Blood biochemistry and hormonal profiles of crossbred calves during hot-humid season under modified roofing systems

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Abstract

Heat stress causes various alterations in normal blood biochemical & hormonal parameters of the animals leading to decrease in comfort and hence production as well as productivity. Its impact is even more during hot-humid climate. This study was therefore designed to witness the effect of various housing models on different blood parameters of crossbred calves during the rainy season in tropics. A total of eighteen crossbred calves (9-11 months old) were randomly selected and allocated in 3 groups viz. control (C): corrugated cemented sheet (CCS) as roofing material, T1: polycarbonate plastic sheet as roof and T2: polycarbonate roof with adjustable height. The aim of the study was to evaluate the effect of modified housing using different roofing materials on growth and physiological performance of calves during the rainy season. The THI at 9:00 am varied between 82.50 ±0.52 to 86.30 ±0.43 and at 2:30 pm between 85.67 ±0.63 to 92.32 ±0.48 during the season. The overall average temperature of shed was significantly ($P<0.05$) lower in T2 (28.18±0.11) than T1 (29.74±0.19) and C (30.55±0.06). Overall average relative humidity (%) was significantly ($P<0.05$) lower in T2 (77.08±0.31) as compared to T1 (82.10±0.76) and C (82.92±0.12). Overall average temperature humidity index (THI) was significantly ($P<0.05$) lower in T2 (76.56 ±0.23) followed by T1 (78.35 ± 0.23) and C (79.30 ± 0.18). Hemoglobin (Hb) concentration (g/dl) was significantly higher ($P<0.05$) in T2 (11.18±0.31) as compared to T1 (10.36±0.47) and C (10.10±0.55). Serum Glutamic Oxaloacetic Transaminase (SGOT) level (IU/L) in C (102.53±3.08) was significantly higher ($P<0.05$) followed by T1 (98.51±3.28) in comparison to T2 (91.73±2.41). No significant difference was found in the serum hormone levels (T_3, T_4 and cortisol) between the treatment groups. It may be inferred that the micro-environment was more conducive in T2 than control; hence the reflective polycarbonate roofing with adjusted higher height may be the desirable choice for animal housing in view of mitigating heat stress during the hot-humid climate.

Key words: Corrugated cemented sheet; Crossbred calves housing; Hot-humid Climate; Polycarbonate roofing; Serum bio-chemicals.

Introduction

Hot-humid climate or rainy season is stressful livestock especially high yielding crossbred cattle. Increase in humidity depresses evaporative heat loss greatly and thus adds heat load to the animals. In combination with high temperature and humidity, the ability of the dairy animals to dissipate excess body heat is compromised which leads to depressed feed intake and consequent reduction in production performance. Change in microclimate not only affects the performance, feed intake and growth but also affect the serum biochemical levels in the body. The assessment of serum- biochemicals is one of the key indicators for identifying animals in stress (Kamal *et al.* 2018). Roof is an integral part of animal house and roofing materials prevent the direct heat from entering the house in different proportions and helps towards favourable micro-climate. Use of suitable roofing material and proper housing may provide a comfortable microenvironment to the crossbred calves in hot-humid climate (Maurya *et al.* 2018) leading to their better growth and performance (Lees *et al.* 2019). Most commonly used roofing materials include: thatch, clay tiles, reinforced cement concrete (RCC), galvanized iron (GI) sheets, asbestos, tin and plastic sheets, however there is limited to certain extent either due to limited durability or limited cost. These days low-cost house is need of the hour with higher durability, U.V protection which could ultimately modify the micro climatic conditions of the house.

Polycarbonate sheets being light and durable may be used as roofing materials for animal sheds. Moreover, it is being used in many agro-industries and commercial buildings by virtue of its higher strength, light weight, easy portability and installation. Adjustment of height of the roof during higher humidity and temperature may be another approach towards modifying the microenvironment for more comfort. Keeping in consideration these points, the study was designed to investigate the effect of roof modifications on blood biochemical and hormonal profiles of crossbred calves during hot humid season.

