Evaluation of the efficiency of some eco-friendly substances for waste water treatment at Beni- Suef Governorate

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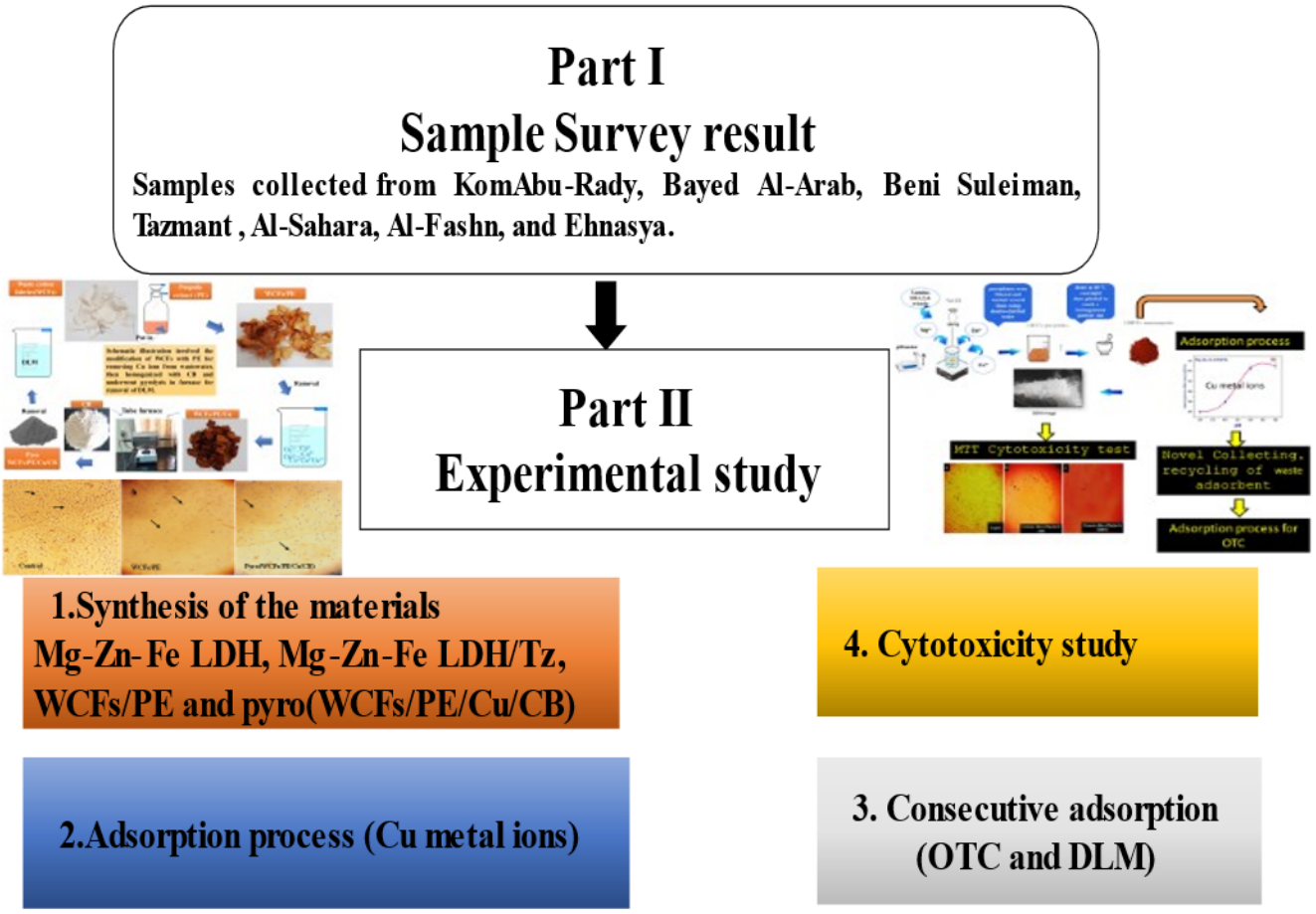
Abstract

