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Effect of pH on Adsorption of Lead(II) Using Syzygium Jambos

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ABSTRACT—*The industrialization and modernization all over the world causes environmental imbalances throughtheir byproducts of heavy metals, these are becoming dangerous to the health of human beings, animals and aquatic creatures. The heavy metals can enter a water supply by industrial and consumer waste and thereby releasing heavy metals into streams, lakes, rivers, and groundwater. Lead (Pb) is one of the heavy metals, it becoming a part of our day to day life through various applications. This paper proposes Syzygium Jambos(SJ) as an adsorbent for the removal of Lead(II) from aqueous solutions. The metal ions mostly dependent on the pH of the aqueous solution, we investigated the effect of pH.The atomic absorption spectroscopy (AAS) is used to determine the amount of adsorption at various pH values. The optimal pH value found as 2.0 for 76.5% of maximum adsorption of Lead(II) using Syzygium Jambos. The detailed research review indicated that very less research happened in the utilization of Syzygium Jambos.Therefore the results presented in this paper are novel and are useful for the society to sidestep the toxicity of Lead(II).*

Keywords*--- Syzygium Jambos, Adsorption, Heavy Metals, Lead (Pb), Toxicity, Effect of pH, etc.,*

I. INTRODUCTION

The recent investigation study by pollution control board of India reveals that the heavy metals found in patients after Diwali festival celebrations, they found that high level of heavy metals, including lead, was found in the urine samples of many patients due to direct or indirect exposure to firecrackers post-Diwali.Heavy metals can pose serious health threats and their toxicity can damage central nervous, cardiovascular and gastrointestinal systems [1].The study showed that there was evidence of increased levels of lead, barium and strontium in the urine samples of many of the subjects.These are some of the metals used in fire cracker manufacturing.Lead affects the central nervous system in humans, when heated it can emit highly toxic fumes, itcauses damage to liver, kidney and reduction in hemoglobin formation, infertility and abnormalities in pregnant women and in young children can suffer mental retardation [2].

Lead is one of the common pollutants of industrialwastewater. Lead pollution exists in aqueous waste streamsof many industries such as manufacture of storage batteriesmost of which is recycled,printing, painting, ceramics, pigments, dying,building constructions, storage tank lining, corrosive liquid containers, radiation shielding, solder, and cable sheathing , pipe work,pesticide, smoking, automobile emission, mining, burning of coal, antibacterial substances and wood preservatives [3]. These all applications indicate that in the modern living society, the people are affianced with the Lead but they are not acquainted the health hazards caused by the Lead.

Lead is non-biodegradable andaccumulates in living organism therefore it must be removedfrom the wastewaters. Several methods of Lead removalfrom wastewater have been applied using chemical precipitation,membrane processes, ion-exchange and adsorption[4].Many researchers have been using the

adsorption as most effective method for the treatment of heavy metalsfrom aqueous solution usinglow-cost natural adsorbents [5-7].In regards of its simplicity andhigh-efficiency characteristics even for a minute amount of heavymetals, adsorption is looked upon as a better technology. Activatedcarbon is a well-known adsorbent and proven to be useful for theremoval of heavy metals but forwastewater treatment is not feasible due to its expensive cost.Adsorption is considered to be a fast physical/chemical processand its rate is controlled by the type of the process. Agriculturalwaste andits industrial by-products, bacteria, yeasts, fungi, and algae can be functioned as adsorbents of heavy metals [8].

The removal of metal ions from aqueous solution by adsorbent is dependent on the pH of the solution, that's why in most of adsorption experiments the popular study is the effect of pH analysis in the removal of metal ions from aqueous solutions and industrial waste waters[9]. In most of analyses the effect of pH shows a significant change in the percentage of adsorption [10]. The pH of the solution also affects the surface charge of the adsorbents and the degree of ionization of adsorbate [11].

