Sodium deficiency as a possible cause of infertility in dairy animals

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ABSTRACT

With the adoption of large scale crossbreeding program in India, repeat breeding and anestrus have become the commonest cause of infertility in the dairy animals of country side. Mineral imbalances have long been held responsible for such reproductive disorders. The present investigation was undertaken to study the sodium status of repeater (n=16) and anestrus cows (n=9) and buffaloes (n=6) belonging to the local farmers adjoining the universality. Sodium and potassium concentrations (and Na:K ratio) were monitored in serum and or urine and muzzle secretion (depending on the availability of the fluid). Besides, magnesium level in urine was also simultaneously monitored to study the possible relationship of low dietary sodium intake with increased urinary Mg excretion. The minerals in different body fluids were estimated by Atomic Absorption spectrophotometry. Results showed that 11 out of 16 repeater and anestrus cows were suffering from sodium inadequacy as revealed by very low urinary and muzzle secretion Na:K ratios (0.02 to 0.04 and 0.14 to 0.24 respectively) as against the optimum Na:K ratio of >0.30 for animals on optimum sodium intake. Similarly, all the anestrus buffaloes and cows seemed to be suffering from sodium deficiency. Both the repeater and anestrus cows suffering from sodium deficiency had a very high urinary Mg level. Increased urinary Mg excretion appeared to be related to the lower urinary Na:K ratios. It was concluded that dietary sodium inadequacy and increased urinary Mg excretion were related to the repeater/anestrus conditions of dairy animals.

It has been known since ancient times that domestic animals need salt(sodium) as man does. Craving for salt appears to be one of the early signs of sodium deficiency but is not confirmatory for diagnosis. Sodium inadequacy has been connected with decreased growth, production, and fertility in domestic ruminants. Ahlswede (1972) reported that in cows with salivary sodium concentration lower than 250 mg% there were incidences of irregular estrus and ovarian dysfunctions. Since milk contains relatively high sodium content, high producing cows become sodium deficient much sooner.Sodium concentration in blood is constant and is not affected by level of dietary sodium intake. Therefore blood sodium determination is not a useful index to diagnose sodium status(Morris,1980). Kemp and Hartmans (1968) suggested that a parotid saliva Na: K ratio < 5 to 10 was indicative of sodium inadequacy. Singh

and Desy (1999) reported that cows and buffaloes with urinary or muzzle secretion Na:K ratio lower than 0.3 should be declared as sodium deficient.

The present investigation was undertaken to study the sodium status of repeater and anestrus cows and buffaloes of rural areas by monitoring Na and K concentration in their plasma, urine and muzzle secretion. Possible relationship between sodium status and Mg concentration was also studied.

MATERIAL AND METHODS

Experimental animals & their Management

The study was conducted on the repeater cows (n=16) and anestrus cows (n=9) and buffaloes (n=6) belonging to the university dairy and the rural farmers adjoining the university. A control group of normal healthy cows served as a common control to both the infertile groups. Majority of the cows aged between 4-10 years and belonged to either jersey or jersey crosses. Repeater group included those animals which did not conceive even after four inseminations and anestrus animals were those which had not shown heat for a continuous period of twelve months .These animals had normal genital organs as revealed by rectal examination. The animals belonging to the university dairy were maintained under standard feeding and management conditions, stall fed and watered ad libitum. They were given concentrate and mineral mixture. The animals from rural areas were being maintained under traditional village animal husbandry practices, fed on local grass or seasonal maize/paddy hay. They were provided concentrate sparingly and salt was offered just two or three times a week. Sodium status of these infertile animals was determined by monitoring Na, K and Mg concentration in blood, urine and muzzle secretion. Blood serum was available from all the animals of the three groups i.e. repeater, anestrus and control. However, urine and muzzle secretion samples could not be collected from all the animals because of obvious difficulties in the field conditions. The same were collected from a minimum of three to six animals of each group. Blood was collected by jugular vein puncture asceptically and separated into serum by centrifugation after clotting. Spot urine samples were collected taking all precautions during the course of natural void by the animal. Muzzle secretion was collected by the method of Singh and Desy(1999) by sucking the watery drops from the animal muzzle into a glass syringe and then transferring it to a tapered- bottom, corked 1.5 ml polypropylene tubes. The samples were stored at $-20C^0$ till analysis. Sodium, potassium and Magnesium were determined by Atomic Absorption spectrophotometer (AAS, Perkin Elmer 3100, USA) as described in the AAS Analytical manual. Data were analysed by t-test comparing the treatment group with the values obtained in control.

