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# Housing Effect on Growth, Physiological and Blood Indices in Crossbred Sheep During Winter

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## ABSTRACT

**Background:** The winter chill in temperate zones of the country affects animal production. It is understood that during cold winter animals have to maintain their body temperature through increased heat production, thus energy partitioning towards the production is compromised. Since sheep has a thick wooly coat that insulates the animal from harsh ambient temperatures, hence present study was undertaken to assess the impact of housing during cold winter on basic physiological, hemato-biochemical indices and growth in crossbred sheep in temperate Kashmir.

**Methods:** Twenty crossbred weaners of same age, sex and body weight were selected and divided into two groups of ten animals each. One group of sheep was managed under conventional closed shed and another group was managed under open fenced shed during winter from January to March. All the animals were maintained on a uniform nutritional regime. Physiological, hemato-biochemical parameters, body surface temperature, body weight and stress hormones were measured fortnightly.

**Result:** Body weight of animals was significantly higher in closed shed (21.04±0.23 kg) as compared to open shed (18.20±0.19 kg). Heart rate, respiratory rate, body surface temperature differed significantly among the groups. NLR was significantly higher in animals under open shed (0.70) as compared to closed shed animals (0.63). Significant difference was observed in stress hormone cortisol with higher values in open shed animals (12.44±0.07 ng/ml) than in closed shed animals (9.97±0.08 ng/ml). No significant difference was observed in plasma total protein and A/G ratio, however, glucose was significantly higher in animals of open shed as compared to closed shed. Present study revealed that housing management during winter in sheep was essential to maintain production.


**Key words:** Cortisol, Growth, Hemato-biochemical indices, Housing, Sheep, Winter.

## INTRODUCTION

Low ambient temperature is characteristic of temperate Kashmir where the temperature during winter ranges from -5 to 10°C (Ovais *et al*., 2019). Physical environmental factors that create stress in animals during the winter season are cold, wind and precipitation. Animals experience cold stress when the temperature falls below lower critical temperature. Increase in metabolic activity of body to generate more heat, is the first reaction of body to combat the effects of cold stress and reduced productivity may be a consequence of the diversion of energy from productive functions to maintenance (Broucek *et al*., 1991). Productivity is adversely affected by changes in ambient temperature yet animal adaptability resists the changes (Al-Tamimi 2007). Exposure of homeotherms to a cold climate results in physiological responses that enable the animal to adapt to the unfavorable conditions. Previous reports have shown that the growth rate of ruminants exposed to cold climate was limited by lack of nutrients to meet both maintenance and growth requirements (Williams and Innes, 1982). Hales *et al*. (1976) reported that cold exposure caused a marked decrease in skin surface temperature and mild, continuous shivering but no change in deep body temperature, and was associated with mean increases in oxygen consumption, heart rate, and cardiac output, however, blood pressure and total peripheral resistance were unchanged. Murmu *et al*. (2021) studied the effect of meteorological variables on physiological parameters in Black Bengal goats and found significant changes in physiological parameters which were proportionate to the THI during autumn and winter season. Sheep is an important livestock species of India contributing greatly to food, fiber, rural employment, and gross domestic product of the country. Sheep with its multifaceted utility (for meat, wool, skin, manure, and to some extent milk) plays an important role in the Indian agrarian economy. Sheep are widely distributed throughout the world in practically all climatic zones and are closely associated with man and well domesticated, however, the sheep has received little attention from physiologists despite being a suitable experimental animal. The union territory of J&K is placed at

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5th position with regard to sheep population of the country. J&K has remained congenial place for sheep rearing owing to its large meadows, alpine and sub-alpine pastures with an old age tradition of rearing sheep in semi-intensive and migratory system. The variation in climatic variables such as temperature, humidity, and radiations are recognized as the potential hazards in the growth and production of all domestic livestock species (Rathwa *et al*., 2017). Since sheep has a thick wool coat and better adapted to temperate climate, the present study was conducted with the hypothesis that housing during winter months will not have any major impact on animal physiology and growth, thus may reduce construction cost on housing and making the sector more profitable.

