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Sustainable Method Development for the removal of Lead from polluted water by using bio-sorbents extracted from Senna Auriculata

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Abstract - Lead metal is used widely because of its mechanical properties like high density, low melting point, ductility, inertness and inexpensive. Half of the lead produced is used as electrodes in lead-acid car batteries. Lead is poisonous to human beings if inhaled or swallowed, lead is very poisonous. Senna auricculata plant has a long tradition of use in local medicine, with the leaves, flowers, seeds, roots, and bark all being utilized. The leaves, stems, fruits and flowers cut from Senna auriculata were washed with distilled water and dried in sun light. The dried materials were crushed and meshed to reduce the size of the particles below75µ and activated at 100^0C using oven. At pH 6, flowers ash has 89.9% of adsorption whereas dry flowers have 87.75% of adsorption of Lead. Flowers ash has maximum adsorption of 97.2% followed by dry fruit's 87.3% adsorption after 7 days. Flowers ash has maximum adsorption of 90.27% followed by dry fruits at 87.3% of adsorption. Removal of Lead from sewage is ranging from 40 to 60% with Leaves powder and 45 to 63% with their ashes, whereas stem powders, flower powders and fruit powders have an adsorption range of 35 to 60%. The Bio sorbent powders are structurally analysed with FT-IR.

Key words: Lead, Bio sorbent, adsorption, Senna auriculata, FT-IR and sustainable

I. INTRODUCTION

Lead (Pb) is a soft, malleable, ductile and heavy metal. It initially has a bluish-white[1] colour that tarnishes to a dull gray colour when exposed to air. It is corrosion resistant[2] and when melted into a liquid has a shiny chrome-silver look. Lead metal is used widely because of its mechanical properties like high density, low melting point, ductility, inertness and inexpensive[3].

Today, over half of the lead produced is used as electrodes in lead-acid car batteries. Its high density and resistance to corrosion makes it useful as the ballast keel of sail boats[4] and as scuba diving weight belts[5]. Lead is also used in the construction industry for roofing, cladding, gutters and glazing bars for stained glass[6,7]. Lead is still widely used to make statues and sculptures[8]. It is used to make bullets and is also used in radiation shields around X-ray equipment[9]. Lead has been used as a paint additive, in face whitening make-up, as water pipes, as a preservative for food and drink, as a pesticide, and in paint used on children's toys.

Lead is poisonous to human beings if inhaled or swallowed, lead is very poisonous. Lead poisoning can have a major effect on the body's brain, kidneys and nervous system[10]. It can damage the body's organs and can cause weakness in the body's joints. Some symptoms of lead poisoning include nausea, vomiting, extreme tiredness, high blood pressure, and convulsions (spasms). Over a long period of time, children often suffer brain damage. They lose the ability to carry out normal mental functions. Lead poisoning occurs due to contamination of soil and water nearby industries, usage of lead pipes, lead paint and residual emissions from leaded gasoline[11].

Due to the above adverse effects it is very essential to remove Lead from the polluted water to prevent environment and human beings. There are few research articles are available for the removal of Lead from the polluted water. Wolvetron B.C and Mc Donald R.C. at al[12] have investigated removal of lead and mercury by water hyacinths (Eichhornia crassipes) (Mart.) Solms and alligator weeds (Alternanthera philoxeroides). Uptake of arsenic, cadmium, lead and mercury from polluted waters by the water hyacinth Eichornia crassipes by Francis E. Chigbo at al[13], bio-sorption: An eco-friendly alternative for heavy metal removal by HK Alluri at al[14] and Azolla pinnata r.br. And Lemna minor l[15]. for removal of lead and zinc from polluted water. so it is essential to develop simple and new methods with low cost by using bio-sorbents like weeds to prevent the environment and living organisms from poisoning of Lead by using simple analytical technique volumetric analysis. There are various techniques available to remove heavy metals like ion exchange, membrane filtration, electrolysis and coagulation but they are high cost, sludge generation and selectivity of metals. Bio-sorption technique is an eco-friendly, sustainable, rapid, easily available and low cost.

Senna auriculata (Thangedu) plant is a perennial shrub belonging to Fabaceae family, growing to a height of 30 to 60 cm. It has a circular, solid and strong stem, brown in color with several branches. It has a compound stipulate leaves, yellowish green in color and huge yellow flower. The fruit of Tanner's cassia contains 7 to 10 seeds. The plant is called as "Tanner's cassia" because the bark is one of the most priceless of Indian tans containing tannin. It is extensively cultivated in area which is dry and warm. Cassia auriculata thrives on dry stony hills and on black soils, along road side, in degraded forest, and waste land.

Fig-1 Senna auriculata plant

The plant has a long tradition of use in local medicine, with the leaves, flowers, seeds, roots, and bark all being utilized. Modern research has demonstrated the presence of various medically active compounds in the plant. Saponin and the cardiac glucoside sennapicrin are reported from the roots. The bark, flowers, and seeds contain pyrrolizidine alkaloids, suspected of hepatotoxic properties. Senna auriculata plant was selected for this experiment due to its easily availability and lot of medicinal values.

