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EVIEW ARTICLE

Study of eco-friendly agricultural wastes as non-conventional low cost adsorbents: A review

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Water scarcity will be a key issue for the sustainable development of a country in future. Now India is facing a water crisis and coming years it is estimated that India's population will be suffered from severe water scarcity. In this paper, we study, review and compare the characteristics of various types of agricultural wastes as natural adsorbents. A vast assortment of ease regular adsorbents have been examined for their capacity to expel different sorts of toxins from water and wastewater. On the off chance that these agricultural wastes could be utilized as best adsorbents, it will give favorable position to ecological contamination. There have been attempts by scientists to investigate the adsorption capability of non-conventional, naturally-occurring agricultural wastes in treatment of different effluents. In India alone in excess of 400 million tons of agricultural wastes is produced every year, which incorporates bagasse, stalk, coir substance, rice husk etc. Investigating use of the agricultural wastes for use as adsorbents can give reasonable options in contrast to the treatment of domestic and industrial effluents.
Keywords: Natural adsorbents; waste water treatment; eco-friendly; agricultural wastes

Introduction

The interest on water use is excessively high as the local and mechanical requests are expanding quickly in the all segments. Be that as it may, then again, the waste litters dealing with are not very much overseen. Release gushing from the mechanical and farming exercises are more in volume that such overwhelming metals, including natural mixes and a few effluents were depleted without legitimate treatment, which specifically influenced the water quality (UNESCAP, 1999) (Lim, & Aris, 2014). Diverse kinds of treatment innovations are accessible with various level of achievement to limit and control water contamination (Mahvi, et al., 2005). Be that as it may, the vast majority of these techniques are high operational and support costs (Hosseinnia et al., 2006). Nearly, the adsorption procedure is a superior option in water and wastewater treatment on account of comfort, simple task and effortlessness of design (Višekruna, Štrkalj & Marinić, 2011; Dubey & Sahu, 2014). Among the different types of contamination, water contamination is of extraordinary worry since water is the essential need of life and extremely basic for the survival of every single living being. It is important that just 0.02% of the complete accessible water on the earth is for use as waterways, lakes and streams (Višekruna, Štrkalj & Marinić, 2011). However, augmentation of mechanical, farming and local exercises results in the age of huge measure of wastewater which contains various dangerous contaminations, which are dirtying the accessible new water ceaselessly. With the acknowledgment that contaminations present in water unfavorably influence human and creature life, residential and mechanical exercises, contamination control and the executives is currently a high need zone. The accessibility of clean water for different exercises is turning into the most difficult errand for analysts and professionals around the world. A huge assortment of minimal effort regular adsorbents have been analyzed for their capacity to expel different sorts of contaminations from water and wastewater. In the event that these squanders could be utilized as ease adsorbents, it will give a two-overlay favorable position to ecological contamination. Right off the bat, the volume of results (or squanders) could be halfway diminished and furthermore the ease adsorbent, whenever created, can decrease the contamination of wastewaters at sensible expense (Mahvi, et al., 2005). In this manner, it is vital to scan for new and conservative process that could treat the emanating and that are generally utilized in the business. For the most part, an ease sorbents can be characterized as one which requires small preparing and is bottomless in nature. In this unique situation, agrarian side-effects and mechanical waste can be viewed as having an extraordinary potential to be created as a minimal effort sorbent. The attainability of utilizing these materials could be valuable not exclusively to the earth in taking care of the strong waste transfer issue, yet in addition the economy. Writing study uncovered that various natural materials have been used as adsorbents.

Traditional techniques for treating wastewater were for some time directed to give a superior water quality and to treat before it being discharged into the water bodies. Among the regular water treatment directed were synthetic precipitation, coagulation, flocculation, particle trade, film filtration and enacted carbon (Bailey et al. 1999; Sud et al. 2008; Demirbas 2008; Chiban et al. 2012; Dave et al. 2012). In any case, the customary strategies were fairly costly, as greater expense was required amid the task. Besides, the customary strategies will in general have residuals and deficient expulsion of the contaminations representing another issue (Chiban et al. 2012). In last few years, researchers have been contemplating on utilizing reasonable adsorbents to evacuate overwhelming metals in the water. The ease adsorbents used to rehearse adsorption exercises were typically squander items from another generation like horticulture, modern and nourishment creation, which can be gotten copiously.

