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## A comparative study on heat tolerance in Deccani and NARI Suwarna sheep

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#### Abstract

The present study was undertaken at sheep unit of Livestock Farm Complex (LFC), College of Veterinary Science, Rajendranagar, Hyderabad-30. Twelve growing healthy Deccani and NARI Suwarna female sheep of 7- 8 months of age with a body weight of 25-30 kg were procured from Livestock Research Station, Rajendranagar. In each breed, 12 sheep were selected and used for the study. Effect of heat stress had shown a significant change in morning and noon recorded rectal temperature, pulse rate and respiration rate within the breed. The haemato-biochemical parameters *viz.*, RBC, WBC, Hb, PCV, MCV, MCH, MCHC, total protein, Urea, albumin, BUN, Creatinine, ALT and AST had also shown a significant change in Deccani and NARI Suwarna. The differences between the breeds were not found to be significant at hourly intervals for all the behavioural patterns that were studied such as foraging, drinking, rumination, standing, lying, excreting and walking. Cortisol had shown a significant difference during the mid of the experiment. NARI Suwarna sheep had shown a nonsignificantly higher cortisol values when compared to that of Deccani. The variations between breeds of all the physiological responses and haemato- biochemical parameters were not found to be significant. The results obtained through different heat tolerance tests regarding heat tolerance coefficient studies could be interpreted that Deccani had shown a more resistance compared to NARI Suwarna.

**Keywords:** Deccani, NARI Suwarna, physiological responses, haemato-biochemical, behavioural, cortisol, heat stress

#### 1. Introduction

Livestock is an important component of the farming system in India and is more popular among the marginal and small farmers as more than 62 percent of marginal households are directly associated with the livestock sector. The significance of the livestock sector can be appreciated from the fact that it contributes about 8.5-9% to the country's GDP. Small ruminants are the most successful animals with a wide geographical distribution, playing an important role in the mitigation of poverty and meeting hunger demands. These animals are well adapted under different geographical and environmental conditions including extreme and harsh climates (Al-Haidary *et al.*, 2012) [3] and perform better than other domesticated ruminants. Sheep is an important livestock species in India contributing greatly to food, fibre and rural employment and play a vital role in the well-being of rural households as asset saving, which can be liquidated at times of crisis within a short time. Telangana state is known for its diversified livestock resources. According to the 20th livestock census, Telangana ranked first in the sheep population with 19.1 million which is about 48.51% of the total sheep population in India. (D.A.H., GOI, 2019). Small ruminants farming is the livelihood for nearly 5.32 lakh families in the state. The IPCC states that due to global warming the environmental temperature may likely to increase by 1.5 °C between 2030 to 2052 if it continues to increase at the current rate. Among all the factors of environment, the environmental temperature plays a major role in influencing the animal productivity and challenge the animal's ability to maintain energy, thermal, water, hormonal and mineral balance and in association with high direct and indirect solar radiation, wind speed and relative humidity, it effects the thermo-neutral zone of the animals causing stress. Different kinds of stress such as physical, chemical, psychological, nutritional and heat stress will affect the animals. Heat stress is most concerning now a days in the ever-changing climatic scenario. Heat stress causes an imbalance between heat gain and heat loss in which there is an inability to dissipate sufficient heat to maintain the homeothermy. The temperature-humidity index (THI) is a good indicator of thermal stress in animals. In Telangana Deccani and Nellore sheep are very popular. Among the two, Deccani, the popular black sheep of the state is very heat resilient and is best suited for semi-arid and arid tracts.

A synthetic breed of sheep, NARI Suwarna having Deccani inheritance is also becoming popular among the sheep keepers of the state. Though, both the breeds, Deccani and NARI Suwarna are adapted to the local climate, the comparative superiority is not known with regard to ability to thrive well, under heat stress conditions. Hence, an experiment was planned to study the effect of heat stress in Deccani and NARI Suwarna.

## 2. Materials and Method

### 2.1 Physiological Responses

Stress in animals, if any due to effect of heat stress in Deccani and NARI Suwarna was recorded by observing and recording different physiological parameters *viz.*, pulse rate, respiration rate and rectal temperature twice daily between 7.30 to 8.00 A.M and 2.30 to 3.00 P.M throughout the experimental period.

#### 2.1.1 Rectal temperature (RT)

The rectal temperature was recorded by using a clinical thermometer with a temperature by inserting into the rectum, ensuring that the thermometer bulb was left in contact with the rectal mucosa for one minute by using a stopwatch. The temperature was recorded in degrees Fahrenheit.

