Extraction of Bioactive Nano Particles from Seaweed for Heavy Metals Removal and Antibacterial Agent

Vikash Kumar Sharma, Piyush Singhal
Department of Mechanical Engineering, GLA University, Mathura, U.P, India

Abstract. The environmental impact and building up toxicity of heavy metals have been a cause of great concern in recent years. This has given rise to a significant increase of studies with the objective of effectively developing alternative technologies for the removal of substances from industrial effluents that are potentially noxious to the environment. Biosorption can be a piece of the arrangement. A few sorts of biosorbents, for example, ocean growth, molds, yeasts, microorganisms or crab shells are instances of biomass tried for metal biosorption with empowering results. Ocean growth offer points of interest for biosorption on the grounds that their naturally visible structures offer an advantageous reason for the creation of biosorbent particles appropriate for sorption process applications. In the present paper a detailed study has been carried out to find a suitable bionano absorbent extracted from various seaweeds which is abundantly available in the coastal area of Thondi and characterized by UV and FTIR and TEM techniques.

Keywords: Biomass, UV, Metal ions uptake, TEM, Antibacterial finish

1. Introduction
The Industrial plants that releases the toxic elements is said to be the primary cause of the pollution other sources being wastes from the agriculture sources and disposal from the sewages. Their persistent nature along with the interference of these polluting particles in the food chain creates a major problem as far as the rise of pollution is concerned [1-4]. The traditional methods for removing these heavy metals like electrolysis, precipitation of chemicals, treating through biological techniques, flotation etc are infeasible (not-efficient) oftenly as these are the quite expensive techniques of eliminating the pollutants (Heavy-Metals) especially in those instances when they are employed for reducing the ions of a heavy metal concentrations into lower value of concentrations [5-9]. These problems as discussed above give rise to practically applying the technology of biosorption in order to minimize pollutants (heavy concentrated ions) and the agglomeration of the toxic (harmful) metals into environment [10].

1.1. Biosorbents
Biosorption is aprocess in which those solid materials which are having the natural or solid origins and their derivatives are used in retaining the heavier metals. This technique of biosorption is having a very good scope for the purpose of achieving such types of objectives. As the availability of the rockweed biomass is very high these are collected in several parts thus it can used to develop the new material for the biomass. The methods to accumulate the rockweeds are used in several different
studies for the purpose of accumulating the metals biologically as they are generally good bioindicators of the pollution in marines caused due to the heavier metals and they are best known for taking up required elements from water directly [11-13].

Corboxyl, elements from the groups of sulphate, phosphate are some of the binding elements that is contained by the “Brown Algae” found in marines. This is a significant outcome of an industrial activity (process) that depends upon the soaking up of the metals into a biomass. The effluents from the industries most probably contains many different metal and the componenets of metals bindings that could interfere in recovering the desired metals. Retaining the physical stability and affinity are the major concerns as far as the properties of any biosorbent which is supposed to take parts in the process of detoxifying the water.

1.2. Antibacterial Agent
The huge development of businesses and increment in an unnatural weather change causes the ecological contamination with more dampness condition. Those textiles mainly that are derived (manufactured) from naturally grown fibers have an excellent atmosphere for the growing and nurturing of the microorganisms provided the presence of fundamental elements such as oxygen, moisture, nutrients and proper temperature. Microorganisms growth on any fabric is also facilitated by the presence greater surface area of the fabric and the fabric’s moisture retaining ability. Thus the antimicrobial agents for fabrics are in great demand for controlling microorganisms growth like fungi, bacteria, mildew thus the textile is prevented to deteriorate further in terms of its quality and strength, odours, stains and other health related issues that are caused due to these microorganisms. Presently those nano particles that are having the synthetic antimicrobial properties are being made and as they have such indeginous properties along with less nano particles material consumption they are applied on the fabrics[14-15]. In this paper a thorough study has been done for having a desired absorbent along with a suitable agent that is having some properties as that of an antibacterial agents that is taken from various natural occuring seaweeds and then it is examined by TEM, UV and FTIR techniques.

2. Experimental

2.1. Biomass
The biomass that is being used in this work was a brown sragassum sp. of seaweed. Firstly it was washed rigorously by water then it is passed by distilled water for distillation and finally it is dried for 1 day (24 hours) at 60 degrees in an oven. After drying the biomass for 24 hours at 105 degrees properly its weight was obtained. Then the dried biomass is subjected to chopping and it is seived to different sizes and different fractions. Thos dried particles that is having a diameter of 0.625 (on an average) were employed for the experiments in which sorption is involved in a number of batches.

