Eco. Env. & Cons. 28 (May Suppl. Issue) : 2022; pp. (S548-S550)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03s.080

Excess of Fluoride and Nitrate in Ground Water of Rajasthan - Their Health Hazards and Remedial Methods

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(Received 25 January, 2022; Accepted 7 March, 2022)

ABSTRACT

Surface water resources in Rajasthan are not abundant so people are dependent on ground water for their needs. Alarmingly excessive pollutants especially fluoride and nitrate in ground water in various districts of the state is a matter of concern as the increased concentration of fluoride and nitrates is causing harmful effects on health. Permissible limit of fluoride and nitrate in ground water is 1.5 ppm and 45 ppm respectively. Excess of fluoride causes severe bone and teeth problems and excess of nitrates causes blue baby disease in infants. Jalore, Jaipur, Ajmer, Nagaur, Pali, Jodhpur and Sirohi are severely affected districts by fluoride contamination. Barmer, Churu, Jaisalmer, Ajmer, Alwar, Banswara, Bhilwara, Bikaner, Bundi, Dhaulpur, Dungarpur, Jaipur, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajsamand, Sikar, Tonk are the districts with high concentration of nitrate in the ground water. Various chemical treatment methods have been discussed for the removal of fluoride and nitrates from ground water in the paper but the upmost requirement is to make people aware to minimise those practices that make the water more contaminated of these pollutants.

Key words *: Fluoride, Nitrate, Blue baby.*

Introduction

Among all the necessary life support systems, water is the most important substance on earth. Without water, there is no existence of flora and fauna as well as animal life. Over seventy percent of the earth's surface is covered in water. But of that water, just one percent is readily available for the human use, and of that one percent, ninety nine percent of it is stored beneath the earth as groundwater. Ground water is the major source for fulfilling most of the needs of animal and plants such as drinking, irrigation, washing etc.Ground water also helps to recharge lakes and rivers. Unfortunately, groundwater is highly susceptible to pollutants. Man-made products such as gasoline, oil, road, salts and chemicals, mining activities are some of the causes that make ground water unsafe and unfit for use. Rajasthan is the state having acute shortage of water.It has very few surface water resources. Most of the water needs (specially drinking) are fulfilled by ground water only. But ground water in most of the districts in the state is contaminated by high concentration of fluoride and nitrate.

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Sources and Health Hazards

According toa report of Union Drinking Water and Sanitation Ministry, Rajasthan has the highest number of habitations where groundwater contains fluoride. One of the reasons of high concentration of fluoride in water in Rajasthan is that the state has a rocky belt extended from Delhi to Gujarat; Rajasthan has mica mines, where the ground water is rich in uoride.

Excess intake of fluoride displaces hydroxide ions from hydroxyapatite, $Ca_5(PO_4)_3OH$, which is the principal mineral constituent of teeth(in particular enamel) and bones, to form the harder and tougher compound uoroapatite,$Ca_5(PO_4)_3F$. Upto some extent this strengthens the enamel, uoro apatite makes the teeth and (after prolonged exposure) the bones denser harder and more brittle. Consumption of water having excess fluoride over a prolonged period leads to a chronicailment known as fluorosis. Dental fluorosis is also called "mottled enamel". In this, loss of shining and development of horizontal yellow streaks on teeth takes place. Apart from teeth fluoride levels exceeding 3 mg/l cause skeletal fluorosis in both adults and children. Typical symptoms of skeletal fluorosis are pain in the joints and backbone. In severe cases this can result in crippling in the patient.Certain non-skeletal health impacts such as gastro-intestinal problems, allergies, and anaemia and urinary tract problems can also be due to excess fluoride intake.

The occurrence of high uoride content in groundwater has now become one of the most important health related geo-environmental issues in the state.Among all the districts, worst affected are Nagaur, Jaipur, Sikar, Jodhpur, Barmer, Ajmer, Sirohi, Jhunjhunu, Churu, Bikaner, Ganganagar, Tonk etc. The minimum value of fluoride has been observed as 0.0 mg/L at Baroda Meo in Alwar district and the maximum value of 9.32 mg/L has been observed at Hasanpura of Alwar district.

Like fluoride, nitrate is another pollutant, concentrations of which in ground water bodies in Rajasthan are increasing alarmingly. Common sources of nitrate include fertilizers and manure, animal feedlots, municipal wastewater and sludge, septic systems, and nitrogen fixation from atmosphere by legumes, bacteria and lightning. It is highly soluble in water and do not bind to soils, so it has a high potential to migrate to ground water.

Presence of nitrate in high concentration in drinking water causes blue baby syndrome or methemoglobinemia. Methemoglobinemia is characterized by reduced ability of blood to carry oxygen because of reduced levels of normal haemoglobin. In the body nitrates are converted to nitrites. These nitrites react to haemoglobin in the red blood corpuscles (RBCs) to form methaemoglobin, affecting the body's ability to carry enough oxygen to the cells. High nitrate concentration in drinking water not only poses threat to human and animal health but may causeeutrophication of aquatic systems threatening fish, biodiversity, and aesthetics.

