



Seasonal changes in haematological and biochemical profile of dairy cows in high altitude cold desert

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ABSTRACT

The present study was undertaken to evaluate haematological and biochemical parameters with response to milk production of Jersey cows at high altitude in 2 different seasons (summer and winter). For each period, ambient temperature and relative humidity were recorded and the temperature-humidity index (THI) was calculated as indicator of thermal comfort zone for cattle. Clinically healthy lactating Jersey crossbred cows (70:70 in each season) were selected for this study. A significant increase in RBC, Hb, and HCT was recorded in winter as compared to summer. Furthermore, MCV, MCH, MCHC and PLT levels also exhibited the similar trend; whereas, the WBC, lymphocyte, monocytes, and granulocytes values were higher in summer compared to winter. Glucose and aspartate aminotransferase (AST) level showed a significant increase in summer but level of albumin went significantly higher in winter. Milk production level was significantly higher in summer. These results provided an insight into the haematological and biochemical responses of Jersey crossbred cows to different environmental conditions. Hence, this study will be helpful for the better dairy cattle management in different seasons for higher production at the cold arid high altitude region.

Key words: Biochemical profile, Cattle, Haematological profile, High altitude stress, Milk production

Ladakh, a high altitude cold arid region, situated at 3,500 m above the mean sea level in the state of Jammu and Kashmir of India, experiences harsh environmental conditions. In a year, the summer stays for approximately 4 months and winter prevails for the rest 8 months. Most of the inhabitants in this region are dependent on small agriculture system and livestock farming. However, in winter, farmers are totally dependent on livestock and among them, Jersey cattle play an important role by providing quality milk as the major source of nutrition. Cattle, therefore, contributes to subsistence farming and enhance the sustainability of smallholder farming systems. There are various factors that reduce cattle productivity in high altitude cold desert, the important one is severe environmental condition. Haematological measurements are used to identify constraints on productivity in cattle (Grunwaldt *et al.* 2005). Blood profile as animal response indicators have been turned to serve as the basis for diagnosis, treatment, and prognosis of diseases (Otto *et al.* 2000, Ndlovu *et al.* 2007). Exposure of cows to hot

environment stimulates thermoregulatory mechanisms and reduces the metabolic rates, feed intake and productivity (Abdelatif and Alameen 2012). In order to maintain homeothermy, an animal must be in thermal equilibrium with its environment, which includes radiation, air temperature, air movement and humidity (Kadzere *et al.* 2002). Armstrong (1994), Kadzere *et al.* (2002), Dikmen and Hansen (2009) suggested that the temperature-humidity index (THI) could be used as the indicator of thermal conditions and the degree of stress on cows. Variations in the haematological profile due to season were reported in temperate and tropical regions (Shaffer *et al.* 1981, Rajcevic *et al.* 1995). However, the literature on such studies in high altitudes is scanty. Therefore, considering that the environmental conditions are major physiological stressors, which affect the animal's biological system and consequently the animal productivity; the present study was undertaken to evaluate seasonal changes in haematological and biochemical responses in Jersey cows under different seasons, which could be used to monitor the herd health and nutritional status at high altitude.

MATERIALS AND METHODS

Study area and experimental animals: Clinically healthy lactating Jersey crossbred cows (70:70 in each season), 2–17 year old, were selected from different villages situated

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Table 1. Analyzed GPS parameters of blood sampling sites

GPS parameter	GPS readings	
	Mean±SD	Range
Altitude (Meter)	3318±115.95	3327–3575
Latitude	33.72°3.51'±0.90°2.40'	31°1.17'–34°6.78'
Longitude	077°38.67'±0°2.99'	077°34.63'–077°44.03'

Values are presented as mean ± standard error mean (SEM) and asterisk marks (*) indicate significant difference ($P < 0.05$) within the same column.

at 3327–3575 meter altitude from mean sea level in the Leh-Ladakh region of Jammu and Kashmir. All the sampling points belong within the latitude of $33.72^{\circ}3.51' \pm 0.90^{\circ}2.40'N$, longitude $077^{\circ}38.67' \pm 0^{\circ}2.99'E$, and 3318 ± 115.95 m above sea level. These coordinates of altitude, latitude and longitude of all the sampling sites/places were recorded by GPS system (Garmin GPS 72H) and are presented in Table 1.

Environmental conditions during the sample collection period are presented as graphical representation (Fig. 1). All the data of environmental condition were taken from the meteorological department of Indian Air Force station, Leh. THI was calculated using the U.S. Weather Bureau's Temperature Humidity Index formula for bovine species. Temperature-humidity index (THI) was 71.51 in summer and 46.10 in winter, which was used as indicator of thermal comfort for cattle.

Blood sample collection and analysis: Blood was collected at two time points under different environmental conditions i.e. during summer and winter, between 15:00–18:00 h. All the haematological parameters, viz. white blood cell (WBC), lymphocyte (LYM), granulocytes (GRAN), red blood cells (RBC), hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and platelets (PLT) were analyzed using PE-6800 VET fully auto Hematology analyzer. Serum were tested for biochemical parameters like total protein (TP), albumin (Alb), globulin (Glb), blood urea nitrogen (BUN), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) using serum semi-auto analyzer.