Wastewater treatment is the process and technology that is used to remove most of the contaminants such as heavy metals, drugs and pesticides that are found in the wastewater to ensure a sound environment and good public health. The terrible rise of heavy metal pollution in the environment is considered a serious threat to the terrestrial and aquatic environment. So, the development of highly cost-effective, highly operation-convenient, and recyclable adsorbents was a must. In this study**,** it focused on the utilization of novel, natural and synthetic materials as sustainable and eco-friendly adsorbent of certain heavy metals, drugs, and pesticides from wastewater. The wastewater samples were collected from Kom Abu-Rady, Bayed Al-Arab, Beni Suleiman, Tazmant, Al-Sahara, Al-Fashn and Ehnasya. These areas are chosen to represent different degrees of water pollution in Beni-Suef governorate. Utilized the ternary layered double hydroxide (LDH) and waste cotton fabrics/propolis extract (WCFs/PE) as an efficient adsorbent for copper metal ions. Also, we enhanced the removal efficiency of the synthesized ternary LDH via loading 3-amino1H-1,2,4-triazole (Tz) using the co-precipitation method. The synthesized adsorbents' characterization before and after the adsorption processes were established. The differences between the adsorbents were investigated in terms of factors affecting the adsorption process, like pH, the dosage, time, and initial concentration. The adsorption isotherm was investigated at pH 5 with a high regression coefficient (R^2) of 0.98, showing a maximum adsorption capacity of 118.45 mg/g for (Cu^{2+} metal ions) using Mg-Zn-Fe LDH as adsorbent, whereas the

investigation using the modified LDH (Mg-Zn-Fe LDH/Tz) with high R^2 of 0.99 showing maximum adsorption capacity of 185.30 mg/g. Kinetic studies were estimated. Mg-Zn-Fe LDH/Tz/Cu^{2+} and pyro (WCFs/PE/Cu/PE) were used as consecutive adsorption for oxytetracycline (OTC) and deltamethrin (DLM), respectively. The results showed a high adsorption capacity (134.60 mg/g) and (20.51 mg/g), respectively. The safety and cytotoxicity of the Mg-Zn-Fe LDH, Mg-Zn-Fe LDH/Tz, WCFs/PE and pyro (WCFs/PE/Cu/CB) were investigated. The results showed that decreasing the cell viability with increasing the concentration of the applied materials.



Introduction

The water pollution and shortage resulting from economic and population growth is considered as one of the most important fears for humankind and a limitation to sustainable development (El-Sayed Abdel-Raouf *et al*., 2019). Waste water is described as both "a resource and a problem" (Hanjra *et al*., 2012). Water pollution affects human health and ecosystems, as well as aquatic plants and animals. Pollutants, such as heavy metals, are serious threats to the environment. They get introduced to aquatic streams due to industrial activities, i.e. mining, refining ores, fertilizer industries, tanneries, batteries, paper industries, and pesticides (Briffa et al., 2020). Heavy metals including chromium (Cr), iron (Fe), selenium (Se), vanadium (V), copper (Cu), cobalt (Co), nickel (Ni), cadmium (Cd), mercury (Hg), arsenic (As), lead (Pb), and zinc (Zn) represent the major toxic hazardous materials to humans and other forms of life. The uptake of heavy metals from wastewater is important not just to eliminate their toxic impact, but also to recover precious materials (Ihsanullah *et al*., 2016). The heavy metals that are observed in water resources in Beni-suef governorate are Aluminium, Manganese, iron, copper, cadmium, and cobalt (Melegy *et al*., 2014). it causes damage to the liver, kidney, and respiratory system (Alalwan *et al*., 2020). In recent years, Pharmaceuticals are either manufactured synthetically or naturally and are considered emerging environmental hazards due to their endocrine-disrupting effects (Oller *et al*., 2011). The pesticide input from farmyards into sewage systems mainly originates from field sprayer filling and cleaning activities on paved surfaces, the direct disposal of unused product residues, accidental spillages, and non-agricultural uses (Münze *et al*., 2017). Therefore, effective, economical, and ecofriendly wastewater treatment is required, Nanotechnology has a great prospect of enhancing water and wastewater treatment. It has potential advantages such as low cost, reuse and being efficient in removing and recovering pollutants. Layered double hydroxides (LDHs) is an universal low-cost sorbent with lamellar construction, can effectively remove various contaminants, e.g., antibiotics (Tang *et al*., 2018), heavy metal (Rojas, 2014), oxyanions (Xue *et al*., 2016) and organic materials (Guo *et al*., 2018). Agricultural materials in general, especially cellulosic materials, show a high potential biosorption capacity due to their structures that include hemicellulose, lignin, extractives, lipids, proteins, simple sugars, water hydrocarbons, and starch (Noor *et al*., 2017). Propolis is a sticky, gummy, resinous substance collected by

