



Ovine Research

Effect of bedding for reducing the postshearing stress in sheep

Kalyan De ^{a,*}, Davendra Kumar ^b, Arpita Mohapatra ^b, Vijay Kumar Saxena ^b^a Animal Nutrition Division, ICAR-Central Sheep and Wool Research Institute, Rajasthan, India^b Animal Physiology and Biochemistry Division, ICAR-Central Sheep and Wool Research Institute, Rajasthan, India

ARTICLE INFO

Article history:

Received 19 December 2018

Received in revised form

6 March 2019

Accepted 27 April 2019

Available online 6 May 2019

Keywords:

bedding
sheep
behavior
stress
welfare

ABSTRACT

Shearing of sheep is routine management. However, the shearing induces stress in the animal. To reduce the postshearing stress, providing bedding may be an effective method. Therefore, the present study was initiated to assess the effect of bedding for reducing postshearing stress in sheep. For this purpose, sixteen Malpura ewes aged 2–4 years were selected. They were equally divided into two groups, viz, G1: control and G2: provided with bedding. Animals of both the groups were kept under asbestos-roofed, four-sided, chain-link fenced mud-floored house. The ewes of G2 were provided with a 2-inch-thick bedding of chopped mustard straw up to 7 days after shearing. The respiration rate, pulse rate, and rectal temperature were recorded from each sheep in the morning and afternoon during day 1, day 3, and day 5 after shearing. Plasma cortisol was estimated on the same days. All the data were analyzed by general linear models with repeated measures analysis (SPSS 14.0). The rectal temperature was significantly ($P < 0.05$) higher both in the morning and afternoon in G2 as compared with the G1 ewes. The idle lying time was significantly ($P < 0.05$) lower in the G1 ewes as compared with G2 ewes. Plasma cortisol was higher on day 3 after shearing in the G1 ewes as compared with G2 ewes. Therefore, from the result of the study, it is pertinent to conclude that, after shearing, the sheep modify their behavior to adapt to the stress arising because of the sudden removal of wool insulation. The postshearing stress may be reduced by providing bedding, which was reflected by improving lying time and reduced cortisol level. Therefore, the availability of bedding in postshearing period improves the welfare of sheep.

© 2019 Elsevier Inc. All rights reserved.

Introduction

Since ancient times, sheep husbandry is a sustainable livelihood for the people living in the arid and semiarid region (Naqvi et al., 2013). Although sheep have multidimensional utility, they are mainly used in meat and wool production industries. The profitability decrease of wool forced wool to backstage. The shearing of sheep is a common management procedure in sheep husbandry as domestic sheep do not shed the wool naturally (Glenn et al., 1996). However, shearing may negatively affect the animal, therefore is also considered as a stress factor that changes the comfort behavior of sheep. Shearing induces both endocrine and metabolic responses (Carcanguiu et al., 2008). Another stress factor in postshearing sheep may be the sudden removal of wool insulation from their body,

insulation that protects them from physical friction of the hard surface of the floor and injuries. This condition may impair the welfare of sheep temporarily until they get adjusted to such removal of wool insulation protection against the hard floor. The regulation of body temperature in homeotherms is ensured by mechanisms of thermolysis and thermogenesis. Thermoregulatory adjustments can be induced not only by changes in environmental temperature but also by a variety of physiological situations including age, fasting, and food intake, inducing changes in the internal temperature (Arfuso et al., 2016).

In recent years, many detrimental effects of thermal stressors on the health of animals have been studied, considering the relationships between behavioral, physiological, and biochemical indicators in the evaluation of the adaptive capacity and consequently “welfare” of the animals. Environmental factors that directly and adversely affect health and welfare of animals include thermal irradiation and wind velocity together with the temperature humidity index, which is the sum of the effects of ambient temperature and relative humidity (RH), capable of estimating the degree of thermal stress (Casella et al., 2016; Fazio et al., 2016; Giannetto et al., 2017).

* Address for reprint requests and correspondence: Kalyan De, PhD, Animal Nutrition Division, ICAR-Central Sheep and Wool Research Institute, Avikanagar, 304501 Rajasthan, India. Tel: +91 1437220129; Fax: +91 1437220163.

E-mail address: kalyande2007@gmail.com (K. De).