Materials and Methods

The present study was conducted on crossbred (*Vrindavani*) cattle calves maintained at the cattle and buffalo farm, IVRI, Izatnagar to evaluate the effect of modified housing using different roofing materials on blood biochemical and hormonal profiles of during the rainy season (July`2017 to September` 2017). The Institute is located at an altitude of 169 m above mean sea level, at the latitude of 28.22°N latitude and 79.24°E longitudes. The climate of the place touches both the extremes of hot (approximately 45°C) and cold (approximately 5°C), and relative humidity (RH) ranges between 15% and 99%. Vrindavani cattle is crossbred strain of India developed by ICAR-IVRI, Izatnagar. It has exotic inheritance of Holstein-Friesian, Brown Swiss, Jersey and indigenous inheritance of Hariana cattle (Singh *et al.* 2011). A total of eighteen female calves (9-11 months old) were randomly selected and allocated in 3 groups viz. control (C); The animals were kept in a loose housing system with 2 m^2 space per animal in covered area and 4 m^2 per animal in open area. Corrugated cemented sheet was used as roofing material. Treatment 1 (T1): Polycarbonate sheet as roofing material, all other aspects of house was kept same as C; Treatment 2 (T2): Polycarbonate sheet as roofing material with adjustable height. Height at eaves was kept 2.5 -2.7 m and the height at centre was 3.5 m (for hot-humid period). The roof was arranged like a ridge system of ventilation for hot air in shed to pass from the roof itself. A gap of two feet was provided for ridge ventilation with one side of roof overhanging the other, all other aspects of house was kept same as C & T1. The difference in the height of the roof in T2 from C & T1 was around 0.3 m at eaves and 0.6 m at centre. The animals were maintained under iso-managerial conditions of management, feeding with semi- intensive system and housed in a well-ventilated brick cemented loose house with non-slippery floor open byre with standard space as per Indian Standard. The calves were offered standard ration having green and dry fodder along with concentrate in all the groups.

Temperature of sheds was measured by maximum and minimum thermometer twice daily at forenoon (9:00 am) and afternoon (2:30 pm). Simultaneously the relative humidity (RH) of sheds was measured using dry and wet bulb thermometer twice daily. Temperature humidity index (THI) was calculated as per McDowell (1972) using the following formula: THI = 0.72 (wet bulb temperature + dry bulb temperature) + 40.6. Inner surface temperature (ST) of roof was recorded by infrared thermometer (ebro, TFI 220) at 9:00 am and 2:30 pm for three consecutive days at fortnightly interval.

Blood samples from experimental calves were collected at monthly interval by puncturing jugular vein following aseptic measures. Serum was separated and stored at -20^{o}C for further analyses. All the serum samples were analyzed in Nuclear Research Laboratory (NRL), IVRI, Izatnagar. Fresh blood samples were utilized for hematological estimation. Erythrocytes and leukocytes were counted using hemocytometer (Neubauer's counting chamber). The blood Hb was estimated by Drabkin's method. Packed cell volume (%) in the blood samples was determined by using microhematocrit method. Serum biochemical level, i.e glucose, total protein, albumin, globulin, creatinine, Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) were estimated using the kit supplied by (Coral Clinical Systems, India) and hormones viz. Cortisol, Serum Triiodothyronine (T_3) and Serum Thyroxin (T_4) were estimated using the kit supplied by (NovaTec, Immundiagnostica, GMBH, Germany). The data obtained from the study was analyzed using standard statistical methods as described by Snedecor and Cochran (1994).

Results and Discussion

Macro climate during rainy season

The solar radiation ranged from 149.33 ±16.05 to 182.89 ±11.44 W/m2 during the course of the experiment, whereas wind speed varied from 0.61±0.14 to 0.87±0.08 m/s. The mean ambient temperature ranged between 27.64 ±0.57 to 32.56 ±0.51°C. The ambient temperature during the experimental period at 9:00 am ranged between 25.11 ±0.40 to 27.24 ±0.22 °C. The mean RH during the observation period ranged between 64.66 ± 1.54% to 75.35 ±1.81%. The THI at 9:00 am varied between 82.50 ±0.52 to 86.30 ±0.43 and at 2:30 pm between 85.67 ±0.63 to 92.32 ±0.48. The mean THI during the observation period was ranged between 84.09 ±0.56 to 89.31 ±0.41. The macroclimatic conditions were more stressful during afternoon as compared to morning hours.

