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Removal of Fluoride by Biochar Prepared from Natural Waste (COCOS NUCIFERA)

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Abstract: Water is life since it supports the existence of all biota. The provision of clean water has indirectly become essential to how well people live nowadays. Water, one of the most abundant and necessary elements in nature, is at risk of being highly polluted due to a variety of factors, despite the fact that it is an important component of the flora and fauna and makes up roughly 75% of the earth's crust. Ground water is frequently contaminated with fluoride. Fluorosis is brought on by the overabundance of fluoride in drinking water. The World Health Organization (WHO) guidelines state that 1.5 mg/l of fluoride is the maximum amount that should be present in drinking water. Investigated were the adsorption processes used to remove fluoride ions from ground water. The goal of this research is to create an environmentally friendly, cost-effective adsorbent for removing fluoride from ground water that can be used in rural areas of many developing nations. Fluoride elimination uses biochar made from natural waste (Cocos Nucifera). The effects of many parameters on adsorption tests, such as adsorbent dose (0.5–2 gm), starting fluoride concentration, have been revealed through batch experiments (10-50ppm). Fluoride elimination was observed using the UV Spectrophotometer.The adsorbent(coconut fiber) showed the maximum defluoridation capacity of 80%.The adsorbent(coconut shell) showed the maximum defluoridation capacity of 90%.
Keywords: Fluoride Removal , Biochar , Adsorption , waste, Adsorbent Natural

I. INTRODUCTION

The first element in the halogen family is fluorine, which is found as a diatomic (F2) gaseous molecule. It is a strong oxidizer and a pale yellow gas. It is the 13th most common element in the crust of the earth. Moissan made it known in 1886. He initially created hydrogen fluoride by reacting fluorite (CaF_2) with concentrated sulfuric acid (H_2SO_4), which was then electrolyzed to produce hydrogen fluoride. After electrolytic dissociation, fluorine gas was collected at the cathode and hydrogen gas was collected at the anode. He received the 1906 Nobel Prize in Chemistry for this work.

Water is one of the numerous natural resources that are available to us, and it is crucial for humans, animals, and plants. There are numerous contaminants that have a direct impact on human health. Fluoride is one of those contaminants that, when consumed through food and beverages, has a direct impact on a person's health. In gaseous form, fluoride is a potent electronegative element and a very strong oxidising agent. According to WHO (World Health Organization) guidelines, 1.5 mg/l of fluoride is acceptable in drinking water. Fluoride enters water through the leaching of soil into groundwater and weathering of fluoride-containing rocks and soils. Due to the breakdown of minerals and rocks like topaz, fluorite, fluorspar, cryolite, and fluorapatite, fluoride is released into groundwater. While less harmful than arsenic, fluoride is more toxic than lead. Due to its contradictory effects on teeth and bones, fluoride has an impact on people. On the one hand, fluorosis, bone brittling, curvature, and other conditions are brought on by fluoride's high concentration. Fluoride is regarded as a two-edged sword for this reason. Fluoride prevents tooth decay in modest doses but produces fluorosis in large quantities. There were numerous treatment techniques used, including coagulation/precipitation, electrochemical, electrodialysis, invert assimilation, adsorption, and ion-exchange, however it was determined that adsorption was the most effective and acceptable technique for defluoridation. Many naturally occurring, inexpensive adsorbents were investigated for the adsorption process, including clays, rice husk ash, nirmali seeds, powdered and granular red mud, and cashew nut shell carbon. The concept to produce adsorbent using agricultural wastes was inspired by their accessibility and affordability. It has been noted that the surfaces of biosorbents contain functional groups such as hydroxyl, carbonyl, amine, amide, carboxyl, sulfhydryl, imidazole, phosphonate, and phosphodiesters, which facilitate biosorption. There are inexpensive remedial procedures needed to remove fluoride from water. Adsorption has been identified as the least expensive method of removing fluoride and is hence needed. The removal of fluoride from drinking water has recently become a significant concern for human health.

