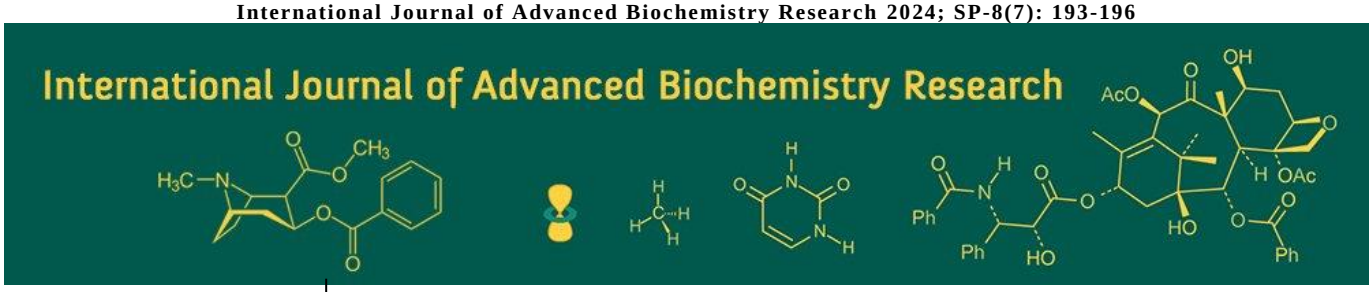

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(7): 193-196
www.biochemjournal.com
Received: 01-05-2024
Accepted: 05-06-2024

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Arsenic contamination of the environment: An update

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DOI: https://doi.org/10.33545/26174693.2024.v8.i7Sc.1514

Abstract
Arsenic is a naturally occurring element that poses a significant threat to animal as well as human beings, due to its widespread presence in the environment, affecting millions worldwide. Ganga-Meghna-Brahmaputra basin is one of the major arsenic contaminated hotspot in the world. Presence of arsenic in groundwater has been reported in many countries, In Chhattisgarh, high concentrations of AS in groundwater have been reported in Koudikasa village of Rajnandgaon area. Arsenic has a direct effect on vital organs of body system the capillaries, causing damage to microvascular integrity, transudation of plasma, loss of blood, and hypovolemic shock. Profuse watery diarrhoea, sometimes tinged with dark blood, is characteristic, as are severe colic, dehydration, weakness, depression, weak pulse, and cardiovascular collapse. Diagnosis of inorganic arsenical toxicities is generally based on suspicion of arsenic poisoning, clinical signs, history of the area, and confirmatory diagnostic testing.In large animals, Sodium thiosulfate has also been used, PO, at 20–30 g in 300 mL of water in horses and cattle, one-fourth this dose in sheep and goats, and 0.5–3 g in small animals or as a 20% solution, IV, at 30–40 mg/kg, every 6–8 hours for 3–4 days or until recovery. The water-soluble analogues of dimercaprol, 2,3-dimercaptopropane-1-sulfonate (DMPS) and dimercaptosuccinic acid (DMSA), are considered to be less toxic and more effective and could be given orally. Adopting rainwater harvesting/ watershed management practices will not only reduce water stress but also ensure arsenic free supply of water (naturally or through filtration) reducing the As exposure to human as well as animals.

Keywords: Arsenic (As), arsenic oxide, chronic poisoning, neuropathy, valence, phosphorylation, diseases

Introduction
The word “arsenic” has become almost synonyms with word “poison” which is a silver-gray or white in color solid element found in anywhere in nature. Arsenic combines with other elements to form organic and inorganic compounds. Inorganic arsenic compounds are thought to be more toxic especially (trivalent than pentavalent) than organic arsenic compounds, but the trivalent state, in particular, holds toxicological significance due to its potent interactions with Sulphur containing proteins, exert their toxicity. In Delaware, little arsenic is found in groundwater or public water. Industry, farming and medicine have all used inorganic arsenic compounds. Arsenic is no longer produced in the United States but it is still imported from other countries. Until the 1940s, inorganic arsenic compounds were often used as agricultural pesticides. Now most uses of arsenic in farming are banned in the United States. The use of chromated copper arsenic to make a wood preservative for pressure-treated wood has been greatly reduced since 2003. Arsenic in soil results from human activities including pesticide use, mining and ore processing operations, operating coal burning power plants, and waste disposal. Sites of former tanneries, which make leather from animal hides, have large amounts of arsenic in the soil. Tanneries once used pits in the ground for preserving the hides or for waste.

Epidemiology
Ganga-Meghna-Brahmaputra basin is one of the major arsenic contaminated hotspot in the world. Presence of arsenic in groundwater has been reported in many countries, like Argentina, Bangladesh, Chile, China, India, Japan, Mexico, Mongolia, Nepal, Poland,

Taiwan, Vietnam and USA. Arsenic is found in groundwater in all 50 states, mainly in areas with shallow groundwater reserves and large amounts of arsenic in soil and mineral deposits.

