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Research Article

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Walking and Dry Season Stresses Modulates the Physiological, Heamatological and Biochemical Profiles of Indigenous Local Goats in Andaman and Nicobar Islands

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Abstract

A study was designed to assess the walking stress and dry seasonal effect on physiological, heamatological and biochemical profiles in indigenous local goat breeds of Andaman and Nicobar Islands (ANI). Twelve bucks of adult age of 3 to 4 yr of age with good body condition (score 5-6) were selected and divided into two groups, viz. group-I: control (n=6, not exposed to stress) and group-II: treatment (n=6, exposed to walking and dry season stress). In treatment group, animals were walked upto10 km to and fro from goat farm in undulated area without allowing grazing. Whereas control animals were placed in separate adjacent goat shed covered with asbestos roof and surrounded by natural trees. Walking time was from 0700 to 1200 h. Experiment was conducted during dry season (November to February). These animals were restrained and physiological parameters were measured immediately after stressful walk in dry season. Simultaneously, blood samples were collected for the heamatological study and antioxidant attributes. The result of the present study revealed that the physiological, heamatological profiles as well as the malondialdehyde concentration were significantly (p<0.05) increased and antioxidant profiles were significantly (p<0.05) decreased in the treatment stressed goats than in unstressed control group. From the study, it was concluded that the process of walking in dry season has induced walking and thermal stress that has significantly (p<0.05) affected the performance of indigenous local goat breeds of ANI.

Keywords: Andaman local goat, walking, physiological, heamatological, antioxidant profiles

1. Introduction

Andaman and Nicobar Islands has indigenous goat breeds such as Teressa and Andaman local goat are used mainly for meat purpose, of which, Teressa breed has been recognized by Government of India (Jayakumar et al., 2016). As per the Ministry of Agriculture, Government of India, per capita availability and production of goat meat is lesser in Andaman & Nicobar Islands as compared to National average. Total number of goat population in Andaman and Nicobar Islands is 65324 as per the 19th Livestock Census of India (2012). There were some preliminary studies were conducted on goat management in Andaman and Nicobar Islands (Saha et al., 2004; Sunder, 2014; Sunder et al., 2016a; Sunder et al., 2016b).

As per the livestock censuses of Govt. of India (2007; 2012), the goat

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population is decreased 3.18% due to lack of suitable breeding buck, increase in intensive inbreeding practices and lack of suitable feeding and breeding management in ANI. So it is important to make sincere efforts from the various quarters like veterinary & animal husbandry department, policy makers, goat breeders & farmers, goat researchers to conserve and propagate the Andaman local goat breeds through proper management of reproduction and production to improve the socio-economic status of the farmers of ANI. Andaman local goat breeds are maintained under semi-intensive system and walks longer distance to get sufficient feed in undulated or hilly areas of ANI especially in dry season. Furthermore, availability of fodder for grazing is often of low quality and also available at low densities per unit area and the time of grazing is limited only in day time exposed to solar radiation with fly and insect irritation (Manteca and Smith, 1994).Walking not only induces stress to the bucks, but also leads to energy loss leads to loss of production and failure of reproductive performances, finally loss of profit in the goat industry. The losses due to different stresses are more prominent and significantly higher especially during the dry or summer season (thermal stress). And also reported that reduces or restricts the walking distance for grazing, the reproductive and productive performance of animals has been significantly improved (Gustafson et al., 1993) and also breed difference was also influenced the susceptibility of animals to different stress in livestock species (D'Hour et al., 1994). Based on the availability of literature, it was noted that no information in indigenous local goat breeds of ANI on walking and dry season stress in ANI. Therefore, the current study was designed to assess the walking and dry season thermal stress effect on physiological, heamatological and antioxidant profiles in ANI local goat breeds under tropical island ecosystem.

2. Materials and Methods

2.1. Location

The experiment was carried out at the goat research farm, ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands, India. The centre is located in between 6°45´ to 13°41´ North Latitude and in between 92º12´ to 93°57´ East Longitude. The average maximum and minimum temperature were 30.1 and 23°C, respectively. Relative humidity is in the range of 82-94%. The annual rainfall is more than 3100 mm spread over more than 8 months in a year (monsoon period). The present experiment was carried out during dry season (November to February).Indigenous goat breeds of ANI such as Andaman local goat and Teressa goat were maintained in the semi-intensive system. The animals were allowed for grazing from 0700 to 1200 hours. Feeding and watering were done as per the farm schedule. *Ad libitum* clean drinking water was available at any time.

