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THI and health estimates of Jersey crossbred calves reared in different housing system in the lower Gangetic plains of West Bengal

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ABSTRACT

Housing and socialization have always played a pivotal role on overall health and welfare of the young calves. Therefore, the study was undertaken to compare the performance of the calves when kept indoors in enclosures (Treatment, T) versus semi covered houses with provision of open space (Control, C), respectively. Calves in semi covered houses (C) was found to display profound results on faecal score ($P<0.01$) and body weight ($P<0.05$). Besides, the housing temperature in the treatment sheds was significantly higher ($P<0.01$) during the mornings in monsoon season although humidity was reportedly higher at all seasons; monsoon ($P<0.01$), post monsoon ($P<0.05$) and winters ($P<0.01$), respectively. The greatest THI were recorded in the month of July (76.72) in Control group (C) and August (79.67) in Treatment group. Besides with the highest THI (74.50±0.81, $P<0.01$) with elevated rectal temperatures (101.22±0.15 °F, $P<0.05$) was recorded in the treatment (T) calves. However, a positive significant correlation of rectal temperature with THI ($r=0.434$; $P<0.01$) and respiratory rate ($r=0.339$; $P<0.01$) was observed in the experimental calves. The calves in C group had fewer incidences of respiratory illness and problems of diarrhoea when compared to the T calves. Therefore, maintaining fewer calves in semi covered houses with provision of open space was found to be beneficial on health, growth and housing environment of the calves.

Key words: Temperature humidity index, crossbred calves, heat stress

Housing and environment plays a vital role in the maintaining health, growth and well-being of the calves during the first few weeks of life when it's coping mechanism is still in its infancy. Consequently, Temperature humidity index (THI) is the most common yardstick determining environmental stress on lactating dairy cows (Bohmanova *et al.,* 2007) and conception rate in cattle (Rawat *et al*., 2014) or sperm quality in bulls (Bernabucci *et al.,* 2014) but little has been understood in crossbred calves of the tropical countries. Also decrease in milk yield was observed at THI range of 72.2 - 91.0 in Karan Fries and Tharparkar cows (Singh *et al.,* 2019). In dairy calves older than 21 days, the thermo neutral zone is 5 to 20 °C where above and below this range alters feed, water intake and metabolic activity (NRC, 2001). Armstrong (1994) identified THI index values below 72 as the comfort zone while above 90 cause severe stress, even mortality. Many animal friendly houses have been introduced to protect the calves from extremes of weather conditions. Physiological indices such as respiratory rate, rectal temperature, skin temperature and heart rate were higher in 7 week Holstein calves when maintained in an unshaded thermal environment (Kovacs *et al.,* 2018) while hutches with reflective polythene covers experienced better temperatures (Manriquez *et al.,* 2017). Even canvas shaded asbestos roof cover had profound microclimate, relative humidity and temperature humidity index (Kamal *et al.,* 2015). Since an appropriate calf housing environment should be clean, dry, and well ventilated, the experiment is conducted in a relatively hot and humid Gangetic belt where the average annual rainfall is around 1250 mm. Here, practically the calves are separated from their mother immediately after birth and raised in groups, sometimes kept in small enclosures protecting them from inclement of weather conditions. Overall, with unprecedented increase in demand for animal products like meat, milk and egg our prime focus must be towards developing low-cost environment suitable animal shelter structures for improved animal production and wellness (Bal and Minhas, 2017).

Therefore, the objective of the study was to find a suitable housing system of the calves in the lower Gangetic plains of West Bengal and to evaluate the performances during monsoon, post monsoon and winter season.

MATERIAL AND METHODS

The present study was carried out at National Dairy Research Institute (NDRI), Eastern Regional Station, Kalyani. Kalyani is located in the lower Gangetic basin of West Bengal in Nadia district, India. The altitude of the place is 9.75 meters above mean sea level, latitude and longitude position being 22° 58'30"N and 88° 26'4"E, respectively. Broadly, the region experiences hot and wet tropical monsoon climate with average annual maximum and minimum temperatures of 39°C and 12°C, respectively. It experiences four marked seasons namely, hot and dry season (March to early June) hot and wet season (mid-June to September), post monsoon season (October to November) and the cold, dry winter (December to February) in the plains (Nandargi and Barman, 2018).