In India, the states of West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam, Manipur and Chhattisgarh are reported to be most affected by arsenic contamination of groundwater above the permissible level.

Groundwater arsenic was reported for the first time from West Bengal in the year 1978, when two blocks were reported to be contaminated. This number has increased to 148 blocks from 14 districts and 111 blocks from 12 districts of West Bengal on both sides of the Ganges River by 2024.

Rajnandgaon is a district of the state of Chhattisgarh in India. It came into existence on 26th January 1973, by way of division of District Durg. Area of Rajnandgaon district is 8022.55 sq Km and population of district is 1537133 as on census 2019. Rajnandgaon district has total 1649 villages with nine blocks. The groundwater arsenic contamination in the Ambagarh Chouki block of Rajnandgaon district of Chhattisgarh contain Arsenic above the guideline of WHO.

Indian Scenario of ground water and soil arsenic contamination

Water is the wonder of nature which is an essential source of nutrient for all forms of life. It helps in proper digestion, energy metabolism, transport of nutrients and metabolites, cellular functions, and excretion of waste materials from our body and animals. Furthermore, water plays a vital role in body thermoregulatory and electrolyte health, and performance the fluidity and cushioning environment for the developing foetus in the human and animals. The quality of water determines the health and productivity of milk and their quality, as it causes bioaccumulation of water solutes in the milk and body tissues. Therefore, its quality has to be good for optimum health, and performance of dairy cattle. The high-altitude environments have limited surface and groundwater resources and more dependent on snow precipitations, very deep bore well ground water, and mountain river. Recently, quality of high-altitude water resources has become questionable due to more environmental pollution, climate change, and high anthropogenic activities at high altitude. Ground water plays a vital role in India to meet the water demands of various sectors, such as domestic, industrial and irrigational needs. In Chhattisgarh, high concentrations of AS in groundwater have been reported in Koudikasa village of Rajnandgaon area, and arsenic boreholes (up to 250µg/l) in groundwater are in granite relief from pegmatic invasion. High levels of arsenic are also reported in the pipes in the Ambagarh-Chowki block, which is applicable only to the Dongargarh rift area of D-D trend. It is used for different insecticides and pesticides preparation. Poisoning of arsenic is a major issue that affects different species. Its occurrence is related to contamination of feed and water; therefore, it is matter of concern globally. However, its level of toxicity is increasing very rapidly in Asian countries especially Bangladesh, India and Pakistan. Its increasing level in ground water is the major source of poisoning to human and animals. In addition, the contact of animals to arsenic lead to absorption and accumulation in vital organs like liver and kidneys that may resulted to carcinogenic development. Elimination of absorbed arsenic in environment through excretions of animals is also one way to increase its level in water/soil.

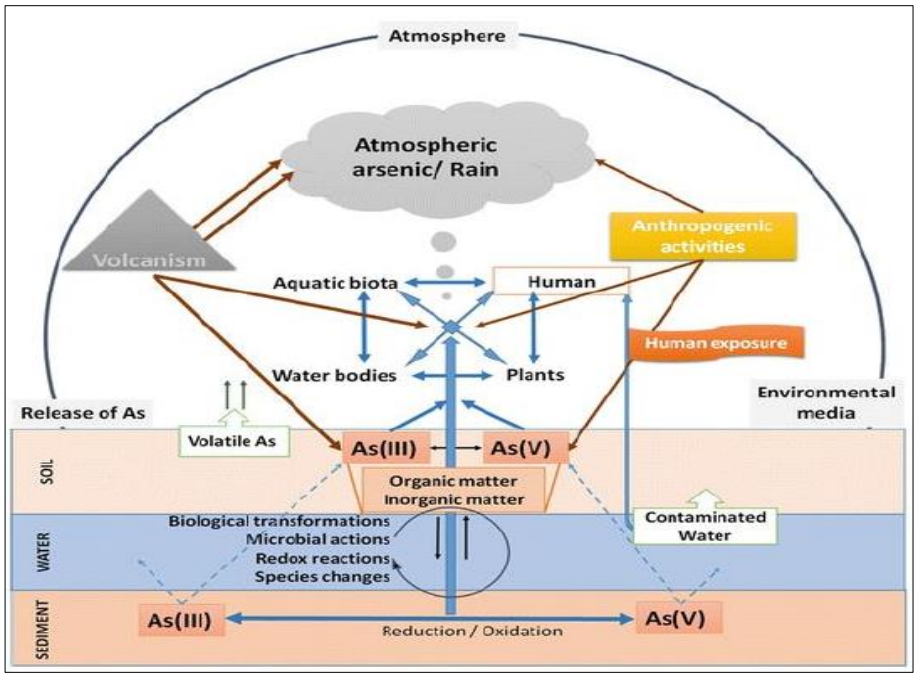

Fig 1: Indian Scenario of ground water and soil arsenic contamination

Arsenic transportation and metabolism in Food Crops

More than 3.4 billion population include rice in their diet to achieve their calories. Higher concentrations of As in crop soil and groundwater may result in increased crop loss and catastrophic health effects in humans. Rice grains have been shown to accumulate 2.24 mg kg^{-1} As compared to other main food crops. Having molecular similarity to silicon (Si) and phosphorus (Pi), rice plants can accumulate As III and As V through Si and Pi transporters. This renders a higher risk of As accumulation in rice, thus exposing humans to As toxicity. Arsenic accumulation in rice grain and paddy straw could be a direct threat for animal as well as human health

via presumably contaminated bovine meat and milk. After accumulation of this arsenic compound, mobilize to different parts of the plants. Intake of As is correlated with many factors as soil texture, PH, Organic matter quality which is depend on availability of minerals.