The stress is a reflex action when the animal is exposed to adverse condition and may cause unfavorable consequences and discomfort (Dantzer and Mormede, 1983). Animal welfare aims to reduce the unfavorable feeling such as pain, suffering, and stress (Fidan et al., 2009). However, the relief of pain due to physical friction with the floor after shearing may be reduced by providing bedding. Generally, cereal straw sawdust and rice husk are used as bedding material (Miranda de la Lama et al., 2012). A recent study showed positive benefits of environmental enrichment through bedding material (Aguayo-Ulloa et al., 2014). Whatever the bedding may be, it should be comfortable, dry, and soft to ensure better welfare to the animals (Teixeira et al., 2015).

In the semiarid tropical region, generally, bedding material is not used for improving the comfort of sheep except at lambing time during winter to provide thermal insulation for newborn lambs. In the semiarid tropical region, mustard cultivation is a major agricultural product. In mustard cultivation, the mustard straw is a major by-product, which is mainly used for fuel purpose. However, it may be used as a good bedding material to provide better comfort to the sheep. Generally, use of bedding material in postshearing period to improve the welfare of animals is not common. Even no literature is available on the effect of bedding on the behavior of sheep immediately after shearing. Therefore, the present study was initiated to assess the effect of bedding material on the postshearing welfare indicator of sheep.

Materials and methods

Site of study

The experiment was carried out at the ICAR-Central Sheep and Wool Research Institute, Avikanagar, located in the semiarid region of India (longitude 75°28'E, latitude 26°26'N, and altitude 320 m above sea level). The average annual maximum and minimum ambient temperature range between 46°C and 3°C in this region. The mean annual RH ranges between 10% and 85%. The annual rainfall in this area ranges from 200 to 500 mm with an erratic distribution throughout the year. The experiment was carried out during January and February. The mean environmental temperatures, RH, and temperature humidity index (THI) during the study period are presented in Table 1. The THI was calculated as described by Marai et al. (2007) as follows:

$THI = db\ ^\circ C - ([0.31 - 0.31 RH] [db\ ^\circ C - 14.4])$, where db °C is the dry bulb temperature (°C) and RH is the relative humidity (RH %)/100.

Experimental animals

The present experiment was carried out on sixteen well-adapted native Malpura ewes of the semiarid region. In the semiarid region, Malpura sheep are of the heaviest sheep breed, widely distributed

in Rajasthan. Malpura is a triple-purpose, hardy sheep breed that originated in the arid and semiarid areas of Western tropical India. They are well known for their hardiness and adaptability to the local environment. This breed is reared by small and marginal landholders who graze them on fallow land and crop residues and also take them on migration during the period of scarcity of feed (Gowane et al., 2014). The selected Malpura ewes were aged 2–4 years with an average body weight of 30.17 ± 0.87 kg.

Animal management and experimental procedure

The selected Malpura ewes were equally divided into two groups, viz, control (G1) and provided with bedding material (G2). For the first one month, selected ewes of each group were kept together inside the same experimental shed, and same feeding regime was followed to form group cohesion and for adaptation. The animals were housed in a well-ventilated shed made up of asbestos roofing, open from the sides, separated and surrounded by wire chain links and were maintained under proper hygienic conditions. All the animals were stall-fed in individual groups with a diet consisting of ad libitum roughage (*Cenchrus ciliaris* hay), and 2500 g concentrate feed (barely 650 g/kg, groundnut cake 320 g/kg, minerals 30 g/kg including 10 g/kg NaCl, with crude protein = 180 g/kg and total digestible nutrients = 650 g/kg) was provided for each group. All ewes were provided with wholesome drinking water in each group. The average daily feed and water intake of all the ewes were recorded by subtracting the leftover and feed water from the offered feed and water, respectively, during the study period. Prophylactic measures against sheep diseases such as sheep pox, Peste des petit ruminants, enterotoxemia, and endoparasitic and ectoparasitic infestations were carried out as prescribed by the health division of the institute to ensure that the animals were in a healthy condition throughout the study. The ewes of G1 were provided mud floor, whereas the ewes of G2 were provided with 2-inch-thick bedding of chopped mustard straw up to 7 days after shearing. The respiration rate, pulse rate, and rectal temperature (RT) were recorded from each sheep in the morning and afternoon during day 1, day 3, day 5, and day 7 after shearing. The blood samples were collected in the morning 0730 h through jugular venipuncture in all the collection days (day 1, day 3, day 5, and day 7 after shearing) using heparinized glass tube. Sampling was done in the same hour of the day to avoid the influence of circadian variations, as described in several animal species (Giannetto et al., 2012, 2015). Plasma samples were separated by centrifuging the whole blood samples at 3500 rpm for 15 min. From the plasma samples, the plasma cortisol (analytical sensitivity was 10 nM; the intra-assay and inter-assay coefficient of variations were 5.8% and 9.2%, respectively) was estimated by RIA gamma counter (PC-RIA MAS; Stratec, Germany), using RIA kits supplied by Immunotech Marseille Codex, France.