honeybees from various plant sources. Bees collect propolis to close holes in the hives, smooth out the internal walls and protect entry against strangers. The composition of propolis varies with the source. Generally, it is composed of 50% resin and vegetable balsam, 30% wax, 10% essential oil and aromatics, 5% pollen, and 5% other substances (Pujirahayu *et al*., 2014). The cuttlebone (CB) is the internal cartilaginous shell of cuttlefish, squid, and octopus. Traditionally, CB is used as a medicine for some ear ailments, to stop bleeding and improve kidney efficiency (Hermelin *et al*., 2015). It is a natural biomaterial source from the chamber of the cuttlefish that can be ground into a powder. The main chemical components of CB are 87.3%–91.75% calcium carbonate and chitin. In addition, it also contains trace amounts of silicon, aluminum, titanium, manganese, barium, and copper (Rosalin and Yosvimol, 2017).

Materials

10% concentrated HNO_3, filter paper was used and copper nitrate (Cu $(NO_3)_2$. $3H_2O$ was utilized as an adsorbate purchased from WINLAB, zinc nitrate [Zn $(NO_3)_2.6H_2O$] obtained from LOBA Chemie, India, Magnesium nitrate Mg $(NO_3)_2$ and iron nitrate [Fe $(NO_3)_3.9H_2O$] from Alpha Chemika made in India that utilized to prepare an adsorbent LDH. 3-amino-1H-1,2,4-triazole($C_2H_4N_4$) from Merch Schuchardt OHG, 85662 Hohenbrunn, Germany. Hydrochloric acid (HCL) from CarloErba reagents (Egypt), and sodium hydroxide (NaOH) from Piochem for Laboratory Chemicals in Egypt. All solutions were prepared using double-distilled water. Waste cotton fabrics (WCFs) were collected from dyeing and weaving factory. Raw propolis were purchased from Beheira Governorate apiaries. Deltamethrin powder (98% pure, El Naser Pharmaceutical Company, Egypt) was obtained as an adsorption analyte, Methyl, and Ethyl alcohol (70%, Brand chemicals, Egypt) were utilized as solvents, The cuttle bone (CB) was collected and removed from cuttlefish in Alexandria. Dimethyl sulfoxide (DMSO) was purchased from Sigma (St. Louis, Mo., USA). Fetal Bovine serum (FBS), Dulbecco modified Eagle medium (DMEM), RPMI-1640, HEPES buffer solution, L-glutamine, gentamycin and 0.25% Trypsin-EDTA were purchased from Lonza.

Conclusion

From the results, it can be concluded that one of the most competitive properties of LDH is that it consists of hydroxides of common and abundant metals on the earth and can be prepared economically. The removal efficiency of Cu^{2+} metal ions from Beni Suleiman wastewater using Mg-Zn-Fe LDH/Tz, achieving the highest and good adsorption performance. The adsorption process was mainly associated with physical and chemical sorption. In addition, cotton fabrics, as waste material from the textile industry, could be potentially used as a less-expensive. The results of the safety and cytotoxicity of the applied materials, showed that decreasing the cell viability with increasing the concentration. Thus, the newly applied Mg-Zn-Fe LDH, Mg-Zn-Fe LDH/Tz, WCFs/PE and Pyro (WCFs/PE/Cu/CB) adsorbents are safer at low concentration and can be utilized in a large-scale wastewater treatment after successful feasibility studies.

Recommendations

The newly applied Mg-Zn-Fe LDH, Mg-Zn-Fe LDH/Tz, WCFs/PE and Pyro (WCFs/PE/Cu/CB) adsorbents are safer at low concentration and can be utilized in a large-scale wastewater treatment after successful feasibility studies.

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