The experiment was conducted up to the milk feeding period of 90 days. Owing to the wet conditions of the place, sixteen new born Jersey crossbred calves were separated from the dam immediately after birth and randomly assigned to 2 groups (8/group), treatment (T) and control (C). The calves in control (C) group were housed in a semi closed housing area with provision of outdoor space while the treatment (T) calves were housed indoors in small enclosures with lack of prominent outdoor facility, respectively. All the calves were fed colostrum and milk as per the standard management practices of the farm. *Ad libitum* supply of concentrates and green fodder was offered to the calves in both the groups. The composition of calf starter was 92% DM and 20% CP while green fodder such as maize had18% DM and 8% CP, respectively. The DMI intake of the calves was recorded at weekly intervals as per AOAC (2005).

Health performance - Calf health was monitored daily for signs of any abnormality. Rectal temperature was recorded using a digital thermometer and respiratory rate was taken by counting the number of right flank movements per minute. Health scoring of the calves were done as per the health chart score chart developed by University of Wisconsin (Love *et al*. 2014) prepared by (0,1= normal; 2,3= diarrhea), nasal score (0,1= normal; 2,3= nasal discharge), eye score (0,1= normal; 2,3= eye discharge crusty eye) and ear score (0,1=normal, 2,3= head tilt, one ears or both ears dropped).

Growth performance - Body weight, length, withers height and heart girth was measured (Siddiqui *et al*. 2015).

Dry matter intake/animal/day - Daily intake of milk, concentrate and fodder was recorded for individual calves on weekly basis. The total intake was calculated on dry matter basis (AOAC, 2005).

Seasonal and Climatic measurements - The temperature, relative humidity was recorded three times a day at 0800, 1300 and 1800 hours. Temperature and humidity were taken with the help of a thermometer (-20 to +60°C) and hygrometer (0 to 100% RH) device that were fitted on wall under shaded structure 1 m above the ground. The temperature humidity index (THI) was calculated by temperature and humidity measurements. THI was calculated using the following equations where temperature is expressed in °C. $THI = (0.8 \times T_{db}) + (RH/100) \times (T_{db} - 14.4) + 46.4$ (Mader *et al*., 2006).

The data obtained during the study were pooled and analysed through SPSS 20.Statistical comparisons between groups were made with the *t*-test. Significance was set at the level of 0.05. The level of statistical significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

No calves died during the experiment. While selecting the calves for the study, the average serum total protein (STP) was measured by a refractrometer so as to confirm that they were healthy and had optimum passive immunity. While many reports on heath and growth performance of the calves have been reported, the overall health performance of the calves for the present study is presented in Table 1. The overall number of sick calves was 8 in T group and 5 in C group, respectively. Mostly the calves in the T group suffered from bloody diarrhoea, loose stool/scour, respiratory illness, pneumonia during the monsoon and post monsoon period (July, August, September and October); the calves in the C group suffered from bloody diarrhoea and scour prominently in the monsoon period (July and August). Most of the studies conducted found that the mortality rate of the calves was higher in larger groups of more than e" 7 (Losigner and Heinrichs, 1997) and lower for small groups and individual calves (Svensson *et al*. 2005)but here in this study, the calves in both the treatment and control group was in smaller numbers. Therefore, this morbidity in both the groups could be accounted for the existing housing environment coupled with the seasons of Bengal. Though in both the groups, diarrhoea, loose stool is a common incidence, even with successful passive immunity during the initial days, the calf's stress response due to early separation from the mother and other managemental strategies could influence

