ADAPTATION OF TARAI BUFFALOES TO SEASONAL VARIATIONS AS INDICATED BY HAEMATOLOGICAL PROFILE

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ABSTRACT

The aim of this study was to investigate the effect of seasonal change in thermal environment on Haematological parameters in Tarai buffaloes under tropical conditions. The highest mean values of maximum ambient temperature (°C) were reported in summer, followed by pre-winter and winter, while the highest values of relative humidity (%) were recorded in winter than other two seasons. The highest values of erythrocyte count, packed cell volume (PCV), haemoglobin concentration (Hb), mean cell volume (MCV), mean cell haemoglobin (MCH) and mean corpuscular heamoglobin concentration (MCHC) were recorded during winter and the lowest in summer. The erythrocyte counts, PCV and haemoglobin concentration differed significantly in all the three seasons. The mean cell volume (MCV) and mean cell haemoglobin (MCH) were significantly lesser in summer as compared to other two seasons. The total leukocyte count (TLC) was affected significantly by seasonal change in thermal environment. The lymphocyte and eosinophil number was highest in winter and neutrophils were highest in summer. The monocyte number was significantly lower in summer as compared to winter and no significant changes in basophil count was observed. It can be concluded from our study that tarai buffaloes adapt to seasonal changes by varying their haematological response.

Keywords: Tarai buffalo, seasonal variations, adaptation, temperature humidity tndex, THI, haematological profile

INTRODUCTION

Livestock farming is an important risk reduction strategy for vulnerable communities and livestock are important providers of nutrients and traction for growing crops in smallholder systems. Livestock production is highly sensitive to climate change and there is a non-linear relationship between climate change and livestock productivity (Kabubo-Mariara, 2009). Increasing frequencies of heat stress, drought and flooding events are estimated to be likely, even though they cannot be modeled in any satisfactory way with current levels of understanding of climate systems, but these will have adverse effects on crop and livestock productivity over and above the impacts due to changes in mean variables alone (IPCC, 2007).

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One strategy for reducing the magnitude of stress is to identify the animals that are genetically superior in tolerating stress. Many local breeds are having valuable adaptive traits that have developed over a long period of time which includes tolerance to extreme temperature and humidity.

The physiological basis of these special adaptation ability has to be unraveled. One such breed is Tarai buffalo breed, the main breed of Uttarakhand and few adjoining districts of Uttar Pradesh, India. The commercial significance of this breed is being realized as this animal performs very well under tarai (hot and humid) climate and can be maintained on low input system by the marginal and small land holding farmers. Reports on haematological data provide valuable information on the adaptability of animal to the seasonal abiotic stressors. The objective of the present study was to get a preliminary insight into the haematological values for Tarai buffalo.

MATERIALS AND METHODS

Study site

The present study was conducted at the Department of Veterinary Physiology and Biochaemistry, College of Veterinary Science, Pantnagar. It is located at 344 m above sea level ($28^o 58^' 79^o 25^'$E / $28^o 97^'$ N $79^o 41^'$E) in the northern upper Gangetic plain, having an annual rainfall of 90–120cm. The mean temperature and relative humidity during the study are shown in Table 1.

Animals

Twenty healthy Tarai buffaloes each above two years of age, non-lactating and non-pregnant were selected from herds maintained by local farmers in semi-intensive rearing system under well ventilated and proper hygienic conditions. The animals had ad libitum access to feed and water. Prior to the commencement of study the animals were accustomed to the process of blood collection for four weeks.

Climatological measurements

The meteorological parameters like Temperature and Relative Humidity (RH) were obtained from the Institute Meteorological unit. Temperature Humidity Index (THI) was calculated as per Kadzere *et al*. (2002) from obtained values. The study period was divided into 3 phases coinciding with 3 seasons of year October (pre-winter), January (winter) and May (summer).

Sampling and analysis

Blood collection was done thrice on alternate days between 9 to 10 am from each animal during October (pre-winter), January (winter) and May (summer). Five millilitres of blood from each animal were collected via jugular venipuncture in sterile centrifuge tubes with EDTA dipotassium salt (Na_2 EDTA) as an anticoagulant at 1mg/ml concentration. The samples were kept in ice box, using ice packs and transferred to the laboratory for further analysis.

