VOLUME - 9, ISSUE - 10, October - 2020 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Chemistry

ARSENIC POLLUTION AND REMEDIAL MEASURES IN WEST BENGAL: AN OVERVIEW

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ABSTRACT During the past twenty years, Arsenic (As) contamination via groundwater has become a significant issue worldwide and is now a serious concern within the Indo-Bangladesh Gangetic delta. Arsenic enters physical body through contaminated groundwater consumed as beverage. Food safety in this region is facing severe consequences as bio-accumulation of Arsenic is happening through food crops irrigated with As-contaminated water. Chronic exposure to Arsenic may cause not only cancerous and non-cancer health effects. Reports suggest that about 20% population in West Bengal is very affected. Various techniques are being introduced to supply arsenic-free beverage at a reasonable cost. But a rigorous change in habit and state of mind for procuring safe beverage in those surviving in As-contaminated zones is that the most essential step towards curbing the fatal consequences of arsenic exposure. Harvesting rain water and utilization of proper purification techniques are often considered a possible alternative of safe beverage.

Arsenic in groundwater above the WHO maximum permissible limit of 0.01 mg l−1 has been found in six districts of West Bengal covering a neighborhood of 34 000 km2 with a population of 30 million. at the present, 37 administrative blocks by the side of the River Ganga and adjoining areas are affected. Areas suffering from arsenic contamination in groundwater are all located within the upper delta plain, and are mostly within the abandoned meander belt. Quite 8,00,000 people from 312 villages/wards are affected with arsenic contaminated beverage and amongst them a minimum of 175 000 people show arsenical skin lesions. Thousands of tube-well waters in these six districts are analyzed for arsenic species. Hair, nails, scales, urine, liver tissue analyses show elevated concentrations of arsenic in people drinking arsenic-contaminated water for an extended period. The source of the arsenic is geological. Bore-hole sediment analyses show high arsenic concentrations in just few soil layers which is found to be related to iron-pyrites. Various social problems arise thanks to arsenical skin lesions in these districts. Poor socio-economic conditions, malnutrition, illiteracy, food habits and intake of arsenic-contaminated water for several years have aggravated the arsenic toxicity. altogether these districts, major water demands are met from groundwater and therefore the geochemical reaction, caused by high withdrawal of water could also be the explanation for arsenic leaching from the source. If alternative water resources aren't utilised, an honest percentage of the 30 million people of those six districts may suffer from arsenic toxicity within the near future.

KEYWORDS : Arsenic, Gangetic Delta, Groundwater, Health, Skin Lesions, Arsenic Poisoning, Groundwater, West Bengal

INTRODUCTION:

In the course of the last a few decades, event of high centralizations of arsenic in drinking-water has been perceived as a significant general wellbeing worry in a few pieces of the world. It is currently perceived that huge number of individuals from India have been imperiled by the possibility of expending water debased with arsenic at levels more noteworthy than the rule estimation of satisfactory level set by the World Health Organization (Flanagan et al, 2012) (10 g/L); more than 95 % of them live in West Bengal (SOES, 2010). Antagonistic wellbeing impacts of arsenic rely unequivocally upon the portion and span of presentation. Constant admission of drinking water with raised arsenic fixations can cause the improvement of arsenicosis, the aggregate term for sicknesses brought about by ongoing introduction to arsenic.

It incorporates a few sorts of skin injuries and tumors, similar to hyperpigmentation, keratosis, gangrene, disease of various inward organs (Smith et al., 1992; NRC, 1999; NRC, 2001). A few examinations have proposed a solid relationship between poor nourishing status with clinical indications of constant arsenicosis, came about less detoxification in the liver and hindered urinary end of arsenic (Rahman et al., 2001; Haque et al., 2003; Mitra et al., 2004). There is no particular clinical treatment for these arsenic-related infections. Employments of chelating operators may decrease the body trouble by upgrading the disposal of arsenic through pee and salicylic corrosive salves to give brief alleviation from keratosis (Bhattacharya et al., 2002; Smedley and Kinniburgh, 2002; Mandal and Suzuki, 2002). The West Bengal alluvial plain is made out of three interconnected spring frameworks: the shallowest spring (reaching out up to 12-15 meters underneath the surface), the moderate spring (35-46 meters), and the lower spring (70-150 meters). All springs are accounted for to be enhanced in arsenic-bound minerals in shifted focuses (Stüben et al., 2003). In the influenced territories, the spring dregs are covered by a layer of mud or sediment which has successfully confined section of arsenic into the surface water (Smedley and Kinniburgh, 2002). Be that as it may, people are confronting higher As-presentation through the tapping of groundwater sources after the presentation of domestic hand pumps and irrigation wells (Nickson et al., 2000).