2.2. Experimental animals

Twelve apparently healthy bucks of 3 to 4 yr of age with good body condition (score 5-6) were selected from the goat flock derived from various parts of the ANI and maintained under homogeneous feeding, housing and lighting conditions. These experimental bucks were maintained under hygienic managemental conditions. Prophylactic measure like deworming and other treatment were undertaken properly as per the farm schedule. Experimental bucks were divided into two groups, viz. group-I: control (not exposed to walking stress; n=6) and group–II: Treatment (exposed to walking stress; n=6).

2.3. Housing management

The goat shed was constructed with asbestos-roof and half of the wall made up of wire mesh and half was constructed by bricks wall in all four side of the animal house with surrounding of the big trees. Experimental bucks were placed under homogeneous feeding, watering, lighting and managemental conditions. At 0700 h, both the groups of experimental bucks were released from the goat shed. At 1200 h, all the bucks were properly restrained in their original positions in the goat shed. This same procedure was followed throughout the experimental period.

2.4. Experimental procedure

The experimental study was carried out for a time period of 7 weeks especially during the dry season (November–February). The bucks were selected randomly into two groups and each group consisted of six animals: Group I (n=6; control) and Group II (n=6; treatment: walking stress). These experimental animals were maintained under a semi-intensive system of management. Both groups were stall-fed and watered at 1200 h and allowed access to *ad libitum* water throughout the day. Walking stress group (Gr II) bucks were made to walk for 10 km. The bucks were in walking stress group (Gr II) were not allowed from grazing/browsing by properly applying a face/ mouth mask. Blood samples were collected from the jugular vein at interval of week to assess walking stress effect on the heamatological and antioxidant profiles in dry season.

2.5. Blood collection and plasma separation

Five ml of blood was collected from both the groups at the interval of week from external jugular vein in tubes containing heparin anticoagulant (20 IU/mL of blood). Blood samples were collected at 1200 h immediately after completing the walking. Complete blood profiles were estimated and plasma was separated by centrifugation at 3500×g at 4 °C for 20 min. Separated plasma was aliquoted into small aliquots in micro-cryo-tubes and placed frozen at −20 °C until further analysis of biochemical profiles. These plasma samples were utilized to estimate the antioxidant profiles with commercial diagnostic kits.

2.6. Parameters studied

Physiological profiles such as rectal temperature (RT), respiration rate (RR), pulse rate (PR), heart rate (HR) and skin temperature (ST) (measured by keeping the thermometer between the skin folds in the body surface, pelvic and pectoral cradle and make average) were recorded twice daily at 0700 and 1200 h. Blood profiles such as red blood cells (RBC), haemoglobin (Hb), erythrocyte sedimentation rate (ESR), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) were estimated using whole blood samples using standard methods with automatic blood analyser. Antioxidant profiles such as like reduced glutathione (GSH), catalase (CAT), superoxide dismutase (SOD), total antioxidant capacity (TAC) and lipid peroxide profile like malondialdehyde (MDA) were estimated using commercially available diagnostic kits (Cayman, USA).

2.7. Statistical analysis

The data was 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 weeks and student "t" test was performed between the treatment and control groups in different weeks of experiment using the SPSS/PC computer program (version 15.0; SPSS, Chicago, IL). Differences with values of $p<0.05$ were considered to be statistically significant by using SPSS 15.

3. Results and Discussion

Walking stress effect during dry season on physiological (Table 1) and heamatological (Table 2) profiles for different weeks between the groups were presented in tables and coefficients of correlation between the heamatological and physiological profiles were presented in both treatment (stressed; Table 3) as well as control (unstressed; Table 4) goat bucks.

