Nanotechnology Project III

Project Summary

This year project aims to identify and efficiently remove selected agrochemicals from agricultural water sources employing nano-technology based processes that utilizes agricultural wastes.

Introduction

This project will allow us to satisfy a current unmet need in obtaining survey data on key classes of agrochemicals and the identification of major contaminants in various agricultural water sources and effluents. The work will result in development and testing of a sustainable and eco-friendly process for the removal of such contaminates. Data obtained from this project may be used to correlate the concentration of the selected antibiotics to their potential health risk through relevant existing models.

Problem Statement

The River Nile accounts for around 97% of Egypt's total fresh water resources of which approximately 80% is used in agriculture. These figures are striking especially considering the additional limitations on water resources through the ever-increasing Egyptian population and the growing need for water resources from other Nile Basin countries. It is thus clear that water contamination in Egypt is an issue of major concern. The reuse of agricultural water therefore is a question of concern. The current project focuses on the removal of agrochemicals as contaminants of emerging concern from agricultural water effluents for their safe re-use.

Background

Agrochemicals are classified as contaminants of emerging or re-emerging concern that are found in the environment but are commonly not monitored or properly detected. They may be either newly identified compounds or compounds that have been found for a long time but has still not been recognized as harmful for the environment, or compounds that are individually innocuous but may affect health and environment upon interaction with others [1]. Pesticides, for example, were reported as endocrine disrupting compounds which interfere with the main processes of the endocrine system responsible for controlling important functions of the human body. Examples of various pesticide removal include the utilization of activated carbons of apricot stone, sky fruit and rice straw for the effective adsorption of ethoprophos, bentazone herbicide and carbofuran, respectively [2-4]. Further studies investigated the use of sunflower seed shells, rice husk, composted sewage sludge and soil for removing atrazine, alachlor, endosulfan sulfate and trifluralin molecules from aqueous solutions [5]. In addition, sugar beet pulp showed promising potential in removing diuron and 3, 4-dichloroaniline (3,4-DCA) from single and multi-component systems [6]. Other potential biosorbents include thermally treated egg shells [7] and acacia etbaica [8]. Cellulose-based nanocomposite was reported to be capable of removing acetaminophen and N,N-diethylmeta-toluamide (DEET) from water [9]. Nanoparticles of gold and silver supported over activated alumina were also effective in the removal of chlorpyrifos and malathion. In addition, chitosan loaded with zinc oxide or silver nanoparticles successfully removed 99% of permethrin and more than 94% atrazine, respectively from aqueous solutions [10].

Significance

To the best of our knowledge, the data on the concentration and types of agrochemicals in various agricultural Egyptian water sources and effluents is very sparse. This research would contribute to this much-needed data. This research will allow for the development and testing of efficient and eco-friendly removal processes of selected agrochemicals, that are relevant to Egypt, using activated carbon- coated metal nano-particles. The use of activated carbon derived from agricultural wastes will add to the environmental merits of this process. This project will thus allow for the safe re-use of agricultural water effluents, an issue of great importance especially due to the current limitation on Egyptian water resources. Data obtained from this project may be used to estimate human health risks through relevant existing models. This is a challenging project that involves environmental sampling, instrumental analysis as well as the development and testing of activated carbon-coated metal nano-particles for the removal of agrochemicals from Egyptian agricultural water.

Project Description

1) Sampling and extraction of various agrochemicals from agricultural water sources and effluents.
2) Analysis of extracted agrochemicals employing techniques that includes HPLC.
3) Synthesis of activated carbon-coated metal nanoparticles using commercially available activated carbon and activated carbon derived from agricultural wastes.
4) Development and testing of sorption processes for the efficient and eco-friendly removal of selected agrochemicals using activated carbon-coated metal nano-particles.

The Advancement of Scientific Knowledge and Broader Impact

This project may allow for the development of an eco-friendly cost effective agrochemicals removal from water through a simple and efficient process that may have the potential for scaling up. This work will also allow for the safe re-use of agricultural water effluents, an issue of great importance especially due the current limitation on Egyptian water resources. Data obtained from this project may be used to estimate human health risks through relevant existing models.

Biographical Sketches

Dr. Shoeib holds an Honors BSc and PhD in Chemistry from York University in Toronto, Canada. His research interests brings to bear knowledge in the areas of analytical chemistry, biophysical chemistry and molecular structural elucidation with the goal of understanding the structure, reactivity, and function of metal-containing bio-molecules, the complexes formed by these interactions and their uses in environmental, medicinal and pharmaceutical chemistry. Dr. Shoeib has supervised over 15 graduate theses, co-authored over 100-refereed publications in academic journals, and conference proceedings and received over 1000 citations.

Dr. Mayyada El-Sayed has a PhD in Chemical Engineering from Cambridge University in the UK. Her expertise lies in areas of separation processes, water treatment, and nanotechnology. She worked and collaborated in several relevant projects funded by STDF, NSF and DARPA in the fields of Environmental and Biochemical Engineering. She authored and co-authored more than 50 refereed publications in academic journals, books and conference proceedings.

Leveraging Resources The proposed project leverages the experience of the Co-PIs in environmental research. This experience extends to conducting surveys of contaminates in various media including water, the development of sorption separation processes for the removal of contaminants from water using nanoporous materials and bio-based materials. The Co-PIs have had previous and current fruitful collaborations employing the techniques to be used in the project which are available at AUC and other Egyptian public institutions (Cairo University and National Research Center in Cairo).

Deliverables

This research project aims to the development of an efficient process for the removal of major contaminants of emerging concern from Egyptian agricultural water effluents for their safe re-use. The results of the research project will be disseminated through international conferences and/or journals. Deliverables also include a master thesis deposited at the Digital Archive and Research (DAR) Repository of the American University in Cairo, which is publically accessible.

Professional Development and Mentoring Plan

The selected student will work as part of an active multidisciplinary research team with broad experience in different aspects of the proposed work. He/she will also be encouraged and supported to participate in local and international venues in the environmental field in order to develop expertise and network with peers and professionals specialized in water treatment and nanotechnology.

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