Methods available for treatments of waste water

1. Absorption,
2. Adsorption,
3. Chemical and biological method,
4. Physical method, and
5. Mechanical method.

Literature review

The motivation behind this audit is to give potential minimal effort materials utilized in the ongoing investigations and furthermore survey the proficiency of different ease materials in expelling the metals. This audit can fill in as precedents for further investigations on adsorption of substantial metals utilizing minimal effort items. Furthermore, the explored minimal effort materials can incorporate for the regular wastewater medications with a superior monetary viewpoint and ecological sound technique. Reconciliation of thoughts and information upon the flow innovation can give a superior wastewater treatment framework and create no auxiliary results of the treatment exercises.

Low cost adsorbents

Calcium carbonate and seafood waste: Calcium carbonate and fish squander were utilized to expel substantial metal because of the precipitation happen between the metal particles and carbonate from the adsorbents (Patterson et al., 1977; Sdiri and Higashi 2012). The employments of regular items from fish are extremely mainstream in the ongoing inquires about as they can be effectively acquired, shoddy and the items can be reused as opposed to being waste items. Numerous investigations found that metal particles can be decreased by utilizing normal clam, crab and mollusk shells as its adsorbent (Lee et al., 1997; Rahman et al., 2008; Moon et al., 2011; Du et al., 2012; Ismail et al., 2013). The characteristic clam shell could decreased 72% of 4.779 mg/kg of arsenic in the mine following 28 days of treatment with 30% normal shellfish shell load to the example; for the calcined clam shell at 25% weight, it successfully diminished 99% of arsenic with a similar contact time of 28 days (Moon et al., 2011; Seco-Reigosa et al., 2012; Hosseinnia et al., 2006) (Figure 1; Table 1).

Figure 1. Seafood waste.

Egg shells: In last few years, carbonated shells from sustenance businesses have been normally utilized in numerous examinations to perform metal particles adsorption because of its plenitudes after nourishment preparing (Ahmad et al., 2012; Wang et al., 2013). Eggshells are one of the instances of carbonate shells utilized for metal evacuation. The normal chicken eggshells were utilized to expel 96.43% of 7 mg/L of Fe(III) in the watery arrangement with the ideal temperature of 20 °C and dose of 2.5 g/L with control pH 6 (Yeddou and Bensmaili, 2007; Hosseinnia et al., 2006) (Figure 2).

Figure 2. Egg shells.

Chitosan: Chitosan is notable for being able to expel overwhelming metals in the water dependent on the past examination (Bailey et al., 1999; Saifuddin and Kumaran, 2005; Pontoni and Fabbricino, 2012). Cu(II) with beginning grouping of 200 ppm was found to tie adequately with the chitosan with its little ionic distance across of 70 pm, which showed 99.25% of Cu(II) expulsion in watery arrangements (Uzun and Gu¨zel, 2000). In the ongoing investigations, chitosan is regularly joined and altered with different adsorbents to advance its viability. Chitosan covered corrosive globules could decreased 65% of 20 mg/L Cr(VI) at pH 1–92% evacuation at pH 5 (Nomanbhay and Palanisamy, 2005; Hosseinnia et al., 2006) (Figure 3).

Figure 3. Chitosan.