The behavioral observations were recorded on day 1, day 3, day 5, and day 7 after shearing in all the ewes individually of both the groups. The behavioral observer was experienced to observe all these behaviors, and the behavior observation protocol was standardized during the initial one month of acclimatization period before shearing. Thus, the experienced observer consistently recorded each behavior in the protocol by direct observations from morning 0700 h to evening 1800 h. The behavioral observations were done instantaneously at 10-minute intervals through scan sampling (Martin and Bateson, 1993) for each animal individually for both the groups. All the animals were marked individually with specific body number so that the animals can be identified individually from distance. The feeding, ruminating, movement, idle standing, and idle lying behaviors were recorded. The animal was considered to be feeding when it was standing beside the feed

Table 1
Meteorological data during experimental period

Parameters	Value
Maximum temperature (°C)	41.8 ± 0.5
Minimum temperature (°C)	23.8 ± 0.7
Relative humidity (%) morning (0700 h)	37.9 ± 2.3
Relative humidity (%) afternoon (1400 h)	18 ± 0.9
THI in the morning (0700 h)	28.72 ± 0.7
THI in the afternoon (1400 h)	29.90 ± 2.68

THI, temperature humidity index.

Temperature humidity index was calculated with the formula, $THI = db\ ^\circ C - ((0.31 - 0.31 RH) (db\ ^\circ C - 14.4))$, given by Marai et al. (2007).

trough while eating, chewing, and swallowing. Ruminating behavior was considered when the animal was chewing ruminal content. Furthermore, the ruminating behavior could be either in standing or in lying position. The animal was considered in movement when the animal was moving aimlessly. The idle standing behavior is that when the animal is standing without showing any other behavior (neither eating nor ruminating), whereas standing behavior denoted that the animal was in standing condition. Likewise, in idle lying behavior, the animal was lying in any position without showing any other behavior (neither eating nor ruminating). One trained veterinarian for each group was involved in recording all these behaviors to avoid individual variations.

Statistical analysis

All the data were analyzed by general linear models with repeated measures analysis (SPSS 14.0). The statistical model comprises the effect of shearing on day 1, day 3, day 5, and day 7 on dependent variables were a physiological response, behavior, and cortisol levels. The effect on feed intake and water intake was measured using general linear models. The level of statistical significance was set at $P < 0.05$; the data are presented as mean \pm SE in the tables.

Result

Physiological response and feed and water intake

The effect of bedding on physiological response and dry matter and water intake is described in Table 2. No significant ($P > 0.05$) difference was found in respiration rate and pulse rate in the morning and afternoon between G1 and G2 ewes. However, the RT was significantly ($P < 0.05$) higher both in the morning and afternoon in G2 ewes as compared with G1 ewes.

Behavior

The effect of bedding on the behavior of sheep after shearing is described in Table 3. The feeding, rumination, and total movement time did not differ ($P > 0.05$) between G1 and G2. However, idle standing and lying time differed significantly ($P < 0.05$). The idle standing time was higher in ewes of the G1 group as compared with the ewes of the G2 group, whereas the idle lying time was significantly ($P < 0.05$) lower in G1 ewes as compared with G2 ewes. The G2 ewes preferred to ruminate less time in standing condition as compared with G1 ewes.

