ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 07 | July - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

GROUND WATER FLUORIDE CONTAMINATION SCENARIO: A REVIEW ON BANKURA DISTRICT, WEST BENGAL, INDIA

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ABSTRACT

This study shows overall ground water fluoride contamination scenario of entire Bankura district of West Bengal. Ten out of twenty two district are recorded to have ground water fluoride concentration above WHO permissible limit 1.5 mg/L. People living in these ten districts are found to have dental fluorosis problem due to regular consumption of fluoride contaminated drinking water in addition to fluoride-contaminated rice, pulses, and vegetables. Body weakness, muscle-nervous fluorosis in addition to skeletal, non-skeletal and dental fluorosis is recorded in Simlapal block due to consumption of highly fluoride contaminated drinking water. Weathering of fluorine rich minerals, lateritic soil character in these regions, unscientific use of fluorine rich phosphatic fertilizers are mainly responsible for the elevated level of fluoride contamination in ground water and soil of Bankura district. Alternative sources of water like rain water harvesting, continuous monitoring of ground water for pollutants, household supply of safe drinking water could be the probable long-term solution for the study area.

KEYWORDS

INTRODUCTION:

Ground water fluoride contamination is considered as an uprising concern across the globe. Due to consumption of fluoride bearing ground water around 260 million people from 25 countries are suffering in some form of fluorosis. In Asia millions of people from India, Pakistan, Sri Lanka, China, Mongolia and Indonesia are suffering with fluorosis. In European subcontinent scenario is comparatively better except the countries like Germany and Estonia. In Africa people from Sudan, Ethiopia, Uganda, Kenya, Tanzania, Malawi, Cameroon, South Africa, Nigeria and Ghana are suffering with fluorosis. In North America countries like Mexico, USA and Canada, the ground water fluoride contamination is reported to be above the WHO permissible limit 1.5 mg/L. In South America country like Argentina the ground water fluoride contamination is above the WHO permissible limit like North America.[1] In India around 17 states covering 50,000 villages and around 62 million people are under high risk of fluorosis due to regular consumption of fluoride contaminated ground water. The states are West Bengal, Bihar, Punjab, Uttar Pradesh, Madhya Pradesh, Rajasthan, Andhra Pradesh, Telangana, Tamil Nadu etc.[2,3] In West Bengal the scenario is more severe. 42 blocks and 7 districts are reported to be affected with fluorosis. The districts are Birbhum, Bankura, Purulia, Dakshin Dinajpur, Uttar Dinajpur, Malda and South 24 Parganas.[4]

Weathering of these fluorine rich minerals such as fluorite (CaF_2), cryolite (Na_3AlF_6), topaz [$Al_2SiO_4(F,OH_2)$], apatite [$Ca_5(Cl,F,OH)(PO_4)_3$], amphiboles [$A_{0-1}B_2C_5T_8\ O_{22}(OH,F,Cl)$], micas [$AB_{2-3}(X,Si)_4O_{10}(O,F,OH)_2$] and sellaite ($MgF_2$) are the main sources of fluoride in the ground water. Anthropogenic activities like mining, usage of pesticides and brick kilns also contribute in the enhancement of fluoride contamination in ground water. Unscientific use of phosphatic fertilizers is the major anthropogenic sources of fluoride contamination in ground water in developing countries such as India. Irrigation by fluoride enriched water and use of superphosphate fertilizers in agricultural also contributes fluoride into groundwater.[5]

Depending on the amount ingested daily fluoride can be considered as harmful or beneficial to humans like any other trace elements. For the formation of enamel and bone mineralization 0.5 mg/L of fluoride is required daily. On the other hand, dental and skeletal fluorosis, chronic joint pain and osteosclerosis may result due to long-term intake of fluoride beyond permissible limit of 1.5 mg/L. Crippling skeletal fluorosis is the most severe form of fluorosis. Further, high doses of fluoride are reported to be associated with cancer. Long time exposure of lower levels of fluoride may result kidney damage in animal. Children's intelligence may be affected due to regular consumption of fluoride contaminated water beyond permissible limit.[5] Fluoride can adversely affect the IQ level of infants by accumulating in their cerebral tissue. Higher fluoride consumption is also reported to enhance skeletal deformities and knock knees.[6]

