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Haematology and biochemical profiles of endangered local cattle of Andaman and Nicobar Islands

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ABSTRACT

Andaman and Nicobar Islands have two different genetic groups of cattle namely Andaman local cattle and Trinket cattle. Andaman local cattle are distributed in Andaman group of Islands and Campbell Bay of Nicobar group of Islands. Andaman local cattle are non-descriptive and represent an admixture of different Indian breeds that had been brought to these islands in different phases of inhabitation and rehabilitation of migrated people. It is believed that the Andaman local cattle have the inheritance from Red Sindhi, Sahiwal and Hariana. It is unique cattle, well adapted to special type of tropical humid island climatic and environmental condition. The present study was designed to standardise the normal reference haematological and biochemical range for different age groups of Andaman local cattle which were maintained in the South Andaman and North and Middle Andaman district, Andaman and Nicobar Islands, India. In this study, haematological parameters, biochemical indices and antioxidant and oxidative stress profiles were estimated in healthy, normal physiological Andaman local cattle for different age groups. The present study results clearly indicated that the values of haematological, biochemical and antioxidant profiles were under the normal physiological range. These results of this study may serve as the reference values in which alterations due to metabolic, nutrient deficiency, physiological and health status can be compared for diagnostic and therapeutic purposes for Andaman local cattle in Andaman and Nicobar Islands and its neighbouring countries or other parts of the country with similar environmental and climatic conditions.

Keywords: Andaman local cattle, Antioxidant profiles, Biochemical profiles, Haematology

Andaman and Nicobar Islands have two different genetic groups of cattle namely Andaman local cattle and Trinket cattle. Trinket cattle are highly endangered feral cattle of Trinket Island. Andaman local cattle are distributed in Andaman group of Islands and Campbell Bay of Nicobar group of Islands. Andaman local cattle are non-descriptive and represent an admixture of different Indian breeds that had been brought to these islands in different phases of inhabitation and rehabilitation of migrated people. It is believed that the Andaman local cattle have the inheritance from Red Sindhi, Sahiwal and Hariana. It is unique cattle, well adapted to special type of tropical humid island climatic and environmental condition. The cows are moderate in size. The body colour may be white, black, red or a mixture of all these. They are humped cattle with stout stature. Teats and udder are small to moderate in size. They are resistant to many bacterial, viral and parasitic diseases. They require less care and management. These cows produce around 1–3 litre of milk daily. They have 6–8 months of lactation period with longer calving interval and higher age at first calving. After long periods of adaptation in forest and semi-forest areas of Andaman and Nicobar Islands, they have become semi-feral (Jangli) type in their look and attitude.

Importance of determining the biochemical and haematological indices of domestic livestock species have been well acknowledged and documented (Opara *et al*. 2006). Haematological as well as biochemical values can provide the strong valuable baseline information which inturn helps to assess the realistic evaluation of managemental practices, physiological and nutritional status of the animals and also help to diagnose and asses the health condition or status (Radostits *et al*. 2006, Jezek *et al*. 2006, Mir *et al*. 2008). Metabolic disorders, nutritional deficiencies and prevalence of the diseases can be easily detected by proper analysis as well as monitoring of blood and other body fluids (Otto *et al*. 1992). However, this requires for the establishment of normal reference values for the particular species. Pathological values are defined as those values deviating from the normal standard reference values (Radostits *et al*. 2006). Evaluation, analysis and interpretation of the obtained results mainly depend on the standard reference values for different species of the animals in different regions as well as under existing environmental or climatically conditions. Since the Andaman local cattle used in the present study did not show any significant

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clinical signs and/ or pathological symptoms, therefore they were believed as healthy animals and the result or data observed can serve as standard reference values for these animals in future in veterinary science and animal husbandry (Kaneko *et al*. 1997). There is paucity of literature or information for Andaman local cattle on haematological attributes, biochemical indices and antioxidant profiles in Andaman and Nicobar Islands of India. To the best of our knowledge and based on the availability of the literature, this study is to be the first report on normal haematological attributes, biochemical indices and antioxidant profiles in Andaman local cattle in India. The present investigation describes the composition of blood, biochemical profiles and serum antioxidant attributes of the Andaman local cattle of Andaman and Nicobar Islands. The data is given in the present communication can serve as the standard reference values for Andaman local cattle grown in the Andaman group of Islands and Campbell Bay of Nicobar group of Island and other islands having similar climatic and nutritional conditions.