Objective of this method

- Stem, fruits, leaves and flowers of the Senna auriculata plant in dry and ash powders were used as bio-sorbents to extract Lead from the polluted water.
- To calculate the pH verses percentage of removal of Lead.
- To calculate the time verses percentage of removal of Lead.
- To calculate the adsorbent doses verses percentage of removal of Lead.
- To calculate the temperature verses percentage of removal of Lead.
- To determine the structural analysis of bio-sorbents before and after adsorption by using FT-IR spectroscopy.

II. ADSORPTION EXPERIMENT

2.1 Preparation of bio-sorbents powder

The leaves, stems, fruits and flowers cut from Senna auriculata were washed with distilled water and dried in sun light. The dried materials were crushed and meshed to reduce the size of the particles below75μ and activated at 100^0C using oven. Ash adsorbents were prepared by burning the plant materials as discussed above.

2.2 Preparation of lead sample solution

One gram of lead nitrate is dissolved 1000 mL distilled water to make the concentration of 1000 ppm.

2.3 Preparation of stock solution.

250 mL of Lead nitrate solution is taken in 500mL of stopper conical flask in that bio-sorbents powders were added at different pH range, at different adsorption doses and kept for different time intervals by thorough shaking with frequent times for better absorption of lead. The bio-sorbents solutions are filtered through Wattmann filter paper through funnel into a cleaned reagent bottle. The filtrate is stored in cold and dry place until further experiment. The powders of bio-sorbents before and after absorption were examined with FT-IR spectrophotometer to determine the adsorption by comparing the change in the spectra.

2.4 Preparation of reagents

Preparation of potassium chromate solution

One gram of potassium chromate is dissolved in 1000 mL of distilled water.

Preparation of acidic buffer

50 ml of acidic acid dissolved 70 ml of distilled water and 4 grams of sodium acitate is added and thoroughly shaken well.

Preparation of hypo solution

15 grams of sodium thio sulphate (hypo) is dissolved in 1000 mL of distilled water.

Preparation of starch solution

One gram of starch powder is dissolved in 2 to 3 ml of distilled water and poured this content into 100mL boiling water. Stirred the contents with glass rod and made into a uniform solution

2.5. Procedure

From stock solution 20 mL of bio-sorbent solution is pipette out into a clean conical flask to this same quantity of potassium chromate solution is added. Yellow precipitate is formed. The precipitate is dissolved with concentrated HCL and 2mL of acidic buffer is added. To this one gram of potassium iodide is added and closed the conical flask and

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kept in dark place for 5 minutes. After 5 minutes the contents are titrated against hypo until pale yellow colour is obtained. To this 1mL of starch indicator is added and titrated against hypo solution till the contents in the flask turn to pale green colour. The end point is noted from the burette the reading. The same procedure is repeated with blank and each bio-sorbent solution.

III. Results and Discussions

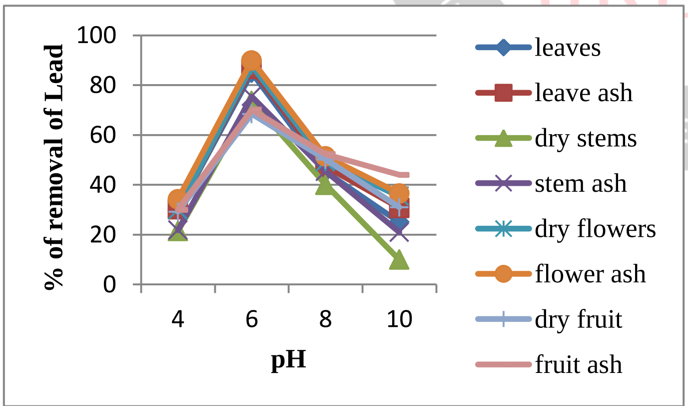
The removal of Lead from polluted water was investigated by changing the various physicochemical parameters like pH, time, adsorbent doses and temperature.

3.1Effect of pH

The adsorption of Lead is maximum at pH 6 range. Flowers ash has maximum adsorption. The adsorption falls gradually by increasing the pH from 6 to 10. At pH 6, flowers ash has 89.9% of adsorption whereas dry flowers have 87.75% of adsorption of Lead. At PH 10, leaves powder has least adsorption of 25.05%. The % of removal of lead by bio sorbent powders are presented in theTable-1. The Adsorption isotherm is shown in the graph-1.

