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A Study on Fluoride Remediation by Nanomaterial.

[1]Amit Kumar Agarwal, [2]Beenesh Kumar and [3]Anshul Agarwal
[1,2]Department of Chemistry, Agra College, Agra
[3]Department of Applied Science (Chemistry), FET, Agra College, Agra

Abstract: *Fluorine, as one of the trace element in drinking water, has an important influence on growth, bone metabolism, and other facts of human health. Long term utilization of high fluorine water can lead to endemic fluorosis, including dental and skeletal fluorosis. So, it is very important to remove excess fluoride from drinking water to maintain the optimum concentration of fluoride. At present, no effective technology is available in the market.*

Now, scientists are tending towards Nano-scale materials (1nm to 100 nm in size) since their properties are different from those of macro and micro-particles due to their broad surface area. Our paper review with an innovative, efficient and cost- effective technique for remediation of fluoride from water using nanomaterial. The development of cost-effective, locally available and environmentally friendly adsorbents for fluoride removal from contaminated water sources is absolutely required. It can be possible by nanomaterial.

Key Words: *Nanomaterial, fluoride, remediation, health problem and efficient technology.*

I. Introduction:

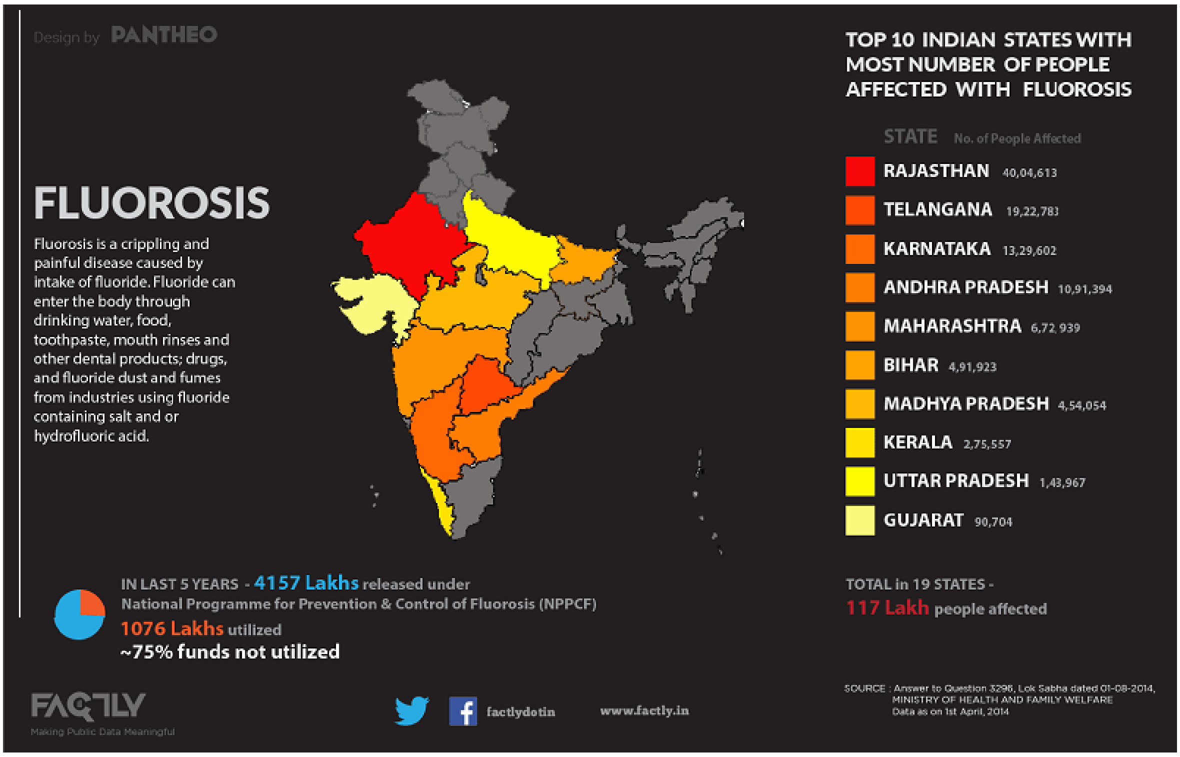
Humans rely on groundwater not only as a source of drinking water but also for various agricultural, industrial, and recreational uses. Groundwater constitutes 97% of total global freshwater, and in many regions constitutes the single largest available supply of fresh drinking water [1]. With the advent of industrialization and modern agriculture, there is pressure on groundwater in terms of both quality and availability. Of the various point and non point pollutants in groundwater, fluoride is one of concern, as this element has far-reaching impact on human health. Fluoride is one of the elements necessary for human life. Deficiency or excess of fluoride in the environment is closely associated with human health outcomes [2]. Fluoride when consumed at less than 0.5 mg/L produces adverse health effects including dental caries , lack of formation of dental enamel, and deficiency of mineralization of bones, especially in children, whereas excessive intake of fluoride (>1mg/L) may lead to loss of calcium from tooth matrix, aggravating cavity formation and dental fluorosis induction [3].

