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DEVELOPMENT OF LOW COST NATURAL ADSORBENT FOR THE TREATMENT OF WASTE WATER: A REVIEW

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ABSTRACT

At present the environmental pollution is the biggest problem in front of world in recent years, the use of physical and Chemical treatments for the waste water are not economically feasible. Theuse of different Natural Adsorbent as an alternative low cost adsorbent for the treatment of waste water has been extensively studied and compiled, together with their adsorption capacities. The advantages of adsorption over the conventional methods are low operating cost, selectivity for specific metal, short operational time and no chemical sludge. Removing of hazardous waste and heavy metals required the use of effective natural adsorbent materials. Many Natural adsorbent materials have been employed for the treatment of waste water which includes: Moringa Oleifera, Orange Peel, Banana Stem, Teak Leaves, E.crassipes, Neem Powder, Charcoal Powder, Sugarcane Bagasse, and Banana Trunk Fiber etc.

Keywords: *Waste Water, Natural Adsorbent, Moringa Oleifera, Orange Peel, Banana Stem, Teak Leaves, E.crassipes, Neem Powder, Charcoal Powder, Sugarcane Bagasse, and Banana Trunk Fiber*

I. INTRODUCTION

Industrial, agricultural anddomestic activities of humans have affected the environmental system, resulting in drastic problems such as global warming and the generation of waste water containing high levels of pollutants. As water of good quality is a precious commodity and available in limited amounts, it has become highly imperative to treat waste water for removal of pollutants. In addition, the rapid modernization of society has also led to the generation of hugeamount of materials of little value that have no fruitful use such materials are generally considered as wasteand their disposal is a problem. Also, there are some materials that are available in nature that have little or no use. The utilization of all such materials as low cost adsorbents for the treatment of waste water may make of some value. An effort has been made to give a brief idea of an approach to waste water treatment, particularly discussing and highlighting in brief the low-cost alternative adsorbents with a view to develop these waste or low –cost materials.

II. NECESSITY OF PROJECT

Industrialization in many regions has increased the discharge of industrial waste, especially those containing toxic materials and heavy metals, into natural water bodies. These toxic materials may be derived from mining operations, refining ores, sludge disposal, metal processing, manufacturing of electrical equipment, plant and pigments, metallurgical engineering, batteries, pesticides therefore chemical precipitation, chemical oxidation or reduction, adsorption and ion exchange, membrane separation are employed for removal of heavy metals. These processes may be ineffective or extremely expensive, especially when the concentration is very high. The use of different naturally available adsorbing materials is the most economic option for the treatment of waste water.

III. MATERIALS USED

One of the most popular Natural Adsorbents are considered for the literature survey to find the suitable alternative option as low cost adsorbent with their adsorbing capacities for the treatment of waste water are as follows;

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Moringa oleifera	E.Crassipes
Sugarcane Bagasse	Teak Leaves
Banana Stem Fiber	Neem Powder, Coconut Powder
Orange Peel (waste)	&Charcoal Powder

IV. LITERATURE STUDY

A. Moringa oleifera:

Development and efficacy analysis of a Moringa oleifera based potable water purification kit: Amanpreet Kaur Virk et al. (2019) The purpose of this study was to develop a water purification kit using seeds of Moringa oleifera (MO). For this purpose, aqueous extract of MO seeds was investigated for antibacterial activity against pathogenic bacterial strains viz. Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella typhi and MRSA (Methicillin-resistant Staphylococcus aureus). It was determined that 100 mg/mL of extract of MO seeds was effective against these bacterial strains resulting in 28.75 ± 0.707mm of inhibition zone against E. coli, 26.0 ± 0.707mm against S. aureus, 26.75 ± 0mm against S. typhi, 29.75 ± 0.707mm against P. aeruginosa and 25.5 ± 0.707mm against MRSA. MIC (Minimum inhibitory concentration) of 12.5 ± 0 mg/mL against E. coli and 6.25 ± 0 mg/mL against S. aureus, P. aeruginosa, S. typhi, and MRSA was obtained. Accordingly, portable water purification kit in the form of a dip bag enclosing extremely safe and edible MO seed powder was developed as a key to drinking water problem. Water purification was performed using dip bag to treat pathogenic strains inoculated in water. The minimum time and seed quantity required for the anti-bacterial activity of seeds was optimized and was noted that a single dip bag containing 100 mg of MO seed powder was capable of eradicating 99.9% of the microbial load from 1 L of water in a time span of 5 min. Drinking water from natural water resources containing coliform bacteria was also tested using dip bag and was found to be equally effective.