Agricultural waste

Coconut husk: Coconut husks are squander result of coconuts and it is typically accessible in wealth in the tropical nations. The high tannin in the coconut husk makes it a decent metal adsorbent (Abdulrasaq and Basiru, 2010). Altered coconut husk is demonstrated to have a superior adsorption of overwhelming metal. The coconut shell treated with corrosive and covered with chitosan has the best evacuation execution for 25 mg/L zinc with 93% expulsion at pH 6, 30 g/L of adsorbent, 3 h contact time and arrangement temperature of 25°C contrasted with the corrosive treated coconut shell and chitosan covered coconut on the grounds that the coconut shell treated with corrosive and covered with chitosan has the most surface regions for Zn(II) to join on (Amuda et al., 2007). The adsorption limits of the adjusted coconut shells were likewise all around spoken to by the Langmuir and Freundlich isotherm (Amuda et al., 2007; Hosseinnia et al., 2006). Coconut husk have great execution to adsorb fluoride from drinking water particularly for high centralization of fluoride and had given an amazing outcomes (Upadhye & Yamgar, 2016). The biosorbent was fruitful in expulsion of fluoride particles from fluid arrangement of 0.7 mg/l fluoride focus with about 86% proficiency at 323K temperature. It was likewise seen that the adsorption was pH subordinate with most extreme adsorption accomplished at pH 5.0 with 78% proficiency (Islamuddin et al., 2016) (Figure 4).

Figure 4. Coconut husk.

Rice husk: Rice is one of the principle sustenance sources in a few nations, and it has been developing to a great extent particularly in South East Asia nations. The usage the side-effect of rice, for example, rice husk will emphatically add to monetary yield (Chakraborty et al., 2011). In Rehman et al. (2011), the common rice husk was altered with polyaniline for a superior adsorption execution. From all the watched variables, pH, contact time, tumult speed, temperature, it was discovered that the polyaniline/rice husk demonstrated the most astounding evacuation of Cd(II) which were 93.08% (20 min), 97.5% (30 °C),and 94.45% (100 rpm) as contrast with the normal polyaniline and polyaniline/saw dust which have bring down expulsion rate (Rehman et al., 2011; Hosseinnia et al., 2006). Sugarcane bagasse have good performance to adsorb of oil by-product from polluted water especially for high concentration of pollutant and the Multimedia Filter process had given an excellent results and significantly assist in the removal of Ph, TDS, BOD, COD, TSS, TDS, DO, hardness, and will improve the physio-chemical quality of the effluent (Islamuddin et al., 2016) (Figure 5).

Figure 5. Rice husk.

Palm fruit: Palm oil ranches are a standout amongst the most worthwhile farming exercises in Malaysia. In Ideriah et al. (2012), the expulsion of Cr by palm natural product fiber biomass at pH somewhere in the range of 4 and 10 was low, while Pb was expelled 100% at pH 10 and Cu was evacuated 100% at pH 10 and 12. Be that as it may, the greatest adsorption of Pb by okra squander was streamlined at pH 5 (Hashem, 2007; Hosseinnia et al., 2006) (Figure 6).

Figure 6. Palm Fruit.

Nut shell: In last few years, agribusiness squanders have been extremely well known among the other minimal effort bioadsorbents. The castor seed body appeared to have just about multiple times adsorption limit than the actuated carbon in correlation with a similar fix contact time (300 min) and beginning focuses (5, 10, 20, and 30 ppm) (Sen et al., 2010). Altered base-washed peanuts shells with citrus extract exhibited a superior expulsion capacity of Cd(II), Cu(II), Pb(II), Ni(II) and Zn(II) than a portion of the business gums, for example, Duolite GT-73 and carboxymethyl cellulose (Chamarthy et al., 2001) (Figure 7).

Figure 7. Nut shells.

Fruit bagasse: Natural product bagasse is the sinewy buildup from the extraction of the organic product juice. It is ordinarily bounteous from the sustenance enterprises after monstrous of nourishment and refreshment creation or bundling (Chakraborty et al., 2012). Sugar stick treated with sulphuric corrosive and sugar stick initiated carbon were utilized to expel Cd(II) (Krishnan and Anirudhan, 2003). Sugar stick treated with 8.9% of sulphuric corrosive had most extreme adsorption of 98.8% of 50 mg/dm^3 Cd(II) while for sugar stick actuated carbon, 56.8% of 50 mg/dm^3 Cd(II) were evacuated at pH 6 with (Krishnan and Anirudhan, 2003). Sugarcane bagasse have good performance to adsorb of oil by-product from polluted water especially for high concentration of pollutant and the Multimedia Filter process had given an excellent results and significantly assist in the removal of Ph, TDS, BOD, COD, TSS, TDS, DO, hardness, and will improve the physio-chemical quality of the effluent (Islamuddin et al., 2016; Hosseinnia et al., 2006) (Figure 8).

