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Use of Fly Ash from Soybean husk and Maize Husk as an Adsorbent for Removal of Fluoride from Water

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Abstract - *The chemical formula of fluoride is F^-. Fluoride is the simplest anion of fluorine. If the range of fluoride less than standard limit then it does not developed teeth in children. Excess fluoride in drinking-water causes harmful effects on human being such as skeletal fluorosis and dental fluorosis. The fluoride-bearing minerals or fluoride-rich minerals in the rocks and soils are the cause of high fluoride content in the groundwater, which is the main source of drinking-water in India. World Health Organisation recommended range of fluoride content in drinking water (1 to 1.5 mg/l) and also Indian standards for drinking water recommended an acceptable fluoride concentration of 1.0 mg/l & an allowable fluoride concentration of 1.5 mg/l in potable water (CPHEEO, 1984). This paper evaluates the efficiency of activated carbon extracted from Soybean husk and maize husk by burning at different temperature for removal of fluoride from water. Optimization of the different parameters to be varied, to find the equilibrium values, in order to get maximum efficiency.*

Key Words: **Water, Fluoride, Soybean Husk, Fluorosis, Maize Husk, fly ash etc.**

1. INTRODUCTION

In this paper, for the removal of fluoride from water, a new low-cost adsorbent, namely, Maize husk [MH] and soybean husk [SH] activated carbon has been used. Fluorine is the chemical element represented by the symbol F and atomic number 9. At standard pressure and temperature, the permissible limit of fluoride level is generally 1 mg/l. The importance of defluorination studies have increased due to high fluoride levels in drinking-water and its impact on human health in many parts of India.

Fluorine, a fairly common element of the earth's crust, is present in the form of fluorides in a number of minerals and in many rocks. Excess fluoride in drinking-water causes harmful effects such as dental fluorosis and skeletal fluorosis. The fluoride-bearing minerals or fluoride-rich minerals in the rocks and soils are the cause of high fluoride content in the groundwater, which is the main source of drinking-water in India. Adsorption is an efficient and economically viable technology for the removal of fluoride. Recently, many naturally occurring materials such as activated carbon from plant materials, egg shell, bone-char, Tamarind seed, rice husk, limestone and some commercially available adsorbent such as Activated Alumina, calcium hydroxide [$Ca(OH)_2$], calcium chloride [$CaCl_2$], and calcium sulphate [$CaSO_4$] have been used for removal of fluoride. However, the alternative absorbents have not displayed significant fluoride removal capacities and, thus, alumina still remains a valuable material to study and pursue. Despite decades of application-based research, the underlying science and specific mechanisms behind fluoride sorption to alumina-based absorbents is still unclear.

1.1 Uses of Fluoride:

1) Beneficial Aspects:

a) Dental carries
b) Medical applications
c) Essential element
d) Glass and ceramic
e) Industries
f) Fertilizer industry
g) Anti-cariogenic agent

2) Harmful Aspects:

a) Dental fluorosis
b) Skeletal fluorosis
c) Cardio vascular effect
d) Gastro intestinal disorder
e) Development effects
f) Reproductive effects

1.2. Objectives:

The main objectives of this study are:

- To determine the efficiency of activated carbon extracted from Soybean husk and maize husk for removal of fluoride from water.
- Use of agriculture waste product for water treatment.

1.3 Instrumentation:

Spectrophotometer (model: UV 240) was used for spectrophotometric determination of fluoride at wavelength 570 nm and 10 mm cell size. Fluoride determination kit in that two reagents (F1, F2) are used. Filter paper, cuvette 3.5 ml.

Image 1. Spectrophotometer

1.4 Collection of materials:

Materials are the main constituents which are required to perform experimentation. The various materials used in this study are water, natural adsorbents (activated carbon extracted from Soybean Husk fly ash, Maize husk fly ash), zicronyl acid reagent, spands solution and reference solution. The descriptions of these materials are as below.

1.5 Activated carbon:

The maize husk and soybean husk were burn in the furnace at 400 to 500°c as shown in image 1. Uniform particle size distribution in the 1 to 80 µm range. The main components of fly ash are silica, alumina, iron oxides, calcium oxide, and residual carbon.

Image 2. Furnace

Table: -1 Constituent of Fly ash (%)

Constituent	Fly ash (%)
So_3	1.45
Cl	3.36
Cao	6.90
K_2o	25.52
Sio_2	40.16

2. METHODOLOGY

a) To determine pH on fluoride removal.
b) To determine contact time for fluoride removal.
c) To determine Adsorbent dose for fluoride removal.
d) To determine stirring rate for fluoride removal.

a) To determine pH on fluoride removal.
The range of pH between 0 to 7 acidic in nature and 7 to 14 basics in nature. For drinking purpose, the acceptable range for pH is 7 to 8.5. hence it is necessary to check the pH of water before treatment and then after treatment to monitoring the change in pH value of water sample.

b) To determine contact time on fluoride removal.
The effect of contact time on adsorption of fluoride onto fly ash (activated carbon extracted from Soybean Hush fly ash and Maize Husk). Batch adsorption studies using the concentrations 2 to 4 mg/l of fluoride solution and with 2.00 g of the adsorbent with particle size of 25-35 µm have to carried out at constant stirring rate of 160 to 240 rpm.

c) To determine Adsorbent dose on fluoride removal.
The adsorbent dose on fluoride removal was kept 2 gm/100ml of water sample. The pH was maintained at 7, while initial fluoride ion concentration has to varies from 2 to 4 mg/l and contact time was kept as 20 to 50 minutes. Stirring rate of 160 to 240 rpm will be set to carry out the experimental work using the two adsorbents (activated carbon extracted from SH & MH).

d) To determine stirring rate on fluoride removal.
Studies on the effect of stirring rate (rpm) on fluoride removal efficiency (percentage) will be conducted by varying speeds from 50 rpm to 250 rpm by using the mechanical stirrers, at pH of 7(neutral) with adsorbent dose of 2 g/100 ml and contact time of 20 to 50 minutes. The initial fluoride concentration of the test solution/sample will be taken as 7 mg/l.

3. RESULT:

Sr. no	Description	Ph before	Fluoride (mg/l)	Adsorbent dose	Stirring rate	Contact time	Ph after	Fluoride {mg/l)	Fluoride removal (%)
1	Distilled water	7	1.02	-	-	-	-	-	0
2	Distilled water + fluoride	7.2	4.65	2gm maize husk	160	20 min	7.5	2.8	39.13
3	Distilled water + fluoride	7.1	3.80	2 gm soybean husk	200	30 min	7.3	2.1	45.94
4	Distilled water + fluoride	7.25	4.2	2 gm Maize husk	200	30 min	7.35	2.08	50.47
5	Distilled water + fluoride	7.30	3.91	2 gm soybean husk	240	40 min	7.47	1.89	51.66
6	Distilled water + fluoride	7.18	3.74	2 gm of (Maize husk+ soybean husk)	240	40 min	7.5	1.8	51.87

4. CONCLUSIONS:

Fluoride removal carried out in batch process in which, the removal efficiency of the two adsorbents used individually was tested for four different parameters, viz. Contact time, pH, adsorbent dose and stirring rate, to find the optimum conditions or equilibrium data.

For the effect of contact time, equilibrium was achieved for 50 minutes in case of both the adsorbents.

In case of both the adsorbents used, the percentage of fluoride removal was found to be a function of adsorbent dose and contact time at a given initial solute concentration.

In case of effect of adsorbent dose, equilibrium dosage of 2g was found in case of both the adsorbents used. while the maximum efficiency was found to be 50.47% and 51.66% for MH fly ash and SH fly ash respectively.

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