DISCUSSION:

Chemistry Of Arsenic:

Arsenic is a very redox-sensitive component and its portability and speciation are exceptionally constrained by pH and Eh (redox capability) of the groundwater. Arsenic is steady in four oxidation states (+5, +3, 0, - 3) under the typical Eh conditions in oceanic frameworks, however the transcendent structures are inorganic oxyanions of trivalent arsenite (As^{3+}) or pentavalent arsenate (As^{5+}) (Smedley and Kinniburgh, 2002). The poisonousness of various arsenic species changes in the request arsenite> arsenate> monomethylarsonate> dimethylarsinate. Trivalent arsenic is around multiple times more harmful than arsenic in the pentavalent state, and inorganic arsenic mixes are around multiple times more poisonous than natural arsenic mixes (Jain and Ali, 2000). As indicated by Lombi et al., (2000) the coarse finished soils are probably going to yield a higher part of promptly portable Arsenic. The vast majority of the groundwater tests from the nine most influenced areas of West Bengal contain exceptionally high groupings of arsenic, disintegrated iron, ammonium, phosphate and extremely low centralizations of

sulfate and nitrate mirroring the lessening state of groundwater. Arsenic may get from reductive disintegration of iron and manganese (oxy) hydroxide and microbial oxidation of natural issue (Nickson et al., 1998; Anawar et al., 2001; Anawar et al., 2001) (Scheme 1).

Source Of Arsenic In Groundwater:

The source of arsenic is geogenic. Arsenic is available in alluvial dregs of the Delta. The instrument and reason for arsenic filtering from source has not yet been set up. Speculations like: 1. Arsenic mixes usually recognized in the climate (Abbreviations are in bracket) [Source: Goessler and Kuehnelt, 2002]. Oxidation of arsenopyrite, present in spring residue, by barometrical oxygen which enters the groundwater as the water table get down on account of exorbitant groundwater reflection (Das et al.,1996; Chowdhury et al., 1999; Chakraborti et al., 2001). Reductive disintegration of ferric-oxyhydroxide that contains sorbed arsenic (in Bengal and other alluvial springs) (Nickson et al., 1998; Nickson et al., 2000). Carbon decrease (Ashraf et al., 2002) Microbial decrease (Chatterjee et al., 2004; Yoshimura et al., 2004) is proposed by various creators. As per Acharyya et al. (2000); Saha et al. (1997), the wellspring of arsenic in ground water of lower Gangetic delta is viewed as the arsenic-rich dregs, moved from the Chotonagpur-Rajmahal of East Bihar, good countries and saved in drowsy streams under lessening conditions. Proceeded with broad siphoning set off the decrease cycle by prompting development of groundwater having exceptionally diminishing debased natural items (Acharyya, 2006).

Stretch Of Arsenic Pollution In West Bengal:

From the general investigation on As in West Bengal and Bangladesh, it is uncovered that the greatness of the groundwater pollution is serious (Pearce, 1998; Smith et al., 2000). Groundwater arsenic defilement in the Lower Ganga bowl of West Bengal, India, was first distinguished in July 1983 (Saha KC. Unpublished information).

Garai et. al. (1984) revealed 16 patients in three families from one town of 24 Parganas District. Saha (1984) further announced 127 patients with arsenical skin sores.

In the joined regions of West Bengal and Bangladesh (Ganga-Padma–Bramhaputra delta), around 150 million individuals are in danger from arsenic-debased groundwater.

As indicated by the reports of SOES, Jadavpur University, India, has recognized cylinder wells with arsenic fixations ≥ 50 µg/L in excess of 3,000 towns. In view of Arsenic focuses, West Bengal was characterized into three zones: exceptionally influenced 9 areas (Malda, Murshidabad, Nadia, North-24-Parganas, South-24-Parganas, Bardhaman, Howrah, Hooghly and Kolkata, mostly in eastern side of Bhagirathi River) where normal arsenic load is > 50 g/L (upto 300 µg/L) can be found in tube-wells; somewhat influenced 5 locale (in northern part) where normal Arsenic load in tube-wells was under 50 µg/L (a couple over 50 µg/L yet all < 100 µg/L).