#### 2.1.2 Respiration rate (RR)

Respiration rate (RR) was measured by counting flank movement with the aid of a stop watch for one minute. The respiration rate was expressed as breaths per minute.

#### 2.1.3 Pulse rate (PR)

Pulse rate (PR) of the animals was recorded by observing the pulsation of femoral artery for one minute using a stopwatch with minimum disturbance to the animals. The pulse rate was expressed as beats/minute

### 2.2 Haemato-biochemical parameters

**2.2.1 Blood Collection:** Blood was collected from all the animals at three stages of experiment *viz.*, at beginning, mid and the end of the experiment. The whole blood sample (5ml) was collected, by puncturing the jugular vein, from all the experimental animals into a clean, dry, sterilized test tube with EDTA as an anticoagulant under aseptic conditions. These test tubes were labelled and brought to the laboratory for further analysis. The haematological study (*i.e.*, Erythrocytic indices like RBC, PCV, MCV, MCH, MCHC, Hb and WBC) was carried out with the help of a haemoanalyser (ABX-MICROS-60). Blood was collected under standard resting conditions as per the guidelines and prior approval of Institutional Animal Ethics Committee (25/24/C.V.Sc., Hyd. IAEC sheep/12.06.2021).

#### 2.2.2 Biochemical studies

Whole blood (10 ml) was collected into a test tube without adding the anticoagulant and serum was separated by centrifugation and then transferred into a sterilized plastic

vial, labelled and stored at  $-20^{\circ}\text{C}$  till use after collection of blood. Clean sterilized glassware was used in the study. Blood serum metabolites like total protein, albumin, urea, blood urea nitrogen, creatinine, SGOT and SGPT were analysed to find out the deviations from the normal range due to the effect of heat stress. The biochemical and liver function tests were carried out using commercial kits (Coral Clinical Systems) on an auto-analyser (Model: Erba-chem 7, India) and spectrophotometer (Thermo).

#### 2.2.2.1 Serum Cortisol

The serum cortisol was estimated using Lumax TM model 4101 chemiluminescence Immuno Assay (CLIA) Strip reader (Monobind, Inc USA) using Acculite CLIA microwells.

#### 2.2.3 Behavioural responses

Behaviour recording was done by scan sampling (collecting data at specified time intervals, and noting what each animal is currently doing) as given by Crews *et al.* (2002). The investigator herself recorded all the behavioral parameters for the purpose. Various behaviours *viz.*, foraging, standing, ruminating, drinking, lying, walking and excreting were recorded once in a week for six hours at hourly intervals from 10:00 AM to 4:00 PM. Enough care was taken not to disturb the animals at the time of recording the behaviours. The investigator, herself recorded the number of animals doing that particular activity at that particular hour.

## 3. Results

The data recorded during the experiment was tabulated, statistically analysed and interpreted.

### 3.1 Physiological responses

#### 3.1.1 Rectal temperature

Effect of heat stress on morning and noon rectal temperature ( $^{\circ}\text{F}$ ) in Deccani and NARI Suwarna was presented in Table 1. Statistical analysis of the data on rectal temperature showed that there was significant difference in morning and noon rectal temperatures in both Deccani and NARI Suwarna but between the breeds it was found to be nonsignificant.

#### 3.1.2 Respiration rate

Effect of heat stress on morning and noon respiration rate in Deccani and NARI Suwarna was presented in Table 2. Statistical analysis of the data on respiration rate showed that there was significant difference in morning and noon respiration rates in both Deccani and NARI Suwarna but between the breeds it was found to be nonsignificant.

#### 3.1.3 Pulse rate

Effect of heat stress on morning and noon pulse rate in Deccani and NARI Suwarna was presented in Table 3. Statistical analysis of the data on pulse rate showed that there was significant difference in morning and noon pulse rates in both Deccani and NARI Suwarna but between the breeds it was found to be nonsignificant.