Table-1 Effect of pH on % of adsorption of Lead

pH range	leaves	leave ash	dry stems	stem ash	dry flowers	flower ash	dry fruit	fruit ash
4	29.96	30.18	21.4	21.78	29.96	34.24	29.18	29.96
6	85.01	86.54	73.68	75.43	87.75	89.9	68.42	70.17
8	45.2	47.3	40	45.4	49.2	51.4	50.16	52.26
10	25.05	30.73	10	21	35.42	36.54	31	44



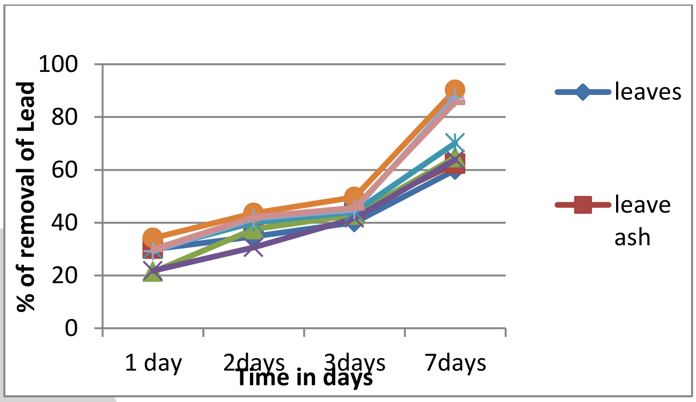
Graph-1 Effect of pH in the % removal of Lead

3.2 Effect of Time on adsorption of Lead

By increasing the time gradually from 1 to 7 days by shaking, flowers ash has maximum adsorption of 97.2% followed by dry fruit's 87.3% adsorption after 7 days. It has been observed that by increasing the time with different bio-sorbents, the adsorption of Lead has increased gradually. The % of removal of lead by bio sorbent powders are presented in theTable-2. The Adsorption isotherm is shown in the graph-2.

Table-2 Effect of time on % of adsorption of Lead

Time in days	leaves	leave ash	dry stems	stem ash	dry flowers	flower ash	dry fruit	fruit ash
1 day	29.96	30.18	21.4	21.78	29.96	34.24	29.18	29.96
2days	34.73	40.06	37.53	30.64	40.09	43.68	41.7	42.17
3days	40.16	43.89	42.97	41.7	44.15	49.69	44.99	45.63
7days	60.02	62.35	64.72	63.84	70.16	90.27	87.3	85.6



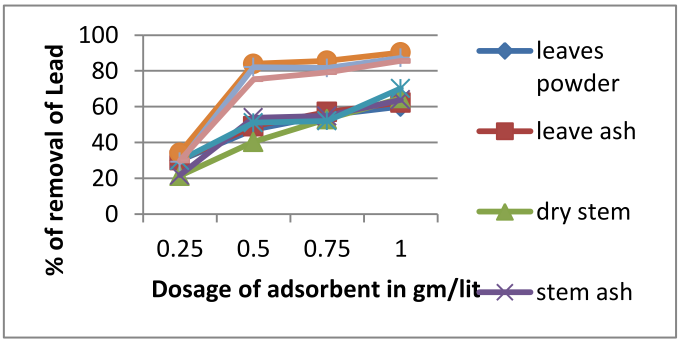
Graph-2 Effect of time in the % removal of Lead

3.3. Effect of adsorbent doses on adsorption of Lead

Initially 0.25gms of bio-sorbents are used for the elimination of Lead. Flowers ash has 34.24% of adsorption. By increasing the doses from 0.25gm to 1gm, the elimination of Lead has also increased gradually, Flowers ash has maximum adsorption of 90.27% followed by dry fruits at 87.3% of adsorption. The % of removal of lead by bio sorbent powders are presented in theTable-3. The Adsorption isotherm is shown in the graph-3.

Table-3 Effect of adsorbent doses on % of adsorption of Lead

Adsorbent doses in grams	leaves powder	leave ash	dry stem	stem ash	flower	flower ash	dry fruit	fruit ash
0.25	29.96	30.18	21.4	21.78	29.96	34.24	29.18	29.96
0.5	47.2	49.13	40.36	53.84	51.07	83.97	82.05	75.28
0.75	55.25	57.1	53.08	54.87	52.09	85.63	81.6	79.19
1	60.02	62.35	64.72	63.84	70.16	90.27	87.3	85.6



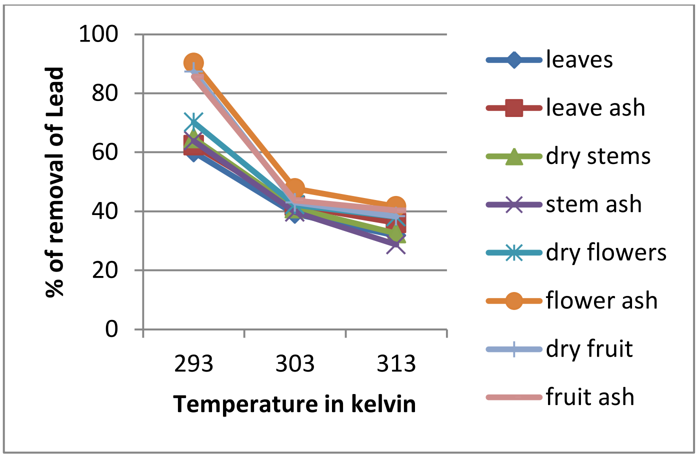
Graph-3 Effect of adsorbent doses in the % removal of Lead

3.4 Effect of temperature on the adsorption of Lead

Flowers ash has maximum adsorption at a temperature of 293K followed by dry fruits at 87.3% of adsorption. By increasing the temperature of bio-sorbents solution by heating, it is observed that adsorption rate is decreased with the increment in temperature at 313K. The % of removal of lead by bio sorbent powders are presented in theTable-4. The Adsorption isotherm is shown in the graph-4.