The western part of West Bengal mainly covering three districts, namely, Bankura, Purulia, and Birbhum, the fluoride toxicity is considerably higher compared to the eastern parts due to its geographical location. Lateritic soil character in these regions mainly responsible for the soil fluoride contamination.[7] It is reported that large number of people from this district is dependent on fluoride contaminated drinking and irrigation water without having any option. So, large number of people are also affected with fluorosis.[8] Out of 22 blocks, 17 blocks are recorded to have ground water fluoride contamination problem.[9] Hence, objective of this review article is to understand the overall scenario of ground water fluoride contamination in Bankura district depending on the recent research updates. Distribution of block wise fluoride contamination in ground water also has been highlighted.

Bankura:

Geographically, Bankura district is situated in the western side of West Bengal, 78m above sea level. Bankura is reported to be situated between latitude 22°38′–23°38′ N and longitude 86°36′–87°46′ E. According to census 2011, the total population of Bankura is 3,596,674 with total area of 6,882 sq. km. According to the census report, 91.7 of the populations live in rural areas of Bankura and most of the local inhabitants depend on agricultural activities. Usually, the regional weather of Bankura is dry with seasonal variation of high and low temperature. Extreme weather and due to the presence of rocky, lateritic soil, a selected group of crops like rice, potato, tomato, lentils, mustard, and various seasonal vegetables are grown in this region.[10] Irrigation is partly dependent upon ground water through shallow and deep tube well pumps.[11] The ground water is the main source for poor people for their agricultural and domestic purposes.[12] Recent study shows that 10 blocks namely Bankura-II, Gangajalghati, Simlapal, Chhatna, Raipur, Hirbandh, Saltora, Indpur, Khatra, and Sarenga out of 22 blocks of Bankura are affected by fluorosis due to regular consumption of fluoride contaminated ground water.

Bankura-II And Gangajalghati:

Bankura-II lies between latitude 23°15′19″ North and longitude 87°05′38″ East, covering an area of 222.24 square kilometres. Gangajalghati lies between latitude 23°25′12.0″ North and longitude 87°07′12.0″ East, covering an area of 371.2 square kilometres. Although the population density of the entire district is thin, but Block II is moderately concentrated as Bankura town is the district head headquarters. The people of this area are dependent on agriculture and agriculture is partly dependent on ground water due to the presence of rivers, lakes and canal facilities. It is reported that 30% of urban and 90% of rural households are still dependent on untreated surface or ground water.[12] Study shows that children living in the fluoride affected Bankura Block II and Gangajalghati area are at high risk of developing dental fluorosis due to the consumption of fluoride-contaminated rice, pulses, and vegetables grown in the study area in addition to the

consumption of contaminated drinking water.[11]

Simlapal And Chhatna:

