Environment & Ecology 35 (1A) : 243—247, January—March 2017
Website: environmentandecology.com ISSN 0970-0420

Physiological Responses and Adaptability Index of Milk-Fed Calves to Thyroxine Supplementation

Lakshmi Priyadarshini, Hari Shyam Singh, Aditya Mishra, Anand Kumar Jain

Received 20 March 2016; Accepted 22 April 2016; Published online 6 May 2016

Abstract The study was conducted on a total of 12 buffalo calves and 12 cow calves. The experiment included four group of animals, control group of buffalo and cow calves, thyroxine supplemented buffalo and cow calves, respectively. Each group included six animals. Thyroxine was administered orally once a day @ 0.167 mg/kg body weight in powder form mixed along with 5 gram jaggery on 15th day, 30th day and 45th day to the experimental calves. The physiological responses were recorded on the day of collection. Studies on physiological responses, suggested that heart rate increased significantly in thyroxine supplemented cow calves but not in buffalo calves, in comparison to control group. The rectal temperature and respiration rate did not increase significantly in thyroxine supplemented buffalo calves and cow calves than control groups of buffalo calves and cow calves. The body weight remained almost constant in treatment groups. The adaptability index (%) of thyroxine supplemented buffalo calves did not differ significantly as compared to control group of buffalo calves whereas, adaptability index (%)of thyroxine supplemented cow calves decreased significantly than control group of cow calves. However, the adaptability index (%) of buffalo calves was found to be higher than cow calves in all respect. The increased thyroxine level in thyroxine supplemented buffalo calves helped to maintain their body temperature and increased basal metabolic rate, thus helped in their survival and reduced mortality.

Keywords Thyroxine, Buffalo calves, Cow calves, Adaptability index.

Lakshmi Priyadarshini*
PhD Scholar,
Dairy Cattle Physiology Division,
NDRI, Karnal (HR), India

Hari Shyam Singh
Professor & Head,
Department of Vety. Physiology & Biochemistry,
COVSc & AH, Jabalpur, India

Aditya Mishra, Anand Kumar Jain
Assistant Professor
Department of Veterinary Physiology & Biochemistry
College of Veterinary Science & A.H., NDVSU,
Jabalpur, MP, India
e-mail : drlpaa@gmail.com
*Correspondence

Introduction

The neonatal buffalo calves have lower rectal temperature than cow calves. The production of heat is by utilization of brown fat in early neonatal life, when the young one is exposed suddenly to the new environment and faces the crisis of thermoregulation. Higher serum lipids further potentiate the cause of

Table 1. Rectal temperature (°F) at different intervals in different groups of calves. Mean values bearing different superscripts in rows and columns (lower case) and in last row (upper case), differ significantly (p<0.05).

Days	Groups I	II	III	IV
16th	100.58 ± 0.39^{d}	100.95 ± 0.29^{cd}	100.95 ± 0.24^{cd}	101.40 ± 0.39^{bcd}
31st	100.45 ± 0.31^{d}	102.07 ± 0.29^{ab}	100.90 ± 0.17^{cd}	102.78 ± 0.50^{a}
46th	100.80 ± 0.29^{cd}	101.95 ± 0.43^{abc}	100.90 ± 0.33^{cd}	102.20 ± 0.36^{ab}
Overall	100.61± 0.18^{B}	101.66± 0.22^{A}	100.92± 0.14^{B}	102.13± 0.26^{A}

hypothermia due to underutilization of lipids by the buffalo calves [1].

Hypothermia might be an important factor for higher mortality of buffalo calves, particularly during winter season. Poor utilization of lipids might be the triggering element for hypothermia in these neonatal buffalo calves. Exogenous supplementation of particular drug will help in maintenance of BMR of calves by its calorigenic effects by uncoupling of oxidative phosphorylation process. Therefore,elevated body temperature will lead to sustenance of calves during initial two months of age. Hence, the present study was planned to explore effect of exogenous thyroxine supplementation on physiological responses and adaptability index in calves.

