# A Study on Removal of Dye and Lead II from Aqueous Solution using Low Cost Adsorbent

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## Abstract

In this research work, the waste Te leaf char powder was used as adsorbent for the removal of dyes and $Pb^{2+}$ion from aqueous solution. The sample was collected from West Yangon University Campus, Htantabin Township, Yangon Region. The prepared Te leaf powder sample was heated with different calcination temperatures 100 °C to 500 °C for 1 h, 2 h and 3 h, respectively. The optimum calcination temperature and time of Te leaf char powder sample (TLCP XII) were 400 °C and 3 h.The physicochemical properties of selected samples were studied. Capability of selected Te leaf char powder samples on the removal of congo red and methylene blue dyes were carried out by contact time method and dosage method. The optimum conditions for removal of dyes from aqueous solution were observed at 120 min contact time and 0.30 g dosage concentration of 25mgL$^{-1}$ of dye solution. Therefore, this research will be utilized for the removal of dyes in waste water nearby textile industries and removal of $Pb^{2+}$ ion nearby battery industry as a low cost material.

***Keywords***:Te leaf char powder, physicochemical properties, dyes,$Pb^{2+}$ ion

## INTRODUCTION

***Diospyros kaki***

*Diospyros kaki* is a tree in the Ebenaceae family and also called persimmon. It is species of the genus Diospyros (Lee *et al.,* 2015). This species, native to China, is deciduous, with broad, stiff leaves. Cultivation extender is first to other parts of East Asia, including Japan where it is very popular. It was later introduced to California and southern Europe in the 19th century, to Brazil in the 1890s and numerous cultivars have been selected. The kaki tree reaches a size of up to 10 meters (33 ft). Its deciduous leaves are medium (about 13 to 15 cm 10 ng) to dark green, voracity lanceolate, stiff and equally wide as long. Blooming from May to June, the trees are typically either male or female, but some produce both types of flowers.

### 1.1.1 Scientific classification of *Diospyros kaki* L.f

*Diospyro kaki* is classified as follows.

| | | |
|---|---|---|
| Family | - | Ebenaceae |
| Botanical name | - | *Diospyros kaki* L.f |
| Myanmar name | - | Te |
| English name | - | Persimmon |
| Part used | - | Leaf |

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## MATERIALS AND METHODS

All chemicals used in this research were procured from British Drug House (BDH), England. The chemicals were used as received unless state otherwise. All specific chemicals used were cited detail in each experimental section. The apparatus consist of conventional lab wares, glass wares and modern equipment. All chemical used in this research were procured form British Drug House (BDH), England.

### Sampling

The main working samples, the waste Te leaves were collected from West Yangon University Campus, Htantabin Township, Yangon Region. The dried Te leaves sample was grinded and sieved with 200 mesh size and stored in air tight glass bottle. The prepared Te leaf powder sample was heated with 100 °C to 500 °C for 1 h, 2 h and 3 h, respectively. It was denoted as TLCP I to TLCP XV respectively. The heat treatment samples were stored in individual air tight bottles. Among them, TLCP I to III were not used because it removed moisture. TLCP IV to VI were not used because it was semi-char and it had no activating properties and TLCP XII, XIV and XV were not used because most of the samples were found as ash. TLCP VII, VIII, IX, , XI and XII were complete char. But, TLCP Vll and X were lowed removal percent than the TLCP VIII, IX, XI and XII. Therefore, TLCP VIII, lX, XI and XII were used for bleaching of dyes.

### Physicochemical Investigation of Te Leaf Char Powder

### Determination of moisture content

Te leaf char powder samples 1 g was placed in the pan and the pan was shaken to spread the sample over the entire pan. When a high drying temperature is set to shorten the drying time, the radiant heat from the halogen lamp becomes significant, the sample surface are sometime scorched. The moisture percent results were obtained. The results are shown in Table 1.

### Determination of ash content

Te leaf char powder samples 1 g was placed in crucible and it was then heated at 550 °C for 4 h in a furnace. The samples were completely ashed at this temperature and were cooled overnight and reweighted. The ash percent of the samplewere shown in Table1.

### Measurement of pH

The sample (about 1g) was placed into a 200mL beaker and 100mL of distilled water was added. The content of the beaker was heated at 80 C for 2 min. The Beaker was gently shaken and the sample was filtered. The filtrate was cooled at room temperature and pH of the sample was determined by a pH meter. The results are presented in Table1.