Simlapal block lies between latitude 22°55′22″ North and longitude 87°04′24″ East, covering an area of 310.15 square kilometres. Laxmisagar, Machatora and Kusumkanali regions of Simlapal block were examined in both pre- and post-monsoon seasons to check the ground water fluoride contamination levels. Ground water fluoride contamination with maximum elevated concentration of 12.2 mg/L was found in Machatora region. The ground water fluoride concentrations of rest of the area were observed to be above 1.5 mg/L, indicating that host aquifers are severely affected by fluoride contamination.[13] Another study shows that the ground water fluoride concentration in the study area of Simlapal block ranges from 0.89 to 10.51 mg/L with a mean of 2.93 mg/L, causing dental, skeletal, and other fluorosis. Children and teenagers are reported to be more susceptible to fluoride poisoning than adults.[14] People from Jamda village of Laxmisagar Gram Panchayat are observed to be highly affected by fluoride where highest level of fluoride contamination is reported to be 11.51mg/ L in drinking water. There is no other option available in Jamda village except using ground water as drinking purpose. People of that village are reported to be affected with skeletal, non-skeletal and dental fluorosis. People are also found to be affected with body weakness and muscle-nervous fluorosis from this locality.[8] Ground water fluoride concentration study also done in 18 selected villages of Simlapal block and 58% of water samples were recorded to have fluoride concentration exceed the WHO permissible limit of 1.5 mg/L.[15] In four Gram Panchayats (Laxmisagar, Simlapal, Harmasra and Machatora) 159 primary school students were examined and prevalences of dental caries, dental fluorosis and skeletal fluorosis among students were recorded to be 32.7%, 72.3% and 11.3% respectively.[16] Studies also suggested that chance of Hypothyroidism was found to be higher in proportion in endemic Simlapal block regions (34%) with respect to non-endemic regions (20%) of Bankura district.[17] Another study from Laxmisagar Grampanchayat reported that fluorosis level in drinking water was not the single most factors for determining the fluorosis. May be nutrition plays the important role to reduce the fluoride level from the human body.[9] Chhatna block lies between latitude 23°18′06″ North and longitude 86°58′58″ East, covering an area of 447.47 square kilometres. Studies shows that children are at high risk of developing dental fluorosis due consumption of fluoride contaminated drinking water, rice, pulses and vegetables.[11]

Raipur And Hirbandh:

Raipur lies between latitude 22°48′ North and longitude 86°57′ East, covering an area of 364.40 square kilometres. Hirbandh lies between latitude 23°03′48″ North and longitude 86°48′08″ East, covering an area of 215.60 square kilometres. Studies shows the bioaccumulation level in rice, pulses, and vegetables through fluoride contaminated soil and irrigation water in Raipur and Hirbandh area. Children living in the study area are at high risk of developing dental fluorosis due to the consumption of fluoride-contaminated rice, pulses, and vegetables in addition to fluoride contaminated drinking water.[11] In another study shows that hand pumps of study areas of Ranibundh block need immediate attention as their water is contaminated with fluoride above the WHO permissible limit.[18]

Saltora And Indpur:

Saltora lies between latitude 23.5333° North and longitude 86.9333° East, covering an area of 312.62 square kilometres. Indpur lies between latitude 23.1667° North and longitude 86.9333° East, covering an area of 300.20 square kilometres. As explained earlier, children living in the study area of both of the districts are at high risk of developing dental fluorosis due to the consumption of fluoride contaminated drinking water in addition to fluoride-contaminated rice, pulses, and vegetables.[11]

Khatra And Sarenga:

Khatra lies between latitude 22°59′ North and longitude 86°51′ East, covering an area of 232.40 square kilometres. Sarenga lies between latitude 22°46′ North and longitude 87°02′ East, covering an area of 228.07 square kilometres. Study was conducted in fluoride affected area of Khatra and Sarenga block area to assess the potential health risk from fluoride exposure among children, teenagers, and adults due to consumption of rice, pulses, and vegetables in addition to drinking water. The estimated hazard index (HI) for children showed that children living in these blocks are at high risk of developing dental fluorosis due to the consumption of fluoride contaminated drinking water in addition to fluoride-contaminated rice, pulses, and vegetables.[11]

CONCLUSION:

The review gives us a present scenario of ground water fluoride contamination level of entire Bankura district. Ten blocks out of twenty two blocks are found to have ground water fluoride contamination level above the WHO permissible limit. Environmental factors like fluoride bearing rocks, abundance of fluorine rich minerals and semi-arid climate mainly regulate the ground water fluoride contamination level in the terrain. Fluorine rich phosphate fertilizer and pesticides also regulate the ground water fluoride contamination level through leaching. Regular consumption of fluoride contaminated water may cause dental and skeletal fluorosis. Children from fluoride contaminated area also found to have low IQ (Intelligent Quotient) level in some cases. Sustainable alternative drinking water resources are required in developmental blocks where ground water fluoride concentration levels are above the WHO permissible limit. Alternative irrigation water resources like rain water harvesting like initiatives are required to minimise the probability of fluorosis due to consumption of fluoride bio-accumulated food grains and leafy vegetables.

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