MATERIALS AND METHODS

Andaman local cattle (80) maintained in South Andaman, North & Middle Andaman districts of Andaman and Nicobar Islands, India were used in the present study. The study area is located at south between 6° and 14° North latitudes and 92° and 94° East longitudes. The average maximum temperature is 30.1°C and the minimum temperature is 23°C. Relative humidity is in the range of 82–94%. The annual rainfall is more than 3,100 mm spread over more than 7 months in a year. The samples have been collected in two seasons as seasons has been classified into monsoon season (April to November) and dry season (December to March) as per the monsoon availability for five whole calendar years in Andaman and Nicobar Islands. The experimental animals were managed under the semi-intensive system of grazing in the jungle or forest in the day time and tying them in the confined shed during night time. The experimental animals in shed were fed daily with *ad lib.* quantity of locally available forage. Fresh water was available throughout the day.

Age of the animals was calculated based on the birth register, dentition and parity of the animals. According to their age, the experimental cows were equally divided into five groups each of 16 cattle, viz. Gr A (0.1-1.0 yr; 10.81 m), Gr B (1-2 yrs; 21.56 m), Gr C (2-3 yrs; 32.70 m), Gr D (3-5 yrs; 53.13 m) and Gr E (5-6 yrs; 69.76 m).

The blood samples were collected from jugular vein into collection tubes (20 IU of heparin/mL of blood) at early morning between 0700 and 0900 h during dry and rainy seasons. Each sample was divided into two parts as one for analysis of haematological profiles and another for biochemical analysis. Heamatological profiles such as total red blood cells (TRBC), haemoglobin (HB), erythrocyte sedimentation rate (ESR), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and total white blood cell (TWBC) were estimated with automatic blood analyser. The second part of blood was centrifuged at 1200 × g for 15 min at 4°C. The plasma samples were separated rapidly, labelled properly and preserved at -80°C in deep freezer for further analysis of biochemical indices and antioxidant profiles. The biochemical indices such as total protein, albumin, globulin, glucose and total cholesterol and antioxidant profiles such as total antioxidant capacity (TAC), catalase (CAT), glutathione (GSH) and superoxide dismutase (SOD) and oxidant profile such as malondialdehyde (MDA) were estimated with commercially available kits.

The results were analysed statistically and expressed as the mean±SEM. Means were analyzed by one way analysis of variance (ANOVA), followed by the Tukey's post hoc test to determine significant differences among the different age groups and student "t" test between the dry and rainy seasons in different age groups of experiment using the SPSS/PC computer program. Differences with values of $P<0.05$ were considered to be statistically significant by using SPSS 15. Correlation between the haematological and biochemical profiles and age was established with correlation coefficient being done as per Pearson's method.

RESULTS AND DISCUSSION

Mean±SEM of haematological attributes (Table 1), biochemical indices (Table 2) and antioxidant profiles (Table 3) in Andaman local cattle of ANI of different age groups were analysed and revealed significant difference between age groups. Haematological profiles were significantly ($P<0.05$) higher in samples collected during rainy than dry season except MCV where dry has higher value than rainy season. Similarly, the blood profiles such as TRBC, HB, ESR, MCHC and WBC were decreased and MCV and MCH decreased as age advanced in both rainy and dry seasons. Positive correlation was observed between age and TRBC, HB, ESR, MCHC and WBC whereas negative correlation was observed between age and MCV and MCH in both the seasons.

Biochemical indices such as total protein, albumin, globulin, glucose and total cholesterol were significantly higher in samples collected in rainy than in dry season and these biochemical indices increased as age advanced. Positive correlation was observed between age and all the biochemical indices except globulin whereas negative correlation was observed between age and globulin in both seasons in Andaman local cattle. Globulin level also decreased as age advanced.

