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Greywater Treatment Technique Using Fruit Peels

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Abstract: *Fruit peel can be a sustainable and useful tool for treating greywater. It can be used as a natural filter to remove pollutants, and contaminants from wastewater before it is used again for non-potable uses like irrigation. This adsorption technology using biodegradable substances is accepted worldwide. Greywater with high phosphate and sulphate content can cause several environmental and health issues. Phosphates are nutrients that encourage the growth of algae and other aquatic plants leading to eutrophication and also it may lead to water pollution. This occurs mainly due to the discharge of high-phosphate greywater into bodies of water like lakes. Sulphates can react with organic matter present in water and form sulphides which are toxic to aquatic life. Usage of a high amount of sulphate-content water for irrigation purposes may lead to an increase in soil salinity which decreases the fertility of soil. The removal of phosphate and sulphate contaminants is crucial. Based on current technology, the adsorption method using fruit peel is an effective approach as it is sustainable and cost-effective. In this study, banana peel after proper cleaning and oven drying was used as a sorbent for removing phosphate and sulphate from grey water. The experimental studies showed that 17.5g/L banana peel can remove 73% of phosphate and 65% of sulphate from synthetic greywater within 1 hour at pH 6. This method is a simple cost-effective method for treating greywater from contaminated wastewater and can be reused. Energy dispersive X-ray analysis (EDX) and Fourier transformation infrared (FTIR) analysis was done to study the characteristics of adsorbent. EDX analysis showed the presence of phosphate and sulphate after adsorption. FTIR analysis showed the presence of functional group that caused adsorption.*

Key Word: *Adsorbents, fruit peel, EDX analysis, FTIR analysis.*

I.INTRODUCTION

Water pollution is a worldwide issue and in recent years it become more crucial to control its increase. Greywater is domestic waste water that can originate from kitchen sinks, bathrooms, washing machines and wash basins. It is also known as silage which contains fewer pathogens when compared with domestic greywater. Reusing grey water can minimise the need for freshwater resources. As world water scarcity increases it is important to find more innovative ways to reuse wastewater. There are many methods used for treating grey water some of them are filtration, biological treatments, chemical treatments, membrane filtration, ozonation, UV disinfection, distillation and adsorption. Among this adsorption method is the more environment friendly method for greywater treatment and also very efficient in removing contaminants as fruit peel powder has high surface area because of its porous structure which will allow it to effectively adsorb large amount of contaminants, the natural compounds like pectin and cellulose present in fruit peels contribute to their porous nature. This method is economical, very cheap, and efficient for the removal of contaminants like the fruit peel powder which is used as adsorbent in this study has high surface area because of its porous structure which will allow it to effectively adsorb large amount of contaminants. Adsorption process does not need any kind of energy purification techniques and can remove contaminants such as phosphates and sulphates. The grey water treated by this method can be used for toilet flushing, irrigation and other non-potable uses. Reusing grey water can also minimise the need for freshwater resources. This Adsorption method is safe from a health point of view without any other effects and also not harmful to the environment.

For the adsoption treatment process, agro-waste and fruit waste can be used as good adsorbents of contaminants. In this study, sustainable adsorbents like fruit peel wastes are used, Compared with the other adsorbents fruit wastes are easily available and also they are biodegradable materials, the natural compounds like pectin and cellulose present in fruit peels contribute to their porous nature which helps in adsorption. Among that the most abundantly available banana peel waste in dried and powdered form were used as adsorbent in this study. Banana is a major fruit crop that grows in developed or developing countries and can be available cheaply. Almost 40 tonnes of banana peels are produced annually, in order to solve the problem of disposing these large amount of fruit peels as wastes it can be used as a good greywater treatment aid when it is converted to powdered form. The cost-effective way of treatment using natural adsorbents is popular in developed and developing countries. Mainly to overcome the high-cost wastewater treatment process this method was introduced.EDX analysis and FTIR analysis was done to study the characteristics of banana peel powder adsorbent before and after adsorption. The elemental composition of the adsorbent was obtained from EDX graph and functional group reacted to adsorb phosphate and sulphate was identified from FTIR graph. The objective of this study is to obtain the maximum removal efficiency of

phosphate and sulphate using banana fruit peel powder as an adsorbent. Through more studies, this adsorption method using fruit peel powders can also be applied to large-scale greywater treatments.

