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Synthesis of Adsorbent Material for the Removal of Fluoride from Drinking Water using Aluminium-Loaded Orange Peelings Carbon

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A Project Report Submitted to the Department of Chemistry in Partial Fulfillment of the Requirement for the Award of Degree of Bachelor of Science Education

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Declaration

I, Chikamoko Diana declare that this research is my original work and has not been submitted elsewhere for an award of a degree or publication. Where other people's work has been used, this has been duly acknowledged and a list of references provided.

Signature..... Date..30th/05/23.....

Approval

This research report has been submitted for examination with the approval of my supervisor.

Dr. Egor Moses

Signature..... Date 30/05/2023

Dedication

I dedicate this research report to my beloved father Mr. Farich Moses and mother Mrs. Yapchesikor Oliver for their continued support throughout my school and university education and bringing me up morally. I owe them a lot.

Acknowledgement

I would to take this opportunity to thank my supervisor Dr Egor Moses for his guidance, time and support towards this research.

I also thank my sponsor, Higher Education Student's Financing Board (HESFB) for supporting my University education financially. In the same line, I also thank my beloved husband Kanga Nicholas for his guidance, emotional and financial support towards my education.

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I finally take this chance to thank the Almighty God for the wisdom, good health, provision, care, love and for always protecting me.

List of Acronyms/Abbreviations

ALOPC - Aluminium Loaded Orange Peelings Charcoal.

CDTA - 1, 2- cyclohexanedinitrilo- tetraacetic acid.

ISE - Ion Selective Electrode.

UNICEF - United Nations International Children's Emergency Fund.

WHO - World Health Organization.

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Abstract

Fluorine is considered essential for the maintenance of human health if the concentration is between 0.5 to 1.0 mg/L. Concentrations higher than this lead to a disorder known as fluorosis (dental and skeletal). According to World Health Organization, the permissible limit of fluoride is 1.5 mg/L in drinking water. Many methods which are generally expensive have been applied to remove fluoride ions from drinking water. However, this has not been effective as the population is still faced with high fluoride content in water and its related effects. In this study, an effective and less costly method was developed by use of orange peelings charcoal impregnated with aluminium. A number of parameters which include adsorbent dose, contact time, initial fluoride concentration, particle size and pH were used to investigate the adsorption capacity and efficiency of aluminium loaded orange peelings charcoal (ALOPC). It was observed that the percentage removal of fluoride increased with increase in adsorbent dose and contact time and decreased with increase in particle size, initial fluoride concentration and pH.This study is useful in designing a local defluoridation unit so as to bring the fluoride level in drinking water to permissible limit.

Chapter 1: Introduction

1.1 Background

Fluorine is considered to be essential for the maintenance of human health. To maintain a healthy level of fluorine in the body, the optimal fluorine level in drinking water should be between 0.5 and 1.0 mg/L (Wang & Reardon, 2001). Concentrations higher than this can lead to a disorder known as fluorosis characterized by stained, darkened or powdery darkened teeth. Apart from dental fluorosis, ingesting too much fluoride can result into twisting of bones in growing organisms and neurological harm in adults (Bhise, Patil, & Raskar, 2012).

Fluorine comes into water due to weathering of fluoride containing rocks and soils and leaching from the soil into ground water. Fluoride enters into ground water due to dissolution from minerals/rocks like topaz, fluorite, fluorspar, cryolite, fluorapatite etc (Tang et al., 2009). Drinking water can be polluted with fluoride naturally or by human activities. This is because it occurs naturally in the earth crust and human activities such as semiconductor manufacturing, glass making, electroplating, aluminium processing, fires and composting can release waste water containing fluoride thus adding it to surface and ground water.

According to World Health Organization, the permissible limit of fluoride is 1.5 mg/L in drinking water (Organization), 2004) and it is important that the level/ concentration of fluoride in drinking water does not exceed this limit. High level of fluoride in ground water is a worldwide problem, which includes various countries from Africa and Asia as well as USA. Ethiopia is the most affected nation in Africa by the fluoride problem. Fluoride concentration as high as 33mg/L has been reported in drinking water sources in Ethiopia (Reimann et al., 2003).

Generally when fluoride content in water is ranging between 1.5-2.0 mg/L, it has a high possibility of causing dental molting which is characterized by opaque white patches at the initial stages which during advanced stages leads to dental fluorosis and finally pitting of the teeth surfaces.

Many methods have been applied to remove excess fluoride from drinking water. The current treatment methods are chemical precipitation with calcium and aluminium salts (Benefield, Junking, & Weand, 1982), ion exchange using polymeric resins (Kunin, 1990) , adsorption on

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