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ARSENIC CONTAMINATION OF GROUND WATER IN ENDEMIC AREA OF UTTAR PRADESH: A CASE STUDY

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ABSTRACT

In recent years much attention is being paid to explore the correlation of varying factors to ground water arsenic poisons. Herein, this has been investigated that ground water samples of Ballia (U.P) meet to exceed the Bureau of Indian standard (BIS) limits for the arsenic and iron of these water samples provide evidence ample discrepancy with waste standards. Here, it was investigated that out of 150 selected sources of water,91 samples have all analyzed parameters beyond desirable limits and water from these sources can't be used for drinking purpose without special treatment. The expected outcome of the present work is to explore the mobilization of arsenic in gangetic plains by correlating the various contributing factors in water arsenic poisonings and developing concern to initiate the remediation measures to tackle this present crisis in drinking water reclamation process.

KEY WORDS: ***Ground water, Physico-chemical Properties, BIS, Ballia, Remediation.***

INTRODUCTION

Arsenic is the 20th abundant rare earth crust metal associated with the areas of gold, silver, copper, lead, zinc, nickel cobalt, antimony and bismuth all of which belongs to the same group in periodic table .The major source of surface and ground water pollution is injudicious discharge of untreated industrial effluents directly into the surface water bodies resulting surface and ground water pollution described by Nasrullah,et al.,(2006) and Malik et al .,(2009). ground water pollution .Now it has been reported that Arsenic not only affect the habitats where it is disposed but also reaches for all places via percolation and leaching such as underground waters. Arsenic always present as allotropes of phosphate .In many biochemical reaction arsenic replace the phosphate and disturb the oxidative phosphorylation of mitochondria that affect the formation of ATP which is main source of energy this process is called arsenolysis.

In 1984 groundwater arsenic contamination was discovered in lower Ganga plains of West Bengal (Garai et al., 1984). Only in1985 was arsenic situation in west Bengal and consequent suffering of people brought to light (Chakraborti et al., 2002). In 1992 identified arsenic groundwater contamination in lower plain area (Terai) of Nepal came to notice (Shrestha et al., 2003). During our study we selected the Ballia District to understand the problem of arsenic affected blocks (Table-2).

Millions of people are drinking groundwater with elevated concentration of arsenic. (I.e. 0.01PPm, WHO standard.) Geological and hydrobiological character of alluvial soil govern the mobility of arsenic in ground water. Widespread arsenic contamination of groundwater has led to a massive epidemic of arsenic poisoning in Bangladesh and neighboring countries. In Uttar Pradesh Ballia, Bahraich and Gazipur is the most affected place of arsenic mainly area nearby Gangatic plains.

Arsenic is known to cause arsenicosis owning to its manifestation in drinking water "the most common species being arsenate [$HAsO_{4;}^{2-}$As(V)] and arsenite [H_3AsO_3 ; As(III)]".Chronic arsenic exposure contaminated drinking water induced dermal lesions skin cancer leucomelanasis. (Fig-2)

The main objective of this paper is to study of the present situation of arsenic contamination in Uttar Pradesh based on arsenic analysis of india mark hand pump water and make people aware stressing the need for remedial actions to avoid shocking situation.

MATERIALS AND METHODS

All the chemicals which are used in the study were of analytical grade (Merk, Germany). All the glassware's and samples bottles were soaked in hot water and rinsed with laboratory dish soap (Lavolene) for at least 2h and then rinsed with deionized water. As stock solution (1000 mg/l) was prepared by dissolving Sodium arsenite in de-ionize water and stored in airtight polythene terphthalate (PET) bottles at a temperature less than 2ÚC.further working solution were freshly prepared from stock solution for each experimental run.

Dr. C P M Tripathi has been actively engaged in the research activities since July, 1973 to date. Worked for Ph.D. degree on the control of reproduction in flesh-fly *Sarcophaga ruficornis* (Fabr.) by using the chemosterilant thiourea. The primary target of thiourea in female *Sarcophaga* were the follicle cells in the ovarioles, which undergo structural transformations inhibiting the transport of nutrient materials into the nurse cells and of yolk into the oocytes. The subnormal eggs produced are not viable (Experientia, 1976; J. Med.Entomol.,1980). Thiourea drastically affected the synthesis of RNA (Ind. J. Exp. Biol., 1979) and DNA (J.Ent.Res., 1981).

For the last twenty five years, actively working on the Biocontrol of Insect Pests of Pulses, Oil seeds, sugarcane, vegetables and cotton for evolving bio-intensive IPM strategies (Agric Ecosystem & Environment, 2003; Biol. Agric & Hortic, 1999, 200; Insect Science & application, 2000, Biocontrol, 2006, 2007, 2008, 2009). It was observed that the age (Biol. Agric. & Hortic., 1983; 1997) quality of food plants (Canadian J. Zool., 1985) and the presence and absence of males (Entomophaga, 1988) drastically affects the parasitising behaviour of the parasitoids.