II.MATERIALS AND METHODS

Materials used - Antimony potassium tartrate, Ammonium molybdate, Ascorbic acid, Phosphate buffer solution, 5N Sulphuric acid, Glycerol, Conc. Hydrochloric acid, Isopropyl alcohol, Sodium chloride, Barium Chloride, sodium hydroxide, hydrochloric acid. All the chemicals used are of analytical grade.

2.1 Preparation of synthetic greywater

Table 1: compositions used for synthetic greywater preparation

Sl. No	Compounds	Concentration taken for making greywater
1	D-Glucose anhydrous (mg/l)	300
2	Sodium acetate trihydrate (mg/l)	400
3	Ammonium chloride (mg/l)	225
4	Disodium hydrogen phosphate (mg/l)	150
5	Potassium dihydrogen phosphate (mg/l)	75
6	Magnesium sulphate (mg/l)	50
7	Cow dung (ml/l)	0.2

Reference: Fathima Shahin et al. (2020), 'Treatment of synthetic grey water using corncob', International Journal Of Creative Research Thoughts (IJCRT).

2.2 Preparation of banana peel

The process of collection of fruit peel was started from houses and shops in our locality. After the collection of fruit peels, removed fruit meat properly from the banana peel, then it was separated into different sections and washed several times to remove dirt and other impurities. peels were chopped into small pieces after washing.

2.3 Preparation of adsorbent

These cleaned and chopped banana peels were dried for 4 hours in the oven at a temperature of 105˚C to remove the moisture content. Then the dried fruit peels were crushed and powdered using a dry mixer grinder commonly used in the kitchen. This powder was sieved through a 4.25 mm IS sieve to maintain the unique size of adsorbents.

Figure 1: Fruit peel collected from juice shops and houses

2.4 Adsorption experiment

The batch study started with addition of 1g of adsorbent to 200ml synthetic greywater. pH was varied from 4pH to 9 pH. Values were taken both before and after adding 1g of adsorbent to each beaker, at time intervals of 10, 20, 30, 40, 50 and 60 minutes. Dosage concentration depends on various factors, such as the type and concentration of contaminants present in synthetically prepared greywater. This treatment technique was also carried out by taking different dosages of fruit peel adsorbent to obtain the maximum removal efficiency of physicochemical parameters present in greywater. The dosage of banana fruit peel were taken in different grams for another experiment(0.5g, 1.0g, 2.0g, 2.5g, 3.0g, 3.5g, and 4.0g) in 7 sets of 200ml of samples in a conical flask and adsorption values were taken. The maximum removal efficiency for phosphate and sulphate was obtained at 3.5 g adsorbent dosage.

III. RESULTS AND DISCUSSION

3.1 Effect of contact time and pH

The effect of contact time and pH in removing phosphate and sulphate. The samples were tested during different duration ranges of 0 to 60 minutes and a different pH value and time is varied for further removal analysis. The removal efficiency increased with time this might be due to the abundance of adsorbent active sites during the initial stages of adsorption. By using 1g of banana peel adsorbent the maximum removal efficiency was obtained by sample of 6 pH at 50 minutes for both phosphate and sulphate. The reason why the adsorption increased at 6 p H which is an acidic pH might be because of chemical reactions, some pollutants become more soluble with or react more with treatment chemicals under acidic conditions .From this study equilibrium time obtained is 50 minutes and p H at which maximum removal obtained is 6 p H.