Statistical analysis: Data were analyzed using statistical software SPSS 22 version. Independent 't'-test was applied to determine the effects of 2 different seasons on haematobiochemical profile studied. $P < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Milk production of dairy cows in this region showed significant ($P < 0.05$) higher production level in the summer (Table 2); although these changes were not much different. Since, animals are generally confined to semi-underground house during winter, hence, they were within the comfort

Table 2. Variation in average milk production per day in two seasons

Season	Milk production (litre)	
	Mean±SEM	Range (litre)
Summer	4.73±0.27*	1.00–10.00
Winter	3.54±0.26	0.50–10.00

Values are presented as mean ± standard error mean (SEM) and asterisk marks (*) indicate significant difference ($P < 0.05$) within the same column.

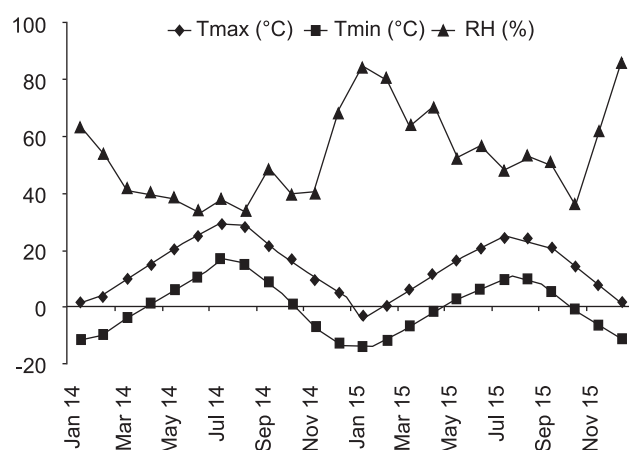


Fig. 1. Environmental condition during the sampling period with maximum, minimum temperature ($^{\circ}C$) and relative humidity (%).

zone, which might have helped them in maintaining the optimum production. Jersey cattle were more adaptive in summer and that reflected through the milk production (Aengwanich *et al.* 2009). In the present study, the recorded ambient temperature (Fig. 1) and calculated THI were within the upper critical zone (THI: 71.51 in summer and 46.10 in winter). Ambient temperature (Fig. 1) reflected the outside temperature, not the inside house temperature, which is generally higher than the outside temperature. However, higher milk yield during summer as compared to winter may be due to compromised feeding during winter as availability of greens is not possible due to harsh climate. The ideal ambient temperature (thermoneutral zone) for a cow is between $5^{\circ}C$ and $25^{\circ}C$ (Roefeldt 1998). As ambient temperature increases, it becomes more difficult for a cow to cool herself adequately and thereafter cows enter into the heat stress. THI values of 70 or less are considered comfortable, 75–78 stressful, and values greater than 78 cause extreme distress with lactating cows being unable to maintain thermoregulatory mechanisms or normal body temperatures (Kadzere *et al.* 2002).

Generally, the haematological profile is an important indicator of the physiological changes in animals (Jain 1993, Kumar and Pachauri 2000). Changes in haematological

parameters such as haemoglobin concentration, total RBC count, PCV and mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) are important in determining the adaptation of animals to the environment (El-Nouty *et al.* 1990, Kumar and Pachauri 2000, Koubkova *et al.* 2002). Independent 't'-test showed a statistically significant effect ($P<0.05$) of seasons on RBC, Hb, HCT, MCV, MCH, MCHC, PLT, WBC, lymphocytes, and granulocytes (Table 3). Further, significant ($P<0.05$) increase in RBC, Hb, HCT, MCV, MCH, MCHC and PLT levels was observed in winter as compared to summer season; whereas, WBC, lymphocyte, monocytes, and granulocytes values were higher in summer as compared

to winter (Table 3). Higher cold stress in winter may be responsible for increased production of erythropoietin hormone, which might be responsible for increased RBC count during winter (Jelkmann 2011). The significant increase of MCV, MCH, and MCHC in the winter season might be due to the more concentrate and hay Lucerne feeding, which is rich in minerals. Owing to hypoxic condition release of erythrocyte-stimulating factor (ESF) increases (El-Nouty *et al.* 1990). However, decreased MCV in the summer may be seen in iron deficiency or chronic blood loss. Decreasing MCH may give an early clue of impending iron deficiency, since MCH falls before MCV and decreased MCHC occurs in iron deficiency anemia (Aengwanic *et al.* 2009). According to the previous studies,

Table 3. Haematological profile of dairy cattle during different seasons at high altitude