Antioxidant profiles such as TAC, CAT, GSH, SOD were significantly higher in samples collected in rainy than in dry season whereas MDA concentration was significantly higher in dry than in rainy season in different age groups. Antioxidants such as TAC, CAT and GSH were initially in Gr A was significantly lower, increased in Gr B and C and then decreased in Gr D followed by Gr E whereas SOD concentration decreased as age advanced in both seasons. On the contrary, MDA concentration increased as age

Table 1. Haematological profiles in Andaman local cattle of Andaman and Nicobar Islands

Parameter	Season	Group A	Group B	Group C	Group D	Group E	Merck's Veterinary Manual (Range)
TRBC ($\times10^6$/mm^3)	Rainy	9.12 ± 0.43^{aC}	8.32 ± 0.65^{aBC}	7.47 ± 1.02^{aAB}	7.59 ± 0.81^{aAB}	7.32 ± 0.76^{bA}	5–10
	Dry	7.23 ± 0.65^{bC}	7.14 ± 0.78^{bC}	6.55 ± 0.73^{bBC}	6.24 ± 0.78^{bAB}	5.43 ± 0.65^{aA}	
HB (g/dl)	Rainy	13.57 ± 1.21^{bB}	13.36 ± 1.05^{bB}	12.63 ± 0.92^{bB}	11.12 ± 0.68^{A}	10.61 ± 0.92	8–15
	Dry	11.33 ± 1.18^{a}	11.23 ± 1.16^{a}	10.75 ± 1.12^{a}	10.60 ± 0.94	9.92 ± 0.69^{A}	
ESR (mm/h)	Rainy	8.85 ± 0.81^{bC}	6.72 ± 0.48^{bC}	6.82 ± 0.68^{bC}	6.31 ± 0.74^{bB}	4.45 ± 0.58^{A}	4–8
	Dry	6.33 ± 0.76^{aB}	5.31 ± 0.98^{aB}	5.64 ± 0.76^{aAB}	4.44 ± 0.92^{aA}	4.42 ± 0.78^{A}	
PCV (%)	Rainy	31.01 ± 1.53^{bA}	38.22 ± 1.64^{bCD}	36.65 ± 1.76^{bD}	34.15 ± 1.87^{bBC}	33.39 ± 1.65^{bB}	24–46
	Dry	28.61 ± 1.32^{aA}	36.48 ± 1.32^{aBC}	34.33 ± 1.53^{aC}	32.12 ± 1.53^{aB}	30.83 ± 1.22^{aA}	
MCV (μm^3)	Rainy	38.92 ± 1.23^{aA}	49.84 ± 2.21^{aB}	54.10 ± 2.23^{aB}	54.87 ± 1.73^{aB}	55.48 ± 2.35^{aB}	40–60
	Dry	43.88 ± 1.76^{bA}	52.87 ± 1.86^{bB}	57.83 ± 2.23^{bB}	60.33 ± 2.45^{bB}	64.65 ± 2.64^{bB}	
MCH (pg)	Rainy	17.72 ± 1.18^{bA}	17.63 ± 1.04^{bB}	18.54 ± 1.23^{bB}	18.75 ± 1.38^{bB}	20.76 ± 1.32^{bC}	11–17
	Dry	15.86 ± 0.79^{aA}	15.78 ± 0.79^{aA}	16.55 ± 0.84^{aA}	16.84 ± 0.33^{aA}	16.82 ± 0.76^{aA}	
MCHC (g/dl)	Rainy	43.12 ± 1.43^{bD}	34.62 ± 1.29^{bC}	32.44 ± 0.82^{bBC}	31.15 ± 1.02^{AB}	32.26 ± 1.72^{aA}	30–36
	Dry	36.56 ± 1.24^{aC}	30.21 ± 1.31^{aA}	29.43 ± 1.63^{aA}	31.59 ± 1.73^{A}	28.45 ± 1.27^{bB}	
WBC ($\times10^3$/mm^3)	Rainy	13.69 ± 1.21^{bB}	12.14 ± 1.11^{bB}	12.22 ± 1.01^{bAB}	12.46 ± 1.23^{bAB}	11.83 ± 1.22^{bA}	4–12
	Dry	12.22 ± 1.34^{aB}	10.25 ± 1.23^{aAB}	10.76 ± 1.09^{aA}	10.08 ± 1.07^{aA}	9.23 ± 1.09^{aA}	

Means within columns with different letters (a, b) differ significantly (P<0.05) between rainy and dry seasons for different heamatological parameters for different age groups. Means within rows with different letters (A, B, C, D) differ significantly (P<0.05) between age groups. n = 16 samples per group. TRBC, Total red blood cell; HB, Haemoglobin; ESR, Erythrocyte sedimentation rate; PCV, Packed cell volume; MCV, Mean corpuscular volume; MCH, Mean corpuscular haemoglobin; MCHC, Mean corpuscular haemoglobin concentration and TWBC, Total white blood cell. Gr A (0.1–1.0 yr; 10.81 m); Gr B (1–2 yrs; 21.56 m); Gr C (2–3 yrs; 32.70 m); Gr D (3–5 yrs; 53.13 m) and Gr E (5–6 yrs; 69.76 m).