### Determination of bulk density

A clean dry 10mL graduated cylinder was weighted. It was then filled withthe dry sample to the 10mL mark and reweighed. The graduated cylinder was placed in a tapping box and the cylinder was tapped gently until there is no morereduction in volume. The minimum volume was recorded and the bulk densitywas calculated. The results are presented in Table 1.

### Preparation of dye solution

The dye solution of the Methylene blue and Congo red were used for the present work. An accurately weighed quantity of the dye dissolved in distilled water to prepared stock solution (0.001%). Dye concentration was determined by using absorbance at 665 nm for Methylene blue and 495 nm for Congo red with UV spectrophotometer.

**Percent Color Removal of Te Leaf Char Powder**

**Dosage method**

Accurately weighed samples of Te leaf char powder varying from 0.05 g to 0.40 g were thoroughly mixed with 100 mL of each dye solution (25 $mgL^{-1}$).Then, they are shaken for 120 min at ambient temperature. After shaking, the solution were centrifuged. The residual content of each dye solution was determined by spectrophotometrically. The results are shown in Table (2 and 3) and removal percent with respect to adsorbent dosage are shown in Figure 1(McKay, Prasad and Mowli 1986).

**Contact time method**

Batch adsorption experiments conducted by 0.3 g of Te leaf char powder into 100 mL of each dye solutions (25 $mgL^{-1}$) in 250 mL conical flask and shaking at a speed at 150 rpm at ambient temperature. At 20 min intervals, the samples were taken and removed by centrifugation. The residual content was determined by spectrophotometrically at the corresponding $\lambda_{max}$ 498 nm (congo red) and 665 nm (Methylene blue) respectively. The resulting data are shown in table (4 and 5) and Figure 2.(Nassar and El-Geundi, 1991).

**Characterization of Te Leaf Char Powder**

**Scanning electron microscopic (SEM) analysis**

The samples were examined by scanning electron microscope (SEM) for a visual inspection of surface morphological porosity and topological texture. The SEM micrographs are shown in Figure 3.

**Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis**

The samples were examined Energy Dispersive X-Ray Fluorescence (EDXRF) for elemental analysis. The EDXRF results are reported and discussed in Table 6 and EDXRF spectrums are shown in Figure 4.

## RESULTS AND DISCUSSION

**Physicochemical Properties of Te Leaf Char Powder**

The moisture percent, ash content, pH and bulk density of the selected Te leaf char were determined by reported method. The data were shown in Table 1**.** The bulk density of the charcoal relates to the rigid structure of the carbon itself. The smaller the bulk densityof sample, it has the greater the surface area of particle. Ash content is attributed to show non-volatile inorganic minerals. The more porous structure has an ability to take up more moisture. The pH values of samples were nearly neutral. The pH of TLCP XII was slightly increased because of partial oxidation during carbonization.

**Table 1 Physicochemical Properties of Te Leaf Char Powder**

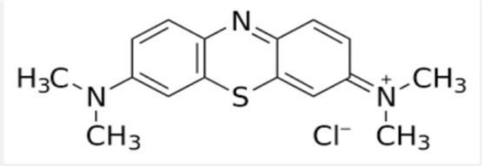
| No. | Samples | Moisture (%) | Ash (%) | Bulk density ($gcm^{-3}$) | pH | Yield |
|---|---|---|---|---|---|---|
| 1. | TLCP VIII | 7.22 | 12.44 | 0.31 | 6.58 | 42.48 |
| 2. | TLCP IX | 6.78 | 14.05 | 0.35 | 7.12 | 37.01 |
| 3. | TLCP XI | 6.89 | 16.81 | 0.36 | 7.29 | 29.34 |
| 4. | TLCP XII | 6.95 | 19.22 | 0.39 | 7.32 | 28.35 |

**Percent Color Removal of Te Leaf Char Powder**

A solution of methylene blue and Congo red ($25mgL^{-1}$) were prepared.Adsorption experiments were carried out at room temperature under batch method. The initial concentration ($C_0$ ) of methylene blue dye and Congo re were obtained by measuring absorbance at 665nm ( $\lambda_{max}$ ) and at 495 nm( $\lambda_{max}$ ) using UV spectrophotometer. The structure of methylene blue andCongo red are as follow.

