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Short communication

Berseem hay supplementation to improve productivity of Bundelkhandi goats in winter season

Deepak Upadhyay[1*], Pooja Tamboli[1], Anup Kumar[1], K. K. Singh[1] and S. K. Mahanta[2]

[1]ICAR-Indian Grassland and Fodder Research Institute, Jhansi-284003, India
[2]ICAR-Indian Agricultural Research Institute, Gauriakarma-825405, India
[*]Corresponding author email: dpkvet@gmail.com

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Abstract

The study was conducted to determine the effect of berseem hay supplementation on the productive performances of goats in the winter season. About 20 Bundelkhandi male goats were selected and fed either on conventional feeding (control group, n = 10) and improved diet (treatment group, n = 10). The control group fed on conventional grazing (8 hours) + conc. mixture @ 1.0% of BW while the treatment group was fed on conventional grazing (8 hours) + conc. mixture @ 1.0% of BW + quality berseem hay (300 g/head/d). The Meteorological variables, feed intake, body weight, nutrient digestibility and physiological parameters (rectal temperature, head surface temp, pulse rate, respiration rate) were measured. The climatic variable suggested that during December and January month animals were under cold stress. There was no significant difference between groups for physiological parameters. However, during peak winter, rectal and head temperatures were recorded in the lower range in both groups during the evening. The body weight gain in goats fed with the treatment diet was significantly (p <0.05) higher as compared to the control group. It was concluded that the supplementation of berseem hay (300 g/h/d) in male Bundelkhandi goats resulted in improvement in protein (8.07 vs. 10.05, g/kg $W^{0.75}$) intake with a positive impact on body weight gain without any significant effect on physiological parameters during the winter season.

Keywords: Berseem hay, Bundelkhandi, Cold stress, Goat, Performances

India is bestowed with a huge livestock population as well as diverse livestock breeds. Livestock rearing has been proved as a tool to mitigate risks associated with agriculture. The marginal and landless population of the country relies heavily on livestock rearing for their livelihood, nutrition and income (Shinde and Mahanta, 2020). Particularly, goat farming is popular among different states of the country, as they are easily adaptable to varied climatic and geographical situations. This is the reason the goat is also recognized as a 'poor man's cow'. Bundelkhandi goat is black colored, medium-sized goat, primarily reared for meat purposes, mainly under the extensive system (Verma *et al*., 2010). They are hardy and well-adapted to the harsh climatic conditions of the Bundelkhand region. However, more extreme climatic variations should be taken care of with anticipated future climate change. Environmental temperature (below or above the threshold) can affect the productivity of goats due to thermal stress (Al-Tamimi, 2007). It includes both heat stress during the extreme summer season as well as cold stress during the extreme winter season. Different physiological parameters like metabolic rates, heart rates and other important factors within the animal body are determined by temperature, so an extreme temperature change can easily distress the animal body. In the Bundelkhand region, temperature crosses its threshold both in summer (very high) and winter (very low) seasons. Goats in India can suffer from heat and cold stress beyond the range of comfort zone, *i.e*., 13 to 27°C (Mishra, 2009). Therefore, there was a need to improve productive performance by overcoming climatic stress. One of the strategies is nutritional intervention, which plays a crucial role in livestock rearing. So at given outset, the study was designed to improve the productive performances of goats during the winter season through nutritional interventions.

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This study was conducted in the Small Ruminant Unit at ICAR-Indian Grassland and Fodder Research Institute, Jhansi, India. The study area is located in a humid-subtropical region at an altitude of 271 m above the mean sea level, at the latitude of 25°27′ north and longitude of 78°35′ east. Summer and monsoon seasons extend from early April to October, with an average annual rainfall of approximately 742.6 mm and extreme temperatures up to 47°C. Winter season commences in October, and minimum temperature up to 4°C reaches in January. The monthly mean temperature ranges from 14 to 33°C. Extreme temperatures range from as high as 45 to 49°C in May-June and as low as 0 to 1°C in December-January. Bundelkhandi male goats with a mean body weight of about 18.60 ± 0.28 kg were selected for the experiment. Based on age and body weight, they were randomly distributed into two groups (10 animals under each group): The control group, *i.e.*, conventional feeding and the treatment group, *i.e.*, improved feeding. In the winter season, the control group fed on conventional grazing (8 hours) + conc. mixture @ 1.0% of BW, while the treatment group was fed on conventional grazing (8 hours) + conc. mixture @ 1.0% of BW + quality berseem hay (300 g/head/d). The meteorological variables like temperature and relative humidity were recorded for every month using standard methodology and THI was calculated as per the formula-

