Removal of Lead from Metal Conaminated Industrial Waste Water By Adsorption onto Banana Peel

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ABSTRACT

Banana peel, a fruit waste was used to produce biosorbant through environment friendly process. Banana peels were washed, dried and ground, before being used for treatment of industrial waste water and used for lead removal. The experiments were carried out by different concentration of dosage for incubation time 24 hours in the batch mode for the measurement of adsorption capabilities. The powdered as an adsorbent, in orbital shaker at 150 to 180 rpm at 25˚C. 8ml waste water sample was used in triplet, each was kept with 10mg, 20mg, and 30mg concentration of banana peel and obtained equilibrium adsorption capacity was 0.649, 0.184, 0.021mg/L respectively. The separation of bio adsorbent and solution was carried out by filtration with Whatman Filter Paper No.42 and the filtrate stored in sample cans for determine the metal lead ion concentration using Atomic Absorption Spectrophotometer (AAS). Heavy metal ions were estimated before and after addition of powdered adsorbents. The powder of that bio sorbent was used for treatment of waste water with different proportion of adsorbents, variation of pH and contact time. Lead adsorption onto banana peel was depended upon the controlling parameter such as pH, conductivity, Total Dissolved solids, Salinity, Sodium, Potassium by Flame Photometer and Lead ion concentration by Atomic Absorption Spectrophotometer (AAS). Slightly basic water (pH = 8.3) was found to be suitable for lead removal.

Equilibrium data were well fitted (R2 = 0.998) with the Langmuir and Freundlich isotherms. The monolayer adsorption capacity was 0.025 mg/L on 30 mg banana peel. The calculated RL and 'n' values has proved the favorability of lead adsorption onto banana peel. Lead adsorption was followed the second order kinetic properly rather than other models. Solvent 0.1N Sulphuric acid showed higher desorption of lead (60%) and adsorption-desorption process can be continued till seven cycles efficiently.

Keywords: **Banana peel, Bio sorbents, heavy metal, lead, atomic absorption spectrophotometer**

INTRODUCTION

India is a developing country with an increasing population density. In order to develop its economy, India requires establishment of new industries. Due to unplanned industrial growth, much of the land and nearby water bodies is polluted by indiscriminate dumping of solid and liquid wastes generated by these units. Increase in the levels of metal ions and organic pollutants in the environment are either due to absence of laws for various

industries to treat their wastes or if there are laws, there is no strict enforcement by the Ministry of Environment and other regulatory authorities in India. Land contaminated by heavy metals is increasingly becoming an environmental, health, economic and planning issue in the India [1].

Eco-toxicity due to polluted water sources effect on living organisms has become a main concern for the last few decades. Due to rapid industrialization and substantial urbanization, the waste effluents get discharge directly in river water causing pollution to environment [2]. Heavy metals are an important class of environmental pollutants. With the onset of fast developing industries and energy stations, metal wastes are getting discharged into the environment in many ways. There have been many instances when heavy metal toxicity has led to mass deaths. Removal of heavy metal ions from effluents can be achieved by various methods. The existing technologies for waste water treatment have major problems.

Costs involved in the construction of waste water treatment plants are un-economical, it also consumes a big space. They also have disposal problem along with unattractive problems. There are three types of technologies such as biological, chemical and physical. These technologies have many merits and demerits as they have high cost and disposal problems. The chemical technologies methods are coagulation, flotation, filtration, conventional oxidations by oxidizing agents, irradiation, which having lots of disposal problems. Some of them are very costly technologies such as membrane technologies and ion exchange. So, an alternative method is required by which waste water can be treated in appropriate way.

Bio sorption is the ability of biological materials to accumulate heavy metals from wastewater through physical-chemical pathways of uptake [3].

The main advantage of bio sorption is that it gives the significant amount of energy saving from a more efficient wastewater treatment system operating for fewer hours; it is economically attractive because waste biomass is inexpensive and widely available [4]. In bio-adsorption, removal of metal ions helps in the effective usage of bio-waste as metals stick on to the surface of biological components.

Full scale Bio sorption process requires the biological materials which have high metal binding capabilities and specific heavy metal selectivity. Bio sorption also offers low operating cost, minimization of chemical and biological sludge, and no additional nutrient requirements [5].

Different bio adsorbents have been used for removal of heavy metals. Some of them include rice straw, sea-weed, wood and bark, tea-waste, maize-corn cob, sugarcane bagasse, tamarind hull, sawdust, rice husk, sunflower stem, etc [6].

Out of the wide range of

adsorbents, banana peel seems to be good adsorbent and can be used as valuable material for cleaning of water. Bio adsorbent prepared from banana peels has been reported for the removal of chromium, cadmium, lead and copper ions from aqueous solution [7].

