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METABOLIC RESPONSES OF DOGS DURING EXTREME HOT AND COLD AMBIENCES

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ABSTRACT

Ambient temperature associated variations in metabolic responses of adult healthy German Shepherd dogs were investigated. Blood samples were collected during moderate, hot and cold ambient temperature periods to harvest sera. Metabolic responses in the serum included cholesterol, triglycerides, glucose, total proteins, urea and creatinine. They were determined by using the standard techniques. During hot ambience the mean values of serum urea and creatinine were significantly ($p \leq 0.05$) higher and mean values of cholesterol, triglycerides, glucose and total proteins were significantly ($p \leq 0.05$) lower in comparison to moderate ambience. During cold ambience the mean values of serum cholesterol, glucose, urea and creatinine were significantly ($p \leq 0.05$) higher and mean values of triglycerides, and total proteins were significantly ($p \leq 0.05$) lower in comparison to moderate ambience. Mean values of cholesterol, triglycerides, glucose and total proteins were significantly ($p \leq 0.05$) higher and mean values of urea and creatinine were significantly ($p \leq 0.05$) lower during cold ambience in comparison to hot ambience. Magnitude of percent variation was maximum for serum creatinine in both hot and cold ambiences. It was concluded that extreme hot and cold ambient temperatures affected the dogs which was evident in the form of variations in the metabolic responses to combat the environmental challenges.

Keywords: Ambient temperature**,** cold, German shepherd dog, hot, metabolic responses.

INTRODUCTION

Metabolism is affected by many factors including physiological and environmental factors. Physiological variations have been reported by researchers in dogs in certain biochemical parameters like gucose, proteins etc. warranting age specific reference intervals [1]. The usefulness of biochemical parameters as markers of metabolic disorders is coming up in companion animals. Ambient temperature may cause enormous impact over energy metabolism. Upholding of equilibrium between the heat production and heat loss is a must for thermoregulation. Change of thermo-neutral environment to adverse conditions causes stress to animals. This can be observed in the form of modulations in the physiological mechanisms. Synergistic approach of various body systems is required for maintenance of health during harsh climate. Metabolic adjustments are a part of mechanisms used by body to handle effect of varying environmental temperatures. Environmental factors and stress are known to affect biochemical parameters [2].

Variation of metabolic responses in thermoregulation of an animal may impose great risk to health. An understanding of the extent of changes in metabolic responses is essential to formulate the health strategies. Changes in ambient temperature influence maintenance energy requirement of dog. Metabolic responses are good indicators of energy metabolism. Climate is an important determinant of the basal metabolic rate. Therefore the scientific community has shown attention about the thermal comfort of animals. Blood is an important medium in assessing the health status of animals. It is helpful in evaluating physiological and pathological conditions [3]. Therefore, routine blood examinations can help the clinician in evaluating the variations in the parameters to assess health status and timely detection of stress, if any. Importance of German shepherd breed is well known as family pet. Though work has been done to establish base line values of biochemical parameters but there is paucity of literature on metabolic responses with changing ambient temperatures. Further the values obtained from one breed cannot be extrapolated to others. Therefore the present investigation was launched to determine metabolic responses during extreme hot and cold ambiences. The data generated will help in healthy management of German shepherd dogs along with contribution to future research.

MATERIALS AND METHODS

To find out variations in metabolic responses associated with environmental temperatures, 10 adult German shepherd dogs of either sex were screened. Blood samples were collected from saphenous vein to harvest the serum in clean and dry test tubes during moderate (mean maximum ambient temperature 29.20± 0.001), hot (mean maximum ambient temperature 45.82 ± 0.001) and cold (mean minimum ambient temperature 3.11 ± 0.001) ambiences. All the animals belonged to private owners and were managed in similar conditions. In each ambience blood samples were collected during morning hours from the same animals. Metabolic responses in the serum included cholesterol, triglycerides, glucose, total proteins, urea and creatinine. They were determined by using the standard techniques i.e. cholesterol by Sackett method [4] , triglycerides by GPO-PAP method of kit (Wipro), glucose by Folin-Wu method [5], total proteins by colorimetric method [6], urea by the method of Natelson [4] and creatinine by the method of Bonsnes and Taussky [4]. Statistical significance for individual parameter between moderate and extreme ambiences was analysed [7]. Mean value during moderate ambience for each parameter was considered as control.

RESULTS

Mean ± SEM values of all metabolic responses in serum *viz.* cholesterol, triglycerides, glucose, total proteins, urea and creatinine and percent change in hot and cold ambiences for each parameter in comparison to moderate ambience are presented in table 1.

For each parameter, mean value obtained during moderate ambience was considered as control and variations during hot and cold ambiences were considered after comparing each value, respectively. During hot ambience the mean values of serum urea and creatinine were significantly ($p \leq 0.05$) higher and mean values of cholesterol, triglycerides, glucose and total proteins were significantly ($p \leq 0.05$) lower in comparison to moderate ambience, respectively.