The most affected districts having nitrate (>45 mg/l) are Ajmer, Alwar, Banswara, Baran, Barmer, Bhilwara, Bikaner, Bundi, Chittaurgarh, Dhaulpur, Dungarpur, Hanumangarh, Jaipur, Jaisalmer, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sikar, SawaiMadhopur, Sirohi, Tonk, Udaipur..The minimum value of nitrate in Rajasthan has been observed as 0.0 mg/L in Dausa, Jalore, Ganganagar, Churu, Pali, Bundi and Bharatpur districts. The maximum value of nitrate as 1250 mg/l has been observed at Nangli of Churudistrict.

Remedial Methods

According to World Health Organisation, 1.5 mg/1 is the maximum permissible level of fluoride in drinking waters. However, climatic conditions, volume of water intake, diet and other factors should also be taken in to consideration in setting national standards for fluoride.

There can be two options to control fluoride concentration in ground water. First is to search for alternative water source nearby having low or permissible concentration of fluoride.These include, provision of a new and alternate source of water with acceptable fluoride levels, transporting water from a distant source, blending high fluoride with low fluoride water, dual water sources, rainwater harvesting etc.

But, when above options are not feasible, de-fluoridation of drinking water is the second option to be practised. It can be done either by the central treatment of water at the source or the treatment of water at the point of use that is, at the household level. First option of de-fluoridation carried out on a large scale under the supervision of skilled persons is quite expensiveso it is not feasible in less developed state like Rajasthan. Second option i.e. treatment of

water at the point of use is cost effective as de-fluoridation done according to the demand for cooking and drinking – usually less than 25% of the total water demand. This treatment can be done simply by adding different chemicals to the water that is to be made free from fluoride. For example Nalgonda technique involves adding lime (5% of alum), bleaching powder (optional) and alum ($Al_2(SO_4)_3.18H_2O$) in sequence to the water, followed by coagulation, sedimentation and filtration. In Contact Precipitation technique of de-fluoridation, fluoride is removed from water through the addition of calcium and phosphate compounds. Precipitation of fluoride takes place as CaF_2, and/or fluorapatite in the presence of a saturated bone charcoal medium act as a catalyst. Adsorption/ion-exchange method can be another good option for de-fluoridation.In this method raw water is passed through a bed containing de-fluoridating material or adsorbent that retains fluoride either by physical, chemical or ion exchange mechanisms.

For nitrate and nitrites removal from potable water, the best available technologies as determined by the Environment Protection Agency are ion exchange and reverse osmosis (RO). Ion exchange removes nitrate ions from the aqueous phase by passing contaminated water through a bed of ion exchange resin. As contaminated water is passed through the resin, contaminant ions are exchanged for other ions, mostly by chlorideion in the resin. In **reverse osmosis (RO)**,a selective semi-permeable membrane is used to remove various inorganic components from the water.A relatively new technology offering, naturally occurring bacteria in most groundwater areused for denitrification (i.e. remove nitrates) and release the nitrogen as a gas.

Conclusion

Fluoride and nitrate in groundwater is a potential problem to human society. Contamination of water by these pollutants is mostly due to man made activities. It is advisable to check those activities which are causing high pollution in water by these contaminants. Ground water should be used judiciously without harming its natural characteristics. People should be made more aware about the problems regarding water pollution, especially in rural area. Remedial techniques that are cheaper, easy to handle, eco-friendly be introduced by government agencies to the people.

References

Agarwal, R. Nitrate Contamination in Ground Water of Jaipur District, Rajasthan, India: It's Impact on Human Health, International Journal of Scientific Engineering and Research (IJSER), 2015.

Agrawal, R., Nitrate contamination in ground water samples of Gangapurcity town (Sawai Madhopur District) Rajasthan, *Journal of Chemical, Biological and Physical sciences,* Nov.2011-Jan. 2012: 2, .1, 511-513.

Archna, A. et al, Nitrate Removal from Ground Water: A Review. *E-Journal of Chemistry.* 9(4) April 2012

Bailey K. et al. 1999, *Fluoride in Drinking Water.* Geneva, Switzerland, World Health Organization.

Cummins, B.T. 1985. *Controlling fluoride levels: a literature review.* Geneva, Switzerland, World Health Organization.

De. A.K., *Environmental Chemistry,* 4th Edition, New Age International Publishers(P) Ltd., New Delhi,

Groundwater report rings fluoride alarm in Rajasthan-Hindustan times

Guidelines for Drinking-water Quality IV Addition (World Health Organisation)

harma, P.K. 2015. Characterization of groundwater quality of Tonk District, Rajasthan, India using factor analysis. *International Journal of Environmental Sciences*. 6(4).

Ranjana Agrawal, Contamination of Nitrate in ground water samples of Sawai Madhopur town Rajasthan. *International Journal of Green and Herbal Chemistry* (Available online at www.ijghc.com) 2(1): 60-64, Feb.2013.

Ranjana Agrawal, Fluoride contamination in ground water samples and its effect on human body in Gangapurcity town (Sawai Madhopur District) Rajasthan. *Journal of Chemical, Biological and Physical Sciences.* Feb. 2012-Apr.. 2012 . 2: (2), 1051-1053