Microenvironment of sheds

Temerature (^{0}C) of the shed

The temperature at 9:00 am during the first fortnight was 25.97±0.55, 24.93±0.46 and 22.63±0.63°C, which decreased to 23.73±0.68, 23.70±0.82 and 21.17±0.20 °C under C, T1 and T2 respectively, during the last fortnight, whereas the corresponding values at 2:30 pm during the first fortnight decreased from 36.40±0.31, 35.27±0.37 and 33.23±0.39 to 35.43±0.72, 35.07±0.39 and 32.27±0.37, respectively, during last fortnight. The overall minimum temperature at 9:00 am was 25.34±0.09, 24.54±0.20 and 22.86±0.17 °C, whereas at 2:30 pm 35.75±0.15, 34.94±0.32 and 33.37±0.15 °C in C, T1 and T2 respectively. The overall average temperature was significantly ($P<0.05$) lower in T2 (28.18±0.11) as compared to T1 (29.74±0.19) and C (30.55±0.06). The temperature of sheds at 9:00 a.m. and 2:30 p.m. were significantly ($P<0.05$) lower in T2 followed by T1 and highest in C, during all the fortnights.

In T2 lower temperature of shed than control was recorded during rainy season which may be due to higher height of house and ridge system of ventilation which allowed the hot air accumulated to pass from the roof itself and hence maintained a slightly lower shed temperature. Increasing the height of shed with ridge ventilation might have helped to dissipate heat easily in T2. The present findings are in agreement with Kamal *et al*. (2013) and Jat *et al*. (2005) who reported higher shed temperature of asbestos sheet roofing material in comparison to thatched roof, mud-plaster roof and agro-net sheet roof house during rainy season. Asbestos roofed houses had higher temperature than the tile roofed house (Sivakumar, 2017). However, in contrary to our results Roy and Chatterjee, (2010) reported that polythene sheet roof had the lowest minimum and higher maximum temperature as compared to GI sheet, and tile roof shade structure in rainy season.

Relative humidity (%) of sheds

The RH at 9:00 am during the first fortnight in C, T1 and T2 was 80.80±1.22, 80.05±1.87 and 76.80±2.04 %, which increased to 86.72±1.52, 85.72 ±2.23 and 79.70±2.65 % at last fortnight. Similarly, RH at 2:30 pm increased from 73.50±0.92, 72.70±1.29 and 69.60±1.92% to 83.51±1.98, 83.51±1.29 and 73.23±1.06 % for C, T1 and T2 respectively. The overall average RH was 82.92±0.12, 82.10±0.76 and 77.08±0.31% in C, T1 and T2 respectively during the rainy season. Irrespective of treatment RH at 9:00 am was significantly ($p<0.05$) higher than at 2:30 pm. The RH at 9:00 am and 2:30 pm was significantly ($p<0.05$) higher in C, followed by T1 as compared to T2 during all the fortnights. The negative diurnal changes in RH were observed in all the shades during rainy season due to rise in environmental temperature from morning to mid day as routine phenomenon as reported earlier also by Kaur and Singh, (2004). The Present finding are also supported by Roy and Chatterjee, (2010), who reported significantly higher in morning and evening in all the shelters (GI sheet, tiles and polythene shade) during rainy season indicating higher stress on the animals, whereas, Das, (2012) observed highest RH in GI sheet roof during rainy season as compared to polythene and tile roof. The RH under T2 was found to be minimum, which might be due to the fact that this system of housing allowed the floor to become dry quickly and provided proper ventilation. The present findings are in accordance with earlier reports (Kamal *et al.* 2013) who observed higher humidity in asbestos roofed house as compared to thatch, tree and agro-net. Asbestos roofed houses had higher relative humidity than the tile roofed house (Sivakumar, 2017).