2.2. Chemicals
Analytical grades of Cu(NO$_3$)$_2$·3H$_2$O Pb(NO$_3$)$_2$ Zn(NO$_3$)$_2$·6H$_2$O and Cr(NO$_3$)$_3$·9H$_2$ONa$_2$CO$_3$ HNO$_3$, and NaOH were used and fine solutions were prepared with demonized and distilled water. The stock solutions of metal jons were prepared as 1,000 mg/L and diluted as desired concentrations with water, respectively.

2.3. Metal Uptake Test
50 mg sample was contacted by 5mM solution of metal for calculating the properties of binding the metals of biosorptents (initially). This lets the full saturation at the sites of sorption for each of the biosorbents. For agitating suspensions at 25 degrees (room temperature) an orbital shaker was used this will let the reaction of sorption to reach the equilibrium. 0.1mM of NaOH (sodium-hydroxide) was used in order to frequently maintain the pH scale of 4.5. If the pH is not adjusted (controlld) the value of every sample was 2.9+0.1 (approx.). AAS (Atomic Absorption Spectrophotometry) was used to find the concentrations of metal at the initial and final stages. Then the uptake capacity (q) of the
biosorbent metal was calculated between initial and final concentrations as per the formula as given by equ. 1

\[ q = \frac{[(C_i - C_f) \times V]}{m} \]  

\[(1)\]

\( V \) denotes the solution volume & \( m \) is for the biosorbent mass.

2.4. Extraction of Antibacterial Substance

T.conoides fresh weeds that are collected from the Mannar Gulf which is located at the seashore east in south and then it is washed by seawater then it is washed by the fresh water. Then the moisture is removed from them by drying these weeds for approximately 48 hours and the procedure of drying these weeds was done only under some shade and then they are subjected to be grounded under a mortar. The powdered form of the seaweed was then added to acetone at a ratio of 1:25. Then for 24 hours this mixture was stored for 24 hrs in some dark place at 25 degrees (room-temperature). Then the liquid was transferred to the screw cap sterile test tube and then at the room temperature it is stored in a darker place[3].

2.5. Spectral Studies

The extract containing the antibacterial substance was examined for functional group identification with UV-visible spectroscopy (Jasco-V-530, Japan) in the wavelength range of 200-800 nm and FTIR spectroscopy (Thermo-Nicolet-380. Madison, USA model.) in the spectral range of 4000 to 400 cm\(^{-1}\).

2.6. Transmission Electron Microscopy

The supernatant liquid of 20 mL was centrifuged at 4000 rpm and 20\(_{\circ}\)C for 20 min in the Kubota 6800 Refrigerated Ultra Centrifuge machine (Kubota Corp., Tokyo, Japan). Then the sample was taken out, the clear acetone was removed, and the residue of extract transferred on the glass plate to get complete dry. The fine particles were collected and then examined in TEM (JEOL, Model: 200CX).

2.7. Antibacterial Finish

Then the last solution was made by the mixing of the extract of acetone and the starch solution in the amount of 20ml/L and 30g/L respectively then the ratio is kept as 1:20. Then the dyed and bioscour fabric of cotton was get into to the solution and it is kept still for 20 minutes. After this the treated fabric is retreated in the padding mangle and then it is dried in the air at the room temperature[4].

3. Results and Discussion

3.1. Spectral Studies

The existence of the carbonyl groups detected, as when the absorption band is analyzed at 281 nanometers because of the presence of this carbonyl group There takes place a p-p* transition. The existence of unsaturated ketone group of alpha beta is shown by these p-p* or "R bands" lying between 350nm to 370nm region. The bands that are having an intensity of 1620 "medium intensity" that is the output of -NH, the vibration in the primary salts of amine also takes place at 1620, 1555, 1507 per cms respectively assigned as I, II, and III bands for the functions of the amide proteins [6].

3.2. Metal Ions Uptake

AAS " Atomic Absorption spectroscopy " were done in order to find out the studies of absorption of metal The results of their AAS technique were as reported in figure 1. It is quite evident from the figure 1 that even though the metals(Pb, Ni, Cr, and Cu) were treated with the same adsorbent but inspite of this they shows different fraction (percentage) of absorption. The abroption of Cr, Pb, Cu and Ni by seawood are 96.7%, 65%, 93.8%, and 69.9 respectively.

