg/dl) compared to healthy control calves (0.69±0.05 mg/dl). These results underscore the intricate interplay between environmental conditions and physiological responses, with seasonal changes possibly contributing to the observed variations in creatinine levels. Moreover, Jayalakshmi *et al*., 2018 [14] reported elevated creatinine levels in buffalo calves affected by winter Coccidiosis, further emphasizing the potential impact of seasonal factors on renal health. Understanding these seasonal variations in creatinine levels is crucial for deciphering the underlying physiological mechanisms and devising appropriate strategies for animal health management, especially in the context of environmental influences on renal function.

One plausible explanation for the decreased blood glucose levels during the rainy season could be attributed to increased exertion, anorexia, and a diminished intestinal absorption of glucose. These factors collectively contribute to a reduced availability of glucose in the bloodstream. Additionally, it is worth considering the possibility that hypoglycemia may result from a decreased rate of conversion of lactic acid to glucose, further exacerbating the decline in blood glucose levels. The multifaceted nature of these physiological responses suggests a complex interplay of factors influencing glucose homeostasis. The observed outcomes align with prior research by Asati *et al*., 2008, who reported decreased mean blood glucose levels in diseased calves compared to their healthy counterparts. This finding resonates with the present study, emphasizing the potential impact of health status on glucose regulation. Further corroboration comes from the work of Roy *et al*., 1984 [40], who documented a significant decrease in glucose levels in diarrhoeic kids. This underscores the role of gastrointestinal disturbances in perturbing glucose homeostasis. Similarly, Jayalakshmi *et al*., 2018 [14] noted higher glucose concentrations in the context of winter coccidiosis, suggesting a season-specific influence on glucose dynamics.

The analysis of variances revealed that the average cholesterol levels revealed a remarkable similarity among different seasons. This suggests that seasonal variations did not exert a significant impact on cholesterol levels in the studied calves. Interestingly, these findings align with the research conducted by El-Seadawy *et al*., 2020 [8], who investigated cholesterol levels in both diarrheic (85.46±1.78) and healthy (85.98±2.04) calves. Similar to the present study, El-Seadawy *et al*. 2020 [8], observed a lack of statistically significant changes in cholesterol levels between the two health conditions. This consistency in results across studies underscores the robustness of the observed patterns, suggesting that seasonal fluctuations and health conditions may not exert a substantial influence on cholesterol levels in the examined calves.

Upon conducting an analysis of variance, it was determined that there exists no statistically significant difference in the mean blood serum calcium concentrations among the aforementioned seasons (7.58±0.20 for rainy, 7.44±0.11 for autumn, and 7.34±0.16 for winter). This observed uniformity in calcium levels aligns with the findings of El-Seadawy *et al*., 2020 [8], who similarly reported a lack of significant difference in the blood serum calcium concentrations between diarrhoeic calves (9.94±0.19) and healthy control calves (9.98±0.32). Consistent with these results, Shrikhande *et al*., 2008 [28] also noted a lack of significant variation in serum calcium levels in healthy cattle across different seasons. These outcomes contribute to our understanding of the stability of blood serum calcium concentrations across seasons, providing valuable insights into the potential influence of environmental factors on mineral homeostasis in cattle.

The analysis of blood serum magnesium levels exhibits noteworthy seasonal variations (p<0.05). Specifically, during the winter season and autumn, the average magnesium concentrations were significantly lower compared to the rainy season. This observed decline in serum magnesium levels may be attributable to potential malabsorption of magnesium, presenting a noteworthy concern within the gaushala environment. These findings parallel those reported by Samand *et al*., 2003 [25], supporting the notion that lower magnesium levels during certain seasons could be indicative of malabsorption issues in cattle. Furthermore, Shah *et al*., 2017 [27] reported similar outcomes in crossbreed cattle, highlighting significant seasonal variations in blood magnesium levels. Specifically, lower levels were observed in spring and winter compared to summer and autumn, with no significant difference between spring and winter levels. The association between low serum magnesium levels and harsh seasons underscores the potential involvement of magnesium in reactions related to oxidative stress within the gaushala setting. This information is vital for gaushala management, emphasizing the need for targeted interventions and nutritional strategies to address seasonal variations in magnesium absorption and mitigate potential oxidative stress in cattle during specific climatic conditions.

