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AMELIORATIVE MEASURE FOR COLD IN BLACK BENGAL GOATS IN COASTAL ODISHA CLIMATE

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ABSTRACT

The objective of the study was to evaluate the effect of slatted floor in ameliorating the effects of cold stress in Black Bengal goats in Odisha. Different vital physiological signs, serum biochemical parameters, stress hormone like cortisol and browsing behaviour were studied to assess the level of stress in the two flooring pattern. Serum haptoglobin and cortisol were assayed as stress indicators in goats. Twenty adult Black Bengal goats (more than 6 months of age) were randomly selected from the Instructional Livestock Farm, OUAT and distributed into two groups (10 in each group) so that th.e mean body weight in both the groups were statistically equivalent. Statistically significant variation ($P<0.05$) was observed in the morning rectal temperature in control and treated groups (101.80 ± 0.13 vs. $100.54 \pm 0.06\ ^{0}F$) in winter season. The evening rectal temperature was significantly higher ($P<0.05$) in control group (102.39 ± 0.07 vs. $101.07 \pm 0.11\ ^{0}F$). Significantly higher ($P<0.05$) respiration rate was evident in control group than treatment during evening (25.84 ± 0.88 vs. 21.87 ± 0.79). The morning, evening and overall pulse rate showed significant lower ($P<0.05$) values in control than treated animals (72.91 ± 0.49 vs. 75.08 ± 0.33; 78.85 ± 0.73 vs. 82.56 ± 0.76 and 75.78 ± 0.58 vs. 79.27 ± 0.44) where the slatted floor was given. The heat tolerance indices of control animals were significantly lower ($P<0.05$) than the treated animals (0.879 ± 0.009 vs. 1.004 ± 0.007). Though the control group showed higher level of cortisol than treatment group, but that was not statistically significant. The control animals showed higher ($P<0.05$) level of serum haptoglobin than treatment. It can be grossly concluded that in winter, slatted floor can be a very good option to alleviate cold stress.

Key words: Cold stress, Cortisol, Haptoglobin, Pulse rate, Slatted floor.

In the Arid and Semi-arid regions of the country, small ruminant rearing is of special importance and main source of family income. As per 19th livestock census[2] goat population in India was 135.17 million, whereas in Odisha, it was estimated to be 6.51 million. Goat population in India during the last four decades has increased at the fastest rate amongst various livestock species, in spite of the fact that nearly 41% of goats are slaughtered annually. Species must keep pace with and rapidly respond to fast climatic fluctuations as well as the increase in frequency and intensity of warming events[8,11]. It has been consistently shown in that goats perform better than other domesticated ruminants in harsh environments[18]. In the tropical climate of Odisha, ambient temperatures frequently rise above the comfort zone and it is therefore important that goats are adapted to these higher temperatures. It is also important to emphasize that, even low temperatures may cause reduction in productivity and increased incidence of pneumonia[12]. Stress is a measure of the forces external to the body that disrupt homeostasis, whereas strain is the internal displacement brought about by the stressor[9]. The present study aimed to

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investigate the effect of ameliorative measures for cold stress in Black Bengal goats with the objective to evaluate the effect of slatted floor against winter stress, to validate the level of haptoglobin and cortisol as indicators of stress in goats.

MATERIALS AND METHODS

The research work was carried out in the Instructional Livestock Farm Complex, College of Veterinary Science & Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar during the winter. Twenty adult Black Bengal goats (more than 6 months of age) were randomly selected from the Instructional Livestock Farm, OUAT and distributed into two groups (10 in each group) statistically similar body weight. The animals were found to be healthy and in their normal physiological state. The study was conducted in the winter season for a period of two and half month from 1st December to 8th February, 2014. The experiment was to study the effect of slatted floor in ameliorating the effects of cold stress. Different vital physiological signs, serum biochemical parameters, stress hormone like cortisol and browsing behaviour were studied. The goats were reared under intensive system of management. During the daytime, they were taken for browsing. Slatted floor constructed by wooden planks was given as the treatment in the study against the normal concrete (non-slatted) floor as control. The act of taking vital signs normally entails recording body temperature (rectal temperature), pulse rate (or heart rate), and respiratory rate. All these signs were recorded at 7:00 am and 6:00 pm after as calmly as possible. The morning observations were taken before offering any feed and water.THI calculation was done as per the formula by NRC (1971).

$$THI = (Tdb + Twb) \times 0.72 + 40.6$$

Where, Tdb = Temperature dry bulb (°C),

Twb = Temperature wet bulb (°C).

All the data were analyzed as per standard statistical methods. The model for the one factor ANOVA was $Y_{ij} = \mu + \alpha_i + \varepsilon_i$

Where

Y_{ij}= Observed frequency,

μ = Overall mean,

α_i= Effect of ith treatment range on a parameter,

ε_i= Random error

RESULTS & DISCUSSION

Meteorological parameters of the experimental area

Fortnightly meteorological parameters are presented in (Table 1). During winter, the maximum temperature ranged from 31.9 to 34.2 ^{0}C whereas the minimum temperature recorded were in the range from 13.2 to 18.7 ^{0}C. Mean relative humidity ranged from 28.8 to 43.6%. Temperature humidity index (THI) was recorded in the range of 68.392 to 73.648.