Arsenic Poisoning:

Bioaccumulation in plant as a rule plants takes up As(V) by phosphate carrier directs in plants developed on oxygen consuming soils and use it through phosphate transport channels (Tripathi et al., 2005). Due to their compound comparability, arsenate rivals' phosphates for root take-up and meddles with metabolic cycle like ATP phosphorylation and consequently displays its poisonous impacts. At higher fixations, Arsenic has hindering impacts towards plant metabolic cycles development (Marques and Anderson, 1986). At high focuses, Arsenate in plants hinders photosynthesis through impedance of the pentose–phosphate pathway (Tu and Ma, 2002; Adriano, 2001). Arsenite[3+] infiltrates the plant fingernail skin to a more prominent degree than Arsenate[5+] and for the most part brings about the loss of turgor (USDHH, 2001). The Chinese brake plant (Pteris vittata) was accounted for as the hyper gatherer of arsenic and consequently ready to eliminate arsenic from soil. Some normal plants of Bengal like Indian mustard (Brassica juncea), kachu sak (Colocasia antiquoram) and Kalmi sak (Ipomea reptans) have moderate arsenic amassing limit (Nickson et al., 1998). Food parts (for example potato skin, verdant vegetables, rice, wheat, cumin, turmeric powder and oats) gathered from the arsenic influenced locales of the Murshidabad region of West Bengal, contained upto 373μgKg-1 (Goessler and Kuehnelt, 2002).

Arsenic in human body Several examinations in people demonstrate that both Soluble Arsenic mixes [also the organoarsenicals] are all around consumed over the gastrointestinal parcel (Hindmarsh and McCurdy, 1986; Bettley and O'Shea, 1975). Urinary discharge represent 55-80 % of every day admissions of inorganic Arsenic in people (Buchet et al., 1981; Crecelius, 1977; Mappes, 1977). The As^{3+} may go through enzymatic methylation essentially in the liver to frame MMA and DMA. Most Arsenic is discharged in the pee as a blend of As^{3+}, As^{5+}, MMA and DMA. Some Arsenic may stay bound to tissues, contingent upon the rate and degree of methylation. Monomethylarsonic corrosive might be methylated to DMA, yet once methylated, neither MMA nor DMA is demethylated to yield As^{3+} or As^{5+}. Arsenic collects in hair, nails, skin, bone, and muscle and its half-life in people is somewhere in the range of 2 and 40 days (Hindmarsh and McCurdy, 1986). Arsenic focus in the hair, nail and pee is set up as biomarkers for arsenic tainting (Chakraborti, 2003).

Network wellbeing impacts Drinking water and food is the most significant wellspring of Arsenic-tainting in people (USDHH, 2001). The event of inorganic Arsenic in drinking water has been recognized as a danger factor for human wellbeing even at generally low focuses. Thus, more severe more secure cutoff points for Arsenic in drinking water have been proposed (USEPA, 1988). IARC (International Agency for Research on Cancer, 2004) has characterized arsenic as a human cancer-causing substance, bunch 1. The poisonou sness of Arsenic in people is an element of its pace of expulsion from the body. Ongoing presentation to raised arsenic fixation in drinking water can cause the improvement of arsenicosis, the aggregate term for the illnesses. It incorporates infirmities like hyper-pigmentation, hyperkeratosis, gangrene, a few sorts of malignancies (Smith et al., 1992; NRC, 1999; NRC, 2001). Hyperpigmentation, an abundance of skin pigmentation, is regularly the principal obvious manifestation. Arsenic can instigate oxidative harm to DNA, changed DNA methylation, adjusted quality articulation, various kinds of chromosomal distortion, enlistment of protein-DNA cross connections, apoptosis and modified guideline of DNA-fix qualities, hindrance of thioredoxin reductase and restraint of pyruvade dehydrogenase in vitro (NRC, 1999; Armstrong et al., 1984). The most trademark impact of constant presentation to Arsenic is hyperkeratosis (an obscuring of the skin and presence of little "moles" on the palms, bottoms, and middle, that is the reason it is known as Black foot ailment (Chakraborti, 2003), which may eventually form into skin malignancy 50 Volume 13 (Hindmarsh and McCurdy, 1986). Early manifestations in people incorporate stomach torment, heaving, the runs, strong torment, and shortcoming, with flushing of the skin (Cullen et al., 1995; Moore et al., 1994; Fennell and Stacy, 1981). These side effects are frequently trailed by deadness of the furthest points, strong squeezing. Further side effects may show mottled skin and reformist decay in engine and tangible reactions (Murphy et al., 1981; Civantos et al., 1995). Intense oral Arsenic harming at portions