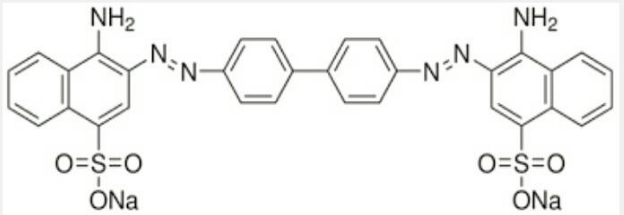
**Methylene blue**

Molecular formula $C_{16}H_{18}N_3SCL$
Molar mass 319.85 g/mol



**Congo red**

Molecular formula $C_{32}H_{22}N_6Na_2O_6S_2$
Molar mass 696.665 g/mol



**Effect of dosage**

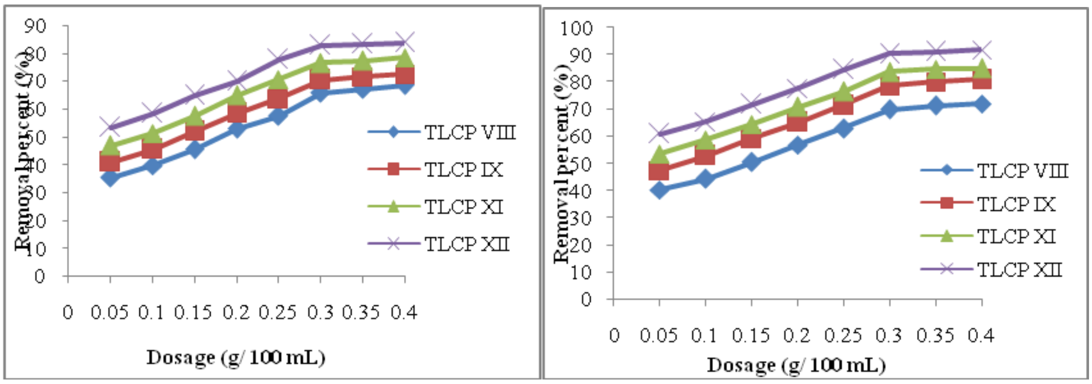
Exactly 100 mL of methylene blue and Congo red solution of knowninitial concentration were shaken at the constant agitation speed with a required dose of charcoal samples 0.05g to 0.4g. After 10 minutes the sample was filtered and measured the absorbance. The percent color removal of charcoal was shown in Table 2,3 and Figure 1.It was found that the color removal percent increased when the dosage of Te leaf char powder sample increased. The adsorptioncapability reaches maximum at (83.76%) for methylene blue and (91.80%) for congored dyes.

**Table 2 Effect of Dosage for the Removal of Methylene Blue by Te Leaf Char Powder**

| Dosage (g/ 100 mL) | Removal Percent (%) | | | |
|---|---|---|---|---|
| | TLCP VIII | TLCP IX | TLCP XI | TLCP XII |
| 0.05 | 35.28 | 40.96 | 46.84 | 53.26 |
| 0.10 | 39.64 | 45.56 | 51.20 | 58.36 |
| 0.15 | 45.52 | 51.80 | 57.44 | 64.76 |
| 0.20 | 52.80 | 58.36 | 64.80 | 69.92 |
| 0.25 | 57.44 | 63.76 | 70.56 | 77.60 |
| 0.30 | 65.72 | 70.28 | 76.44 | 82.84 |
| 0.35 | 67.08 | 71.40 | 77.16 | 83.16 |
| 0.40 | 68.44 | 72.44 | 78.32 | 83.76 |

**Table 3Effect of Dosage for the Removal of Congo Red by Te Leaf Char Powder**

| Dosage (g/ 100 mL) | Removal Percent (%) | | | |
|---|---|---|---|---|
| | TLCP VIII | TLCP IX | TLCP XI | TLCP XII |
| 0.05 | 40.20 | 47.32 | 53.52 | 60.88 |
| 0.10 | 44.32 | 52.68 | 58.64 | 65.36 |
| 0.15 | 50.40 | 59.16 | 64.36 | 71.60 |
| 0.20 | 56.76 | 65.12 | 70.84 | 77.60 |
| 0.25 | 62.88 | 71.36 | 76.48 | 84.56 |
| 0.30 | 69.84 | 78.56 | 83.68 | 90.28 |
| 0.35 | 71.24 | 80.08 | 84.80 | 91.16 |
| 0.40 | 71.96 | 80.84 | 85.04 | 91.80 |




**(a)** **(b)**

Figure 1 Effect of dosage for the removal of(a) methylene blue,(b)congored by Te leaf char powder

**Effect of contact time**

For the present work, the dye solution of 100 mL taken and 0.3g ofadsorbent fed into conical flask. The sample withdrawn from the flask at the time intervals for 20 minutes each. At the end of each 10 minutes the agitatedsample is taken from the flask and tested for it optical density using the UV spectrophotometer. The effect of contact time on adsorption dye solution is presented in Table 4,5and Figure 2.The adsorption equilibrium of dye solution was obtained after 120 minutes and no remarkable changes were observed for longer contact time.