The study into blood serum phosphorus concentrations showed significant seasonal variations (p<0.05). These findings align with the results reported by Samand *et al*., 2003 [25], suggesting a potential increase in phosphate loss through the intestine during winter, contributing to the observed decrease in serum phosphorus levels. Corroborating evidence from Shah *et al*., 2017 [27] in crossbred cattle and Shrikhande *et al*., 2008 [28] in cattle revealed elevated serum phosphorus levels during the summer. This elevation was associated with dehydration and decreased kidney function, possibly attributed to environmental stressors. These results underscore the significance of understanding seasonal variations in phosphorus levels for effective herd management. The lower phosphorus concentrations during winter and autumn suggest a potential increase in phosphate loss, emphasizing the need for targeted nutritional strategies to address these seasonal fluctuations. Additionally, the observed elevation in phosphorus levels during summer warrants attention to mitigate dehydration and maintain kidney function, aligning with a comprehensive approach to environmental stress management within the gaushala setting

The correlation findings between biochemical and physiological parameters suggest complex interactions between metabolic processes and temperature regulation, providing insights into the body's adaptive responses during specific times of the year. Furthermore, the strong positive correlation observed between urea levels and eye temperature implies a close link between urea metabolism and ocular thermoregulation. Overall, these results highlight the dynamic nature of physiological responses to seasonal changes, prompting further exploration into the underlying mechanisms and potential implications for health and well-being in diverse.

The findings of this study imply that certain biochemical parameters undergo alterations in cattle calves experiencing

diarrhea, with discernible fluctuations across different seasons. In particular, the rainy season exhibited elevated levels of several biochemical markers, signifying a potential correlation between diarrheic conditions and the prevailing environmental conditions during this period. Conversely, the winter season showcased distinct biochemical signatures, notably in albumin, urea, and creatinine levels, suggesting a seasonal influence on these parameters.

Overall in conclusion, the study underscores the intricate interplay between environmental conditions, diarrheal incidents, and the physiological responses of calves in a gaushala. The observed variations in blood serum parameters provide valuable insights for understanding and managing the health of cattle in such settings. These findings emphasize the importance of considering seasonal factors and implementing targeted interventions for effective herd management and health maintenance within a gaushala environment.

Acknowledgment

The authors appreciatively acknowledge the Vice-chancellor of the Rajasthan University of Veterinary and Animal Sciences, Bikaner and Dean Post Graduate Institute of Veterinary Education & Research, Jaipur, Rajasthan, India for providing the necessary funds and facilities to conduct this research.

