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Rameshwar
Guest Faculty, Collage of
Agriculture and Research
Station, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

N Savino
Associate Professor,
Department of Livestock
Production and Management,
School of Agricultural Science
(SAS), Nagaland University,
Medziphema, Nagaland, India

VK Vidyarthi
Professor, Department of
Livestock Production and
Management, School of
Agricultural Science (SAS),
Nagaland University,
Medziphema, Nagaland, India

Manish Meshram
Guest Faculty, Collage of
Agriculture and Research
Station, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Thejanuo Rio
Ph.D. Scholar, Department of
Livestock Production and
Management, School of
Agricultural Science (SAS),
Nagaland University,
Medziphema, Nagaland, India

Corresponding Author:
Rameshwar
Guest Faculty, Collage of
Agriculture and Research
Station, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Assessment of seasonal effects on selected serum biochemical parameters of crossbred cattle in Medziphema, Nagaland

Rameshwar, N Savino, VK Vidyarthi, Manish Meshram and Thejanuo Rio

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Abstract

The present study was conducted to evaluate the influence of seasonal variation on selected serum biochemical parameters in crossbred cattle maintained under the agro-climatic conditions of Medziphema, Nagaland. Ten clinically healthy crossbred cattle reared under similar feeding and management practices at the Modern Dairy Farm, Nagaland University, were included in the study. Seasonal Temperature-Humidity Index (THI) values were determined using local meteorological records for spring, summer, and winter seasons. The highest THI was observed during summer (78.08 ± 0.74), followed by winter (72.66 ± 3.19), while the lowest value was recorded in spring (67.72 ± 3.35) ($p < 0.05$). Blood samples were collected twice during each season and analyzed for serum glucose, total protein, and albumin concentrations. Serum glucose levels were significantly lower ($p < 0.05$) in summer (83.14 ± 1.72 mg/dl) compared to spring (86.06 ± 4.91 mg/dl) and winter (96.20 ± 1.47 mg/dl). Similarly, total protein concentration was lowest during summer (4.73 ± 0.11 g/dl), intermediate in spring (5.01 ± 0.32 g/dl), and highest in winter (6.07 ± 0.23 g/dl) ($p < 0.05$). Albumin concentration differed significantly among seasons, with the highest value recorded in winter (5.15 ± 0.17 g/dl) and the lowest in spring (4.16 ± 0.21 g/dl). The results indicate that seasonal fluctuations, particularly elevated summer THI, significantly affect serum biochemical attributes in crossbred cattle. These changes may reflect physiological adaptations to thermal stress and should be considered while developing management strategies aimed at improving cattle health, welfare, and productivity under changing climatic conditions.

Keywords: Cattle, THI, glucose, total protein, albumin, heat stress

Introduction

Livestock production is a major component of agricultural economies worldwide and plays an essential role in food security, nutritional support, and rural livelihoods. Among farm animals, cattle contribute substantially to milk and meat production and provide income to millions of farmers. The productivity of cattle depends on genetics, nutrition, health status, management practices, and environmental conditions. In recent years, climate variability and increasing ambient temperatures have emerged as important constraints to livestock production systems, particularly in tropical and subtropical regions.

Environmental stressors such as temperature, humidity, solar radiation, and wind speed influence the physiological and metabolic functions of animals. Heat stress occurs when the amount of heat generated by the body exceeds its ability to dissipate heat to the environment. Cattle exposed to heat stress exhibit reduced feed intake, altered endocrine activity, changes in blood biochemical parameters, and decreased productivity (Kadzere *et al.* 2002) [14]. These effects are often more pronounced in crossbred cattle because of their higher metabolic rate and milk-producing potential.

The Temperature-Humidity Index (THI) is widely used as an indicator of thermal stress in cattle. THI combines the effects of ambient temperature and relative humidity into a single value and is considered a reliable measure of environmental stress (Armstrong, 1994) [5]. Studies have shown that THI values above the comfort threshold adversely affect feed intake, milk yield, reproductive performance, and physiological functions in dairy cattle (Bouraoui *et al.* 2002) [8].

Therefore, monitoring THI provides valuable information regarding the degree of environmental challenge faced by animals.

Blood biochemical parameters are commonly used as indicators of the physiological and metabolic status of animals. Changes in serum glucose, total protein, albumin, and electrolyte concentrations often reflect the adaptive responses of cattle to environmental stress (Marai *et al.* 2007) [15]. Evaluation of these parameters helps in understanding the impact of seasonal variation on animal health and productivity.

