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Original Article

Chronic Arsenicosis of Cattle in West Bengal and It's Possible Mitigation by Sodium Thiosulfate

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ABSTRACT

Thirty milch cows having arsenic concentration in hair varying from 3 to 4 mg/kg from Dakhin Panchpota village of Nadia district, West Bengal, were divided into three equal groups where high amount of arsenic is reported to be present in soil and ground water. Groups II and III received, respectively, sodium thiosulfate 20 and 40 g to each animal for 30 days as a pilot study, whereas group I served as untreated control. Arsenic content of milk, feces, hair, and urine was estimated before and after administration of sodium thiosulfate orally at two dose level once daily for 1 month. Paddy straw, mustard oil cake, and water fed by animals were also assayed. Sodium thiosulfate significantly decreased arsenic load in milk, urine, and hair after 1 month. In milk, arsenic concentration was decreased significantly which may be beneficial for animal and human beings.

Key words: Chronic arsenicosis, cattle, sodium thiosulfate

INTRODUCTION

Arsenic problem in ground water of West Bengal was first reported[1-4] in the late 1980s and its effect on health personnel documental process was also reported. Likewise the arsenicosis problem in other states, such as Assam, Bihar, Uttar Pradesh, and Manipur of India, has also been reported.[1,5-7] Out of the 19 districts of West Bengal, 9 districts having arsenic level at 50 μg/l of water (24.7% water sample) are considered heavily affected, while arsenic level at 4–10 μg/l of water in 9.8% sample of five districts are mildly affected and another 5 districts are less affected and all had less than 3 μg/l arsenic.[8]

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Arsenic contamination in cattle occurs through ingestion of drinking water, paddy straw, mustard oil cake, crops, and vegetables grown in arsenic-prone zone where arsenic is higher than the permissible limit,[9,10] and ingestion of contaminated meat, milk, egg, and milk products causes a vibrant type of arsenicosis which cause public health hazards in human beings.[10,7] Considering the above, a pilot project has been undertaken to mitigate the arsenic concentration in different substrates of cattle reared in arsenic endemic area with oral administration of sodium thiosulfate at different concentration. For this study, village Dakhin Panchpota under Chakda block of Nadia district as arsenic-endemic zone has been considered.

MATERIALS AND METHODS

Selection of animals

It has been reported earlier that the concentration of arsenic in the hair of cattle rearing in non-endemic region was 0.425 μg/g.[10] Based on the finding, hairs of 100 cattle

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of arsenic-affected zone were collected and processed, and concentration of arsenic was evaluated (1.60–4.00 μg/g). Out of them, 30 cattle having arsenic concentration in the range of 3.00–4.00 μg/g in hair was chosen for this experiment.

Design of experiment

Thirty milch cows of indigenous breed were selected from Dakshin Panchpota village and considered for this experiment. Animals were fed with straw, mustard oil cake; and drinking water from household tube well (150–200 ft deep). All exposed animals were divided into three equal groups containing 10 animals each. Milk, feces, urine, and tail hair samples were obtained from all the individual cattle, including animal feeding materials were collected on 0 day, processed and assayed for arsenic. Groups II and III received sodium thiosulfate at the rate of 20 and 40 g daily orally for 30 days, where as group I served as untreated control. Sodium thiosulfate was dissolved in 250 ml distilled water and fed to individual cattle by drenching tube. After 1 month of sodium thiosulfate administration, milk, feces, urine, and tail hair of corresponding cattle of groups I, II, and III were collected to analyze arsenic. This project was carried out after the approval of the Institutional Animal Ethics Committee.

Reagent

All chemicals of analytical grade were purchased from Rankem Pvt. Ltd., E-Merck (India), and Sigma Aldrich (USA).

Collection of samples

Milk samples were taken in a dry plastic container prewashed with nitric acid (20%). Pooled milk samples were obtained from all four teats capped after manual milching. Feces samples were taken from rectum manually and kept in plastic zipper bag. Hair samples were collected from tail. Straw and water samples were collected directly from manger of respective cow. Urine sample was collected by gently stroking a cow just under her vulva.[11] All substrates except straw and hair were stored at −20°C till further process.

Estimation of total arsenic

Total arsenic was estimated as per standard method[10] in atomic absorption spectrometer equipped with vapor generation accessories.

Instrument

A Varian AA240 model AAS equipped with vapor generation accessories (model no VGA77) was used for total arsenic estimation. Reducing agent (aqueous solution of 0.6% sodium borohydride in 0.5% sodium hydroxide) and acid (40% Hydrochloric acid) were prepared freshly before use.

Instrumental condition

Operating parameters for Varion AA240: lamp, arsenic hollow cathode lamp; wavelength, 193.7; slit width; 0.5 nm; lamp current, 10.0 mA; vapor type, air/acetylene; air flow, 10.00 l/min; inert gas for hydride generation, Argon.

Statistical analysis

The data were analyzed by two-way analysis of variance and each data were compared by Duncan multirange test.