Syzygium Jambos (L.) belongs to the family of Myrtaceae. *Carl Linne* was the first who discovered the plant. He gave the plant Latin name as Eugenia Jambos. These are native to south-east Asia. Now a dayit's known as Syzygium Jambos. E [12]. It is also called as rose apple because if one cuts the fruit it smells like a rose and it can be eaten[13].It has a long history of being used in traditional and folk medicine in various cultures. The fruit has been used as a diuretic and as a tonic for better health of the brain, liver, against fever, skin irritations and many medicinal benefits [14]. When the presence of Lead(II) ismore than its permissible levels of 0.01mg/L,it causes damage to animals and aquatic creatures. This can be overcome when we treat the waste waters with the powder made from the leaves, seeds and bark of *S. Jambos.*

Many of the low cost and freely available sorbents have been investigated for the removal of lead but till now no researcher used the *Syzygium* Jambos as an adsorbent for the removal of lead. In this paper first time we have investigated the effect of *S-Jambos* in removal of Lead(II) from aqueous solutions.

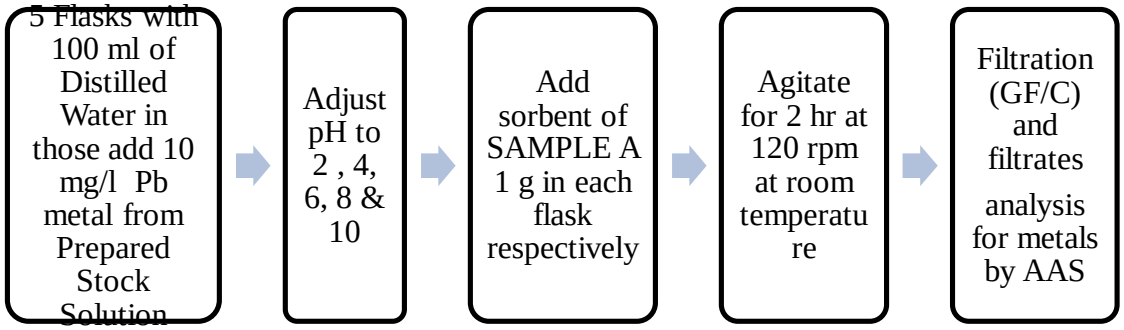
II. SYZYGIUM JAMBOS AS AN ADSORBENT

In this paper, we propose *Syzygium Jambos (S. Jambos)* as a novel adsorbent for the removal of Lead(II) from the prepared stock solutions. The *S. Jambos*plant locally called as rose apple tree, its leaves are collected from our farm garden at Kakupally, Nellore, Andhra Pradesh, India. The combination of*S. Jambos*leaves along with upcoming fruits isshown in Fig.1, the eatable fruits are shown in Fig. 2 [15]. The *S. Jambos* leaves are washed thoroughly under tap water to remove dust over the leaves, after that washed thoroughly with distilled water and then dried for 15 days under sunlight. The dried leaves became completely crispy, after that grinded, filtered and finallyobtained the fine powder as shown in Fig. 3.

Figure 1: Syzygium Jambos plant with leaves and upcoming

Figure 2: Syzygium Jambos grownup fruit

Figure 3: Syzygium Jambos leaves powder after drying process



III. MATERIALS AND METHODS

I.I. Preparation of Stock solution for Lead (II) solution

Stock solution of Lead(II) is prepared by dissolving 1.598 g of $Pb(NO_3)_2$ in one liter of Milli-Q water (Distilled Water) to achieve a metal concentration of 1000 mg/l, which is equivalent to 1000 ppm. Water samples for all experiments to be prepared by diluting this stock solution to the pre-determined concentration.

I.II. Experimental procedure for effect of pH

The optimum pH for adsorption of Lead(II) by the *Syzygium Jambos* is determined experimentallybased on the following steps and its experimental sequences is shown in the block diagram of Fig.4.