Table 2. Biochemical indices in Andaman local cattle of Andaman and Nicobar Islands

Parameter	Season	Group A	Group B	Group C	Group D	Group E	Merck's Veterinary Manual (Range)
Total protein (g/dl)	Rainy	7.49 ± 0.22^{A}	7.43 ± 0.17^{A}	7.78 ± 0.29^{A}	7.61 ± 0.35^{A}	7.62 ± 0.24^{A}	6.5–7.5
	Dry	4.54 ± 0.30^{B}	5.05 ± 0.25^{B}	5.50 ± 0.07^{B}	6.06 ± 0.11^{B}	6.45 ± 0.18^{B}	
Albumin (g/dl)	Rainy	3.24 ± 0.24^{aB}	3.38 ± 0.07^{aB}	3.88 ± 0.05^{abB}	4.03 ± 0.16^{abB}	4.55 ± 0.08^{bB}	2.5–3.8
	Dry	1.23 ± 0.04^{aA}	1.88 ± 0.05^{abA}	2.45 ± 0.08^{bcA}	3.00 ± 0.03^{cdA}	3.25 ± 0.05^{dA}	
Globulin (g/dl)	Rainy	4.25 ± 0.13^{cB}	4.05 ± 0.06^{bcB}	3.90 ± 0.04^{bcB}	3.59 ± 0.09^{abB}	3.07 ± 0.07^{aB}	3.0–3.5
	Dry	3.31 ± 0.06^{A}	3.17 ± 0.13^{A}	3.05 ± 0.07^{A}	3.06 ± 0.06^{A}	3.21 ± 0.08^{A}	
Glucose (mg/dl)	Rainy	49.41 ± 0.55^{aB}	52.03 ± 1.16^{aB}	59.44 ± 0.80^{bB}	64.86 ± 1.03^{bcB}	68.46 ± 1.19^{cB}	40–100
	Dry	45.17 ± 0.75^{aA}	43.92 ± 0.70^{aA}	48.29 ± 0.83^{abA}	53.93 ± 1.12^{bA}	58.80 ± 1.21^{cA}	
Total cholesterol (mg/dl)	Rainy	98.10 ± 0.40^{aB}	99.65 ± 0.77^{aB}	100.79 ± 1.12^{aB}	105.01 ± 1.27^{bB}	107.57 ± 1.10^{bB}	
	Dry	80.82 ± 0.63^{A}	84.07 ± 1.54^{A}	96.32 ± 1.23^{A}	92.04 ± 1.14^{A}	97.83 ± 1.55^{A}	

Means within columns with different letters (A, B) differ significantly (P<0.05) between rainy and dry seasons for different biochemical profiles for different age groups. Means within rows with different letters (a, b, c, d) differ significantly (P<0.05) between age groups. n = 8 samples per group. Gr A (0.1–1.0 yr; 10.81 m); Gr B (1–2 yrs; 21.56 m); Gr C (2–3 yrs; 32.70 m); Gr D (3–5 yrs; 53.13 m) and Gr E (5–6 yrs; 69.76 m).

advanced. Positive correlation was observed between age and MDA production whereas negative correlation was observed between age and TAC, CAT, GSH and SOD in both seasons in Andaman local cattle.