3
3.3. TEM Studies
A magnified image as taken out through TEM having extracted powdered seaweed is as depicted in figure 2. It is quite clear from the figure that the seaweed granules lie in the scale of the nano meter range also they tend to have of several shapes. Due to the different functional groups that are there in the extracts the shape and size of the granules varies.

4. Conclusions
The existence of the phenols, amide-groups, phenols, nitroso group and sulphate groups can be confirmed by the spectral analysis. TEM indicated the existence of the nano sized seaweed granules possessing different shapes and sizes. Lastly, the acetone that was prepared also showing satisfactory results as an antibacterial agent.

5. References
[1] Senthil kumar.R, Vijayaraghavan.K, Thilakavathi.M, Iyer.P.V.R, Velan.M, “Application of Seaweeds for the Removal of Lead from Aqueous Solution”, Biochem. Eng. J., Vol.33 No.3, March 2007, pp211-216.
[2] Yadav. A, Prasad. V, Kathe.A.A, Raj.S, Yadav.D, Sundaramoorthy.C, Vigneshwaran.N, “Functional Finishing in Cotton Fabrics using Zinc Oxide Nanoparticles”, Bull. Mater. Sci., Vol.29 No.6, November 2006, pp641-645.
[3] Singh PK, & Sharma K, Molecular Dynamics Simulation of Glass Transition Behaviour of Polymer based Nanocomposites, Journal of Scientific & Industrial Research, 77 (10) (2018) 592-595.
[4] A Kumar, K Sharma, AR Dixit, Carbon nanotube-and graphene-reinforced multiphase polymeric composites: review on their properties and applications, Journal of Materials Science, 1-43.
[5] Sreenivasa Rao.P, Parekh.K.S, “Antibacterial activity of Indian Seaweed extracts”, Bot. March., Vol.24 No.11, January 1981, pp577-582.

[6] A Kumar, K Sharma, AR Dixit, A review on the mechanical and thermal properties of graphene and graphene-based polymer nanocomposites: understanding of modelling and MD simulation, Molecular Simulation 46 (2), 136-154

[7] K Mausam, K Sharma, G Bharadwaj, RP Singh, Multi-objective optimization design of die-sinking electric discharge machine (EDM) machining parameter for CNT-reinforced carbon fibre nanocomposite using grey relational analysis, Journal of the Brazilian Society of Mechanical Sciences and Engineering 41 ...

[8] Sastry. V.M.V.S, Rao.G.R.K, “Antibacterial Substances from Marine Algae: Successive Extraction Using Benzene, Chloroform and Methanol”, Bot. Mar., Vol.37 No.4, January 1994, pp357-360.

[9] Kubanek.J, Jensen.P.R, Keifer.P.A, Sullards.C, Collins.M.D.O, Finical.W, “Seaweed resistance to microbial attack: A targeted chemical defense against marine fungi”, Proc. Natl. Acad. Sci. USA., Vol. 100 No.12, June 2003, pp6916-6921.

[10] K Kumar, K Sharma, S Verma, N Upadhyay, Experimental Investigation of Graphene-Paraffin Wax Nanocomposites for Thermal Energy Storage, Materials Today: Proceedings 18, 5158-5163

[11] Goyal, M., Shape, size and phonon scattering effect on the thermal conductivity of nanostructures. Pramana, 2018. 91(6): p. 87.

[12] Silverstein.R.M, Bassler. G.C, Morill.T.C “Spectrometric Identification of Organic Compounds”, 5th Ed:Wiley: New York, Chichester, 1991.

[13] Goyal, M. and M. Singh, Size and shape dependence of optical properties of nanostructures. Applied Physics A, 2020. 126(3): p. 1-8.

[14] A Kumar, K Sharma, AR Dixit A review of the mechanical and thermal properties of graphene and its hybrid polymer nanocomposites for structural applications, Journal of materials science 54 (8), 5992-6026.

[15] K Sharma, M Shukla, Three-phase carbon fiber amine functionalized carbon nanotubes epoxy composite: processing, characterisation, and multiscale modeling, Journal of Nanomaterials 2014