## MATERIALS AND METHODS

Twenty crossbred weaners of same age, sex and body weight were selected from Mountain Research Station for Sheep and Goat, SKUAST-K and were distributed in two groups, each of 10 animals. The study was conducted during winter for three months from January to March at Shuhama with an elevation of 5500ft amsl and located at 34.19°N, 74.83°E. One group of sheep (N=10) was managed under conventional four walled closed shed and another group (N=10) was managed under open fenced shed (Fig 1). Animals were maintained on a uniform nutritional regime and management.

The environmental temperature was measured as wind chill index to include wind velocity (increases the heat transmission to the environment from the body) along with ambient temperature in temperate climate as against THI (temperature humidity index) in tropics where humidity is included with ambient temperature. Wind Chill Index was calculated by using index

$$WCTI\ (^\circ C) = 13.12 + 0.6215T - 11.37\ (V^{0.16}) + 0.3965T\ (V^{0.16})$$

As introduced by U.S. National Weather Service and Meteorological Services of Canada.

Where,

WCTI= Wind chill temperature index.

V= Wind speed Km/h.

T= Air temperature°C.

Surface temperature of animals was measured at different sites by digital infrared thermometer, keeping the instrument about 3 inches away and directed towards skin of the specific site while displacing the wool. Rectal temperature was recorded by a digital clinical thermometer. The readings were taken every fortnight for 3 months. Animals were weighed every fortnight by a digital weighing machine from Thomson Electronic, India.

5 ml blood was drawn in heparinized vacuttainers from jugular vein of each animal at an interval of 15 days for 3 months. Blood smears were prepared and other hematological parameters determined immediately after blood collection. Total erythrocyte and leukocyte counts were determined by using Hemocytometer, Hb concentration by cyanmethemoglobin method and packed cell volume (PCV) was determined by microhematocrit method (Jain, 1986). Blood samples were centrifuged at 2500 rpm for 20 minutes to separate plasma that was preserved at -20°C for biochemical analysis. Blood glucose, plasma total proteins and albumin were estimated by colorimetric method using kits from Coral Clinical Systems, India. Plasma cortisol was determined by ELISA method using ELISA kits from Calbiotech, CA, USA.

Mean values and standard errors were calculated and results were treated statistically using Student's - t test assessing the mutual statistical differences between the two groups (Snedecor and Cochran, 1982).

## RESULTS AND DISCUSSION

### Wind chill index (WCI)

In present study the WCI during the study period ranged from -2.5 to 14.56°C in open shed as compared to 9.11 to 20.85°C in closed shed (Fig. 2). In a study Peep *et al*. (2020) revealed that sheep at WCI of ≤ 10°C preferred to remain indoors. In present study a low WCI of -2.5°C has been recorded in open sheds that could have been enough cold to put the animals under cold stress.

### Growth

The growth of animals was measured as an absolute gain in body weight over the study period and the mean ± SE of body weight is presented in (Table 1). Over all mean body


**Fig 1:** Types of animal shed.

weight was significantly higher (P<0.05) in animals of closed shed as compared to the animals of open shed. Hongran *et al.* (2021) reported reduced weight gain in sheep exposed to cold environment thus supporting the present findings. In cold climate, animals divert a part of energy from productive functions to maintenance, as a result body weight of animals gets compromised (Broucek *et al*., 1991). Wellington *et al*. (2020) has reported decreased body weight in goats exposed to cold conditions (THI- 33-46) as compared to goats at thermo-neutral zone (THI- 58-65). Since in the present study the feeding regime remained same for both the groups, therefore, less growth in animals of open shed indicates that energy was diverted from body gain to maintenance of body temperature. However, provision of extra feed to the animals in open shed can improve the weight gain.