Arsenic and human health

Arsenic have shown to cause widespread health effects in humans as a consequence of exposure through drinking-water when present in excessive quantities. Long-term exposure to arsenic in drinking-water is causally related to increased risks of cancer in the skin, lungs, bladder and kidney, as well as other skin changes such as hyperkeratosis and pigmentation changes. Soluble inorganic arsenic is acutely toxic, and ingestion of large doses leads to gastrointestinal symptoms, disturbances of cardiovascular and nervous system functions, and eventually death. In survivors, bone marrow depression, haemolysis, hepatomegaly, melanosis, polyneuropathy and encephalopathy may be observed. In few studies, increased risks of lung and bladder cancer and of arsenic-associated skin lesions have been reported to be associated with ingestion of drinking-water at concentrations below 50 µg of arsenic per litre.

Effect on Livestock

Livestock reared in locality heavily contaminated with AS either in groundwater or in soil. In nature, AS bearing minerals undergo oxidation and release AS to water. Groundwater could be a major source of AS especially in the inorganic form.AS concentration in unpolluted fresh water from 1-10µg/L. However, As content can be much higher in waters in some geological environments. These include aquifers under strongly reducing conditions, aquifers under oxidizing, high pH (>8) condition areas of sulphide mineralization and mining and geothermal areas.

Diagnosis

- Clinical signs.
- History of the area.
- Confirmatory diagnostic testing.

Diagnosis of inorganic arsenical toxicities is generally based on suspicion of arsenic poisoning, clinical signs, history of the area, and confirmatory diagnostic testing. Presence of inorganic arsenic can be confirmed at a diagnostic laboratory by testing of stomach contents, the suspect material, or soil (because large animals may lick the soil).
Chemical determination of arsenic concentration in tissues (liver or kidney) or stomach contents provides confirmation. Liver and kidneys of healthy animals rarely contain >0.1 ppm arsenic (wet weight); toxicity is associated with tissue concentrations >3 ppm (wet weight). The determination of arsenic concentration in stomach contents is usually of value if performed within the first 24–48 hours after ingestion. The concentration of arsenic in urine can be high for several days after ingestion. Drinking water containing >0.25 ppm arsenic is considered potentially toxic, especially for large animals.

Treatment

Large Animals

- IV fluid therapy and supportive care
- Thioctic acid, alone or in combination with dimercaprol
- Sodium thiosulfate
- DMPS and DMSA (succimer)
- d-Penicillamine, as a chelator
- Continual monitoring of liver and kidney function

Reducing arsenic exposure

Arsenic concentrations of 5 µg/l or lower using can be achieved by using any of several possible treatment methods. However, the focus should be to reduce contamination through anthropogenic source. The most common arsenic-mitigation strategies include use of uncontaminated or less contaminated wells, replacement of arsenic-contaminated sources by less-contaminated ones, and removal of arsenic from contaminated water before consumption. In places where is mitigating contamination is not possible careful process optimization and control, and a more reasonable expectation of 10 µg/l should be achieved by conventional treatment (e.g. coagulation) Adopting rainwater harvesting/ watershed management practices will not only reduce water stress but also ensure arsenic free supply of water (naturally or through filtration).
The limited translocation of arsenic by roots and its limited translocation to the shoots is usually used by most plants such as carrot, tomato and grass. These plants contain relatively low arsenic and accumulate arsenic primarily in their root systems. In all plant species tested so far, it has been shown that arsenate is taken up via. the phosphate transport systems.

Conclusion

Arsenic compounds are toxic substances that can significantly affect the health of animals. Arsenic poisoning has been confirmed to be related to its chemical forms. Although most are known to affect mammals' signaling pathways, in this evaluation, we associated phosphorylation spots in diverse mammal and no mammalian species.
As a result, we can assume that the same effects found in mammalian specimens of aquatic life are likely to occur. Also, arsenic has been shown to cause oxidative tension in mammals and nearly marine organisms. Current work shows that animals intoxicated with arsenic trioxide show significant impairment of liver function and kidney function. There are reports that the effects of AS exposure on the development of sensory systems are minimal. It is also likely to cause significant changes in specific biochemical parameters, including the liver and kidneys. There is reliable and consistent evidence to support an optimistic relationship among high levels of inorganic arsenic exposure to drinking water, miscarriage, stillbirth, and low birth weight.

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