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Arsenic removal kit

Arsenic in drinking water is a severe problem in West Bengal. People from nine districts, namely Malda, Murshidabad, Nadia, 24-Paraganas (North), 24-Paraganas (South), Burdwan, Hoogly, Howra and Kolkata, are highly affected due to arsenic poisoning. The area and population of the nine districts of West Bengal are 38,865 km^2 and 42.7 million, respectively[1].

Arsenic removal from drinking water using alum (90% removal), iron salt (90% removal), iron filings (90% removal), activated alumina metal oxide (90% removal) and bucket or tea-bag method (80–90% removal) has been described by several workers[2–4]. There are other methods like precipitation and conventional filtration (cloth, sand, charcoal, etc.), but their performance is not satisfactory (70–80% removal)[2]. Some arsenic-removal systems like ion exchange, membrane filtration, reverse osmosis and nanofiltration have been reported[2–4]. There is a report on arsenic removal from soil using *Pteris vittata* (brake fern)[5].

To solve the problem of arsenic in drinking water, the author has prepared an arsenic removal kit (Trade name 'Arsenil') which can reduce the concentration of arsenic from 1 to 0.02 mg/l. (Maximum permissible limit of arsenic in drinking water is 0.05 mg/l, according to the Bureau of Indian Standards.) The removal of arsenic is 98%. The kit is in the form of a pouch containing a chemical composition prepared using charcoal, bentonite powder, sodium chloride, ferrous sulphate and potassium permanganate.

For removal of arsenic, the contents of the pouch were mixed with 3 l of arsenic contaminated water (1 mg/l) in a plastic bucket. The water was collected from Chakda, Nadia district, West Bengal. By stirring vigorously with a wooden stick, the powder was mixed well and allowed to stay for 20 min. The treated water was filtered through a sand filtration bed. (In a plastic funnel of 6 inches diameter, a piece of clean cotton cloth was placed and upon this, a sand bed of 2 inches thickness was prepared using clean reddish sand (0.5–1.0 mm). Clean water was passed through this bed and this was used to filter the treated water (Figure 1 *a–c*).) The arsenic concentration of the filtered water was 0.02 mg/l, i.e. removal of arsenic was 98% and the water was of potable quality (Table 1). Analysis of the filtered water was done according to the method of the American Public Health Association[6]. After the use of seven pouches, the sand bed has to be changed. The efficiency of the kit regarding arsenic-removal was verified by the Environmental Engineering Department, Jadavpur University.

In a plastic bucket (13 inches height and 11 inches diameter), ten small pores (1 cm diameter) were created at the bottom. Inside this, the soil was filled up to a height of 6 inches. The bucket containing the soil was placed in a plastic vat (18 inches diameter and 6 inches height). The sludge containing arsenic was disposed to the soil. Three litres of distilled water was poured on the sludge, passed through the soil and collected in the vat. This water contained arsenic with a concentration of 0.022 mg/l, which was below the maximum permissible limit (0.05 mg/l). This process can be applied in another way. For this, a restricted area has to be selected for sludge disposal. After disposal, a common brake fern *P. vittata* is planted in the soil. This plant absorbs arsenic from the soil[5] (Figure 1 *d*, *e*).

The arsenic removal kit is completely non-toxic. Bentonite powder, sodium chloride and ferrous sulphate[7,8] used in the kit are generally used in the formulation of medicines. Potassium permanganate is widely used for the purification of drinking water. The test of toxicity[9] was

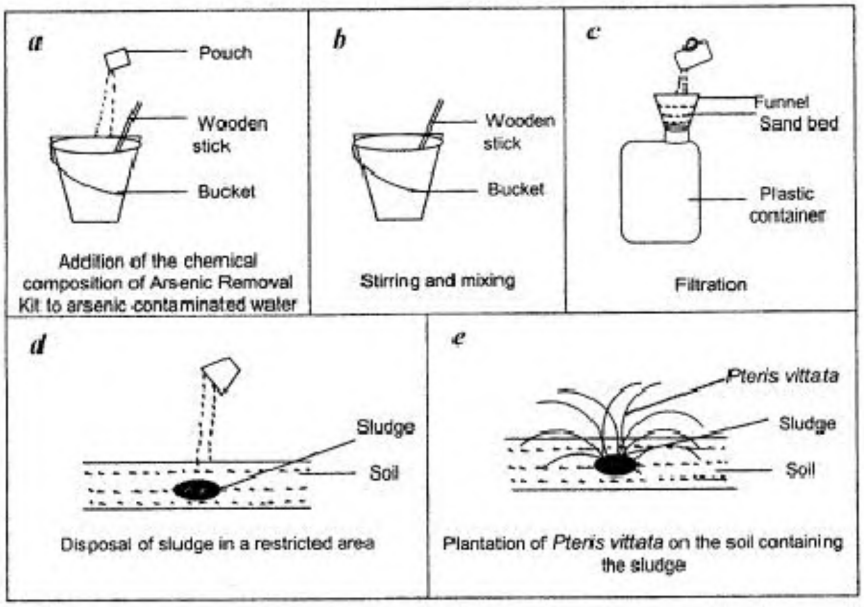

Figure 1. Process of application of Arsenic Removal Kit and disposal of sludge.

Table 1. Test parameters of filtered water

Parameter	Result	Limit (IS 10500: 1991)
Odour	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable
pH	7.05	6.5–8.5
Arsenic (as As)	0.02 mg/l	0.05 mg/l
Chloride (as Cl)	8.15 mg/l	250 mg/l
Iron (as Fe)	0.1 mg/l	0.3 mg/l
Residual chlorine	Not traceable	0.2 mg/l
Sulphate (as SO_4)	5.74 mg/l	200 mg/l
Silica (as SiO_2)	Not traceable	–
Manganese (as Mn)	Not traceable	0.1 mg/l
Aluminium (as Al)	Not traceable	0.03 mg/l
Calcium (as Ca)	4.6 mg/l	75 mg/l
Sodium (as Na)	4.0 mg/l	–
Potassium (as K)	1.55 mg/l	–
Coliform organism per 100 ml	Nil	10
Toxicity	Nil	–

carried out on mice (dose per mice was 1.0 ml daily; number of mice used was 5 per group; weight of mice was 17–22 g and route of administration was oral). No toxic symptoms were seen during the observation period of seven days. Hence, the filtered water was completely non-toxic. The water collected from the arsenic-contaminated sludge through the soil was also non-toxic. The results were verified by Italab Pvt Ltd, Mumbai.

The kit has been developed for household use by the people of arsenic-affected areas. The advantages of the kit are:

(i) The kit is simple and cost is low (manufacturing cost of safe arsenic water is Rs 0.15/l); (ii) It is for individual use; (iii) It can be used for treatment of arsenic-contaminated water in arsenic-treatment plants; (iv) It removes arsenite and arsenate forms of arsenic; (v) It oxidizes other impurities and kills microbes; (vi) It is non-electrical; (vii) Maintenance cost is minimum; (viii) Regeneration is not required; and (ix) Investment for manufacturing of the kit is not much.

The disadvantages of other arsenic removal processes (such as ion exchange, reverse osmosis, membrane filtration, nanofiltration, etc.) are:

(i) Installation cost is high; (ii) Regeneration is required; (iii) Time-to-time maintenance is needed; (iv) High-tech operation is involved, and (v) Investment for manufacturing of these systems is high.

A survey had been done among the general public of different arsenic-affected areas of West Bengal regarding the application of the kit. The kit has been generally appreciated. This household preparation will save people from arsenic-poisoning by providing safe drinking water.

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