**Physiological parameters**

The mean ± SE of physiological parameters like heart rate, respiratory rate and rectal temperature are given in (Table 1). The physiological parameters of an animal are relevant indicators of their comfort and health status during environmental stress (Hyder *et al*., 2017). Heart rate of animals in open shed was significantly higher (p<0.05) in comparison to the animals of closed shed. Increased metabolic rate during cold to generate heat against cold climate may be the reason of higher pulse rate in animals under open shed. Respiratory rate was significantly higher (P<0.05) in closed shed animals as compared to open shed animals, that may be the mechanism to minimize heat loss through respiration as long as it is possible. The present results were comparable to the findings of Wellington *et al*. (2020) in dairy goats. Murmu *et al*. (2021) and Hales *et al*. (1976) also reported decreased respiration rate in goats during cold winter and their findings are in agreement with the present findings. No significant change was seen in rectal temperature between the two groups which is a characteristic of homeotherms like sheep maintaining body temperature within a normal range despite the significant changes in ambient temperatures. Our results from the present study are supported by the findings of Karthik *et al*. (2021) who reported higher pulse rate during winter in sheep.

The mean ± SE of surface temperature of animals is given in (Table 2). Surface temperature around eye differed significantly (p<0.05) between the two groups of animals whereas surface temperatures from other parts of the body did not differ significantly yet the values were lower in the animals of open shed than the animals of closed shed. Hales *et al*. (1976) observed similar changes in skin surface temperature in cold climate. Decrease in surface temperature

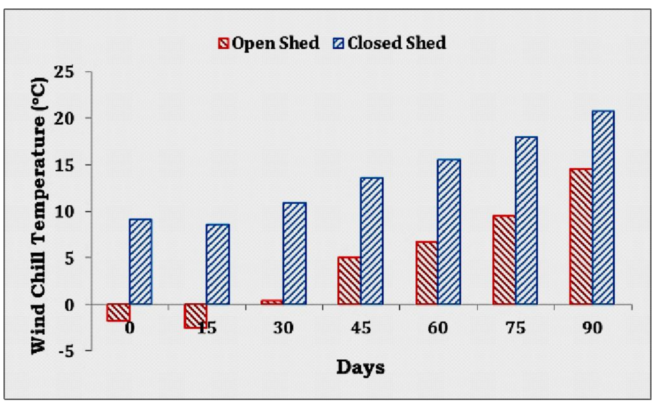


**Fig 2:** Wind chill Index (°C) during the experimental period.

**Table 1:** Physiological parameters and body weight of sheep managed in closed and open sheds during winter.

| Days | Rectal temperature (°C) | | Heart rate (per minute) | | Respiratory rate (per minute) | | Body weight (kg) | |
|---|---|---|---|---|---|---|---|---|
| | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed |
| 0 | 39.06±0.91 | 39.09±0.83 | 68.37±2.09 | 68.67±1.39 | 16.23±0.49 | 16.12±0.29 | 14.87±0.33 | 14.69±0.21 |
| 15 | 39.1±0.99 | 39.36±0.89 | 68.13±1.99 | 60.98±1.27 | 15.98±0.55 | 11.39±0.42 | 15.49±0.18 | 15.03±0.15 |
| 30 | 39.01±0.94 | 39.24±0.79 | 68.84±1.96 | 61.79±1.22 | 16.9±0.65 | 12.21±0.39 | 17.34±0.11 | 16.28±0.12 |
| 45 | 38.87±0.98 | 39.2±0.82 | 69.88±2.12 | 62.31±1.33 | 17.58±0.48 | 12.73±0.41 | 20.56±0.27 | 16.89±0.24 |
| 60 | 38.77±0.99 | 39.16±0.78 | 70.11±2.11 | 63.49±1.41 | 17.81±0.62 | 13.32±0.34 | 23.87±0.32 | 18.78±0.27 |
| 75 | 38.68±1.01 | 39.1±0.89 | 71.66±1.97 | 64.37±1.22 | 18.72±0.58 | 14.97±0.29 | 26.47±0.18 | 21.76±0.15 |
| 90 | 38.54±0.98 | 39.02±0.91 | 72.17±2.16 | 65.28±1.36 | 19.64±0.61 | 15.94±0.39 | 28.64±0.19 | 23.78±0.21 |
| Mean±SEM | 38.8 ±0.97 | 39.2±0.84 | 63.7±1.31 | 69.8±2.06* | 17.5±0.57* | 13.9±0.36 | 21.04±0.23* | 18.20±0.19 |