**Table 4 Effect of Contact Time for the Removal of Methylene Blue by Te Leaf CharPowder**

| Contact time (min) | Removal Percent (%) | | | |
|---|---|---|---|---|
| | TLCP VIII | TLCP IX | TLCP XI | TLCP XII |
| 20 | 38.88 | 44.36 | 50.44 | 57.08 |
| 40 | 43.28 | 49.20 | 55.20 | 62.48 |
| 60 | 49.64 | 55.72 | 62.20 | 67.80 |
| 80 | 55.28 | 61.36 | 68.44 | 74.44 |
| 100 | 62.16 | 69.56 | 74.84 | 80.96 |
| 120 | 68.64 | 75.92 | 81.76 | 86.60 |
| 140 | 70.04 | 76.96 | 82.56 | 87.08 |
| 160 | 70.68 | 78.08 | 83.48 | 87.68 |

**Table 5 Effect of Contact Time for the Removal of Congo Red by Te Leaf Char Powder**

| Contact time (min) | Removal Percent (%) | | | |
|---|---|---|---|---|
| | TLCP VIII | TLCP IX | TLCP XI | TLCP XII |
| 20 | 43.20 | 50.56 | 56.64 | 64.12 |
| 40 | 48.68 | 54.40 | 61.40 | 70.24 |
| 60 | 54.28 | 60.76 | 66.76 | 75.84 |
| 80 | 61.76 | 67.24 | 72.48 | 81.56 |
| 100 | 68.36 | 73.96 | 78.56 | 87.44 |
| 120 | 76.80 | 81.56 | 86.56 | 93.28 |
| 140 | 77.32 | 82.56 | 87.44 | 94.04 |
| 160 | 78.32 | 83.68 | 88.56 | 94.92 |

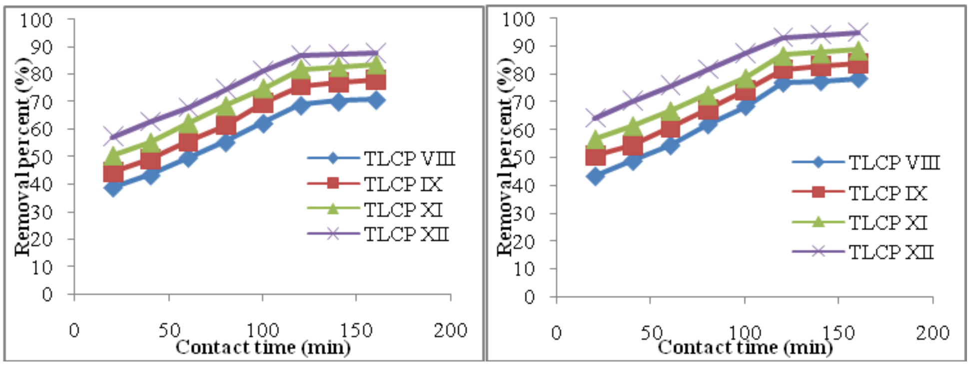



Figure 2 Effect of contact time for the removal of (a) methylene blue(b) congored by Teleaf char powder