of 8 mg arsenic kg - 1 or more have been accounted for to influence the respiratory framework (Cullen et al., 1984). Various investigations in people have demonstrated that Arsenic ingestion may prompt genuine consequences for the cardiovascular framework (Moore et al., 1994). Studies have additionally uncovered hepatic impacts of Arsenic harming, demonstrated by swollen liver with raised degrees of hepatic proteins in blood (Cullen et al., 1984). Ongoing examinations have demonstrated that GSH height is a characteristic response to arsenic assault which most likely goes about as a defensive system (McKinney, 1992; Mazumder et al., 1988). The circumstance turns out to be more basic when the accessibility of free thiol bunch is low (lack of healthy sustenance/protein insufficiency) and improved articulation of harmfulness can happen. This might be a potential clarification for wide spread clinical indication of arsenicosis among the rustic, malnourished populace in West Bengal. Arsenic incites hematological sicknesses like leucopaenia and thrombocytopaenia (Cullen et al., 1984; Saha, 2003; Guha Mazumder, 2008). No decisive data on pregnancy result and baby mortality corresponding to arsenic levels in drinking water is accessible in writing (Chakraborti et al., 2004).

Mitigation Measures

There is an intense shortage of medication to fix ongoing Arsenic poisonousness. Safe water, nutritious food and some physical exercise are just the demonstrated measures to battle ongoing Arsenic poisonousness (Maeda, 1994). Appropriate watershed the executives and savvy use of accessible surface water alongside the instruction of the residents and their dynamic support have all the earmarks of being the main answers for settling the current Arsenic emergency in the Gangetic delta (Tripathi et al., 2005). Inorganic Arsenic can go through microbially interceded biochemical change, i.e., the hydroxyl gathering of arsenic corrosive is supplanted by the CH_3- gathering to frame MMA, DMA, and TMA, accordingly get moved into moderately non-poisonous structure (Frankenberger and Losi, 1995). The pathway of As^{5+} methylation at first includes the decrease of As^{5+} to As^{3+}, with the resulting methylation of As^{3+} to dimethylarsine by coenzyme S-adenosylmethionine (Pierce and Moore, 1982). Methylation is regularly upgraded by sulfate-diminishing microscopic organisms. A few contagious animal groups additionally have demonstrated capacity to lessen Arsenic (USDHHS, 2000). A portion of the current arsenic expulsion advances can be decreased in scale and helpfully be applied at family and network levels for the expulsion of arsenic from defiled water drawn by tube wells. 1. Oxidation: Arsenite can be oxidized by oxygen, ozone, free chlorine, permanganate, hydrogen peroxide and so on. Air oxygen, hypochlorite and permanganate are generally utilized for oxidation in creating nations. Air-oxidation of arsenic is moderate yet synthetics like chlorine and permanganate can quickly oxidize arsenite to arsenate under wide scope of conditions (Wegelin et al., 2000). 2. Sun oriented Oxidation: It is a straightforward strategy for sun-based oxidation of arsenic in straightforward jugs to decrease arsenic substance of drinking water (Young, 1996). Bright radiation can catalyze the cycle of oxidation of arsenite in presence of different oxidants like oxygen (Ahmed et al., 2000). Trials show that the cycle on normal can diminish arsenic substance of water to around 33%. 3. Co-precipitation and Adsorption measures: Water treatment with coagulants, for example, aluminum alum, initiated alumina, ferric chloride and ferric sulfate are compelling in eliminating arsenic from water. Ferric salts have been discovered to be more successful in eliminating arsenic than alum on a weight premise and powerful over a more extensive scope of pH. In the two cases pentavalent arsenic can be more adequately eliminated than trivalent arsenic (Pierce and Moore, 1982). The Bucket Treatment Unit (BTU), intended for house-hold need, depends on the standards of coagulation, co-precipitation and adsorption measures. It comprises of two containers, every 20-liter limit, put one over the other. Synthetic substances are blended physically with arsenic polluted water in one of the containers by lively mixing and afterward flocculated by delicate mixing. The blended water is then permitted to make due with 1-2 hours. The water from the pail is then permitted to stream into another container through a sand channel introduced in the subsequent can, cautiously dodging the inflow of settled ooze in the principal can. Presently the subsequent can basically contains treated water (Guha Mazumder, 2003). There are a couple of promising therapy techniques presently being used, including chelation treatment, that may diminish or if nothing else capture disintegration of ongoing As-harmed people. Two principle medicines were dimercapto succinic corrosive (DMSA) and 2,3-dimercapapto-1-propanesulfonate (DMPS). The examination demonstrated that DMSA didn't improve the skin injuries in ongoing arsenicosis patients. Conversely, DMPS improved fundamentally ongoing arsenicosis (Guha Mazumder et al., 2001). DMPS expanded discharge of arsenic in the pee a few overlay (Simon et al., 2006). The expansion in urinary Arsenic discharge during chelation treatment might be the key factor in DMPS treatment. Further examination is expected to affirm the adequacy of this medication. Guha Mazumder, (2003) demonstrated that proteins in food may build the disposal of inorganic Arsenic by expanding methylation. Henceforth, individuals presented to Arsenic are encouraged to build protein utilization from both creature and plant roots. Also, retinoids and cell reinforcements have hostile to keratinizing impacts and may forestall malignant growth. Clinical afflictions like constant bronchitis, pneumonic sickness, gateway hypertension and fringe neuropathy, must be dealt with consistently, so the patient's wellbeing won't fall apart. Early recognition of tumors because of ongoing arsenicosis, particularly skin, urinary bladder and lung, can hinder the advancement of infection (Khuda-Bukhsh et al., 2005). A potentized homeopathic cure, Arsenicum Album 30, has demonstrated profoundly reassuring exercises of different poisonousness marker proteins and mixes in the blood and propose that the medication can reduce arsenic harming in people (Chowdhury et al., 2001).