Biochar is used to remove fluoride from drinking water at a minimal cost, particularly in fluoride-affected areas. The majority of adsorption experiments used natural activated carbon that had been modified by doping, impregnating, or mixing with other chemicals to enhance the surface area for greater removal effectiveness, which required a more involved process. Natural trash made of coconut can be conveniently gathered from fruit stands and local markets. With this perspective in mind, the current research was done to look into the ability of biochar made from coconut waste to remove fluoride from synthetic fluoride solution

II. MATERIAL AND METHOD

A. *Selection of Adsorbents*

There are several fluoride removal techniques that are popular around the world. However, the majority of methods have substantial operating costs and necessitate the use of highly qualified and trained personnel. As a result, we chose affordable, environmentally beneficial adsorbents made from natural waste (Cocos Nucifera)

B. *Sample Collection*

The coconut shell and fibres are gathered from the fruit stands at the neighbourhood market. Following collecting, the fibres are chopped into small pieces and the shells are broken into smaller bits. To ensure accuracy, the sample was cleaned with distilled water to get rid of any mud, garbage, etc. The material was cleaned and then dried for around 3–4 days. These naturally dried materials were baked at 70 °C for six hours before the sample was ground into powder. This ground-up powder was then put through sieves with 150, 200, and 300 µm openings.

C. *Carbonization of Samples*

After samples had dried, they were placed in a muffle furnace devoid of oxygen and heated to 500 ±20°C for one hour to create biochar. To avoid turning the sample into ash, it was stored in a muffle furnace in a silica crucible with a covering. Now that it has been made, Biochar could be used in studies

D. *Adsorbate and Experimentation*

A volumetric flask was used to create Fluoride Stock Solution by dissolving 221 mg of anhydrous sodium fluoride of AR grade in 1000 ml of deionized water. The studies were carried out in batch mode using an initial fluoride ion concentration range of 10 mg/L to 50 mg/L in the lab. In addition, plastic bottles with a capacity of 250 ml were employed for the 100 ml test solution volume, and the bottles in use were mechanically wrought at a constant rate of 120 rpm at a temperature of 30±2 °C. Fluoride elimination was seen using a UV Spectrophotometer operating at a wavelength of 570 nm.The percentage of fluoride removal (% F) and the amount of F^- adsorbed per unit weight of adsorbent at time t (qt, mg g^{-1}) and at equilibrium (qe, mg g^{-1}) were calculated using the following equation, respectively:

$$\% F = \frac{(C_o - C_e)}{C_o} \times 100$$

$$qt = \frac{(C_o - C_t)v}{m}$$

$$qe = \frac{(C_o - C_e)v}{m}$$

Where v (L) is the volume of fluoride solution, and C0 (mg L^{-1}) is the initial concentration of F. Ct (mg L^{-1}) is the concentrationof F at a given time t, Ce (mg L^{-1}) is the concentration of F^- at equilibrium and m (g) is the dry weight of the adsorbents

III. RESULTS AND DISCUSSION

A. *Effect of Contact Time*

10-50mg/L of fluoride concentration was taken into the 100 ml beaker and was added with adsorbent dose(0.5g)and were stirred at various time duration ranging from 30, 60, 90, 120 and 150 minutes. All samples once they wereremoved from the stirrer were filtered using filter paper and the filtrate was analyzed using spectrophotometer