Glucose serves as the primary source of energy for body tissues and is closely regulated through hormonal and metabolic mechanisms. Heat stress may alter glucose metabolism by reducing feed intake and modifying energy utilization patterns. Several investigators have reported significant seasonal variations in serum glucose concentrations in cattle, with lower values commonly observed during periods of high environmental temperature (Bernabucci *et al.* 2010) [7]. Reduced glucose availability during heat stress is often associated with increased maintenance energy requirements and altered carbohydrate metabolism.

Serum proteins are important components of blood and perform a variety of physiological functions, including maintenance of osmotic pressure, transport of nutrients, immune defense, and tissue repair. Total protein concentration is influenced by nutrition, hydration status, and physiological condition. Seasonal fluctuations in environmental conditions can significantly affect protein metabolism in cattle (Sejian *et al.* 2018) [19]. Lower protein concentrations during summer months have been attributed to reduced feed consumption and changes in nutrient utilization associated with thermal stress.

Albumin is the most abundant plasma protein and plays a critical role in maintaining colloidal osmotic pressure and transporting numerous metabolites. Variations in serum albumin concentration may reflect changes in protein synthesis, nutritional status, and physiological adaptation to environmental stressors. Previous studies have demonstrated significant seasonal differences in serum albumin levels in cattle and buffaloes exposed to varying climatic conditions (Aengwanich, 2007) [3].

Seasonal changes in climate are known to affect numerous physiological functions in cattle. High ambient temperatures during summer can increase respiration rate, body temperature, and water consumption while reducing feed intake and productive performance (West, 2003) [23]. These physiological adjustments are aimed at maintaining thermal balance but often result in altered metabolic activity. Conversely, cooler seasons generally favor improved feed efficiency and better physiological performance.

The northeastern region of India experiences considerable seasonal variation in temperature and humidity. Nagaland, in particular, is characterized by distinct spring, summer, and winter seasons that may influence cattle physiology. Despite the increasing importance of dairy farming in the region, limited information is available regarding seasonal changes in serum biochemical parameters of crossbred cattle maintained under local climatic conditions. Generation of baseline data is essential for understanding the adaptive responses of animals and developing appropriate management interventions.

Therefore, the present study was undertaken to investigate the influence of seasonal variation on Temperature-Humidity Index and selected serum biochemical parameters in crossbred cattle maintained under the agro-climatic conditions of Medziphema, Nagaland.

Materials and Methods

The present study was conducted at Nagaland university dairy farm, School of Agricultural Science (SAS) Medziphema campus Nagaland, India. The metrological factors such as ambient temperature and relative humidity values were obtained from the metrological station of ICAR research complex for NEH region, Nagaland center, India located at the experimental stations for calculation of temperature humidity index (THI). Seasons wise THI calculated for calendar year 2022 and year divided in three seasons such as spring (January to April), summer (May to August), and winter (September to December).

The present research was carried out on ten crossbred cattle's with an average age of 1.5 to 3 years and average body weight of 100-300 kg were selected organized dairy farm at Nagaland university school of agricultural science, Medziphema campus, Nagaland, India and were maintained standard under the same feeding, housing, and natural photoperiod, environmental temperature condition. Blood sample were 5 ml collected from jugular vein two times between monthly intervals in each seasons under different environmental condition from all animals for of recorded influence of seasonal variations on electrolyte activity parameters in crossbred. The blood sample was collected in heparin tubes and immediately stored in ice box for transportation. The experimental data obtained were subjected to statistical analyzed of using randomized block design as per the standard procedure described by Snedecor and Cochran (1994) [21].

Results and Discussion

The mean values of seasonal variation in biochemical parameters as an indicator of metabolic status in crossbred cattle under Nagaland climatic condition

Table 1: Local climatic parameters during different seasons of experimental period (THI Values)

Seasons	Air Temperature (°C)			Relative humidity (%)			THI Value
	Max.	Min.	Mean	Max	Min.	Mean	Mean
Spring	27.25 (22.7-32.2)	13.77 (9.6-19.9)	20.51	92.75 (90-96)	53 (40-68)	72.87	67.72
Summer	32.2 (30.5-33.0)	23.62 (21.9-24.6)	27.51	93.25 (92-95)	70.5 (69-72)	81.87	78.08
Winter	29.4 (25.7-33.0)	17.9 (11.7-23.8)	23.65	94.25 (91-96)	62.25 (53-69)	78.25	72.66

a, b, c Mean bearing different superscripts in a column varied significantly ($p < 0.05$).

