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Effect of modified housing on behavioural and physiological responses of crossbred cows in hot humid climate

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ABSTRACT

The present study was carried out to investigate the effect of modified housing on behavioural and physiological responses of 16 lactating cows during hot humid season. Data on various parameters such as activity patterns of feeding, rumination, lying and standing time, rectal temperature, respiration rate, pulse rate and skin temperature were recorded. Analysis revealed that cow comfort, resting time, time spent on feeding and rumination were significantly higher in modified shed (G2) as compared to existing loose shed (G1). Respiration and pulse rate were significantly lower in G2 as compared to G1. Frequency of lying bouts significantly decreased while the duration of lying bouts increased in G2 as compared to G1 group. It was concluded that the cows housed in modified shed were more comfortable and had improved physiological reactions and behavioural responses during hot-humid season as compared to cows housed in existing shed.

Key words: Behavioural response, Cow comfort, Lying time, Physiological parameters, Shelter modifications

Housing is one of the major factors that reflect the production performance, health status, and behavioural expression of dairy cows. Modification of housing during adverse climatic condition can protect the animal from heat stress, which can decrease lying and rumination time. Heat stress decreases dry matter intake, increases respiration rate, skin temperature, rectal temperature and behaviour in dairy cattle (Mitlohner *et al.* 2001, West *et al.* 2003). Modification of shelter significantly improves the behavioural activity and reduces the skin temperature and respiration rate within the physiological limit (Haley *et al.* 2000, Kendall *et al.* 2007). Loose housing system provides optimum space and *ad lib.* feed resources to the animal, which have less competition for feed resources (Grant and Albright 2001). Lying of dairy animal has a high priority and cows spent more time on lying than feeding (Munksgaard *et al.* 2005). Dairy animals can change both behavioural and physiological responses when they are subjected to discomforting of their lying surface (Fisher *et al.* 2002). Keeping in view these facts, the present investigation was carried out to study the effect of modified housing on behavioural and physiological responses of crossbred lactating cows in hot humid climate.

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MATERIALS AND METHODS

The present investigation was conducted on Karan Fries crossbred lactating cows maintained at Livestock Research Centre, ICAR-NDRI, Karnal for a period of four months (July to October 2015) during hot humid season. All experimental procedures were approved by the Institutional Animal Ethics committee. Sixteen randomly selected cows were divided into two groups (eight in each group) on the basis of similarity in parity and lactation yield. In group 1, animals were housed under loose housing system, which consist of covered floor area made up of concrete cement, brick paved open floor area, elevated feeding manger and asbestos roof at a height of 12 ft and width of 10 ft. In group 2, animals were housed under modified shed characterized by raising the roof height to 15 feet and width to 20 feet. It consisted of fenceline feeding manger, time-controlled foggers with high speed fans and sand bedding in open paddock and half of covered area to alleviate the heat stress. The maximum and minimum thermometer (OMSONS™), dry and wet bulb thermometer (OMSONS™) and four CCTV cameras (Dahua Technologies) were installed in open and covered area of both shed and data on microclimatic variables were recorded. The temperature humidity index (THI) was calculated by using the U.S. Weather Bureau formula (McDowell 1972).

$$THI = 0.72\ (Cdb + Cwb) + 40.6$$

Where, Cdb is dry bulb temperature (ºC) and Cwb is wet bulb temperature (ºC).

The average time spent by animal in shed was 18:38 h and the rest 5:22 h were spent in going to the milking parlour for milking thrice in a day. The behavioural observation such as time spent for eating, rumination, lying and standing time, frequency of feeding and laying bouts, feeding and lying bout duration were calculated from CCTV digital video recording cameras (Dahua Technologies) as time spent in shed. The times spent by animals outside the shed during milking, washing, weighing etc were not taken into consideration for behavioural studies.

Physiological parameters such as rectal temperature, skin temperature, respiration rate and pulse rate were recorded at weekly interval as per standard protocol.

Statistical analysis: The data recorded on microclimatic variable were analysed by One Way Analysis of Variance (ANOVA) and means between groups were compared using Duncan's multiple range test. The data on behaviour and physiological parameters were analyzed by paired *t*-test.