*Values in the same row under same parameter differ significantly (P<0.05).

may be a physiological change were in blood supply to periphery is decreased in order to decrease heat loss through surface and in turn conserve body heat to counter cold. Present study also revealed that surface temperature around the eye can serve a good indicator of cold.

### Hematological indices

The hematological parameters along with their mean ± SE are presented in (Table 3). PCV, TLC and neutrophil count was significantly higher in animals of open shed in comparison to the animals of closed shed. Neutrophil-lymphocyte (N/L) ratio that serves an important indicator of stress was significantly different between the two groups of animals with 0.63 in animals of closed shed and 0.70 in animals of open shed indicating neutrophilia, a marker of stress, in open shed animals. Haemoglobin was non-significantly higher in open shed animals (11.37±0.36 mg%) than in closed shed animals (10.62±0.29 mg%). Similar results were reported by Dipak *et al*. (2015), showing an increase in number of neutrophils and decrease in lymphocyte numbers during cold climate in Indian goats. Present results are also supported by the findings of Abdelatif *et al*. (2009) who observed increased total leucocyte count, total haemoglobin concentration and PCV during winter months in goats.

**Table 2:** Body surface temperature (°C) of sheep managed in closed and open sheds during winter.

| Days | Around eye | | Muzzle | | Pinna | | Fore head | |
|---|---|---|---|---|---|---|---|---|
| | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed |
| 0 | 22.32±0.88 | 22.21±0.51 | 17.33±0.57 | 17.24±0.58 | 12.34±0.03 | 12.27±0.18 | 18.03±0.62 | 18.12±0.41 |
| 15 | 21.76±0.79 | 16.87±0.66 | 16.87±0.39 | 16.03±0.63 | 11.77±0.21 | 11.17±0.34 | 17.53±0.42 | 16.63±0.25 |
| 30 | 22.56±0.93 | 17.63±0.59 | 17.98±0.67 | 16.58±0.49 | 12.98±0.11 | 12.32±0.12 | 18.31±0.59 | 17.56±0.38 |
| 45 | 23.61±0.76 | 18.66±0.74 | 18.36±0.29 | 17.07±0.58 | 13.35±0.02 | 13.26±0.29 | 18.94±0.38 | 18.37±0.36 |
| 60 | 24.33±0.63 | 19.21±0.47 | 18.98±0.24 | 17.41±0.51 | 13.87±0.09 | 13.48±0.21 | 19.71±0.61 | 19.3±0.22 |
| 75 | 25.53±0.66 | 21.34±0.57 | 19.32±0.36 | 18.11±0.42 | 14.07±0.18 | 13.98±0.24 | 20.86±0.48 | 20.66±0.27 |
| 90 | 25.98±0.85 | 22.27±0.54 | 19.88±0.49 | 19.03±0.38 | 14.72±0.13 | 14.06±0.31 | 21.98±0.62 | 21.21±0.29 |
| Mean±SEM | 23.7±0.79* | 19.8±0.58 | 18.4±0.43 | 17.3±0.51 | 13.3±0.11 | 12.9±0.24 | 19.3±0.53 | 18.8±0.31 |
| | **Foreleg** | | **Hind leg** | | **Shoulder** | | **Rump** | |
| Days | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed | Closed shed | Open shed |
| 0 | 8.03±0.13 | 8.07±0.18 | 7.4±0.12 | 7.39±0.05 | 13.78±0.16 | 13.8±0.18 | 12.34±0.31 | 12.31±0.27 |
| 15 | 7.73±0.03 | 7.43±0.11 | 7.34±0.08 | 7.11±0.19 | 13.54±0.07 | 13.29±0.14 | 12.11±0.22 | 11.77±0.21 |
| 30 | 8.39±0.09 | 8.12±0.06 | 7.61±0.03 | 7.47±0.09 | 14.34±0.14 | 13.66±0.24 | 12.69±0.31 | 12.56±0.19 |
| 45 | 8.61±0.14 | 8.33±0.06 | 8.11±0.11 | 7.61±0.09 | 14.66 ±0.18 | 14.23±0.15 | 13.31±0.22 | 12.87±0.26 |
| 60 | 8.85±0.01 | 8.46±0.13 | 8.22±0.15 | 8.03±0.03 | 14.86±0.08 | 14.41±0.27 | 13.73±0.33 | 13.56±0.22 |
| 75 | 9.32±0.06 | 8.78±0.16 | 8.3±0.16 | 8.19±0.01 | 15.23±0.17 | 14.66±0.28 | 14.48±0.21 | 13.67±0.2 |
| 90 | 9.55±0.11 | 9.13±0.08 | 8.43±0.08 | 8.3±0.11 | 15.65±0.13 | 14.86±0.22 | 14.72±0.36 | 13.86±0.34 |
| Mean±SEM | 8.6±0.08 | 8.3±0.11 | 7.9±0.10 | 7.7±0.08 | 14.6±0.13 | 14.1±0.21 | 13.3±0.28 | 12.9±0.24 |

