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ORIGINAL ARTICLE

Effect of calf mother contact on physiology, abnormal behaviour, and health status of Murrah buffalo calves during winter season

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ABSTRACT
To study the effect of calf-mother contact on physiology, abnormal behaviour, and health status of Murrah Buffalo calves during winter season. Study was done at Livestock Research Centre (LRC), ICAR-NDRI, Karnal, India between November to February. A total of 21 advanced-pregnant Murrah buffaloes were carefully chosen and the buffalo-calf pairs were divided into three treatment groups, each consisting of seven pairs. In the first group (T0), the Murrah buffalo mothers were permitted to nurse their calves with colostrum and later milk twice a day. In the second group (T1), buffalo mothers were allowed to nurse their calves twice a day, following a similar routine as the T0 group, and they were housed near their calves, separated by a fence line. In the third group (T2), all conditions were similar those of the T1 group, a notable distinction was that the calves in the T2 group were provided with halogen lights in the shed. The T2 shed's minimum temperature was notably higher (p<0.05) than that in the T0 and T1 sheds. The findings indicate that within the group of experimental calves, both T2 and T1 groups displayed significantly reduced (P<0.05) pulse rates (PR) when compared to the T0 group. Both T2 and T1 calves exhibited significantly fewer (P<0.05) frequency of abnormal behaviours than the T0 calves. Calves in the T2 and T1 groups had fewer incidences of diseases compared to the T0 group of calves. The results demonstrate that providing fenceline mother-calf contact is a more effective approach during the winter season for reducing stress, abnormal behaviour, and disease incidence, while simultaneously enhancing the welfare of calves when compared to restricting their contact.
Keywords: Murrah calves, cold stress, mother-calf contact, fenceline

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INTRODUCTION

Maternal behaviour is a complex and essential mechanism crucial for the survival and growth of the offspring [1]. Within the realm of cow maternal behaviour, it can be delineated into two vital components: the actual care provided to their offspring and their tendency to focus their care on specific young. This form of behaviour plays a pivotal role in shaping how individuals interact within their social environment [2]. [3] emphasized the importance of rapidly establishing stable bonds between mothers and their young. The vulnerability of the young to starvation, predation, and exposure to the cold underscores the critical role played by the parents in accurately assessing the needs of their offspring and adapting their behaviour accordingly to ensure their survival and overall fitness. This connection is marked by actions like mutual grooming, supplying nourishment, offering warmth and protection, resting in close proximity, and participating in synchronized activities. Remaining in proximity functions as a social comfort, bestowing a calming influence on both mothers and their offspring.

The calming and satisfying quality of physical contact, food sharing, and grooming among bonded individuals becomes apparent through the decrease in heart rate and the release of natural pain-relieving compounds [4]. In the context of intensive buffalo dairy farming, it is common practice to separate the calves from their mothers shortly after birth, typically within the first few days (around 3-6 days). Subsequently, these calves are nourished with milk or milk substitutes until they reach the age of 45-90 days when the weaning process is initiated [5]. In recent times, intensive buffalo farming has started to adopt techniques initially developed for dairy cattle. These methods encompass artificial calf rearing, twice-daily mechanical milking, cubicle housing systems, and specific space allocations [6].

By comprehending the requirements of calves during the winter season, effective resource allocation, encompassing food, space, and veterinary attention, can be enhanced. Winter proves to be a precarious period for young buffalo calves, rendering them more prone to a range of health challenges [7]. The impact of dramatic temperature swings, particularly in severe winter conditions, can have a significant effect on the growth and progress of calves [8]. Extended exposure to such challenging conditions can result in reduced growth and a weakened immune system in susceptible young calves.

Understanding how the degree and quality of calf-mother interaction can impact the health of these animals is vital, as it can lead to improved management practices that enhance both the welfare of the animals and the efficiency of dairy operations. The findings of this research endeavor hold the potential to revolutionize calf management practices and contribute to the overall success and sustainability of dairy operations in cold climate regions. Understanding the intricate dynamics of maternal contact and its effects on the well-being of Murrah buffalo calves during the challenging winter season can provide valuable insights for optimizing buffalo husbandry practices.