RESULTS AND DISCUSSION

Microclimatic variable: The mean maximum temperature was significantly (P<0.05) lower in modified shed (group 2) as compared to existing loose shed (group 1). The maximum temperature was reduced to the extent of around 6.35ºC in the group 2 in comparison to open paddock and to the extent of 2.31ºC in comparison to the group 1. Present results were in agreement with findings of Frazzi *et al.* (2000), who reported that reduction in shed temperature by provision of fan and misting in dairy cattle houses due to its evaporative cooling system. Verma *et al.* (2015) and Vijaykumar *et al.* (2009) reported that, use of sprinkler and cooling jacket in combination with force ventilation helped to ameliorate the thermal stress in Murrah buffalo under loose housing system during hot humid season. Reduction of temperature in hot humid season in the present findings may be due to increased height and width of the roof as well as cooling system by using foggers and fans. Inadequate ventilation and housing system reduce milk production up to 25% in summer in dairy cows (Bucklin *et al.* 2000).

The mean THI value was significantly lower (P<0.01) in group 2 as compared to group 1 (Table 1). However, the means THI values recorded in two types of shed were significantly (P<0.01) lower than that found in the open paddock. The average THI values in present findings were higher than normal (THI=72) value in both types of sheds. Pennington and Deven (2010) classified the THI values in dairy cattle as mild stress (THI=72 to 79), moderate stress (THI=80 to 89) and severe stress (THI=90 to 99), respectively. Hence the overall mean THI value obtained in modified shed were under mild stress and existing loose shed under moderate stress category. The results were in agreement with the reports of various authors (Khongdee 2010, Chandra *et al.* 2012, Verma *et al.* 2015) who reported reduction of THI values due to provision of cooling system with forced ventilation in dairy cattle; this might be due to lower relative humidity by using forced ventilation, resulting into better replacement of humid air by fresh air.

Table 1. Maximum, minimum temperature and temperature humidity index in shed of two group of animals

Parameter	Existing shed (G1)	Modified shed (G2)	Open paddock
Maximum temperature	$33.03^a \pm 0.87$	$30.72^b \pm 0.72$	$37.07^c \pm 1.10$
Minimum temperature	22.87 ± 1.22	20.25 ± 1.18	20.65 ± 1.31
Temperature humidity index	$80.96^a \pm 1.10$	$76.13^b \pm 1.04$	$84.97^c \pm 1.32$

[a,b,c]Mean with different superscripts in a row differ significantly (P<0.05).

Feeding and rumination behaviour: Time spent by cows on feeding and total rumination were significantly (P<0.01) higher in group 2 as compared to group 1, which reflects the feeding behaviour (Table 2). Cooper *et al.* (2007) and Madke *et al.* (2010) reported that, dairy cows on sand bedding, spent more time on feeding, rumination and lying compared to concrete floor, similar to present finding. However, there were non-significant differences between eating time of cows kept on concrete floor and rubber mattress (Rushen *et al.* 2007). Modification of housing and bedding material such as sand provide more comfortable environment for resting and rumination of dairy animals.

Lying and standing behaviour: Cows spent significantly (P<0.01) higher lying time in group 2 as compared to group 1 cows, whereas standing time was significantly (P<0.01) lower in group 2 cows (Table 3). The proportion of mean daily lying time was 6.8% (1:17 h) higher in group 2 cows as compared to group 1 cows. So it can be stated that housing modification provides the most comfortable environment. The finding of this study corroborrated with observation of Tucker *et al.* (2003) and Madke *et al.* (2010) who observed increased lying time in cows provided with sand bedding material, which increase cow comfort due to evaporative cooling and softness. Increase in ambient temperature beyond the limit can be evident from increase in standing time of dairy cow (Smith *et al.* 2012). Haley *et al.* (2001) reported that, when cows were given opportunity for both resting and feeding after long term deprivation it was observed that animal prefer more lying than feeding.