This study reveals about the importance of using an environmental pollution free approach, Banana peels for the removal of heavy metal ions from waste water.

Effects of heavy metals on the human health

In addition to degrading the quality of natural waters, heavy metals can also cause several serious health problems in humans, affecting the nervous system, kidney, liver, and respiratory functions. Most "metal trace elements" (MTEs) are strongly carcinogenic. MTEs can produce delays in the human growth and development and disruption of bio regulatory systems responsible for functional or psychosomatic disorders, like chronic fatigue syndrome and neurodegenerative pathologies, such as the Parkinson's and Alzheimer's diseases.

Intoxication by some heavy metals, such as mercury and lead, can also lead to autoimmunity phenomena, in which the immune system of the patient attacks his own cells. This can lead to joint diseases, such as rheumatoid arthritis and kidney, circulatory or nervous problems. We have given in table several human health disorders that are caused by heavy metals. There is, below sections, we have given a specific study on the impact and toxicity on the environment and human health of most important heavy metals lead. (Table 1)

Name of Metal	Route of exposure	Major sources	Health impacts
Lead	Water ingestion,paint, soil	Mining, fossil fuel burning, manufacturing of lead—acid batteries, oxidesynthesis for paint, and pigments	Neurotoxic effects on intelligence, decreasedmemory, hemolytic anemia, CVS diseases, reproductive toxicity,lung cancer, bladder Cancer

Impact and toxicity of lead

Lead poisoning is long term toxicity, which effects on the nervous, hematopoietic and cardiovascular human systems. At high doses, lead can cause neurological, hematological, and renal disorders. In children, it can also produce brain development disorders, with psychological disturbance and learning difficulties. Lead poisoning results in decreased fertility, death of fetuses and spontaneous abortion, and neurological, cardiovascular, and gastrointestinal disorders and may have also mutagenic and carcinogenic effects. Lead is very toxic to many invertebrates, especially to the freshwater invertebrates. But marine invertebrates generally tolerate it better and some invertebrates show adaptability or are

more "tolerant" to lead than others. Lead salts are poorly soluble in saltwater and in hard water and the presence of other salts reduces the availability of lead for organisms, due to lead precipitation. In aqueous medium, the lead toxicity varies with fish species. Eggs and very young fishes are the most vulnerable. Bird spinaldeformity and blackening of the caudal region are symptoms of lead intoxication. Lead salts can also affect the poison on birds from around 100 mg of lead kg−1 of food. In addition, the exposure of quail toward food containing 10 mg of lead kg−1 can yield negative effects on the egg production [8]

The anemias caused when lead interfere with heme synthesis. The δ-aminolevulinic acid (δ-ALA) levels increased due to inhibition of δ-aminolevulinic aciddehydrates (δ-ALAD) enzyme. Due to which genotoxic effects produced because it developed oxidative stress [9]

LITERATURE SURVEY

Many scientists researched on the different biological sorbent at time to time to remove the heavy metal toxicity from the environment as these metal toxicity cause so many health complications.

Li Y et al., suggested that in this work, carbon foam become prepared with the aid of physical activation of banana peel in a facile and green way. The banana peel carbon foam (BPCF) become implemented for elimination of various heavy metal ions (Cu2+, Pb2+, Cd2+ and Cr6+) from aqueous answers. the prevailing work explores a brand-new technique of development in the area of purification of water via minimal electricity input, less labor and low funding, additionally proves to be biodegradable and powerful as compared to synthetic adsorbent and chemicals. The bio-adsorbents once used will be re-used through desorption strategies for a sure time period and this could be hired commercially inside the future.[10]

Darge & Mane, said that present paintings explore a brand-new method of development in the area of purification of water thru minimal energy enter, less labor and occasional funding, also proves to be biodegradable and powerful compared to synthetic adsorbent and chemicals. Adsorption tends to growth with touch time. at first the boom in adsorption may be very fast as there are lots of unfastened sites for the adsorption to take area. as a result, it may be concluded that Banana peels and Fish Scales, which are discarded waste materials and are in abundance within the nearby market, can be used for the elimination of heavy metal from waste water. efficiency of removal of heavy metallic awareness is greater with banana peel and then with fish scale. combination of both the adsorbents offers extra efficiency. The bio-adsorbents once used could be re-used via desorption methods for a positive time frame and this may be hired commercially in the destiny.[1]