Significant alteration was observed in physiological, blood as well as antioxidant profiles in bucks due to walking stress, causes adverse effects on reproduction and production performance in bucks. Thus it creates a truth that grazing or walking or exercising bucks need higher nutrition with more energy to counteract the deleterious effects due to stress and assessment of effect of stress due to walk in buck will help to the buck growers, goat farmers and goat breeders to understand and adopt suitable protecting strategies with or without nutritional influence to avoid energy wastage in the walking or exercise. Particularly the current study assists

Table 1: Mean (±SEm) physiological parameters of Andaman local bucks exposed to walking stress at different weeks

Param-eters		Experimental Periods							Overall
		1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
RT	GI	99.87 ± 1.26^{aA}	100.14 ± 1.19^{abA}	99.73 ± 1.12^{aA}	99.43 ± 1.23^{aA}	99.54 ± 1.12^{aA}	100.87 ± 1.14^{bA}	100.32 ± 1.15^{abA}	99.98 ± 0.93^{A}
	GII	103.74 ± 1.34^{abB}	103.56 ± 1.34^{aB}	104.76 ± 1.32^{cB}	103.76 ± 1.28^{abcB}	103.34 ± 1.14^{aB}	104.79 ± 0.98^{cB}	104.65 ± 1.12^{bcB}	104.16 ± 0.98^{B}
RR	GI	27.78 ± 1.21^{abA}	28.34 ± 1.28^{abA}	27.85 ± 1.44^{abA}	27.33 ± 1.38^{aA}	27.76 ± 1.32^{abA}	29.08 ± 1.51^{bA}	28.56 ± 1.66^{abA}	27.98 ± 0.87^{A}
	GII	39.98 ± 1.55^{bB}	37.65 ± 1.32^{aB}	42.65 ± 1.43^{cB}	39.87 ± 1.74^{bB}	37.82 ± 1.43^{aB}	43.67 ± 1.65^{cB}	43.63 ± 1.56^{cB}	40.72 ± 1.82^{B}
PR	GI	66.32 ± 1.34^{abA}	66.43 ± 1.25^{abA}	66.12 ± 1.24^{abA}	65.45 ± 1.37^{aA}	65.97 ± 1.13^{abA}	67.76 ± 1.47^{cA}	66.89 ± 1.34^{bcA}	66.45 ± 0.76^{A}
	GII	75.54 ± 1.43^{aB}	74.23 ± 1.58^{aB}	76.89 ± 1.19^{bB}	74.53 ± 1.18^{aB}	74.53 ± 1.19^{aB}	78.31 ± 1.42^{bB}	77.31 ± 1.43^{b}B	75.91 ± 1.42^{B}
HR	GI	72.64 ± 1.18^{abA}	72.54 ± 2.28^{abA}	72.31 ± 1.14^{aA}	72.65 ± 1.19^{abA}	72.54 ± 1.28^{abA}	72.87 ± 1.24^{abA}	73.42 ± 1.37^{bA}	72.54 ± 0.87^{A}
	GII	80.52 ± 1.54^{aB}	80.63 ± 1.43^{aB}	82.23 ± 1.45^{bcB}	80.87 ± 1.44^{abB}	80.31 ± 1.52^{aB}	82.76 ± 1.51^{cdB}	83.87 ± 1.32^{dB}	81.43 ± 1.32^{B}
ST	GI	98.83 ± 1.28^{abA}	99.33 ± 1.38^{abA}	98.56 ± 1.21^{aA}	98.25 ± 1.33^{aA}	98.76 ± 1.23^{abA}	99.91 ± 1.26^{bA}	98.76 ± 1.23^{abA}	98.86 ± 0.98^{A}
	GII	101.65 ± 1.31^{abcB}	101.45 ± 1.23^{abcB}	101.81 ± 1.32^{bcB}	100.47 ± 1.28^{aB}	100.67 ± 1.32^{abB}	102.31 ± 1.16^{cB}	101.55 ± 1.42^{bcB}	101.43 ± 0.91^{B}

RT: Rectal Temperature (°F), RR: Respiration Rate (beats per minute), PR: Pulse Rate (beats per minute), HR: Heart Rate (beats per minute) and ST: Skin Temperature (°F); GI: Unstressed animal group, GII: Stressed animal group; Within rows means with different letters (a, b, c, d) differ significantly ($p<0.05$); Within columns means with different letters (A, B) differ significantly ($p<0.05$) between the stressed and unstressed for the particular parameter

Table 2: Mean (± S.E.) heamatological parameters of Andaman local bucks exposed to walking stress at different weeks

