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Effect of Cold Stress on Milk Yield, Physiological and Hemato-biochemical Profile of Cross Bred Dairy Cattle

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ABSTRACT

The present study was performed to evaluate haematological and biochemical parameters with response to milk production of dairy cattle at low temperature. Ambient temperature and relative humidity were recorded and the temperature-humidity index (THI) was calculated as indicator of thermal comfort zone for cattle. Lactating crossbred dairy cattle were selected for this study. A significant increase in RBC, Hb, and PCVWBC was recorded in winter. Glucose and aspartate aminotransferase (AST), albumin level showed a significant increase in winter. Milk production level was decrease due to cold stress. 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 winter seasons for higher production at the cold arid high altitude region

Keywords: Low temperatures, Milk production, Hematobiochemical parameters, Dairy cattle

The purpose of the study was to evaluate the response to cold stress in cross bred dairy lactating. Exposure of a lactating dairy cow to a continuous cold stress, physiological adjustments lead to a marked decline in milk production. Due to stress the animal may become acclimated or exhausted, depending on the level of milk production, its adaptability to cold stress, or other factors (Johnson and Vanjonack, 1976). In dairy cattle, cold stress due to low temprature reduce milk yield, an effect most marked during the early stages of lactation (Young, 1981). As the temperature fall, the milk yield reduces decline also as a function of breed, level of feed intake, and acclimatization Thus, cattle should be protected from strong winds and moisture under these conditions, and the utilization of heat sources is recommended (Johnson, 1986). MacDonald and Bell (1958) found that milk yields began to decline in cows fed ad libitum at -4 ^{O}C, and there was a marked depression in yield with further reduction in the environment temperature. With increasing milk yield, the lower critical temperature (LCT), which is the temperature below which the animal has to increase metabolic heat production in order to maintain homeothermia, decreases to values of during peak lactation (Young 1983), -40 ~ C with daily milk yields of 36 kg (Webster, 1974; Ames, 1980), or even -45 ~ C (Christopherson and Young, 1986). The sympathetic nervous system evokes three major physiological responses to cold stress: increased metabolic heat production, a higher cardiac output and a redistribution of blood flow, and a mobilization of substrates for metabolism - free fatty acids from the adipose tissue (Horwitz, 1971; Girardier and Stock, 1983), and glucose from the glycogen stores in the liver and by hepatic gluconeogenesis. The physiological role of the thyroid hormone is to balance heat loss by regulating heat production (Beattie, 1978; Robertshaw, 1981; Kriesten, 1981). In previous studies, we determined the changes in some physiological parameters in heifers exposed to an extremely cold microclimate in winter; low temperatures significantly increased the concentration of free fatty acids (FFA) and thyroxine (Broubek *et al.,* 1987). Shiftmaya *et al.* (1985) observed in Holstein-Friesian cows housed under cold conditions, a higher red blood cell count and haematocrit, and increased plasma glucose and FFA concentrations in comparison with the control. 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. 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 dairy Cattle under different winter seasons.

Present study was planned with the objective to develop the database for various physiological, hematobiochemical cold seasons. The major objectives of the study were to find out the deviations in physiological, hematological parameters due to temperature variability from comfortable temperature and winter season. The study will help in developing the strategies to overcome the adverse impact of temperature on dairy cattle.

MATERIALS AND METHODS

Animals

Lactating cross bred dairy cattle, were selected form ILFC R S Pura. Two group was made one group was kept for control in the thermocomfort zone, another group (Group 2) was kept for estimation of cold stress in the month of December. They had access to a concrete-floored yard. Drinking water was heated to 15 ˚C in electronic geysers. The concentrate mixture was fed 1-2 kg/animal/day as per the age and body weight for maintenance. Roughage (paddy straw) were fed ad libitum. Dairy cattles were milked twice daily and the milk yield recorded for each animal.

Hematobiochemical analysis

Blood samples were also collected from both the groups control (thermocomfort zone) and cold stressed of animals at the similar interval for haematological parameters viz. Haemoglobin (Hb), Packed Cell Volume (PCV), Red Blood Corpuscles (RBC), White Blood Corpuscles (WBC) MCV, MCH, MCHC, Blood pH. Blood samples were collected from jugular vein at 20:00 hour in night of cold stressed dairy cattle and analysed for hematological parameters against the control animal group animals kept at of thermocomfort zone.

Meteorological and physiological parameters

The meteorological parameters viz. dry and wet bulb temperature (°C), relative humidity (%) were recorded during the different seasons and have been presented in Table 1. Physiological parameters viz. Respiration Rate (RR), Heart Rate, Rectal Temperature, Pulse Rate (PR), Dehydration and Skin Temperature (ST) were recorded between 8.00-9.00 AM and 2.00-3.00 PM, winter (10±2°C),. The skin temperature was recorded using non contact Tele thermometer, keeping the thermometer 4-6 cm away from the skin. Hematological parameters viz. Hb, PCV was carried out using Drabkins solution and hematocreit tubes, respectively. The RBC and WBC counts were made using hemocytometer. Serum was used for cortisol estimation DetectX Cortisol Enzyme Immunoassay Kit Method and plasma were tested for biochemical parameters like l, blood urea nitrogen (BUN, total protein (TP), albumin (Alb), globulin (Glb), A:G, alanine aminotransferase (ALT), aspartate aminotransferase (AST), Creatninine and cholestrol by using standard kits of erba Mannheim kits. Group 2 represent the cold stressed cattle.