Table-4 Effect of temperature on % of adsorption of Lead

Temperature in Kelvin degrees	leaves	leave ash	dry stems	stem ash	dry flowers	flower ash	dry fruit	fruit ash
293	60.02	62.35	64.72	63.84	70.16	90.27	87.3	85.6
303	39.12	41.89	40.97	39.75	42.15	47.69	42.99	43.69
313	31.73	36.06	32.53	28.64	38.09	41.62	38.26	40.25

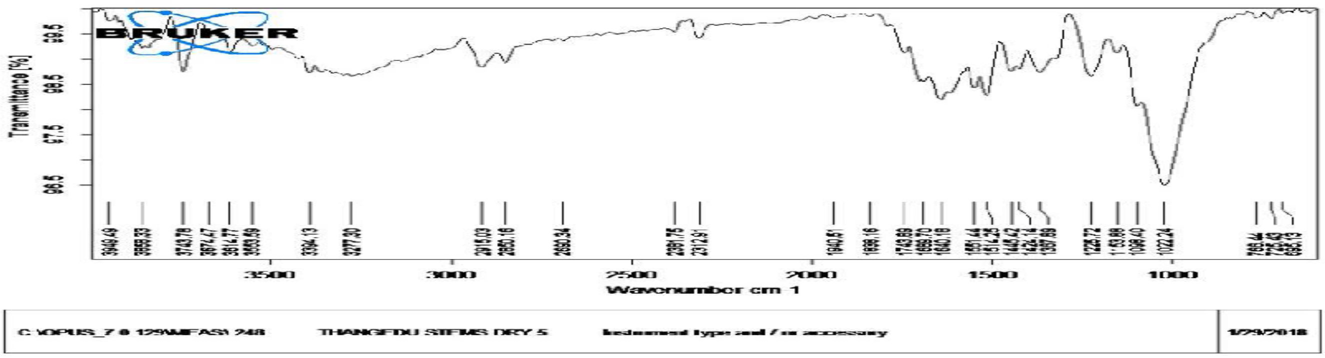


Graph-4 Effect of temperature in the % removal of Lead

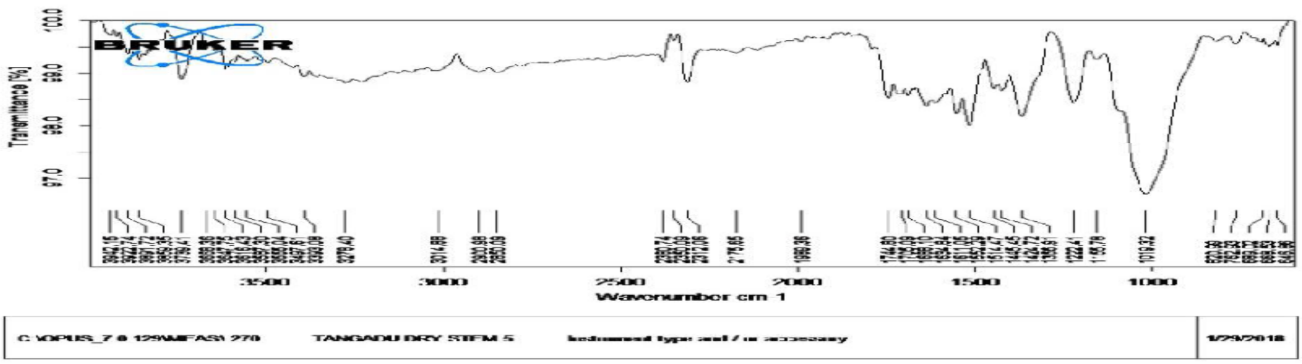
V. CONCLUSION

The bio-sorbents extracted from Senna Auriculata plant are used for the removal of Lead from polluted waters by developing a new and simple volumetric method. Percentage of removal of Lead is 85 to 90% with some adsorbents in this experiment. At pH 6, the removal of Lead is maximum by most of the bio-sorbents. The developed method is inexpensive and sustainable for the removal of Lead from polluted water which makes soil and water free Lead pollution.

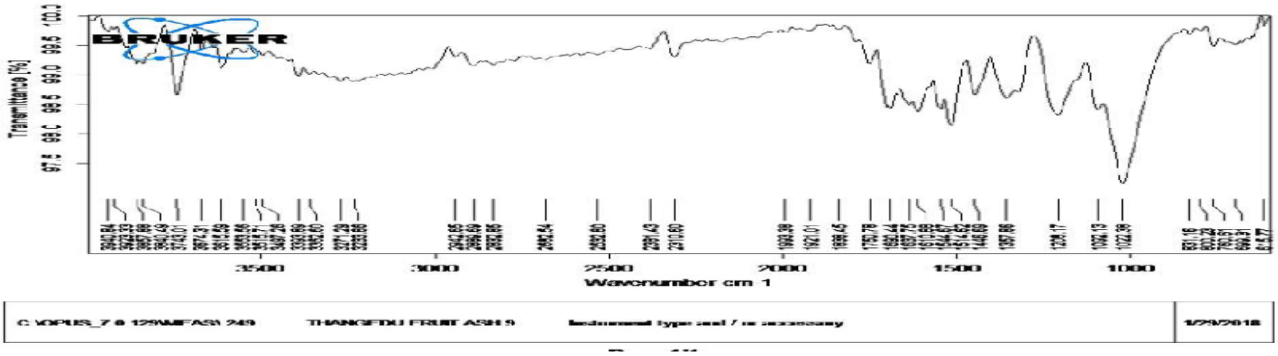
2. FT-IR spectras of Senna auriculata bio sorbent powders