Evaluation of using aluminum sulfate and water- soluble moringa oleifera seed lectin to reduce turbidity and toxicity of polluted stream water: Jose Henrique Edmilson souza, et al., (2016) Theyevaluated the potential of using aluminum sulfate and WSMoL to reduce the turbidity and toxicity of water from the Cavouco stream located in Recife, Pernambuco, Brazil. The water sample used (called P1) was collected from the stream source, which was found to be strongly polluted based on physicochemical and water quality analyses, as well as ecotoxicity assays with Artemia salina and seeds of Eruca sativa and Lactuca sativa. The assays combining WSMoL and aluminum sulfate were more efficient than those that used these agents separately. Furthermore, the greatest reduction in turbidity (96.8%) was obtained with the treatment using aluminum sulfate followed by WSMoL, compared to when they were applied simultaneously (91.3%).

B. Sugarcane Bagasse:

Adsorption of fluoride onto Sugarcane Bagasse (Saccharum Officinarum): An Application of Taguchi's Design of Experimental Methodology: Kalpana Singh et al. (2015) This paper deals with the application of Taguchi's experiment design to optimize various parameters for the removal of fluoride ions from aqueous solution using sugarcane bagasse as an adsorbent. The effect of various parameters (initial concentration of fluoride (Co), temperature (T), adsorbent dose (m) and contact time (t) on adsorption capacity (qtot) of bagasse to adsorb fluride ions has been studied at three levels. The analysis of variance (ANOVA) shows that parameter B (CO) is the most significant with 49.72% contribution followed by parameter A (m) with the contribution of 40.49% in the adsorption process. The percent removal of fluoride at optimum condition was found to be about 56% with the adsorption capacity of 2.23 mg/g of the adsorbent.

C. Banana Stem Fiber:

Adsorption of emulsified oil, from the waste water by adsorbent from banana trunk fibre: A.R. Tembhurkar et al. (2018) The purpose of this study to safe disposal of spent cutting fluids used as coolant in material processing industries is a serious problem. Applications of ultra-filtration or membrane technology are found to remove spent cutting fluids but are costly. Adsorption is to be found cost-effective method for removal of emulsified cutting oil. Currently researches are focused on the developing a adsorbent from waste material. In present study, efforts have been made to develop adsorbent using agro-waste '' banana trunk fiber (BTF)'' for the removal of emulsified oil from the waste water. Batch adsorption studies demonstrated that chemically modified adsorbent has significant capacity to absorb emulsified oil. The parameters investigated in this study included ph, temperature, contact time, initial oil concentration, adsorbent dosages. SEM micrograph of the powdered activated banana trunk fiber before and after the adsorption is determined which indicate adsorption of oil, it is found that the adsorption of oil onto BTF adsorbent follows Freundlich isotherm. Freundlich constant 'K1' and 'n' were obtained to be 1.3091mg/g and 1.348 at an adsorbent dose of 6g/L andtemperature 26+ C.

Kinetic and equilibrium modelling of lead (II) sorption from water and wastewater by polymerized banana stem in a batch reactor: B.F. Noeline at el. (2005) The aim of this research work was a kinetic and equilibrium study of the sorption of lead(II) ions from water and wastewater by formaldehyde polymerized banana stem containing sulphonic acid groups. The adsorbent was characterized using surface area analyzer, infrared spectroscopy and scanning electron microscopy measurements. The surface charge and the acid groups of the adsorbent were determined using potentiometric and acid–base titrations, respectively. Batch experiments were performed under kinetic and equilibrium conditions. The optimum pH range for the maximum removal of lead(II) was 5–9. The maximum adsorption of 98.5 and 89.9% took place for an initial concentration of 10 and 25 mg/l, respectively, at pH 6.0. The sorption process occurred in two stages: external mass transport occurred in the early stage and intraparticular diffusion occurred in the long-term stage. The Langmuir, Freundlich and Redlich–Peterson isotherm models were tried to represent the equilibrium data of lead(II) adsorption. The data fitted very well to the Freundlich isotherm model in the studied concentration range of lead(II) adsorption. Quantitative removal of 10.0 mg/l lead(II) in 50 ml of battery manufacturing wastewater by 125 mg of the adsorbent was observed at pH 6.0. The adsorbent was suitable for repeated use (for more than four cycles) without noticeable loss of capacity.