CONCLUSION:

Arsenic tainting has been spreading to fresher zones and at the current circumstance, roughly 450 million individuals living in the Ganga-Meghna-Brahmaputra delta, is in danger (Maeda, 1994). It had been assessed that deep-rooted ingestion of arsenic (1 g/kg of body weight/day) is related with an around 0.1 % danger of skin disease (Smith et al., 1992). This is disturbing as the degree of arsenic pollution has been very high and its quality in different sources expands the introduction recurrence. A water flexibly framework requires high capital interest in establishment and upkeep. A comparable danger could be presented by funneled water flexibly because of pollution through spillage in gracefully lines. Spread utilization of arsenic channels could make further harm the nearby biological system because of impromptu open removal of the profoundly poisonous ooze delivered after their utilization. This may dirty soil and surface water, presently the main wellspring of sans arsenic water. Water gathering is a typical innovation utilized for assortment and capacity of water. In numerous conditions of India generally in the eastern parts, the normal yearly precipitation of rainfall in eastern portion of India is around 2,000 mm/year (Tripathi et al., 2005). So, downpour water gathering followed by legitimate decontamination can be utilized as a very practical proportion of getting Arsenic free drinking water. Reports have indicated the function of financial divergence in high event of constant arsenicosis and absence of cooperation in dynamic. Nonetheless, such a significant social issue has not been tended to in strategy and there is a

need to guarantee more noteworthy support of underest imated and exceptionally influenced networks. Financial investigation in arsenic-influenced towns demonstrated that locals were living in exceptionally helpless conditions. Indeed, even now, numerous who are drinking arsenic-tainted water are not even mindful of this reality and its results (Das et al., 2009). Specialists at the School of Environmental Studies (SOES), Jadavpur University, India, have seen from their most recent 18 years' field involvement with West Bengal, arsenic-influenced individuals have likewise been confronting genuine social issues. Some of the time, the arsenic-influenced patients are compelled to keep up a confined life (Dinesh et al., 2007). Arsenic moderation can be a twofold edged issue. There are issues of conceiving deductively stable, financially savvy, locally worthy techniques which should be supportable through network contribution. For the relief program to be effective, it is fundamental to create far reaching the executives plans including satisfactory clinical, paramedic and infrastructural uphold inside the umbrella of essential medical services is required. An adjustment in water use conduct and tapping of fresher water assets is fundamental, considering regularly exhausting ground water. The legislative offices and NGOs need to contact the helpless victims of this destructive infection. We live with the expectation that some time or another each man on the earth will approach arsenic free drinking water; sometime the world will no longer bear the moles of arsenicosis.

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