Isotherm Study Of The Biosorption Of Cu (II) From Aqueous Solution By *Vigna Subterranea* (L.) *Verdc* Hull.

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Abstract: - The removal of Cu(II) ions from aqueous solutions is critical to minimize its toxicity to both plants and animals. *Vigna subterranea* (l.) *Verdc* hull (VSVH) was investigated for its potential to remove Cu(II) ions from wastewaters. Batch equilibrium studies were carried out to optimize pH, contact time, and dosage at constant temperature (25 ± 1 °C) and agitation rate (180 rpm). The effect of initial Cu(II) ion concentration was investigated under optimized conditions (pH, 6; contact time of 60 minutes and dosage of 6 g/L) and the equilibrium data were analyzed using two parameter isotherms; Temkin, Langmuir and Freundlich models. The equilibrium data fitted the isotherms in the order; Langmuir > Freundlich > Temkin, all with $R^2 > 0.98$. The biosorption of Cu(II) ions by *VSVH* was found to be favorable ($0 < R_L < 1$ and $1/n < 1$), endothermic, spontaneous (ΔG^o = -11.11 kJ/mol) and chemisorption in nature. Very high removal efficiency and maximum sorption capacity were realized indicating the viability of the removal of Cu(II) ions by the novel biosorbent. The use of *VSVH* for the removal of Cu(II) ions from wastewaters can be implemented as a standalone technology or coupled with the conventional methods in order to complement their wastewater cleaning potentials.

Keywords: - Biosorption, Cu(II) ions, Equilibrium, Temkin, *Vigna subterranea* (L.) *Verdc.*

1 Introduction

The proliferation of small scale farmers, small scale industries and small scale mining activities in Zimbabwe has to be accompanied by cheap, readily available wastewater treatment methods to clean the effluents of heavy metal ions to meet the Standard Association of Zimbabwe (SAZ) and the World Health Organization (WHO) regulations. Copper is one of the most used metal and gets into the environment through wastewaters from copper wire mills, coal burning industries, electroplating, tanning, smelting and refining, insecticides, fungicides and iron and steel industries [1]. Copper is an essential micronutrient that is incorporated into a number of metallo-enzymes involved in hemoglobin formation, drug metabolism, carbohydrate metabolism, catecholamine biosynthesis, the cross-linking of collagen and the antioxidant defense mechanism [2].

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However if present in drinking water at concentrations higher than 5 mg/L, copper causes nausea, vomiting, abdominal pain and diarrhea immediately following ingestion. At very high concentrations in drinking water, it damages the immune system. Araya et al.[3] reported decrease in fetal growth in rats, mice and mink that were exposed to Cu(II) ions. It was against this background that the removal of Cu (II) ions from wastewater was prioritized. The conventional methods of metal-ion removal that include chemical precipitation, membrane technologies, filtration, evaporation recovery, chemical oxidation or reduction, ion exchange and electrochemical treatment require extremely high initial capital investment, generate chemical sludge whose disposal is problematic and have been reported to be ineffective when the metal ion concentration is less than 100 mg/L [4]. Recent developments are focusing on biosorption that has the following advantages: reusability of biomaterial, low initial and operating costs, selectivity for specific metal ion, short operation time and minimization of chemical sludge [5]. Several biomaterials have been investigated for their ability to remove metal ions from aqueous solutions. These include; river green algae [6], water hyacinth roots [7], [8], maize tassels [9], *Caesalpinia bonducella* seed [10], Nile rose plant [11], bael tree leaf [12], *Canna indica* roots [13], *Sphagnum* moss [4], groundnut hull [5] and fluted pumpkin waste [14]. These materials were able to biomine different metal ions from wastewaters. Bambara groundnut, *Vigna Subterranea* (L.) *Verdc* (*VSV*), is an important African legume that is grown across all farming regions in Zimbabwe [15]. The kernels can be boiled and eaten as a soft porridge; the dry seeds are eaten after being boiled, either on their own or mixed with maize grain or can be used as a relish during dry season [16]. The literature search done indicated that *Vigna Subterranea* (L.) *Verdc* hull has not been used as a biosorbent for metal-ion sorption. Investigating its potential for metal ion sorption is therefore important. The study was carried out to investigate the use of *Vigna Subterranea* (L.) *Verdc* hull for the sorption of Cu(II) ions from wastewater. Two parameter equilibrium adsorption isotherms were used to describe the sorption process under optimized conditions of pH, contact time and dosage.