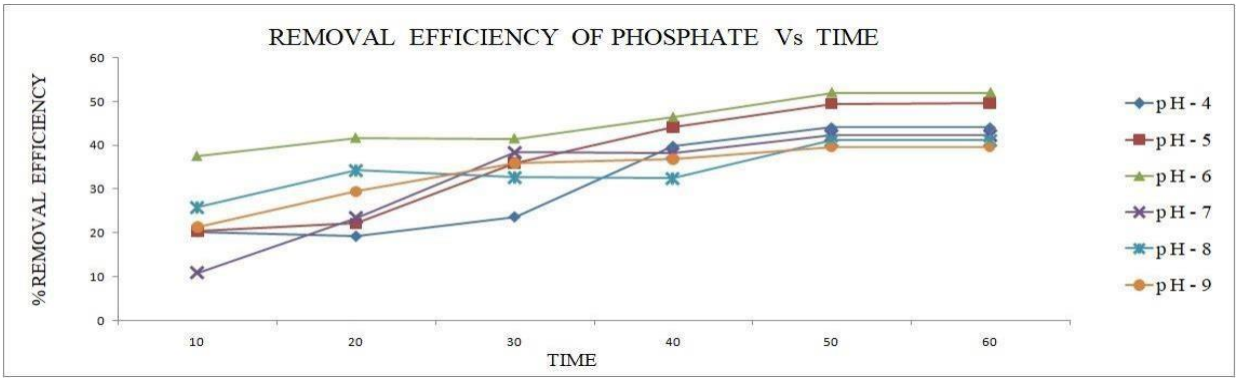

Figure 2: phosphate removal efficiency using 1g of banana peel Vs time

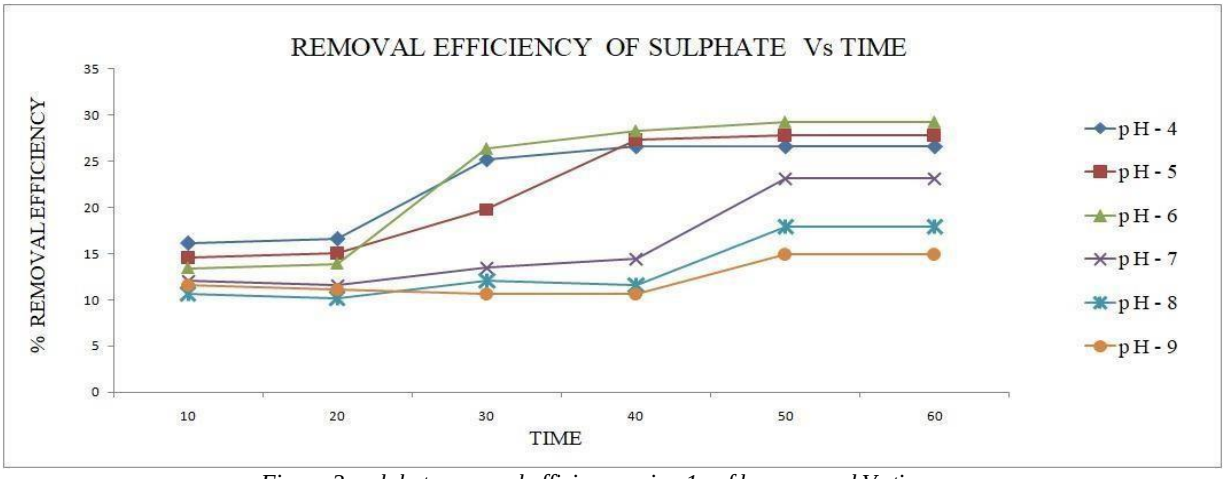

Figure 3: sulphate removal efficiency using 1g of banana peel Vs time

Removal of phosphate and sulphate using banana peel powder adsorbent with various dosages

This parameter was analyzed by using spectrophotometer equipment. The banana peel adsorbent with various dosages were added to the greywater sample of constant pH as obtained in the earlier experiment that sample of pH 6 showed maximum removal. Here the removal efficiency increased when the adsorbent dosage increased. Then it reached to the optimum removal efficiency. Here the optimum removal efficiency of phosphate and sulphate were obtained at 3.5g/l of adsorbent dosage in 200 ml greywater sample. The removal efficiency of phosphate obtained at 3.5g/l of banana adsorbent is 74% and the removal efficiency of sulphate obtained at 3.5g/l of banana adsorbent is 65%.