During cold ambience the mean values of serum cholesterol, glucose, urea and creatinine were significantly ($p \leq 0.05$) higher and mean values of triglycerides, and total proteins were significantly ($p \leq 0.05$) lower in comparison to moderate ambience.

Mean values of cholesterol, triglycerides, glucose and total proteins were significantly ($p \leq 0.05$) higher and mean values of urea and creatinine were significantly ($p \leq 0.05$) lower during cold ambience in comparison to hot ambience.

Magnitude of percent variation was maximum for serum creatinine in both hot and cold ambiences. Magnitude of percent variation was minimum for serum total proteins in hot ambience and for urea in cold ambience. As compared to moderate ambience the extent of variation for each parameter was comparatively greater in hot ambience than in cold ambience.

Table 1. Mean ± SEM values of metabolic responses in dogs (n=10)

Metabolic responses	Mean ± SEM values			% change	
	Moderate ambience	Hot ambience	Cold ambience	Hot ambience	Cold ambience
Cholesterol, m mol L^{-1}	4.55±0.01 ^{b}	3.80±0.01 ^{b}	4. 90±0.01^{b}	-16.48	7.69
Triglycerides, m mol L^{-1}	1.30±0.01 ^{b}	0.80±0.01^{b}	1.00±0.01^{b}	-38.46	-23.07
Glucose, m mol L^{-1}	5.00±0.002 ^{b}	4.30±0.002^{b}	5.31±0.001^{b}	-14.00	6.2
Total proteins, g L^{-1}	75.00±0.02 ^{b}	68.50±0.02 ^{b}	70.00±0.01 ^{b}	-8.66	-6.66
Urea, m mol L^{-1}	5.88±0.05 ^{b}	8.00±0.02^{b}	6.00±0.03^{b}	36.05	2.04
Creatinine, µmol L^{-1}	80.00±1.00 ^{b}	130.00±1.00 ^{b}	100.00±1.00 ^{b}	62.50	25.50

^{b} = significant differences among mean values of a parameter during varying ambiences

DISCUSSION AND CONCLUSION

An increase in cholesterol can be attributed to the physiological alteration of endocrine function. Role of increased thyroid activity in cold ambience is associated with increased cholesterol [8]. An enhanced ability to mobilize body fat should confer an advantage in a dog subjected to prolonged stress in which fatty acid oxidation accounts for most of the oxygen consumption [9]. Research in the field of clinical medicine links the cholesterol with oxidative stress [10]. Changes in triglyceride level indicated the extreme ambience associated modulations in metabolism [11]. In human medicine triglycerides has been correlated with oxidative stress [12]. Blood glucose concentration my also reflect the effect of haemoconcentration or haemodilution [13]. Changes in glucose levels during hot and cold ambiences can also be mediated through increased glucocorticoid secretions [14] or variation in thyroid hormones [15]. Decrease in food intake due to heat stress can contribute in lowering of blood glucose. Glucose-derived oxidative stress may play a central role linking together many physio-pathogenetic mechanisms [16]. Researchers have correlated glucose level and reactive oxygen species [17].

Earlier research has correlated the urea with the parameters of oxidative stress [18]. This is probably based on the fact that as a part of oxidative stress mediated solute-signaling pathway in tissues, urea increases expression of the oxidative stress-responsive transcription factor and therefore can be related with oxidative stress. Higher serum urea during extreme hot and cold conditions showed the increased activity of urea cycle [19]. Environmental stress can result into higher serum creatinine concentration due to higher metabolic activity in liver and muscle mediated by cortisol [20]. In human patients higher serum creatinine levels have been correlated with oxidative stress [21]. Due to paucity of such studies in animals, it is very important to link creatinine as one of the important diagnostic parameters of environment related oxidative stress. Extreme ambiences stimulate free radical formation which can modulate metabolism of fuel molecules. Heat stress is known to mobilise proteins causing variations in value [15]. Stress conditions may produce oxidative changes in proteins leading to high turnover in blood [22]. It can be surmised that total serum proteins can also serve as marker of environment related stress.

It can be concluded that extreme hot and cold ambiences influenced the metabolism which was evident by the variations in the mean values of metabolic responses. Modulation in metabolic responses was greater in hot ambience than cold ambience. This showed that impact of hot ambience was greater on metabolism than cold ambience. Perhaps variations in the metabolic responses signified metabolic adaptations to combat environmental challenges. The data generated in the present investigation could help in the future research in the field of metabolic stress responses.

