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# Adsorption of copper from aqueous solution onto agricultural Adsorbents: Kinetics and isotherm studies

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ABSTRACT

Investigations were conducted to evaluate the adsorption of copper ions from artificially stimulated wastewater onto Egg Shells (ES), Spent Tea Leaves (STL) and their biochars. Batch studies on ES and STL were carried out at varying pH (3–8), contact time (30–150 min), solid:liquid ratio (0.25:25–2:25) and initial copper concentration (5–20 ppm). On the other hand, batch studies with biochar as adsorbent were conducted at contact time of 180 min, pH 6, solid:liquid ratio of 1:50 and 20 ppm of initial copper concentration. Kinetics and isotherm studies were taken place for evaluating the potential of ES and STL for adsorption of copper ions from artificially stimulated wastewater. Copper removal by ES and STL was 84.5% (adsorption capacity 422.5 mg/g) and 91% (adsorption capacity 447.5 mg/g) under the optimum conditions respectively. EDX-SEM analysis of ES and STL indicated that the particles were present on ES as well as STL after adsorption process. Elemental analysis showed 1.26% and 0.89% by weight were present due to copper adsorption onto ES and STL respectively. STL biochar yielded the best adsorption amongst all with more than 99% of copper removal. Its EDX-SEM analysis showed that there was the presence of particles at the surface of STL biocahr after adsorption process having 0.59% weight due to copper adsorption. Adsorption isotherm studies on ES and STL revealed multilayer adsorption with Freundlich isotherm. Study on adsorption kinetics for ES and STL revealed that ES followed pseudo-first-order kinetics while as STL followed pseudo-second-order kinetics.

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## 1. Introduction

After industrial revolution, industrialization and urbanisation have contributed hugely to the contamination of the earth, which has become a critical issue that must to be fathomed or conceivably bring under control [1]. The arrival of poisonous effluents from various ventures impacts soil fertility, aquatic life and water resources. The heavy metals due to industrial pollution can cause physical distress and treacherous diseases [2]. Copper being a transition metal, is forgeable, conductor of electricity and heat and adaptable. Copper smelters, foundries, and power stations are the man-made exercises responsible for pollution caused by copper. In spite of the fact that it is an important nutrient, its presence in excess is toxic for living organisms. The toxicity caused due to copper is called copperiedus. A metallic taste, hypotension, nausea and melena are few of the manifestations of intense copper harming by ingestion. Long-term side-effects include liver and kidneys damage [3].

From an efficient perspective, an adsorbent should be rich in nature and can be effectively accessible, or a by-product from industrial activity, that has almost no financial worth, and requires almost zero preparing. Agricultural residues (ligno- cellulosic biomass), are the left over from the agricultural system which include stalks, leaves etc. These wastes are generally of two types. First type belongs to residues left in the field after harvest time season where leaves shrink and fall, for instance tree fronds and oak tree dead leaves [4]. The other type is the one which is caused due to by-products of industrial processing, for instance, date stones, olive stones, and tea leaves. Lately, more consideration has been paid for the use of these adsorbents' dependent on financial and ecological purpose of perspectives [5].

Biochars have excellent adsorption capacity [6]. The adsorption by biochar is done through an initial surface adsorption followed by intra-particle diffusion. Treatment of acidic mine water with biochar recommends that it cradles the acid and is capable for

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