Impact of different housing modification systems on growth performance and feed intake of Gir calves during winter season

Maya Jat¹, Ram Prasad Jat¹, Vinod Bhateshwar², Vinod Kumar Paswan² and Hanuman Lal Nehra¹

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Abstract: The current study was carried out to investigate the impact of different housing modification systems on growth performance and feed intake of Gir calves during winter season. Selected 24 Gir calves of 12 months old were randomly divided into three homogenous modified housing groups containing with eight calves in each viz., group GC-1: conventional barn (during night) + open paddock (during day), GC-2: conventional barn + rubber mat and GC-3: loose house + curtains (during night). The concentrate supplement was given 1.5 kg/calve/day as pellet feed, green lucerne (*Medicago sativa*) 2.5 kg/calve/day and wheat straw (*Triticum aestivum*) *ad lib* as dry fodder. During the statistical analysis, the mean of morning minimum temperature ($P<0.05$) was higher in GC-2 (11.81°C) over than GC-3 (11.27°C) and GC-1 (10.64°C) and the morning maximum temperature was significantly higher in GC-3 (22.97°C), which was above than groups GC-2 (22.39°C) and GC-1 (22.21°C). However, the mean value of the evening minimum temperature was significantly lower in GC-1 (11.67°C) followed by GC-3 (11.86°C) and GC-2 (12.40°C) and the evening maximum temperature was highest in GC-1

(24.95°C) followed by GC-3 (23.98°C) and GC-2 (23.54°C). The average mean of both relative humidity (RH) percent and temperature humidity index (THI) along with morning and evening times was ($P<0.05$) higher in GC-2 than GC-1 and GC-3 groups. However, total dry matter intake, voluntary water intake and feed conversion efficiency were significantly higher in the GC-1 group compared to the calves in the GC-2 and GC-3 groups. The initial body weight of the calves was similar as 122.37, 121.13 and 121.88 kg in GC-1, GC-2 and GC-3 groups. However, the final body weight of the calves was significantly ($P<0.05$) highest in group GC-1 (170.12 kg) followed by GC-2 (163.61 kg) and GC-3 (162.36 kg) respectively. The average daily weight gain was significantly achieved by GC-1 (530.90 g/day) followed by GC-2 (472.05 g/day) and GC-3 (449.88 g/day). It was concluded that the housing modification system can be effectively used to improve the growth performance, feed intake and sheds micro-climate of Gir calves during the winter season.

Keywords: Body weight; Feed efficiency; Feed intake; Gir calves; Housing modification; Micro-climate

Housing is one of the foremost requirements of dairy animals for better production, health and welfare. Housing protects animals from adverse climatic conditions, provides comfort for resting, eating, drinking, walking and prevents injury and disease (Anderson, 2002). The calves growth may be adversely affected by the environmental stress during management practices (Laxmi et al. 2013). Dairy cow shelters will be designed to modify the micro environment and protect the animals from severe weather conditions to reduce peak stress levels (Sinha et al. 2018). Kumat et al. (2016) reported that loose housing modified shed were improved productivity during the autumn and winter seasons. Therefore, the present investigation was conducted to assess the impact of different housing modification systems on growth performance and feed intake of Gir calves during winter season.

The current study was carried out on the dairy farm of Sri Karan Narendra Agriculture University, Jobner (Rajasthan) from November 2019 to March 2020, with the total duration of the experiment being 105 days, i.e. first preliminary (adaptation) period

¹Department of Livestock Production Management, Sri Karan Narendra Agriculture University, Jobner- 303 329, Rajasthan, India

²Department of Dairy Science and Food Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi- 221 005, Uttar Pradesh, India

Vinod Bhateshwar (✉)

Department of Dairy Science and Food Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India

E-mail: vinod.bhateshwar@bhu.ac.in

for 15 days and the next 90 days of actual trail period. Twenty-four healthy Gir calves of both sex with approximately the same body weight (121.79 ± 18.76 kg) and 12 months old were selected. The calves were randomly divided into three identical modified housing groups with eight calves in each group viz., group GC-1: conventional barn (during night) + open paddock (during day), GC-2: conventional barn + rubber mat and GC-3: loose house + curtains (during night). The following changed housing conditions were used for all groups during the experimental period: GC-1 group of calves were tied at the neck with iron-chains, fed individually and allow open paddocks during the day (08:00 am to 05:00 pm) and closed at night in winter (05:00 pm to 08:00 am). GC-2 group the conventional barn is completely closed structure as roofed and walls are also complete with windows and ventilators to get proper ventilation and lighting. The calves were tied to their neck with iron-chains and the rubber mat was laid on the floor in this barn to protect them from the cold. The calves in the GC-3 group were kept in the loose house for around 24 hours. The loose house had a covered area with simple asbestos sheet roofs and an open area paved with kaccha brick, which surrounded on three sides by 1.5 meters high walls, but gunny bag curtains were fitted in the open front side, only made available to the calves at night. Twice a day (10:30 am and 4:00 pm) the experimental calves received a basic diet with dry fodder as wheat straw (*Triticum aestivum*) *ad lib* and green lucerne (*Medicago sativa*) 2.5 kg/calve/days as green fodder and 1.5 kg concentrate as pellet feed with free access to water. The concentrate mixture contained 19.26% crude protein, 3.60% ether extract and 6.22% crude fiber.

