Intense Salt hunger in migratory crossbred sheep at high altitude pastures of North-western Himalayas.

S.P. Singh[a], R.Kumar[b], K.B. Sharma[c], Naresh Kumar[d]

a : Project Director, Project Directorate on Cattle, Pallavpuram-II, Meerut-250110 (UP) India

b,c,d : Department of Physiology, College of Veterinary & Animal Science, HPKV, Palampur-176062 (HP) India

ABSTRACT

Sheep husbandry is the backbone of rural people of North-western Himalyan states of Himachal Pradesh & Kashmir in India. Massive migration of sheep takes place from the plains to the alpine pastures during summer & back to the plains with the onset of winter. We have observed an intense salt hunger in the sheep flock after their stay at the high altitude pastures. In the present study the possible cause of salt hunger was investigated by monitoring sodium & potassium concentration in plasma (n=20) and urine (n=12) of crossbred sheep (Gaddi x Merino, n=20) at pre-ascent base camp (mean height from sea level 3000 ft) and subsequently, after their one month stay at Kara high altitude pastures of Kinnaur District of state of Himachal pradesh (mean ht from sea level 13000 ft). A few fodder/pasture samples were also analysed for Na & K. The minerals in plasma, urine & fodder samples were analysed by Atomic Absorption sepctrophotometer. Stay at the Kara high altitude pastures was accompanied by a significant increase ($p<0.05$) in plasma Na & K concentration but with a decline in Na: K ratio. The urinary Na level fell from 38.25 mmol/l (at base camp) to 14.23 mmol/l at high altitude station. Similarly, urinary Na:K ratio fell from 0.28 to 0.039 after stay at alpine pastures. The alpine pasture species contained considerably higher potassium level (1.72g %) compared to the base camp fodders (1.13 g %). Salt hunger in sheep was related to ingesting low sodium but high potassium herbage, insufficient dietary sodium intake and resulting sodium deficiency in these animals. It was recommended that sheep at alpine pastures must be provided extra salt supplementation to sustain optimum production.

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Sodium (Salt) has been recognized as one of the essential mineral elements in the nutrition of mammals deficiency of which results in decreased production and lower fertility (Ahlswede, 1972; Aitken, 1976). In sheep, Joyce and Brunswick (1975) reported 16 to 38% depression in wool growth in animals not supplemented with NaCl. Bunge (1873) found that it were the herbivores,

rather than carnivores, that showed more appetite for salt in nature. Leek (1917) described how in the United States hunters would make a salt lick to lure deer and other wild animals and lie in wait in the vicinity of salt licks to shoot them. During the course of project work in NorthWest Himalayas, we had heard stories of villagers using salt to lure and gather at one place their yaks and sheep. Similarly, some nomadic shepherd heading for high altitude pastures every summer in this region, were found to carry bags of salt for the sheep flock without having much knowledge about what the salt was required for. In the present study the possible cause of salt hunger in the sheep flock at high altitude pasture Kara was investigated by monitoring Na and K concentration in plasma and urine of sheep and also in pasture grasses and water samples ingested by these animals at the base camp and high altitude station.

MATERIALS AND METHODS

Place of study, experimental animals, their feeding and management

The study was conducted on the sheep flock of State Govt. sheep farm, Tal, in the state of Himachal Pradesh in North-Western Himalayas. Every summer, in the first week of June, these animals migrate from base camp Tal (mean height from Sea level 3000 ft) to high altitude pastures, Kara (mean ht 13000 ft) and back to the base camp with the onset of winter in October. The animals normally stay at high altitude station for a period of 3½ months. Out of the total distance of approx. 500 kms between Tal and Kara, first 400 kms are covered by the sheep flock in farm Trucks and the remaining ascending journey of 100 km on foot. Twenty crossbred sheep (Gaddi x Merino; GXM) of approx. 2 years of age were selected at the base camp Tal and suitably trained for collection of samples. They were kept in well-ventilated barns and allowed a minimum of 8-h day grazing on natural pastures in the vicinity of the farm and partially stall fed. The animals were also given concentrate every day depending on body weight and requirement. The composition of concentrate mixture was as follows. milled grass 45.4%, maize 27%, Ground nut cake, 13.6%, wheat bran 4.5%, molasses 6.8%, DCP 0.9%, mineral mixture, 0.9% and Common salt 0.9%. Water was provided ad libitum. During ascending journey in the trucks no feed or water was offered, whereas during the journey on foot, the sheep flock had free access to the roadside scarce grasses and trees and occasional watering. After arrival at high altitude pastures Kara, the sheep were maintained on the natural alpine pastures spread around 1000 hectares where they grazed approx. 10 hrs every day. The animals were taken to water stream twice a day but no concentrate or mineral mixture was provided. As per the prevailing practice at the alpine pastures in the past years, the farm attendants offered common salt to the sheep flock twice a week by spreading it over the rocks. The general salt intake was estimated about 0.5 g salt/sheep/day but the behavioral symptoms of salt hunger were frequently present.