Parameters		Experimental Periods							Overall
		1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
TRBC	GI	5.52 ± 0.88^{aA}	6.02 ± 0.85^{abA}	5.53 ± 0.86^{aA}	6.10 ± 0.82^{abA}	5.65 ± 0.86^{aA}	6.41 ± 0.85^{bA}	6.27 ± 0.87^{bA}	5.92 ± 0.71^{A}
	GII	7.04 ± 0.90^{aB}	7.38 ± 0.96^{aB}	7.56 ± 0.95abB	7.15 ± 0.70^{aB}	6.98 ± 0.85^{aB}	8.23 ± 0.86^{cB}	8.13 ± 0.84^{bcB}	7.48 ± 0.82^{B}
HB	GI	11.22 ± 0.87^{bA}	11.42 ± 0.90^{abA}	11.11 ± 0.87aA	11.12 ± 1.10^{bA}	10.98 ± 0.89^{aA}	11.97 ± 0.91^{bA}	11.51 ± 0.85^{abA}	11.42 ± 0.68^{A}
	GII	12.48 ± 0.82^{abB}	12.22 ± 0.85^{aB}	12.97 ± 0.91bcB	12.21 ± 1.12^{aB}	11.94 ± 0.97^{aB}	13.56 ± 0.93^{cB}	13.17 ± 0.86^{bcB}	12.63 ± 0.85^{B}
ESR	GI	4.82 ± 0.73^{abA}	4.93 ± 0.71^{abA}	4.79 ± 0.68abA	5.12 ± 0.76^{abA}	4.64 ± 0.71^{aA}	5.44 ± 0.71^{cA}	5.12 ± 0.74^{bcA}	4.96 ± 1.60^{A}
	GII	5.42 ± 0.66^{aB}	5.58 ± 0.75^{aB}	5.56 ± 0.70aB	5.70 ± 0.77^{aB}	5.31 ± 0.68^{aB}	6.52 ± 0.74^{cB}	6.18 ± 0.76^{bB}	5.74 ± 0.74^{B}
PCV	GI	32.52 ± 1.16^{abA}	32.58 ± 1.20^{abA}	32.29 ± 0.89abA	32.94 ± 1.14^{bA}	31.74 ± 1.01^{aA}	32.94 ± 0.98^{bA}	31.91 ± 0.85^{aA}	32.42 ± 0.77^{A}
	GII	37.03 ± 1.18^{cB}	36.29 ± 1.22^{bcB}	36.86 ± 1.11cB	33.64 ± 1.13^{aB}	35.42 ± 0.86^{bB}	37.10 ± 1.30^{cB}	36.53 ± 1.13^{cB}	36.11 ± 1.21^{B}
MCV	GI	60.72 ± 2.12^{bA}	55.49 ± 2.74^{abA}	59.89 ± 2.94bA	56.20 ± 2.72^{abA}	57.69 ± 2.81^{abA}	52.50 ± 2.44^{aA}	52.18 ± 2.46^{aA}	56.45 ± 1.93^{A}
	GII	53.78 ± 2.59^{cB}	50.15 ± 2.42^{abcB}	49.84 ± 2.53abcB	47.77 ± 1.93^{ab}B	51.68 ± 2.23^{bcB}	45.63 ± 1.87^{aB}	46.21 ± 1.75^{aB}	50.15 ± 1.58^{B}
MCH	GI	20.88 ± 1.82^{A}	19.39 ± 1.65^{A}	20.46 ± 1.89A	18.97 ± 1.78^{A}	19.91 ± 1.74^{A}	19.15 ± 1.60^{A}	18.77 ± 1.61^{A}	19.63 ± 0.86^{A}
	GII	18.10 ± 1.58^{B}	16.84 ± 1.37^{B}	17.54 ± 1.64B	17.30 ± 1.33^{B}	17.43 ± 1.56^{B}	16.71 ± 1.40^{B}	16.53 ± 1.41^{B}	17.21 ± 0.83^{B}
MCHC	GI	34.42 ± 1.21^{aA}	34.97 ± 1.37^{abcA}	33.98 ± 1.16aA	33.63 ± 1.40^{aA}	34.51 ± 1.47^{abA}	36.25 ± 1.37^{c}	35.98 ± 1.37^{bc}	34.92 ± 0.59
	GII	33.43 ± 1.13^{aB}	33.62 ± 1.37^{aB}	35.10 ± 1.18abB	36.16 ± 1.47^{bB}	33.56 ± 1.50^{aB}	36.55 ± 1.43^{b}	35.71 ± 1.32^{b}	34.923 ± 1.21

RBC: Red blood cells (x106/ mm3), HB: Haemoglobin (g/dl), ESR: Erythrocyte sedimentation rate (mm/hr), PCV: Packed cell volume (%), MCV: Mean corpuscular volume (µ3), MCH: Mean corpuscular haemoglobin (µµg), MCHC: Mean corpuscular haemoglobin concentration (%); GI: Unstressed animal group, GII: Stressed animal group; Within rows means with different letters (a, b, c, d) differ significantly (p< 0.05); Within columns means with different letters (A, B) differ significantly (P < 0.05) between the stressed and unstressed for the particular parameter

to understand the walking stress effect on reproduction and production performances and assists to manage the goat bucks more efficiently under island ecosystem.