In various provinces in developing countries e.g. India, the groundwater is rich in halide and the provisions of different installations are tough. Treatment of contaminated water is the sole choice to offer safe drinking water. India has concerning seventieth rural and quite twenty to half-hour of urban population in several states, depends on spring water for its domestic demand. High concentrations of fluoride ions in water render it unfit for drinking. Fluoride ions are a vital part of drinking water however at a higher concentration i.e. around 1.5 mg/L might cause harmful effects on human health. Its contamination in water has been recognized as a worldwide downside and its concentration in drinking water at several places of the planet exceeds the permissible limits [4]. Interference of halide with carbohydrates, lipids, proteins, vitamins and mineral metabolism is reported to be attributable to the presence of high concentrations of it in water and intake of higher quantities of fluoride has been reported to result in dental and skeletal pathology [5]. The Bureau of Indian Standard (BIS) suggested a fascinating limit of one milligram per liter of it in drinking water, which may be extended to 1.5 mg/L as permissible limit, if no totally different supply of drinking water is accessible [6]. Various technologies like sorption, natural process, precipitation, electro-dialysis and reverse diffusion are used for the removal of halides mostly fluoride ions from water[7,8,9,10,11].

Literature reports a wide variety of methods for the trace level determination of fluoride. Various methods available for the determination of fluoride are, high-performance liquid chromatography with hydride generation-atomic fluorescence spectrometry (HPLC-AFS)[12] , non-chromatographic hydride generation-atomic fluorescence spectrometry[13], electro-thermal atomic absorption spectrometry (AAS)[14] high-resolution continuum source graphite furnace atomic absorption spectrometry[15], high performance liquid chromatography-inductively coupled plasma-mass (ICP) spectrometry[16,17] etc. Although, that methods are more time consuming, very costly and difficult.

Electro-analytical methods[18,19,20,21,22] on the other hand, offer the advantages of low-cost, ease in sample handling, and above all, extremely high sensitivity and are thus the methods of choice for the detection and trace-level determination of fluoride. Chemically modified electrodes (CMEs) have been employed widely in the trace level determination of both metal_ions[23,24,] as well as organic molecules [25,26]. CMEs in the form of carbon paste electrodes (CPEs) have been extensively used due to their wide anodic potential range, low residual current, ease of fabrication, easy surface renewal, and low cost. Plain carbon paste electrode (PCPE) has been modified employing various modifiers, viz., nanomaterials[27,28], surfactants [29], copper complexes[30,31], macrocycles[32,33], etc. Glassy carbon electrodes (GCEs) are very versatile as electrode materials for trace level determination of organic molecules as they provide high sensitivity, negligible porosity, and good mechanical rigidity. GCEs have been modified by means of various modifiers viz., chitosan, nanomaterial's, etc.[34,35,36].

In many respects water is only useful for human beings but also useful for industrial and agricultural purpose. But at present due to the increasing level of pollution water is become unsafe for use. For this region there is a need to focus on the long term impact of water resources keeping in mind all the related problems in India, fluoride is a molar element found in ground water. Here the nanotechnology methods for the removal of fluoride has been studies.



II. Need and Consequences of higher Fluoride

Literature reported that fluoride in a minute quantity is an extremely crucial part for normal mineralization of bones and formation of dental enamel. Although, its high intake might lead to slow, progressive crippling scourge referred to as pathology. The square measure quite 20 developed and developing nations that square measure endemic for pathology. The square measure Argentina, U.S.A., Morocco, Algeria, Libya, Egypt, Jordan, Turkey, Iran, Iraq, Kenya, Tanzania, S. Africa, China, Australia, New Zealand, Japan, Thailand, Canada, Saudi Arabia, gulf, Sri Lanka, Syria, India, etc[37].

As per literature available on India, it was 1st detected in Nellore district of Andhra Pradesh in 1937. Since then, research has been exhaustively carried out on different parts of Asian nations to explore halide laden water sources and their impacts on humans in addition to animals[38,39]. At present, it has been calculable that pathology is rife in seventeen states of India.