As **Full Bright Scholar** at **Texas A&M University, U.S.A.**, worked on the effect of kairomone extracts of *Helicoverpa armigera* on the behaviour of the parasitoid *Campoletis chloridae* in the wind tunnels designed by Prof. S.B. Vinson.

For the first time, successfully experimented (at Institute of Arable Crops Rothamsted, Harpenden, U.K.) and observed the effects of aphid sex pheromone components, on aphid parasitoid activity, in arable field margins. The presence of aphid sex pheromones (+)-(4aS, 7s, 7aR) -nepetalactone, in 50µl of ether, significantly increased parasitisation by the generalist parasitoid *Praon volucre* on the plants adjacent to the vials and on plants placed 20 cm away (Biocontrol Science & Tech. 1998). Successful experiments were also conducted and are still in progress by using the other aphid Sex pheromone nepetalactol. The results obtained during the field trials are very encouraging for the prospect of using aphid sex pheromones to manipulate parasitoids in order to improve aphid population control.

The quality of food plants also has been found to affect the prey-predation relationship between the mustard aphids and the predator *Coccinella septumpunctata* (J. Appl. Ent., 1999, Phytophaga, 2000). The experiments conducted demonstrate, that after 24h period of starvation the *Coccinella septumpunctata* grub satiated in 85 min after eating 31.57±7.12 mustard aphids. Again 24-36h of deprivation, the maximum appetite was attained. To be used as a bio agent, 24h starved grubs are the best (J. Appl. Ent., 2002, 2003, 2004).

We evaluated temperature effects on the development, survival, fecundity, progeny sex ratio and life-table parameters of *C. chlorideae* to optimize its quality and efficiency, both in field and laboratory (BioControl, 2009). Newly emerged parasitoid *Campoletis* show maximum reproductive fitness and this attribute can be implemented to optimize its quality and efficacy both in field and laboratory for successful biocontrol of the pod borer, *Helicoverpa armigera* (BioControl, 2010).

The area and population of UP situated in upper and middle Ganga plain are 238,000 km^2 and 166 million (Census 2001), respectively. We focused the several block of Ballia district (area 3168 km^2, population 2.75 millions). Fig.1 show the ground water contamination in UP.

The Hand pump water, samples were collected from different block of Ballia district and analyzed for arsenic by flow injection – hydride generation-atomic absorption spectrometry (AAS). The physico-

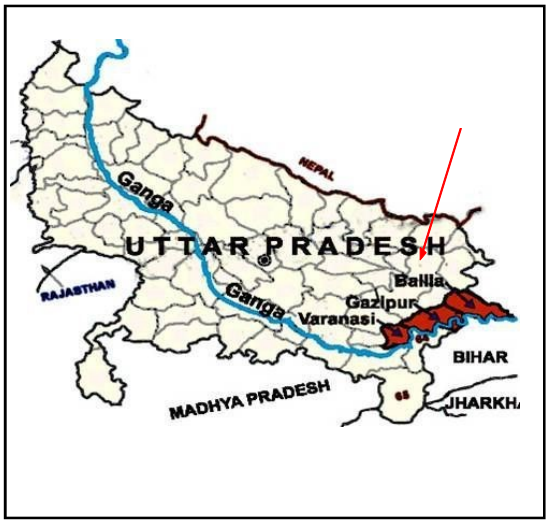

Fig1- Centre of attention of Arsenic rich Area in UP

Fig 2 : Advanced stage of Arsenicosis Patient.

chemical parameters and other heavy metals were analyzed following the standard Methods of APHA (2005).

RESULTS AND DISCUSSION

The Gangetic plain is an area relatively rich in water resources; however, the current water exploitation and utilization have only reached a relative low degree. The blanket study survey in summer (March, 2010) season of Ballia district of Uttar Pradesh were preferred after conducting the literature survey and evaluating the people size, development of socioeconomic and water consumption need of these districts. During the study survey, it was found that this endemic parts of gangetic plains rely on only groundwater sources for drinking water purposes in absence of any alternate source.

The physico-chemical parameters studied of groundwater includes pH, hardness, Total Alkalinity, Total dissolve solid, conductivity, Nitrate, fluoride.

Table 1- physico-chemical characteristics of Groundwater samples.

SN	Ph	Hardness Mg/l	Alkalinity Mg/l	TDS Mg/l	Nitrate (Mg/l)	Fluoride
1	7.6	160	72	437	7.36	0.15
2	7.7	120	96	109	5.78	0.22
3	7.7	160	88	683	3.68	0.95
4	7.5	120	96	248	4.52	0.17
5	7.6	120	64	339	7.7	0.20
6	7.0	120	52	915	5.7	0.11
7	7.6	120	60	256	4.34	0.04
8	7.5	120	56	229	4.26	0.22
9	7.6	120	68	281	5.96	0.20
10	7.1	120	60	399	3.18	0.16
11	7.6	140	64	261	5.82	0.19
12	7.5	120	52	283	9.9	0.17
13	7.6	120	60	240	7.02	0.12
14	7.7	120	52	269	6.92	0.15
15	7.7	120	48	265	4.5	0.19
16	7.5	120	56	293	3.74	0.26
17	7.7	120	48	224	2.78	0.13
18	7.6	120	80	315	6.38	0.23
19	7.6	120	76	295	3.94	0.20
20	7.5	120	112	319	5.1	0.17
21	7.0	120	96	259	7.76	0.19
22	7.6	120	84	229	3.78	0.34

Table2- Arsenic concentration in samples of Groundwater.