Vital physiological parameters of control and treated animals in winter season

Rectal temperature in control and treated animals

The morning and evening rectal temperature (^{0}F) in control and treated group is presented in (Table 2). In winter seasons, the morning rectal temperature was lower than the evening rectal temperature. Statistically significant variation ($P<0.05$) was observed in the morning rectal temperature in control and treated groups (101.80 ± 0.13 vs. 100.54 ± 0.06 ^{0}F) in winter season. The evening rectal temperature was significantly higher ($P<0.05$) in control group (102.39 ± 0.07 vs. 101.07 ± 0.11 ^{0}F). The daily average rectal temperature also showed the similar trend where the control group showed significantly higher ($P<0.05$) than treated animals. Slatted floor provided an insulation which helped in heat conservation and reduced thermolysis (heat loss) particularly during the night time when the animal spent most of the time lying or sleeping. Lying or sleeping increases the net body contact area with the ground which acts as a potent source of heat loss. The insulating slatted floor acted as a barrier and helps to maintain the euthermia. In the control group, lack of any insulation put the animals under cold stress where the animals' thermoregulatory centre is disturbed. Hence, this signalled to produce larger amount of heat which incidentally showed a higher evening and average rectal temperature. As the stress was not beyond the lower critical temperature, the control animals did not show hypothermia, but their productivity and welfare might be compromised.

Pulse rate in control and treated animals

The morning and evening pulse rate (per min) in control and treated group is presented in (Table 2). In winter season, the morning, evening and overall pulse rate showed significant lower ($P<0.05$) in control than treated animals (72.91 ± 0.49 vs. 75.08 ± 0.33; 78.85 ±0.73 vs. 82.56 ±0.76 and 75.78 ± 0.58 vs. 79.27 ± 0.44) where the slatted floor was given. This might be due to the better cold tolerance due to insulatory provision of slatted floor in treated animals. As the animals were in stress in cold stress, a lower pulse rate might be due to peripheral vasoconstriction and visceral vasodilation.

Respiration rate in control and treated animals

Respiration rate in control and treated groups is presented in (Table 2). In winter season, a significantly higher ($P<0.05$) respiration rate was evident in control group than treatment during evening (25.84 ± 0.88 vs. 21.87 ± 0.79). This might be due to better acclimation of the treated animals to the cold stress. Increased respiration rate during the afternoon in control animals might be due to signalling to produce more amount of heat by preoptic anterior hypothalamus which is a usual cold stress alleviating strategy.

Heat tolerance indices in control and treated animals

Heat tolerance index is a single numerical value considering the three vital physiological parameters. Value closer to unity is considered to be better tolerant. Heat tolerance indices of control and treated animals have been presented in (Table 2). In the winter season, the heat tolerance indices of control animals were significantly lower ($P<0.05$) than the treated animals (0.879 ± 0.009 vs. 1.004 ± 0.007). This might be due to the fact that the slatted floor acted as a barrier for heat loss, hence the treated animals' thermoregulation was optimized. On the contrary, the control animals suffered from cold stress for which their respiration and pulse rate changed markedly between morning and evening hours resulting in lowered heat tolerance. In the evening, the HTI of the control animals were significantly higher ($P<0.05$) than the control (1.033 ± 0.010 vs. 1.008 ± 0.010). This might be due to the higher rectal temperature because of the increased signalling for thermogenesis in control animals. The current study is in agreement with previous reports[5] who reported a higher recording of rectal temperature, pulse rate and respiration rate in Shahbadi goats during afternoon as compared to the morning hours.

Browsing behaviour in three different seasons

Different behaviours during browsing is presented (Table 3 and 4). No significant variation was observed in the different behavioural activities during browsing in winter between control and treatment ($P<0.05$). This might be due to the fact that the animals were allowed browsing during day time which was not thermatically harsh. Moreover, behavioural manifestation of stress is last to be observed[15]. Hence, there was no significant variation among the different activities in winter. In winter, the animals spent about 50% time in browsing, 14% in walking, 8% in standing idle and 27% in sitting idle. In the summer, there 67.20% time was spent on browsing, 8.81% on walking, 8.93% on standing idle and 15.06% on sitting idle. The results from the present study corroborated with the findings of previous workers[19], who reported that goats spent 62.4% time for grazing, 19.2% for sitting, 10.6% in standing and 7.8% in walking.

Blood biochemical parameters

Different blood biochemical parameters in control and treatment animals are presented in (Table 5).

1. Glucose

Glucose level in control animals showed significantly lower value ($P<0.05$) than treatment animals in winter season (50.78 ± 2.36 vs. 58.56

± 1.69 mg/dl). In cold stress there is more demand for heat production. Hence, the insulin sensitivity of the cells increases which results in decreased blood glucose level.