References

1. Asati CK, Roy S, Roy M. Hemato-biochemical study and diagnosis of colibacilosis in calves. Intas. Polivet. 2008;9(2):245-8.
2. Benjamin MM. Outline of veterinary clinical pathology. Iowa State University Press; c1978.
3. Bouda J, Jagoš P. Biochemical and hematological reference values in calves and their significance for health control. Acta. Veterinaria. Brno. 2014 Feb 23;53(3-4):137-42.
4. Brar AP, Ahuja CS, Sood NK, Sandhu BS, Gupta K. Hematological changes in neonatal diarrheic calves of different age groups. Indian J Vet. Pathol. 2015:39(1):73-77.
5. Brenner J, Elad E, Markovics A, Grinberg A, Trainin Z. Epidemiological study of neonatal calf diarrhoea in Israel-A one-year survey of faecal samples. Israel Journal of Veterinary Medicine. 1993;48:113-113.
6. Chao DL, Roose A, Roh M, Kotloff KL, Proctor JL. The seasonality of diarrheal pathogens: A retrospective study of seven sites over three years. PLoS neglected tropical diseases. 2019 Aug 15;13(8):e0007211.
7. Chernecky CC, Berger BJ. Laboratory tests and diagnostic procedures. Elsevier Health Sciences; c2012 Dec 1.
8. El-Seadawy S, El-Attar HE, Elkhyat H, Helal M. Clinical and biochemical investigations on bacterial diarrhea in Egyptian buffalo calves. Benha Veterinary Medical Journal. 2020 Dec 1;39(2):90-4.
9. El-sheikh AK, Hayam M, Morsy S, Tarek H, Abbas A, Wafaa M, *et al*. Clinical and laboratory examinations of diarrhea and dehydration in newborn Friesian calves with special reference to therapy with hypertonic and isotonic solution. Life Science Journal. 2012;9(4):181-4.
10. Freitas MD. Avaliação dos parâmetros clínicos e laboratoriais de bezerros com diarréia neonatal naturalmente adquirida; c2009.
11. Grech-Angelini S. Effts de la déshydratation sur le métabolisme énergique et sur l' étatcorporel du dromadaire Camel usd roma darius. Thèsed' exercice Médecine Vétérinaire. Ecole Nationale Vétérinaire (ENV) de Toulouse, France; c2007, 121.
12. Guatteo R. Fluidothérapie des bovins (carnet clinique). Point Vétérinaire, France; c2004. p. 244.
13. Guzelbektes H, Coskun AL, Sen I. Relationship between the degree of dehydration and the balance of acid-based changes in dehydrated calves with diarrhoea. Bulletin-Veterinary Institute in Pulawy. 2007 Jan 1;51(1):83.
14. Jayalakshmi K, Sasikala M, Dhivya B, Yogeshpriya S, Veeraselvam M, Krishnakumar S, *et al*. Winter Coccidiosis in a buffalo calf. Indian Vet. J. 2018 Jan;95(1):75-6.
15. Kaneko JJ. Serum proteins and the disproteinemias. In: Clinical biochemistry of domestic animals, JJ Kaneko, JW. Harvey & ML. Bruss, (Ed.), Academic Press, ISBN 0-12-396305-2, San Diego, California; c1997. p. 117-138.
16. Kumar M, Kumar A. Effect of herbal treatment on haemato-biochemical recovery in a Colibacillosis calves. 2021;10(8):303-307.
17. Kumar S, Jakhar K. Haematological, biochemical and oxidative stress parameter as prognostic indicators in calf diarrhoea. The Pharma Innovation Journal. 2020;9(1):10-3.
18. Leal ML, Cyrillo FC, Mori CS, Michima LE, Nichi M, Ortolani EL, *et al*. Model for osmotic diarrhea in Holstein calves. Ciência Rural. 2008;38:1650-7.
19. Malik YS, Kumar N, Sharma K, Sharma R, Kumar HB, Anupamlal K, *et al*. Special Issues. Journal of Animal Health and Production. 2013;1(1):10-4.
20. Muktar Y, Mamo G, Tesfaye B, Belina D. A review on major bacterial causes of calf diarrhea and its diagnostic method. Journal of Veterinary Medicine and Animal Health. 2015 May 31;7(5):173-85.
21. Navetat H, Rizet C, Meyus A, Foucras G, Schelcher F. La réhydratation du veau: présentation d'un système expert. Bulletin de l'Académie vétérinaire de France. 2007;160(4):325-30.
22. Navetat H, Rizet C, Meyus A, Foucras G, Schelcher F. La réhydratation du veau: présentation d'un système expert. Bulletin de l'Académie vétérinaire de France. 2007;160(4):325-30.
23. Özkan C, Altuğ N, Yüksek N, Kaya A, Akgül Y. Assessment of electrocardiographic findings, serum nitric oxide, cardiac troponins and some enzymes in calves with hyperkalemia related to neonatal diarrhoea. Revue Méd Vét. 2011 Apr 1;162(4):171-6.
24. Roy S, Roy M, Asati CK, Vishwakarma P. Colibacillosis in calves - Its prevalence and therapeutic management. Intas. Polivet. 2009;10(2):207-11.
25. Samad MA, Islam MA, Hossain KA, Islam MT, Saha S. Haemato-biochemical Changes and Antibiotic Sensitivity to *Escherichia coli* Associated with Concurrent Enteric and Septicaemic Infection in Calves. Bangladesh Journal of Veterinary Medicine. 2003;1(1):39-43.
26. Sekhar S, Ranjan R, Singh CV, Kumar P. Prevalence, clinicohaemato-biochemical alterations in colibacillosis in neonatal calves. International Journal of Current Microbiology and Applied Sciences. 2017;6:3192-3198.