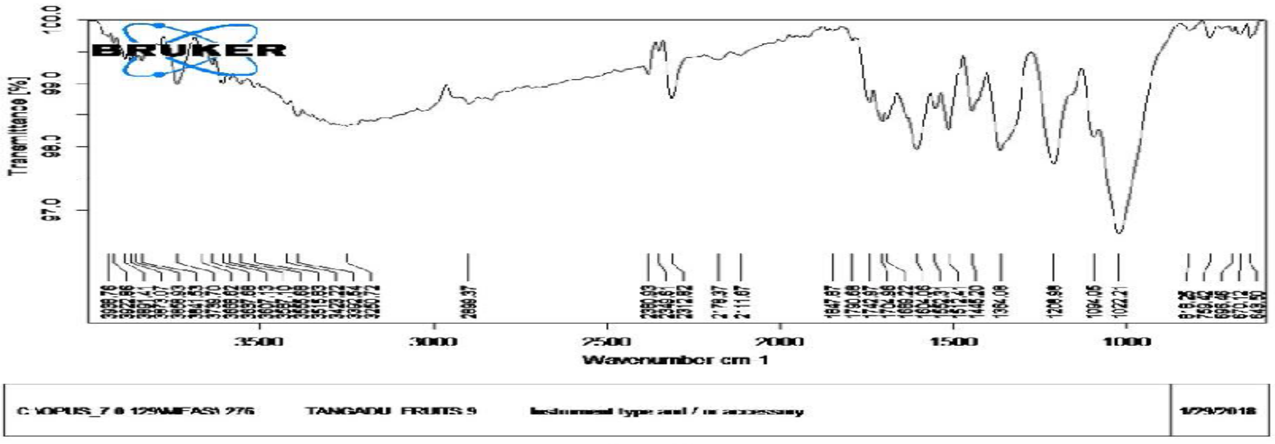
Spectra-1 Senna auriculata dry stem before adsorption



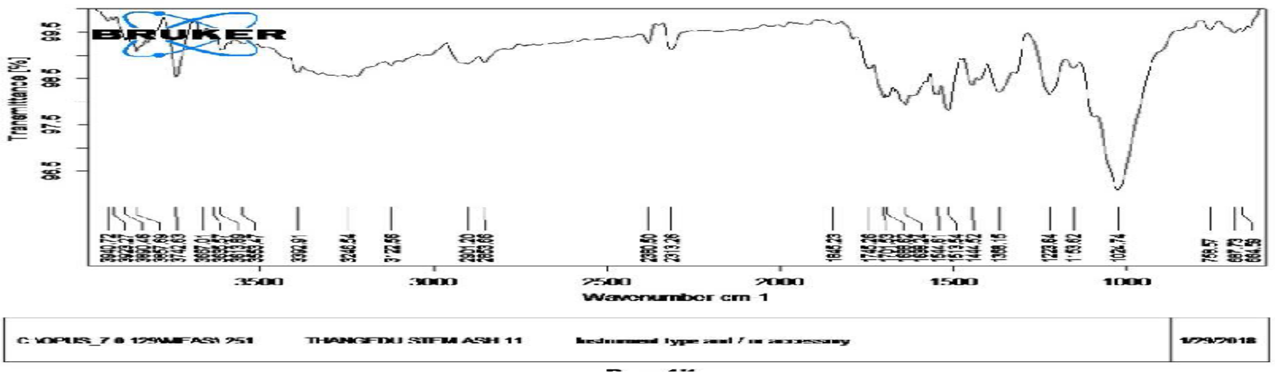
Spectra-2 Senna auriculata dry stem after adsorption