Mohd. Salim R et al., in 2015, suggested that this examine, it was discovered that banana peel powder (BPP), however untreated (BPPU) and handled (BPPT), could be used for the removal of poisonous metals, lead (Pb) and copper (Cu), from aqueous solutions. the quantity of toxic metals adsorbed by way of BPPU and BPPT changed into discovered to increase with the boom

inside the adsorbent mass, pH, preliminary attention and get in touch with time. The end result of this study shows that BPPT, banana peel that has been handled with NaOH, has a higher capability to get rid of toxic metallic ions as compared to BPPU. Adsorption isotherms, Langmuir and Freundlich isotherms were used to analyse the experimental records. Banana peel also has a higher tendency to adsorb lead as compared to copper. most adsorption ability of the banana peel.[11]

Maximum adsorption potential of the banana peel referred to as the Langmuir's maximum monolayer coverage ability (Qo) states that 1 g of BPPT can absorb 89.286 mg of lead below a favorable circumstance. This indicates that chemical change with NaOH set up the adsorption circumstance greater energetically favorable. FTIR analysis of banana peel confirmed the presence of functional organizations indicating the nature of the banana peel, whilst SEM statement shows the micro-hard structure of the surface. Banana peel may be used as a herbal supply of adsorbent so one can advantage the society as a whole in place of being discarded as waste. this cannot best preserve the surroundings, but it could additionally be a low-fee natural adsorbent. [11]

Sallet al., said that during this critical review, we have offered generalities on the environmental effect and toxicity of heavy metals and ions. we've shown the risks of these heavy metals and their ions for the human health and the environment, with a focal point on mercury, chromium, cadmium, lead, and nickel which have been the problem of many experimental studies. further, we've got examined the main analytical methods (XPS, ft-IR and UV-seen absorption spectrometry, ICP-OES, SEM), which allowed one to signify the law enforcement officials and/or to recognize the qualitative and quantitative analyses of lines of heavy metals found in environmental water samples. in the end, we've got also supplied the nation of research on the usage of the law enforcement officials in the removal of poisonous heavy metals and in the discipline of decontamination of water containing heavy metals.[8]

Kateryna et al. in 2015, stated that Heavy metals may additionally play crucial roles inside the nuclear environment, especially at decrease levels. Their motions have to be always analyzed in a holistic manner, with attention paid to all their capacity consequences. Mimicking microelements, heavy metals get admission to the cellular and input physiological pathways. Furthermore, they exert their toxic outcomes due to chemical interactions with nucleic acids and proteins, technology of ROS and modifications in physical conformation of nuclear macromolecules. These bring about deregulation of important nuclear processes, along with transcription, replication and DNA restore, regularly introducing unexpected and irreversible adjustments in the mobile program and leading to carcinogenesis. [12]

Chen et al., in 2010 said that during this evaluate batch adsorption experiments had been accomplished to cast off Pb (II) ions from its aqueous solutions the usage of a herbal biosorbant, fallen C. camphora leaves. Adsorption kinetic researches monitor that movie diffusion mechanism should be a prime fee manipulate mechanism and is superior at better temperatures. All equilibrium facts obtained at unique temperatures in shape flawlessly with the Langmuir

isotherm version as compared to the Freundlich and D–R isotherm models, and the maximum adsorption capacities of Pb (II) adsorbed onto FCCL are 73.15, seventy-three.58, seventy-four.13 and seventy-five. Eighty-two mg g−1 at 303.2, 313.2, 323.2 and 333.2 ok, respectively. The ion alternate and surface complexation fashions controlled simultaneously at some point of the adsorption process, and the surface complexation model can be stronger with increase of initial lead concentration and temperature. the overall effects indicate that the fallen C. camphora leaves is a powerful adsorbent for the elimination of Pb (II) from aqueous solutions.[13]

DeMessie et al. in 2015, mentioned that in this newsletter the removal of heavy steel ions by adsorption on PBP-clay become studied and as compared with the adsorption onto a commercial activated carbon, F-four hundred. both the bodily and chemical residences of the BP and activated carbon had been measured. PBP is a singular high potential and rapid appearing, adsorbent that became efficiently eliminated heavy metals from water. The advanced adsorption capability of PBP in comparison to different adsorbents is especially attributed to its especially hydrophobic surface property, large floor area and the presence of well-developed mesosphere that offer adsorptive filters with ion alternate systems. Dried and PBP adsorbents can achieve elimination performance of up to 96 % of Cu (II) and an adsorption capability of 351 mg/g. changing agricultural waste and bio- primarily based materials the use of low price and sustainable method for ingesting water treatment could have a giant impact in imparting safe water rural areas of developing nations. The take a look at has continued in information the interference of different ions which might be typically determined in water and the improvement of a prototype water remedy system.[14]

MATERIALS AND METHODS

Materials

a. Digestion method of waste water:

- Prepared 2% HCL solution by taking 2 ml concentrate HCL in 100 ml volumetric flask then make up volume in volumetric flask with the help of milli-Q water.
- Prepared digestion mixture by taking 4ml HNO3 + 1ml HClO4. This 5ml solution heated mildly at 60°C with sample waste water.

b. Sodium Potassium standards preparation for flame photometer:

- **For Sodium standards**

Firstly prepared 100 ml stock solution of Sodium standard by the help of source

Solution as:

{50ml (volumetric flask) × 100ppm} ÷ {1000(source of sodium ions)} = 5ml

Took 5 ml sodium ion solution taking from source solution in 50ml volumetric flask and finally make up volume with milli-Q water.

