Abstract—Arsenic in food chain is a great concern in Bangladesh. Excretion of arsenic in milk can play important role in daily arsenic consumption of human. The study designed to detect arsenic level in cow’s milk in arsenic affected areas and correlate with drinking water and urine arsenic content. In this study, 80 freshly drawn cow’s milk, its drinking water and urine sample were collected from one non-affected and four arsenic affected areas. Arsenic contents of samples were detected by Hydride Generation Atomic Absorption Spectrophotometer (HGAAS). Milk arsenic content was very few amounts in compare to its drinking water and urine arsenic content. The average arsenic contents of water, milk and urine of arsenic affected areas were 0.0475±0.006, 0.0146±0.002 and 0.0361±0.003 mg/L respectively. Though milk arsenic content was significantly correlated with water arsenic level, the arsenic level in cow’s milk was within acceptable limit and not significant for public health concern. The present study would like to recommend that milk and the foods of animal milk origin of arsenic affected areas are safe for human being in context of Bangladesh.

Keywords—Public health, arsenic, HGAAS, milk, water

I. INTRODUCTION

Nowadays arsenic (As) is a very sensitive environmental issue in Bangladesh, even it is a major health concern in Asia due to its adverse impact on human health. It has been estimated that 61 districts out of 64 have been affected with significantly higher concentrations (above WHO recommended level) of arsenic. The arsenic has now emerged as hazard in Bangladesh and particularly in people of villages now appeared as a ‘real disaster’, affecting thousands physically, physiologically, mentally and economically; thus intensifying malnutrition and destitution. The arsenic has one of the most environmental hazardous element, it is ubiquitous in nature, i.e. present in all natural resources like soil, rocks, water, organisms, plants, atmosphere etc. Arsenic salts are soluble in water and there is no way to know its presence by simple observation, taste or smell and acts as an invisible killer. Arsenic was first confirmed in 1993, in Chapai-Nawabgang district of Bangladesh.

Only after a decade since 1993, arsenic contamination of groundwater in Bangladesh has been reported as the biggest arsenic catastrophe in the world. Levels of arsenic in drinking water are so high that WHO describes arsenic contamination of Bangladesh’s water supply as "the largest poisoning of a population in history". It is accumulating in human bodies through the intake of contaminated drinking water and its presence in foods. The most well-known concern is As entering the food chain, affecting food safety. This poses a potential dietary risk to human health in addition to the risk from drinking contaminated groundwater. More than 50 percent of the total population is estimated at risk of contamination and already thousands of people have been affected by the disease arsenicosis.

Animals generally drink large amount of water (average 40 liters), 10 to 12 kg of straw and 2-4 kg husk every day. If drinking water was contaminated with arsenic then animal take a large amount of arsenic per day. The straw arsenic concentration in all cases was above the grain level. The order of arsenic contents in tissues of rice was: straw > husk > brown rice grain > polish rice grain. In Bangladesh, arsenic contaminated rice straw and husk were widely used as feed for cattle, which also increases the susceptibility of animal to arsenic contamination. Human take a little amount of arsenic everyday through foods (plant and animal origin). But due to its cumulative poisoning nature, arsenic deposited in body for long period of time and produce clinical signs. Arsenic containing tube-well water is the chronic source of arsenic poisoning for both human and animals in Bangladesh.

Various governmental and NGOs taken massive program for mitigation of contaminated arsenic water, but it is necessary to determine first that the amount of arsenic comes from livestock and its products that still ingesting arsenic contaminated water. However, the cumulative effect of arsenic taken from food chain over long time is irreversible and is demonstrated in the worst form of skin lesions, to cancer and eventually lead to slow and painful death of the victims. So its needs immediately detection the source, absorption, accumulation and excretion of arsenic from milking cows that have significant contribution in food chain by milk.
Under these circumstances, the present research was therefore undertaken to detect arsenic in freshly drawn cow’s milk belonging to arsenic affected areas. The main objective was quantitative detection of arsenic and observation of correlation of arsenic content in freshly drawn cow’s milk with its drinking water and urine arsenic content.

II. MATERIALS AND METHODS

To conduct this research, different arsenic affected areas were selected based on prior study and the arsenic surveillance report published by Department of Public Health Engineering (DPHE), Bangladesh. From these areas of Bangladesh, freshly drawn cow’s milk, cows’ drinking water and urine were collected. The selected areas were:

Area 1: Bangladesh Agricultural University dairy farm of Mymensingh district
Area 2: Sujanagar thana of Pabna district
Area 3: Faridganj thana of Chandpur district
Area 4: Kulaura thana of Moulavibazar district
Area 5: Sadar thana of Bogra district

Area 1 comprises arsenic non-affected area and taken as control and remaining four were arsenic affected areas. From each area 16 sample (water, milk and urine) were collected. 