Materials and Methods

The study was conducted on a total of 12 apparently healthy buffalo calves and 12 cow calves at Livestock Farm (calf unit), Adhartal, N.D.V.S.U., Jabalpur (M.P.). The experiment included total four group of animals (I-IV), control group of buffalo calves and cow calves, thyroxine supplemented buffalo and cow calves, respectively. The thyroxine was administered orally once a day @ 0.167 mg/kg body weight in powder form mixed along with 5 gram jaggery on 15th day, 30th day and 45th day to the experimental calves. The physiological parameters viz., rectal temperature was recorded (°F) with the help of clinical thermometer by contacting the same with the mucous membrane of rectum for a minimum of 2 minutes. The respiration rate (per minute) was noticed by observing the movement of the ribs for 30 seconds. The rate per minute was determined by doubling the recorded values. Heart rate was measured by indirect ausculation method with the help of binaural stethoscope. It was measured by placing the phonendoscope on body surface in between the 3rd and 6th pairs of the ribs on left side of the body. The body weight (kg) of the calves was determined taking weight of calves along with animal attendant. The difference in the weight was taken as weight of the

Table 2. Respiration rate (per min) at different intervals in different groups of calves.

Days	Groups I	II	III	IV
16th	28.33±2.30	27.67±2.01	29.33±1.73	29.50±2.17
31st	27.33±2.12	30.50±1.67	30.00±1.59	30.50±1.54
46th	26.00±1.69	30.83±2.63	31.00±1.77	31.00±1.03
Overall	27.22±1.14	29.67±1.2	30.11±0.93	30.33±0.91

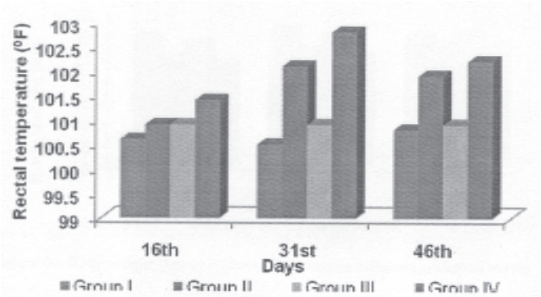

Fig. 1. Rectal temperature (°F) at different intervals in different groups of calves.

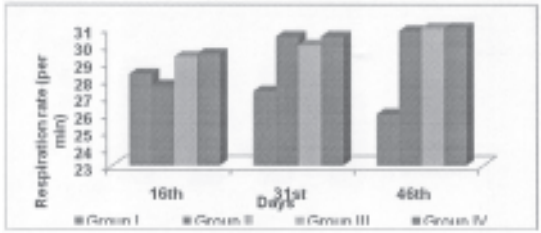

Fig. 2. Respiration rate (per min) at different intervals in different groups of calves.

Table 3. Heart rate (per min) at different intervals in different groups of calves. Mean values bearing different superscripts in last row, differ significantly ($p<0.05$).

Days	Groups I	II	III	IV
16th	87.33± 1.20	91.33 ± 0.92	89.50 ± 3.03	96.67 ± 1.23
31st	86.00 ± 0.58	96.00 ± 1.37	87.33 ± 2.68	99.17± 1.01
46th	85.67 ± 1.82	94.00 ± 1.41	88.50 ± 1.50	99.17 ± 1.01
Overall	86.33 ± 0.73^{C}	93.78 ± 0.82^{B}	88.44 ± 1.36^{C}	98.33 ± 0.65^{A}

Table 4. Body weight (kg) at different intervals in different groups of calves. Mean values bearing different superscripts in rows and columns (lower case) and in last row (upper case), differ significantly ($p<0.05$).

Days	Groups I	II	III	IV
16th	29.00 ± 1.33^{ab}	24.08 ± 0.60^{cd}	27.80 ± 0.72^{ab}	22.90 ± 0.57^{d}
31st	29.90 ± 1.14^{a}	26.10 ± 0.52^{bc}	29.50 ± 0.88^{a}	24.68 ± 0.82^{cd}
46th	30.80 ± 1.69^{a}	27.80 ± 0.94^{ab}	30.33 ± 0.93^{a}	27.92 ± 0.65^{ab}
Overall	29.88 ± 0.78^{A}	26.00 ± 0.53^{B}	29.19 ± 0.52^{A}	25.17 ± 0.62^{B}

calves. The body weight of the calves was recorded on the day of blood collection.