Andaman local cattle are available only Andaman group of Islands and Campbell Bay of Nicobar group of Islands. The local cattle are well adapted to this island tropical climate. They are resistant to many bacterial, viral and parasitic diseases. These animals after Tsunami have survived against environmental challenge which brings the greater possibility that; specific adaptive traits have evolved to survive in this island ecosystem. Metabolic, nutritional, health as well as physiological status of animal can be determined by analysis, evaluation and monitoring the blood and other bio-fluids are by the use of the different clinical pathological and also with chemistry procedures (Bogin 1994, Kaneko *et al*. 1997). Pathologic values are defined as the values that are deviated from the standard normal

Table 3. Antioxidant and oxidant profiles in Andaman local cattle of Andaman and Nicobar Islands

Parameter	Season	Group A	Group B	Group C	Group D	Group E
MDA (nmol/L)	Rainy	70.38 ± 1.67^{aA}	74.98 ± 2.31^{bA}	81.72 ± 1.78^{cA}	91.73 ± 2.62^{dA}	96.37 ± 2.54^{eA}
	Dry	89.33 ± 1.19^{aB}	94.32 ± 1.26^{bB}	102.35 ± 3.45^{cB}	121.76 ± 2.83^{dB}	122.75 ± 3.12^{eB}
TAC (nmol/μL)	Rainy	38.87 ± 1.89^{bB}	45.21 ± 0.73^{cB}	39.74 ± 1.83^{bB}	29.26 ± 0.98^{aB}	28.53 ± 1.29^{aB}
	Dry	24.33 ± 1.43^{aA}	35.98 ± 1.68^{bA}	34.73 ± 2.47^{bA}	24.39 ± 1.76^{aA}	23.57 ± 1.73^{aA}
CAT (nmol/min/L)	Rainy	29.75 ± 1.44^{aB}	29.67 ± 1.49^{aB}	37.94 ± 1.65^{cB}	33.32 ± 0.89^{bB}	29.65 ± 1.13^{aB}
	Dry	25.76 ± 3.64^{aA}	28.39 ± 2.62^{bA}	32.80 ± 1.23^{cA}	24.44 ± 1.32^{aA}	24.32 ± 1.64^{aA}
GSH (nmol/L)	Rainy	34.32 ± 1.64^{aB}	48.90 ± 1.37^{cB}	43.78 ± 1.65^{bB}	35.98 ± 1.03^{aB}	34.36 ± 1.98^{aB}
	Dry	24.45 ± 1.87^{aA}	34.98 ± 1.12^{cA}	38.35 ± 1.39^{dA}	27.64 ± 1.12^{bA}	23.75 ± 0.36^{aA}
SOD (nmol/min/L)	Rainy	0.96 ± 0.12^{eB}	0.87 ± 0.13^{dB}	0.78 ± 0.17^{cB}	0.66 ± 0.03^{bB}	0.55 ± 0.02^{aB}
	Dry	0.43 ± 0.11^{cA}	0.57 ± 0.12^{dA}	0.42 ± 0.13^{cA}	0.36 ± 0.15^{bA}	0.23 ± 0.18^{aA}

Means within columns with different letters (A, B) differ significantly ($P<0.05$) between rainy and dry seasons for different biochemical profiles for different age groups. Means within rows with different letters (a, b, c, d) differ significantly ($P<0.05$) between age groups. n = 16 samples per group. MDA, Malondialdehyde; TAC, Total antioxidant capacity; CAT, Catalase; GSH, Glutathione; SOD, Superoxide dismutase. Gr A (0.1–1.0 yr; 10.81 m); Gr B (1–2 yrs; 21.56 m); Gr C (2–3 yrs; 32.70 m); Gr D (3–5 yrs; 53.13 m) and Gr E (5–6 yrs; 69.76 m).

references values (Kaneko *et al*. 1997), for that, it is required to establish the normal reference values for different haematological, biochemical and antioxidant indices. In the present study, the animals used were almost healthy by observation, palpation and percussion and did not reveal any abnormal clinical signs and/or pathological conditions, therefore, this can be considered as healthy animals and the haematological as well as the biochemical profiles of these animals can work as the standard reference values for the Andaman local cattle for future use in Andaman and Nicobar Islands or having similar nutritional, climatic or environmental conditions in other countries. These established standard values will be served as reference values and which will be helpful to estimate the health status of these precious germplasm of Trinket cattle in any future studies related to this bovine species. However, the final interpretation of obtained results by laboratory analysis will depend on the standard reference values of each and every species of animal in different geographical as well as the environmental conditions.

Biochemical reports to the different physiological stages are very complex as these values are influenced by many different factors like species, breed, age, sex, nutrition, physiological status such as pregnancy and lactation, illness and also the seasonal variations (Kaneko *et al*. 1997, Whitaker 1997). The reports of the biochemical investigation has shown some sort of variation indicating that these are influenced by various factors like nutrition, health status, lactation stage and season (Jezek *et al*. 2013).