Table 1: Health performance of the calves during the study period

Health Parameter	Indoors (T)	Semi covered (C)	P Value
Serum total protein (g/dl)	7.58±0.35	7.33±0.20	-
No of calves that suffered from illness during the study period	8/8	5/8	-
Age at which they fell ill (Range)	20.13±4.82 days (9.59- 31.17)	15.17±4.27 days (4.50-24.33)	-
Months in which they fell ill	July, August, September and October (Monsoon and Post Monsoon)	July, and August (Monsoon)	-
Common disease occurrence	Bloody diarrhoea, loose stool, scour, pneumonia and respiratory illness	Bloody diarrhoea and scours	-
No. of calves affected with diarrhoea and loose stool	6	5	-
Total days treated for diarrhoea and loose stool	29	19	-
No. of calves affected with respiratory problems	2	0	-
Total days treated for respiratory problems + Pneumonia	18	0	-
Eye Discharge	2.00±0.06	1.52±0.05	NS
Ears	1.55±0.05	1.43±0.06	P<0.01
Faecal consistency	1.67±0.06	1.09±0.03	P<0.01
Cough	1.76±0.06	1.19±0.05	P<0.05
Nasal Discharge	1.58±0.09	1.39±0.06	NS
Respiratory rate	1.78±0.07	1.71±0.08	NS

(NS=not significant, **P<0.01, *P<0.05)

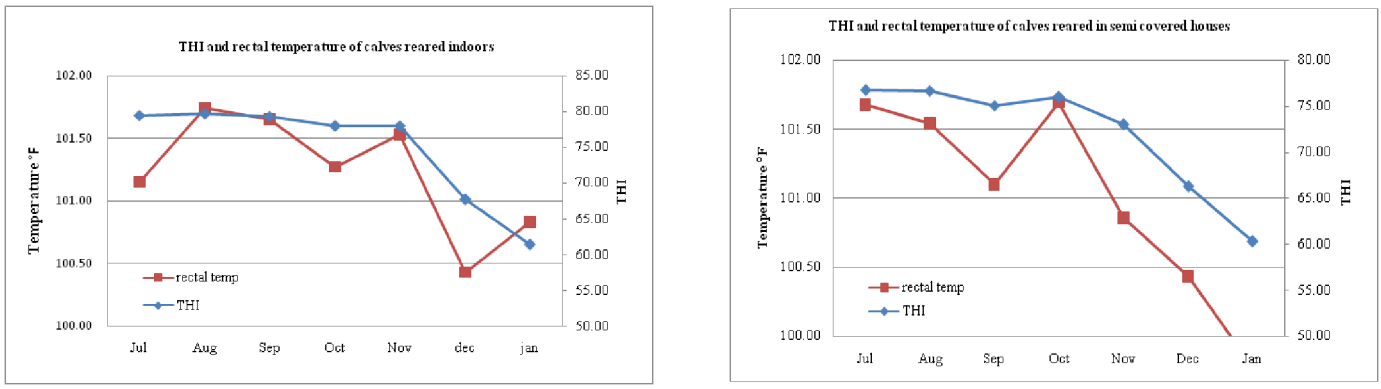

Fig 1: Comparison of THI and rectal temperature at different months during the study period

its immunity as mentioned by Hulbert and Moisa, 2016). But the bigger problem of respiratory illness and pneumonia in treatment calves may be due to the higher humidity and lack of circulating fresh air maybe, causing opportunistic microbes to sustain and cause the infection. Earley *et al*. (2004) also reported lower incidence of diarrhoea but higher incidence

Table 2: Growth performances and dry matter intake of the experimental calves

Parameter	Indoors (T)	Semi covered (C)	Sig.
Initial Body Weight (kg)	21.87±1.17	20.12±1.13	NS
Final Body weight (kg)	49.25±3.44	53.12±2.82	P<0.05
BW gain in 90 days (kg)	27.37±2.80	33.00±2.46	P<0.05
Average daily gain (g)	302.50±31.44	365.3±28.08	P<0.05
Initial Body length (cm)	49.33±3.75	48.83±3.51	NS
Final Body length (cm)	108.64±7.90	113.28±5.91	NS
Initial heart girth (cm)	61.78±0.84	60.16±1.07	NS
Final heart girth (cm)	79.66±2.03	82.12±1.01	NS
Initial Wither Height (cm)	65.71±1.17	67.56±0.90	NS
Final Wither Height (cm)	79.37±1.75	79.79±2.18	NS
Total DMI from Concentrate (kg)	2.81±0.24	3.14±0.27	NS
Total DMI from Green (kg)	0.76±0.07	0.79±0.05	NS
Total DMI from Milk (kg)	0.73±0.09	0.62±0.11	NS
Total DMI (kg)	4.30±0.34	4.55±0.32	NS
DMI in Kg/animal/day	1.11±0.10	1.23±0.17	NS
DMI/100 Kg Body weight	3.09±0.19	3.29±0.31	NS

