Role of Infrared lamps in cold stress alleviation during winter in Murrah calves

Showkat A. Bhat*,1, Bharat Bhushan2, Narendra Kumar1, S. A. Lone1, Pranay Bharti1, T. Chandrasekar1, Asu Singh Godara4 and Ranjeet Singh Godara5

Indian Veterinary Research Institute, Izatnagar, Bareilly-243 122, Uttar Pradesh, India.
Received: 01-01-2016 Accepted: 29-02-2016 DOI:10.18805/ijar.10766

ABSTRACT
The main aim of this study was to determine the role of Infrared lamps in cold stress alleviation during winter in Murrah calves. Ten newborn calves were randomly divided into two groups (G1 and G2) of five each. The calves of G1 were provided with no additional protection; however calves of G2 were protected against cold weather by using Infrared lamps. The body weight (kg) of calves was recorded at weekly interval. The blood samples collected at fortnightly interval were analyzed for Packed Cell volume (PCV, %), hemoglobin (Hb, g/dl), Total Serum Protein (TSP, g/l), albumin (g/l), globulin (g/l) and albumin globulin (A:G) ratio and hormones viz., triiodothyronine (T3, ng/ml), thyroxine (T4, ng/ml) and cortisol (ng/ml). The total body weight gain and average daily gain (ADG) was significantly (P<0.01) higher in G2, as compared to G1. The PCV values were significantly (P<0.05) higher on day 15 and day 45 in G2 than G1. The albumin and A:G Ratio were significantly (P<0.05) higher on day 60 and 45, respectively in G2 than G1. The cortisol levels were higher in G2 than G1 and differences were highly significant (P<0.01) on 15th day and significant (P<0.05) on 45th day. Significantly (P<0.01) higher values of T3 and T4 were observed on 15th and 45th day in G2, as compared to G1. On the basis of the results, it may be concluded that Infrared lamps can be effectively used to protect newborn calves from adverse conditions of winter and to improve their body growth performance.

Key words: Body weight, Cold stress, Hematobiochemical parameters, Infrared lamps, Murrah calves.

INTRODUCTION

Calves are considered to be the future herd and increasing their proportion of survival to weaning is of utmost economic importance. In modern dairying, calf management plays an important role in replacement of old and unproductive animals from herd and finally to improve the economy of the farm. The better management of calves during postnatal period ensures optimum growth rate and efficient feed conversion efficiency and has thus direct effect on the life time production performance of animals. Losses of calves during the early neonatal period have a negative impact on the economic sustainability of the cow/calf operation. Extreme variations in the ambient temperatures can influence the growth of calves to a greater extent and prolonged exposure may lead to stunting of the calves along with compromised immune status. Calves are relatively cold sensitive at birth, due to their relatively larger surface area than adults, lack of heat production from rumen fermentation and being wet from foetal fluid (Collier et al., 1982).

The winter climate in Northern region of the country is quite harsh due to low ambient temperature (1-2°C), which causes high mortality and low growth rate in buffalo calves leading to great economic loss. It is therefore, essential to protect the buffalo calves from cold to obtain optimum growth as per their genetic potential. The thermoneutral zone for calves lies in a range of 15–25°C (Scanes, 2011) and the lower critical temperature ranges from 9 to 15 °C at birth and during the first two weeks of life (Phillips, 2010). It appears reasonable for the livestock sector to come up with new strategies in order to maintain and increase the production potential under altered climatic conditions. Several effective measures including the use of calf jackets, hot box or warm water bath are used to prevent cold stress (Butler et al., 2010). Reduction in the overall heating requirement of calf shed can be accomplished by taking advantage of the thermal and optical properties of Infrared radiations. Hence, the present study was conducted to find out the role of Infrared lamps in cold stress amelioration during winter in Murrah calves.

