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Assessment of haematological parameters during different climatic seasons

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Abstract
Stress affects the animal welfare and production. It is an important challenge for the livestock especially under intensification. As the livestock production increases, there is increase in the production related diseases in high yielders. The environmental variables like temperature, humidity and rainfall are the major factors determining the wellbeing of livestock. Any changes that occur in livestock are immediately exhibited in the blood parameters. Physiological equilibrium is maintained mainly by the blood in the body but this equilibrium gets altered due to stress. The objective of this review is to present an overview of the haematological parameters during different seasons.

Keywords: Blood parameter, stress, season

Introduction
Livestock is susceptible to various type of stress such as physical, chemical, nutritional, thermal and psychological stress. Heat stress is one of the most important factors which are severely affecting the animal welfare and economic benefits of the animal husbandry. Heat stress occurs due to imbalance in heat gain and heat loss mechanism. Stress in animals causes a cascade of drastic changes in biological functions that include reduction in dry matter intake, growth feed efficiency, disturbances in metabolism of water, protein, energy and mineral balances (Purwar *et al*., 2017 [33];Purwar *et al*., 2018 [34}). It also causes altered hormonal secretions, enzymatic reactions, and blood metabolites (Ganaie *et al*., 2013) [13]. Such changes cause impairment of growth, production, and reproduction performance. Seasonal and environmental alteration may influence blood indices in livestock (Feldman *et al*., 2002) [12]. The seasonal stress in animal can be predicted with the help of temperature humidity index (Akyuz *et al*., 2010) [6]. Indian subcontinent has a variety of indigenous breeds of cow (Bos indicus) with wide genetic diversity. Thus, response to stressors varies among animal species.
Physiological equilibrium is maintained by blood and hence every change that takes place in livestock body is seen in the blood indices (Casella *et al*., 2012) [9]. Increased animal productivity is related with increased production diseases that causes changes in blood indices (Hewett, 1974) [18]. The changes in environmental variables such as temperature, humidity, wind and rainfall were categorized as the potential hazards in animal growth and production. Some adaptive species shows endogenous annual rhythmicity to counter in advance to seasonal environmental changes (Piccione *et al*., 2009) [31]. Heat is produced in the animal's body by metabolic activities and may also be gained from the environment. Heat is lost from the animal body by radiation, conduction, convection, evaporation of water from skin and respiratory passages and excretion of faeces and urine. A thermal steady state exists, when the heat gain and the heat loss are balanced. In homeotherms, the various thermoregulatory mechanisms consist of a series of physiological adjustments that serve to establish a thermal steady state at the level of normal body temperature, which consequently struggle to maintain equality in heat gain and heat loss. Physiological equilibrium is maintained mainly by the blood in the body but many physiological conditions may alter this equilibrium (Ahmed *et al*., 2003) [3].
The changes in blood parameter are important indicators of the physiological state of the animal. The Complete Blood Count (CBC) is an important diagnostic tool for monitoring response and differential diagnosis. It is well known that variables such as breed, physiological stage, age, reproductive and lactation stage and environmental conditions/season have an influence on physiobiochemical parameters. Blood parameters have been used to sort out constraints on productivity in beef cattle (Grunwaldt *et al*., 2005) [14]. Haemoglobin and packed cell volume were incorporated in metabolic profile tests amongst other biochemical

constituents by Payne *et al.* (1970) [29]. Jazbec *et al.* (1993) [20] and Klinkon *et al.* (1994) [21] also have discussed the importance of erythrocyte indices in interpretation of metabolic profile tests in cattle. Variations in certain components of the haematological profile due to the physiological status of animals (Rowlands *et al.*, 1974) [35] and due to different season (Shaffer *et al.*, 1981) [38] have been reported in temperate and tropical regions.

Hematological parameters

Red Blood Corpuscles

Heat stress causes peripheral vasodilation and redistribution of cardiac output which are related with expansion of blood volume and haemodiltution (Hales, 1973) [16]. Haemodilution was reported both in fed and unfed goats during heat stress. During heat exposure Silanikove, 2000 [41] reported rise in cardiac output and cutaneous blood flow linked with redistribution of blood to peripheral tissues in goats and sheep. He also reported increased MCV and MCH values during winter season in goats.

Shibu *et al.*, (2008) [39] reported the highest values of erythrocytes count during wet summer compared to values obtained during winter and dry summer. But no such pattern in RBC number was observed during study of Bhan *et al.*, 2012 [8]. The mean Total Erythrocyte Count varied shows the highest value during summer and minimum value during monsoon in the elite cow (Babeker *et al*., 2013) [7]. But Soly and Singh (2003) [43] in milch cow and Mirzadeh *et al*. (2010) [26] in Iranian cow reported lower TEC during summer season. Prava and Dixit (2008) [32] documented higher TEC during summer in milch cow and calves. In the summer rise of TEC might be due to adaptive mechanism of the animal to boost oxygen carrying capacity of blood (Naik *et al*., 2013) [27]. Ahnad *et al*., 2003 [3] reported significantly higher RBC counts (106 /µL) in the endometritic cows (9.32 ± 0.46) than the cyclic (7.23 ± 0.31) or non-cyclic (6.89 ± 0.20) crossbred cows.