(NS=not significant, **P<0.01, *P<0.05)

Table 3: Average temperature (°C) of the calf shed indoors or semi covered houses during different seasons

Hours of the day housing	Monsoon (Jul-Sept)		Post Monsoon (Oct-Nov)		Winter (Dec-Jan)		Housing x Season	Housing x Season x Hour
	Indoors	Semi covered	Indoors	Semi covered	Indoors	Semi covered		
8.00 AM	30.26±0.18	30.39±0.20	26.44±0.42	28.05±0.37	21.92±1.06	19.12±0.52	P<0.01	0.43
1.00 PM	32.17±0.21	32.09±0.22	30.78±0.32	30.85±0.36	26.54±0.32	24.54±0.27	0.30	0.32
6.00 PM	31.42±0.19	31.21±0.18	29.02±0.30	29.07±0.28	25.19±0.45	25.12±0.44	0.86	0.51

(NS=not significant, **P<0.01, *P<0.05)

of respiratory disease in calves reared in indoors. As a consequence, the antibiotics used on these T calves were higher than the C calves. Workers like Kung *et al.* (1997) also found similar trend on number of medication used for the calves that suffered from respiratory distress when raised indoors. Therefore, calves raised in semi covered houses had no incidence of respiratory illness and fewer problems of diarrhoea when compared to the calves raised indoors but unfortunately to justify the reasons; we could not measure the level of ammonia of the respective housing. Also it was found that THI was comparatively higher in calves housed in small enclosures (T) during the monsoon and post monsoon period while in semi covered houses with provision for outdoor space experienced higher THI only in the monsoon period. The performance of the calves in terms of the body weight and dry matter intake have been summarised in Table 2. The body weight (P<0.05) and body measurements of the calves reared in C group have yielded better results when compared to the T group. Such optimum growth performances of crossbred calves may be due good genetic makeup along with maintenance of favourable housing environmental in C group as supported by Sreedhar and Sreenivas (2015). The temperature (°C) and humidity (%) of the animal houses at different seasons during the study period is presented in Table 3 and 4, respectively. Since the environmental temperature and humidity is closely associated with body temperature; rectal temperature is measured to evaluate the physiological adaptation to the housing environment. In the mornings at 8.00 the temperature and humidity of the calf shed was significantly higher (P<0.01) during the

Table 4: Average temperature (°C) of the calf shed indoors or semi covered houses during different seasons

Hours of the day housing	Monsoon (Jul-Sept)		Post Monsoon (Oct-Nov)		Winter (Dec-Jan)		Group x Season	Group x Season x Hour
	Indoors	Semi covered	Indoors	Semi covered	Indoors	Semi covered		
8.00 AM	75.04±1.12	64.64±1.05	72.16±1.16	59.18±1.13	69.62±2.40	66.65±1.59	P<0.01	P<0.01
1.00 PM	70.01±1.16	61.66±1.10	59.91±1.56	52.60±1.46	51.15±2.19	52.08±1.83	P<0.05	0.56
6.00 PM	68.52±1.14	62.26±1.24	56.05±1.51	52.05±1.29	46.58±1.03	50.58±1.22	P<0.01	P<0.05

(**P<0.01, *P<0.05)

Table 5: THI rectal temperature and respiratory rates of experimental calves kept in pairs and groups