Need for remediation

Fluoride ion concentration in drinking water because of natural and phylogenesis activities has been recognized as the foremost issue worldwide imposing a significant threat to living being's health. Fluorine is an extremely negative aspect and has an extraordinary tendency to induce attraction by charged ions like metallic elements. Therefore the impact of halide on mineralized tissues like bone and teeth resulting in organic process alternations is of clinical significance as they need the highest quantity of metallic element and can attract the utmost quantity of halide that gets deposited as calcium-fluorapatite crystals. Solid body substance consists chiefly of crystalline hydroxyl apatite. For underneath traditional conditions, once halide is present in water system, most of the eaten halide ions get incorporated into the mineral lattice of metal tissue enamel throughout its formation. The particle gets substituted by halide ion since apatite is more stable than hydroxyl apatite. Thus, an outsized quantity of halide gets certain in these tissues and solely a tiny low quantity is excreted through sweat, piss and stool. The intensity of pathology is not just obsessed with the halide content in water, however conjointly on the halide from different sources, physical activity and dietary habits[40].

Health Impact- Fluoride can be a double-edged sword owing to both its beneficial and harmful impacts on human body. Fluoride is thought to reduce tooth decay although there are several controversial facts regarding the relationship between the level of fluoride and tooth decay. Research regarding the impact of fluoride on tooth decay suggests three ways of how fluoride mitigates the process of tooth decay. Development of the chemical structure of the enamel at the development stage, making the enamel more resistant to acid attacks, and enhancement of remineralization with an improved quality of crystals are the three proposed ways [41]. Some studies suggest that dental caries reduction is improved in the studied area after the fluoridation. Consuming the recommended level is very important in this scenario. Up to a certain level, fluorides in drinking water replace hydroxide ion from hydroxyapetite, the main constituent of teeth, and strengthen teeth and bones. However, some authors claim there is no significant effect of fluoride ingestion on preventing tooth decay [42, 43]. Long-time exposure and high dosage of fluoride makes the enamel and bones so hard and brittle rather than making it strong. Earlier stage can be visible as white spots on teeth and known as dental fluorosis where it spread further into the skeletal system which is known as skeletal fluorosis [44]. Strengthening of the bone structure is influenced by the interface of collagen and the bone surface. During the long term exposure, the exchange between fluoride and hydroxyapetite becomes perpetual and irreversible reaction is prohibited, is triggers the synthesis of bone material, and ostesclerosis (hardening and classifying of bones) is induced. Many of the mechanical properties as bone matrix proteins and mineral-organic interfacial bonding are affected. Tensile strength of the bone decreases. It is widely accepted that fluoride causes fetal chronic kidney diseasessince fluoride excretion takes place in the kidney. Sri Lanka is no exception which is suggested by its high percentage of prevalence of chronic kidney disease of unknown etiology (CKDu), especially in North Central Province which is reported to contain the highest level of fluoride. The study of Illeperuma et al. [45] attributed the ingestion of high amount of fluoride into the human body to using low-quality aluminum vessels in cooking. Leaching of heavy metals as aluminum and lead happens in high-fluoride containing water and complexation of fluoride with metals amplifies the entry of toxins into the body. However, some studies revealed no significant correlation between fluoride and CKDu [46,47,48].

III. Current remediation method and technologies

In India, more than 7 million children and about 63 million people are estimated to suffer serious problems from drinking fluoride contaminated water. According to Indian Standard IS10500 for drinking water, the highest permissible concentration of fluoride in drinking water is 1 mg/L. (PPM) is. The currently existing methods of treatment of fluoride are based on activated alumina, tap-blowing process (alum) and electrolytic defluoridation. These methods require the presence of residual aluminum and electricity. To overcome these difficulties, we can use these methods to reduce the concentration of fluoride from a high level of about 20 mg/l (PPM) to a safe level of 1 (PPM). The quality of this treated water is well below the drinking water limit prescribed by IS10500. This technology is bumpy and the pH of the water. And TDS works very well regardless. Its product is made by sodium fluoride and it can be used in the treatment of tooth cavity and medicine. The low cost of fluoride removal by nanotechnology method and will be very suitable for operation in village level areas, as this method does not require electricity.

IV. Nano technology

Nanotechnology is a means of the near future to produce new structures, devices and materials. Such as energy, consumer products, technology helps in scientific progress in many fields such as medicine, construction and materials. The length of nanomaterial is between 1 and 100 nanometers. Nanotechnology assists in the engineering, design of systems and equipment. It thus begins to exhibit unique properties and materials that influence chemical, physical and biological behaviors. The health risks associated with the use and manufacture of nanomaterial are not yet clearly understood. Research work is going on to understand this.

V. Conclusion

In India, water contaminated with fluoride is causing health problems. We have studied different techniques in this review article, how to solve the problems of high concentration of fluoride ions in drinking water. Almost every state in India is affected by the problem of fluoride. Through our research, by using such technology, we will be able to provide fluoride free water to the society at a low cost, so that our society can get maximum benefit.

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