Meteorological observations such as maximum, minimum, dry and wet bulb temperatures of different modified sheds were recorded daily at 07:30 am and 02:30 pm during the experiment. The relative humidity (RH) was calculated using the hygrometric tables (Indian Meteorological Department, Pune) from the readings of the dry and wet thermometer. The Temperature

Humidity Index (THI) was calculated according to the formula of McDowell (1972).

$$THI = 0.72 (\text{dry bulb temperature } ^\circ\text{C} + \text{wet bulb temperature } ^\circ\text{C}) + 40.6$$

The amount of green fodder (lucerne), dry fodder (wheat straw) and concentrate (pellet feed) were offered to the animals and the leftover was weighed on two consecutive days at weekly intervals during the experiment for analysis of dry matter intake (DMI). The samples of feed and fodder were analyzed for proximate principles (AOAC, 2000). The calves voluntary water intake was recorded once a week, morning and evening by offering a measured quantity of clean and fresh water through a measured/ marked bucket during the experiment. All calves were weighted at the beginning and monthly intervals as well as at the end of the experiment. The body weights of the calves were recorded in the morning at 08:00 am before providing water and feed. Fasting before weighing was done in an attempt to reduce the gut fill and thereby minimizing the weight fluctuations.

In the present study, the mean of the morning minimum temperature was significantly ($P < 0.05$) higher in GC-2 (11.81°C) over than GC-3 (11.27°C) and GC-1 (10.64°C) groups. The morning minimum temperature was higher in the conventional barn (GC-2) as compared to the loose house (GC-3) due to the protection against the cold through the maximum area enclosed by a wall. The average morning maximum temperature was significantly higher ($P < 0.05$) in GC-3 (22.97°C) than in GC-2 (22.39°C) and GC-1 (22.21°C). However, the mean value of evening minimum temperature was recorded significantly lower in GC-1 (11.67°C) followed by GC-3 (11.86°C) and GC-2 (12.40°C). While the average means value of the evening maximum temperature was noted significantly in GC-1 (24.95°C) then followed by GC-3 (23.98°C) and GC-2 (23.54°C). The average mean Relative Humidity (RH) percent in both morning and evening times was significantly

Table 1 Average dry matter intake (DMI) and voluntary water intake (VWI) in Gir calves

Parameters	GC-1	GC-2	GC-3
DMI, kg/day			
Wheat straw	$2.32^a \pm 0.01$	$2.04^b \pm 0.01$	$1.92^c \pm 0.03$
Green lucerne	$0.61^a \pm 0.00$	$0.61^a \pm 0.00$	$0.61^a \pm 0.00$
Concentrate mixture	$1.35^a \pm 0.00$	$1.35^a \pm 0.00$	$1.35^a \pm 0.00$
Total DMI	$4.28^a \pm 0.01$	$4.00^b \pm 0.01$	$3.88^c \pm 0.01$
DMI kg/100 kg BW	$2.93^a \pm 0.08$	$2.80^b \pm 0.09$	$2.77^{bc} \pm 0.13$
VWI, lit			
Morning	$4.64^a \pm 0.04$	$4.51^{ab} \pm 0.03$	$3.65^c \pm 0.03$
Evening	$7.55^a \pm 0.04$	$6.65^b \pm 0.04$	$6.68^b \pm 0.04$
VWI/day	$12.19^a \pm 0.05$	$11.16^b \pm 0.05$	$10.33^c \pm 0.04$
VWI/kg DMI	$2.85^a \pm 0.02$	$2.81^{ab} \pm 0.02$	$2.71^c \pm 0.03$

a, b and c means with different superscripts are significantly different ($P < 0.05$) in a row

Table 2 Feed conversion efficiency in Gir calves (twelve months to fifteen months)

Attributes	GC-1	GC-2	GC-3
Initial weight (kg) at 365 days	122.37 ^a ±4.92	121.13 ^b ±6.32	121.88 ^{bc} ±8.96
Final weight (kg) at 455 days	170.12 ^a ±14.16	163.61 ^b ±12.65	162.36 ^c ±10.98
Total gain (kg) in 90 days	47.78 ^a ±0.53	42.48 ^b ±0.54	40.48 ^c ±0.76
Average daily gain (g/day)	530.90 ^a ±24.21	472.05 ^b ±38.84	449.88 ^c ±26.49
Total feed intake (wheat straw + green lucerne + concentrate) (kg) in 90 days	385.20 ^a	360.00 ^b	349.20 ^c
Feed efficiency (%)	12.40 ^a	11.80 ^b	11.59 ^c

a, b and c means with different superscripts are significantly different ($P < 0.05$) in a row