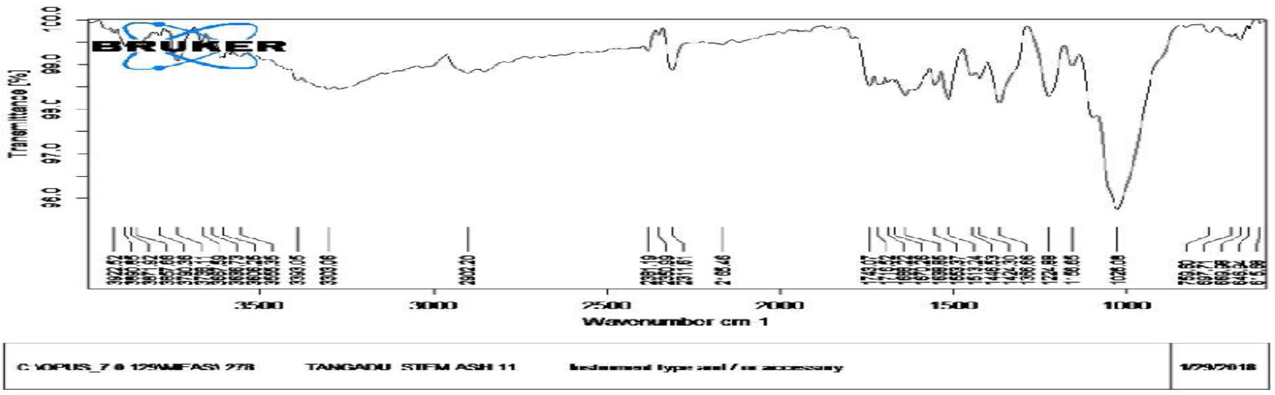
Spectra-3 Senna auriculata fruit ash before adsorption



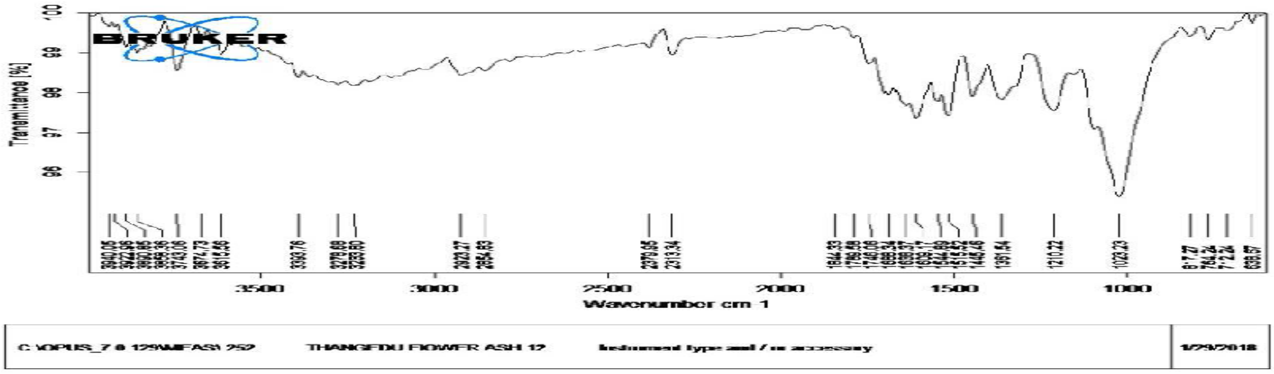
Spectra-4 Senna auriculata fruit ash after adsorption



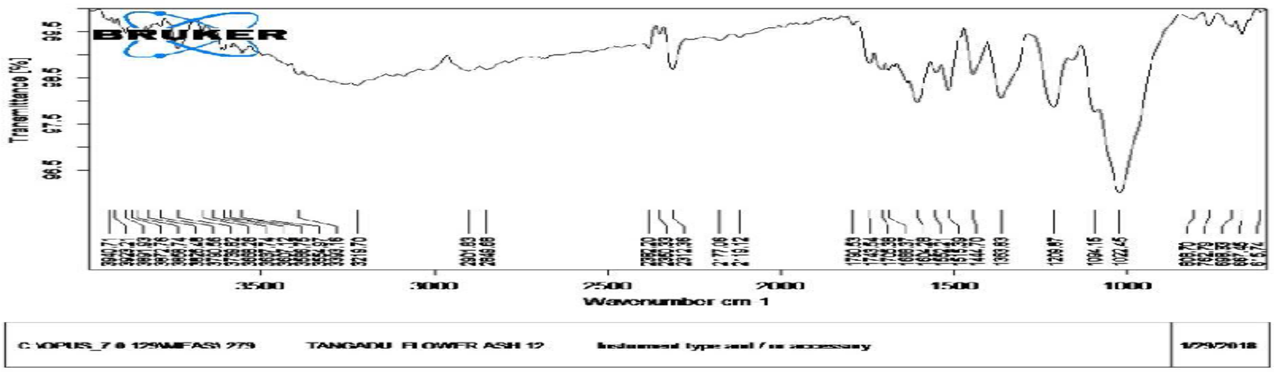
Spectra-5 Senna auriculata stem ash before adsorption



