Serum and CSF Mineral Profile of Himalayan Yak (*Bos grunniens*) in their Natural Habitat

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ABSTRACT : Mineral profile of serum and cerebrospinal fluid (CSF) of 15 Himalayan Yak (adult female, n=8; adult male n=4 and young male,n=3) was studied in their natural habitat at an altitude of 3300 meters above mean sea level at Sangla in north western Himalayas. The macro and micro minerals estimated in serum and CSF were; Sodium, Potassium, Calcium and Magnesium and Zinc, Copper and Iron respectively. The values recorded among different Yak groups did not significantly differ from each other except serum iron and haemoglobin which were significantly higher ($p<0.05$) in young male Yaks compared to the adult male and female Yaks. An observation of great significance was considerably higher potassium and lower sodium level in Yaks compared to other bovine species of plains. The serum potassium values in some adult female Yaks were recorded as high as 10.4 mEq/l and the values varied between 6.6 to 9.8 mEq/l in young male Yaks. The serum Sodium values and Na:K ratios in Yak serum ranged between 117.5 to 122.6 mEq/l and 13.7 to 15.3 respectively. The possible relationship of high serum Potassium value with hypoxic conditions and hostile mountain environment has been discussed. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 2 : 189-191*)

Key Words : Yak, Minerals in Serum and CSF

INTRODUCTION

Yak (*Bos grunniens*) is an animal of tremendous economic importance to the highlanders in China, India, Mongolia and other south Asian countries. Owing to their location in difficult terrain and hostile nature, it is rather difficult to conduct scientific studies on them in their natural habitat and an investigator has to walk to meet them on their grounds. Some information on haematology of yak (Sahu et al, 1981, Hawkey et al, 1983; Weber et al, 1988; Singh et al, 1989 and Winter et al, 1989) and aspects of pulmonary circulation (Anand et al, 1988) are available but we have not come across any report on the mineral profile of yak blood or cerebrospinal fluid (CSF).

In the present study the macro and micro mineral profile of yak blood serum and CSF in their natural habitat at an altitude of 3,300 meters above sea level was studied.

MATERIALS AND METHODS

The study was conducted in the month of November (ambient temp. 15 to 20℃, relative humidity, 50 to 60 %) on eight adult female yaks (aged 5-7 years), four adult male yaks (aged 3-5 years) and three young male yaks (aged 4 to 6 months) belonging to the University's High Altitude Research station at Sangla & Chittkul, District Kinnaur, Himachal Pradesh, India in the North Western Himalayas (Altitude 3,300 metres). The animals were housed in the barn and let loose for grazing during the day time. There was negligible concentrate or other supplementation and the yaks mainly survived on grazing. The yaks usually travelled quite a distance for grazing on adjoining steepy mountain peaks. On the day of the experiment, the animals were herded in a makeshift wooden barn and restrained by fastening them to the locally-erected wooden logs. Jugular blood was collected aseptically and serum was separated by centrifugation after allowing about 60 min. of clotting time. Cerebrospinal fluid was collected aseptically by lumbar puncture.

Samples of serum and CSF were stored under ice at 4℃ and transported to the main laboratory at Palampur (altitude 1,200 metres) for analysis. The macro (Na, K, Ca, Mg) and micro (Zn, Cu, Fe) minerals were estimated by Atomic Absorption Spectrophotometer (Perkin Elmer model 3100, U.S.A,) and haemoglobin by cynamet haemoglobin method using a hemoglobinometer (Systronics, India). The results were statistically analysed by analysis of variance technique as described by Steel and Torrie (1960).

RESULTS AND DISCUSSION

The concentration of macro and micro minerals in serum and CSF of yaks are presented in tables 1 and 2 respectively. There was no significant difference in the values of macro and micro minerals among different yak groups except serum Iron. Young male yaks had significantly higher ($p<0.05$) serum iron concentrations (4.56 μg/ml) and haemoglobin (16.0 g/dl) compared to the respective values recorded in adult female (3.44 μg/ml; 12.8 g/dl) and male yaks (3.55 μg/ml; 12.1 g/dl, table 2). Of the three young male yaks, one had haemoglobin value as high as 18.0 g/dl. Although we have no other literature report on serum iron values in yaks to compare our results with, the higher values of haemoglobin and iron in young animals is understandable and represents an adaptational feature to the hypoxic and cold environment. The value of serum iron in yaks were almost 1.5 to 2 times higher than the serun iron values reported for cattle (Kaneko, 1989).

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Table 1. Mean concentration of macro minerals in serum and CSF of yaks (Mean±SEM)

Yaks (No. of animals)	Fluid	Mineral concentrations				
		Na (meq/ℓ)	K (meq/ℓ)	Na:K	Ca (mg/dℓ)	Mg (mg/dℓ)
Adult female (n=8)	Serum	122.60±2.72	9.30±0.28	13.70±1.73	10.00±0.81	2.50±0.83
Adult male (n=4)	Serum	121.60±6.16	8.00±0.53	15.30±1.40	10.80±0.43	2.12±0.09
Young male (n=3)	Serum	117.50±11.50	8.30±0.92	14.20±0.80	10.30±1.12	2.15±0.39
	CSF	148.90±7.80	6.50±0.47	23.00±0.74	4.70±0.43	3.30±0.44

When the observed mineral levels obtained in yak serum were compared with values in species of lowlanders, especially cattle, a number of interesting features emerged. Of particular interest was the high serum potassium concentration in yak serum of all ages and sex. The serum K values were as high as 10.4 meq/l in some adult female yaks (with mean value of 9.3 meq/l, table 1) where as the values varied between 6.6 to 9.8 meq/l in young male yaks. These values were in contrast to the normal serum K values of 4 to 6 meq/l reported for cattle, sheep, goat and other bovine species (Kaneko, 1989). The mean CSF potassium concentration in young yaks (table 1) was also considerably higher than the CSF potassium values reported for cattle and horses (Swenson, 1982). In contrast to high serum K, the mean serum Na values in yaks (117.5 to 122.6 meq/l) were comparatively lower than the reported serum sodium values (132-155 mmol/l) in bovine species of low-landers (Kaneko, 1989). As a result of relatively high serum K and low serum Na, the Na:K ratios in yak serum were considerably lower than the serum Na:K ratios reported for cattle.