RESULTS AND DISCUSSION

The permissible limit of arsenic in water is 0.01 mg/l (World Health Organization)[12] and 0.05 mg/l (National Standard).[9] The arsenic content of water in experimental zone was above the World Health Organization-permissible limit [Figure 1]. Likewise, arsenic content in the straw of the village was 3.03 mg/kg which is much higher than the permissible limit (2.60 mg/kg).[13] Average intake of water and straw per day by a cow was 55 l and 13.5 kg, respectively.[14,15] It is obvious that cow of Dakhin Panchpota village consume much higher content of arsenic through water and straw leading to accumulation in different substrates of cow as depicted in Figure 1.

It appears from the Table 1 that oral administration of sodium thiosulfate at both concentration, i.e., 20 and 40 g (total dose) decreased arsenic concentration in milk significantly ($P < 0.05$) and dose dependently. Sodium thiosulfate at 20 and 40 g decreased the arsenic concentration in milk by 37.8 and 26.8% compared with "0" day level. On the other hand, sodium thiosulfate at 20 and 40 g increased the excretion of arsenic from urine significantly ($P < 0.05$) from the control value and the increases were 201 and 211%, respectively. The excretion of arsenic concentration through urine in was not significant between the cattle of groups II and III. Likewise, sodium thiosulfate each used at 20 and 40 g significantly ($P < 0.05$) increased the excretion of arsenic through feces and the percentages of increase were 133 and 166, respectively. Sodium thiosulfate at 20 and 40 g slightly decreased the

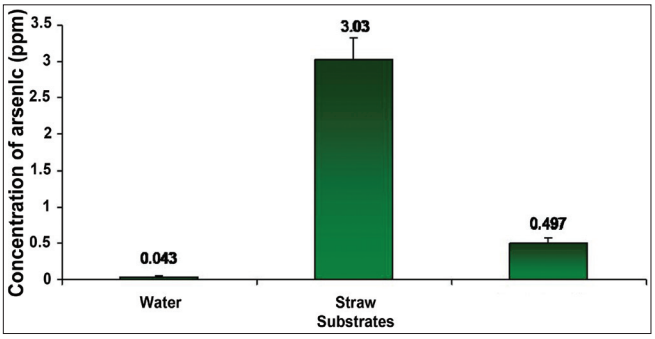


Figure 1: Concentration of arsenic (ppm) in water, straw, and mustard oil cake fed by cattle of Dakhin Panchpota village ($n = 30$).

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Table 1: Concentration of arsenic in different substrates of cattle from Dakhin Panchpota village before and after sodium thiosulfate oral administration for 1 month (*n* = 10, mean ± SE)

Group	Substrate							
	Milk (mg/l)		Urine (mg/l)		Feces (mg/kg)		Hair (mg/kg)	
	Day 0	Day 30	Day 0	Day 30	Day 0	Day 30	Day 0	Day 30
I	$0.114^{ax} \pm 0.012$	$0.119^{ax} \pm 0.017$	$0.088^{ax} \pm 0.088$	$0.093^{ax} \pm 0.010$	$0.522^{ax} \pm 0.089$	$0.537^{ax} \pm 0.067$	$3.43^{ax} \pm 0.37$	$3.66^{ax} \pm 0.47$
II	$0.107^{ax} \pm 0.015$	$0.045^{by} \pm 0.009$	$0.091^{ax} \pm 0.009$	$0.187^{by} \pm 0.024$	$0.482^{ay} \pm 0.087$	$0.719^{by} \pm 0.094$	$3.42^{ax} \pm 0.41$	$3.36^{axy} \pm 0.41$
III	$0.098^{ax} \pm 0.061$	$0.031^{bz} \pm 0.010$	$0.085^{ax} \pm 0.010$	$0.197^{by} \pm 0.020$	$0.554^{ax} \pm 0.094$	$0.894^{bz} \pm 0.099$	$3.52^{ax} \pm 0.49$	$3.13^{by} \pm 0.41$

Mean value with dissimilar superscripts (a,b) in the row vary significantly ($P < 0.05$)., Mean value with dissimilar superscripts (x,y) in the column vary significantly ($P < 0.05$)., Group I was untreated control; group II received sodium thiosulfate 20 g/day for 30 days; group III received sodium thiosulfate 40 g/day for 30 days.

concentration of arsenic from hair, and only cattle treated with sodium thiosulfate at 40 g showed the significant ($P < 0.05$) decrease of the arsenic content of the hair from the basal value.

It transpires from the observation that sodium thiosulfate helps to eliminate arsenic from different substrates of the body. Lesser excretion of arsenic through milk after sodium thiosulfate treatment is beneficial both for human and animal. Maximum amount of arsenic after sodium thiosulfate administration is excreting through feces and urine. How sodium thiosulfate helps in excreting arsenic from body is not known. It is postulated that sulfur of thiosulfate might react with arsenic and immobilized the metalloid.[16,17] To explore the mechanism of thiosulfate against arsenic mobilization and or toxicity warrants further works.

From this study it may be concluded that administration of sodium thiosulfate may be one of the possible mode of the mitigation of arsenic from animal substrates.

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