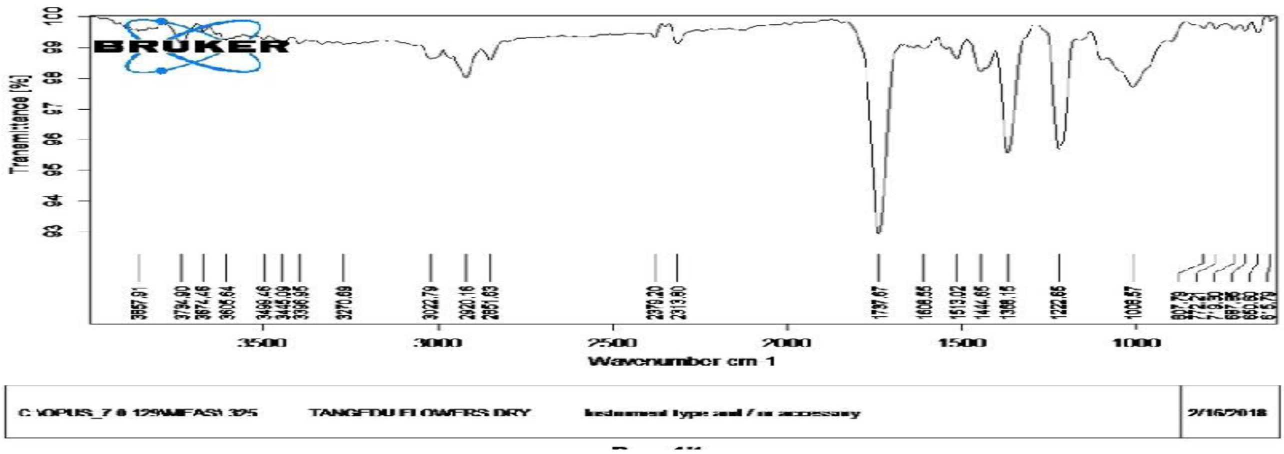
Spectra-6 Senna auriculata stem ash after adsorption



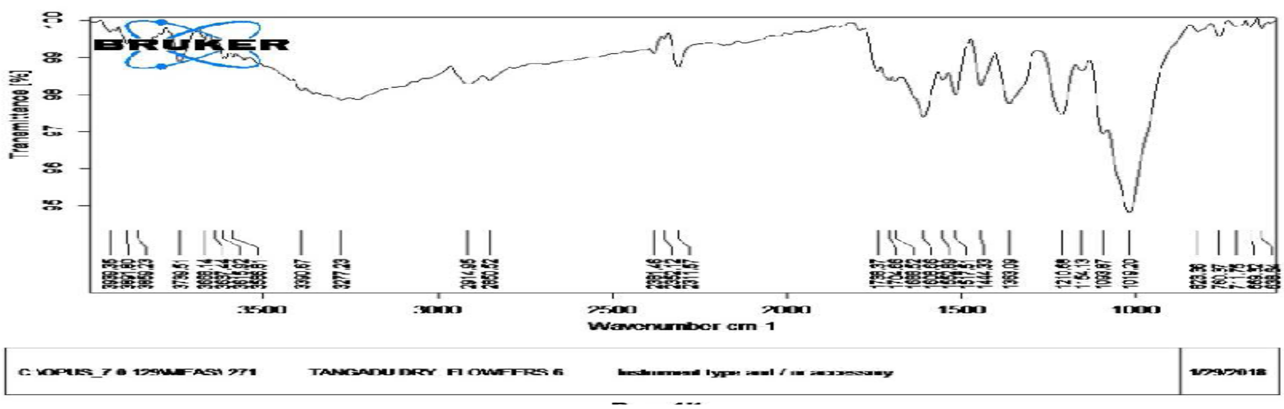
Spectra-7 Senna auriculata flower ash before adsorption



