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Application of Low Cost Novel Bio Sorbent, Textured Vegetable Protein- In Treatment of Industrial Wastewater

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ABSTRACT - Toxic metals are produced and dumped into water supplies by various anthropogenic activities, for example, industrial effluents, making them inaccessible and threatening human health. Conventional chemical precipitation and membrane filtration are two methods for elimination of toxic elements and are exceedingly costly when treating large amounts of water, and ineffective at low metal concentrations (incomplete elimination) can produce large amounts of sludge and other harmful compounds, which necessitate disposal with care. Biosorption is environmentally acceptable option that offer advantages over other methods. Natural and other agro-based materials that are abundant, such as microbial agro-wastes, biomass, and industrial leftovers, have been proposed as suitable biosorbents for heavy metal removal. Temperature, pH, metal ion concentration, biosorbent dose, and agitation speed are all factors that influence biosorption. Before usage, the biomass might be chemically and physically altered. By renewing and recycling the biosorbent after it has removed heavy metals from wastewater, the process can be made more cost-effective. Various bioreactors could be used to eliminate toxic metal ions from large volumes of effluents or water in biosorption. In biosorption, a variety of bioreactors can be used to remove metal ions from huge volumes of effluents or water. The current study looks at the future potential of textured vegetable protein (TVP) or Soya Chunks in the biosorption of industrial effluent, with a prime focus on Chromium and Lead.

KEYWORDS – Agro waste, biosorption, heavy metal, Textured Vegetable Protein, biosorbent

I. INTRODUCTION

Industrialization is to a greater extent responsible for pollution of the environment, particularly water, with harmful compounds contaminating lakes and rivers. Heavy metals are reaching dangerous levels in comparison to other poisonous compounds [1]. Overconsumption and buildup result from their constant discharge from industries. As a result, individuals all across the world are exposed to the harmful effects of heavy metal accumulation. Many industries (metallurgical, herbicides and pesticides, leather, aviation, mineral extraction, filmmaking, electroplating, surface finishing, steel and iron, electroporation, metal surface treating, energy and resource production, electro-osmosis, and appliance production) discharge heavy metal-containing waste into the water, by one way or the other [2]. Chromium (Cr), cadmium (Cd), copper (Cu), zinc (Zn), arsenic (As) and lead (Pb) are all heavy toxic metals to be concerned about in biosorption, because they are non-biodegradable, they build up in the environment, resulting in a variety of illnesses in biological creatures, disorders that, in the end, endanger human life [3]. Even when present as a minor hazard, they can be harmful to human health. Biosorption has been a popular technique for extracting toxic metal contaminants from effluents emitted by a variety of industries, which eventually enter and pollute fresh water resources [4]. The purpose of this paper is to discuss research on the use of textured vegetable protein(TVP) as a biosorbent in the biosorption process. The paper discusses the most recent developments as well as the process's future.

II. MATERIALS AND METHODS

A. Materials

The sorbent material, soya chunks, were provided by a local manufacturer in Srinagar (Sorbent material under consideration is TVP or textured vegetable protein). Impurities were carefully isolated. Soya pieces are high in protein, fibres, lignin, and some other organic substances, as well as mineral components like phosphorus, calcium, potassium and trace minerals. Soy is a promising biosorbent because it contains polyunsaturated lipids, proteins, omega 3 fatty acids, and salt.

B. Sampling

Fil Industries, Rangreth, Srinagar provided wastewater samples. Polyethylene Terephthalate (PET) bottles were used to store the gathered samples. The Environmental Quality Act of 1974 specifies the heavy metal effluent requirements as in Table 1.

Table 1: Standard Values for Toxic Heavy Metal effluents

Parameter	Standard Value
Nickel	0.2mg/l
Lead	0.1mg/l
Chromium	0.2mg/l
Arsenic	0.05mg/l
Cadmium	0.01mg/l
Mercury	0.005mg/l
Zinc	1.0mg/l
Copper	0.20mg/l

C. Synthetic Solution Preparation

In a 700 mL flask, water - soluble solutions of lead (Pb) and chromium (Cr) had been prepared. The heavy metal salts were thoroughly soaked in deionized or distilled water using a magnetic stirring rod. A solution (700 mL) was prepared and then diluted with distilled water to create the Lead (Pb) and Chromium (Cr) synthetic solution. All tests have been carried out with the help of AR grade chemicals and purified water. Table 2 and Table 3 which are given below highlight the specifications and amounts of metal salts used in the preparation of synthetic solution and the elimination of Chromium and Lead through the use of exclusive adsorbent vs by undertaken biosorbent, respectively [5].