MATERIALS AND METHODS
The experiment was carried out at the Calf Unit of Cattle and Buffalo Farm, Livestock Production Management Section, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh (India) which is located at an altitude of 169 meters above mean sea level and at the latitude of 28.22°N and longitude of 79.22°E. The average maximum

*Corresponding author’s e-mail: drshowkatbhat813@gmail.com; 1Division of Livestock Production and Management, ICAR-National Dairy Research Institute, Karnal-132001, 2Division of Animal Genetics, ICAR-Indian veterinary research Institute, Izatnagar, Bareilly-243122, 3Division of Animal Reproduction Gynaecology and Obstetrics, ICAR-National Dairy Research Institute, Karnal-132001, 4Division of Livestock Production and Management, ICAR-Indian veterinary research Institute, Izatnagar, Bareilly- 243122, 5Division of Livestock Production and Management, Rajasthan University of Veterinary and Animal Sciences, Bikaner-33401.
and minimum values of air temperature during the last three years (2011, 2012 and 2013) were 38.07°C and 7.43°C, respectively. During study period, mean environmental temperature and relative humidity inside the calf shed ranged between 9.5 to 21.5°C and 72.1 to 91.7%, respectively. The external temperature and relative humidity varied between 7 to 18°C and 58 to 95%, respectively.

All the calves were reared under similar management and proper hygienic conditions throughout the period of study. Calf shed was having double row system of housing. Calves of G1 and G2 were housed individually in opposite rows in the same calf shed. The pens were cleaned daily and all hygienic precautions were taken to prevent the incidence of infectious and contagious diseases.

**Experimental design:** The experiment was conducted from 2nd November, 2013 to 10th February, 2014 when the environmental temperature was at the lowest. Ten newborn Murrah buffalo calves were randomly divided into 2 groups (5 each). Calves of Group 1 (G1) were provided with no heat source while the calves of Group 2 (G2) were provided protection against the cold weather by using 250 W Infrared heat lamps. Infrared lamps were used at the rate of one per two calves placed at the height of 30 inches from the body of the calf. The Infrared lamps were used from 5:00 p.m. to 9:00 a.m. in order to protect the calves from adverse effects of cold weather. The Infrared lamps are in common use to protect pigs and chicks from the cold stress during winter. However, protecting calves by using Infrared lamps is a less known practice. Due to the directional, draught free and instant heat properties of infrared radiations, the comfort zone can be achieved within a short period of time as compared to conventional warm air systems. Keeping above in view, the Infrared lamps were selected as a source of heat to protect calves from cold winter during their early part of life.

**Recording of individual body weight:** Birth weights of individual calves for the two groups were recorded soon after birth before feeding colostrums. Subsequently, individual body weights (Kg) of calves under each group were recorded at weekly intervals from birth to the ninth week of age. The calves were weighed in the morning before offering feed and water, with the help of a digital weighing balance.

**Hematobiochemical parameters:** The blood samples were collected from the jugular vein following the aseptic measures within 6 h of birth and then at fortnightly interval prior to feeding and watering. The blood samples were analyzed for hematological parameters, viz., packed cell volume (PCV, %), hemoglobin (Hb, g/dl). These parameters were estimated by using automatic Hemalyzer. Serum was separated by centrifugation for 10 min at 1200×g and was immediately frozen at –20°C until the time of analysis. Serum biochemical parameters, viz., Total serum protein (TSP, g/l), albumin (g/l), Globulin (g/l) and albumin globulin ratio (A:G) were estimated. TSP was determined by Modified Biuret method and serum albumin level (g/l) by Bromocresol Green (BCG) method. Globulin (g/l) was calculated by deducting albumin level from TSP and albumin globulin ratio (A:G) were also estimated

**Hormonal Parameters:** Sera were also analyzed for important stress parameters, viz., T3 (ng/ml), T4 (ng/ml) and cortisol (ng/ml). These parameters were estimated by radio immuno assay (RIA) using a gamma counter.

**Meteorological observations:** Environmental temperature (°C) and relative humidity (%) were recorded in the calf shed daily in morning between 7:30 a.m. to 8:00 a.m. and in evening between 3:30 p.m. to 4:00 p.m. For the external macroclimatic environment the data was obtained from the Meteorological Station of Division of Physiology and Climatology, IVRI, Izatnagar.