Spectra-8 Senna auriculata flower ash after adsorption



Spectra-9 Senna auriculata flower dry before adsorption



Spectra-10 Senna auriculata flowers dry after adsorption

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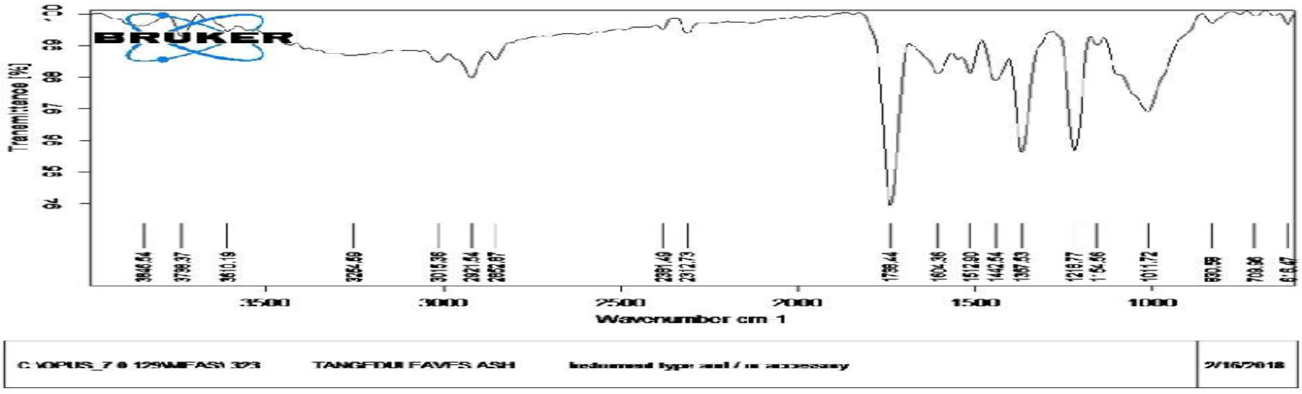
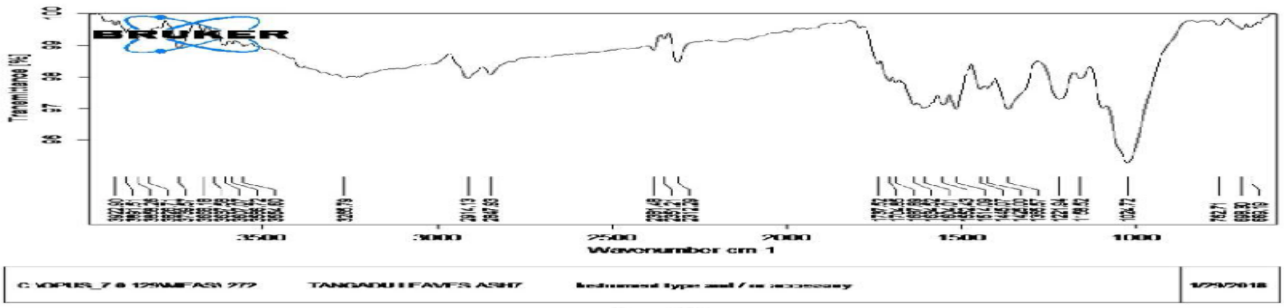
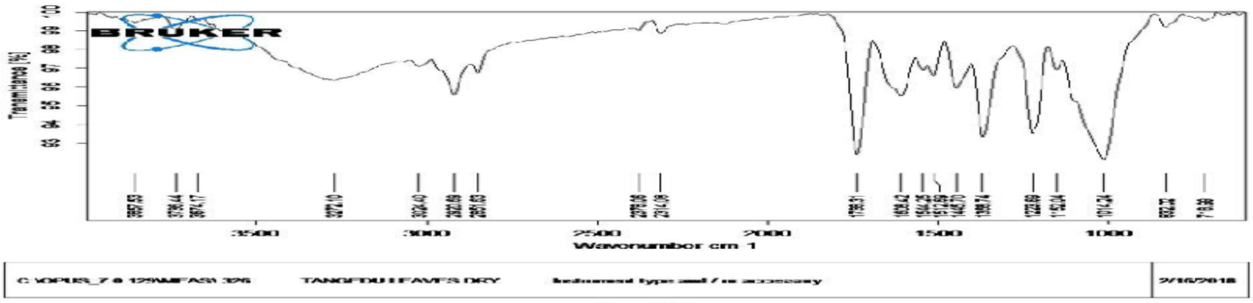


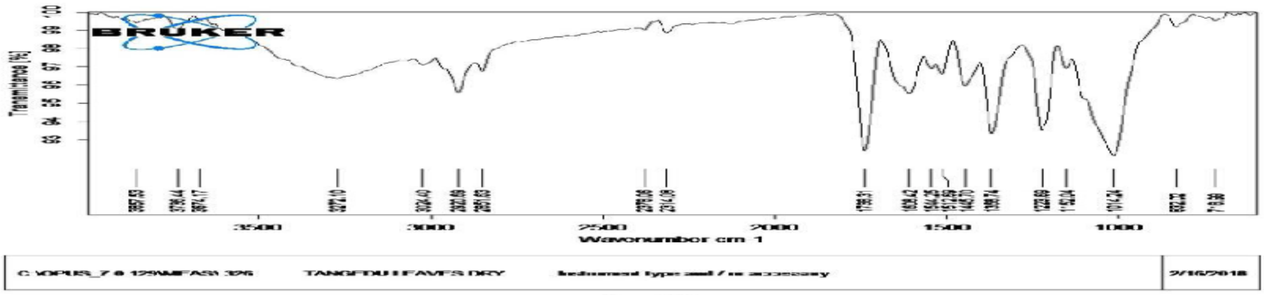
Spectra-11 Senna auriculata leaves ash before adsorption



Spectra-12 Senna auriculata leaves ash after adsorption



Spectra-13Senna auriculata dry leaves before adsorption



Spectra-14 Senna auriculata dry leaves after adsorption

REFERENCES

[1]. Green wood and Earn Shah – 1998 pp 372.

[2]. Green wood and Earn Shah – 1998 pp 372 to 373.

[3]. Baird and Cann – 2012 pp 537 to 538, 543 to 547.

[4]. Parker- 2005 pp 194 to 195.

[5]. Krestovhikoff and Hals – 2006 pp 70.

[6] & [7]. Pink Lead Research – Weathering to parapets .

[8]. Putnam – 2003 pp 216.

[9]. National Council on Radiation, Protection and Measurements – 2004 pp 16.

[10]. Rudolph Etal – 2003 pp 369.

[11].Kosnett – 2006 pp 238.

[12]. Wolvetron B.C and Mc Donald R.C. at al.

[13]. Francis E Chigbo, Ralph Wayne Smith and Fred L. Shore.

[14]. HK.Alluri,SR Ronda, VS Settalluri, JS Bondili, V. Suryanarayana &P.Venkateswar.

[15]. Azolla pinnata r.br. And lemna minor l.