Above prepared solution used as stock solution for

preparation of 1, 3,5,10 and 15 ppm sodium standards.

- **For Potassium standards**

  Firstly prepared 100 ml stock solution of potassium standard by the help of source solution

  {50ml (volumetric flask) × 100ppm} ÷ {1000 (source of potassium ions)} = 5ml

  Took 5 ml potassium ion solution from source solution in 50ml volumetric flask and finally make up the volume with milli-Q water.

  Above prepared solution used as stock solution for preparation of 1, 3,5,15 and 20 ppm potassium standards.

c. The standards preparation of stalk solution of lead was prepared for AAS as follows:

Firstly prepared 100 ml stock solution of lead standard by the help of source solution

{50ml (volumetric flask) × 100ppm} ÷ {1000(source of lead ions)} = 5ml

Took 5 ml lead ion solution from source solution in 50ml volumetric flask and finally make up volume with milli-Q water. The prepared solution used as stock solution for preparation of 1, 2, 4 and 6 ppm lead standards. The banana peel was collected from different sources, the most commonly from kitchen for using conducting complete experiments.

METHODS

1: Adsorbent Preparation:

Banana peel divided into small pieces of size < 5 mm after collection, they were washed three times firstly with tap water than with distilled water, to remove dirt. The water from the surface was removed from wetted banana peel by kept in air than dried in oven for 24 hours at 25°C. After that, dried banana peel was grinded into powder form and kept in an air tied glass bottle for uses in experiment.

2: Adsorbent doses studies:

The adsorbent doses effect was investigated with banana peel of 10, 20 and 30 mg concentration in three set of 8 ml waste water sample on the equilibrium adsorption of lead, which contained -0.649, -0.184 and -0.021mg/L of lead concentration in each. The flask was shaked continuously at 25 ^{0}c temperature for 24 hours at 150 to 180 rpm. Then waste water samples were filtered and analyzed by AAS for Pb.

3. pH studies:

The pH effect on banana peel for lead adsorption was investigated at the pH 7.4 before and after absorption respectively using either 1N H2SO4 or NaOH solution. The Erlenmeyers were shaken for 24 hours with 120 rpm at room temperature. 10mg,

20mg, 30mg of banana peel respectively were used with 8 ml waste water containing 10mg/l of lead and each sample was adjusted.

4. Particle sizes studies:

After grinding, banana peel was purified with standard sieves of the size 600, 420, 300, 150, 75 and < 75 µm. After that, from each graded size, purified 0.5 gm banana peel were added to six flasks separately with 100 ml waste water having 10 mg/l lead concentration. The mixture was shaken at 120 rpm for 24 hours.

5. Temperature, shaking speed and contact time studies:

For the study of temperature, shaking speed and contact time on lead adsorption at different temperature (30-70°C), speed (30-200 rpm) for contact time of 3 hours was examined with 0.5 g banana peel in 100 ml waste water for 10 mg/l lead concentration.

6. Conductivity studies:

The conductivity of waste water samples was examined before and after adsorption. The

Erlenmeyers were shaken for 24 hours with 120 rpm at room temperature. 10mg, 20mg, 30mg

of banana peel respectively were used with 8 ml waste water containing 10mg/l of lead and

each sample was adjusted.

7. **Study of Total Solid (TS):**

Total solid was determined by residue left after the evaporation and subsequent drying in the oven at specific temperature of 103-105°C. As total solids include "Total suspended solids" (TSS) and "Total dissolved solids" (TDS). Whereas loss in weight on ignition of the same sample at 500°C, 50°C, in which organic matter is converted to CO_2 volatilization of inorganic matter as much as consistent with complete oxidation of organic matter, are volatile solids.

8. Sodium and potassium level studies:

Sodium and potassium concentration in sample was determined before and after the adsorption process by Flame Photometer, after calibration with the help of 5 standards. 01, 03,05,15,20 ppm sodium ion standard and 01, 03, 05, 10, 15 ppm potassium ion standard was used for analysis. After adsorption on 16 ml of waste water sample with 20, 40, 60 mg of banana peel, sodium and potassium level was analyzed.