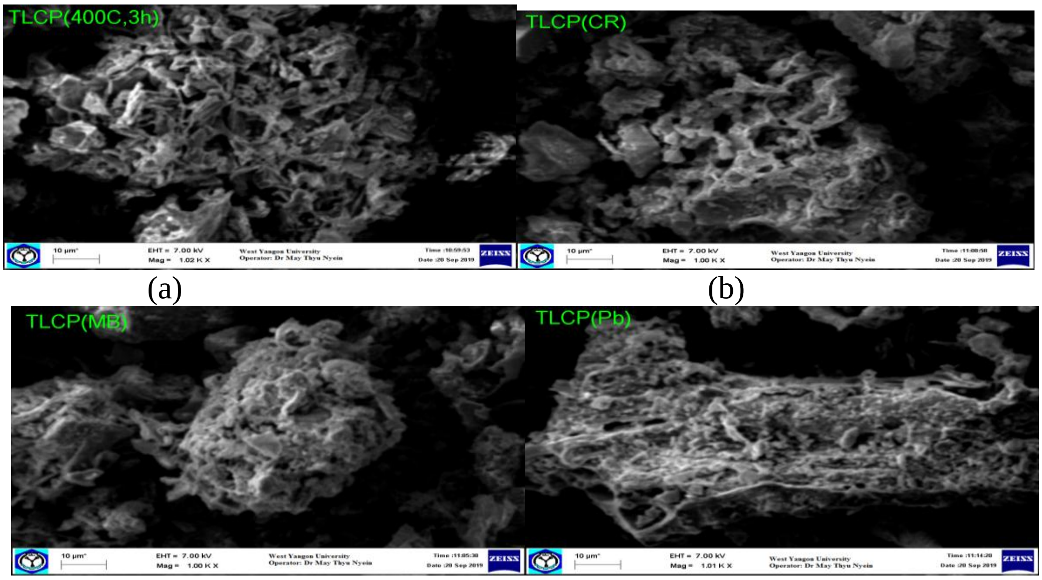
**Removal of $Pb^{2+}$ ion by Te leaf char powder TLCP XII**

Presence of lead, a heavymetal in the environment has been a serious concernespecially withrapid industrialization which hascreated new uses for lead. Theacute toxicity of lead toaquatic lifeand humans and thestringent eminent standard to be met by industries asspecified by regulatory organ nations hasnecessitated thedevelopment of innovative,effective and economical methods for treating leadbearing waste water. So, the adsorptionprocess were used to remove $Pb^{2+}$ ion and selected Te leaf char powder TLCP XIIisan inexpensive adsorbent which have an attractive option for theremoval of lead from wastewater.

**Characterization of Te Leaf Char Powder TLCP XII**

**SEM analysis**

Surface morphology of before and after adsorption of Te leaves char powder are shown in Figure 3. In before adsorption sample, it can be seen that porous structure very much. They are nearly the same size and same diameter. High porosity is an indication of the presence of many active sites, which enhance the adsorption properties. In after adsorption sample, the porousstructures are not clearly seen due to adsorption of color dye and lead on the surface.




(a) (b) (c) (d)

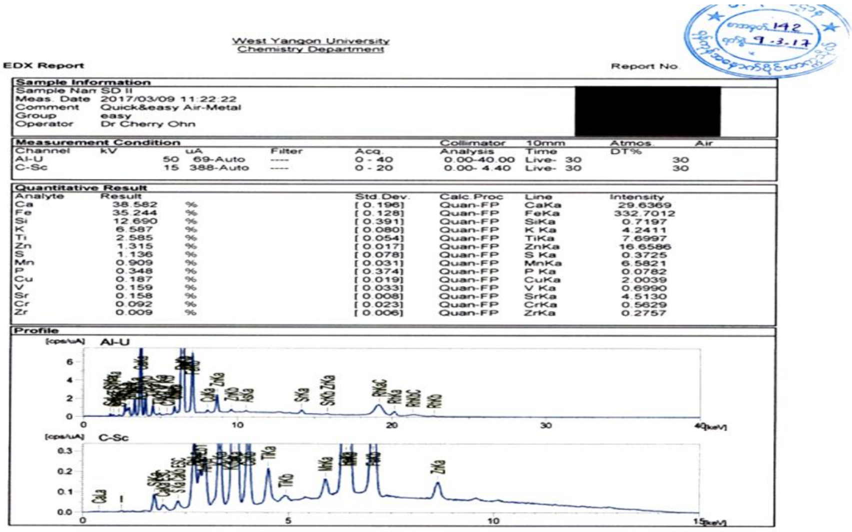
Figure 3 SEM photograph of(a) Before adsorption(b) After removal ofcongored (c) After removal of methylene blue (d) After removal of lead

**EDXRF analysis**

The elemental analysis of Te leaf char powder samples TLCP XII by EDXRF method was shown in Table 6 and Figure 4. From the data, Ca(38.58%) and Fe (35.22%) as the major constituents and Si, K, and Ti as minor constituents were observed in the sample. EDXRF spectrum quantitatively shows the presence of the trace amount of elements such as Sr, Cr and Zr in the sample. Since the high contents of Ca and Fe are present in sample.