Erythrocytic indices were determined according to the methods described in Schalm's Veterinary Haematology (Jain, 1986). The packed cell volume of erythrocytes was determined by the micro-haematocrit method using a special centrifuge. Haemoglobin concentration was determined by the cyano-methaemoglobin method as described by Van Kampen and Zijlstra (1961). Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC) and Mean Corpuscular Volume (MCV) calculated from the following formula (Simon *et al.,* 2001):

MCV (fl) = {Haematocrit (%) × 10} / {RBCs count (million /µl)}
MCH (pg) = {Haemoglobin (g/dl) × 10} / {RBCs count (million /µl)}
MCHC (g/dl) = {Haemoglobin (g/dl) × 100} / {Haematocrit (%)}

Differential leukocyte count (DLC) was determined microscopically from a count of 100 leukocytes in thin May-Giemsa stained blood smears (Kelly, 1984).

Statistical analysis

The statistical analysis of the data was performed using SPSS17 software using one-way ANOVA.

RESULTS

The ambient temperature and Relative humidity prevailed during the study period are presented in Table 1. The RH was highest during winter and THI was maximum during summer.

Haematological values: the haematological values were shown in Table 2.

Erythrocytic series: The RBC count, PCV and Haemoglobin were significantly differing in all the samplings with highest values being recorded in winter. The pre-winter thermoneutral values significantly differed from both summer and winter samples. The MCV and MCH values were significantly higher in thermoneutral and winter samples than that of summer. The MCHC values of summer and thermoneutral were significantly lower as compared to winter.

Leucocytic series: The WBC count showed a significantly reducing trend from summer to winter. The lymphocyte count significantly increased in pre-winter and winter samplings as compared to summer whereas the neutrophil count showed vice versa result. The monocyte count was significantly lower in summer as compared to winter and pre-winter whereas the eosinophil count was significantly higher in winter sample than other two with non significant changes in basophil count.

DISCUSSION

As can be inferred from Table 1, the buffaloes were subjected to marked seasonal variation in ambient temperature and relative humidity which will in turn have impact on the physiology of animal. The Livestock Weather Safety Index (**LWSI**; LCI, 1970) is a benchmark commonly used to assign heat stress levels to normal, alert, danger, and emergency categories. In the LWSI, THI values ≤ 74 are classified as alert, $74 < \text{THI} < 79$ as danger, and $79 \leq \text{THI} < 84$ as emergency. As per the above index of THI, the area of study can be categorized as emergency in summer which shows the stressful condition for the animal.

In our study the reduction in RBC count in summer might be due to increase in erythrocyte destruction and haemodilution resulting from more water transportation to circulatory system to facilitate evaporative cooling during heat stress (Lee *et al.,* 1976). Roy *et al.* (1964) found that water intake in buffaloes increased 13.5% with increasing environmental temperature and the ratio of water intake/food consumption also increased. Exposure to direct solar radiation increases free water intake. It could also be attributed partly to the decrease in feed intake during summer as reduced TEC, haematocrit and haemoglobin may be attributed to reduced erythropoiesis (Pati and

Table 1. Environmental parameters at time of sample collections.

Environmental condition	Day	Max. temp (C°)	Min. temp (C°)	Relative humidity%	Tdb (C°)	Twb (C°)	THI
Winter	1	17.4	2.4	97	4.2	4.0	46.5
	2	17.2	2.5	97	4.4	4.2	46.8
	3	17.5	2.0	95	4.2	3.8	46.4
Pre-winter (Thermoneutral)	1	24.1	5.9	80	25.0	9.1	65.2
	2	25.3	5.4	81	25.2	9.4	65.5
	3	23.8	5.4	78	25.0	9.2	65.2
Summer	1	39.0	20.4	64	39.5	26.5	87.4
	2	39.8	21.0	68	39.0	25.8	87.3
	3	40.0	20.6	69	40.2	26.8	88.8

Table 2. Haematological values of Tarai buffalo (n=20) (Mean±SE).

Parameter	Summer	Thermoneutral	Winter	Average
RBC ($x10^6/\mu l$)	7.06 ± 0.11^a	7.76 ± 0.16^b	8.31 ± 0.12^c	7.71±0.13
PCV (%)	29.38 ± 0.42^a	32.38 ± 0.32^b	32.88 ± 0.35^c	31.55±0.36
Hb conc.(g/dl)	10.85 ± 0.14^a	12.30 ± 0.11^b	13.30 ± 0.13^c	12.15±0.13
MCV (fl)	41.61 ± 0.28^a	42.43 ± 0.57^b	41.98 ± 0.30^b	42.01±0.38
MCH (pg)	15.37 ± 0.15^a	15.92 ± 0.22^b	16.01 ± 0.07^b	15.77±0.15
MCHC (g%)	36.95 ± 0.27^a	37.43 ± 0.30^a	38.13 ± 0.16^b	37.50±0.24
WBC ($x10^3/\mu l$)	13.45 ± 0.13^a	12.59 ± 0.35^b	11.73 ± 0.29^c	12.59±0.26
Lymphocyte (%)	58.25 ± 0.37^a	61.50 ± 0.42^b	63.50 ± 0.50^c	61.08±0.43
Neutrophil (%)	31.38 ± 0.38^a	29.88 ± 0.30^b	28.38 ± 0.46^c	29.88±0.38
Monocyte (%)	5.13 ± 0.30^a	5.50 ± 0.19^b	6.38 ± 0.26^b	5.67±0.25
Eosinophil (%)	2.75 ± 0.25^a	2.88 ± 0.23^a	3.63 ± 0.26^b	3.09±0.25
Basophil (%)	0.38 ± 0.18^a	0.25 ± 0.16^a	0.25 ± 0.16^a	0.29±0.17