MATERIAL AND METHODS

Location of experiment and Climatic condition

The study was carried out at the Livestock Research Centre (LRC), ICAR-NDRI, Karnal. This centre is positioned at coordinates 290 42' 20' N Latitude and 760 58' 52.5' E Longitude, at an elevation of 247 meters above sea level. During the summer, the highest recorded temperatures range from 42 to 46 °C, while in winter, they range from 2 to 5 °C, with a daily fluctuation of 16–22ºC. The typical annual rainfall in this area amounts to approximately 650 mm.

Experimental animals

To carry out the investigation, 21 advanced-pregnant Murrah buffaloes were carefully selected from the general buffalo herd maintained at the institute. The study took place from November to February. After successful calving, the buffalo-calf pairs were distributed into three treatment categories, each containing seven pairs. In the initial group (T0), Murrah buffalo mothers were allowed to nurse their calves with colostrum and then milked twice daily. After milking, they were separated from their calves and placed in a shelter without any specific measures to protect them from the cold. In the second group (T1), the buffalo mothers were housed in close proximity to their calves, separated only by a fenceline. These buffalo mothers were allowed to nurse their calves twice a day. However, like the T0 group, these buffaloes were also housed in a shelter without specific measures to alleviate the effects of cold stress. In the third group (T2), the buffalo mothers were housed in close proximity to their calves, separated only by a fenceline and mothers were also permitted to nurse their calves twice a day after milking sessions. However, a significant difference was that the buffalo calves in the T2 group were provided with halogen lights to shield them from the effects of cold stress.

Housing and feeding of animals

The experimental calves were placed in a communal enclosure with both a sheltered area and an adjacent open space, providing a total of 3 square meters of floor space per calf. They shared a feeding area accessible through a fenceline feed barrier and a common water source. The allocation of floor space and feeding space was consistent with the standards of the Bureau of Indian Standards for buffaloes in loose housing systems (BIS: 1223–1987). Calves from the T0 group were separately group-housed in accordance with farm practices, and during cold winter nights, they remained indoors. As for the T2 and T1 group of calves, they were accommodated in a shelter with covered sheds, while having access to an adjoining open paddock. During the nighttime, the shelter of the fenceline group calves was enclosed with curtains on three sides, leaving one side open for interaction with their mother buffaloes. In the case of the T2 group, halogen lights were installed in the shed to provide additional warmth and comfort.

Calves were offered whole buffalo milk twice a day at 10% of their body weight until 2 months (**table 1**). At the second week of age ad libitum chopped maize green fodder with clean water and salt lick block until weaning were fed. Calf starter was fed from 2nd week of age. Calf starter was composed of maize 35%, wheat bran 20%, gram 10%, Ground nut cake 32%, mineral mixture 2%, and salt 1%. Calves were offered concentrate at 1 % of their body weight, and *ad libitum* chopped green fodders. Clean and fresh water with salt lick was offered *ad libitum*.

Recording of climatic conditions

The highest and lowest temperatures were documented with the use of maximum-minimum thermometers placed within all sheds. These thermometers were suspended 2 feet above the level of the animals' heads: one positioned in the middle and one on each longitudinal side wall of the shed, with the aim of reducing potential inaccuracies.

Statistical analysis

Calf pulse rate, rectal temperature, and abnormal behavior comparisons were analyzed using IBM SPSS version 28.0.1.1 software. This analysis involved the utilization of a one-way analysis of variance (ANOVA) and univariate general linear models (GLM). The model incorporated treatment and time as fixed factors, and their interaction was also considered in the analysis. Differences were considered statistically significant when $p < .05$. Results are presented as LS means ± SE.

RESULTS AND DISCUSSION

Environmental variables

Data on fortnightly average minimum and maximum temperature during winter season are presented in the table 1. Average minimum temperature ranged from 4.66 to 11.28, 4.56 to 11.18 and 10.96 to 16.53 in T0, T1 and T2 sheds respectively. Minimum temperature in T2 shed was higher (P<0.05) as compared to the T1 and T0 shed. The higher temperature in T2 shed might be due to extra provision of cold stress amelioration. Similar higher temperature in the shed provided with IR lamps was reported by Bhatt et al [8].