Table 2. Mean hemoglobin (g/dℓ) and concentrantion of trace minerals (μg/mℓ) in serum and CSF of yaks (Mean± SEM)

Yaks (No. of animals)	Fluid	Mineral concentrations			
		Zn	Cu	Fe	Hemoglobin
Adult female (n=8)	Serum	0.69±0.04	0.57±0.04	3.44±0.15	12.80±0.33
Adult male (n=4)	Serum	0.70±0.04	0.56±0.09	3.55±0.18	12.10±0.06
Young male (n=3)	Serum	0.91±0.18	0.43±0.04	4.56*±0.09	16.00*±0.95
	CSF	0.72±0.09	0.26±0.02	-	-

* Significantly higher ($p<0.05$) than the corresponding values in adult female and male yaks.

The high K values in serum of yaks seem to be an adaptive response to hypoxia and strenuous living on the mountains and to the low dietary sodium content of high altitude pastures. Paterson et al (1988) reported that in human subjects hypoxia raised the arterial K concentration by an amount which was sufficient to excite the arterial chemoreceptors. In later studies these authors (Paterson et al 1989, 1990) found that arterial plasma K concentration was Increased during excercise. They also observed that moderate to severe hypoxia in cats was always associated with an increase in arterial K concentration. In the light of these findings, it is plausible that one of the reasons of high K in the blood of yaks could be continuous hypoxic environment of the high altitude. The possible cause of relatively lower serum sodium in Yaks compared to other bovine species seems rather difficult to explain. What is, however, of interest is the reported intense salt hunger in wild and nomadic animals living and grazing at high altitude (Denton, 1982). It has also been suggested that salt hunger in these animals was due to lowered sodium intake from pastures which were deficient in sodium and rich in potassium. In a study on human subjects, Hack et al (1964) reported lower serum sodium in persons living at high altitude compared to those who stayed at sea level. These observations could provide a possible explanation for lowered sodium values in blood of yaks compared to the bovine species that are inhabitants of the plains. The values of other serum minerals like calcium, magnesium, zinc and copper in yaks were within the normal range as reported for bovine species of the plains. However, the CSF magnesium (3.3 mg/dl) values in yaks were comparatively higher than the corresponding CSF values reported for bovine species (Kaneko, 1989).

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REFERENCES

Anand, I., D. Heath, D. Williams, M. Dean, R. Ferrari, D. Bergel, and P. Harris. 1988. The pulmonary circulation of some domestic animals at high altitude. International Journal Biometerology. 32 (i). 56-64.

Denton, D. A. 1982. The hunger for salt. Springer-Verlag, New York. p.24

Hack, D., N. W. Levin, B. Goldberg, S. M. Perold, A. S. and Rubenstein. 1964. African Journal of Medical Science 29:11.

Hawkey, C. M., D. G. Ashton, M. G. Hart, R. N. Cindery and D. M. Jones. 1983. Normal and clinical haematology in the Yak (*Bos grunniens*). Research in Vetennary Science. 34:31-36.

Kaneko, J. J. 1989. Clinical Biochemistry of Domestic Animals. Fourth Edn. Academic Press Inc. San Diego, California. p. 888-889.

Paterson, D. J., J. A. Estavillo, and P. C. G. Nye, 1988. The effect of hypoxia on plasma potassium concentration and the excitation of arterial chemoreceptors in the cat. Quarterly J. of Experimental Physiology. 73:623-625.

Paterson, D. J., J. S. Friedland, D. O. Oliver, and P. A. Robbins. 1989. The ventilatory response to lowering potassium with dextrose and insulin in subjects with hyperkalaemia. Respiration Physiology, 76, 393.

Paterson, D. J., C. Peers, and P. C. G. Nye. 1990. Effects of hypoxia, potassium and other stimuli on the on the discharge of the carotid body. In "Arterial chemoreception" Ed by Eyzaguirre and others 1990. Springer-Verlag, New York. p. 272.

Sahu, R. N., R. D. Katiyar and R. C. Khera. 1981. Blood studies on yak of Sikkim. Indian Veterinary Journal, 58:614-616.

Singh, S. P., K. B. Sharma, S. K. Rastogi and M. P. Narang. 1989. A few physiological parameters of Yak. Indian Journal of Animal Sciences. 59:1108-1109.

Steel, G. D. and J. H. Torrie. 1960. Principles and procedures of statistics. Mcgraw-Hill Book Company, Inc, New York. p. 101.

Swenson, M. J. 1982. Dukes' Physiology of Domestic Animals. Comstock Publishing Associates, Cornell University Press/Ithaca and London. p. 170.

Weber, R. E., R. Lalthantluanga and G. Braunitzer. 1988. Functional characterization of foetal and adult Yak hemoglobin: An oxygen binding cascade and its molecular basis. Achieves of Biochemistry and Biophysics. 263(1): 199-203.

Winter, H., U. Tshewang, B. J. Gurung and A. W. Beattle. 1989. Hemoglobin and packed cell volume of Yaks at high altitude. Australian Veterinary Journal, 66(9):299.