**Statistical analysis:** Data collected were analysed by Statistical Analysis System (SAS, 2011) Software Programme, version 9.3.

**RESULTS AND DISCUSSION**

**Body weight changes and average daily gain:** The effect of cold stress on weekly body weight changes and weekly average daily gain of calves of both the groups is presented in figure 1 and figure 2, respectively. The results revealed that the calves protected under Infrared lamps had significantly higher (P<0.01) body weight gain of 31.24 ± 7.5 Kg as compared to 25.12 ± 7.6 Kg of G1 as presented in Table 1. It was observed that the weekly ADG was highly significant (P<0.01) during 6th, 7th and 8th week and significant (P<0.05) during 3rd, 4th, 5th and 8th week in calves of G2 as compared to G1.

The reduced rate of body weight gain in the calves of G1 might be due to cold induced thermogenesis. This homeostatic response to cold stress might have increased heat production by using substrates mobilized from body tissues or from dietary metabolizable energy. Higher ADG

![Fig 1: Body weight (Kg) of Murrah calves during the experimental period](image-url-1)
Hematological Parameters:
The mean serum concentration of albumin was significantly higher in calves of G₂ compared to G₁. However, the Hb concentration did not vary significantly between the groups, although it was comparatively higher in the calves of G₁ as compared to G₂. The reason for the increase in PCV and Hb in the calves of G₁ might be due to increase in the synthesis of RBC and Hb to maintain the homeostasis. Maurya et al. (2013) also observed higher values of PCV and Hb in cold stressed lambs as compared to those protected against cold weather. Bhat et al. (2015) also reported comparatively higher values of PCV and Hb in Vrindavani calves which were not protected against cold as compared to calves protected with Infrared lamps during winter.

Serum Biochemical Parameters:
In general the values of serum biochemical parameters were found higher in calves of G₁ as compared to G₂. However, at day 60 of the experiment, the mean serum concentration of albumin was significantly (P<0.05) higher in calves of G₁ as compared to G₂. The A:G ratio was also found significantly (P<0.05) higher on day 30 of the experiment in calves of G₁ as compared to G₂. Significantly (P<0.05) higher values of albumin found on day 60 in calves of G₂ as compared to G₁.

**Table 2: Mean±SE of hematobiochemical parameters of Murrah buffalo calves at fortnightly interval**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 day</th>
<th>15 day</th>
<th>30 day</th>
<th>45 day</th>
<th>60 day</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV (%)</td>
<td>G₁</td>
<td>34.26±1.55</td>
<td>36.92±0.84</td>
<td>35.56±1.71</td>
<td>37.98±0.87</td>
<td>40.64±1.92</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>33.92±1.53</td>
<td>33.92±0.55</td>
<td>36.02±1.24</td>
<td>34.95±0.57</td>
<td>38.88±2.37</td>
</tr>
<tr>
<td>Hb (g/dl)</td>
<td>G₁</td>
<td>11.68±0.39</td>
<td>11.42±0.15</td>
<td>11.76±0.41</td>
<td>12.98±0.66</td>
<td>13.5±0.85</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>11.02±0.25</td>
<td>11.36±0.19</td>
<td>11.96±0.31</td>
<td>12.77±0.57</td>
<td>12.46±0.20</td>
</tr>
<tr>
<td>TSP (g/l)</td>
<td>G₁</td>
<td>60.54±0.31</td>
<td>62.96±0.75</td>
<td>65.86±0.46</td>
<td>68.98±2.33</td>
<td>68.62±1.06</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>60.30±0.42</td>
<td>62.62±0.52</td>
<td>68.28±3.24</td>
<td>66.38±1.47</td>
<td>66.92±0.83</td>
</tr>
<tr>
<td>Albumin (g/l)</td>
<td>G₁</td>
<td>31.32±1.37</td>
<td>33.42±1.59</td>
<td>34.38±0.58</td>
<td>38.36±0.65</td>
<td>41.62±0.85</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>28.86±0.32</td>
<td>30.82±0.24</td>
<td>33.60±1.38</td>
<td>35.30±1.54</td>
<td>39.14±0.50</td>
</tr>
<tr>
<td>Globulin (g/l)</td>
<td>G₁</td>
<td>29.22±1.21</td>
<td>29.56±1.75</td>
<td>31.48±0.94</td>
<td>30.62±1.83</td>
<td>26.98±1.14</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>31.44±0.22</td>
<td>31.80±0.29</td>
<td>34.68±1.87</td>
<td>31.00±1.75</td>
<td>27.78±1.33</td>
</tr>
<tr>
<td>A:G Ratio</td>
<td>G₁</td>
<td>1.09±0.10</td>
<td>1.16±0.13</td>
<td>1.10±0.05</td>
<td>1.27±0.06</td>
<td>1.55±0.08</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>0.92±0.01</td>
<td>0.97±0.00</td>
<td>0.97±0.01</td>
<td>1.16±0.11</td>
<td>1.43±0.09</td>
</tr>
</tbody>
</table>