Glucose Concentration

The seasonal variation in blood glucose concentration of crossbred cattle is presented in Figure 1. The mean glucose concentrations recorded during spring, summer, and winter were 86.06 ± 4.91 , 83.14 ± 1.72 , and 96.20 ± 1.47 mg/dl, respectively. Statistical evaluation revealed a significant ($p < 0.05$) seasonal effect on glucose concentration. The lowest glucose level was observed during summer, whereas the highest value was recorded in winter. Spring values were intermediate and did not differ significantly from those observed during summer.

The reduction in glucose concentration during the summer season may be associated with heat-induced stress, which adversely affects feed intake and energy metabolism. Elevated ambient temperatures often reduce voluntary feed consumption, thereby limiting the availability of dietary nutrients required for glucose production. In addition, heat stress increases the energy demand of body tissues, resulting in greater utilization of circulating glucose. Under such conditions, hepatic glycogen reserves may become depleted due to prolonged mobilization, ultimately contributing to lower blood glucose concentrations. These observations suggest that thermal stress has a substantial influence on carbohydrate metabolism and energy balance in crossbred

cattle.

The present findings are in agreement with those reported by Chandrashekhara *et al.* (2017) [9], who observed significantly higher glucose concentrations during winter compared with summer in Deoni crossbred cattle. Similar trends were documented by Rasooli *et al.* (2004) [18], Shrikhande *et al.* (2008) [20], and Das *et al.* (2014) [12], who reported a significant decline in serum glucose levels during the summer season. Furthermore, Muna *et al.* (2009) [2] recorded maximum glucose concentrations during winter in Badri cattle, supporting the seasonal pattern observed in the current investigation.

However, the present results differ from the observations of Vijayakumar *et al.* (2011) [22], who reported elevated blood glucose levels in buffalo heifers subjected to sprinkler cooling during periods of heat stress. Likewise, Arup *et al.* (2017) [6] found significantly higher glucose concentrations during summer in dairy cows, while Al-Saeed *et al.* (2009) [17] reported greater glucose levels in summer than in winter among dairy cattle maintained under high-altitude cold desert conditions. Such variations among studies may be attributed to differences in breed characteristics, environmental conditions, management practices, nutritional status, and physiological adaptation to climatic stress.

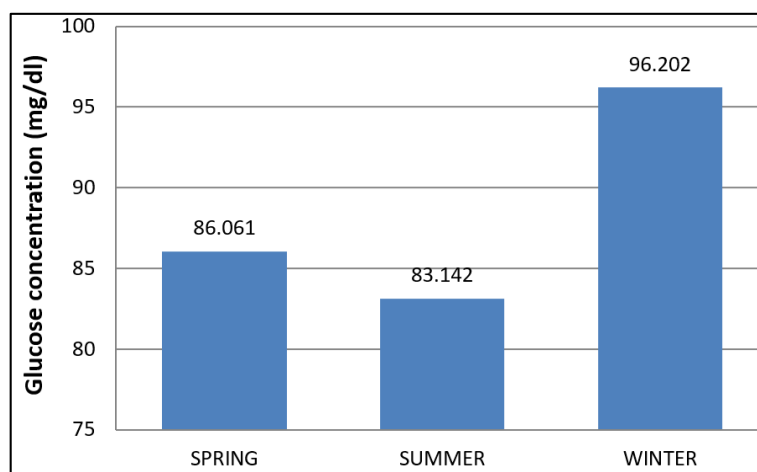


Fig 1: Glucose concentration (mg/dl) in crossbred cattle during different seasons.

Total Protein Concentration

The seasonal variation in serum total protein concentration of crossbred cattle is illustrated in Figure 2. The mean total protein values recorded during spring, summer, and winter were 5.01 ± 0.32 , 4.73 ± 0.11 , and 6.07 ± 0.23 g/dl, respectively. Statistical analysis demonstrated a significant ($p < 0.05$) influence of season on total protein concentration. The lowest value was observed during the summer season, while the highest concentration was recorded in winter. Spring values were intermediate and did not differ significantly from those observed during summer.