Research of Gutierrez-De Lar *et al*., 1971 [14] and Casella *et al*., 2012 [9] on cow showed a significant decrease in RBC count with concomitant significant changes in haemoglobin (Hb) and haematocrit (Hct) during summer. This depression in RBC, Hb and Hct in heat-induced cows was probably related to haemodilution effect, because more water was diverted in circulatory system for evaporative cooling (Koubkova *et al*., 2002) [22]. Together with the reduction in Hb and Hct, the significant decrease of MCV and MCH under high atmospheric temperatures reveals that this adaptation is associated with reduction in cellular oxygen requirements in order to reduce metabolic heat load (El-Nouty *et al*., 1990) [11]. Singh *et al*., (2016) [42] also reported lower TEC in sheep during heat stress. RBC parameters decrease in animal that are poorly adapted to cold, but increase in the highly adapted ones (Habibu, 2018) [15].

Haemoglobin

Shibu *et al*., (2008) [38] reported significantly lower Hb during heat compared to cold temperature. Lateef *et al*., (2014) [23] found Hb values were within the physiological limit and reported no significant change with temperature. Naik *et al*., (2013) [27] observed apparently higher level of Hb in Kankrej cattle during monsoon and summer than that of winter. The higher Hb concentration during monsoon and summer may be as a result of higher total Fe level during the two seasons or could be due to hemo-concentration reported in stressful condition of hot and high humidity during monsoon and summer, respectively. The apparent rise in HCT during summer and monsoon may be due to the high temperature and humidity, respectively. It is stated that hot and humid environment provokes sweating causing loss of water leading to hemo-concentration and increase in TEC and thereby HCT value (Piccione *et al*., 2010) [30].

Srikhande *et al*., (2008) [40] reported the higher average hemoglobin level during summer season. However, there was no significant difference in hemoglobin levels of rainy and winter season. Rowland's *et al*. (1979) [36] also reported similar findings. The higher level of hemoglobin during summer may be because of higher total binding capacity of Fe+ during summer season.

Chaudhary *et al*. (2015) [10] observed significantly increased total RBC count, Hb, hematocrit, MCHC in surti buffalo during heat stress. Singh *et al*. (2016) [42] reported significant ($P \leq 0.05$) decrease in Hb and PCV% in all the three sheep (Chokla, Marwari and Magra) breeds due to heat stress.

White Blood Corpuscles

According to Hassan *et al.* (1987) [17] there were no marked seasonal changes in (TLC) in goats. He also reported change in climate had no significant effects on the ratios of neutrophils, lymphocytes, eosinophils and basophils in goats.

Abdelatif (2009) [2] observed that physiological measurement of stress include neutrophil: lymphocyte ratios and white blood cell count. Bhan *et al*. (2012) [8] in his study on Sahiwal cattle reported increase in WBC during winter and decrease during heat stress compared to spring season indicates the variation in WBC with the variability in ambient temperature.

Lateef *et al*. (2014) [23] reported there were no marked seasonal changes in TLC amongst the experimental groups of Kankrej cattle. Similar findings were also previously reported in goats by Abdelatif (2009) [2]. However, the highest values of TLC were recorded during winter with a slight reduction during the other two seasons. This reduction may be associated with physiological responses to hot and humid climate. However Al-Saeed *et al.* (2009) [5] recorded significantly lower level of TLC in local cattle during winter as compared to summer season and concluded that the summer increase of TLC might be due to higher levels of parasitic infection observed during hot humid conditions of summer.

Minka and Ayo (2007) [25] revealed that the seasonal change in climate had no significant effects on the ratios of neutrophils, lymphocytes, eosinophils and basophils. However, the ratio of neutrophil and lymphocyte (N: L) was apparently higher during summer. In fact, the N: L is the most common index of measurement of stress and adaptability of the animals to the local environment, which generally increases under stress condition.

Al-Busaidi *et al*., (2008) [4] observed that the monocyte count was found to be higher in summer as compared to winter and monsoon. The increase monocyte count recorded during summer could be associated with increased cortisol secretion. Monocytes respond to rise of blood cortisol level, but species differences are seen with the type of response and the mechanism of monocytosis (Jain, 1993) [19].

Abdelatif and Alameen, 2012 [1] and Mazullo *et al.,* 2014 [24] reported WBC values were higher with increase in temperatures. This could be due to release of corticosteroids or epinephrine hormones due to environmental heat stress which in turn increased leukocyte count. Narayan *et al.* (2007) [28], reported lymphocyte values were increased in the hottest period, whereas the neutrophil values were decreased.

The total WBC count was significantly lower in the local cattle during the winter season. Similarly, a higher total WBC values in White Fulani Cattle during summer season (Saror & Coles, 1973) [37] Mazullo *et al*., 2014 [24] stated in cattle an increase in monocytes in summer could be associated with increase in cortisol secretion. Singh *et al*., 2016 [42] observed higher TLC in Chokla and Magra and lower in Marwari under heat stressed condition.

Conclusion

Heat stress all around is a major concern as it is associated with production losses. The effect of heat stress is highly observed when higher temperature is accompanied by higher humidity. From the review, it is observed that Hb, MCV, MCH and TEC were higher in summer in local cattle with certain varied observations also. The TLC value studied by researchers varied with respect to breeds in different seasons. These effects could be direct or indirect due to changes in feeding and alteration in other rearing practices which may be further studied.

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