PCV=Packed cell volume; Hb=Hemoglobin; TSP=Total Serum Protein; A:G=Albumin Globulin Ratio.
Mean showing different superscripts in lower case letters (a, b) in a column differ significantly at 5% (P<0.05).
might be due to their response to cold winter to maintain homeostasis. These results were in accordance to Olson (1986), who also observed higher plasma protein values in dairy calves due to cold stress.

**Hormonal parameters:** The Mean±SE of cortisol (ng/ml), triiodothyronine (T₃, ng/ml) and thyroxine (T₄, ng/ml) of calves in both groups at fortnightly interval are presented in Table 3. Various stress measurements have been described and it has been reported that changes in hormones such as cortisol and thyroxine are utilised in quantifying the response to stress (Carolyn, 1997).

**Cortisol:** In general a trend in the level of cortisol was observed from birth to 60 days of age. At birth a very high value of cortisol was observed followed by decreased levels in both groups with increase in age. The cortisol levels were found comparatively higher in calves of G₂, as compared to G₁, and the differences were highly significant (P<0.01) on 15th day and significant (P<0.05) on 45th day of the study. At birth very high level of cortisol was observed in calves of both groups. This neonatal hypercortisolemia might be due to the hyper secretion of cortisol by foetal adrenals which precedes and probably induces parturition. Significantly (P<0.01) higher values of cortisol were observed on day 15 and day 45 in calves of G₂ as compared to G₁. The increased level of cortisol in calves of G₂ might be due to increase in lipolysis and utilization of brown adipose tissue for heat production. Godfrey et al. (1991) also observed significantly (P<0.05) higher values of cortisol in Brahman calves after their exposure to cold. Maurya et al. (2013) also reported significantly (P<0.05) higher values of cortisol in cold stressed lambs as compared to protected lambs. The mean serum concentrations of cortisol were also found significantly (P<0.01) higher in calves which were not protected against cold as compared to calves protected with Infrared lamps during winter (Bhat et al., 2015).

**Thyroid hormones:** The level of thyroid hormones recorded did not exhibit specific trend. At birth, the levels of thyroid hormones were found high in both groups. The T₃ and T₄ concentrations were comparatively higher in calves of G₂ as compared to G₁ and the differences were found to be highly significant (P<0.01) on 15th and 45th day of the study. The high levels of triiodothyronine and thyroxine at birth might be due to an early adaptation of the calf to the external environment. Ingole et al. (2012) also reported significantly (P<0.01) higher values of thyroid hormones in zero to seven days old buffalo calves. The higher values of T₃ and T₄ in calves of G₂ might be due to effort of calves to adapt their metabolic balance to cold conditions. Godfrey et al. (1991) observed significant (P<0.05) increase in thyroid levels of Brahman calves after birth when they were exposed to cold treatment. Similarly, Souza et al. (2002) also reported increased thyroid levels in rams exposed to cold weather.