Temperature humidity index of sheds

The THI recorded fortnightly at 9:00 am and 2:30 pm during the experimental period under different roofing materials are presented in (Figure-1). The overall THI at 9:00 am in C, T1 and T2 was 77.28 ± 0.20, 76.69 ± 0.24 and 74.34 ± 0.23, whereas at 2:30 pm was 81.33 ± 0.19, 80.01 ± 0.24 and 78.78 ± 0.23, respectively. Overall average THI was significantly ($P<0.05$) lower in T2 (76.56 ±0.23) followed by T1 (78.35 ± 0.23) and C (79.30 ± 0.18). The THI at 9:00 am was significantly ($p<0.05$) lower from THI at 2:30 pm in all the treatments groups. Lower values of THI in T2 compared to control indicates more conducive micro-environment, which may be due to less heat penetration and effective ventilation viz. higher height of roof.

The present finding is also supported by Khongdee, (2008), who concluded that the difference between maximum and minimum THI during the rainy season was lower suggesting that the dairy cows were exposed to heat stress conditions more consistently during the rainy season. However, the shade of polypropylene had a significantly lower ambient temperature and THI ($P<0.05$) for 5 h and 5 h 30 minute respectively, a difference most likely due to the reduction in re-radiated heat in the Shaded shed. Pusta *et al*., (2006) reported higher THI (>72) in pasture heifers in the month of rainy season as compared to cows during lactation. Jat *et al*., (2005) recorded higher THI in asbestos in morning (81.52 ±0.35) and evening (85.71 ±0.51) as compared to mud plaster and less in thatch during rainy season, whereas, Das, (2012) and Roy and Chatterjee, (2010) observed higher THI (83.48 ±0.52) under GI sheet roof.

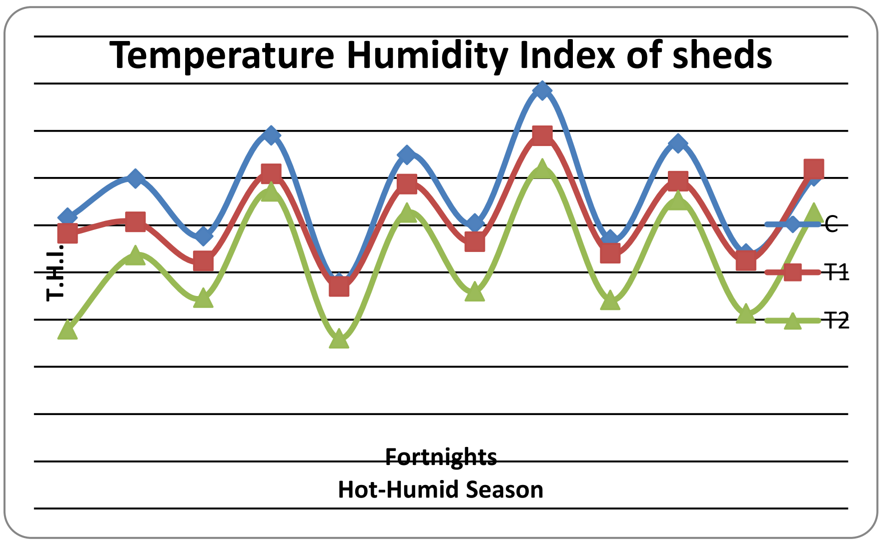

Fig 1: Temperature Humidity Index of experimental sheds during rainy season.

Inner surface temperature (°C) of roofing materials

The inner surface temperature of roof for different sheds has been presented in Table 1. The overall inner surface temperature of roofs at 9:00 a.m. and 2:30 p.m. were significantly lower ($p<0.05$) in T2 followed by T1 and highest in C. Polycarbonate being reflective and UV resistant might have allowed minimum heat to pass and thus provided better microclimate as compared to control in T2 and T1. The present findings are in agreement with Kamal *et al.* (2013) who recorded higher inner surface temperature of asbestos sheet in comparison to thatched roof and agro-net roof during rainy season.