Water

Water was collected from the tube-well after pumping of 15 minutes for removal of stagnant water within the tubewell body. At first water collected in an acid washed plastic bottle. From there water was collected in 50 ml syringe through the filter tube for removal of iron from water sample. Then the water was transferred to 50 ml acid washed plastic capped tube containing 5 ml 2% nitric acid. The tubes were 1% nitric acid washed and oven dried. For each sample 50 ml water was collected.

Milk

The apparently healthy lactating cows are selected as the source of sample. All of these cows get drinking water from tubewell and without providing any arsenical feed supplements. From the cows of selected areas, milk samples were collected directly from the udder. Prior to collection the udder was washed with fresh water and the udder surface was dried by using a towel. A quantity of 50 ml milk was drawn from each cow and collected aseptically. For milk collection sterile screw capped tubes were used. Milk samples were transferred in a large wide mouthed thermo flask containing good quality ice thus maintaining the temperature to about 4°C.

Urine

Urine sample was collected from same animal during urination and about 50 ml urine was collected for each sample. Acid washed capped plastic bottle was used for the collection of urine. Every sample was marked with appropriate identification marks. The samples were brought from the experimental site as quick as possible. The arsenic level of water, milk and urine was determined by HGAAS (as per instruction and recommendation, Welsch et al.).

Quantitative detection of arsenic by Hydride Generation Atomic Absorption Spectrophotometer (HGAAS)

Arsenic was determined in the Laboratory for detection of arsenic in man and livestock, Department of Pharmacology, Bangladesh Agricultural University, Mymensingh and in CIMMYT Arsenic Laboratory, Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh using Hydride Generation Atomic Absorption Spectrophotometer (HGAAS) PG-990 system and Perkin-Elmer Hydride Generation AAS-300 system respectively. Arsenic was determined directly from water and after digestion of milk and urine. All the data was presented in mg/L.

Milk and urine digestion

For determination of arsenic in milk and urine, it first requires decomposition of organic components that are responsible for binding arsenic in milk and urine and then subsequent analysis of arsenic. Milk and urine samples weighing 5 ml was transferred into a dry clean acid washed digestion vessel. Five ml analytical grade 70% nitric acid was added to the vessel and allowed to stand it for overnight with covering the vessel by vapour recovery device. In the following day the digestion vessels were placed on a heating block and were heated at a temperature slowly raised to 118°C for three hours. After cooling 5 ml analytical grade hydrogen peroxide (H₂O₂) was added and kept for few minutes. Again the vessel was heated at 118°C for one hour. Then again after cooling 2.5 ml of hydrogen peroxide (H₂O₂) was added and heated for 30 minutes at 120°C. Heating was momentarily stopped when dense white fumes occurred. At the end of the heating generally volume was reduced to 5-6 ml. Finally the digest was cooled and diluted to 15 ml with demineralized water and filter through Whatman no. 42 filter paper into acid washed plastic bottle. These solutions were stored in refrigerator until analysis. Total arsenic content in milk and urine was determined from the digest by flow injection hydride generation atomic absorption spectrophotometer.
Statistical analysis

Data of the arsenic content in milk, water and urine sample were analyzed statistically using one way analysis of variance to find out the level of significance and determined any significant correlation between the variable factors with the help of statistical analysis system (SAS).\textsuperscript{18}

III. RESULTS AND DISCUSSION

With greater public awareness of arsenic poisoning in animal and human nutrition, there has been a growing interest in developing regulatory guidelines for mitigating As-contaminated ecosystems.\textsuperscript{7} The acceptable level of arsenic as defined by WHO for maximum concentrations of arsenic in safe drinking water is 0.01 mg/L. The Bangladesh government's standard is at a slightly higher rate, at 0.05 mg/L being considered safe.\textsuperscript{19} The fate of arsenic in groundwater and its transport and distribution in the environment and food chain have become matters of great concern in Bangladesh. The present study reflects an approach to the recognition of potential public health hazard in cow’s milk in different arsenic affected areas.