Table 2

Effect of bedding on physiological response and dry matter and water intake of sheep after shearing

Parameters	Control (G1)	Provided with bedding material (G2)	SE	P value
RR in the morning	20.4	20.4	1.1	0.97
PR in the morning	61.4	60.3	1.0	0.45
RT in the morning ($^{\circ}$ C)	38.2	38.5	0.07	0.01
ST in the morning ($^{\circ}$ C)	36.2	36.1	0.19	0.72
RR in the afternoon	46.2	42.0	2.6	0.23
PR in the afternoon	67.8	68.3	0.95	0.68
RT in the afternoon ($^{\circ}$ C)	39.0	39.2	0.04	<0.01
ST in the afternoon ($^{\circ}$ C)	40.7	40.5	0.25	0.72
Dry matter intake (gm)	1064	1080	21.68	0.58
Water intake (L/kg of DMI)	4.23	4.17	114.81	0.54

RR, respiration rate; PR, pulse rate; RT rectal temperature; ST, skin temperature; DMI, dry matter intake.

Table 3

Effect of bedding on the behavior of sheep after shearing

Behavior	Control (G1)	Provided with bedding material (G2)	SE	P Value
Feeding (min)	271.9	278.8	10.14	0.63
Ruminating (min)	194.2	176.3	7.77	0.11
Idle standing (min)	113.8	75.6	6.32	<0.01
Idle lying (min)	104.7	157.5	8.19	<0.01
Movement (min)	2.2	2.2	0.74	1.0
Rumination in standing (min)	52.5	36.6	5.78	<0.05
Rumination in lying (min)	141.7	139.7	7.06	0.84

Plasma cortisol

The effect of bedding on plasma cortisol levels in ewes after shearing is described in Figure 1 and Figure 2. No significant ($P > 0.05$) difference was found in plasma cortisol levels in ewes; however, it was higher on day 3 after shearing in the ewes of the G1 group as compared with the ewes of the G2 group.

Discussion

In the present study, the physiological indicators and behavioral changes can be used to evaluate the welfare of sheep in relation to providing bedding in the postshearing period. The study showed significantly lower RT in G1 ewes compared with G2 ewes, which might be attributed to that the removal of fleece increased the conductive heat loss from the body in the morning in G1 ewes (Piccione et al., 2002), whereas the bedding material acted as an insulation against conductive heat loss in G2.

The lying behavior is important to provide rest periods and improve the welfare of the animals (De et al., 2017; Leme et al., 2013). In the present study, the idle lying time increased significantly in the G2 ewes as compared with G1 ewes after shearing. In concurrence with the present study, the previous study also reported that availability of bedding increased the lying time in shorn sheep (Faerevik et al., 2005; Richmand et al., 2017). Sheep prefer to ruminate in lying condition. In the present study also, the animals spent higher time in lying for rumination as compared with standing in both the groups. However, the time spent in rumination in standing condition was higher in G1 ewes as compared with the G2 ewes, which might be attributed to the discomfort in sitting in hard surface of the floor immediately after sudden removal of cautions of wool and fleece.

In the present study, the plasma cortisol level did not differ among the groups. However, the plasma cortisol showed higher value in the G1 ewes and was significantly higher on the 3rd day of

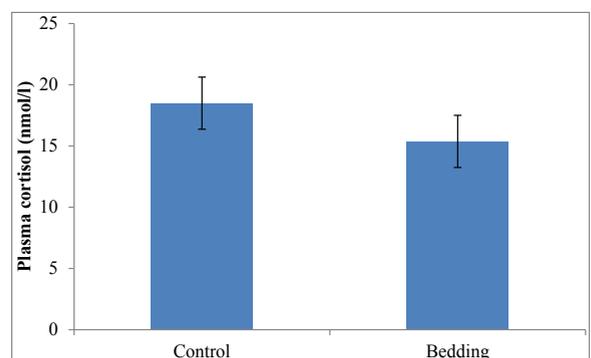


Figure 1. Effect of bedding on the plasma cortisol level of sheep after shearing.

