

**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

Environmental Science

**Department of Agricultural Science
Institute of Environmental Studies &
Research
Ain Shams University**

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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.

Contents

Introduction	1
Review of literatures	4
1. Assessment of chromium in wastewater and treatment methods.	4
1.1. Preface.	4
1.2. Utilization of adsorbents in the removal of chromium and some other heavy metals from wastewater effluents.	6
1.2.1. Chromium pollution.	6
1.2.2. Heavy metal and some anions adsorption.	7
1.2.2.1. Adsorption on activated carbon.	7
1.2.2.2. Adsorption on other material.	8
1.2.2.3. Adsorption on living and non-living biomasses.	9
1.2.2.4. Adsorption on non carbonized plant wastes.	10
2. Assessment of nickel in wastewater and treatment methods.	12
2.1. Preface.	12
2.2. Utilization of adsorbents in the removal of nickel and some other heavy metals from wastewater effluents.	14
2.2.1. Nickel pollution.	14
2.2.2. Heavy metal adsorption.	15
2.2.2.1. Adsorption on activated carbon.	15
2.2.2.2. Adsorption on living and non-living biomasses.	16
2.2.2.3. Adsorption on non carbonized plant wastes.	16
3. Assessment of pesticides in wastewater and treatment methods.	18
3.1. Preface.	18
3.2. Utilization of adsorbents in the removal of pesticides from wastewater effluents.	20

3.2.1. Pesticides pollution.	20
3.2.2. Adsorption of pesticides.	20
3.2.2.1. Adsorption on activated carbon.	21
3.2.2.2. Adsorption on living and non-living biomasses.	23
3.2.2.3. Adsorption on non carbonized plant wastes.	24
Materials and Methods	25
1. Tested pollutants.	25
1.1. Chromium.	25
1.2. Nickel.	25
1.3. STOMP herbicide.	25
2. Preparation of agricultural wastes as adsorbents of pollutants from wastewater.	26
2.1. Chromium adsorbents.	26
2.2. Nickel adsorbents.	26
2.3. STOMP adsorbents.	27
3. Preparation of stock solutions.	27
4. Biosorption experiments.	28
5. Analysis of the tested pollutants.	28
6. Factors influencing in adsorption capacity.	32
7. Kinetics of biosorption.	33
8. Sorption isotherms.	33
Results and Discussion	34
1. Chromium	34
1.1. Effect of pH on Cr (VI) adsorption capacity.	34
1.2. Kinetics of Chromium (VI) biosorption .	35
1.3. Effect of initial Chromium (VI) concentration on biosorption.	37
1.4. Effect of biosorbent dosage.	38
1.5. Sorption isotherm.	40
1.6. Structure and adsorption mechanism.	45
1.7. Actual sample treatment.	49

2. Nickel	50
2.1. Effect of pH on Ni (II) adsorption capacity.	50
2.2. Kinetics of Ni (II) biosorption .	51
2.3. Effect of initial Ni (II) concentration on biosorption.	53
2.4. Effect of biosorbent dosage.	54
2.5. Sorption isotherm.	56
2.6. Structure and adsorption mechanism.	60
2.7. Actual sample treatment.	61
3. STOMP	62
3.1. Effect of pH on STOMP adsorption capacity.	62
3.2. Kinetics of STOMP biosorption .	64
3.3. Effect of initial concentration on pendimethaline biosorption.	67
3.4. Effect of biosorbent dosage in the removal of STOMP.	69
3.5. Sorption isotherm.	71
3.6. Structure and adsorption mechanism.	73
Summary and Conclusion	75
References	79
Arabic Summary	98