($P < 0.05$) higher in GC-2 (80.92% and 62.10%) over than in GC-1 (77.44% and 59.20%) and GC-3 (75.78% and 57.60%). The wide gap in the morning relative humidity may be due to frequent water supplies and morning washing of the animal shed. The values of the Temperature Humidity Index (THI) were recorded both in the morning and evening times significantly ($P < 0.05$) higher in GC-2 (61.35 and 70.00) than in the GC-1 (60.15 and 66.68) and GC-3 (59.11 and 65.47) groups respectively. Similar trends were observed in calves and heifers through various houses modifications in winter concerning temperature, RH and THI by (Jat et al. 2003; Jat and Yadav, 2010; Kailash et al. 2018). While, Shekhawat and Choudhary (2012) reported different trends during the winter season in their study of lactating crossbred cows, which could be due to variations in the place or the location system of housing.

The average daily total dry matter intake (TDMI) of calves in different groups is presented in (Table 1). However, the TDMI (kg/day) and DMI (kg/100kg BW) during the experiment were significantly ($P < 0.05$) higher in GC-1 (4.28±0.01 kg and 2.93±0.08 kg) compared to calves of the GC-2 and GC-3 groups. The higher DMI in both groups GC-1 and GC-2 than in the GC-3 group may be due to protection from cold winds that resulted in better growth by diverting the nutrients for growth. Similar results were obtained in the different studies by (Jat et al. 2003; Kailash et al. 2017). However, in another study according to (Lowe et al. 2019) floor type, as a completely slatted concrete floor or a completely slatted concrete floor covered with rubber strips, had no significant effect on forage or total dry matter intake over the entire trial period.

The results (Table 1) showed that the average daily voluntary water intake (lit/day) and voluntary water intake (kg/DMI) were significantly ($P < 0.05$) higher in both groups GC-1 (12.19±0.05 lit. and 2.85±0.02 lit.) and GC-2 (11.16±0.05 lit. and 2.81±0.02 lit.) than in group GC-3 (10.33±0.04 lit. and 2.71±0.03 lit.). The VWI is mostly connected to the DMI of the animals, there was a positive correlation between the water intake and the DMI of Gir calves. Similar results were obtained by Jat et al. (2003) and Kailash et al. (2017).

The results of table 2 revealed that the initial (365 days of age) body weight of Gir calves were similar as 122.37±4.92, 121.13±6.32

and 121.88±8.96 kg in group GC-1, GC-2 and GC-3 respectively and the corresponding final body weight at 455 days of age in groups GC-1, GC-2 and GC-3 has significantly differed 170.12±14.6, 163.61±12.65 and 162.36±10.98 kg. The findings of the present result are in agreement with Kailash et al. (2018) who reported that the body weight of calves significantly improved conventional barn with an open shed during the winter season under semi-arid environmental conditions.

The average daily weight gain (ADG) as depicted in table 2 indicates that the significantly ($P < 0.05$) higher rate in GC-1 (530.50±24.21 g/day), which was over than GC-2 (472.05±38.84 g/day) and GC-3 (449.88±26.49 g/day) groups. Similarly, Jat and Yadav (2010) and Kailash et al. (2017) observed that protecting buffaloes and cross-bred cows calves from cold stress during the winter season improved calves growth performance.

The total feed intake during 90 days found out highest in Gir calves of GC-1 (385.20 kg) followed by GC-2 (360.00 kg) and lowest in GC-3 (349.20 kg) respectively (Table 2). However, the highest feed conversion efficiency percent was recorded in GC-1 (12.40%) over than GC-2 (11.80%) and GC-3 (11.59%) groups. This feed conversion efficiency percent was better in GC-1 due to the higher growth rate as well as the physical comfort and higher feed intake of these calves the during winter season. The findings of the present study agree with Yadav et al. (1990) and Jat and Yadav (2010) observed that during the winter season a higher feed intake and body weight were observed in buffaloes calves in a conventional closed barn with open house rearing. However, Lowe et al. (2019) reported that using concrete slats or rubber covered slats did not affect bulls feed conversion efficiency.

Conclusions

Therefore, it is concluded that the conventional barn during night time and open paddock during day time ameliorate the cold stress and improved feed intake, feed conversion efficiency, water intake, body growth and average daily gain of Gir calves compared to other housing modified systems during the winter season in the semi-arid zone of Rajasthan.

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