REFERENCES

1. Rørtveit R, Saevik BK, Eggertsdóttir AV, Skancke E, Lingaas F, Thoresen SI, Jansen JH. (2015). Age-related changes in hematologic and serum biochemical variables in dogs aged 16-60 days. Vet Clin Pathol. [Epub ahead of print].
2. Balikci E, Yildiz A, Gurdogan F. (2007). Blood metabolite concentrations during pregnancy and post-partum in Akkaraman ewes. *Small Rum Res*, 67, 247-251
3. Ariyibi AA, Oyeyemi MO, Ajadi RA. (2002). A comparative study of some hematology and biochemical parameters of clinically healthy alsatian and local dogs. *Afr J Biomed Res*, 5, 145 – 147
4. Varley H. (1988). In: Practical Clinical Biochemistry. 4th edn. CBS publishers, New Delhi, 349-393.
5. Oser BL. (1976). In: Hawk's physiological chemistry. 14th edn. Tata McGraw Hill Publishing Co Ltd, New Delhi, 900-1125.
6. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. (1951). Protein measurement with the folin-phenol reagents. J Biol Chem, 193, 265-275.
7. Kaps M, Lamberson WR. (2004). Biostatistics for Animal Science, CABI Publishing Oxford shire, 36-270.
8. Kataria N, Kataria AK, Agarwal VK, Garg SL, Sahni MS, Singh R. (2000a). Thyroid hormone in dromedary camels in winter and summer during water restriction. *J Camel Prac Res*, 7, 21–26.
9. Hammel EP, Kronfeld DS, Ganjam VK, Dunlap HL Jr. (1977). Metabolic responses to exhaustive exercise in racing sled dogs fed diets containing medium, low, or zero carbohydrate. *Am J Clin Nutr*, 30, 409-418.
10. Pappolla MA, Smith MA, Thomas TB, Bazan N, Petanceslea S, Perry G, Thal JL, Sano M, Refolo LM. (2002). Cholesterol, oxidative stress and alzheimer's disease: expanding the horizons of pathogenesis. *Free Radic Biol Med*, 33, 173-181.
11. Karapehlivan M, Atakisi E, Atakisi O, Yucart R and Pancarci SM. (2007). Blood biochemical parameters during the lactation and dry period in Tuj ewes. *Small Rum Res*, 73, 267-271.
12. Katsuki A, Sumida Y, Urakawa H, Gabazza EC, Murashima S, Nakatani K, Yano Y, Adachi Y. (2004). Increased oxidative stress is associated with serum levels of triglyceride, insulin resistance, and hyperinsulinemia in japanese metabolically obese, normal-weight men. *Diabetes care*, 29, 2327-2328.

13. Lane SL, Koenig A, Brainard BM. (2015). Formulation and validation of a predictive model to correct blood glucose concentrations obtained with a veterinary point-of-care glucometer in hemodiluted and hemoconcentrated canine blood samples. *J Am Vet Med Assoc*, 246, 307-312
14. Weber G, Singhal RL,Srivastava SK. (1965). Effect of nutrition on hormonal regulation of liver enzymes. *Can J Biochem*, 43, 1549-1553.
15. Nath R. (2006). Seasonal variation of blood biochemical parameters in crossbred calves. *Indian Vet J*, 83, 800 – 801.
16. Greene, DA, Stevens MJ, Obrosova I, Feldman EL. (1999). Glucose-induced oxidative stress and programmed cell death in diabetic neuropathy. *Eur J Pharmacol*, 375, 217-223.
17. Russella JW, Golovoy D, Vincent AM, Mahendru P, Olzmann JA, Mentzer A, Feldman E. (2002). High glucose-induced oxidative stress and mitochondrial dysfunction in neurons. *Faseb J*, 16, 1738-1748.
18. Chena J, Linc T, Liouc C, Liaoa S, Leea L, Wangb P, Tiaod M. (2008). Correlation of oxidative stress biomarkers and peritoneal urea clearance with mitochondrial DNA copy number in continuous ambulatory peritoneal dialysis patients. *Am J Nephrol*, 28, 853-859.
19. Nazifi S, Saeb M, Rowghani E, Kaveh K. (2003). The influences of thermal stress on serum biochemical parameters of Iranian fat-tailed sheep and their correlation with triiodothyronine (T_3), thyroxine (T_4) and cortisol concentrations. *Comp Clin Pathol*, 12(3), 135-139.
20. Kataria N, Kataria AK, Agarwal VK, Garg SL, Sahani MS, Singh R. (2000b). Effect of water restriction on serum aldosterone and cortisol in dromedary camel during winter and summer. *J Camel Prac Res*, 7, 1-7.
21. Kolagal V, Karanam SA, Dharmavarapu PK, D'Souza R, Upadhya S, Kumar V, Kedage V, Muttigi MS, Shetty JK, Prakash M. (2009). Determination of oxidative stress markers and their importance in early diagnosis of uremia-related complications. *Indian J Nephrol*, 19, 8-12.
22. Goswami K, Nandakumar DN, Koner BC, Bobby Z, Sen SK. (2003). Oxidative changes and desialylation of serum proteins in hyperthyroidism. *Clin Chim Acta*, 337, 163-168.