*Values in the same row under same parameter differ significantly (P<0.05).

**Table 3:** Hematological parameters of sheep managed in closed and open sheds during winter.

| Days | PCV (%) | | Hemoglobin (g%) | | WBC count (× 10 /µl) | | N/L Ratio | |
|---|---|---|---|---|---|---|---|---|
| | Closed Shed | Open Shed | Closed Shed | Open Shed | Closed Shed | Open Shed | Closed Shed | Open Shed |
| 0 | 38.52±1.41 | 38.57±1.09 | 10.36±0.33 | 10.39±0.31 | 7.09±0.29 | 7.11±0.44 | 0.69 | 0.69 |
| 15 | 37.01±1.29 | 34.3 7±1.19 | 10.13±0.38 | 9.66±0.19 | 7.21±0.38 | 8.96±0.41 | 0.68 | 0.74 |
| 30 | 39.86±1.38 | 36.55±1.24 | 10.88±0.35 | 10.13±0.27 | 6.93±0.31 | 8.43±0.39 | 0.65 | 0.71 |
| 45 | 40.54±1.26 | 38.03±1.07 | 11.31±0.41 | 10.51±0.34 | 6.84±0.28 | 8.16±0.38 | 0.64 | 0.70 |
| 60 | 41.63±1.34 | 39.76±1.13 | 11.86±0.32 | 10.83±0.31 | 6.67±0.37 | 7.96±0.34 | 0.62 | 0.69 |
| 75 | 42.34±1.29 | 41.59±1.08 | 12.27±0.33 | 11.19±0.28 | 6.61±0.39 | 7.66±0.42 | 0.60 | 0.67 |
| 90 | 43.33±1.27 | 42.22±1.12 | 12.81±0.42 | 11.63±0.33 | 6.58±0.29 | 7.51±0.43 | 0.59 | 0.66 |
| Mean±SEM | 38.73±1.13 | 40.45±1.32* | 10.62±0.29 | 11.37±0.36 | 6.84±0.33* | 7.97±0.41 | 0.63 | 0.70* |

*Values in the same row under same parameter differ significantly (P<0.05).