Months	THI		Rectal temperature (°F)		Respiratory Rate (rates/min)	
	Indoors	Semi covered	Indoors	Semi covered	Indoors	Semi covered
July	79.47±0.03	76.72±0.02	100.15±0.26	101.68±0.42	26.00±1.25	24.38±2.13
Aug	79.66±0.22	76.70±0.22	101.74±0.17	101.54±0.16	36.52±2.31	35.05±1.93
Sept	79.32±1.32	75.10±0.10	101.65±0.12	99.45±0.57	32.75±4.60	28.25±1.03
Oct	77.98±0.70	75.99±0.59	101.27±0.21	101.69±0.16	35.71±2.24	36.94±2.94
Nov	78.01±0.68	73.03±1.93	101.53±0.23	100.86±0.30	34.43±3.19	31.14±2.12
Dec	66.27±0.44	67.82±0.28	100.39±0.73	100.53±0.17	33.57±1.86	29.29±0.96
Jan	60.90±1.07	61.88±0.77	100.86±0.04	99.12±0.27	30.40±0.60	30.80±0.62
Overall	74.50±0.81	72.79±0.62	101.22±0.15	101.02±0.12	33.68±0.95	32.20±0.94
P value	P<0.01		P<0.05		NS	

(NS=not significant, **P<0.01, *P<0.05)

Table 6: Correlation of rectal temperature, THI and respiratory rate amongst the experimental calves

Correlations (n =162) parameters	Rectal temperature (°F)	THI	Respiratory rate (rates/min)
Rectal temperature (°F)	1		
THI	0.434**	1	
Respiratory rate (rates/min)	0.339**	0.165*	1

**. Correlation is significant at the 0.01 level, *. Correlation is significant at the 0.05 level

monsoon season though no significant differences observed in temperatures at 1.00 PM and 6.00 PM.

Since thermo-neutral zone for the calves ranged from 15 to 25°C (Scanes, 2011) with 26°C as the upper thermoneutral zone (Davis and Drackley, 1998), Nardone *et al.* (2006) considered 30°C as the critical temperature for the young calves. The average air temperature in the respective houses during the monsoon and post monsoon period was above the critical level as mentioned by the above authors. Only in the winter months, the temperature was seen to be favourable at all times of the day. Adequate ventilation is essential to create safe environment to the calves with recommended ammonia levels less than 10 ppm (Woolums *et al.,* 2009). In our study we found that the T calves experienced higher humidity during the monsoon period at 8.00 AM (P<0.01), 1.00 PM (P<0.05) and 6.00 PM (P<0.01) than the C calves. Since indoor calves had limited access to fresh air with impaired ventilation, humidity increased with solid panels, dung and urine (Lago *et al.*, 2006). However, the humidity level was below the acceptable limit of 85% (Webster, 1984) at all seasons in both the sheds. The THI estimates the magnitude of heat stress in animals given in Fig.1 with changes in the rectal temperatures.

However, along with THI, rectal temperatures and respiratory rates have been furnished in Table 5 in two different housing conditions of the calves. During the study

period ambient THI ranged from 47.46 to 84.20 units. The greatest THI were recorded during the month of August in T group (79.67) and July in C group (76.72), respectively though the cut off value was 77 units. Besides with the highest THI (74.50±0.81, P<0.01) with elevated rectal temperatures (101.22±0.15 °F, P<0.05) was recorded in the treatment (T) calves which maybe a physiological response to the high ambient temperature and humidity in these types of accommodation. Dikmen and Hansen (2009) estimated THI value above 78 units, increased respiratory rate and rectal temperatures during the afternoon especially in calf hutches. A positive significant correlation of rectal temperature with THI (r=0.434; P<0.01) and respiratory rate (r=0.339; P<0.01) is presented in Table 6. Nascinmento *et al*. (2017) also supported the idea that respiratory rate and body surface temperature had a significant and positive correlation with THI in the tropical environment. The study of THI in calves above which performance is affected requires through research. However, THI and disease incidence could not be correlated due to small number of animals in the study.

CONCLUSION

In summary, there are a many studies dealing the various aspects of indoor small enclosures and semi covered houses for the calves with sometimes contradicting results. Overall, semi covered housed with open space, where the calves are raised in small groups (d"8 in number) was better in comparison to small calf enclosures indoors with regards to calf health, growth, THI and housing environment. Therefore, though indoor enclosures protected the calves from inclement of weather conditions, housing calves in semi covered spaces with open space and makeshift provisions of plastic coverings during rainy seasons and winter drafts will however be beneficial in rearing the young calves at village level in the Gangetic belt of West Bengal.

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