Table 2 : Specifications and amounts of metal salts used in the preparation of synthetic solution

Heavy-Metal	Salt Used	Percentage of Purity of Metal Salt (%)	Weight of Metal Salt used (g)	Volume of salt solution (mL)	Concentration of heavy metal in solution (mg/L)
Chromium	Chromium Nitrate Salt	99.6	202	780	1.3
Lead	Lead Nitrate Salt	99.2	202	780	24.35

Table 3: Elimination of Chromium and Lead through the use of exclusive adsorbent vs by undertaken biosorbent

Adsorbent / Type	Chromium Removal Percentage	Lead Removal Percentage
Sugar Bagasse / Agri Waste	32 %	56 %
Smectite / Clay	97 %	88 %
Onion Peel / Natural	90 %	78 %
Rice Husk Agri Waste	4.2 %	7.9 %
Saw Dust / Industrial Waste	7.7 %	15.4 %
Wheat Bran / Agri Waste	51.4 %	67.3 %
Sugar Beet Pulp / Agri Waste	2.56 %	-
Sludge / Industrial Waste	1.46 %	6.4 %
Modified Lignin / Industrial Waste	0.56 %	1.1 %
Coconut Husk / Agri Waste	58 %	52 %

Tea Industry Waste / Industrial Waste	1.22 %	0.66 %
Textured Vegetable Protein / Agro-Tech Industry	98 %	86 %

D. Preparation of Textured Vegetable Protein (pre-boiled)

Impurities were manually removed from the TVP or textured vegetable protein after it had been collected and sun-dried. It was boiled for 5 hours with distilled water, then filtered to remove colored chemicals. The resulting leftover material was dried in a hot oven at 75°C for 22.5 hours before being ground. This same material was then placed in an airtight small plastic container for subsequent use.

E. Production of Phosphorus (phosphate) Textured Vegetable Protein (P-TVP)

For 22.5 hours, 8g dried TVP or textured vegetable protein was immersed in 120 ml of potassium hydrogen sulphate (KHSO4). To remove excess phosphate, the processed TVP or textured vegetable protein was properly washed and then filtered three times with pure water.. After drying at 86°C for 22.5 hours, the biosorbent was stored at room temperature in an insulated plastic bottle. All of the chemical compounds used were of the highest standard.

F. TVP (biosorbent) preparation treated with high grade Formaldehyde

The soy protien chunks were treated with standard formaldehyde at room temperature of 27°C in 1:5 ratio for 22.5 hours to incapacitate the colour and water-soluble chemicals. To remove free formaldehyde, the soy protein chunks were filtered and rinsed with distilled water before drying for 22.5 hours in a preheated oven at 86°C. The final product was sieved through sieves with a mesh size of 20. The material was then placed in an airtight plastic container for later use.

G. Experiments on Adsorption

Various experiments were carried out with various TVP doses (2-3g) and a contact time of 4.5 hours at a stirring speed of 110rpm. Fifty-five milliliters of a synthetic solution containing 1.4 mg/l of Cr were treated with 2 g and 3 g of biosobent, respectively. For 2.6 hours, it was permitted to stay in touch with the bio-sorbent. The sample was then filtered using filter paper, a glass funnel, and a beaker to remove any particles present. Similarly, two doses (2 g and 3 g) of TVP or textured vegetable protein are administered to 35 millilitres of effluent using the same process.

III. RESULTS AND DISCUSSION

The biosorbent used i.e textured vegetable protein or TVP was added in dosages of 2g and 3g to synthesized. Lead and Cadmium solutions. The concentration of Chromium was lowered from 1.22 mg/l to 0.05 mg/l by using a 2g dosage of TVP (textured vegetable protein). Likewise, 3g dose of textured vegetable protein (TVP) also reduced the Lead synthetic solution concentration from 1.22 mg/l to 0.16 mg/l. The nickel concentration was completely eliminated by adding 2 gram of textured vegetable protein(TVP) to a waste-water sample with a nickel content of 0.06 mg/l. Textured vegetable protein has eliminated nearly all (98 percent) of the chromium from a synthetic solution. The removal effectiveness diminishes as the dose of textured vegetable protein is increased; for example, a 2g-3g dose reduces removal efficiency by 10 to 12%. The bio-sorbent i.e textured vegetable protein (TVP) was also used to remove nickel from waste- water obtained from Fil Industries Srinagar. As mentioned in Table 3 (above), the efficiency of TVP in removing toxic elements i.e Chromium and Lead from wastewater is 98 and 86 percent respectively which is quite a good efficiency for 2 g dosage. The said biosorent has a nickel removal effectiveness of 96 percent for a 2g dose and 50 percent for a 3g dose. The amounts of Zn, Pb, and Cr were found to be reduced by up to 59, 56, and 55 percent, respectively. Various researchers' investigations into the application of various organic biosorbents for the removal of heavy metals from wastewater support the findings of the current study [6]. Upon studying various results of earlier researchers, some of which are mentioned below we can say Textured Vegetable Protein (TVP) has good efficiency in removing of toxic elements from the waste water effluent of industries.

IV. CONCLUSION

This study investigated heavy metal adsorption on Textured Vegetable Protein(TVP), which had a high potential for removing all of the heavy metal ions tested. The results show that TVP, like most other natural and agricultural absorbents used, has a higher degree of efficiency in the heavy metal treatment process, and thus the treatment efficiency could be as high as 98-100 percent by precisely defining the adsorbent amount. The concentration of heavy metals has also an important effect on the treatment outcome. Because TVP is a low-cost material, it may be advantageous to use it in industrial wastewater treatment. The initial toxic heavy metal concentration, contact period, and adsorbent dose were realized to have a massive impact on sorption process. Textured vegetable protein is more effective at removing heavy metals from samples, but its efficacy decreases as the dose is increased. Another thing to keep in mind is the availability of the biosorbent. Textured vegetable protein(TVP) is readily available and inexpensive, allowing it to be used as a low-cost yet highly effective biosorbent for removing unwanted and highly toxic wastewater contents.

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