Study on the blood composition can address the valuable information about the general health of the animal and so that, this can be utilized to evaluate the health status of the animal. Deviation of values in certain blood parameters from their normal ranges could be a very good guide to make diagnosis or for differential diagnosis of a particular disease or pathological condition (Radostits *et al*. 2006). Haematological profile or complete blood profile is being very essential in evaluation of the animal health status as well as the laboratory data clinical interpretation which is a prerequisite for proper diagnosis for different patho-physiological as well as infectious disorders in the Andaman local cattle (Opera *et al*. 2006). Moreover, the complete blood profile is an important as well as the powerful diagnostic tool in the component of a minimum database for disease diagnosis. It can also be used to monitor or watch the response to treatment or therapy, to follow up the severity of a disease or illness or used as a starting point to formulate a list of differential diagnosis. Interpretation on the complete blood profile can be grouped into three divisions as erythrocyte, leukocyte and platelets evaluation. Each of these divisions can be interpreted separately and individually and integration of these divisions is very much important to get highest diagnostic yield or result (Barger 2003). Haematological examination is also done as a routine screening procedure for assessment of general health (Gutienez De Lar *et al*. 1971). Blood values are also clear indicators to assess the stress and welfare of animals (Anderson *et al*. 1999). Similar total red cell count was reported in bovine species by Sripad *et al*. (2014) and Mahima *et al*. (2013), Bedenicki *et al*. (2014), Manjappa *et al*. (2018) and Suharti *et al*. (2017) reported lower TRBC than the present study. Haemoglobin value in our study is similar to reported by Bedenicki *et al*. (2014) and Manjappa *et al*. (2018) whereas lower values were reported by Mahima *et al*. (2013), Bedenicki *et al*. (2014), Suharti *et al*. (2017) and Sripad *et al*. (2014). Similarly, Otto *et al*. (2000), Mahima *et al*. (2013), Manjappa *et al*. (2018) and Sripad *et al*. (2014) reported similar values of packed cell volume as in the present study for Andaman local cattle whereas Suharti *et al*. (2017) reported lower value than in the present study. With regards to MCV, Mahima *et al*. (2013), Manjappa *et al*. (2018) and Sripad *et al*. (2014) were reported similar values, Suharti *et al*. (2017) reported higher value and Bedenicki *et al*. (2014) reported lower value than the present experiment. In case of MCH, Mahima *et al*. (2013) and Manjappa *et al*. (2018) reported similar values, Sripad *et al*. (2014) reported higher value and Suharti *et al*.

(2017) reported lower value than in the present study. The present study has reported the TWC count is lower than reported by Sripad *et al*. (2014) and higher than the reports of Mahima *et al*. (2013), Bedenicki *et al*. (2014), Manjappa *et al*. (2018) and Suharti *et al*. (2017) for bovine species.

Knowledge on the haematological values is very much useful to diagnose the different pathological as well as the metabolic disorders, which are adversely or deleteriously affect the reproductive and productive performance of the cows (Ahmad *et al.* 2003). Therefore, these haematological data can help to a large extent to determine the disease course and their outcome of several viral, bacterial and parasitic diseases. Factors such as breed, sex, age, seasonal variation, pregnancy, lactation, nutritional and health status of the animal alter haematological attributes (Mirzadeh *et al.* 2010).

Blood glucose concentration is one of the biochemical profiles from which one may get body energy supply. Serum protein concentration suggests the balance between catabolism and anabolism of protein in the body and its concentration at any given time which in turn is a function of nutritional status, hormonal balance, water balance and other parameters affecting health status (Samanta and Das 2007). Albumin is a transport protein which remains functioned in calcium, phosphorus, fat soluble vitamins, free fatty acids transport etc. Albumin indicates a long-term protein status and plasma albumin concentrations could be changed by effect of liver function, protein and energy intake, age and protein losses during some disease condition like parasitism. Plasma albumin concentrations are indication of plasma protein levels. Physiological status or pathological status or lactation stage of the cows significantly can alter the serum levels of albumin (Otto *et al.* 2000). Moreover, the concentration of total protein, globulin, albumin and urea-N in blood serum is the biomarkers of the adequacy or inadequacy of nitrogen in the animal diet (Hammond 1983). In addition, serum proteins constitute a portion of the amino acid pool in the body and it is believed to be indicative of the nutritional status of the animal.