Figure 8. Fruit bagasse.

Table 1. Review articles concerning low-cost adsorbents.

S No	References	Goal	Pollutants investigated
1)	Bhatnagar et al. (2015)	The review gathers the work directed by different specialists in the course of the most recent couple of decades on the utilization of different farming waste strips as adsorbents for the water and wastewater treatment. In this survey, adsorption capacities with respect to natural and inorganic contaminations by various strip based adsorbents are condensed.	Dyes; heavy metals
2)	Sunil Jayant Kulkarni et al., (2015)	In this review summarizes the packed and fluidized treatment of the wastewater for removal of organic matter.	Organic pollutants
3)	Ashwani Kumar Dubey et al., (2014)	This article reviewed the currently used practices of constructed wetlands, single-pass and recirculating sand filters for the treatment of dairy parlour wastewaters.	Organic pollutants
4)	M.T. Yagub et al., (2014)	The survey article gives broad writing data about dyes and colors, its grouping and danger, different treatment strategies, and dyes adsorption qualities by different adsorbents.	Dyes
5)	Enas M. Abou-Taleb et al., (2014)	In this review Treatment of this wastewater using different coagulants indicated that the use of 500 mg/l alum aided with400 mg/l lime and 0.35 mg/l anionic polymer are capable of removing 69%, 65% and 61% of COD, BOD and color.	Organic pollutants, Dyes
6)	Gautam et al., (2014)	This review gave a thorough evaluation of the balance demonstrating of various biosorption forms just as the basic, synthetic and morphological adjustments and enactment of biosorbents.	Heavy metals
7)	George Z. Kyzas et al., (2014)	In this paper survey the initiated carbons were set up from potato strips either with pyrolysis or aqueous treatment and these materials were utilized for the expulsion of two medication mixes	Pharmaceutical effluents

		(dorzolamide and pramipexole) from manufactured watery effluents.	
8)	S. Rangabhashiyam et al., (2013)	The review article centers around the different wellsprings of the farming waste items and its adsorption limit of the distinctive dyes.	Dyes
9)	Randhir Kumar et al., (2013)	In this review an overview on the development of low-cost adsorbents derived from eggshell by-products and spent tea waste.	Dyes
10)	Bakhtyar K. Aziz et al., (2013)	This paper reviews that spent bleaching clay can be used as a best adsorbent for removing phenol concentrations from waste water after De-oiling of the spent clay.	Phenol & Dyes
11)	Muhammad Ali Zulfikar et al., (2013)	In this review, the adsorption of CR on powdered eggshell under the influences of contact time, initial concentration, particle size of adsorbent, adsorbent dosage and pH were investigated.	Organic pollutants
12)	Emmanuel E. Egbon et al., (2013)	In this review the activated carbon prepared from maize cob for the removal of colours and dyes, solid particles, inorganic materials and heavy metal levels	Organic pollutants, Dyes
13)	I. Ali et al., (2012)	This review portrayed the change of waste items into successful adsorbents and their application for water treatment.	Organic pollutants
14)	Tejal R Patil et al., (2012)	A Review of Package Treatment Options for Domestic Wastewater.	Organic pollutants
15)	Syafalni S et al., (2012)	In this review The treatment of dye wastewater using GAC and zeolite adsorbents was investigated under different experimental conditions in column process.	Dyes
16)	Kafia M. Shareef Surchi et al., (2011)	In this paper review This paper highlighted the use of highly efficient low cost and abundant materials for removal of toxic Pb ions from contaminated aqueous solution.	Heavy metals
17)	Mohammad Mirjalili et al., (2011)	In this review article, wheat husk was applied as a natural adsorbent for the dye C. I. Reactive Yellow 15 removal from aqueous solutions.	Dyes
18)	A.Višekruna et. al., (2011)	In this article, the utilization of ease adsorbents for the expulsion of toxic substances from wastewater has been investigated.	Heavy metals, Phenol & Dyes.
19)	Bhatnagar and Sillanpää, (2010)	In this survey, a broad rundown of ease adsorbents (arranged by using diverse sorts of waste materials) from huge results has been gathered and their adsorption capacities with respect to different water	Various toxic pollutants (Dyes heavy metals; PAHS)
20)	V.K. Gupta and Suhas et al., (2009)	This survey features and gives a diagram of these ease adsorbents (LCAs) containing normal, mechanical just as manufactured materials/squanders and their application for colors and dyes expulsion.	Dyes
21)	Nour El-Din T. Abdel-Ghani et al., (2008)	In this review the study clearly demonstrated the potential use of rice husk and Nile rose plant for the removal of Cr (III), Cu (II), Zn(II), Cd (II) and Pb (II) from mixed metal ions aqueous solutions.	Heavy metals
22)	A. Hosseinnia et al., (2006)	Removal of surfactants from waste water by rice husk.	Organic pollutants
23)	G.M. Taha et al., (2006)	In this study Bagasse fly ash, a waste material generated in the sugar industry, was used, successfully, as a low cost and effective adsorbing surface for the removal of Ni21, Zn21, Cu21 and Cr31 from industrial waste water.	Heavy metals
24)	Zainab Ziad Ismail et al.,	This review shows shows the potential of walnut-	Oil & Greece