Physiological parameters of calves

The mean pulse rate (PR) (beats/min) of calves recorded at weekly intervals after birth is presented in the table 3. The significant difference (P<0.05) in PR was observed from first week onwards, the PR in T2 and T1 group calves was lower than that in T0 group calves. But the overall mean PR was significantly different among the three groups of calves, the PR in T2 (84.07±3.74 beats/min) group calves was lowest followed by T1 (91.14±3.97 beats/min) and T0 (105.70±3.81 beats/min) group calves.

The lower pulse rate (PR) observed in both the T2 and T1 groups compared to the T0 group may be attributed to the presence of fenceline mother contact. Additionally, the T2 group's calves exhibited a lower PR than those in the T1 group, possibly because of the combined influence of fenceline mother contact and the measures taken to alleviate cold stress for the T2 group calves. Conversely, the increased PR in the T0 group might be a consequence of restricted mother contact during the suckling period. Numerous studies have reported that physical separation of mother and calf induces both physiological and psychological stress [9]. The decreased PR in both the T2 and T1 groups, in contrast to the T0 group, is likely a result of the fenceline mother contact they were provided with. These findings align with previous studies [10-11]. The lowest recorded PR in the T2 group could be attributed to the cumulative effect of fenceline mother contact and the cold stress mitigation measures implemented in the T2 shed.

The data on mean rectal temperatures (RT) of claves recorded weekly during winter season are presented in the table 4. No significant difference in RT was observed among the three groups. The overall mean RT during first 12 weeks of age in the T0, T1 and T1 groups were 101.70±0.09, 101.95±0.09 and 101.94±0.10 ºF, respectively. In winter season no differences in RT were observed in our study and the recorded RT was well within the normal range in all the three groups.

Abnormal behaviour

The data on the average frequency of cross-suckling is presented in the table 5. The overall average and average frequency on all recorded days of cross suckling was significantly (P<0.05) higher in T0 group of calves than the T1 and T2 groups of calves. There was declining trend in cross suckling frequency with the age in all the three groups (Fig. 1). The frequency of overall mean ± SE of cross suckling were 12.81±0.70, 1.25±0.09and 1.12±0.09 in T0, T1 and T2 group of calves respectively.

The calves in both the T2 and T1 groups displayed minimal instances of cross-sucking behaviour, likely because these groups of calves had the advantage of continuous mother contact during the initial five days, followed by fenceline contact afterward. In these groups (T1 and T2), the calves had more opportunities for visual, tactile, and auditory interaction with their mothers. This increased contact may have allowed the calves to focus more on their mothers and their dietary habits, ultimately resulting in reduced oral abnormal behaviour. The lower levels of behavioural discomfort exhibited by these calves could also contribute to the decreased occurrence of cross-sucking in the T2 and T1 groups. These findings align with previous research [9, 2, 12-14], which utilized fenceline weaning in calves, supporting our conclusion that fenceline contact between mothers and young reduces behavioural distress compared to abrupt separation of calves from their mothers immediately after birth.

Even though the calves with restricted contact were granted opportunities for natural suckling and maternal touch, they consistently exhibited elevated levels of cross-sucking behaviour throughout the study. This behaviour might be attributed to the limited interaction periods with their mothers. In our study, the calves with restricted contact (T0) had shorter contact durations, intensifying their craving for natural suckling and promoting non-nutritive suckling. These findings are in line with those of a previous study [15], which indicated that calves responded with greater behavioural distress to temporary separation. The study concluded that these restricted interaction periods induced significantly higher psychological stress compared to the contact between mothers and calves facilitated by the fence.

The data on the average frequency of licking inanimate objects during winter season is presented in the table 6 and in the fig 6. The overall average and average frequency on all recorded days of licking inanimate objects was significantly ($P<0.05$) higher in T0 group of compared to T1 and T2 groups of calves. There was declining trend in frequency licking inanimate objects with the age in all the three groups (Fig. 6). The frequency of overall mean ± SE of licking inanimate objects were 8.53±0.44, 1.23±0.09and 1.27±0.08 in T0, T1 and T2 group of calves respectively.