Means bearing different superscripts in a row within a trait are significantly different from each other ($P\leq0.05$).

Thapliyal, 1984). Vasodilation which occurs when animals are exposed to heat causes a decline in the hydrostatic blood pressure below the blood colloidal pressure so that more interstitial fluid passes into the intravascular compartment (Kamal *et al.,* 1972). The decline in erythrocyte count and consequently (PCV) and (Hb) in dry summer could be related to depression of thyroid secretion which is associated with decreased erythropoiesis. Thyroid hormones increase the proliferation rate of erythroid progenitors (Popovic *et al.,* 1977 and Dainiak *et al.,* 1978) and enhance the production of erythropoietic growth factors (Dainiak *et al.,* 1986; Fandrey *et al.,* 1994).

The MCV, MCH and MCHC are called absolute red blood corpuscular indices. The current results indicate that the MCV and MCH values were significantly higher in winter compared to that obtained in wet and dry summer. But the increase in MCV cannot be considered as an indication of presence of immature erythrocytes as there is no corresponding decrease in MCHC since immature erythrocytes have less Hb%. The low MCV value obtained could be related to the negative correlation between size and number of erythrocytes that has been suggested by Holman and Dew, 1964. The values obtained in the present study for MCV and MCH during winter and summer are in general agreement with previous findings (Guiterrez *et al.,* 1971) that reported high values of MCV and MCH in cold dry environment compared to values in hot humid conditions. But the interestingly significant increase in MCHC in winter is due to large proportionate increase in haemoglobin concentration with corresponding small proportionate increase in PCV which indicates the enhanced oxygen carrying capacity of blood in winter where the metabolic heat production has to be more to counteract the cold stress. Earlier studies also revealed increased amounts of haemoglobin during winter months which may be considered as a pathway of increasing the oxygen-carrying capacity (Al Eissa, 2011). Due to presence of sparse hair coat and less sub cutaneous fat, the predominant mechanism in Tarai buffalo to counteract cold stress will be to generate more heat rather than to conserve it. Hence the increase in MCHC is an evolutionary justification to ambient cold stress.

The total WBC count was significantly lower in the animals during the winter season. Similarly, (Saror and Coles, 1973) reported a higher total WBC values in White Fulani Cattle during summer season. Nouty *et al.* (1986) noticed higher TLC in Holstein breed in summer months than other seasons. In the present study also mean TLC was higher in summer than either in monsoon or winter. This could be due to release of corticosteroids or epinephrine hormones due to summer stress which in turn increased leukocyte count (Jain, 1986) and might also be due to higher levels of sub clinical parasitic infection during the summer season (Rutkowiak, 2001; Rothwell and Dineen, 1972) which may also cause extravasation of eosinophils leading lower counts in blood. Mean neutrophil count was significantly higher in summer than in winter and monsoon seasons. This is in contrary to results reported by Udaynarayan *et al.* (2007) who observed a decrease in summer. This increase might be due to accelerated mobilization of mature neutrophlis from marrow storage pool which occurred when the animal were exposed to any stress due to release of glucocorticoids (Jain, 1986). The mean monocyte per cent recorded in the present study was higher in winter than in summer or monsoon. These findings are in contradiction to Udaynarayan *et al.* (2007) who reported no variation among different seasons and Al-Busaidi *et* *al.* (2008) who reported slightly increased numbers in summer as compared to winter in Dhofari goats. The increase in monocyte number in winter might be a breed and species specific response which varies with respect to type of response and mechanism of monocytosis (Jain, 1993).

CONCLUSION

As a whole, different seasonal stressors significantly affected haematological profile. Our study also proves that haematological parameters can be used as indirect indicators of seasonal stress in buffaloes. The results of the present study provide new knowledge about the variations in blood cellular response of Tarai buffaloes to seasonal stress when compared to other livestock. Our study shows that the haematological response to seasonal stress is species and breed specific which is an evolutionary significance in itself.

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