The reduction in serum total protein concentration during summer may be associated with decreased feed intake and compromised nutritional status resulting from heat stress. Exposure to elevated environmental temperatures often suppresses appetite and nutrient consumption, thereby limiting the availability of amino acids required for protein synthesis. In addition, physiological adjustments aimed at maintaining thermal balance may alter metabolic activities, leading to reduced circulating protein levels. Total protein is an important biochemical constituent involved in maintaining osmotic equilibrium, acid-base balance, and

transport functions within the bloodstream. Consequently, seasonal fluctuations in total protein concentration can serve as useful indicators of nutritional adequacy and metabolic adaptation in cattle subjected to varying climatic conditions. The findings of the present investigation are consistent with those reported by Muna *et al.* (2009) [2], who observed significantly lower total protein concentrations during summer compared with winter and spring seasons. Similar observations were made by Chandrashekhara *et al.* (2017) [9], who recorded the lowest protein values during summer in crossbred cattle. Aashaq *et al.* (2019) [1] also reported higher serum total protein concentrations during winter than in summer in Badri cattle. Likewise, Arup *et al.* (2017) [6] found maximum protein levels during winter in dairy cows maintained under high-altitude conditions. Das *et al.* (2019) [11] documented significantly reduced serum protein concentrations during summer in Badri cattle, whereas Gaafar *et al.* (2021) [13] reported elevated total protein levels during winter in Friesian calves. Collectively, these studies support the seasonal decline in serum total protein concentration during periods of heat stress.

However, the present findings differ from those of Shrikhande *et al.* (2008) ^[20], who reported significantly higher serum total protein concentrations during the summer season. Such inconsistencies among studies may be related to differences in breed characteristics, feeding management, environmental conditions, and intensity of heat stress, physiological status, and adaptive responses of animals to local climatic factors.

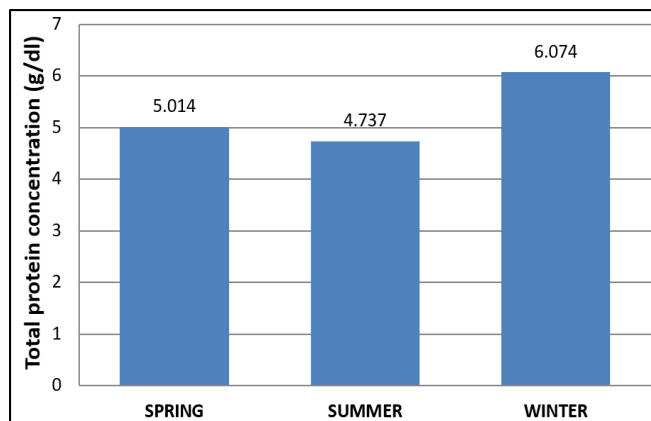


Fig 2: Total protein concentration (g/dl) in crossbred cattle during different seasons.

Albumin Concentration

The seasonal pattern of serum albumin concentration in crossbred cattle is presented in Figure 3. The mean albumin concentrations recorded during spring, summer, and winter were 4.16 ± 0.21 , 4.91 ± 0.13 , and 5.15 ± 0.17 g/dl, respectively. Statistical analysis revealed a significant ($p < 0.05$) effect of season on albumin concentration. The highest value was observed during winter, followed by summer, while the lowest concentration was recorded during spring. No significant difference was detected between the summer and winter seasons.

The elevated albumin concentration observed during winter may be associated with favorable environmental conditions and reduced thermal stress compared with warmer seasons. Improved climatic conditions during winter can enhance feed utilization and metabolic efficiency, thereby supporting greater protein synthesis. In addition, lower water consumption during cooler months may contribute to a relative increase in plasma protein concentration. Albumin is the most abundant plasma protein and plays a vital role in maintaining colloidal osmotic pressure, transporting various metabolites, and regulating fluid distribution between vascular and extra vascular compartments. Since albumin is synthesized primarily in the liver, seasonal variations in its concentration may reflect changes in metabolic activity, nutritional status, and physiological adaptation to environmental conditions.

The present findings are in agreement with the observations of Meyer and Harvey (1998) ^[16], who reported significantly higher albumin concentrations during the winter season. Similar results were documented by Arup *et al.* (2017) ^[6], who observed elevated serum albumin levels in dairy cattle during winter. Das *et al.* (2019) ^[11] reported relatively stable albumin concentrations across seasons in Badri cattle, whereas Abdalla *et al.* (2009) ^[2] observed a progressive decline in albumin levels from wet summer to winter and dry summer conditions. Furthermore, Arup *et al.* (2017) ^[6] recorded significantly higher albumin concentrations in

dairy cattle maintained under cooler, high-altitude environments.