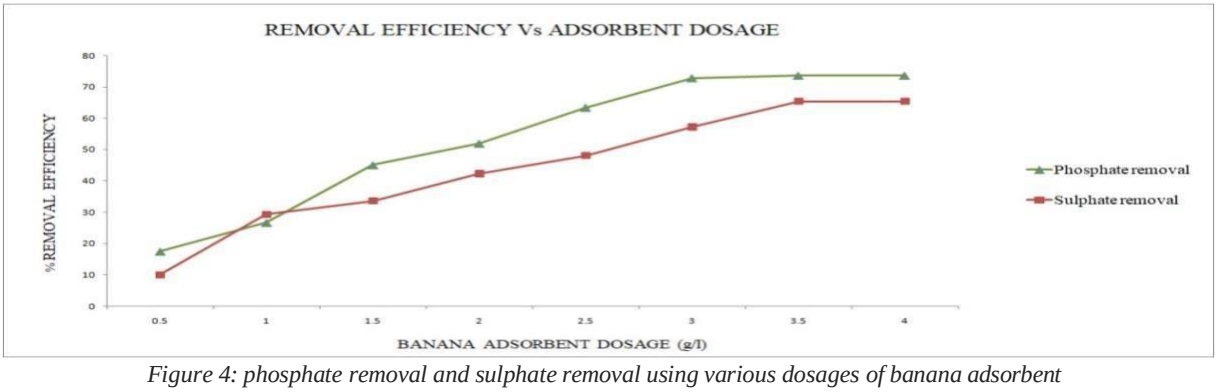

Figure 4: phosphate removal and sulphate removal using various dosages of banana adsorbent

Discussion: pH 6 is acidic in nature, so surface of adsorbent has H+ more ions and it will undergo electrostatic attraction of negatively charged ions, because of this reason maximum removal efficiency was obtained. The adsorption treatment requires a perfect pH which was pH 6. When the H+ ion concentration becomes favorable for adsorption on surface of adsorbent then only maximum adsorbent occurs. When the time increases the removal efficiency also increases and it reaches to its optimum at equilibrium time.

3.1.1 EDX analysis

In this study EDX analysis was done for characterization study of banana peel material before and after adsorption. This analysis is done from Sophisticated Test and Instrumentation Centre (STIC) at CUSAT, Cochin.