Sampling protocol and analysis

Initial sampling was done at the base camp Tal in the last week of May approx. two weeks before the ascending journey. Subsequent sampling was done at high altitude station, Kara, after the flock had spent a period of one month there. At both the stations, samples of blood plasma and urine were collected from each sheep. Besides, samples of mixed pasture grasses and water ingested by the animals were also collected at three different occasions taking all precautions. Heparinized blood was collected asceptically by jugular vein puncture and separated into plasma by centrifugation. For urine, a spot urine sample of 10-20 ml was collected in clean graduated glass cylinder during the course of natural void by the animal, and later, a representative sample was taken from the large

sample and stored in screw-capped polypropylene tubes. Sodium and potassium in plasma, urine and pasture/grasses were determined by use of an Atomic Absorption Spectrophotometer (AAS, Perkin Elmer, USA) as described in the AAS analytical manual with some modifications. Samples of pasture/grasses were processed by use of the wet acid digestion method before analysis by AAS. Data were analyzed using a t- test. The salt ingesting behavior of the sheep flock was visually recorded at the time of offer of salt on the rocks. Later, a video film was also prepared.

RESULTS

As long as the sheep flock stayed at base camp Tal, the behavioral phenomenon of salt hunger or geophagia in the sheep flock never came to light. The animals did not show any appreciable interest in the salt placed on the rocks except an occasional sniffing at the worker's hand carrying the salt. However, majority of the sheep (70-75%) on arrival and prolonged stay at high altitude station Kara, showed intense appetite for salt. Quite often, the animals were found chasing the attendants carrying the salt.

Table 1. Mean urinary and plasma sodium and potassium concentration (mmol/l) and Na:K ratio in migratory crossbred sheep and Na and K concentration in the pasture grasses (g%) and water samples (ppm) at base camp Tal and after one month stay at high altitude station, Kara (Mean ± SEM).

Substrate	Base camp Tal			High altitude station Kara		
	Na	K	Na:K	Na	K	Na:K
Urine	38.25 ± 10.1	128.41 ± 20.3	0.28 ± 0.064	14.23* ± 6.12	355.9* ± 25.2	0.039* ± 0.022
Plasma	125.42 ± 2.95	5.47 ± 0.17	23.10 ± 0.69	155.64* ± 2.0	7.96* ± 0.17	19.87* ± 0.58
Pasture grasses	0.0042 ± 0.0006	1.13 ± 0.20	0.0038 ± 0.0007	0.0053 ± 0.0009	1.72* ± 0.057	0.0031 ± 0.0006
Water Samples	12.63 ± 2.94	1.87 ± 0.66	7.80 ± 1.87	0.85* ± 0.086	0.70 ± 0.11	1.24* ± 0.085

* Significantly different ($P<0.05$) from the corresponding value recorded at base camp Tal.

Each value is a mean of 12 (urine), 20 (plasma) and 3 (pasture grasses and water) determinations.

As soon as salt was placed on the rocks in the grazing area, the sheep were found colliding with each other in the race to get to the salt spot. We noticed that selected animals not having an opportunity to ingest salt exhibited continuous bleating and a tendency to refuse to retire for the day. We determined the sodium status of the sheep flock at base camp and high altitude station by monitoring Na and K concentration in plasma, urine, pasture grasses and water samples. Our results show that the salt seeking behavior and intense appetite for salt observed in sheep on arrival and stay at high altitude was infact due to their being in poor sodium status. This was confirmed by urine analysis. The mean urinary Na concentration at base camp Tal was recorded as 38.25 mmol/l with Na : K ratio of 0.28. However, after stay at high altitude station Kara, the urinary sodium concentration and Na:K ratio significantly decreased to 14.23 mmol/l and 0.039 respectively (table 1). At Kara station, nine out of 12 sampled sheep were voiding almost sodium free urine (having sodium as low as 0.22 mmol/l and Na : K ratio as low as 0.0006). The changes in urinary potassium concentration were just opposite. In contrast to a significant decline in urinary Na content at Kara, the mean urinary K concentration was significantly elevated (355.9 mmol /l) compared to the urinary K concentration at base camp Tal (128.41mmol/l, Table 1). Blood plasma Na concentration of sheep at high altitude station Kara did not show any decline, but instead, showed a rise from 125.42 mmol/l at base station to 155.64 mmol/l at Kara. Similarly, mean plasma K rose from 5.47 mmol/l at base camp to 7.96 mmol/l at Kara. Consequent to these changes in plasma Na and K, the plasma Na : K ratio declined from 23.10 to 19.87 at Kara (Table 1).The sodium content in the mixed grass samples collected from the two stations did not significantly vary, but the herbage at high altitude station Kara had significantly higher K concentration (1.72 g%) than the samples of base camp (1.13 g% , table 1). On the other hand, water samples collected from high altitude station Kara were very low ($P < 0.05$) in Na (0.85 ppm) and K (.0.70 ppm) concentration compared to the respective value of these elements at base camp Tal. (12.63 and 1.87 ppm)