Based on the analysis of literature, there was a scanty of information on walking stress effect on physiological, haematological and antioxidant profiles in livestock species and no information is available for the island goat breeds. Earlier authors investigated and observed that stress due to walking or working leads to severe deleterious effects on reproduction and production profiles in different livestock species (Daramola and Adeloye, 2009; Sejian et al., 2010b; Perumal et al., 2016; Wolfenson and Roth, 2019).

3.1. *Physiological profiles*

Significant (p<0.05) difference was observed between the experimental groups in different weeks of the experimental periods with regards to physiological profiles such as RT, RR, PR, HR and ST and also among the experimental weeks, a significant (p<0.05) difference was observed. Similarly stressed bucks suffered significantly higher (p<0.05) than in unstressed bucks.

Significantly (p<0.05) higher physiological parameters (RT,

Table 3: Correlation coefficients among the physiological and heamatological parameters of unstressed Andaman local bucks

	RT	RR	PR	HR	ST	TRBC	HB	ESR	PCV	MCV	MCH	MCHC
RT	1	0.96**	0.97**	0.47	0.93**	0.73*	0.94**	0.82**	0.25	-0.63	-0.36	0.95**
RR		1	0.96**	0.52	0.91**	0.70*	0.91**	0.74*	0.12	-0.76*	-0.44	0.93**
PR			1	0.49	0.91**	0.65	0.92**	0.75*	0.14	-0.61	-0.35	0.92**
HR				1	0.21	0.66	0.52	0.52	-0.22	-0.78*	-0.69	0.64
ST					1	0.57	0.88*	0.65	0.19	-0.51	-0.32	0.84**
TRBC						1	0.83*	0.87**	0.34	-0.95**	-0.92**	0.79*
HB							1	0.94**	0.45	-0.74*	-0.55	0.87**
ESR								1	0.52	-0.79*	-0.68	0.74*
PCV									1	-0.21	-0.20	-0.15
MCV										1	0.95**	-0.77*
MCH											1	-0.52
MCHC												1

RT: Rectal Temperature, RR: Respiration Rate, PR: Pulse Rate, HR: Heart Rate, ST: Skin Temperature, TRBC: Total Red Blood Cells, HB: Heamoglobin, ESR: Erythrocyte Sedimentation Rate, PCV: Packed Cell Volume, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Heamoglobin and MCHC: Mean Corpuscular Heamoglobin Concentration; *: Correlation coefficients were significant, $p<0.05$; **: Correlation coefficients were highly significant, $p<0.01$

Table 4: Correlation coefficients among the physiological and heamatological parameters of stressed Andaman local bucks

	RT	RR	PR	HR	ST	TRBC	HB	ESR	PCV	MCV	MCH	MCHC
RT	1	0.95**	0.96**	0.88**	0.76**	0.88**	0.95**	0.75*	0.45	-0.73*	-0.40	0.75*
RR		1	0.97**	0.93**	0.74*	0.87*	0.93**	0.77*	0.49	-0.82*	-0.41	0.72*
PR			1	0.89**	0.86**	0.85**	0.95**	0.81*	0.67	-0.65	-0.43	0.65
HR				1	0.65	0.91**	0.86**	0.78*	0.41	-0.78*	-0.66	0.66
ST					1	0.78*	0.88**	0.64	0.94**	-0.32	0.30	0.32
TRBC						1	0.90**	0.91**	0.50	-0.68	-0.78*	0.56
HB							1	0.89**	0.62	-0.70	-0.45	0.62
ESR								1	0.33	-0.79*	-0.71*	0.86*
PCV									1	0.26	-0.32	-0.21
MCV										1	0.50	-0.94**
MCH											1	-0.58
MCHC												1