2. Total protein (TP), Albumin, Globulin and A: G ratio

In winter, there was no significant variation between the total protein, albumin, globulin or A: G ratio. This might be due to availability of plenty of green roughage. Hence, the demand for more heat production could have been met through higher dry matter intake. So the energy sparing through gluconeogenesis might have been avoided though the animals suffered from cold stress.

3. Plasma cortisol

The level of plasma cortisol is presented in (table no. 6). In the winter season though the control group showed higher level of cortisol than treatment group, but that was not statistically significant. The increase in cortisol levels might be facilitated to meet the energy requirement by diverting proteolysis derived amino acid towards gluconeogenesis[14].

4. Serum haptoglobin

The level of serum haptoglobin is presented in (table no. 6). In winter, the control animals showed higher ($P<0.05$) level of serum haptoglobin than treatment. In the winter, it was 61% higher than treatment (0.198 ± 0.026 vs. 0.123 ± 0.017 g/dl). The rise in serum Haptoglobin might be due to induction by glucocorticoids, which has been indicated through a higher value.

Table 1. Fortnightly meteorological recordings and THI in winter season

Period	Max. Temp. (^{0}C)	Min. Temp. (^{0}C)	Mean WBT (^{0}C)	Mean RH (%)	Mean THI
1-14 Dec	34.2	16.3	23.2	38.4	69.042
15-28 Dec	31.9	14.8	26.2	43.6	70.127
29 Dec-11 Jan	33.7	13.2	25.6	40.1	68.536
12-25 Jan	32.8	16.2	22.4	28.8	68.392
26 Jan-8 Feb	34.3	18.7	27.2	39.3	73.648

Table 2. Morning and evening Rectal temperature (^{0}F), Pulse rate, Respiration rate and Heat Tolerance Index in control and treated group

Rectal Temperature (^{0}F)	Morning	Evening	Overall
Group			
Control	$101.80^a \pm 0.13$	$102.39^a \pm 0.07$	$102.09^a \pm 0.07$
Treatment	$100.54^b \pm 0.06$	$101.07^b \pm 0.11$	$100.81^b \pm 0.08$
Pulse rate			
Control	$72.91^a \pm 0.49$	$78.85^a \pm 0.73$	$75.78^a \pm 0.58$
Treatment	$75.08^b \pm 0.33$	$82.56^b \pm 0.76$	$79.27^b \pm 0.44$
Respiration rate			
Control	18.10 ± 0.79	$25.84^a \pm 0.88$	22.31 ± 0.77
Treatment	20.75 ± 0.76	$21.87^b \pm 0.79$	21.81 ± 0.78
Heat tolerance index			
Control	$0.879^a \pm 0.009$	$1.033^a \pm 0.010$	$0.954^a \pm 0.009$
Treatment	$1.004^b \pm 0.007$	$1.008^b \pm 0.010$	$1.006^b \pm 0.007$

Values bearing different superscripts within a column differed significantly ($P<0.05$)

Table 3. Different behavioural activities during browsing

Activities	Control (min)	Treatment (min)
Browsing	316.67 ± 12.39	329.89 ± 18.98
Walking	89.33 ± 7.56	95.11 ± 5.47
Standing idle	52.77 ± 4.85	57.11 ± 5.11
Sitting idle	169.67^{a} ± 17.56	194.44^{b} ± 14.26

Values bearing different superscripts within a row differed significantly (P<0.05)

Table 4. Percentage of total time spent in different activities during browsing

Activities	Control	Treatment
Browsing	50.39	48.76
Walking	14.21	14.06
Standing idle	8.39	8.44
Sitting idle	26.99	28.74

Table 5. Different blood biochemical parameters in control and treatment animals

Parameters	Control	Treatment
Glucose (mg/dl)	50.78^{a} ± 2.36	58.56^{b} ± 1.69
Total protein (g/dl)	6.47 ± 0.48	6.61 ± 0.23
Albumin (g/dl)	3.26 ± 0.19	3.33 ± 0.17
Globulin (g/dl)	3.21 ± 0.53	3.28 ± 0.44
A:G	1.017 ± 0.062	1.014 ± 0.018

Table 6. Cortisol and haptoglobin level in control and treatment animals

Parameters	Control	Treatment
Cortisol (µg/dl)	1.09 ± 0.18	1.02 ± 0.11
Hp (g/dl)	0.198^{a} ± 0.026	0.123^{b} ± 0.017

Values bearing different superscripts within a row differed significantly (P<0.05)

CONCLUSION

In the winter, serum haptoglobin level was 61% higher in animals housed in non-slatted floor. Both cortisol and haptoglobin can serve as a good indicator of stress. It can be grossly concluded that in winter, slatted floor can be a very good option to alleviate cold stress. Further study can be directed towards the type of floor to be used during winter. Moreover, standardization of haptoglobin as stress indicator can be a good investigative proposition.

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