Adaptability index was measured by using Iberia heat tolerance test. Heat tolerance test was calculated by modified standard method [2]. For calculating the test all groups of animals were kept in open paddock with access to water but having no shed from 8.00 am to 4.00 pm. At 4.00 pm rectal temperature was recorded. This experiment was done for 3 consecutive days with average air temperature 85°F or more.

Heat tolerance coefficient= 100 — 10 (BT – 101.1)

Adaptability coefficient

Where BT is average body temperature after sun exposure in °F, 101.1 is animal normal body temperature, 10 is a factor to convert degrees'deviation in body temperature from the normal to a unit basis and 100 is perfect efficiency in maintaining temperature at 101.1 °F.

The physiological data were analyzed by analysis of variance using hierarchical design and adaptability index was analyzed by using completely randomized design (CRD) [3].

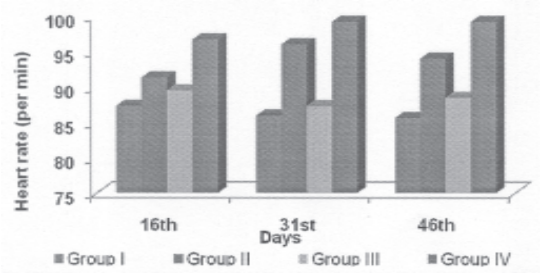

Fig. 3. Heart rate (per min) at different intervals in different groups of calves.

Results and Discussion

The higher rectal temperature as shown in Table1, Fig. 1 of thyroxine treated calves [4] is clearly related to the calorigenic effect of exogenously supplemented thyroxine, which maintains a critical role in the control of body temperature by stimulation of thermogenesis and regulation of cellular metabolism [5]. Some calorigenic effect of thyroxine (T_4) is also due to the metabolism of fatty acids as well as increase in the activity of the membrane bound Na^+-K^+ ATPase in many tissues.

The thyroid hormones also increase dissociation of oxygen from hemoglobin by increasing the concentration of 2, 3-diphosphoglycerate (2,3-DPG) in erythrocytes [6]. The higher value of respiration rate obtained with T_4 supplemented group is attributed to the increase in metabolic rate, which increases the utilization of oxygen and the formation of carbon monoxide (CO), these effects may activate all those mechanisms pertaining to increase in the rate and depth of respiration. However, the increased respiration could also be attributed to thermally stimulated increase in pulmonary ventilation

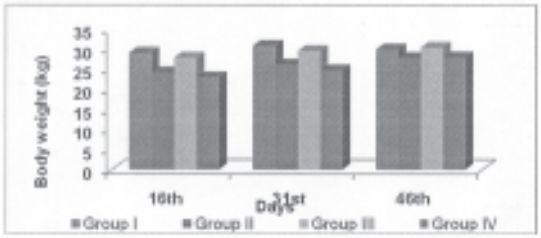

Fig. 4. Body weight (kg) at different intervals in different groups of calves.

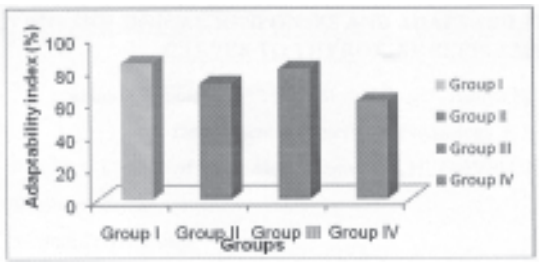

Fig. 5. Adaptability index (%) of different groups of calves.