Direct maternal contact and the freedom to choose colostrum suckling during early life, followed by fenceline contact in the T1 and T2 groups, likely contributed to a decrease in the frequency of inanimate object licking. This arrangement allowed the calves to dedicate more of their time to sleeping and resting since their nutritional and social needs were adequately met through maternal presence and colostrum access. The calming influence of the dam's presence may have further reduced the calves' inclination to lick objects within the calf pen. Similar results were reported by [16 and 17], where calves that remained with their mothers during the initial four days of life exhibited fewer non-nutritive oral behaviours following weaning. Our findings are in harmony with [18 and 19], which suggested that extending the duration of milk consumption helps minimize non-nutritive licking and sucking in mother-reared calves. When newborn calves engage in udder suckling, it was observed that they tend to focus their activities more on milk or solid food consumption and maternal interaction. Natural suckling and fenceline interaction with the calves appear to contribute to the reduction of non-nutritive oral behaviour. Similar findings regarding a reduced frequency of inanimate object licking in calves with fenceline mother contact have been reported by [14] in buffalo calves and [20] in Sahiwal calves.

Health status of buffalo calves

The primary health issue observed during the experimental period was diarrhoea, affecting all three groups of calves, with some minor instances of respiratory distress also noted. Notably, the incidence of diarrhoea was more frequent in the control group (T0) when compared to the T1 and T2 groups. Specifically, a higher number of buffalo calves in the control group (6 out of 7) experienced diarrhoea compared to T1 (5 out of 7) and T2 (3 out of 7). Incidents of respiratory problems were exclusively observed in the T0 group (2 out of 7). The increased occurrence of diarrhoea among buffalo calves in the T0 group may be attributed to potential infection resulting from reduced maternal contact and higher environmental temperatures. Importantly, no fatalities occurred in any of the calf groups. These findings align with the observations of [21], who noted that calves separated from their mothers by a fence line demonstrated effective responses, likely due to the reduced physical stress of separation and the continued visual and auditory connection with their dams. These results are also consistent with the research conducted by [22], which indicated that fence-line weaned crossbred beef steer calves experienced lower rates of illness and mortality, along with improved health and overall performance.

Table 1: Feeding schedule of calves for five months

Age group (months)	Whole milk	Calf starter/Concentrate mixture (gms/kg)	Green fodder
0-5 days	1/10th of body weight	--	--
6-30 days	1/10th of body weight	Introduced after 2nd week onwards	Introduced after 6th day onwards
1-2 months	1/10th of body weight	250-300 gms	*ad libitum*

Table 2. Fortnightly mean maximum and minimum temperature (ºC) inside the sheds

Fortnight	Minimum Temperature (°C)			Maximum temperature (°C)
	T0 shed	T1 shed	T2 shed	
1	$11.28^a±0.46$	$11.18^a±0.32$	$16.53^b±0.38$	28.61±0.15
2	$8.51^a±0.18$	$8.57^a±0.11$	$14.61^b±0.18$	26.21±0.21
3	$8.70^a±0.58$	$8.75^a±0.50$	$14.56^b±0.50$	23.04±0.61
4	$4.66^a±0.44$	$4.56^a±0.41$	$10.96^b±0.40$	19.39±0.67
5	$7.96^a±0.84$	$7.76^a±0.82$	$14.65^b±0.72$	16.47±0.71
6	$6.38^a±0.43$	$6.18^a±0.42$	$13.13^b±0.44$	14.27±0.67
7	$6.23^a±0.54$	$6.33^a±0.51$	$11.21^b±0.34$	19.03±0.83
8	$6.10^a±0.67$	$8.12^a±0.65$	$12.62^b±0.38$	23.40±0.33
Overall	**$7.69^a±0.25$**	**$7.59^a±0.21$**	**$13.52^b±0.22$**	**21.19±0.47**

Data are presented as LS means ± SEM. a, b, c indicate differences between the mean values of different groups. Differences at all points for each parameter were considered at $P < 0.05$.