9. Equilibrium studies:

The experiment of equilibrium adsorption was conducted in triplicate in flask of 100 ml waste water having lead concentration of 1 to 500 mg/l. The 0.05, 0.1 and 0.5 g of grounded banana peel were added in triplicate in each set of experiments and was shaken overnight at room temperature with 120 rpm. The Langmuir and Freundlich isotherm models were used to fitted the

equilibrium data.

10. Lead level studies:

The lead concentration in waste water sample was measured by Atomic Absorption Spectrophotometer (AAS). Wash the probe with distilled water and calibrated. After calibration with the help of 4 standards of 01, 02, 04, 06, ppm was used for analysis. By measurement we can identify the lead toxicity of waste water sample.

11. Analysis:

The waste water sample collected from Kudiya Ghat, Lucknow for analysis was filtered by Whtsmann 5 filter paper and sample was prepared for analysis of lead (Pb) on Atomic Absorption Spectrometer (AAS 932 plus, GBC, Australia). The pH of prepared sample for analysis was measured by pH meter (Hanna HI 9025 Instrument, Romania).

12. Calculation:

The adsorbed lead by adsorbent (q) amount in the adsorption systems were calculated by mass balance equation as following:

$$q = V^* (C_0 - Ce)/ m$$

The batch method was used for performing adsorption experiments. Following equation was used to calculate removal of metal ion percentage:

$$\text{Removal of Pb (\%)} = (C_0 - Ce) / C_0 * 100 \quad (1)$$

where C_o and C_e are respectively the initial and equilibrium concentrations of lead (II) ions (mg/L) in the waste water sample. The quantity of Pb ions adsorbed in unit time (q_t) was calculated from the following:

$$q_t = (C_0 - C_t) * V/m \quad (2)$$

where C_0 and Ct are the concentrations of lead (II) ions in the solution at initial and after sorption (mg/L), V = volume of the solution (L) and m = mass of banana peel bio sorbent (g).

For determination of adsorption isotherms, it was necessary to find the equilibrium concentration (q_e) of adsorbed Pb (II) ions on banana peel biosorbant. The equilibrium concentration (qe) was determined by using the following formula:

$$q_e = (C_0 - C_e) * V/m \quad (3)$$

where qe = quantity of metal ions adsorbed at equilibrium(mg/g), and Ce = equilibrium metal ion concentration (mg/L).

RESULTS

1. Environment friendly preparation

As due to many morphological properties i.e., particle shape and size, removal capacity and binding surface area, preparation methods of biosorbant play a very important role. They should be simple, hazard free, easy to prepare for use and environment friendly. So, considering these our research study used simple

and cheaper preparation methods rather than the expensive chemical-based methods [15]. This is the novelty of this study. The image of electron micrographs of banana peel revealed the particles microscopic heterogeneous structure of irregular shape with rough surface, by which lead adherence can be promoted.

2. Impact of doses

The effect of doses became investigated with three lead attention-sets (10, 20, 30 mg/l) in 08 ml waste water by means of including three doses for every set. The percentage removal of lead was observed to boom with a growth within the mass of adsorbent. highest lead removals were eighty-five and 88 % for the lead awareness of 0.649, -zero.184 and -0.021 mg/l, respectively on the adsorbent dose of 8 g/l. Thereafter, the elimination of lead commenced to say no with increasing in mass of adsorbent for all three sets and then remained leveled. The partial aggregation the various to be had lively binding websites may additionally acts for less removal of lead at excessive doses [15], additionally, because of loss of lively binding site, the lower removals had been acquired at low adsorbent doses [16]. accordingly, 5g (0.5 g/100ml) of banana peel and -0.021 mg/l of lead awareness have been selected to use for other experiments.

3. Impact of pH

pH is a controlling aspect for any sort of metallic adsorption technique from aqueous solution. The floor properties of adsorbents, ionic nation of functional companies and species of metals are depending on pH situation. PH dependent experiments have been conducted and the results are proven in table (2). The lead adsorption changed into found to increase with a boom in pH from three to 8 and attained a maximum price (8.33 mg/g), when 20 mg banana peel was used. The imply cost of pH become 8.24 after adsorption (Fig 1). This have a look at suggests that the removal of lead metallic ions was accelerated with increasing preliminary pH of lead metallic ion solution and maximum fee was reached at pH 8 for lead. The plots of Langmuir isotherms Ceq/q vs Ceq display that the adsorbent accompanied the Langmuir isotherm with admire to the steel ions. (Fig 4).