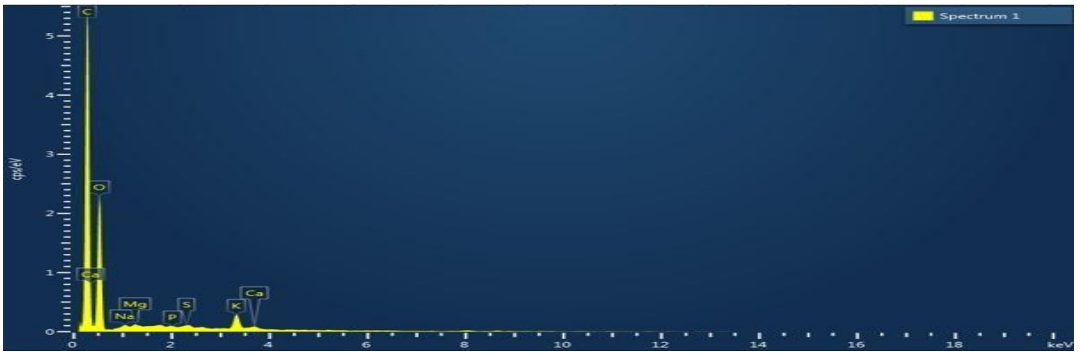

Figure 5: EDX analysis of banana peel before adsorption treatment

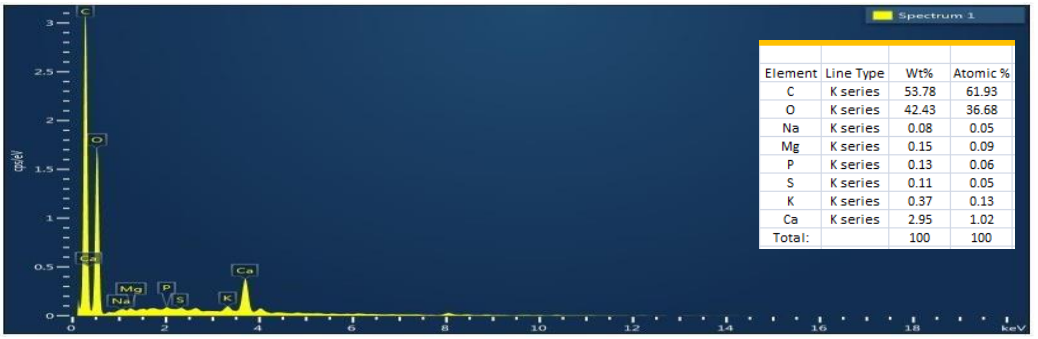

Figure 6: EDX analysis of banana peel after adsorption treatment

In before adsorption graph the presence of sodium, magnesium, calcium and potassium was observed as they are mineral constituents of banana peel. There is also the presence of carbon and oxygen before and after adsorption in the obtained graph, banana peel has a high amount of carbon content naturally which makes it a good adsorbent. In the after graph, elements like carbon, oxygen, sodium, calcium and potassium were present at minute differences. The reason why calcium is found in the after graph is likely due to the presence of dissolved solids, as calcium is the primary type of dissolved solid in greywater. The presence of phosphate and sulphate was observed in the after graph which indicates that the adsorption has taken place.

3.2 FTIR Spectra

FTIR analysis was conducted to identify the presence of functional groups which were able to adsorb phosphate and sulphate. Figure 4 and Figure 5 given below explain the FTIR spectra of dried banana peel.

This analysis is done from the Sophisticated Test and Instrumentation Centre (STIC) at CUSAT, Cochin.

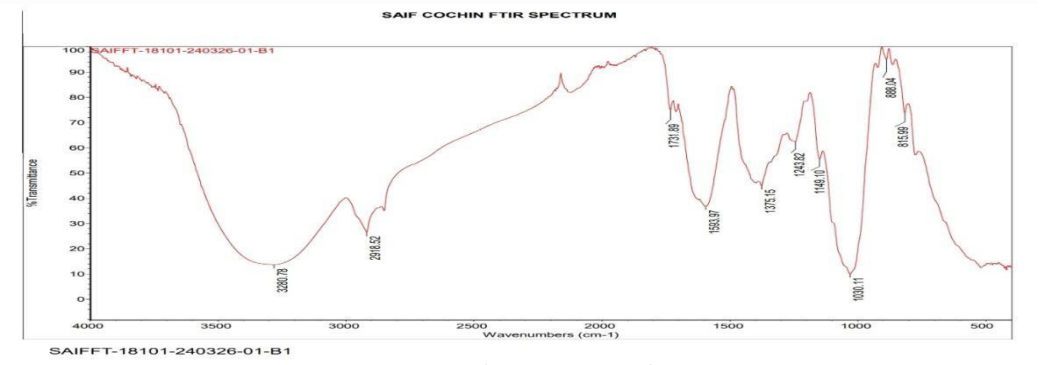

Figure 7: FTIR spectra of banana peel before adsorption

The above figure 7 shows FTIR spectra of dried and powdered banana peel before adsorption. The wide adsorption peak around 3000-3500 cm^{-1} with maximum value at 3280.78 cm^{-1} indicates O-H stretching which is hydroxyl functional group which is due to cellulose and lignin present in the banana peel. The maximum absorption peak between 2500-3000 cm^{-1} which is 2918.52 cm^{-1} indicates the presence of O-H stretching functional group. The bands at 1731.89 cm^{-1} belongs to C-H functional group under aromatic class whereas,N-H functional group was detected at peak point of 1593.97 cm^{-1} which is in amine class. C-N stretching functional group was obtained at 1243.82 cm^{-1},1149.10 cm^{-1} and 1030.11 peaks which comes under amine class. At 888.04 cm^{-1} peak and 815.99 peak C=C bending was obtained which comes under alkene class.