THI = (1.8 × T + 32) -(0.55- 0.0055 × RH) × (1.8 × T- 26)

Where T = air temperature in °C and RH = relative humidity in percent

Feed intake was calculated by the difference in the amount of feed offered and residue on a weekly basis. Nutritional digestibility was estimated through seven days digestion trial. The nutrient composition of feed and feces was estimated through proximate analysis, according to AOAC (2012). Physiological parameters like rectal temperature (^{0}F), head surface temp (^{0}F), pulse rate (beats/minute), and respiration rate (breaths/min) were measured on a monthly basis. Body weight was recorded fortnightly, early in the morning before feeding. The difference with the previous week's weight calculated body weight gain. The information collected by the datasheet was pooled and analyzed as per standard statistical procedure (Snedecor and Cochran, 1994).

The average climatic parameters were recorded during the experimental periods (Table 1). During winter season (December to February), the average temperature ranged from 15 to 18°C, average relative humidity varied from 65 to 74% and THI was recorded between 59 to 61. The lowest temperature recorded was 4.4°C during 3rd week of December. Further, shed temperature was also significantly lower during the month of January. This indicated that animals were under cold stress during the month of December and January. Indeed, Jhansi is a district of Uttar Pradesh State that lies in the Bundelkhand region. This region experiences very high ambient temperatures during summer and very low temperatures during winter. This huge seasonal difference in the environmental temperature poses a challenge to the animals to cope with conditions in the summer and winter seasons. Colder climate increase the maintenance requirement of animal by 20% (NRC, 2007). Therefore, it can affect the productivity and growth of animals. Although goats are adaptable to wide climatic situations, they have also been reported to suffer from cold temperatures with different degrees of thermal tolerance (Bøe and Ehrlenbruch, 2013). The LCT of castrated male feral goats fed at the maintenance level was found to be 9°C.

No significant difference was observed between groups for physiological parameters (Table 2). Rectal temperature and head surface temperature were higher in the evening as compared to morning hours except during January, where the opposite trend was observed. It indicated that during January, animals in both groups were equally affected with the cold conditions. Physiological parameters (rectal temperature, pulse rate, respiration rate) are vital to illustrate the mechanism of physiological adaptation. Core temperature indicates the heat tolerance capacity of the animal. In our study, rectal temperature variations were low between months and groups. This indicated the animals were able to tolerate the low temperature in the winter month except during a sharp decline in temperature. Some researchers also reported that body temperature exhibits minimal variation in several stress conditions (Barhanu *et al.*, 1994; Derman and Noakes, 1994). However, variations of rectal temperature with the environmental temperature were also reported (Marai *et al.*, 2007). Differences in morning and evening temperatures suggest that during January month body temperature reduced due to the colder climate in the evening. Similar results were obtained after 6 hours of

Table 1. Average temperature, humidity and THI during the winter period

Month	Temperature (°C)	Relative humidity (%)	THI* (range)	Shed temperature (°C)		
				Maximum	Minimum	Average
December	15.63 ± 0.88	74.62 ± 1.13	59 (57–61)	21.31 ± 0.35	14.87 ± 0.48	18.09 ± 0.38
January	14.86 ± 0.68	74.12 ± 0.88	58 (57–60)	19.12 ± 0.41	12.68 ± 0.42	15.90 ± 0.38
February	17.95 ± 1.14	65.12 ± 1.68	61 (59–63)	25.79 ± 0.39	15.61 ± 0.35	20.70 ± 0.36