RT: Rectal Temperature, RR: Respiration Rate, PR: Pulse Rate, HR: Heart Rate, ST: Skin Temperature, TRBC: Total Red Blood Cells, HB: Heamoglobin, ESR: Erythrocyte Sedimentation Rate, PCV: Packed Cell Volume, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Heamoglobin and MCHC: Mean Corpuscular Heamoglobin Concentration; *: Correlation coefficients were significant, $p<0.05$; **: Correlation coefficients were highly significant, $p<0.01$

RR, PR, HR and ST) were observed in goat bucks affected with walking stress. It was observed that respiration rate was significantly affected especially after draught work and followed by pulse rate as well as the rectal temperature in cattle species. Moreover the RT and RR are the suggestive stress markers in domestic animal species (Daramola and Adeloye, 2009; Sejian et al., 2010b; Perumal et al., 2016). Similar reports were observed in caprine and bovine species that RT and RR were increased as the animals were exercise or walking (Kasa et al., 1995; Coulon and Pradel, 1997; Perumal et al., 2016). Based on the earlier literatures in other livestock species, it was indicated that the goat bucks were affected with severe stress that undergone walking and grazing as evidenced from the different physiological, heamatological and antioxidant profiles. However, these physiological values were significantly higher in the present study than the values were reported in earlier study of caprine species in the island ecosystem (RT: 102.5-104 °F, PR: 70-80 beats min^{-1}, RR: 15-30 beats min^{-1}; Sunder et al., 2016). Estimation of RR indirectly helps to assess the heat production status during the stress condition (Berhan et al., 2006) and higher RR in bucks may have more homeostatic relevance for the excessive heat dissipation and lower body temperature maintenance (Rahardja et al., 2011). Significantly higher respiratory rate was observed in the stressed animal because it is required for the thermoregulation of the systems (Sejian et al., 2012; Perumal et al., 2016; Berihulay et al., 2019). Further, it was noted that the experiment was carried out during dry hot season causes increased the detrimental effects due to walking stress or exercise leads to higher heat load and ultimately increased the RR in goat bucks. Stress due to walking has also increased severe energy imbalance and/or deficit because the locomotor activity of goat uses substantial amount of energy for the purpose of walking and exercise. Moreover, level of energy was also reduced as the respiratory muscular activity was increased due to significantly greater respiratory movements especially during stress to disseminate or dissipate the body heat during the process of walking or exercise.

Pulse rate of animals reflects the circulation homeostasis primarily along with the other general metabolic status of the animals (Sejian et al., 2010a). Pulse rate in treatment group goat bucks has increased significantly as compared to the control goats after exposure to walking stress in dry season in the current study. The present result was clearly indicated that there is a significant correlation between metabolic heat production and heart rate (Marai et al., 2007). Similarly, the ST was higher significantly in the walking thermo stressed group than unstressed control group, however, it is lower than the RT of the same buck as because higher sweating inturn reduce the ST. Measurement of sweating was also used to assess the heat stress response in domestic livestock species like bovine, ovine and equine (Kumar et al., 2011). This fact clearly indicates that besides the heat has been relieved through respiratory evaporative cooling, the animal also needs cutaneous evaporation to eliminate heat from the body indicated the severity of stresses on these animals in physiological parameters. Moreover, it was also reported that RT acts as a suggestive marker of walking stress in the ovine species (Sejian et al., 2011; Lees et al., 2019a; Lees et al., 2019b). Similar type of results was obtained in bovine species, Hariana bullocks (Yadav and Dhaka, 2001), Surungi bullocks (Behera et al., 2008) and mithun (Perumal et al., 2016). In India, Tomar and Joshi (2008) was in Kenkatha bullock, Shelke and Siddiqui (2009) was in Red Kandhari bullocks, , Singh and Nanavati (2013) was in crossbred bullocks and Perumal et al.(2016)was in mithun reported similar findings as in the present study.

3.2. Heamatological profiles

Significant (p<0.05) difference was observed between the stressed and unstressed bucks with regards to the heamatological profiles such as TRBC, HB, ESR, PCV, MCV, MCH and MCHC. However, these parameters were differed significantly (p<0.05) among the different experimental weeks. Group II (stressed) has significantly (p<0.05) higher TRBC, HB, ESR, PCV and MCHC than group I whereas MCV and MCH were significantly (p<0.05) lower in group II.