Table 1: inner surface temperature (^{O}C) of different roofing materials

Fortnight	Time	Corrugated cemented sheet roof (C)	Polycarbonate Roof (T2)	Roof with Adjustable height (T3)
F1	9:00 am	40.83 ± 0.44 ^{a}	39.50 ± 0.29^{ab}	38.87 ± 0.47^{b}
	2:30 pm	48.97 ± 0.62	47.30 ± 0.49	46.87 ± 0.47
	Avg	44.09 ± 0.48 ^{a}	43.82 ± 0.22 ^{ab}	42.87 ± 0.47 ^{b}
F2	9:00 am	40.50 ± 0.29	40.48 ± 0.29	39.01 ± 0.38
	2:30 pm	49.17 ± 0.64	48.40 ± 0.45	47.53 ± 0.29
	Avg	44.83 ± 0.38	44.43 ± 0.36	43.27 ± 0.32
F3	9:00 am	40.81 ± 0.43^{a}	39.57 ± 0.32^{ab}	39.31 ± 0.17^{b}
	2:30 pm	48.82 ± 0.59	47.43 ± 0.62	47.03 ± 0.44
	Avg	44.82 ± 0.38 ^{a}	43.50 ± 0.20^{ab}	43.17 ± 0.29^{b}
F4	9:00 am	40.80 ± 0.18 ^{a}	39.75 ± 0.34^{ab}	39.16 ± 0.30^{b}
	2:30 pm	48.67 ± 1.16 ^{a}	48.23 ± 0.15 ^{ab}	46.63 ± 0.86 ^{b}
	Avg	44.74 ± 0.61 ^{a}	43.99 ± 0.24 ^{ab}	42.90 ± 0.56 ^{b}
F5	9:00 am	39.10 ± 0.59	37.30 ± 0.85	36.50 ± 0.66
	2:30 pm	48.80 ± 0.62	47.67 ± 0.28	46.03 ± 0.55
	Avg	43.95 ± 0.19	42.48 ± 0.53	41.27 ± 0.45
F6	9:00 am	40.33 ± 0.33	38.83 ± 0.73	38.11 ± 1.16
	2:30 pm	49.20 ± 1.29 ^{a}	49.03 ± 1.06 ^{a}	47.93 ± 0.62 ^{b}
	Avg	44.77 ± 0.49	43.92 ± 0.23	43.02 ± 0.88
Overall	9:00 am	40.40 ± 0.04 ^{a}	39.24 ± 0.24^{ab}	38.49 ± 0.28^{b}
	2:30 pm	48.94 ± 0.56 ^{a}	48.14 ± 0.33 ^{ab}	47.02 ± 0.19 ^{b}
	Avg	44.67 ± 0.27 ^{a}	43.69 ± 0.14 ^{ab}	42.75 ± 0.19 ^{b}

Means values between 9:00 am & 2:30 pm differ significantly (P<0.05) within the treatments
Means bearing different Superscript differ significantly (P<0.05) row wise

Blood parameters

The Hb of crossbred calves to different house modifications has been presented in Table 2. Calves in T2 group had significantly (P<0.05) more Hb as compared to T1 and C. This might be due to the provision of healthy micro-environment due to respective housing modification as compared to other groups which increased the DMI of the respective group, resulted in more Hb level. The normal Hb values in calves vary from 5.6 to 12.5 g/dl (Roland *et al.* 2014). Our findings are similar to Kamal, (2013) who also reported a significant increase in Hb in calves kept in thatch and agro-net as compared to asbestos during rainy season. Sinha *et al.* (2019) also found significantly higher Hb concentration (g/dl) and white blood corpuscles (103/cmm) in the crossbred cows housed with foggers plus fan (10.54±0.36 and 12.35±0.64) as compared to cows housed with sprinklers (9.52±0.43 and10.88±0.57) during the summer. Reena *et al.* (2016) also found significant increase in Hb conc. of calves in more comfortable sheds having cooler microenvironment during the rainy season. The Total Erythrocyte Count, Total Leukocyte count and Packed Cell Value of crossbred calves to different housing modifications has been presented in Table 2. However, no significant difference was observed among the three groups during rainy season. Our findings are in accordance with Verma, (2015) who reported non-significant difference in the heifers kept under different cooling systems during rainy season. The values of TEC, TLC and PCV in present study was under normal range (4.9-7.5x10^6/µL 5 -12 x 10^3/µL and 22-38% respectively) (Roland *et al.* 2014).

Serum biochemical parameters of calves

The effect of shade materials on various biochemical parameters viz. glucose, total protein, albumin, globulin and creatinine at monthly interval has been presented in table2. The results are in accordance with Kamal, (2013) who reported non-significant difference in the Vrindavani calves kept in thatch, agro-net and asbestos during rainy season. Serum glucose value of present finding is supported by Shrikhande *et al*. (2008) in cattle during rainy season.