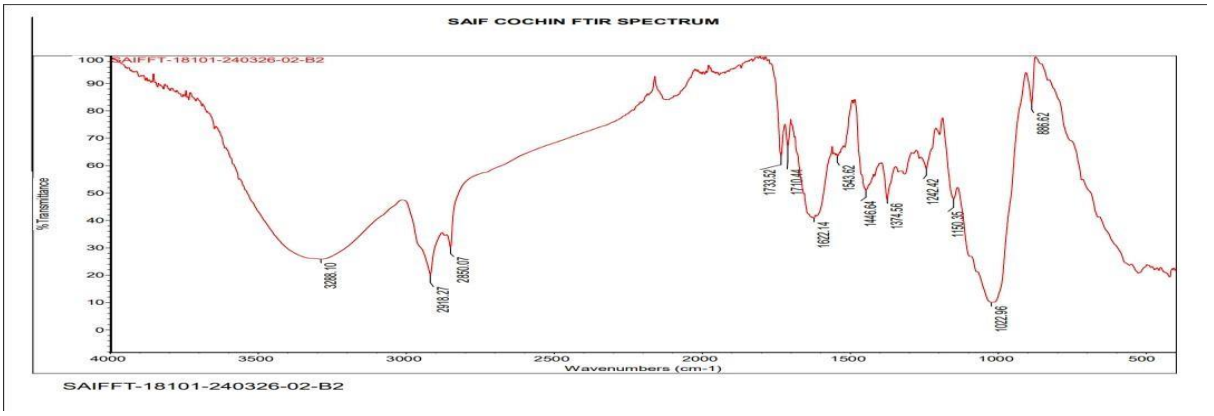

Figure 8: FTIR spectra of banana peel after adsorption

The above figure shows FTIR spectra of dried and powdered banana peel after adsorption. After treatment along with all these functional groups, a new peak is formed which is 1622.14 cm^{-1} peak in the C=C stretching functional group. The interaction of this functional group with phosphate and sulphate must be the reason that caused adsorption.

IV. CONCLUSION

Grey water is wastewater from dishwashing, bathing, sinks, laundry, and other kitchen appliances. Banana peels are used as adsorbent in powdered form in this study are also waste material produced in juice shops, factories, food processing industries and in houses. Reusing this waste product is a sustainable way of treatment of greywater where both greywaters is treated and the waste product is reused as an adsorbent.

The experiment for finding the effect of contact time and pH in removing phosphate and sulphate was also conducted from the graph obtained as a result the maximum removal efficiency was obtained at 50 minutes and the pH at which maximum removal was obtained is 6 p H. Experiment for Removal of phosphate and sulphate using banana peel powder adsorbent with various dosages in 200 ml greywater sample of pH 6 was also conducted. This experiment obtained the optimum removal efficiency of phosphate and sulphate at 3.5g/l of adsorbent dosage. The maximum removal efficiency of phosphate obtained at 3.5g/l of banana adsorbent is 74% and the removal efficiency of sulphate obtained at 3.5g/l of banana adsorbent is 65%. FTIR analysis was also done to identify the presence of functional groups which were able to adsorb phosphate and sulphate from the greywater sample. The new peak was observed in the after graph which is 1622.14 cm-1 peak that comes in C=C stretching functional group. The reason for the adsorption might be because of the interaction of this functional group with phosphate and sulphate. EDX analysis was also done for characterisation study of banana peel material before and after adsorption. phosphate and sulphate was present in after graph was obtained which indicates that the adsorption has taken place. The above results indicates that banana peels are good adsorbents and can treat grey water efficiently. Also it is a sustainable way of treating grey water because of reusing waste product as an adsorbent. The treated grey water can be used for toilet flushing, irrigation and all other non-potable purposes.

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