Severe and hard exercise or walk or work load leads severe metabolic, haematological and acid-base & ionic changes in animals, which are species-specific and are depended on the magnitude or severity of the cumulative effects of physiological and physical trauma related to the stressful events (Hassanein, 2010). Physical stress and acidosis causes disturbances in haematological and antioxidant profiles (Moyes et al., 2006). Its serum profiles in bucks provide indicators to assess the status of internal environment and understanding the causes of impairment in homeostasis as evidenced by marked alterations in physiogical indexes under various internal as well as external environmental conditions (Sattar and Mirza, 2009). Constituents of blood clearly demonstrated the normal physiological and abnormal pathological states of the animals including stress (Satue et al., 2009).

In general, haematological profiles such as PCV, RBC, MCV, MCHC and MCH are commonly used to assess the adaptability of livestock to different adverse environmental situations (Koubkova et al., 2002).Blood constituents were affected significantly in stressed goat bucks as clearly suggested that these stressed animals were severely suffered with severe haemoconcentration. In the stressed goat, the blood profiles were higher than that the normal values reported in goat. Significantly higher blood profiles in the stressed animal were due to adaptive mechanism expressed by the goat bucks in the present study. Usually, oxygen consumption rate is increased as when the animal walking or running or exercising. Moreover, the goats in ANI were managed under the semi-intensive system of rearing and walking long distance to search the feed in the forest especially in dry hot months. This cause the animals needs increased level of the oxygen to meet the muscular activity which causes increased the RBC production and Hb concentration in the goat bucks. Moreover, in the present study, the bucks were not allowed to take water or feed or fodder while walking leads to haemoconcentration inturn causes increased the value blood indices especially RBC, HB, PCV and ESR (Sejian et al., 2012; Perumal et al., 2016). Such similar findings were also observed in other domestic species (Garcia-Belenguer et al., 1996: cattle; Sejian et al., 2012: sheep; Perumal et al., 2016: mithun). In general, severe dehydration was observed during thermal stress in livestock species where increased level of Hb and PCV was observed (Marai et al., 2007; McManus et al., 2009). Moreover, during walking stress, severe water deprivation could have aggravated the condition in these goat bucks. Further, the present study was conducted in dry heat season causes more severe deleterious effects on these heamatological profiles. It was also reported that walking in dry hot season is a highly energy consuming activity for bucks and also causes higher sweating during the process of walking causes increased haemoconcentration. Moreover, Hb and PCV are believed to be the best indices of the organic response to exercise or walking stress (Sejian et al., 2010b; Perumal et al., 2016).

3.3. *Antioxidant profiles*

Significant (p<0.05) difference was observed between the stressed and unstressed free animals with regards to the antioxidant profiles (TAC, CAT and GSH: Figure 1 and SOD: Figure 2). In affected bucks, concentration of the antioxidants was significantly (p<0.05) reduced than in unaffected control buck group. Same as like other parameters, malondialdehyde (MDA: Figure 3) concentration was significantly (p<0.05) increased in stress affected buck than in unaffected stress free bucks.

Significantly (p<0.05) decreased antioxidant profiles (GSH, SOD, CAT and TAC) were observed in the stressed bucks and

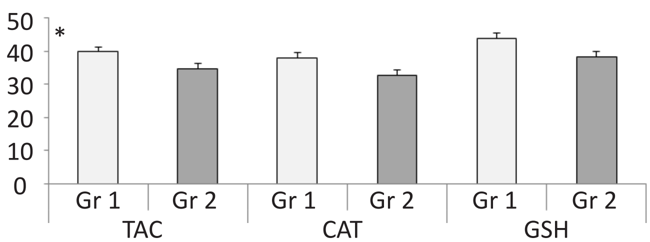

Figure 1: Effect of walking stress on antioxidants activity in goat bucks (* indicates p<0.05). TAC: Total antioxidant capacity (nmol μl^{-1}), CAT: Catalase(nmol min^{-1} l^{-1}) and GSH: Glutathione(nmol l^{-1}). Gr 1: Unstressed animal group, Gr 2: Stressed animal group.

