Removal of Some Pollutants from Wastewater by Using Some Dry Plants

by

Khaled Roushdy AbdEl-Latif Metwally
B. Sc. Agric. Sc., Cairo Univ., 1982

A Thesis Submitted in Partial Fulfillment

of

The Requirement for the Master Degree

in

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Department of Agricultural Science
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Approval Sheet

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Dedication

To:

My dear beloved parents, cherished lovely kids, Nahla and Waleed and to Cleo, my wonderful exceptional wife, for their long patience, perceptive understanding, and unlimited encouragement. May Allah Almighty bestow blessing, grant forgiveness and have mercy on them all…..

Abstract

Khaled Roushdy AbdEl-Latif Metwally, Removal of Some Pollutants from Wastewater by Using Some Dry Plants. A published Master of Science Thesis, Institute of Environmental Studies and Research, I.E.S.R., Ain Shams University 2005.

Seven plant waste-based biomasses were tested as potential adsorbents for heavy metals such as Cr (VI) and Ni (II), and herbicide like STOMP from aqueous solutions. These wastes were okra preparation (OPW), hazelnut shell (HNSW), walnut shell (WSW), peach stone shell (PSSW), apricot stone shell (ASSW), corncob (CCW) and Jew's mallow (Molokhia) preparation wastes (MPW). Batch scale experiments were carried out to test the main adsorption parameters such as pH, adsorbent concentration, initial adsorbate concentration and the kinetics of biosorption. The process was a pH dependant with an optimal at pH 5 for nickel removal, pH 3 for chromium mitigation and pH 3 for SOTMP adsorption onto (CCW) and pH 7 for SOTMP adsorption onto both (OPW) and (MPW). At 5.0 g l^{-1} adsorbent concentration, and 300 mg l^{-1} adsorbate initial concentration, the capacity of the studied biosorbents to bind Cr (VI) were 48.0, 40.0, and 27 mg g^{-1} for WSW, NSW and OPW respectively at pH 3.0.; whereas the capacity to bind nickel (II) were 56.88, 56.12 and 56 mg g^{-1} for HNSW, ASSW and PSSW respectively at pH 5. In the case of STOMP herbicide, the capacity of the studied biosorbents to bind it were 46.7, 44.7 and 44.5 mg g^{-1} for (OPW), (CCW) and (MPW) respectively at 0.5 g l^{-1} adsorbent concentration, and 25 mg l^{-1} adsorbate initial concentration at pH 3 for (CCW) and pH 7 for (MPW) and (OPW). Under optimized test conditions, the equilibrium adsorption data fit the Langmuir adsorption isotherm for (WSW), (HNSW) and (OPW) with correlation coefficient of 0.9819, 0.9783 and 0.9199 respectively for the removal of Cr (VI) by the tested biosorbents. The correlation coefficient for the Langmuir isotherm, when removing NI (II) by (HNSW) and (PSSW), were 0.843, 0.6762 respectively. The correlation coefficient for the linear, Langmuir and Freundlich isotherm for (OPW), (MPW) and (CCW) were 0.65, 0.60 and 0.51 respectively when removing STOMP herbicide. These results emphasized the effectiveness of the studied adsorbents in the removal of chromium and nickel from the polluted water such as the wastewater of electroplating shops and other industrial plants.

It is also cast light on the efficacy of the tested biosorbents in the removal of STOMP herbicide from agricultural wastewater polluted with that herbicide.

Key words: Wastewater, Plant wastes, Heavy metals, Chromium, Nickel, Herbicides, STOMP, Removal, Adsorption, Water treatment.

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Introduction

Water is the most precious element of life on Earth, it is vital for absolutely every basic life needs. Although 70% of the earth is covered with water, freshwater only accounts for a small percentage of this (2.5%), of which 70% is contained in glaciers and ice sheets. Surfaces freshwater (rivers, lakes etc.) only comprise 0.3% of all freshwater and the remainder of freshwater is groundwater: aquifers and soil moisture. The amount of available water is declining every year, with water quality deteriorating due to excessive consumption, which leads to land salinity and desertification, reducing living standards and affecting the health of the population, which is now 6 billion people, and will rise to 9.6 billion by 2025 which 80% of whom will live then in developing countries. Water consumption in high-income countries shows that 30% of water used for agricultural needs, 59% for industry and 11% for municipal needs, while the global average is 70% used for agricultural needs, 22% for industry and 8% for municipal needs, comparable percentage of overall freshwater consumption used in Egypt in 2001 for agricultural, industrial and municipal sectors was 88%, 5% and 7% respectively. The shortage of water resources that many countries experience is aggravated by growing water pollution. Pollution can be of mineral, organic, bacterial or biological nature; assuming that 1 liter of wastewater pollutes 8 liters of freshwater leads to estimate that the discharge of 1,500 km^3 wastewater pollutes as much as 12,000 km^3 of water annually. This global water crisis will require countries to take concrete actions to rehabilitate polluted rivers and recharge depleted aquifers as well as adopting new standards of water quality and water use programs. Such programs have contributed to reduce pollutants through treatment, reuse and recycle of purified municipal and industrial wastewater, introduction of cheap technologies and stricter control of municipal and industrial discharges. Over recent years, all 191 participants countries, including Egypt, gathering in the UN World Summit on Sustainable Development (WSSD) held in 2002 in Johannesburg, reaffirmed their commitment to September 2000 Millennium Declaration that they have adopted to ensure environmental sustainability. They set common numerical and time-bound goals in eight key-development areas, one of which is halving, by 2015, the proportion of people without access to safe drinking water and sanitation by using all proactive and protective measures against water shortage (UNWWR, 2003).

Water scarcity will remain a critical challenge for Egypt in the future. Per capita water availability is about 950 cubic meters per year, lower than even the regional average of 1,200 cubic meters per year. Compounding the problem of water quantity are issues related to quality, because of water-logging, salinity, and degradation by pollution (World Bank, 2004).

The amount of heavy metals and synthesized organic compounds generated by industrial and agricultural activities has increased drastically in the past few decades. Many of these compounds are found in wastewater and some of them are difficult and costly to treat by conventional wastewater treatment processes (Tchobanoglous *et al.*, 2003). In Egypt the industrial wastewater as well as agricultural drainage water are considered the main sources of water pollution because of their toxic chemicals and organic loading (Myllyla, 1995).

The ultimate goal of wastewater treatment, as a branch of environmental science dealing with solving the issues associated with the treatment and reuse of wastewater, is the protection of public health in a manner commensurate with environmental, economical, social and political concerns. Removal of the toxic materials from wastewater is carried out by using various techniques; existing methods are precipitations with lime, oxidation/reduction, ion exchange, reverse osmosis, solvent extraction, membrane filtration, electrochemical treatment, adsorption with activated carbon, which is not easily available in many countries, and biosorption. Most of these methods suffer from several disadvantages such as high energy requirements, unsuitability for small-scale industries, elevated capital and operational costs in addition to disposal problems of the generated residual toxic metal sludge (Patterson, 1985 and 1989; Sharma and Forster, 1994b; Changgeng and Qiaoyun, 1995; Mohammad Abdul-Razek, 1999; Gupta *et al.*, 2001).

However, in developing countries, due to these disadvantages, there is a huge need which necessitate greater efforts to develop novel treatment methods that use low-cost, abundant and available materials so as to efficiently adsorb heavy metals like hexavalent chromium and other contaminants from polluted industrial wastewater with using simple local technologies instead of costly imported, highly sophisticated and expensive ones (Huang and Wu,