**Table 1:** Mean rectal temperatures ( $^{\circ}\text{F}$ ) in Deccani and NARI Suwarna during the study period

Month	Deccani		NARI Suwarna	
	Morning	Noon	Morning	Noon
March	101.8 $\pm$ 0.08	103.6 $\pm$ 0.07	102.1 $\pm$ 0.26	103.0 $\pm$ 0.08
April	102.2 $\pm$ 0.07	104.7 $\pm$ 0.08	102.6 $\pm$ 0.23	104.2 $\pm$ 0.12
May	102.4 $\pm$ 0.51	104.9 $\pm$ 0.06	102.8 $\pm$ 0.12	104.8 $\pm$ 0.07
June	101.8 $\pm$ 0.08	102.7 $\pm$ 0.08	101.0 $\pm$ 0.06	102.9 $\pm$ 0.16

**Table 2:** Mean respiration rates in Deccani and NARI Suwarna during the study period

Month	Deccani		NARI Suwarna	
	Morning	Noon	Morning	Noon
March	30.23±0.97	36.15±0.77	30.66±0.79	35.12±0.46
April	31.13±0.77	37.08±0.64	32.15±0.79	38.40±0.85
May	31.12±0.46	47.44±1.71	34.23±1.41	47.56±0.97
June	35.15±0.79	45.93±1.04	33.44±0.85	46.61±1.12

**Table 3:** Mean pulse rates in Deccani and NARI Suwarna during the study period

Month	Deccani		NARI Suwarna	
	Morning	Noon	Morning	Noon
March	75.60±0.92	85.00±1.02	76.00±0.02	90.60±0.96
April	77.37±1.12	89.86±1.68	77.63±0.98	91.66±1.56
May	80.54±1.16	102.1±2.42	82.13±1.38	103.0±1.13
June	84.14±0.93	101.0±1.03	81.95±1.44	101.4±1.25

### 3.2 Haemato-biochemical parameters

#### 3.2.1 Haematological constituents

Effect of heat stress on haematological constituents in Deccani and NARI Suwarna was presented in Table 4 and Table 5 respectively. Statistical analysis of the data on haematological constituents showed that there was significant difference was observed between the stages of experiment in both Deccani and NARI Suwarna but between the breeds it was found to be nonsignificant at all the stages of experiment.

#### 3.2.2 Biochemical Indices

Effect of heat stress on biochemical indices in Deccani and NARI Suwarna was presented in Table 6.

Statistical analysis of the data on biochemical parameters showed that there was a significant difference was observed between the stages of experiment in both Deccani and NARI Suwarna but between the breeds it was found to be nonsignificant at all the stages of experiment.

#### 3.2.3 Stress tolerance (Cortisol estimation)

The estimated cortisol values at different stages of experiment in Deccani and NARI Suwarna was presented in Table 7. Statistical analysis of the data showed that there was significant increase in cortisol levels during heat stress period viz., during mid of the experiment. NARI Suwarna sheep had shown a nonsignificantly higher values when compared to that of Deccani.

**Table 4:** Haematological Parameters of Deccani at different stages of experiment

Parameters	Beginning	Mid	End
Hb (g/dl)	8.67 ± 0.34b	8.82 ± 0.40b	10.80 ± 0.78a
RBC (106 /µl)	8.81 ± 0.44a	8.80 ± 0.49a	9.11 ± 0.64a
PCV (%)	26.33 ± 1.47b	25.41 ± 1.27b	33.25 ± 2.13a
WBC (103 /µl)	9.42 ± 0.71a	9.05 ± 0.94a	9.40 ± 0.63a
MCV (fl)	32.58 ± 1.66b	29.00 ± 0.62c	35.56 ± 2.41a
MCHC (g/dl)	30.58 ± 0.84b	26.82 ± 0.19c	32.72 ± 1.50a
MCH (pg)	10.75 ± 0.28b	10.09 ± 0.21b	11.90 ± 0.67a

Means with different superscripts row-wise differ significantly ( $p < 0.05$ ).

**Table 5:** Haematological parameters of NARI Suwarna at different stages of experiment

Parameters	Beginning	Mid	End
Hb (g/dl)	8.50 ± 0.52c	9.08 ± 0.52b	10.36 ± 0.64a
RBC (106 /µl)	8.81 ± 0.73a	8.83 ± 0.66a	9.12 ± 0.79a
PCV (%)	24.72 ± 1.66b	25.69 ± 1.72b	30.96 ± 1.90a
WBC (103 /µl)	8.78 ± 0.79a	7.38 ± 0.62b	8.80 ± 0.55a
MCV (fl)	31.58 ± 1.38b	29.83 ± 1.16c	35.81 ± 1.08a
MCHC (g/dl)	30.41 ± 0.69b	28.66 ± 0.11c	32.03 ± 1.23a
MCH (pg)	10.27 ± 0.46b	10.32 ± 0.42b	11.18 ± 0.61a

Means with different superscripts row-wise differ significantly ( $p < 0.05$ ).