Parameter	Seasons			
	Summer (n=70)		Winter (n=70)	
	Mean±SEM	Range	Mean±SEM	Range
WBC ($\times 10^3 \mu/L$)	38.63±0.81*	3.90 - 52.50	31.62±0.97	15.10 - 51.10
LYM (%)	85.18±0.48*	69.20 - 92.20	80.82±0.46	62.40 - 89.50
Monocytes (%)	3.85±0.09	2.00 - 7.40	3.84±0.10	2.00 - 6.90
GRAN (%)	15.34±0.43*	8.00 - 32.20	10.98±0.43	5.10 - 24.00
Lym ($\times 10^3 \mu/L$)	31.34±0.70*	3.20 - 46.30	27.11±0.89	12.30 - 45.20
Monocytes ($\times 10^3 \mu/L$)	1.51±0.049*	0.10 - 2.90	1.24±0.05	0.50 - 2.20
GRAN ($\times 10^3 \mu/L$)	5.78±0.17*	0.60 - 11.10	3.28±0.11	1.40 - 6.00
RBC ($\times 10^6 \mu/L$)	3.56±0.05	2.58 - 4.51	4.91±0.06*	3.44 - 6.42
Hb (g/dL)	9.39±0.15	6.50 - 12.50	12.37±0.16*	9.20 - 17.60
HCT (%)	21.79±0.32	16.20 - 30.00	29.32±0.34*	22.70 - 40.20
MCV (μ/L)	60.01±0.45	50.60 - 72.70	61.52±0.60*	52.20 - 82.90
MCH (pg)	25.14±0.13	22.50 - 28.40	26.36±0.27*	22.90 - 39.10
MCHC (g/dL)	42.11±0.19	38.40 - 50.00	43.07±0.29*	36.50 - 51.30
PLT ($\times 10^3 \mu/L$)	298.26±15.56	98.00 - 1510.00	461.18±23.20*	152.00 - 1032.00

Values are presented as Mean±Standard error mean (SEM) and asterisk marks (*) indicate significant difference ($P<0.05$) within the same row. WBC, white blood cell; LYM, lymphocytes; GRAN, granulocytes; RBC, red blood cell; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; PLT, platelet.

Table 4. Biochemical profile of dairy cattle in two different seasons at high altitude

Parameter	Seasons			
	Summer (n=70)		Winter (n=70)	
	Mean±SEM	Range	Mean±SEM	Range
Glucose (mg/dl)	72.23±9.86*	38.78 - 776.96	53.41±0.96	38.78 - 76.47
TP (g/dl)	5.91±0.10	3.14 - 14.4	6.14±0.16	3.71 - 14.40
Alb (g/dl)	3.66±0.06	0.00 - 6.08	4.01±0.10*	0.00 - 6.08
Glb (g/dl)	2.25±0.11	0.03 - 10.09	2.13±0.18	0.03 - 10.09
BUN (mg/dl)	18.02±1.08	5.26 - 56.46	19.05±1.15	5.26 - 56.20
Uric Acid (mg/dl)	1.21±0.10	0.52 - 8.52	1.09±0.04	0.52 - 3.44
ALT (IU/l)	29.91±0.93	10.78 - 55.23	29.79±0.85	10.78 - 48.00
AST (IU/l)	93.39±3.01*	46.88 - 224.20	73.56±1.89	46.92 - 118.07
ALP (IU/l)	97.06±7.08	1.75 - 435.20	81.43±6.00	1.75 - 310.23

Values are presented as Mean±Standard error mean (SEM) and asterisk marks (*) indicate significant difference ($P<0.05$) within the same row. TP, total protein; Alb, albumin; Glb, globulin; BUN, blood urea nitrogen; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase.

and as observed in our study, increase in PLT values was associated with the lowering temperature (Mirzadeh *et al.* 2010, Casella *et al.* 2013).

In the present study, WBC level was higher in the summer, confirming the results obtained in previous studies (Abdelatif and Alameen 2012). This could be due to the release of corticosteroids or epinephrine hormones as a result of relatively higher temperature, which in turn had increased leukocyte count (Jain 1993, Lateef *et al.* 2014). Cattle might be affected due to sub clinical parasitic infection in summer for which leucocyte profile might be higher (Rutkowiak 2001).

However, significant ($P < 0.05$) higher levels of glucose and aspartate aminotransferase were recorded in summer, whereas albumin showed significant ($P < 0.05$) increase in winter (Table 4). Higher glucose level in the blood might be due to the higher fodder plants consumption in summer than in winter (Al-Saeed *et al.* 2009). However, level of albumin significantly was higher in winter might be due to the low water intake in winter which may have elevated the concentration of the plasma protein (Meyer and Harvey 1998). Total protein and blood urea nitrogen were slightly higher in winter but those were not significant. Moreover, uric acid and ALP level showed insignificant ($P > 0.05$) lower level in winter (Table 4). These findings indicated influence of seasonal variation of climatic factors on biochemical parameters, which may be important indicator of health status of dairy cattle (Onasanya *et al.* 2015).

Hence, this study indicated that seasonal changes in the thermal environment influence the physiological responses of animals. The changes in haematological and biochemical profile indicated that winter was stressful to Jersey cattle. In spite of variation in some haematological and biochemical parameters between the seasons, milk yield had not shown greater variation. The present study also indicated that animals should be kept within the thermal comfort zone to minimize the adverse effect of environmental stress on milk yield. Further, this study might be helpful for providing baseline information on the haematological and biochemical profile of dairy cattle for the evaluation of nutritional and health status at high altitude.

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