D. Orange Peel (waste):

Use of chemical modification to determine the binding of Cd(II), Zn(II) and Cr(III) ions by orange waste: A.B. Perez Marin et al. (2009) This study focuses on the roles played by three major functional groups (amine, carboxyl and hydroxyl) in the orange waste biomass for sorption of three heavy metals (Cd2+, Zn2+ and Cr3+). The biosorbent was chemically modified to block the mentioned functional groups in order to determine their contribution to the adsorption of metals. Fourier transform infrared (FTIR) and solid state carbon-13 nuclear magnetic resonance (13C NMR) spectroscopy were used to investigate the chemical modification. Additionally, batch biosorption tests were carried out with the different biosorbents in order to determine the possible reduction in metal uptake with the chemically modified biosorbent. Blocking of the COOH groups by chemical esterification resulted in an important reduction in metal binding. Nevertheless, no significant modification in metal removal was observed with acetylated and methylated orange waste.

Adsorption study of copper (II) by chemically modified orange peel: Ningchuan Feng at el. (2009) In this study an adsorbent, the chemically modified orange peel, was prepared from hydrolysis of the grafted copolymer, which was synthesized by interaction of methyl acrylate with cross-linking orange peel. The presence of poly (acrylic acid) on the biomass surface was verified by infrared spectroscopy (IR), scanning electron microscopy (SEM) and thermogravimetry (TG). Total negative charge in the biomass surface and the zeta potentials were determined. The modified biomass was found to present high adsorption capacity and fast adsorption rate for Cu (II). From Langmuir isotherm, the adsorption capacity for Cu (II) was 289.0 mg g−1, which is about 6.5 times higher than that of the unmodified biomass. The kinetics for Cu (II) adsorption followed the pseudo-second-order kinetics. The adsorbent was used to remove Cu (II) from electroplating wastewater and was suitable for repeated use for more than four cycles.

E. Teak Leaves:

Removal of Copper (II) from Aqueous Solutions Using Teak (Tectona grandis L.f) Leaves: S. Rathnakumar et al. (2009) The experiments were performed in a batch set up under different concentrations of Cu (II) (0.2 g.l-1 to 0.9 g.l-1), pH (4- 6), temperatures (20o C – 40o C) with varying teak leaves powder (as biosorbent) dosage of 0.3 g.l-1 to 0.5 g.l-1. The kinetics of interactions were tested with pseudo first order Lagergran equation and the value for k1 was found to be 6.909 x 10-3 min-1. The biosorption data gave a good fit with Langmuir and Fruendlich isotherms and the

Langmuir monolayer capacity (qm) was found to be 166.78 mg. g-1. Similarly the Freundlich adsorption capacity (Kf) was estimated as 2.49 l g-1. The mean values of the thermodynamic parameters ΔH, ΔS, and ΔG were -62.42 KJ. mol-1, -0.219 KJ.mol-1 K-1 and -1.747 KJ.mol-1 at 293 K from a solution containing 0.4 g l-1 of Cu(II) showing the biosorption to be thermodynamically favourable. These results show good potentiality of using teak leaves as a biosorbent for the removal of Cu(II) from aqueous solutions.

F. E.Crassipes:

A Study on natural adsorbents for the removal of chloride ion in water: M. Shanmugasundaram at el. (2012) This study is focused onChlorides, which are generally present in water in the form of NaCl. Chloride in concentration above 600mg/l tends to give water a salty taste. WHO specifies highest desirable concentration of chloride in portable water must be 200ppm. Chloride attack is one of the most important aspects for consideration when we deal with the durability of concrete. Chloride attack primarily induces corrosion, which is responsible for 40% of the failure of structure. As per IS46:2000 the water used for mixing and curing concrete should comprise a chloride content with a permissible limit of 2000mg/l for plain concrete and 500mg/l for reinforced concrete work. In industries there are various methods adopted to produce potable water, of which, the adsorption process is a widely used phenomenon. Here for the removal of chlorine we are using E.crassipes (A natural adsorbent) and Amberlite (a synthetic adsorbent). The objective of our project is to find the adsorption capacity of E.crassipes and Amberlite for the removal of chloride ion in water. The adsorption capacity is found out by Batch studies which include Effect of dosage, Effect of pH, Effect of initial concentration and Effect of contact time. And adsorption capacity is found out theoretically by Langmuir adsorption isotherm and freundlich adsorption isotherm.

G. Neem Powder, Coconut Powder & Charcoal Powder:

Removal of Chloride Ion from water by using Adsorbents: Yogendra Singh Tomar et al. (2018) Chloride is commonly present in water as Sodium Chloride. Concentration of Chloride above 250 mg/l imparts a salty taste to water. Excess Chloride concentration in water is responsible for the cardiovascular diseases & corrosion of RCC structures. In order to avoid these problems, removal of excess Chloride from water is desired. There are various methods available for the removal of chloride from water, such as reverse osmosis (R.O.), and distillation. These methods are costly and have some limitations. Therefore, the adsorption process which is alternatives to these methods can be used effectively. In our study, we have used different adsorbents i.e. Neem powder, Coconut shell powder and Charcoal powder and examine their efficiency of Chloride at natural pH and at room temperature. Keeping the pH Controlled at 7 by using 0.1N HCL & 0.2N NaOH as acid/basic solution, the Chloride removal efficiency of each adsorbent will depend upon its doses and contact time for mixing.