The total serum protein values for C, T1 and T2 grouped calves were 7.09±1.12, 6.98±0.98 and 7.12±0.77 g/dl respectively. The table revealed that there was non-significant difference between the groups. The present value for total serum protein is in support with Shrikhande *et al*. (2008) and Hooda and Naqvi (1990) during rainy season. The values of serum albumin and globulin were found to be non significant (P<0.05) within the groups. The present

Table 2: Effect of roofing materials on Blood parameters of experimental calves

	July			Aug			Sept			Overall		
	C	T1	T2	C	T1	T2	C	T1	T2	C	T1	T2
Hemoglobin (g/dl)	9.56 ±0.51	9.7 ±0.63	10.35 ±.47	10.89 ±0.78	10.5 ±0.52	11.5 ±0.63	9.87 ±0.92	10.89 ±0.69	11.7 ±0.56	10.10±0.55^{a}	10.36±0.47^{a}	11.18±0.31^{b}
TEC (10^6/ µL)	5.30 ±0.32	5.40 ±0.19	5.40±0.21	5.80±0.17	5.17±0.11	6.26±0.14	5.45±0.11	5.96±0.18	6.42±0.12	5.52±0.09	5.51±0.04	6.03±0.07
TLC (10^3/ µL)	9.76 ±0.77	9.54 ±0.53	11.60±0.70	10.52±0.63	10.52±0.46	11.45±0.51	9.53±0.94	11.18±0.36	10.72±0.42	9.94±0.53	10.41±0.25	11.26±0.22
PCV (%)	29.10 ±1.23	30.05 ±0.92	31.80±1.06	32.67±0.98	31.90±1.15	34.50±1.08	30.56±1.86	32.42±1.04	34.80±0.81	30.78±0.98	31.46±0.73	33.70±0.67
Glucose (mg/dl)	53.70 ±6.30	54.60 ±5.83	55.24±4.78	50.80±3.98	53.22±4.88	52.70±3.79	54.89±4.53	56.46±3.32	55.89±3.08	53.13±3.30	54.73±2.83	54.61±2.78
Serum Biochemicals												
Total Protein(g/dl)	6.91 ±1.18	6.75 ±1.78	6.86±2.01	7.09±1.79	7.04±1.21	7.18±0.56	7.26±2.71	7.15±0.85	7.33±1.08	7.09±1.12	6.98±0.98	7.12±0.77
Ablumin (g/dl)	3.51 ±0.29	3.29 ±0.12	3.57±0.15	3.54±0.32	3.46±0.09	3.73±0.22	3.70±0.41	3.58±0.26	3.72±0.12	3.58±0.19	3.44±0.08	3.67±0.07
Globulin (g/dl)	3.40 ±0.38	3.46 ±0.34	3.29±0.41	3.55±0.29	3.58±0.23	3.45±0.39	3.56±0.59	3.57±0.30	3.61±0.52	3.50±0.23	3.54±0.12	3.45±0.21
Creatinine (mg/dl)	1.09 ±0.14	1.07 ±0.12	1.03±0.14	1.25±0.11	1.13±0.11	1.09±0.12	0.91±0.09	0.85±0.08	0.77±0.09	1.08±0.08	1.02±0.07	0.96±0.06
Serum Enzymes												
SGOT(IU/L)	99.10 ±4.41^{a}	101.07 ±8.45^{a}	82.92 ±5.18^{b}	103.30 ±5.60^{a}	93.67 ±3.71^{b}	92.51 ±3.51^{b}	105.20 ±5.45^{a}	100.81±4.76^{b}	99.78±3.97^{b}	102.53±3.08^{a}	98.51±3.28^{b}	91.73±2.41^{c}
SGPT(IU/L)	36.61 ±5.89	35.70 ±5.04	35.21 ±4.17	34.41 ±7.10	35.95 ±4.35	34.18 ±5.38	36.6 2±5.04^{a}	37.81±5.72^{a}	32.38±4.73^{b}	35.88±3.84	36.48±1.71	33.92±3.30
Serum Hormones												
Cortisol (nM/L)	17.89 ±1.54	16.78 ±1.88	16.71±1.72	20.05±1.42	19.42±1.09	17.90±2.01	19.56±1.55	19.83±0.84	18.76±0.64	19.17±0.96	18.68±1.02	17.79±0.91
T_3(nM/L)	2.01±0.25	2.34±0.16	1.98±0.19	1.65±0.26	1.97±0.24	1.57±0.43	2.09±0.41	1.78±0.31	2.54±0.96	1.92±0.10	2.03±0.09	2.03±0.11
T_4(nM/L)	67.85 ±4.51	64.21 ±4.92	63.45 ±4.65	72.90±5.33	69.82±3.50	67.85±4.45	64.87±3.51	59.75±3.39	63.30±3.92	68.56±2.41	64.59±2.17	64.87±1.42