Table 3: Mean pulse rate (beats/min) of different groups of calves recorded at weekly intervals

Week after birth	Pulse rate (beats/min)		
	T0	T1	T2
1	171.57±7.21	162.57±5.25	160.71±5.45
2	149.43^{b} ±5.32	133.71^{ab}±5.45	120.71^{a}±2.81
3	105.29^{b} ±2.85	96.71^{b}±4.93	77.14^{a}±4.06
4	101.71^{b} ±6.91	87.71^{ab}±4.60	72.14^{a}±2.72
5	98.86^{b} ±3.14	86.71^{ab}±6.63	75.14^{a}±3.17
6	96.29^{b} ±3.25	77.14^{a}±4.80	74.71^{a}±2.99
7	91.14^{b} ±5.45	70.29^{a}±1.87	67.71^{a}±2.19
8	87.86^{b} ±4.94	67.57^{a}±4.03	64.57^{a}±2.91
9	81.57^{b} ±4.20	65.57^{a}±4.21	65.29^{a}±2.97
10	73.29^{b}±3.93	63.43^{ab}±2.81	62.57^{a}±1.04
Overall	**105.70^{c}±3.81**	**91.14^{b}±3.97**	**84.07^{a}±3.74**

Data are presented as LS means ± SEM. a, b indicate differences between the mean values of different groups. Differences at all points for each parameter were considered at P < 0.05.

Table 4: Mean rectal temperature (ºF) of different groups of calves recorded at weekly intervals

Week after birth	Rectal temperature (ºF)		
	T0	T1	T2
1	101.83±0.25	102.21±0.19	102.33±0.38
2	102.24±0.32	101.79±0.37	101.50±0.29
3	101.19±0.25	101.49±0.31	101.74±0.34
4	102.01±0.28	101.97±0.42	102.27±0.36
5	101.49±0.28	101.90±0.27	101.84±0.34
6	101.60±0.21	101.77±0.33	101.77±0.34
7	101.17±0.29	102.07±0.28	101.82±0.24
8	102.03±0.33	101.97±0.35	101.66±0.31
9	102.22±0.29	102.13±0.27	102.05±0.37
10	102.13^{a}±0.29	102.23^{b}±0.18	102.38^{b}±0.19
Overall	**101.70±0.09**	**101.95±0.09**	**101.94±0.10**

Data are presented as LS means ± SEM. a, b indicate differences between the mean values of different groups. Differences at all points for each parameter were considered at P < 0.05.

Table 5: Average frequency of cross-sucking in different groups of calves

Day after birth	Frequency of cross-sucking		
	T0	T1	T2
6	19.61^{a}±0.89	1.79^{b}±0.11	1.62^{b}±0.24
10	22.43^{a}±1.07	1.46^{b}±0.19	1.72^{b}±0.19
15	13.62^{a}±0.68	1.70^{b}±0.20	1.70^{b}±0.19
30	11.96^{a}±0.59	2.04^{b}±0.19	1.64^{b}±0.14
45	12.13^{a}±0.63	1.40^{b}±0.23	1.00^{b}±0.16
60	10.50^{a}±0.21	1.19^{b}±0.11	1.09^{b}±0.15
75	9.23^{a}±0.80	0.43^{b}±0.08	0.47^{b}±0.09
90	8.46^{a}±0.70	0.66^{b}±0.13	0.42^{b}±0.12
120	7.37^{a}±0.68	0.57^{b}±0.10	0.46^{b}±0.09
Overall	**12.81^{a}±0.70**	**1.25^{b}±0.09**	**1.12^{b}±0.09**

Data are presented as LS means ± SEM. a, b indicate differences between the mean values of different groups. Differences at all points for each parameter were considered at P < 0.05.

Table 6: Average frequency of licking inanimate objects in different groups of calves

Day after birth	Frequency of licking inanimate		
	T0	T1	T2
6	10.98^{a}±0.76	0.63^{b}±0.12	0.79^{b}±0.08
10	12.33^{a}±0.98	1.64^{b}±0.05	1.79^{b}±0.06
15	11.80^{a}±0.73	1.79^{b}±0.07	1.81^{b}±0.05
30	10.52^{a}±0.67	1.82^{b}±0.07	1.77^{b}±0.07
45	7.71^{a}±0.88	1.66^{b}±0.05	1.86^{b}±0.05
60	7.44^{a}±0.86	1.81^{b}±0.05	1.73^{b}±0.05
75	6.12^{a}±0.66	0.48^{b}±0.12	0.70^{b}±0.06
90	5.36^{a}±0.54	0.68^{b}±0.13	0.48^{b}±0.09
120	4.51^{a}±0.31	0.60^{b}±0.18	0.51^{b}±0.10
Overall	8.53^{a}±0.44	1.23^{b}±0.09	1.27^{b}±0.08

Data are presented as LS means ± SEM. a, b indicate differences between the mean values of different groups. Differences at all points for each parameter were considered at $P < 0.05$.