RESULTS

Table 1 presents the mean concentration of minerals in urine, muzzle secretion and serum of repeater, anestrus and healthy cows and buffaloes.

Repeater cow's serum Na, K and Mg concentration were within normal range and did not significantly differ from the respective values in the control animals. However, anestrus cows had significantly lower serum sodium concentration(128.9 mmol/l) compared to the healthy control(134.7 mmol/l). Similarly, serum Mg concentration in anestrus cows(1.16 mg/dl) and buffaloes(1.22 mg/dl) was lower ($P<0.05$) compared to the values in controls(1.74 mg/dl). Urinary and muzzle secretion sodium concentration and Na:K ratios in repeater cows

Table 1: Mean Na and K concentration (mmol/l) and Na:K ratio and Mg content (mg/dl) in different body fluids of repeater and anstrus cows and buffaloes (Mean±SEM).

Fluid+	Mine. Elem.	Control cows	Repeater cows	Anestrus Animals	
				Cows	buffaloes
serum	Na	134.7±1.11	134.3±1.05	128.9*±1.59	131.7±1.26
	K	5.60±0.16	5.36±0.16	5.2±0.18	5.36±0.19
	Na:K Ratio	24.3±0.70	25.32±0.72	24.9±0.68	24.6±0.89
	Mg	1.74±0.12	1.52±0.13	1.16*±0.15	1.22*±0.14
Urine	Na	79.5±16.8	32.8*±11.49	22.0*±9.64	40.6±14.8
	K	125.5±33.5	173.54±26.6	308.0**±8.32	313.3*±6.67
	Na:K Ratio	0.69±0.10	0.19**±0.05	0.07**±0.03	0.12*±0.048
	Mg	7.93±1.49	19.82*±4.49	66.53*±26.87	55.73* ±11.76
Muzz. Secre.	Na	12.11±1.58	7.87*±0.40	10.01±3.43	9.8±3.67
	K	23.75±2.50	34.8*±3.12	48.16*±10.26	56.5*±13.81
	Na:K Ratio	0.51±0.04	0.24**±0.029	0.19*±0.026	0.16**±0.037
	Mg	0.56±0.05	0.47±0.060	0.48±0.042	0.45±0.025

* Significantly different (P< o.o5) from the respective value in control group.

\+ Each value is a mean of 9 to 16 (serum) and 3 to 11 (urine and muzzle secretion) determinations.

and anestrus cows and buffaloes were significantly lower($P<0.05$) than the value in healthy controls and below the reported value for animals in normal sodium balance. For instance, the mean urinary Na concentration in the control cows was of the order of 79.5 mmol/l where as in repeater and anestrus cows and buffaloes sodium concentration was as low as 22.0 mmol/l (Table 1). On the other hand, urinary K concentration in the later was as high as 308.0 mmol/l compared to the value of 125.5 mmol/l in the healthy controls. Consequent to these changes in Na and K concentration, the urinary Na:K ratio in repeater cows and anestrus cows and buffaloes was recorded as 0.19, 0.07 and 0.12 respectively, compared to the urinary Na:K ratio of 0.69 in healthy (control) cows. Six out of 11 repeater cows and two out of three anestrus cows had urinary Na:K ratio as low as 0.02 to 0.06.

Like urinary Na:K ratios, the muzzle secretion Na:K ratio in repeater and anestrus cows and buffaloes were very low (between 0.16 to 0.24) compared to the Na:K ratio of 0.51 in healthy controls. Further, muzzle secretion K concentration was significantly higher in repeater and anestrus animals compared to the muzzle secretion K values obtained in healthy controls (Table 1).

An observation of significance was that almost all repeater and anestrus animals excreted quite high magnesium in their urine. Thus, mean urinary Mg level in repeater cows and anestrus cows and buffaloes ranged from 19.82 to 66.53 mg/dl compared to the urinary Mg concentration in healthy controls(7.93 mg/dl). It was interesting to note that increased urinary Mg excretion appeared to be somehow related to the lower urinary Na level / Na:K ratios. Thus urinary excretion of Mg was of higher order in those animals which had comparatively lower urinary Na:K ratio or lower urinary sodium concentration (Table 1).