DISCUSSION

Salt appetite and attraction for salt in the wild animals is well documented but information on salt hunger in domesticated herbivores temporarily exposed to high altitude environment and herbage are meager. The sheep flock in the present study were reared under standard feeding and management conditions of the base camp for nearly seven months, from October to April, and then exposed to migratory stress and to a high altitude environment for next 4-5 months period. Although the farm attendants accompanying the flock to the hills every summer were aware of increased salt liking by these animals on arrival and stay there, but were ignorant about their actual sodium requirement and status. During the course of study, we were told that traditionally the shepherds offered some salt to their sheep bi-weekly but it was not enough to alleviate the salt appetite of these animals . We estimated that during the course of stay at the base camp, the daily sodium requirement of sheep (approx. 2.5 to 3 g/a/d) were suitably met from the concentrate, Pasture grasses and water offered. However, on arrival and at stay at high altitude station this optimum requirement was hardly being met. The intake of sodium from natural pasture grasses and water at high altitude station was far below the optimum sodium requirement of these animals. Besides, the animals were exposed to pasture grasses which were not only low in sodium but also rich in potassium. In spite of the fact that these animals were offered some salt bi-weekly, it was hardly able to meet the normal daily Na requirement resulting into their poor sodium status and consequential development of salt hunger.

That these sheep were infact suffering from sodium deficiency was confirmed from

urinary Na and K analysis. It is well established that determination of blood sodium concentration was unsuited to the diagnosis of sodium deficiency because animals maintain normal concentration through increased adrenocorticcal secretion of aldosterone, which effectively reduces sodium from saliva and urine (English,1967 ;Morris and Gartner,1971). Morris (1980) suggested that cattle were probably sodium deficient when urine sodium concentration decreased to <7 mmol/l. Similarly, Singh and Desy (1999) have reported, that in Cattle, a urinary Na : K ratio lower than 0.10 was indicative of severe Sodium deficiency. In the present study the mean urinary Na concentration and Na : K ratio in the sheep at high altitude station were recorded as 14.23 mmol/l and 0.039 respectively (table 1). Nine out of 12 sampled sheep had urinary Na values between 0.22 to 1.4 mmol/l and Na : K ratio as low as 0.0006. Obviously, these animals were in the state of severe Na inadequacy , which was reflected in the form of Salt hunger . The sodium intake by these animals through water and pasture grasses was far below the optimum requirement. According to Minson (1990), animals fed exclusively on forages that contained less than 0.15 g% sodium may eventually become sodium deficient provided there is no other source of sodium intake. Following this criteria all the pasture grasses at base camp as well as at high altitude station contained sodium far below the normal requirement of sheep. However, at base camp the sodium requirement were being met by supplementary salt supply through concentrate as well as water. At high altitude station, there was no concentrate feeding and the snowy water was nearly devoid of sodium. Besides, the potassium-rich pasture grasses of high altitude served as a further contributory factor in the development of salt hunger. Dobson and McDonald (1963) also reported development of sodium deficiency in sheep following feeding of grasses which had been fertilized with potash fertilizers. Hyperkalemia observed in the sheep at high altitude station could be the effect of hypoxic environment of the mountains. This argument is supported by the findings of other investigators. Paterson et al (1988) reported that severe hypoxia in cat was always associated with an increase in arterial K concentration. In an earlier study (Singh et al,1999) we had reported hyperkalemia in yaks which were natural inhabitants of high mountains and were subjected to sodium inadequacy and hypoxic conditions. It is plausible that increased plasma K concentration in sheep at high altitude station (compared to base camp value) was due to hypoxic effect of prolonged stay there.

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