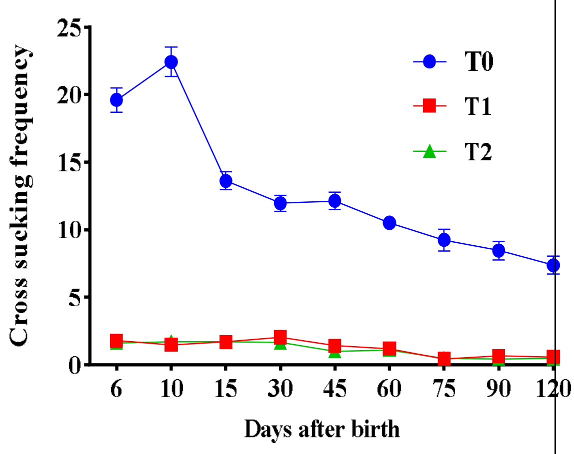

Fig 1: Mean frequency of cross-sucking by the calves

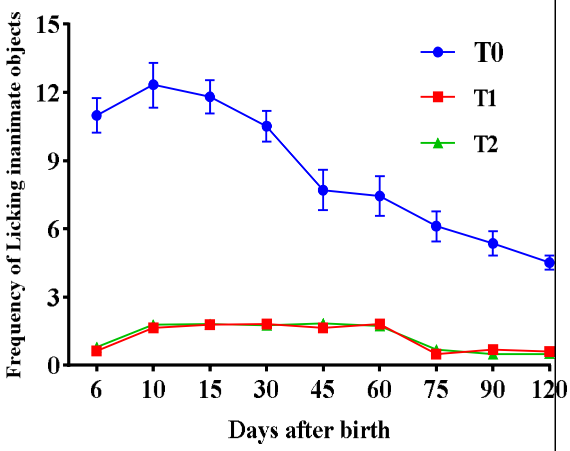

Fig 2: Mean frequency of licking inanimate objects by the calves

CONCLUSION

The animal's level of comfort becomes instantly evident through physiological indicators such as respiratory rate and rectal temperature. These parameters are vital for evaluating the animal's comfort level and, as a result, its potential for growth. This suggests that maternal contact is of paramount importance in mitigating stress levels among buffalo calves in the winter season. The study highlighted a significant impact of maternal contact on abnormal behaviors. The findings strongly suggest that the combination of fenceline calf contact and the halogen bulbs in the shed effectively reduces calf stress during the winter season.

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REFERENCES

1. Le Neindre, P., Murphy, P. M., Boissy, A., Purvis, I. W., Lindsay, D., Orgeur, P. and Bibé, B. (1998). Genetics of maternal ability in cattle and sheep. In: *Proceedings of the 6th world congress on genetics applied to livestock production.* **27**: 23-30.
2. Price, E. O., Harris, J. E., Borgwardt, R. E., Sween, M. L. and Connor, J. M. (2003). Fenceline contact of beef calves with their dams at weaning reduces the negative effects of separation on behavior and growth rate. *Journal of Animal Science.* **81**(1): 116-121.
3. Jensen, M. B. (2004). A note on the effect of isolation during testing and length of previous confinement on