S.N.	Sample		pH
1	Before Adsorption	Kudiya ghaat	7.4
2	After Adsorption	Waste water 8ml + 10 mg banana peel	8.082
3		Waste water 8ml + 20 mg banana peel	8.330
4		Waste water 8ml + 30 mg banana peel	8.320

Table (2): pH of water samples

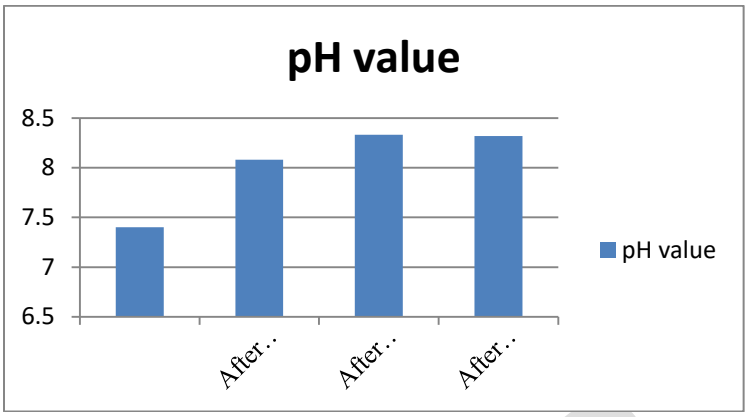

Fig (1): PH value of waste water samples before adsorption and after adsorption

4. Effect of particles sizes of adsorbent

Batch experiments for the results of debris on adsorption were conducted for 6 particle sizes (560µm to <70 µm) at room temperature and pH of 6-6.5 (without adjustment). The removal of lead become improved by lowering the particle sizes. The percent elimination of lead extended from 70 to 98% whilst decreasing particle sizes from 560µm to <70µm. This behavior may be attributed to the powerful floor vicinity extended because the particle length reduced and therefore, the lead adsorption expanded [17].

5. Impact of contact time

Experiments for contact time were carried out with 5 initial lead concentrations (10, 20, 30, 50 and 100 mg/l) with a dose of 10 g/l banana peel at 120 rpm and room temperature for two hours. Adsorption charge of lead on banana peel turned into determined to be incredibly a good deal faster than those pronounced for a few different bio-adsorbents [18]. The fee of lead removal was very speedy during the first 30 min, after which remained constant. there was no big growth in adsorption after approximately 60 min. The experiment with high Pb confirmed the higher amount of lead removal. The lead ion adsorption on banana peel changed into reached at equilibrium after 1h. first of all, there had been many vacant active binding web sites on banana peel and therefor large quantity of lead ions bounded rapidly onto banana peel. The binding web site was emerge as confined shortly and the ultimate vacant floor sites are tough to be occupied by using lead ions because of the formation of repulsive forces between the lead at the solid surface and the liquid phase [19]. while the steel ions are absorbed, meso-pores turn out to be saturated at the initial stage of adsorption in which the metal ions are adsorbed. As a result, the riding pressure of mass switch between liquid and stable segment in an aqueous adsorption machine decreases with growing the time. similarly, the metal ions need to bypass through the deeper surface of the pores for binding and come across a good deal large resistance which slowing down the adsorption during the later phase of adsorption [19].

6. Effect of shaking speed

The effect of shaking speed on adsorption of lead was studied over the variety of 30-200 rpm for 2h with a hundred ml water containing 08 mg/l lead and 10/20/30mg of banana peel. Fig. (2) Indicates that the percent adsorption elevated with an elevated of shaking velocity. At low and excessive speeds, the lead elimination turned into lower than finest. Low speed couldn't spread the debris properly within the water for supplying active binding websites for adsorption of lead. It's far resulted an accumulation of banana peel inside the backside of water and buried the energetic binding websites. alternatively, the high velocity vigorously spreading the debris of banana peel inside the water and did not allow enough time to bind with lead ions [19].