**Economic importance of using Infrared lamps:** The cost of electricity per kilowatt hour at the time of study was five rupees. The Infrared lamps (250 W) were used for about 16 hours per day. The cost of utilization of electricity per day was therefore Rs. 20 (0.25 X 16 X 5) and for whole period of study (63 days) was Rs.1260. The cost of Infrared lamp was Rs.250 and the installation cost per two calves was Rs.50. Since Infrared lamps were used at the rate of one per two calves, hence total cost for two calves was Rs.1560. Therefore, additional cost of raising one calf during the study period was Rs.780 and per day was Rs. 12.38 (780/63). The newborn calves are usually susceptible to the cold during their early part of life. The climate in the Northern region of our country usually remains cold for three months. Therefore, additional cost of rearing of calves under Infrared lamps for three months will be Rs.1114.20 (Rs.779.94 for 63 days) per calf. The ideal body weight gain in calves should be atleast 500 grams / day (Blood and Radostits, 1989). The ADG was found significantly (P<0.01) higher in calves of G₂ (495.8±8.16) as compared to calves of G₁ (398.7±8.18). The extra body weight gain of 97.1 g per day was obtained in calves of G₂ over the body weight gain of calves of G₁. Therefore, extra body weight gain in calves of G₂ over calves of G₁ for three months would be 8.739 Kg. (6.117 Kg. for 63 days). One day decrease in productive life resulted in loss to the tune of Rs. 368 in cross bred cows (Abdullah et al. 2014). Hence, the expected gain of life time productive days in animals of G₁ would be around 17.48 days (8.739/0.5) or 12.23 days (6.117/0.5, considering 63 days) as compared to calves of G₂. This in turn would lead to total benefit of Rs. 6432.64 (17.48x368) and net benefit of Rs.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 day</th>
<th>15 day</th>
<th>30 day</th>
<th>45 day</th>
<th>60 day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortisol (ng/ml)</td>
<td>G₁</td>
<td>56.06±4.19</td>
<td>15.10±0.66</td>
<td>7.50±0.54</td>
<td>6.86±0.82</td>
<td>3.60±0.61</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>55.46±4.90</td>
<td>10.58±0.91</td>
<td>6.56±0.51</td>
<td>4.20±0.68</td>
<td>2.80±0.5</td>
</tr>
<tr>
<td>T₃ (ng/ml)</td>
<td>G₁</td>
<td>2.76±0.05</td>
<td>2.60±0.05</td>
<td>2.16±0.04</td>
<td>2.48±0.14</td>
<td>1.54±0.22</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>2.67±0.08</td>
<td>2.12±0.08</td>
<td>2.06±0.09</td>
<td>1.44±0.10</td>
<td>1.40±0.14</td>
</tr>
<tr>
<td>T₄ (ng/ml)</td>
<td>G₁</td>
<td>55.84±3.93</td>
<td>51.96±0.90</td>
<td>42.24±0.58</td>
<td>49.28±0.90</td>
<td>41.46±0.81</td>
</tr>
<tr>
<td></td>
<td>G₂</td>
<td>55.70±3.46</td>
<td>43.84±1.09</td>
<td>37.14±1.50</td>
<td>38.98±0.86</td>
<td>37.32±1.00</td>
</tr>
</tbody>
</table>

T₃=Triiodothyronine; T₄=Thyroxine

Mean showing different superscripts in lower case letters (±) and in upper case letters (×) in a column differ significantly at 5% (P<0.05) and 1% (P<0.01), respectively.
5318.44 (6432.64-1114.20) per calf considering three months or total benefit of Rs. 4500.64 (12.23x368) and net benefit of Rs.3720.7 (4500.64-779.94) per calf considering 63 days.

CONCLUSION
The results of present study indicated that the buffalo calves raised under the protection of Infrared lamps during winter had better growth rate and were in more comfortable conditions compared to calves maintained without provision of Infrared lamps. Thus, Infrared lamps in the calf shed could be effectively used to provide favourable microclimate for the calves during winter in their early part of life.

ACKNOWLEDGEMENT
The authors are highly thankful to the Director of the Indian Veterinary Research Institute for providing the facilities. Also, we thankfully acknowledge, Indian Council of Agricultural Research for providing Fellowship (as a source of fund) throughout the Masters study.

REFERENCES