which, in turn, augmented evaporative heat loss. The data recorded for heart rate of buffalo calves (Group I) and cow calves (Group II) at different stages of neonatal periods indicate the conspicuous changes. The respiration rate did not differ significantly (Table 2, Fig. 2) but the heart rate differed significantly (p<0.05) in thyroxine supplemented cow calves as compared to control group of cow calves. The heart rate of thyroxine supplemented buffalo calves (Group III) did not differ significantly than that of control group as shown in Table 3, Fig. 3. During day 15 to 46, in both cow and buffalo calves data clearly that newly borne neonates require more energy to fulfil their maintenance required. The extra amount of energy could be obtained through increased BMR. The increased BMR further results into increase in the respiration and heart rate in the early stages of life. However, the role of the autonomic nervous system cannot be ignored for increased heart rate, as there used to be low vagal tone in the early stages of development, which resulted into increased heart rate.

The decrease in mean body weight, but not significantly (Table 4, Fig.4), associated with exogenous T_4 is related to an increase in metabolic rate and negative nitrogen balance associated with stimulation of protein catabolism. It has been indicated that the increase in basal metabolic rate (BMR) by thyroid hormones is usually associated with mobilization and degradation of protein and lipids in tissues, depletion of the body stores of fat and body weight loss. In hyperthyroidism, if the feed intake is not increased, catabolism of endogenous protein and fat stored within the body leads to body weight loss [7].

Table 5. Adaptability index (%) of different groups of calves. Mean values bearing different superscripts in rows differ significantly (p<0.05).

Groups	I	II	III	IV
Adaptability index (%)	84.00 ± 1.34^{A}	71.33 ± 1.25^{B}	80.33 ± 1.80^{A}	60.33 ± 1.90^{C}

In the present study the adaptability index (%) of thyroxine supplemented buffalo calves did not differ significantly as compared to control group of buffalo calves whereas adaptability index (%) of thyroxine supplemented cow calves decreased significantly (p<0.05) than cow calves. However, the adaptability index (%) of buffalo calves was found to be higher than that of the cow calves in all respects (Table 5, Fig.5).

The buffalo and Friesian cow's adaptability index to the sub-tropical environment of Egypt as 89.1% and 82.9%, respectively [8]. Thyroid hormones decline in response to heat stress is probably an attempt to reduce metabolic heat production [9].

Conclusion

The adaptability index (%) of buffalo calves was found to be higher than cow calves in all respect. The increased thyroxine level in thyroxine supplemented buffalo calves helped to maintain their body temperature and increased basal metabolic rate, thus helped in their survival and reduced mortality.

References

1. Jain AK, Tripathi RK, Sharma IJ, Quadri MA, Agrawal

RG (2007) Relationship of serum lipids with development of hypothermia in neonatal bovines. Buffalo Bull 26 : 67—71.
2. Rhoad AO (1944) The Iberia heat tolerance test for cattle. Trop Agric 21 : 162.
3. Snedecor GW, Cochran WG (1989) Statistical methods. 8th edn. Lowa State Univ Press, Ames, Lowa, USA, pp 593.
4. Abdelatif AM, Saeed IH (2009) Effect of altered thyroid status in the domestic rabbit (*Lepus cuniculus*) on thermoregulation, heart rate and immune responses. Global Veterinaria 3 : 447—456.
5. Qi X, Chan WL, Read RJ, Zhou A, Carrell RW (2014) Temperature responsive release of thyroxine and its environmental adaptation in Australians. Proc R Soc B 281 : 20132747. http://dx.doi.org/10.1098/rspb.2013.2747.
6. Ganong WF (2005) Review of medical physiology. 22nd edn . Appleton and Lange, Stanford, Connecticut, pp 320—335.
7. Wilmar M, Wiersinga MD (2013) Adult hypothyroidism. Dep of Endocrinol F5-171 Academic Medical Center Meibergdreef 9 NL-1105 AZ Amsterdam, The Netherlands.
8. Marai IFM, Haeeb AAM (2010) Buffalo's biological functions as affected by heat stress—A review. Livest Sci 127: 89—109.
9. Rasooli A, Nouri M, Khadjeh GH, Rakesh A (2004) The influence of seasonal variations on thyroid activity and biochemical parameters of cattle. Iran J Vet Res 5 : 1383.