Arsenic level in water

The result of arsenic content level (mg/L) in water sample of different areas was presented in Table 1. The mean values of water arsenic level in area 1, 2, 3, 4 and 5 were 0.0054 ± 0.0063, 0.0465 ± 0.0286, 0.0572 ± 0.0340, 0.0455 ± 0.0295 and 0.0403 ± 0.0247 mg/L respectively. Among the areas, the highest mean of arsenic contents was found in area 3. The fate of arsenic in groundwater and its transport and distribution in the environment and food chain have become matters of great concern in Bangladesh. The present study reflects an approach to the recognition of potential public health hazard in cow’s milk in different arsenic affected areas.

Arsenic level in cow’s milk

The result of arsenic content level (mg/L) in milk sample of different areas was presented in Table 1. Milk samples from area 1 showed very negligible amount of arsenic. The mean values of milk arsenic level in area 1, 2, 3, 4 and 5 were 0.0011 ± 0.0026, 0.0125 ± 0.0078, 0.0178 ± 0.0091, 0.0145 ± 0.0092 and 0.0136 ± 0.009 mg/L respectively. Among the areas the highest mean of arsenic contents was found in area 3 and the highest arsenic content in single milk sample was also found in area 3 and that was 0.032 mg/L. Result of this study showed that arsenic was present in milk sample of arsenic affected areas, which supports the findings of Samanta et al., Carrera and Cirelli, Sharma and Perez and Crout et al. who found excretion of arsenic in milk.\textsuperscript{20-29} Ulman et al. and Concha et al. found mean arsenic 4.219 ± 0.079 μg/L in breast milk with range from 0.83 to 7.6 μg/L and 4.932 ± 0.38 μg/L in cow's milk.\textsuperscript{30-31} In present study relatively higher amount of arsenic was found in cow’s milk, may results from increase ingestion of arsenic through arsenic contaminated drinking water, contaminated straw and concentrate. In Bangladesh, drinking water contain up to 0.48 mg/L of arsenic,\textsuperscript{39} arsenic accumulation in straw reaches up to 3.5 mg/L,\textsuperscript{12} and husk from contaminated rice also contain high level of arsenic. Animals generally drink large amount of contaminated water (average 40 liters), average 10 kg straw and about 4 to 5 kg of husk every day resulting animal gets large amounts of arsenic per day. Arsenic salts readily absorb in blood and from which very few amount is excreted in milk. Among the areas, the highest concentration in area 3 may result from increase water arsenic concentration in that areas and use of high arsenic containing rice straw and husk for feeding of animal.

Arsenic level in urine

The result of arsenic content level (mg/L) in urine sample of different areas was presented in Table 1. The mean values of urine arsenic level in area 1, 2, 3, 4 and 5 were 0.0039 ± 0.0048, 0.0351 ± 0.0233, 0.0431 ± 0.0266, 0.0343 ± 0.0239 and 0.032 ± 0.0198 mg/L respectively. The highest mean value was found in area 3 and the highest individual arsenic content was found in area 3 that was 0.091 mg/L. Urinary excretion is the most important exit route and approximately 90% of the arsenic is excreted in the urine.\textsuperscript{32-33} Present study agrees with their findings. Selby et al. also recommend the probability of arsenic excretion in feces.\textsuperscript{33}
Min = Minimum, Max = Maximum, SD = Standard Deviation

Average arsenic content in different arsenic content areas was 0.0475 ± 0.006 mg/L in water, 0.0146 ± 0.002 mg/L in cow’s milk and 0.0361 ± 0.003 mg/L in urine (Table 1) indicated that very small amount of arsenic was excreted in milk and relatively higher amount of arsenic was excreted in urine than milk. Our findings corroborate with the findings of Shariatpanahi and Anderson, and Selby et al. Ulman et al. found 4.932 ± 0.003 mg/L in cow’s milk of some arsenic affected areas in Izmir, Turkey. **Correlation was significantly correlated with water arsenic content.**

### Correlation among water, milk and urine arsenic contents

Correlation between water, milk and urine arsenic content of different areas was determined (Table 2). The correlation matrix showed that milk arsenic content was significantly correlated with water arsenic content.

### IV. Conclusion

In Bangladesh 61 districts was affected with high concentration of arsenic. Although many tube-wells are now under the arsenic mitigation program for human but steps are not available for animal. It is undesirable that human get exposed to arsenic by foods from animal origin. Though the level of milk arsenic contents (detected by HGAAS) was significantly correlated with water arsenic contents, the present level of arsenic (0.0146±0.002 mg/L) in cow’s milk of arsenic affected areas was below the acceptable level (0.05mg/L) and not of concern to health hazards of human being.

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