Block	No Of total HPs tested	Upto 10ppb	(10-40) ppb	(40-50) ppb	Above50 ppb
Belhari	25	11	05	02	07
Bairiya	25	12	07	02	04
Murli chhapra	25	13	06	02	04
Revati	25	11	06	02	06
Maniyar	25	03	03	03	16
Bansdih	25	09	06	01	09
Total	**150**	**59**	**33**	**12**	**46**

Physico-chemical parameters are shown in table -1. The pH of the water was always found in alkaline range i.e (7.0-7.7). Total hardness ranges from 120-160 mg/l, total hardness is within the prescribed limit of BIS (300-600 mg/l). Alkalinity ranges from 110-149 mg/l. Alkalinity is the cause of carbonate and bicarbonate ion and its salts. It is in the prescribed limit of BIS i.e (200-600) .Fluoride was found within prescribed limit of (0.6-1.5 mg/l).

The presence of high level of nitrate in drinking water due to excess of decayed vegetable, animal matter, industrial effluent, use of pesticides has become a very serious problem. The World Health organization has recommended that water containing high levels of nitrate in water 45 mg/l should not be used for drinking and food preparation. Bureau of Indian standard prescribed highest desirable limit for nitrate is 45 ppm and maximum Permissible limit is 100 ppm .we found nitrate is within prescribed limit.. The total dissolve solid within permissible limit of 500mg/l except sample no 3 and 6 .

Table 3- Various heavy metal concentrations in ppm of (Belahari block)

Sample sites	Cd^{2+}	Cr (Total)	Cu^{2+}	Fe^{2+}	Mn^{2+}	Ni^{2+}	Pb^{2+}
1	0.0030	0.0010	0.0050	0.9600	1.2783	-	
2	-	-	0.0025	1.2400	-	-	
3	0.0006	0.0018	0.0146	1.2440	-	0.0128	0.0105
4	0.0003	0.0014	0.0094	1.2680	-	0.0037	
5	0.0001	0.0056	0.0081	0.8610	-	0.0157	0.0121
6	-	-	0.0025	0.8138	-	0.0157	
7	0.0060	-	0.0238	1.3300	-	-	
8	0.0001	0.0060	0.0096	1.2600	-	0.0017	
9	0.0010	0.0200	0.0109	1.3400	-	0.0081	0.0239
10	0.0011	0.0129	0.0056	1.3300	-	-	0.0097
11	0.0008	0.0155	0.0100	1.1890	-	0.0077	0.0123
12	0.0001	-	0.0014	1.2680	-	-	0.0172
13	0.0004	0.0023	0.0050	1.2500	-	0.0044	0.0017
14	0.0005	0.0397	0.0022	1.3400	-	0.0093	
15	0.0008	0.0018	0.0006	0.8490	-	0.0067	0.0032
16	0.0010	0.0017	0.0038	1.2800	-	0.0086	0.0077
17	0.0005	0.0072	0.0033	1.1470	-	0.0028	0.0226
18	0.0001	-	0.0001	1.3006	-	0.0023	0.0030
19	-	-	0.0013	1.0836	-	0.0024	0.0744
20	0.0005	-	0.0012	0.8798	-	0.0057	0.0070
21	0.0005	-	0.0017	1.3396	-	0.0064	0.0054
22	0.0004	-	0.0120	1.2516	-	0.0078	0.0010
23	0.0002	0.1074	0.0012	0.3762	-	0.0065	0.0043
24	0.0004	0.0067	0.0026	1.2036	-	0.0098	0.0002
25	0.0003	-	0.0038	1.1767	-	0.0098	0.0067

On the basis of As and other heavy metal analysis Our study has concluded that Ballia district was most affected part with struggling groundwater arsenic contamination as this is main drinking water source. Our group has investigated that drinking water samples of Ballia (UP) in India meet to exceed the Bureau of Indian Standard (BIS) limits for the arsenic that provides evidence ample discrepancy with drinking water standards. Here, it was investigated that iron was also identified above their recommended permissible limit as set by BIS i.e , 10 ppb (table 3).

Out of 150 sources of ground water, 91 samples have all analyzed parameters beyond desirable limit and water from these sources can't be used for drinking purpose without special pretreatment. 59 sources of water have some parameters more than desirable limit but still within permissible limit, water from these sources can be used for drinking purpose in absent of alternate source. Ballia district is our main arsenic contamination site as conducting the blanket survey of these areas for arsenic. Arsenic along with iron was investigated above their permissible limits during the study.

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