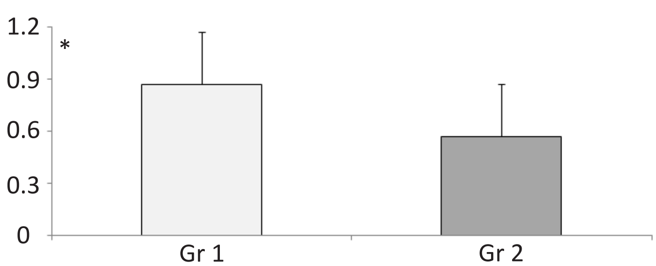

Figure 2: Effect of walking stress on superoxide dismutase activity in goat bucks (* indicates p<0.05). Gr 1: Unstressed animal group, Gr 2: Stressed animal group

significantly (p<0.05) higher oxidative profile (MDA) was observed in walk and heat stressed goat bucks (Figure 1) in the present study. Different types of stresses leads to deficiency of antioxidants because the neutralization of lipid peroxide by the antioxidants. Various free radical oxidations are induced in animal species in different types of stressors and the products due to lipid peroxidation accumulate in different organs (Yarovan, 2008). Free radical concentration was significantly

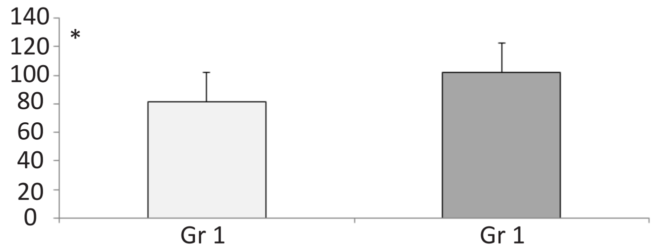

Figure 3: Effect of walking stress on malondialdehyde (MDA) production in goat bucks (* indicates p<0.05). Gr 1: Unstressed animal group, Gr 2: Stressed animal group

(p<0.05) higher in treatment bucks in the present study as same kind of report was reported that heat stress and/or walking stress induces excessive production of lipid peroxides (Bernabucchi et al., 2002; Sivakumar et al., 2010; Perumal et al., 2016). It was also postulated that exercise/walking stress has to generate free radicals/lipid peroxides by the fallowing mechanisms (1) increases the concentration of catecholamines such as epinephrine and other catecholamines which leads to increased production of free radicals whenever they are inactivated metabolically, (2) increased concentration of lactic acid which can produce a strongly damaging one (hydroxyl) from a weakly damaging free radical (superoxide) and (3) secondary muscle damage leads to inflammatory responses with overexertion (Sen,1995). Walking and/or thermal stresses can be controlled or counteracted with proper and higher supplementation of suitable antioxidants which are very useful to the livestock species (Sejian et al., 2012) as these antioxidant systems are essential compounds and/or systems which delay self autoxidation through inhibition of the free radicals formation or by interfering the free radical propagation by different various mechanisms (Brewer, 2011). Through this, the antioxidant system helps to neutralize the free radical to protect the cells from damage during the stressful condition any.

3.4. *Correlation study*

Present study revealed a significant (p<0.05) positive correlation was observed between the RT and RR, PR, ST, TRBC, HB, ESR & MCHC. Similarly significant (p<0.05) positive correlation was observed between the respiratory rate and PR, ST, TRBC, HB, ESR & MCHC and significant negative correlation was with MCV. Pulse rate has significant (p<0.05) positive correlation with HB, ESR, MCHC and ST. And also significant (p<0.05) positive correlation was observed between TRBC and HB, ESR & MCHC and correlated negatively with MCV and MCH. Same correlation pattern in both control unstressed (Table 3) and treatment stressed (Table 4) groups was observed.

Results of the current study clearly suggested that the goat breeds needs a suitable grazing and feeding policy or strategy to counteract or overcome the deleterious stress induced by walking and dry season and also need to identify or select the suitable timeframe for grazing to reduce or minimize the walking and dry season stress to the indigenous goat breeds of ANI. However detailed systematic study need to be conducted in dry and monsoon seasons in different age group of bucks to estimate hormonal as well as other biochemical profiles other than physiological as well as heamatological profiles in caprine species to warrant the results of the present study under island ecosystem and formulation of protective strategy. Further suitable investigation protocols needs to be carried out with regards to feed supplementation and supplementation of suitable electrolytes as well as antioxidants to overcome or counteract the deleterious stresses induced by walking and also by dry season in ANI.

4. Conclusion

From the study, it was concluded that the process of walking in dry season has induced walking and thermal stress that has significantly (p<0.05) affected the performance of indigenous local goat breeds of ANI.

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