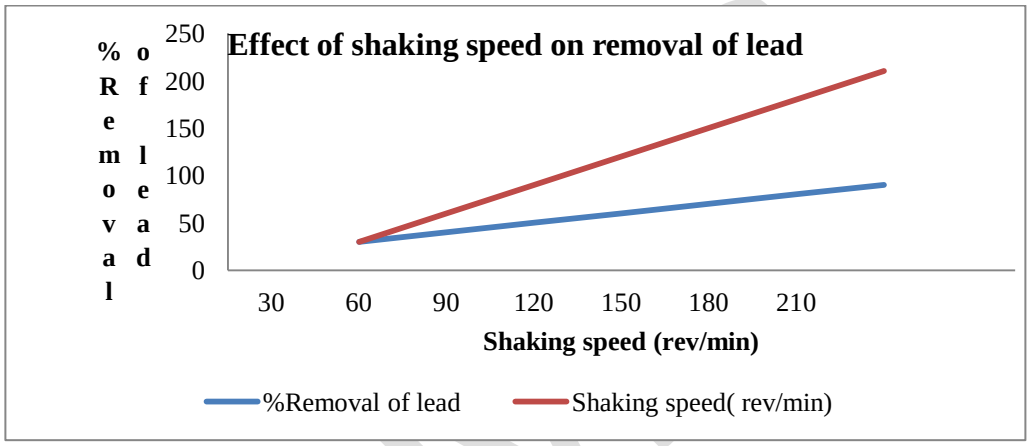

Fig (2): Effect of shaking speed on removal of lead

7. Adsorption isotherms

Adsorption isotherms describe the equilibrium relationships between adsorbent and adsorbate. Two adsorption isotherms (1)-(2) were used to fit the equilibrium data namely, Langmuir [20], Freundlich [21]. Its applicability was judged with the correlation coefficients (R2). Langmuir equation can be linearized by the following form:

$$\frac{1}{qe}=\frac{1}{bqmCe}+\frac{1}{qm} \quad (4)$$

Where, Ce is the equilibrium concentration in liquid phase (mg/l), q_m = monolayer adsorption capacity (mg/l) and b is the Langmuir constant related to the free adsorption energy (l/mg).

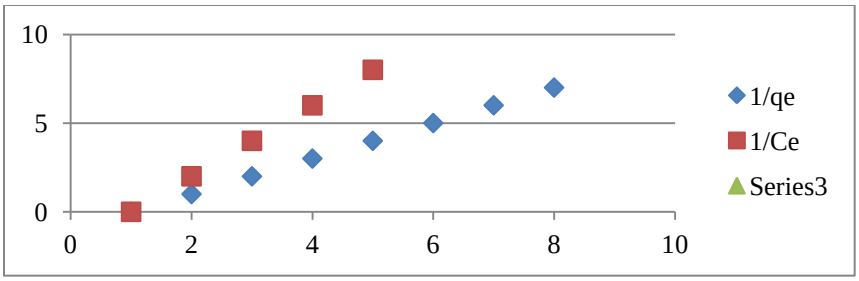

Fig (3) Langmuir isotherm for lead adsorption onto banana peel (Co: 1-500 mg/l; t: 24h;

rpm: 120; pH: 6-6.5; T: 20°C)

Freundlich equation can be linearized by the following form:

$$\text{Log } q_e = \log K_f + 1/n \log C_e \quad (5)$$

Where, KF is a constant indicative of the adsorption capacity of the adsorbent (mg/ g) and the constant 1/n indicates the intensity of the adsorption.

The linear plot of Langmuir isotherm for lead adsorption and the calculated parameters at the side of regression coefficients are shown in Fig (3), most adsorption ability (qm), for whole monolayer coverage are determined 124, 34.82 and 29.62 mg/g for 0.5, 1 and 5 g/l doses, respectively. R2 values drawing near to 1, definitely suggest that Langmuir isotherm follows a great relation of lead adsorption with banana peel. The adsorption capability for banana peel was observed better than the previously mentioned techniques of steel adsorption [22]. 'b' is the adsorption steady related to the affinity of binding sites (l/g) and decrease cost of 'b' (0.24, 0.21 and 0.021 l/g for three doses) imply that the particles radius of banana peel had been small toward adsorption [23].

The Freundlich isotherm model was found best with experimental records as its poses better R2 fee (0.981, 0.978 and 0.963). KF is a Freundlich consistent that shows adsorption ability on heterogeneous sites with non-uniform distribution of electricity stage and n indicates the intensity among adsorbate and adsorbent. The calculated values of 'n' (Table 3) prove that the adsorption of lead onto banana peel is favorable as the magnitude lies among 1 and 3 [24].

Doses (g/l)	Langmuir			Freundlich		
	qm (mg/g)	b (1/mg)	R^2	Kf	n	R^2
0.5	124	0.34	0.965	12.26	2.03	0.981
1	32.14	0.17	0.982	3.32	2.03	0.978
5	26.72	0.02	0.990	1.47	1.19	0.963

Table 3: Langmuir and Freundlich isotherm parameters and correlation coefficients for the adsorption of lead onto banana peel at different adsorbent doses

DISCUSSIONS

Our look at on removal of heavy steel from the economic waste water by means of the usage of of banana peels finished containing the parameters like pH, TDS, Conductivity, Sodium Potassium and heavy metals (lead) and many others. The effect of various mass of banana peel powder (BPPU and BPPT) on poisonous steel adsorption turned into investigated using hundreds ranged (0.1, 0.3, 0.5, 0.7 and 0.9 g) of the adsorbent powder in 100 mL of every toxic metal (Pb and Cu) containing constant awareness of 10 mg/L and under consistent stirring speed of 500 rpm. the two unique forms of powders (i) Banana Peel Powder Untreated (BPPU) and (ii) Banana Peel Powder dealt with (BPPT) have been experimented one by one. The experiment was run for an hour and the answer was filtered the usage of filter paper and filter out funnel. The filtrate turned into analyzed thru atomic absorption spectrometer (AAS). The residue became found beneath scanning electron microscope (SEM) [11]. In our observe 3 dosage of the organized banana peels bio adsorbent used to deal with the industrial wastewater. The parameter which includes Lead has been modified with the growth and decrease within the bio adsorbent