*THI: Temperature-humidity index

Table 2. Physiological responses during the winter month

Month	Group	Rectal temperature (ºF)		Head surface temperature (ºF)		Pulse rate		Respiration rate	
		Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
December	Control	102.3 ± 0.2	102.9 ± 0.2	95.8 ± 0.7	97.5 ± 0.1	91.6 ± 1.8	92.1 ± 2.7	24.9 ± 1.0	25.5 ± 1.4
	Treatment	101.9 ± 0.2	102.7 ± 0.1	93.5 ± 0.8	98.0 ± 0.1	92.0 ± 1.4	92.8 ± 3.3	25.4 ± 1.1	26.9 ± 3.4
January	Control	101.1 ± 0.1	100.8 ± 0.2	92.7 ± 0.2	83.3 ± 0.1	105.3 ± 3.9	105.8 ± 5.3	21.3 ± 0.8	24.0 ± 3.2
	Treatment	101.1 ± 0.1	100.8 ± 0.3	92.8 ± 0.5	84.0 ± .01	102.9 ± 3.0	103.4 ± 4.3	25.5 ± 1.0	26.8 ± 4.1
February	Control	101.2 ± 0.1	103.3 ± 0.2	94.9 ± 0.7	96.7 ± 0.4	96.3 ± 1.6	97.1 ± 3.3	24.0 ± 0.6	25.3 ± 2.3
	Treatment	101.4 ± 0.2	103.2 ± 0.2	96.3 ± 0.5	97.5 ± 0.5	97.05 ± 1.8	96.3 ± 5.6	24.9 ± 0.6	26.8 ± 2.1

exposure to 4.5°C in Coopworth × Texel sheep (Verbeek *et al*., 2012).

Dry matter intake (g/d) and DMI (g/kg $W^{0.75}$) were not significantly (p >0.05) different between control and treatment group (Table 3). Herbage intake was significantly (p <0.01) lower in the treatment group. However, CP intake was found to be significantly (p <0.01) higher in the treatment group as compared to control group. Digestibility of DM, OM and Cellulose were not significantly (p >0.05) different between the groups. But digestibility of NDF and ADF were significantly (p <0.01) lower in treatment group. Similar to our results no effect of cold climate on DM intake was reported in Murciano-Granadina goat (García *et al*., 2020). Additionally, Bøe and Ehrlenbruch (2013) reported that inclement cold weather had no effect on time spent feeding in goats. It was reported that rumen volume decreased during cold temperature (Chase, 2016). No effect on DM intake could also be explained as the severity of cold in the current study was not enough to induce a change in DM intake (García *et al*., 2020).

Initial body weight (December) was 18.60 ± 0.33 and 18.61 ± 0.43 kg in the control and experimental group, respectively. Final body weight (January) was 20.56 ± 0.40 and 21.39 ± 0.40 kg in the control and experimental group, respectively. The body weight gain in goats fed with an experimental diet was significantly (p <0.05) higher despite similar DM intake. This indicated that goats in the control group converted fat reserves to maintain their body temperature, compromising their weight gain. Increased NEFA levels in cold-exposed animals indicated the mobilization of fat reserve for energy production (García *et al*., 2020). Magee (1924) showed that the heat production rate (cal/h) was increased when the ambient temperature was below 13°C in dry, pregnant goats.

It was concluded that during the winter season, THI reached to lower critical limit, resulting in cold stress and supplementation of berseem hay (300 g/h/d) in Bundelkhandi goats resulted in improvement in protein (8.07 *vs* 10.05 g/kg $W^{0.75}$) consumptions with a positive impact on body weight gain. However, there was no significant effect of treatment on physiological parameters.

Table 3. Feed intake and nutrients digestibility in experimental goats

Attributes	Control	Treatment
Concentrates (g/d)	185	185
Berseem hay(g/d)	0	265
Herbage (g/d) **	480.6	223.7
Feed (DM) intake (g/d)	665.6	673.7
DMI (kg/100 kg wt)	3.39	3.35
DMI (g/kg $W^{0.75}$)	72.27	70.99
Digestibility (%)		
DM	65.26	64.15
OM	66.38	66.54
NDF**	58.02	53.19
ADF**	46.21	40.32
Cellulose	57.32	52.38
CP**	64.32	68.08
Nutrient Intake (g/kg $W^{0.75}$)		
CP**	8.07	10.50
TDN	46.47	46.07

**(p <0.01)

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