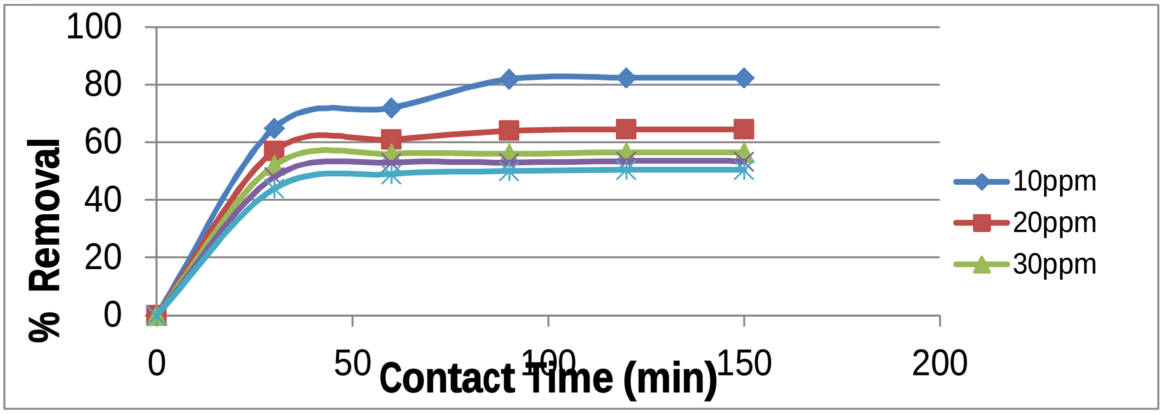

Fig.1: Effect of Contact Time on Fluoride Adsorption atAdsorbent (coconut shell) Dose= 0.5g, Concentration = 10-50mg/L

B. *Effect of Adsorbent(coconut shell) Dosage*

Batch adsorption experiment was carried out in stirrer at 30±2° C. Different adsorbent dose (0.5, 1.0, 1.5and2.0gm) was placed into separate beaker of 100ml of 10mg/L to50mg/L fluoride solution. The mixture in the beaker wassubjected to continuous stirring for the time period of 90minutes. After stirring of 1.5 hours, supernatant was filteredthrough the filter paper and the filtrate was analyzed using UV-spectrophotometer to find fluoride concentration

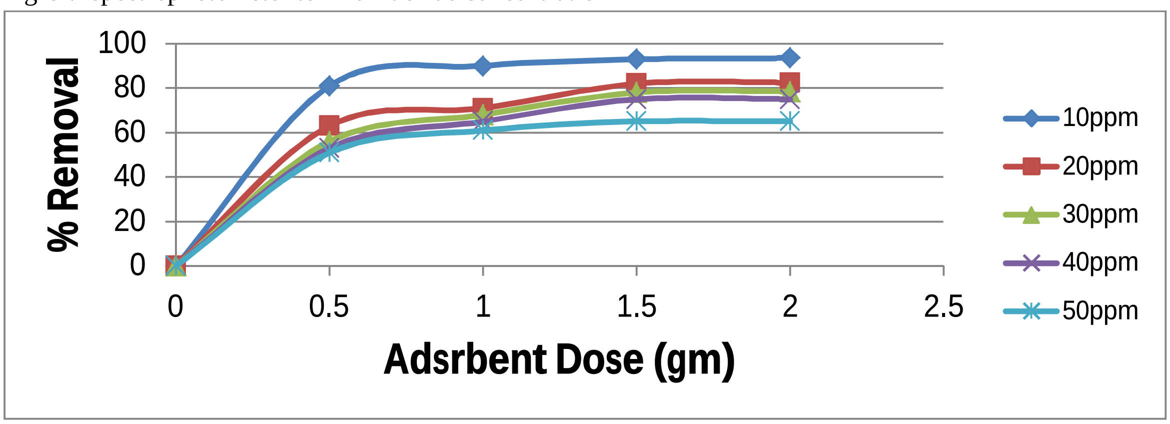

Fig.2: Effect of Adsorbent (coconut shell) Dose on Fluoride Adsorption at Contact Time =90minutes, Concentration = 10-50mg/L

C. *Effect of Adsorbent(coconut fibers) Dosage*

Batch adsorption experiment was carried out in stirrer at 30±2° C. Different adsorbent dose (0.5, 1.0, 1.5and2.0gm) was placed into separate beaker of 100ml of 10mg/L to50mg/L fluoride solution. The mixture in the beaker was subjected to continuous stirring for the time period of 90minutes. After stirring of 1.5 hours, supernatant was filtered through the filter paper and the filtrate was analyzed using UV-spectrophotometer to find fluoride concentration