**Table 6 Relative Abundance for Elemental Composition of Charcoal**

| No. | Element | Relative abundance (%) |
|---|---|---|
| 1 | Ca | 38.582 |
| 2 | Fe | 35.22 |
| 3 | Si | 12.690 |
| 4 | K | 6.587 |
| 5 | Ti | 2.585 |
| 6 | Zn | 1.315 |
| 7 | S | 1.136 |
| 8 | Mn | 0.909 |
| 9 | P | 0.348 |
| 10 | Cu | 0.187 |
| 11 | V | 0.159 |
| 12 | Sr | 0.158 |
| 13 | Cr | 0.092 |
| 14 | Zr | 0.009 |



West Yangon University
Chemistry Department

EDX Report | Report No.

**Sample Information**

Sample Nan SD II
Meas. Date 2017/03/09 11:22:22
Comment Quick&easy Air-Metal
Group easy
Operator Dr Cherry Ohn
[redacted]

**Measurement Condition** Collimator 10mm Atmos. Air

| Channel | kV | uA | Filter | Acq. | Analysis | Time | DT% |
|---|---|---|---|---|---|---|---|
| Al-U | 50 | 69-Auto | ---- | 0 - 40 | 0.00-40.00 | Live- 30 | 30 |
| C-Sc | 15 | 388-Auto | ---- | 0 - 20 | 0.00- 4.40 | Live- 30 | 30 |

**Quantitative Result**

| Analyte | Result | | Std.Dev. | Calc.Proc | Line | Intensity |
|---|---|---|---|---|---|---|
| Ca | 38.582 | % | [ 0.196] | Quan-FP | CaKa | 29.6369 |
| Fe | 35.244 | % | [ 0.128] | Quan-FP | FeKa | 332.7012 |
| Si | 12.690 | % | [ 0.391] | Quan-FP | SiKa | 0.7197 |
| K | 6.587 | % | [ 0.080] | Quan-FP | K Ka | 4.2411 |
| Ti | 2.585 | % | [ 0.054] | Quan-FP | TiKa | 7.6997 |
| Zn | 1.315 | % | [ 0.017] | Quan-FP | ZnKa | 16.6586 |
| S | 1.136 | % | [ 0.078] | Quan-FP | S Ka | 0.3725 |
| Mn | 0.909 | % | [ 0.031] | Quan-FP | MnKa | 6.5821 |
| P | 0.348 | % | [ 0.374] | Quan-FP | P Ka | 0.0782 |
| Cu | 0.187 | % | [ 0.019] | Quan-FP | CuKa | 2.0039 |
| V | 0.159 | % | [ 0.033] | Quan-FP | V Ka | 0.6990 |
| Sr | 0.158 | % | [ 0.008] | Quan-FP | SrKa | 4.5130 |
| Cr | 0.092 | % | [ 0.023] | Quan-FP | CrKa | 0.5629 |
| Zr | 0.009 | % | [ 0.006] | Quan-FP | ZrKa | 0.2757 |

**Profile**



Figure 4 EDXRF spectrum for Te leaf char powder sampleTLCP XII

## CONCLUSION

Industries are responsible for one of the major environmental pollution problems in the world because they release and undesirable contaminants effluents. Textile waste water contaminates and waste water discharged from battery manufacturing industry also contains $Pb^{2+}$. Removal of $Pb^{2+}$ and dyes from industrial wastes water by using different methods has been reviewed. Adsorption is an effective and efficient technique for the removal of colored pollutant from waste water. In this research, the waste Te leafchar powder was used as adsorbent for the removal of dyes and $Pb^{2+}$ ion from aqueous solution. In this research, the optimum calcination temperature was 400 °C and calcination time were found to be 3 h was selected. Adsorption is focus on two types of dyes which were congo red and methylene blue by contact time and dosage methods. The optimum percentremoval of congo red and methylene blue were found to be 93.28 % and 86.60 % respectively. In before adsorption, SEM photograph shows porous structure very much. After adsorptionsample,the porous structures are not clearly seen due to adsorption of color dye and lead on the surface. EDXRF spectra showCa(38.58%) and Fe (35.22%) as the major constituents. Therefore, this research will be utilized for the removal of dyes treatment of waste water nearby textile industries and removal of $Pb^{2+}$ion nearby battery industry as low cost materials.

### ACKNOWLEDGEMENT

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