27. Shah OS, Amin U, Baba AR, Hussain T, Dar ZA, Nabi SU, *et al*. Studies on seasonal changes in mineral concentrations of cross breed cattle in Kashmir valley. Journal of Entomology and Zoology Studies. 2017;5(6):1818-31.
28. Shrikhande GB, Rode AM, Pradhan MS, Satpute AK. Seasonal effect on the composition of blood in cattle. Veterinary world. 2008 Nov 1;1(11):341.
29. Singh DD, Kumar M, Choudhary PK, Singh HN. Neonatal calf mortality-an overview. Intas. Polivet. 2009;10(2):165-9.
30. Singh M, Gupta VK, Mondal DB, Bansal SK, Sharma DK, Shakya M, *et al*. A study on alteration in Haemato-biochemical parameters in Colibacillosis affected calves. Int. J Adv. Res. 2014;2(7):746-50.
31. Svensson C, Lundborg K, Emanuelson U, Olsson SO. Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. Preventive veterinary medicine. 2003 May 15;58(3-4):179-97.
32. Taylor R. Interpretation of the correlation coefficient: A basic review. Journal of diagnostic medical sonography. 1990 Jan;6(1):35-9.
33. Torche S, Boussena S, Beroual K, Guidoum BM, Kerrour M, Moula N, *et al*. Physiopathology of diarrhea in young calves: clinical signs and metabolic disturbances. Journal of New Sciences. 2020;76(4443-4451).
34. Trotz-Williams LA, Martin SW, Leslie KE, Duffield T, Nydam DV, Peregrine AS, *et al*. Calf-level risk factors for neonatal diarrhea and shedding of Cryptosporidium parvum in Ontario dairy calves. Preventive veterinary medicine. 2007 Nov 15;82(1-2):12-28.
35. Walker PG, Constable PD, Morin DE, Drackley JK, Foreman JH, Thurmon JC, *et al*. A reliable, practical, and economical protocol for inducing diarrhea and severe dehydration in the neonatal calf. Canadian Journal of Veterinary Research. 1998 Jul;62(3):205.
36. Wudu T, Kelay B, Mekonnen HM, Tesfu K. Calf morbidity and mortality in smallholder dairy farms in Ada'a Liben district of Oromia, Ethiopia. Tropical Animal Health and Production. 2008 Jun;40:369-76.
37. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, *et al*. Heart disease and stroke statistics - 2013 update: A report from the American Heart Association. Circulation. 2013 Jan 1;127(1):e6-245.
38. Navetat H, Rizet C, Schelcher F. How to choose oral fluids in calf? BULLETIN-GTV. 2002;17:31-5.
39. Dabbas N, Muktar Z, Ade-Ajayi N. GABBY: An: ex vivo: model for learning and refining the technique of preformed silo application in the management of gastroschisis. African Journal of Paediatric Surgery. 2009 Jul 1;6(2):73-6.
40. Lepage G, Roy CC. Improved recovery of fatty acid through direct transesterification without prior extraction or purification. Journal of Lipid research. 1984 Dec 1;25(12):1391-6.