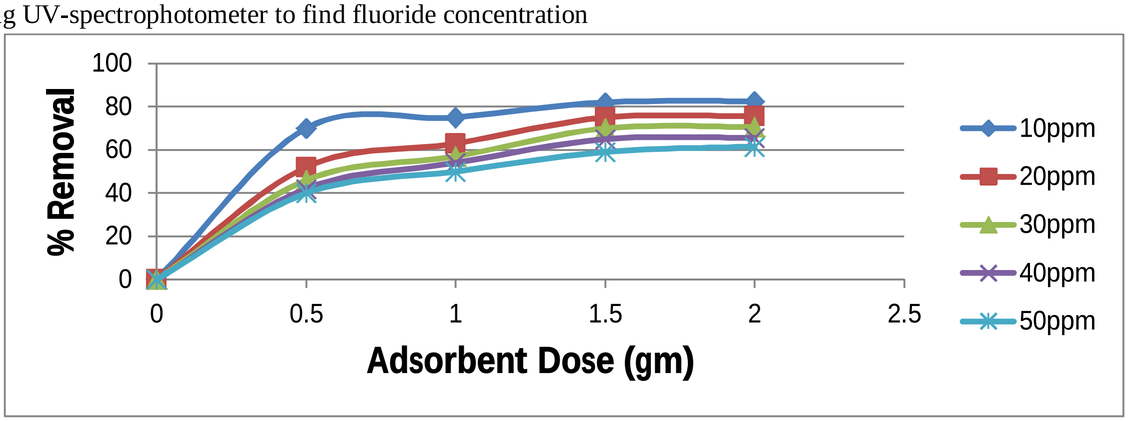

Fig.3: Effect of Adsorbent(coconut fibers) Dose on Fluoride Adsorption at Contact Time =90minutes, Concentration = 10-50mg/L

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D. Adsorption Isotherm

The equilibrium data fits Freundlich isotherm successfully.

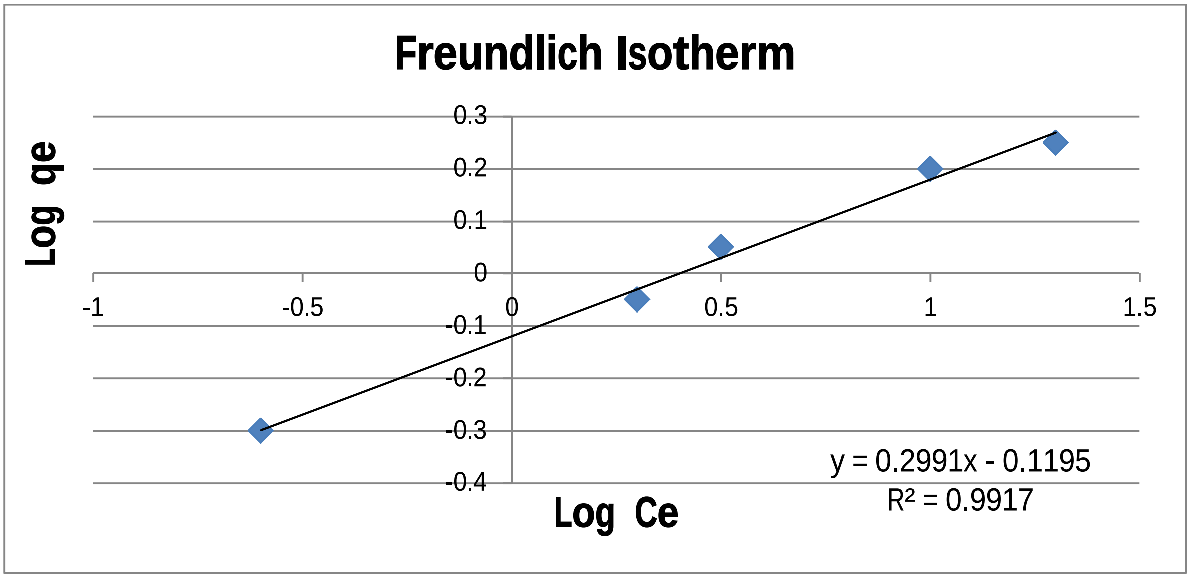

Fig4: Freundlich Isotherm

IV. CONCLUSIONS

According to the results, a natural adsorbent made from Cocos Nucifera, which is widely available, could be utilised to successfully remove fluoride at a variety of concentrations. In order to remove fluoride ions from ground water, it was discovered from the observations and the results that the adsorbent made from cocos nucifera needed to be pre-treated. The best time of contact was determined to be 90 minutes and gives maximum removal of 80% fluoride ions in case of coconut fibres and gives maximum removal of 90% fluoride ions in case of coconut shells for fluoride concentrations of 10 mg/L to 50 mg/L.

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