However, the present observations are not in accordance with the findings of Rasooli *et al.* (2004) ^[18] and Das *et al.* (2014) ^[12], who reported maximum albumin concentrations during the summer season. Likewise, Muna *et al.* (2009) ^[2] documented significantly higher serum albumin levels during summer in indigenous cattle. Such differences among studies may be attributed to variations in breed, climatic conditions, nutritional management, physiological status, and adaptive responses of animals to environmental stressors.

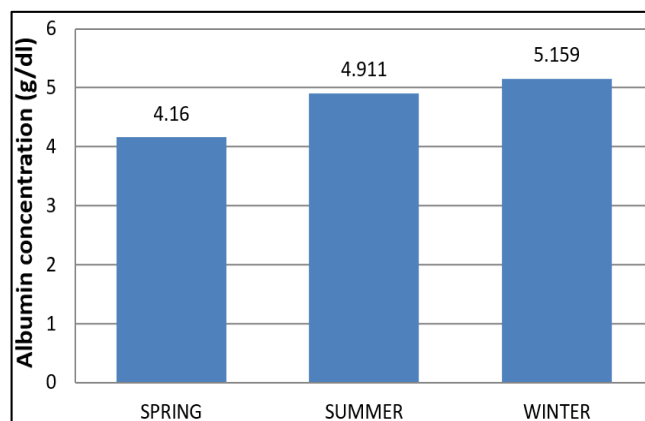


Fig 3: Albumin concentration (g/dl) in crossbred cattle during different seasons.

Seasonal fluctuations exert a considerable influence on the biochemical profile of crossbred cattle. The mean serum glucose concentrations recorded during spring, summer, and winter were 86.06 ± 4.91 , 83.14 ± 1.72 , and 96.20 ± 1.47 mg/dl, respectively, total protein levels were observed at 5.01 ± 0.32 , 4.73 ± 0.11 , and 6.07 ± 0.23 g/dl across the corresponding seasons. Albumin concentrations also exhibited seasonal variation, with values of 4.16 ± 0.21 g/dl in spring, 4.91 ± 0.13 g/dl in summer, and 5.15 ± 0.17 g/dl in winter. Assessment of blood biochemical constituents serves as an important indicator of the physiological and nutritional status of livestock. Such evaluations provide valuable information for identifying health-related constraints and support the development of effective management practices aimed at enhancing productivity and animal welfare. In Nagaland, information regarding the seasonal dynamics of serum biochemical parameters in crossbred cattle remains limited. Variations in environmental factors, particularly ambient temperature and relative humidity, can directly affect metabolic and physiological processes in animals while also influencing feed availability and nutrient utilization. Furthermore, seasonal climatic changes may promote the proliferation of pathogenic microorganisms, thereby increasing disease susceptibility and contributing to alterations in blood biochemical composition. Understanding these seasonal responses is therefore essential for improving the health, adaptability, and productive performance of crossbred cattle under the agro-climatic conditions of the region.

Conclusions

The study established that environmental conditions associated with different seasons exert a measurable influence on the biochemical status of crossbred cattle

maintained in Medziphema, Nagaland. Distinct variations in serum glucose, total protein, and albumin concentrations were observed among the seasons, indicating alterations in metabolic activity in response to changing climatic conditions. The elevated Temperature-Humidity Index recorded during summer was associated with comparatively reduced biochemical values, suggesting the presence of thermal stress and its impact on normal physiological processes.

Season-related modifications in blood biochemical constituents reflect the adaptive capacity of crossbred cattle to fluctuations in temperature and humidity. Continuous monitoring of these indicators can therefore serve as a valuable approach for assessing animal well-being and physiological resilience. The findings highlight the necessity of adopting appropriate nutritional, housing, and environmental management interventions during periods of climatic challenge to sustain optimal health and productive efficiency. Furthermore, the information generated from this investigation contributes to the understanding of seasonal physiological responses of cattle in the northeastern Himalayan foothill region and may assist in the formulation of climate-resilient livestock management practices.

Future Scope

The serum biochemical parameters of crossbred cattle that obtained for correct interpretation of normal physiology behavioral crossbred cattle in particular medziphema Nagaland region. Variation in these parameters due to seasonal changes may helpful improved better health management practices crossbred cattle and designing strategies for combating stress maximum production in Medziphema Nagaland.

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