DISCUSSION

These results show that majority of repeater and anestrus cows and buffaloes were in poor sodium status and could infact be classified as severe sodium deficient. All such animals were found to excrete excessively high magnesium in urine. Olson et al (1989) reported that urinary Na concentration could be used to diagnose Na deficiency in a herd of lactating cows. These authors reported a significantly lower urinary Na level in sodium deficient cows (21.4 mmol/l) compared to the value in controls (43.4 mmol/l). Our earlier findings also suggested that cows and buffaloes having a urinary or muzzle secretion Na:K ratio <0.30 could be declared as sodium deficient (Singh & Desy, 1999). Taking these criteria of sodium deficiency into consideration, it was observed that most of the repeater and anestrus animals were suffering from sodium inadequacy. Seven out of eleven sampled repeater cows had a urinary Na concentration between 1.2 to 17 mmol/l and a Na:K ratio as low as 0.03 to 0.16. Similarly, urine samples from six sampled anestrus cows and buffaloes had a urinary Na:K ratio between 0.02 to 0.18. The muzzle secretion Na:K ratio in 10 out of 17 infertile animals varied between 0.10 to 0.18. On the contrary, the cows in the control group had urinary and muzzle secretion Na:K ratio of 0.69 and 0.51 respectively (Table 1).

Repeater and anestrus cows and buffaloes had a very high urinary Mg level. Gardner (1973) have reported that cattle in normal magnesium balance normally contain a urinary Mg level of 10 mg/dl . In the present study the mean urinary Mg in the control cows was recorded as 7.93 Mg/dl (Table 1). However, seven out of eleven sampled repeater cows and 6 out of 6 sampled anestrus cows and buffaloes had mean urinary Mg level between 19.82 to 66.53 mg/dl. A few cows were excreting magnesium as high as 116.0 mg/dl in their urine.

It was surprising to find such a high urinary Mg level in these animals because serum Mg concentration did not reflect this status and was in normal to below normal range (Table 1). It was of interest that increased urinary Mg excretion appeared to be somehow related to the lower urinary Na:K ratio. Thus urinary Mg was higher in those animals which had comparatively lower urinary Na:K ratio. In other words, animals which were categorized as sodium deficient were found to excrete more Mg compared to the animals which were in normal sodium balance (controls). A number of workers have investigated the possible relationship between sodium and magnesium. Greene et al (1983) and Martens et al (1987) have conclusively proved that low dietary sodium intake retarded magnesium absorption from the rumen. Similarly, the absorption of Mg was reportedly depressed by high level of dietary potassium (Minson ,1990). Findings of these authors provide the most plausible answer to our findings of a possible relationship between sodium deficiency in the infertile animals and increased urinary Mg excretion because there was a higher urinary Mg excretion in the animals which had a lower urinary Na:K ratios. We suggest dietary Sodium inadequacy (and increased urinary magnesium) as one of the possible factors responsible for repeater/anestrus condition.

REFERENCES

1. Ahlswede, L. Inaugral Dissertation Tieratzliche Hochschule, Hannover (1972), 89 (Vet. Bull.43: 682).
2. Morris, J. G. J. Anim. Sci. 50 (1980) 145.
3. Kemp, A and Hartmans, J. Mineral stoffversorgung Tiergesundheit. 8 (1968). 5.
4. Singh, S. P. and Rani Desi ; American J. Vet. Res. 60 (1999) 1074
5. Olson, K. G; Link, K.R.J; Otterhy, D.F. and Stevens, J.B. Bovine Practioner 24 (1989) 126.
6. Gardner, J.A.A. Res. Vet. Sci. 15 (1973) 149.
7. Greene, L.W; Fontenot, J. P. and Webb, K.E. Jr. J. Anim. Sci. 57 (1983) 503.
8. Martens, H; Kubel, O.W. and Gabel, G. J. Agric. Sci. (Camb) 108 (1987) 237.
9. Minson, D. J. Sodium . In : Minson D.J. (ed) Forage in Ruminant Nutrition. San Diego : Academic Press Inc, 1990.

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