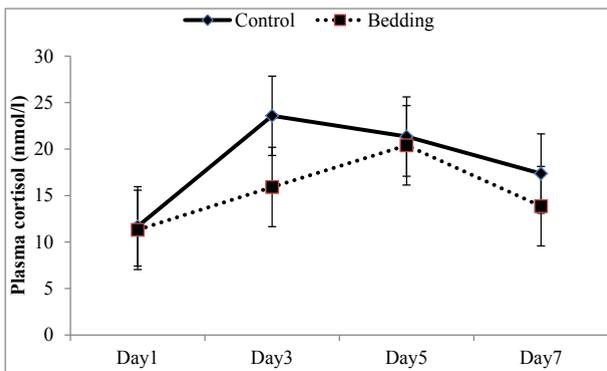


Figure 2. Effect of bedding on plasma cortisol level in different days of after shearing.

shearing in comparison with G2 ewes. Cortisol levels are indicators of short-term stress (Mousa-Balabel and Salama, 2010). Plasma cortisol levels are elevated after physical and psychological stress (Mears et al., 1999). Shearing is a stress for sheep due to restraining and handling (Piccione et al., 2017). However, the provision of bedding improves comfort and decreases the stress in animals (Munzo-Osorio et al., 2017). Therefore, the plasma cortisol level of G2 ewes reduced significantly as their stress level decreased, and ewes felt more comfortable after shearing as compared with G1 ewes.

Conclusion

Shearing is a stressful process in sheep. However, after shearing, sheep modify their behavior to adapt to the stress that arises because of the sudden removal of wool insulation. The postshearing stress may be reduced by providing bedding material, which was reflected by improving lying time and reduced cortisol level. Therefore, the availability of bedding in postshearing period improves the welfare of sheep.

Acknowledgments

The authors are thankful to Shivendra Sharma and Rajendra Singh Rajawat for their technical assistance in animal management and data entering to carry out this study. Authors are thankful to the Director ICAR-Central Sheep and Wool Research Institute, Avikanagar for providing facilities for carry out this work.

Conflict of interest

The authors declare no conflict of interest.

References

Aguayo-Ulloa, L.A., Villarroel, M., Pascual-Alonso, M., Miranda-de la Lama, G.C., María, G.A., 2014. Finish feedlot lambs in enriched pens using feeder ramps and straw and its influence on behavior and physiological welfare. *J. Vet. Behav.: Clin. Appl. Res.* 9, 347–356.

Arfuso, F., Rizzo, M., Giannetto, C., Giudice, E., Fazio, F., Piccione, G., 2016. Age-related changes of serum mitochondrial uncoupling 1, rumen and rectal temperature in goats. *J. Therm. Biol.* 59, 47–51.

Carcangiu, V., Vacca, G.M., Parmeggiani, A., Mural, M.C., Pazzola, M., Dettori, M.L., Bini, P.P., 2008. The effect of shearing procedures on blood levels of growth hormone, cortisol and other stress haematochemical parameters in Sarda sheep. *Animal* 2, 606–612.

Casella, S., Giudice, E., Passantino, A., Zumbo, A., Di Pietro, S., Piccione, G., 2016. Shearing induces secondary biomarkers responses of thermal stress in sheep. *Anim. Sci. Pap. Rep.* 34, 73–80.

Dantzer, R., Mormède, P., 1983. Stress in farm animals: a need for reevaluation. *J. Anim. Sci.* 57 (1), 6–18.

De, K., Kumar, D., Saxena, V.K., Thirumurugan, P., Naqvi, S.M.K., 2017. Effect of high ambient temperature on behavior of sheep under semi-arid tropical environment. *Int. J. Biometeorol.* 61 (7), 1269–1277.

Færevik, G., Andersen, I.L., Bøe, K.E., 2005. Preferences of sheep for different types of pen flooring. *Appl. Anim. Behav. Sci.* 90, 265–276.

Fazio, F., Casella, S., Giannetto, C., Giudice, E., Piccione, G., 2016. Erythrocyte osmotic fragility in response to a short road transport in cattle, horses, and goats. *J. Thermal. Biol.* 12, 82–84.

Fidan, A.F., Kucukkurt, I., Eryavuz, A., Cigerci, I.H., Yardimci, M., Ozdemir, A., 2009. Effects of shearing procedures on oxidant/antioxidant status in Chios sheep. *Rev. Med. Vet.* 160 (7), 349–355.