Means bearing different superscript in a row differ significantly ($P<0.05$)

values for serum albumin and globulin during rainy season are in accordance with the values reported by Shrikhande *et al*. (2008). Kamal, (2013) also reported non-significant difference in serum albumin values in crossbred calves kept under thatch, agronet, tree and asbestos during rainy season.

The serum creatinine values for C, T1 and T2 were 1.08±0.08, 1.02±0.07 and 0.96±0.06 mg/dl respectively. The results suggested that there was no significant difference in the serum creatinine values among the groups. Moreover, in our study, the creatinine concentration in the calves in all the housing system was in the safe range. (Hammon *et al*. 2002).

Serum enzymatic parameters

The effect of house modifications on enzymes viz. SGOT and SGPT at monthly interval has been presented in table 2. The result suggested that there was significantly ($P<0.05$) higher SGOT level in C followed by T1 in comparison to T2. Though, the overall value for SGOT falls under the normal range (Radostits, *et al*, 2007). Higher level of serum SGOT in control and T1 grouped calves as compared to T2 might be due to higher temperature and THI which increased the serum SGOT activity in order to compensate the other negative effects of thermal stress on the physiological and biochemical homeostatic mechanisms. The finding is in agreement with Verma, (2015); Kamal, (2013) and Nazifi *et al*. (2003) as they reported an increase in serum SGOT activity during thermal stress.

Serum SGPT was found to be non significant ($P<0.05$) between the groups. This is in agreement with the report of Kamal (2013) who also reported non-significant difference in serum SGPT during rainy season under different shade materials. Nazifi *et al.*, (2003) reported that there will be increase in serum SGPT activity at hot temperature as compared to cooler temperatures.

Hormonal parameters

The impact of different roofing materials during rainy season on Cortisol, T_3 and T_4 was studied fortnightly and presented in the table 2. The serum cortisol levels for the three treatment groups, during rainy season was 19.17±0.96, 18.68±1.02 and 17.79±0.91 nmol/l for C, T1 and T2 respectively. There was no significant difference within the groups, though the serum cortisol levels are higher in control followed by T1 as compared to T2. Serum total T_3 level was 1.92±0.1, 2.03±0.09 and 2.03±0.11, whereas total T_4 values were 68.56±2.41, 64.59±2.17 and 64.87±1.42 nmol/l for C, T1 and T2 respectively. From the table, it is clearly evident that the serum total T_3 and total T_4 did not differ significantly among the groups. Present finding is in agreement with Khongdee et al. (2010) who reported non-significant difference in T_3 and T_4 between the double shade polypropylene and single shade polypropylene cloth. Similarly, Kamal, (2013) also found nonsignificant ($P<0.05$) difference in in T_3 and T_4 in Vrindavani calves under different shade materials during rainy season. Vijayakumar (2005) found also non-significant difference in in T_3 and T_4 in buffalo heifers treated with fan and sprinkler to reduce heat stress and the control group. In contrast, Pusta et al., (2003) observed lower plasma concentration of both T_3 and T_4 when animals are heat stressed.

Conclusion

From the study, it may be inferred that the micro-environment was more conducive in the reflective polycarbonate roofing with adjusted higher height than corrugated cement roofing as the levels of stress biochemicals like cortisol and enzymes were found lower within the normal range. The polycarbonate sheets as roofing material may be the desirable choice for animal housing in view of mitigating heat stress during the hot-humid climate.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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