Removal of Methylene Blue Using Low Cost Adsorbent: A Review: Mohammed M.A. (2014) In this article, adsorption process has been found to be one of the best treatment methods for Methylene blue (MB) removals. As the control of water pollution has become an increasing importance in recent years, the use of physical/chemical treatments such as membrane filtration, reverse osmosis, coagulation/flocculation and fenton reagents are not economically feasible. The use of different biosorbent as an alternative low cost adsorbent in the removal of methylene blue has been extensively studied and compiled, together with their adsorption capacities and experimental conditions such as adsorbent dose, pH of the solution, temperature and equilibrium time. But, there are issues as regards to draw back in the use of activated sorbents which were also discussed briefly. However, it is evident from the results of experiments in the literatures Surveyed that various low-cost adsorbents have shown good potential for MB.

V. OBJECTIVES OF STUDY

- To study about the natural adsorbent which are locally available with their adsorbing capacities.
- By applying set of trial for suggesting suitable adsorbent for removing different types of Toxic elements and heavy metals.
- To find the suitable combination of the adsorbents to absorb the hazardous elements with highest capacity from the waste water.

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VI. PROPOSED METHODOLOGY

- To study the property of low cast natural adsorbent in available literatures.
- To collect the sample of the waste water from the different identified points.
- To test the collected waste water and identify the property of the waste water.
- To prepare Natural adsorbent in fine powdered form for the testing of waste water.
- To test the waste water with the specified quantity of adsorbent in the laboratory.
- To identify the percentage removal of the toxic substance from waste water sample after testing.
- To repeat the test with the different percentage of adsorbent and with the other alternatives.
- To suggest the suitable adsorbent with their percentage and best suitable combination of natural adsorbent.

VII. CONCLUSION

In this study, Adsorption process has been discussed as the most respective methods for the treatment of waste water and the removal of hazardous waste due to its low maintenance costs, high sufficiency and ease of operation. After survey on the various types of Natural Adsorbents has been done and their adsorption properties of the natural adsorbent are tabulated below.

Table 1. Natural Adsorbents

S.N.	Natural Adsorbent	Description
1	Moringa oleifera	Reduction of turbidity up to 96.8% was obtained with thetreatment using aluminum sulfate followed by Water Soluble Moringa Oleifera. One dip bag containing 100 mg of Moringa Oleifera seed powder was capable oferadicating 99.9% of the microbial load from 1 L of water in a time span of 5 min.
2	Sugarcane Bagasse	The percent removal of fluoride at optimum condition was found to be about 56% with the adsorption capacity of 2.23 mg/g of the adsorbent.
3	Banana Stem Fiber	The optimum pH range for the maximum removal of lead(II) was 5–9. The maximum adsorption of 98.5 and 89.9% took place for an initial concentration of 10 and 25 mg/l, respectively, at pH 6.0. Scanning electron microscopy (SEM)micrograph of the powdered activated banana trunk fiber before and after the adsorption is determined which indicate adsorption of oil, it is found that the adsorption of oil onto BTF adsorbent follows Freundlich isotherm.
4	Orange Peel (waste)	TheOrange Peel adsorbent was used to remove Cu (II) from electroplating wastewater and was suitable for repeated use for more than four cycles.
5	E.Crassipes	E.crassipes (A natural adsorbent)and Amberlite (a synthetic adsorbent) is used for removal of chlorine. The adsorption capacity of E.crassipes and Amberlite for the removal of chloride ion in water is effected with dosage, Ph, initial concentration and contact time. The adsorption capacity of water hyacinth and Amberlite were studies using chloride solution. Amberlite is better adsorbent compared to water hyacinth as the former shows best fit for both Langmuir and Freundlich isotherms.
6	Teak Leaves	Results show good potentiality of using teak leaves as a biosorbent for the removal of Cu(II) from aqueous solutions.
7	Neem Powder &Coconut Powder&Charcoal Powder	Neem powder, Coconut shell powder and Charcoal powder and examine their efficiency of removal of Chloride at natural pH and at room temperature. Keeping the pH Controlled at 7 by using 0.1N HCL & 0.2N NaOH as acid/basic solution, the Chloride removal efficiency of each adsorbent will depend upon its doses and contact time for mixing.

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