Similar total protein was reported in bovine species by Otto *et al*. (2000) and Surya Prakash *et al*. (2018) and Xuan *et al*. (2018), Mamun *et al*. (2013) and Suharti *et al*. (2017) reported higher value and Mahima *et al*. (2013) reported lower value than in the present study. Albumin value in our study is similar to reported by Otto *et al*. (2000), Mahima *et al*. (2013) and Mamun *et al*. (2013) whereas lower values were reported by Surya Prakash *et al*. (2018) and Suharti *et al*. (2017) and higher value reported by Xuan *et al*. (2018) than in the present study. Similarly, Otto *et al*. (2000) and Xuan *et al*. (2018) reported similar values of globulin as in the present study for Andaman local cattle whereas Mahima *et al*. (2013) reported lower value than in the present study. With regards to glucose, Otto *et al*. (2000) and Mamun *et al*. (2013) reported similar values, Surya Prakash *et al*. (2018) and Suharti *et al*. (2017) reported lower value than in the present experiment.

The haematological parameters in the present study were compared with other indigenous cattle breeds studied in India (Hallikar breed: Lankesh *et al.* 2015, Khillar breed of Karnataka: Sripad *et al.* 2014). The haematological profiles were higher in the Andaman local cattle than in other indigenous cattle breeds such as Hallikar, Khillari, Hariana, Hardhenu and Sahiwal (Mahima *et al.* 2013). This might be due to this Andaman local cattle is maintained in the hilly alternate plain areas with jungle for grassing and oxygen content is less as compared to plain land, therefore this breed needs more TEC and Hb.

In physiological conditions, there is a balance between the factors that promote the formation of free radicals and the levels of antioxidants. The body contains an elaborate antioxidant defense system that depends on dietary intake of antioxidant vitamins and minerals and the endogenous production of antioxidant compounds such as GSH. Reactive oxygen species are scavenged by enzymatic antioxidants like SOD, GSHPx, CAT (Halliwell and Gutteridge 2006) and by small molecular antioxidants such as GSH. GSH appears to be essential for the activation and maintenance of cellular defences against oxidative stress, since it provides the substrate for glutathione peroxidase to detoxify peroxides. The antioxidant profiles such as GSH, SOD, CAT and TAC were significantly decreased in the dry heat stressed animals and MDA production was significantly higher in summer heat stressed cattle than animals in rainy season. Deficiency of antioxidants may occur due to different kinds of stress (McDowell *et al*. 2007). These free radical oxidations are activated in animals under various types of stresses and lipid peroxidation products accumulate in various organs. In the present study, the free radical production was significantly higher in animals in dry season as similar report was observed that heat stress/stress stimulates excessive production of free radicals (Bernabucchi *et al*. 2002, Sivakumar *et al*. 2010). Moreover, exercise in summer season is postulated to generate free radicals by a) increases in epinephrine and other catecholamines that can produce oxygen radicals when they are metabolically inactivated, b) production of lactic acid that can convert a weakly damaging free radical (superoxide) into a strongly damaging one (hydroxyl), and c) inflammatory responses to secondary muscle damage incurred with overexertion (Sen 1995). The stress can be counteracted by supplementation of antioxidants are very helpful in animal species (Sejian *et al*. 2012) as because the antioxidants are compounds or systems that delay autoxidation by inhibiting the formation of free radicals or by interrupting propagation of the free radical by several mechanisms (Brewer 2011). This in turn helps to protect cellular damage during any stressful condition.

It can be concluded that most of the analyzed haematological attributes, biochemical indices and serum antioxidant profiles were in normal range, which clearly indicates that, the study Andaman local cattle populations were in healthy condition. Thus, during diagnostic procedure or measurement, it is very useful to compare the

values obtained from ill or sick animals with normal reference values of healthy animal (Jezek *et al.* 2006). The values or findings of the present study may serve as the standard reference values in which deviations due to metabolic, nutrient deficiency, physiological and health status can be compared for diagnostic, prognostic and therapeutic purpose for Andaman local cattle.

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