ABSTRACT

Groundwater is the principal source accounting for nearly 85% of rural drinking water supply in the country. At the same time, rural water supply sector as such uses only around 5% of the annual replenishable groundwater recharge. In spite of that, sustainability of the source is adversely affected by a number of factors including competing demands from the irrigation sector which utilises nearly 85% of the annual groundwater recharge. The favourable attributes of groundwater coupled with lack of any effective institutional mechanism for its regulated development, have resulted in over-exploitation, leading to certain undesirable situations like groundwater depletion and pollution. As a result there are two major issues involved in water supply namely (i) the sustainability of the sources and (ii) deteriorating water quality.

Provision of safe drinking water for all is the goal that is still to be achieved in India. Safe potable water is no longer a 'God given gift' in a modern industrial world. Rural ground water in most places is not potable. Drinking water must be free from organisms and concentrations of chemical substances that may be hazardous to health. Coolness, absence of turbidity, absence of colour and disagreeable taste or smell are the most important qualities of drinking water.
The natural quality of water depends on the conditions in the catchment area, especially its geology. To adhere to the drinking water regulations, resources are carefully selected not only to ensure supply of adequate quantity of water throughout the year, but also to ensure consistency of the quality of water.

Among the various contaminants in groundwater, fluoride is the principal and most hazardous one. Fluoride ion in drinking water may be beneficial or may have an adverse impact on the health of human beings and animals depending on its concentration level and total consumption. Fluoride enters into the body through various routes viz., water, air, food, medicines and cosmetics. Although 80% of fluoride entry into the human body is through drinking water containing excess concentration of this contaminant, its entry through the other sources mentioned above has yet not been studied in detail in India.

Dissolution of fluoride containing rock minerals introduces fluoride into the ground water. Effluents from fertilisers, aluminium and glass industries increase the fluoride ion concentration in the soil. Long term ingestion of fluoride beyond the permissible limit of 1.5 mg/l can cause dental and skeletal fluorosis. The natural concentration of fluoride ion in groundwater depends on a number of factors viz., geological, chemical and physical characteristics of the water supplying area, consistency of soil, porosity of rocks, temperature, rainfall, vegetation, oxidation - reduction reaction, amount of soluble or insoluble fluoride in rock, nature and composition of soil, pH, depth of water table etc.
Among the various techniques available for defluoridation, adsorption over activated carbon is simple, economical and does not involve any complicated equipment. The adsorbents like activated alumina, activated carbon, activated bauxite, rare earth oxides, alum sludge, fish and animal bone charcoal have been studied for the adsorption of fluoride from aqueous solution. Commercially available activated carbon derived from natural materials like coal, wood and coconut shell possesses high surface area but is expensive. This has necessitated the production of low cost activated carbon from readily available cheaper source materials. Hence it was decided to make use of the discarded agricultural solid waste materials. Further there will not be shortage of these materials at any point of time. In the present study, cheaper source materials like palm seed coat, rubber seed coat, cashewnut sheath, palm tree flower, myrobalan waste, pongam seed coat, pinnaie seed coat and casuarina seed were identified for the preparation of activated carbon employing processes like acid, carbonate, chloride, dolomite, pyrolysis and sulphate.

Characterisation study and preliminary batch tests helped to identify the carbons suitable for the removal of fluoride. The acid and dolomite varieties exhibited better adsorption with impregnation of 2% aluminium sulphate solution.

Adsorption experiments were carried out by batch shaking and continuous flow column experiments. The performance of the carbons were studied by varying the pH, carbon dose, contact time and desorbing agents. Adsorption isotherms like Freundlich and Langmuir were tested and the
rate of the adsorption process was identified with kinetic studies. The exact adsorption capacity of each carbon was determined by an extensive continuous flow operation. The continuous flow operation was carried out by varying the flow rate of influent, the particle size of the carbon, the bed height of the carbon, the initial concentration of fluoride and the quantity of regenerant. The effect of common anions on the adsorption capacity was also studied. A domestic defluoridation filter was fabricated and operated with fluoride rich water. This filtration process proved to be easy to operate.

The important objective of the present study is to identify various low cost materials for the preparation of activated carbon in order to replace the expensive commercially activated carbon. The materials like palm seed coat, rubber seed coat, cashew nut sheath, palm tree flower, myrobalan waste, pongam seed coat, pinnaiie seed coat and casuarina seed are identified as potential alternatives. The study comprises the preparation, characterisation and removal of fluoride by batch as well as continuous flow methods. The various controlling factors and the efficient functioning of the domestic filter for fluoride removal also form a part of the investigation. The efficiency of the prepared carbons was compared with that of the commercial activated carbon for the removal of fluoride.