**Table 6:** Mean values of biochemical indices at different stages of experiment in Deccani and NARI Suwarna

Parameters	Beginning		Mid		End	
	Deccani	NARI Suwarna	Deccani	NARI Suwarna	Deccani	NARI Suwarna
Urea (mg/dl)	36.63±2.00	35.58±2.61	33.78±1.36	35.61±0.87	36.02±2.11	37.39±2.12
BUN (mg/dl)	16.56±0.83	16.90±0.59	15.78±0.63	16.84±0.39	17.23±0.89	18.08±0.86
Creatinine (mg/dl)	1.385±0.04	1.418±0.04	1.398±0.04	1.447±0.08	1.458±0.05	1.508±0.07
Total protein (g/dl)	7.50±0.33	7.50±0.33	6.74±0.12	7.79±0.12	7.17±0.15	7.60±0.27
Albumin (g/dl)	2.32±0.12	2.32±0.12	3.3±0.12	3.6±0.10	3.4±0.09	3.6±0.17
SGPT/ALT (IU/L)	41.48±3.31	36.48±2.56	35.86±3.85	33.55±2.26	34.01±1.61	38.87±2.67
SGOT/ALT (IU/L)	150.6±1.36	147.9±1.33	165.2±1.87	161.0±1.42	159.2±1.05	155.8±1.02

There was no significant difference between the breeds in all biochemical indices

**Table 7:** Cortisol values (µg/dl) at different stages of experiment in Deccani and NARI Suwarna breeds

Breed	Beginning	Mid	End
Deccani	2.35	3.32	2.12
NARI Suwarna	2.48	3.48	2.14

### 3.3 Behavioural responses

Behaviour is taken as an indicator to assess the comfort level of the animals in reaction to the environment.

The results showed that the differences between the breeds were not found to be significant at hourly intervals for all behaviours that were studied.

**Table 8:** The percentage of animals showing foraging behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	95.10	88.16	71.91	39.14	24.27	29.12	18.71
NARI Suwarna	12	90.55	86.09	78.2	37.49	22.40	28.02	16.6

**Table 9:** The percentage of animals showing standing behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	15.25	13.16	13.16	67.61	61.66	76.91	77.63
NARI Suwarna	12	13.85	14.40	15.01	66.05	64.50	78.09	78.30

**Table 10:** The percentage of animals showing rumination behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	4.16	7.62	24.15	28.46	32.22	48.15	44.16
NARI Suwarna	12	5.55	6.85	28.16	26.53	34.99	46.12	48.91

**Table 11:** The percentage of animals showing drinking behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	14.84	15.54	20.85	24.85	28.84	53.76	53.38
NARI Suwarna	12	12.08	12.77	23.46	26.25	24.15	51.53	51.15

**Table 12:** The percentage of animals showing lying behaviour in Deccani and NARI Suwarna

Breed	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	10.23	6.23	12.07	26.23	24.84	22.76	22.31
NARI Suwarna	12.77	7.38	10.77	28.32	26.22	24.52	23.32

**Table 13:** The percentage of animals showing walking behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	80.39	71.78	21.78	4.01	2.99	2.42	4.16
NARI Suwarna	12	73.62	72.47	22.77	6.38	2.12	1.76	1.73

**Table 14:** The percentage of animals showing excreting behaviour in Deccani and NARI Suwarna

Breed	N	10:00 A.M	11:00 A.M	12:00 A.M	1:00 P.M	2:00 P.M	3:00 P.M	4:00 P.M
Deccani	12	39.83	35.66	32.88	27.25	33.41	23.41	28.02
NARI Suwarna	12	33.22	31.92	31.44	29.25	31.40	21.01	27.00

## 4. Discussion

### 4.1 Physiological responses

#### 4.1.1 Rectal temperature (RT)

The results presented in Table 1 revealed that significant difference ( $p < 0.05$ ) was observed in morning and afternoon mean rectal temperatures in Deccani and NARI Suwarna breeds. The results were in consistence to the findings of Sejian *et al.* (2010) [14], Srikandakumaret *al.* (2003) [16], AI-Haidary (2004) [2], whereas the same were contrary to the

findings of Panda *et al.* (2016) [11].