List of tables

Table No.	PageNo.
1. Standard solutions of Cr(VI) & Ni(II) and its relevant absorbance values.	29
2. Standard curve's parameters of STOMP herbicide.	31
3. Langmuir isotherm parameters for the investigated biosorbents.	43
4. Summary of adsorptive capacities of various biosorbents for chromium (VI)	44
5. Removal of Cr(VI) from general wastewater effluents using OPW, WSW and HNSW.	49
6. Removal of Cr(VI) from actual chromium electroplating effluents using OPW, WSW and HNSW.	50
7. Langmuir isotherm parameters for investigated biosorbents.	58
8. Summary of adsorptive capacities of various biosorbents of nickel .	59
9. Removal of Ni(II) from general wastewater effluents using PSSW, ASSW and HNSW.	61
10. Removal of Ni(II) from actual nickel electroplating effluents using PSSW and HNSW.	62
11. Effect of pH on STOMP removal by using OPW, CCW and MPW.	63
12. Effect of time elapsed on adsorption of STOMP onto OPW, CCW and MPW.	65
13. Effect of initial STOMP concentrations when adsorbed onto OPW, CCW and MPW.	67
14. Effect of adsorbents weight on removal of STOMP by using OPW, CCW and MPW.	69
15. Correlation coefficient (r^2) for linear, Langmuir and Freundlich isotherm for OPW, CCW and MPW when removing STOMP herbicide.	71

List of figures

Fig NO.	PageNo.
1. Cr (VI) standard curve.	29
2. Ni (II) standard curve.	29
3. Stomp herbicide standard curve.	31
4. Effect of pH on Cr(VI) removal by using OPW, WSW and HNSW.	34
5. Effect of time on Cr(VI) removal efficiency by using OPW, WSW and HNSW.	35
6. Effect of time on adsorption of initial conc. of 400 ppm onto WSW.	36
7. Effect of time on Cr(VI) removal capacity by using OPW, WSW and HNSW.	36
8. Effect of various initial conc. of Cr(VI) on removal Efficiency by using OPW, WSW and HNSW.	37
9. Effect of various initial conc. of Cr(VI) on removal capacity by using OPW, WSW and HNSW.	38
10. Effect of biosorbents dosage on adsorption efficiency of Cr(VI) by using OPW, WSW and HNSW.	39
11. Effect of biosorbents dosage on adsorption capacity of Cr(VI) by using OPW, WSW and HNSW.	39
12. Linear isotherm plot for adsorption of Cr(VI) onto OPW, WSW and HNSW.	40
13. Langmuir isotherm plot for adsorption of Cr(VI) onto OPW, WSW and HNSW.	41
14. Freundlich isotherm plot for adsorption of Cr(VI) onto OPW, WSW and HNSW.	42
15. pH dependence for removal of Ni(II) by using PSSW, HNSW and ASSW.	51
16. Effect of time on adsorption efficiency of Ni(II) onto PSSW, HNSW and ASSW.	52
17. Effect of time on adsorption capacity of Ni(II) onto PSSW, HNSW and ASSW.	52
18. Effect of initial conc. on Ni(II) adsorption efficiency Onto PSSW, HNSW and ASSW.	53
19. Effect of initial conc. on Ni(II) adsorption capacity Onto PSSW, HNSW and ASSW.	54

20. Effect of adsorbent weight on Ni(II) adsorption efficiency Onto PSSW, HNSW and ASSW.	55
21. Effect of adsorbent weight on Ni(II) adsorption capacity Onto PSSW, HNSW and ASSW.	55
22. Langmuir isotherm relation for adsorption of Ni(II) onto PSSW, HNSW and ASSW.	56
23. Freundlich isotherm plot for adsorption of Ni(II) onto PSSW, HNSW and ASSW.	57
24. Linear isotherm plot for adsorption of Ni(II) onto PSSW, HNSW and ASSW.	57
25. Effect of pH on STOMP removal by using OPW, MPW and CCW.	64
26. Effect of time on adsorption efficiency of STOMP onto OPW, CCW and MPW.	66
27. Effect of time on adsorption capacity of STOMP onto OPW, CCW and MPW.	66
28. Effect of initial conc. on STOMP adsorption efficiency Onto OPW, CCW and MPW.	68
29. Effect of initial conc. on STOMP adsorption capacity Onto OPW, CCW and MPW.	68
30. Effect of biosorbents dosage on adsorption efficiency of STOMP by using OPW, CCW and MPW.	70
31. Effect of biosorbents dosage on adsorption capacity of STOMP by using OPW, CCW and MPW.	70
32. Langmuir isotherm relation for adsorption of STOMP by using OPW, CCW and MPW.	72
33. Freundlich isotherm plot for adsorption of STOMP by using OPW, CCW and MPW.	72
34. Linear isotherm plot for adsorption of STOMP by using OPW, CCW and MPW.	73

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. Surface 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 km³ wastewater pollutes as much as 12,000 km³ 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,