Giannetto, C., Arfuso, F., Fazio, F., Giudice, E., Panzera, M., Piccione, G., 2017. Rhythmic function of body temperature, breathing and heart rates in newborn goats and sheep during the first hours of life. *J. Vet. Behav.: Clin. Appl. Res.* 18, 27–36.

Giannetto, C., Fazio, F., Alberghina, D., Assenza, A., Panzera, M., Piccione, G., 2015. Different daily patterns of serum cortisol and locomotor activity rhythm in horses under natural photoperiod. *J. Vet. Behav.: Clin. Appl. Res.* 10, 118–121.

Giannetto, C., Fazio, F., Vazzana, I., Panzera, M., Piccione, G., 2012. Comparison of cortisol and rectal temperature circadian rhythms in horses: the role of light/dark cycle and constant darkness. *Biol. Rhythm Res.* 2012 (43), 681–687.

Glenn, J., Larson, S., Markegard, G., Nelson, A., Phillips, R., Price, E., Stull, C., 1996. Sheep care practices. In: Beall, G. (Ed.), *Sheep Workgroup, Animal Care Series*. University of California Cooperative Extension Davis.

Gowane, G.R., Chopra, A., Misra, S.S., Prince, L.L.L., 2014. Genetic diversity of a nucleus flock of Malpura sheep through pedigree analyses. *Small Rumin. Res.* 120, 35–41.

Leme, T.M.C., Titto, E.A.L., Titto, C.G.A., Pereirab, A.M.F., Netoc, M.C., 2013. Influence of stocking density on weight gain and behavior of feedlot lambs. *Small Rumin. Res.* 115, 1–6.

Marai, I.F.M., El-Darawany, A.A., Fadiel, A., Abdel-Hafez, M.A.M., 2007. Physiological traits as affected by heat stress in sheep—a review. *Small Rumin. Res.* 71, 1–12.

Martin, P., Bateson, P., 1993. *Measuring Behaviour: An Introductory Guide*. Cambridge University Press, UK.

Mears, G.J., Brown, F.A., Redmond, L.R., 1999. Effects of handling, shearing and previous exposure to shearing on cortisol and β -endorphin responses in ewes. *Can. J. Anim. Sci.* 79, 35–38.

Miranda-de la Lama, G.C., Salazar-Sotelo, M.I., Pérez-Linares, C., Figueroa-Saavedra, F., Villarroel, M., Sañudo, C., María, G.A., 2012. Effects of two transport systems on lamb welfare and meat quality. *Meat Sci* 92 (4), 554–561.

Mousa-Balabel, T.M., Salama, M.A., 2010. Impact of shearing date on behaviors and performances of pregnant Rahmani ewes. *Int. J. Anim. Vet. Sci.* 4 (5), 367–371.

Muñoz-Osorio, G.A., Aguilar-Caballero, A.J., Sarmiento-Franco, L.A., Wurzingler, M., Gutiérrez-Reynoso, G.A., 2017. The effect of two housing systems on productive performance of hair-type crossbreed lambs in sub-humid tropics of Mexico. *J. Appl. Anim. Res.* 45 (1), 384–388.

Naqvi, S.M.K., De, K., Gowane, G.R., 2013. Sheep production system in arid and semi-arid regions of India. *Ann. Arid Zone* 52 (3&4), 1–9.

Piccione, G., Caola, G., Refinetti, R., 2002. Effect of shearing on the core body temperature of three breeds of Mediterranean sheep. *Small Rumin. Res.* 46, 211–215.

Piccione, G., Rizzo, M., Giannetto, C., 2017. Reducing the stress response of alpacas during shearing. *Vet. Rec.* 180, 566–567.

Richmond, S.E., Wemelsfelder, F., Beltran de Heredia, I., Ruiz, R., Canali, E., Dwyer, C.M., 2017. Evaluation of animal-based indicators to be used in a welfare assessment protocol for sheep. *Front. Vet. Sci.* 4, 210.

Teixeira, D.L., Miranda-de la Lama, G., Villarroel, M., Olleta, J.L., García-Belenguer, S., Escós, J., María, G.A., 2015. Effects of alternative bedding substrates on lamb welfare, productive performance, and meat quality during the finishing phase of fattening. *J. Vet. Behav.: Clin. Appl. Res.* 10, 171–178.