#### 4.1.2 Respiration rate (RR)

Statistical analysis of the data revealed that the noon RR was reported significantly higher ( $p < 0.05$ ) than morning RR. The results were in concurrence with the findings of Srikandakumar *et al.* (2003) [16], AI-Haidary *et al.* (2012) [3], Ramana *et al.* (2013) [12]. Between the breed variations which were statistically significant were not found in the present study indicating the similar responses pertaining to acclimation; a temporary short term adaptive mechanism of the species to adjust to the unfavourable environment.

#### 4.1.3 Pulse rate (PR)

The perusal of results presented in Table no 3 revealed that the PR was significantly high ( $p < 0.05$ ) in afternoon than morning in both Deccani and NARI Suwarna. Similar findings were reported by Sejian *et al.* (2010) [14]. In contrary to these findings decreased PR was reported by Rashid *et al.* (2013) [13] this decreased PR might be due to the acclimation mechanism to withstand higher heat load reflecting the ability to maintain homeostasis.

## 4.2 Haemato-biochemical parameters

### 4.2.1 Haematological parameters

The perusal of results revealed that there was an increase in Haemoglobin (Hb) and Packed cell volume PCV) during different stages of experiment. The results were in close agreement with Singh *et al.* (1982) [15], Srikandakumar *et al.* (2003) [16], AI-Haidary (2004) [2], Sejian *et al.* (2010) [14], Rashid *et al.* (2013) [13]. In contrary to these findings the decrease in Hb and PCV was reported by Abdelatif *et al.* (2009) [1], Cwynar *et al.* (2014) [6]. Usually a decrease in haemoglobin and PCV levels due to the increased attack of free radicals on the erythrocyte membrane causing ultimate lysis of RBC during thermal stress and also due to haemodilution effect. The results also revealed that there was no significant difference ( $p > 0.05$ ) between breeds. The breed differences might be since the blood profiles are essentially affected by the genetic potential and parameters of homeostasis in the body.

There was a nonsignificant difference ( $p < 0.05$ ) in white blood corpuscles during the study when compared with the standard values. These findings were in agreement with Gomes da silva *et al.* (1992) [7], Uwayjana and Bhattacharya (1975) [5], AI-Haidary. (2004) [2] and heat stress appeared to have affected the WBC values in both the breeds.

There was a significant difference between beginning and mid stages, mid and end stages of experiment. The results obtained in the present study in Deccani and NARI Suwarna were in confirmity with the findings of Abdelatif *et al.* (2009) [1]. The same trend was observed with regard to MCHC (g/dl) and MCH (pg) values in both Deccani and NARI Suwarna sheep breeds showing similar kind of responses during the exposure to heat stress.

### 4.2.2 Biochemical indices

The results revealed that there was a significant difference in all the parameters studied. There was a clear reduction in the mean values from beginning to mid of the experiment in Deccani and the same trend was observed in NARI Suwarna sheep also. These results were similar to the findings of Srikandakumar *et al.* (2003) [16], AI-Haidary *et al.* (2012) [3], Banerjee *et al.* (2015) [4] and in contrary to the findings of

Abdelatif *et al.* (2009) <sup>[1]</sup>. The results indicated that both the breeds responded similarly to the heat stress. In both the breeds all the parameters had shown a reduction in the mean values at the end of the experiment compared to the beginning of experiment and the differences were significant.

#### 4.2.3 Stress tolerance

The mean cortisol level ( $\mu\text{g/dl}$ ) was found to be high during the mid of experiment compared to the other two stages of experiment indicating the level of stress faced by the two breeds. The cortisol level was well within the range of standards (1.4 – 3.1  $\mu\text{g/dl}$ ). At no point of experiment, they had shown noticeably increased levels warranting intervention, showing the similar adaptability traits of the two breeds. The results were in conformity with the findings of Nazifi *et al.* (2003) <sup>[9]</sup>.

#### 4.3 Behavioural responses

Statistical analysis of the data revealed that there was a significant difference in all the behaviours within the breeds with increase in exposure to heat stress and nonsignificant difference between breeds was observed. The results obtained in the present study were like the findings of Nejad and Sung (2017), Yang *et al.* (2018).

#### 5. Conclusion

The conclusion that can be drawn from the above study is as following, The between breed variations were not seen with regard to physiological, haemato-biochemical and behavioural parameters studied during the summer season, indicating a similar response by both Deccani and NARI Suwana. Whereas the heat tolerance studies indicated that Deccani breed appeared to be a little more resilient to heat stress when compared to NARI Suwana sheep breed.

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