The duration of lying bouts were significantly (P<0.05) higher in group 2 as compared to group 1 cows, but lying bouts frequency did not differ significantly (Table 3). The duration of lying bouts was 10% more in group 2 as compared to the group 1. The results of present study were in close consensus with the results of Manninen *et al.* (2002) and Tucker *et al.* (2003) who found significantly higher average lying bouts in sand bedded cows as compared to concrete flooring.

Physiological responses: The average respiration and pulse rate per minute were significantly (P<0.01) lower in

Table 2. Feeding behaviour of crossbred cow housed under modified (8) and existing shed (8) during hot-humid season

Behavioural parameter	Existing shed (G1)		Modified shed (G2)		P-value
	Mean ± SE	Median	Mean ± SE	Median	
Eating time (min/day)	$321.85^a \pm 4.32$	323.68	$336.65^b \pm 3.80$	337.81	0.009
Sitting rumination (min/day)	$295.25^a \pm 6.37$	294.95	$348.46^b \pm 6.57$	352.49	<0.001
Standing rumination (min/day)	$98.61^a \pm 3.32$	100.87	$84.52^b \pm 3.34$	89.43	0.010
Feeding bouts (number/day)	$9.63^a \pm 0.32$	9.71	$8.61^b \pm 0.20$	8.49	0.007
Feeding bout duration (min/day)	23.02 ± 0.53	23.30	24.52 ± 0.52	23.77	0.097

^{a,b}Mean with different superscripts in a row differ significantly (P<0.01).

Table 3. Lying and standing behaviour of crossbred cow housed under modified (8) and existing shed (8) during hot-humid season

Behavioural parameter	Existing shed (G1)		Modified shed (G2)		P-value
	Mean ± SE	Median	Mean ± SE	Median	
Lying time (min/day)	$520.32^a \pm 6.67$	515.00	$596.95^b \pm 5.36$	598.00	<0.001
Standing time (min/day)	$599.25^a \pm 9.79$	599.31	$521.24^b \pm 9.55$	511.68	<0.001
Frequency of lying bouts (number/day)	9.27 ± 0.86	9.40	8.88 ± 0.53	8.80	0.300
Lying bouts duration (min)	$65.43^a \pm 1.15$	66.25	$71.77^b \pm 0.59$	72.30	<0.001

^{a,b}Mean with different superscripts in a row differ significantly (P<0.01).

Table 4. Physiological parameters of crossbred cow housed under modified (8) and existing shed (8) during hot-humid season

Physiological parameter	Existing shed (G1)		Modified shed (G2)		P-value
	Mean ± SE	Median	Mean ± SE	Median	
Rectal temperature (ºF)	101.00 ± 0.15	101.07	10.36 ± 0.19	01.57	0.180
Skin temperature (ºF)	94.84 ± 0.86	95.43	95.15 ± 0.98	95.25	0.810
Respiration rate (number/day)	36.88 ± 1.89	37.50	43.75 ± 1.85	46.08	0.017
Pulse rate (number/min)	75.09 ±1.28	75.30	80.21 ± 1.43	82.20	0.020

G2 group as compared to G1 group (Table 4). Rectal temperature and skin temperature were statistically nonsignificant between groups. Ankush *et al.* (2014) reported that pulse rate decreased in dairy cattle kept under shower inside the shed. Similar to present findings, Boonsanit *et al.* (2010) and Chanpongsang *et al.* (2010) reported that physiological parameters such as respiration rate, pulse rate etc decreased due to the provision of foggers in dairy cows. These results were in agreement with the findings of other researchers (Gupta *et al.* 2004, Chaiyabutr *et al.* 2011) who reported that mattress bedding was more comfortable as compared to concrete flooring in terms of physiological responses of dairy cows.

The present findings concluded that cows housed under modified shed were more comfortable and had improved physiological reactions and behavioural pattern during the hot humid season. Animals spent more time on eating with better feeding temperament score and rumination time under modified house as compared to existing loose housing, which reflects more comfortness and normal behaviour. Thus present study indicated that sand bedding with fogger ameliorate heat stress with normal physiological parameter during hot-humid season and do not exhibit any discomfort to dairy cows.

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