**Table 4:** Biochemical Parameters of sheep managed in closed and open sheds during winter.

| Days | Glucose (mg/dl) | | Total protein (g/dl) | | Albumin (g.dl) | | Globulin (g/dl) | | Cortisol (ng/ml) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Closed Shed | Open Shed | Closed Shed | Open Shed | Closed Shed | Open Shed | Closed Shed | Open Shed | Closed Shed | Open Shed |
| 0 | 52.96±1.11 | 53.43±1.06 | 6.29±0.05 | 6.31±0.03 | 29.41±0.54 | 29.31 ±0.63 | 42.6±1.32 | 43.2±0.91 | 9.52±0.06 | 9.61±0.03 |
| 15 | 45.31±1.06 | 56.69±1.13 | 6.46±0.02 | 6.29±0.06 | 29.67±0.53 | 28.46±0.81 | 43.31±1.03 | 42.11±0.86 | 9.4±0.09 | 11.76±0.01 |
| 30 | 44.46±1.13 | 55.43±1.17 | 6.71±0.03 | 6.43±0.01 | 31.65±0.42 | 30.55±0.29 | 45.46±0.78 | 44.53±0.96 | 9.63±0.06 | 12.81±0.08 |
| 45 | 43.41±1.11 | 52.73 ±1.1 | 6.79±0.01 | 6.56±0.02 | 30.99±0.39 | 29.96±0.54 | 44.97±0,96 | 44.61±1.3 | 10.21±0.09 | 12.93±0.1 |
| 60 | 41.96±1.01 | 52.33±1.13 | 6.83±0.09 | 6.37±0.09 | 31.63±0.33 | 30.33±0.63 | 45.4 ±1.26 | 43.47±0.89 | 10.36±0.08 | 13.36±0.09 |
| 75 | 42.33±1.12 | 50.65±1.09 | 6.76±0.05 | 6.48±0.03 | 31.46±0.48 | 30.47±0.49 | 45.66±0.39 | 44.83±1.11 | 9.97±0.06 | 13.08±0.11 |
| 90 | 41.3±1.17 | 51.21±1.15 | 6.81±0.07 | 6.33±0.05 | 31.76±0.37 | 30.73±0.43 | 45.73±1.01 | 44.71±1.23 | 10.71±0.11 | 13.52±0.09 |
| Mean±SEM | 44.53±1.1 | 53.21*±1.12 | 6.66±0.05 | 6.4±0.04 | 30.94±0.44 | 29.97±0.55 | 44.73±0.98 | 43.92±1.04 | 9.97*±0.08 | 12.44±0.07 |

*Values in the same row under same parameter differ significantly ($P<0.05$).

**Biochemical parameters**

Plasma biochemical parameters analyzed during present study are presented in (Table 4). Overall average glucose concentration was reported high in animals of open shed when compared to the animals of closed shed. Total protein, albumin and globulin did not show any significant difference between the two groups of animals. These results are comparable to the findings of Rathwa *et al*. (2017). Increased glucose concentration in animals of open shed may be due to high levels of cortisol in this group of animals, which is a calorigenic hormone causing gluconeogenesis thus elevating blood glucose concentration. The cortisol concentration was significantly higher in animals of open shed when compared to the animals of closed shed. Elevated levels of cortisol is an important reliable indicator of stress in animals (Novak *et al*., 2013). Present study therefore, indicated that animals in open shed were under cold stress.

Thermal stress is one of the major concerns that may affect the health and welfare status of domestic animals and thus their productivity (Schnier *et al*., 2003). While sheep are better adapted to cold temperatures than other livestock, their lower critical temperature, can vary widely between shorn and unshorn sheep, in wind or rain and wool length (Ekesbo, 2011).

## CONCLUSION

The higher body weight of the animals in closed shed as compared to open shed indicated that cold climate negatively affects growth of the animals. Higher values for cortisol and N/L ratio was an indicative of stress in animals under open shed. The present study concludes that sheep yet being wooly animals experience cold stress during winter if not provided with proper housing and extra ration during cold season. Growth during winter gets compromised due to cold stress probably because part of the energy is diverted in the maintenance of homeostasis during cold. Therefore, housing management during winter in sheep is imperative.

**Conflict of interset:** None.

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