dosage. The results of adsorbent dosage were various from 10, 20 and 30 mg for banana peel. therefore 10, 20 and 30 mg turned into observed to be the most appropriate dosage in treating the wastewater for Banana peels adsorbent. The plots of Langmuir isotherms Ceq/q vs Ceq show that the adsorbent accompanied the Langmuir isotherm with recognize to the metal ions.

The effect of pH on - Banana peel carbon foam (BPCF) sorption performance is shown in Fig.3 as the initial pH of the answer expanded from 2.0 to 7.0, the elimination efficiency of Cu2+, Pb2+ and Cd2+ ions furnished little alternate, suggesting that adsorption of those ions on BPCF changed into basically unaffected through pH values. this may be explained by way of the truth that the binding web sites of BPCF consist of no longer handiest the pH-prone sensible businesses which include carboxyl and hydroxyl, but additionally the ion trade factors in conjunction with "ok, Ca, Mg". The latter is immune to pH alteration. further, we determined that addition of BPCF raised pH of answer by manner of 1.5~2.0, which may be ascribed to lifestyles of compounds like CaO, MgO and KOH in BPCF because of calcinations of banana peel. those oxides or hydroxides of alkali metals changed pH when BPCF contacted with water and brought on micro precipitation of heavy metal ion on surface of BPCF.

In 2016, a study stated that a inexperienced adsorbent derived from banana peel for exceptionally powerful elimination of heavy metal ions from water [10]. In our study the impact of pH on adsorption, experiments have been finished inside the pH range three–8 for Lead. This observe shows that the removal of lead ions emerges as expanded with increasing initial pH of lead metal ion answer and maximum price become reached at pH eight for lead. The plots of Langmuir isotherms Ceq/q vs Ceq display that the adsorbent observed the Langmuir isotherm with appreciate to the Pb ions.

Impact of contact time on adsorption of heavy steel on banana peel changed into investigated in the kind of 0–12 hours. Maximum charge of removal came about inside 6 hours of contact time there after removal fee have become slow and after 12 hour of touch time no alternate turn out to be determined for Lead (60%), which installed that the machine has reached the equilibrium aspect. The plots of Langmuir isotherms Ceq/q vs Ceq showed the adsorbent accompanied the Langmuir isotherm with recognize to the steel ions. Have a take a look at cautioned the use of bio adsorbent suggests promising approach towards the purification technique of wastewater at several parameters. At the aspect of bringing the homes as pH, TDS, Conductivity and so forth. Closer to the desirable restriction, it is been determined quite effective for the removal of Lead.[20]

The floor interest of banana peels is specifically because of the presence of carboxyl, hydroxyl and amide businesses at its floor due to which it can chelate with numerous metals

and help of their removal. Within the presence of several steel ions, a competition is there among them for the coordination internet websites present on the ground of adsorbent. immoderate surface vicinity of banana peels adds to the assets and makes it an incredible and financial adsorbent, for water purification manner, various contact time and specific pH of waste water with adsorbent used in treatment turn out to be determined to be green to at least one-of-a-type extents within the path of various parameters, so it is a subject to in addition have a look at in order to optimize the system.

CONCLUSION

Banana peel is a high capacitate, economically viable and low-cost adsorbent for lead removal. Lead adsorption onto banana peel follows a pseudo second order kinetics. Adsorption of lead on banana peel shows high association with Langmuir and Freundlich isotherm model. This study can conclude that banana peel is the favorable alternative of lead removal from water. The existing paintings explores a new method of development in the subject of purification of water thru minimal power enter, less labor and occasional investment, additionally proves to be biodegradable and effective in comparison to synthetic adsorbent and chemical substances. Adsorption has a tendency to growth with contact time. in the beginning the growth in adsorption could be very fast as there are plenty of loose web sites for the adsorption to take region. Therefore, it may be concluded that Banana peels, that's discarded waste material and abundance in the nearby market, may be used for the removal of heavy metallic from waste water. Efficiency of removal of heavy metallic attention is more with banana peel. The bio-adsorbent as soon as used may be re-used via desorption techniques for a certain period of time and this could be employed commercially within the destiny.

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FUTURE SCOPE

As we have found that banana peel act as good biosorbant thus our research findings will be helpful to remove lead toxicity from the environment, if we commercialized the banana peel as biosorbant.

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