	(2005)	shell application for the oil removal from wastewater.	
25)	Amir Hossein Mahvi et al., (2004)	In this review article focuses on the study, expulsion of cadmium, lead and nickel from industrial wastewaters has been investigated by using teawaste as a best natural adsorbent.	Heavy metals

Results and conclusion

The untreated wastewater which is released into the natural bodies like river, lakes, ponds etc. tends to deteriorate the quality of the fresh water disturbing the aquatic system. Even after there is huge amount of capital investment in the treatment plants, they are not running to their full efficiencies due to various miscellaneous reasons (Gautam, 2016; Zainab, 2005). It is therefore required to bring alternative options such as use of natural adsorbents which freely available are at zero cost and can be implemented with an ease (Figure 9).

The study reports that among the various adsorbents used the activated carbon has the highest removal efficiencies which are about 95% followed by sugarcane bagasse which is 85%. The egg shells, nut shells, coconut husk, sea food wastes, rise husk, palm fruit can be also used as adsorbents depending upon their removal efficiencies and type of wastewater to be treated. Chitosan has reported to be least efficient in the removal of BOD which is as low as 62%, however it is easily available and easy to use as a natural filtering material. Collectively, these adsorbent not only increase the efficacy but also increase the overall efficiency of the treatment system at zero capital input. The natural adsorbents may be utilized in the decentralized low cost treatment units for the above stated problem so that sustainable solution can be implemented and administered.

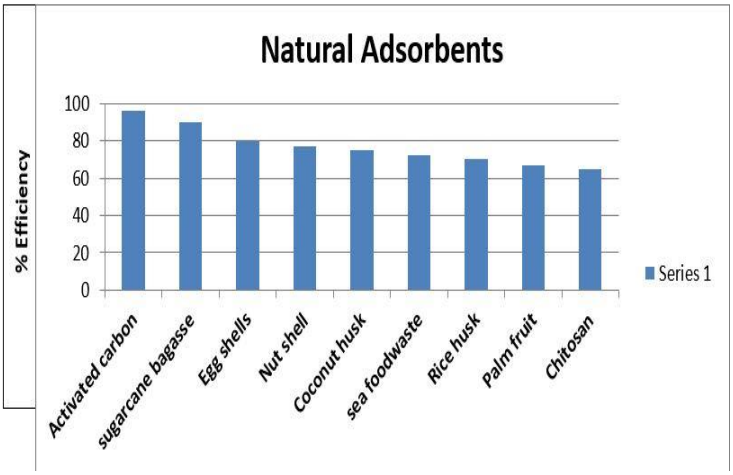

Figure 9. Natural adsorbents efficiency.

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