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Adsorptive Removal of Nitrate Ions from Aqueous Solutions Using Acid Treated Sunflower Seed Husk (*Helianthus annuus*)

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Abstract

The ability to convert a waste by-product, sunflower seed husk (Helianthus annuus), into an economically cheap adsorbent has been investigated for nitrate removal from aqueous solution through sorption studies. The sunflower seed husk was characterized by physisorption, Brunauer Emmet Teller (BET). Fourier transform Infrared (FTIR) were recorded before and after adsorption to explore the number and position of the functional groups available for nitrate binding on to the studied adsorbent. Optimum adsorption conditions for nitrate removal were determined as a function of pH, adsorbent dosage and contact time. The sorption capacity decreased with increasing sorbent dosage. The optimum contact time was 120 min, optimum biomass dose was 3.0 g and the optimum pH for nitrate removal was 2.0. The adsorption data conformed to both the Langmuir and the Freundlich isotherms but fitted best into the Langmuir model. The R^2 for Langmuir equation was 0.9940 and that for Freundlich was 0.8190. The study demonstrated the efficacy of disposed sunflower seed husk as efficient adsorbent material for the removal of nitrate ions from aqueous solution.

Keywords: *Biosorption, sunflower seed husk, BET, FT-IR, equilibrium isotherms*

1. Introduction

Rapid urbanization, agricultural activities and industrialization of the world has lead to the accumulation of vast number of contaminants in the environment [1]. Nitrate ions hold a superlative position in that list and are responsible for contaminating soil, ground and surface waters in many parts of the world [2, 3]. Nitrates enter the environment through industrial waste and farm runoff. Nitrogen fertilisers are the main sources of nitrates in water bodies in rural areas and farm lands. Their high solubility in water means that they are easily washed by rain water to natural water bodies [4]. Nitrates are a potential threat to human health especially in adults causing gastric problems due to the formation of nitrosamines in water [5]. In infants a condition known as methemoglobinemia (blue baby syndrome) develops [2]. In this condition, nitrate is converted to nitrite which then combines with hemoglobin to form methemoglobin and tends to decrease the ability of the blood to carry oxygen [6].

Various studies have been conducted for the removal of nitrate ions before being discharged to receiving sink to eliminate toxic effects to humans. The treatment of this type of wastewater has been reported extensively and involves recuperative techniques such as biological denitrification, adsorption, reverse osmosis filtration, precipitation, ion exchange, and destructive techniques such as ozonation and oxidation [1, 7]. The main disadvantages associated with these techniques are that they are slow especially for large volumes and highly concentrated waste water and at low temperatures [8-10]. Chemical reduction requires addition of chemicals, as a result it is not cost effective and it releases toxic compounds which are a threat to the environment [11]. In electro-dialysis the metal hydroxides formed clog the membrane [12]. Ion exchange though the most suitable and most used technique of the above due to its simplicity, effectiveness and temperature independence is costly [13].

Recently, adsorption has attracted considerable interest especially from low cost materials such as peanut hull, tea waste and wheat straw, maize plant adsorbents [14, 15]. Agro based anionic adsorbents such as rice hulls, pine barks and sugarcane bagasse have been reported to have maximum adsorption capacity and high cationic exchange capacity [16]. Research using activated carbon prepared from sugar beet bagasse has also been conducted [17]. The capacity of