STATISTICAL ANALYSIS

Statistical analysis of the obtained data were performed using SPPS 16 software.

RESULTS AND DISCUSSION

The results of different environmental parameter, physiological and hematological and biochemical parameters and their statistical analysis have been presented in Table 1 to Table 4. Mean dry bulb thermometer, Relative humiditity and temperature Humidity was recorded as 7.5±0.42, 84±0.22 and 50.68±0.61 (Table 1).

Table 1: Environment parameter during the cold stress period

Environmental Parameter	Cold Stress Period
Dry bulb temperature (°C)	7.5±0.42
Relative humidity (%)	84.5±0.22
Temperature Humidity Index (THI)	50.68±0.61

Physiological Parameters

Mean ±SE value of respiration rate, heart rate, rectal temperature, pulse rate, dehydration, skin temperature of cold stressed animals are given in Table 2. Mean ±SE values of respiration rate (breaths/min) of Group 2 animals was 15.56±0.08. Cold stress resulted in non-significant ($P<0.05$) increase in values of respiration rate (breaths/min).

Table 2: Effect of cold stress on physiological parameters of dairy cattle

Parameters	Control (n=6)	Group 2 (n=6)
Respiration Rate (Breaths/min)	20.17±0.09^{Aa}	15.56±0.08^{Aa}
Heart Rate (beats/min)	57.50±1.63^{Aa}	60.91±0.31^{ABb}
Rectal Temperature (˚F)	102.20±0.09^{Ba}	101.45±0.14^{Aa}
Pulse Rate (Pulse / min)	50.91±1.42^{Aa}	65.35±0.40^{ABa}
Dehydration (%)	3.46±0.03^{Aa}	4.54±0.01^{Bc}
Skin temperature (˚F)	37.31±0.04^{Aa}	37.36±0.39^{Aa}

Effect on hematobiochemical parameters

Mean ±SE values of hematobiochemical parameters is given in Table 3 and 4. Mean ±SE values of Hb (g/dl) of Group 2 animals was 9.53±0.09. Mean ±SE values of PCV (%) of Group 2 animals was 36.22±0.07. The PCV(%) values showed non-significant difference between control and stressed Group. Mean ±SE values of RBC ($\times 10^6/\mu l$) of Group 2 animals was 7.74±0.14. Mean ±SE values of WBC ($\times 10^3/\mu l$) of Group 2 animals was 11.98±0.15. Mean ±SE values of MCV (fl) of Group 2 animals was 46.90±0.93. Mean ±SE values of MCH (pg) of Group 2 animals was 12.35±0.29. Mean ±SE values of MCHC (g/dl) of Group 2 animals was 26.32±0.23. Mean ±SE values of Blood pH of Group 2 animals on day zero (pre-treatment), was 7.33±0.01. Mean ±SE values of plasma cortisol (µg/dl) of Group 2 animals was 0.82±0.00. Mean ±SE values of BUN (mg/dl) of Group 2 animals was 27.12±0.75. Mean ±SE values of Total Protein (g/dl) of Group 2 animals was 7.21±0.01. Mean ±SE values of Albumin (g/dl) of Group 2 animals were 3.60±0.19 Mean ±SE values of Globulin (g/dl) of Group 2 animals 3.60±0.19.Mean ±SE values of A:G (g/dl) of Group 2 animals were 1.03±0.17. Mean ±SE values of AST (U/L) of Group 2 animals were 82.87±0.24. Mean ±SE values of ALT (U/L of Group 2 animals was 27.08±0.04. Mean ±SE values of Creatinine (mg/dl) of Group 2 animals were 1.47±0.06. Mean ±SE values of Cholestorol (mg/dl) of Group 2 animals were 127.14±2.88.

Table 3: Effect of cold stress on some hematological parameters of dairy cattle

Parameter	Control (n=6)	Group 2 (n=6)
Hb(g/dl)	9.92±**0.20**^{Aa}	9.53±0.09 ^{Aa}
PCV(%)	32.33±0.49^{Aaa}	36.22±0.07^{Aa}
RBC($\times 10^6/\mu l$)	5.40±0.05 ^{Ca}	7.74±0.14 ^{Da}
WBC($\times 10^3/\mu l$)	9.78±0.25 ^{Ca}	11.98±0.15 ^{Da}
MCV(fl)	44.85±0.64^{Bab}	46.90±0.93^{Aa}
MCH(pg)	13.36±0.30 ^{Ba}	12.35±0.29^{Aa}
MCHC(g/dl)	29.82±0.90^{ABa}	26.32±0.23^{Aa}
Blood pH	7.39±0.02^{Aa}	7.33±0.01^{Aa}

Values with superscript a, b, c, d ($P<0.05$) differ significantly within the group whereas A, B ($P<0.05$) differ significantly between the groups.