locomotor behaviour during open-field test in dairy calves. *Applied Animal Behaviour Science*. **70**(4): 309-315.
4. Feh, C. and De Mazières, J. (1993). Grooming at a preferred site reduces heart rate in horses. *Animal Behaviour*. **46**(6): 1191-1194.
5. Bharti, P. K., Dutt, Triveni, Patel, B. H. M., Pandey, H. O., Ojha, B., Kamal, Reena. and Gaur, G. K. (2018). Effect of weaning age on growth measurements and sero-biochemical parameters in Murrah buffalo calves. *Indian Journal of Animal Sciences*. **88**(11): 1305-1309.
6. Masucci, F., De Rosa, G., Grasso, F., Napolitano, F., Esposito, G. and Di Francia, A. (2011). Performance and immune response of buffalo calves supplemented with probiotic. *Livestock Science*. **137**(1-3): 24-30.
7. Bazeley, K. J., Barrett, D. C., Williams, P. D., and Reyher, K. K. (2016). Measuring the growth rate of UK dairy heifers to improve future productivity. *The Veterinary Journal*. ***212***: 9-14.
8. Bhat, S. A., Bhushan, B., Kumar, N., Lone, S. A., Bharti, P., Chandrasekar, T., and Godara, R. S. (2017). Role of Infrared lamps in cold stress alleviation during winter in Murrah calves. *Indian Journal of Animal Research*. ***51***(5), 827-831.
9. Stookey, J.M. (1997). Effects of remote and contact weaning on behaviour and weight gain of beef calves. *Journal of Animal Science*. **75**(1):157.
10. Lynch, E. M., Earley, B., McGee, M. and Doyle, S. (2010). Effect of abrupt weaning at housing on leukocyte distribution, functional activity of neutrophils, and acute phase protein response of beef calves. *BMC Veterinary Research*. **6**(1):1-9
11. O'Loughlin, A., McGee, M., Doyle, S. and Earley, B. (2014). Biomarker responses to weaning stress in beef calves. *Research in Veterinary Science*. **97**(2):458-463.
12. Johnsen, J. F., Ellingsen, K., Grøndahl, A. M., Bøe, K. E., Lidfors, L. and Mejdell, C. M. (2015). The effect of physical contact between dairy cows and calves during separation on their post-separation behavioural response. *Applied Animal Behaviour Science*. **166**: 11-19.
13. Pérez-Torres, L., Orihuela, A., Corro, M., Rubio, I., Alonso, M. A. and Galina, C. S. (2016). Effects of separation time on behavioral and physiological characteristics of Brahman cows and their calves. *Applied Animal Behaviour Science*. **179**:17-22.
14. Choudhary, S., Kamboj, M. L., Ungerfeld, R. and Singh, P. (2022). Calf-cow and bull-cow management in buffaloes: Effects on growth, productive and reproductive performance of mothers and their calves. *Reproduction in Domestic Animals*. ***57***(11): 1428-1439.
15. Enríquez, D., Hötzel, M. J. and Ungerfeld, R. (2010). Minimising the stress of weaning of beef calves: a review. *Acta Veterinaria Scandinavica*. **53**(1): 1-8.
16. Krohn, C. C., Foldager, J. and Mogensen, L. (1999). Long-term effect of colostrum feeding methods on behaviour in female dairy calves. *Acta Agriculturae Scandinavica, Section A-Animal Science*. **49**(1):57-64.
17. Veissier, I., Caré, S. and Pomiès, D. (2013). Suckling, weaning, and the development of oral behaviours in dairy calves. *Applied Animal Behaviour Science*. **147**(1-2):11-18.
18. Haley, D. B., Rushen, J. and Passillé, A. D. (2006). Behavioural indicators of cow comfort: activity and resting behaviour of dairy cows in two types of housing. *Canadian Journal of Animal Science*. **80**(2): 257-263.
19. Jung, J. and Lidfors, L. (2001). Effects of amount of milk, milk flow and access to a rubber teat on cross-sucking and non-nutritive sucking in dairy calves. *Applied Animal Behaviour Science*. **72**(3):201-213.
20. Ingle, S.V. (2022). *Effect of different milk let-down stimuli and biostimulation on the performance and behaviour of Sahiwal cattle*. Ph.D. Thesis, ICAR-NDRI, Karnal, Haryana India.
21. Boland, H. T., Scaglia, G., Swecker Jr, W. S., & Burke, N. C. (2008). Effects of alternate weaning methods on behavior, blood metabolites, and performance of beef calves. *The Professional Animal Scientist*. ***24***(6), 539-551.
22. Boyles, S. L., Loerch, S. C., & Lowe, G. D. (2007). Effects of weaning management strategies on performance and health of calves during feedlot receiving. *The Professional Animal Scientist*. ***23***(6), 637-641.

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