Table 4: Effect of cold stress on some biochemical parameters of dairy cattle

Parameters	Control (n=6)	Group 2 (n=6)
Cortisol (µg/dl)	0.85±0.01^{ABa}	0.82±0.00 ^{Ac}
BUN (mg/dl)	14.26±0.22^{Aa}	27.12±0.75 ^{Ba}
Total Protein (g/dl)	6.44±0.16^{Aa}	7.21±0.01^{ABb}
Albumin (g/dl)	3.30±0.33^{Aa}	3.60±0.19^{Aa}
Globulin (g/dl)	2.74±0.21^{Aa}	3.60±0.19^{Ab}

A:G (g/dl)	1.71±0.19^{Aa}	1.03±0.17^{Aa}
AST (U/L)	82.95±0.73^{Aa}	82.87±0.24^{Ba}
ALT (U/L)	38.61±0.52^{Aa}	27.08±0.04^{Aa}
Creatinine (mg/dl)	1.31±0.01^{Aa}	1.47±0.06^{ABa}
Cholestorol (mg/dl)	127.64±2.68^{Ab}	127.14±2.88 ^{Ac}

Values with superscript a, b, c, d (P<0.05) differ significantly within the group whereas A, B (P<0.05) differ significantly between the groups.

Effect on milk production

Mean ±SE values of milk production and milk composition is given in Table 5 Mean ±SE values of milk yield (litres/day) of control group was 12.83±1.38 L/day, whereas in cold stressed animals was 10.35±0.36. Stress resulted in non-significant decrease (P<0.05) in daily milk yield.

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CONCLUSION

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 dairy 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 winter season.

REFERENCES

Armstrong, D.V. 1994. Heat stress interaction with shade and cooling. *J. Dairy Sci.,* **77**: 2044–50.

Beattie, D. 1978 Physiological changes in rats exposed to cold stress. *Life Sci*., **23**: 2307-2314.

Brouek, J., Kovalik, K., Gajdogik, D. and Brestensk, V. 1987. The effect of extreme ambient temperatures on haematological and biochemical parameters of heifers. *Vet. Med*., **32**:259-268.

Christopherson, R.J. and Young, B.A. 1986. Effect of cold environments on domestic animals. In: Gudmundsson O (ed) Grazing research at Northern latitudes. Plenum, pp. 247-257.

Dikmen, S. and Hansen, P.J. 2009. Is the temperature-humidity index the best indicator of heat stress in lactating dairy cows in a subtropical environment? *J. Dairy Sci.,* **92**: 09–16.

Grunwaldt, E.G., Guevara, J.C., Estevez, O.R., Vicente, A., Rousselle, H., Alcuten, N., Agurregaray, D. and Stasi, C.R. 2005. Biochemical and haematological measurements in beef cattle in Mendoza plain rangelands (Argentina). *Trop. Anim. Health Prod.,* **37**: 527- 40.

Horwitz, B.A. 1971. Brown fat thermogenesis: Physiological control and metabolic basis. In: Nonshivering thermogenesis. Proceedings of Symposium, Praha, pp. 63-65.

Johnson, H.D. 1986. The effects of temperature and thermal balance on milk production. In: Moberg GP (ed) Limiting the effects of stress on cattle. *Utah State University, Res. Bull*., **512**: 33-45.

Johnson, H.D. 1987. Bioclimate effects on growth, reproduction and milk production. In: Johnson HD (ed) Bioclimatology and the adaptation of livestock. Elsevier, Amsterdam, pp. 35-57.

Johnson, H.D. and Vanjonack, W.J. 1976. Effects of environmental and other stressors on blood hormone patterns in lactating animals. *J. Dairy Sci*., **59**: 1603-1617.

Kadzere, C.T., Murphy, M.R., Silanikove, N. and Maltz, E. 2002. Heat stress in lactating dairy cows: a review. *Livest. Prod. Sci.,* **77**: 59–91.

MacDonald, M.A. and Bell, J.M. 1958. Effects of temperature on milk yield and milk composition. *Can J. Anim. Sci.,* **38**: 160.

Rajcevic, M., Jazbec, I., Levstek, J. and Ilc T. 1995. Nutritional and mineral matters in rations and metabolic profile of cows. *Krmiva*, **37**: 314–22.

Shaffer, L., Roussel, J.D. and Koonce, K.L. 1981. Effects of age, temperature, season, and breed on blood characteristics of dairy cattle. *J. Dairy Sci.,* **64**: 62–70.

Young, B.A. 1981. Cold stress as it affects animal production. *J. Anim. Sci.,* **52**: 154-163.

Young, B.A. 1983. Ruminant cold stress: effect on production. *J. Anim. Sci.,* **57**: 1601-1607.