- Lead(II) solution with the concentration of 10 mg/L (10 ppm) from the stock solutionsis to be added in 100 ml of distilled water. Prepare such 5 sample flasks.
- The initial pH of these samples is to be adjusted to 2, 4, 6, 8 & 10 and each sample is to be adjusted using either 0.1N H_2SO_4 or NaOH solution.
- Add 1 g of Sample A to each flask.
- Equilibrium condition for heavy metal adsorption was obtained after 2 hours of agitation at room temperature and 120 rpm.
- Samples were taken after filtering the samples by WhatmanTM filter
- After equilibrium was achieved and heavy metal concentrations are to be analysed using atomic adsorption spectrometer (AAS)
- The optimum pH is to be found from above steps and it is used as the FINAL pH for the next experiments

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I.III. Analytical Instrumentation[16]

I.III.I. Atomic Absorption Spectroscopy (AAS)[17]

The samples obtained from the procedure of section B are used in AAS. The aliquant of the mixture solution subjected for the determination of metal ions using Atomic absorption spectroscopy of model ZEEnit 700P, Germany.

The Pb (II) uptake is calculated in terms of percentage by using the Eq. 1. All experiments were conducted in duplicate.

$$\% \text{ Removal} = \frac{C_i - C_e}{C_i} X\ 100 \text{Co-CeCoxd} \qquad (1)$$

Where, C_e and $C_i$are the final and initial concentration of heavy metal respectively. The adsorption capacity q_e (mg/g) was calculated using Eq. 2.

$$q_e = (C_i - Ce)\ \frac{V}{W} \qquad (2)$$

Where, V is the volume of solution in litre (L) and W is the mass of adsorbent in gram (g)

I.III.II. Fourier Transform Infrared (FTIR) Spectroscopy[18]

The FTIR spectra of the samples will be recorded on a PerkinElmer 1600 spectrophotometer in KBr medium. The *Syzygium Jambos* and KBr will be mixed in the ratio of 1: 5 and grind it around 30 minutes using agate motor and pestle till the mixture get homogeneously formed.

I.III.III. Powder X-Ray Diffraction (XRD) [19]

The powder X-ray's diffraction patterns were studied by using CuK_α radiation (λ = 1.5406 Å) of Philips X-ray diffractometer at the scanning range of 2θ = 10°– 80° with the scanning rate of 2° per minute. The prepared samples were subjected for sonication in acetone media for 10 minutes in order to remove water completely from the samples and grounded before exposing to X-ray's beam.

I.III.IV. Scanning Electron Microscope (SEM) [20]

The mixed *Syzygium jambos* were pressed under hydraulic press about 1 tone to form transparent pellets. The morphology of the Syzygium *Jambos* in the form of powder deposited on glass was investigated using Philips XL 30 ESEM scanning electron microscope (SEM).

IV. RESULTS & DISSCUSSIONS

The procedures mentioned in the Section III-A&B are used to obtain the results shown in Table I. The results from Table I, Fig. 5 and Fig.6 indicates that the maximum adsorption of Lead (II) occurred at the lower values of pH than the higher values of pH. The maximum percentage removal of adsorption is found as 76.5% at the pH value of 2 using *Syzygium Jambos* as an adsorbent for initial Lead concentration of 10 mg/L , adsorbent dosage of 1g and contact time of 2 hours.

The FTIR result shown in Fig. 7 indicates the pure adsorbent of *Syzygium Jambos* without treated any heavy metal ions. The important characteristic peaks found at 3442 cm^{-1} is corresponds to N–H vibration stretching which indicates adsorbent has capacity of metal sorption and aliphatic and aromatic properties, 1633 cm^{-1} for C=C-stretching band of alkene group, 1103 cm^{-1}R-O-R aliphatic group. The XRD result shown in Fig. 8 indicates that the maximum intensity of molecules present in the *Syzygium Jambos* found as 2121a.u at a diffraction angle 17.03^0 and minimum intensity found as 7 a.u at a diffraction angle 4.12^0. The SEM results shown in Fig. 9indicate that there is adsorption capacity of *Syzygium Jambos*.

TABLE 1: Effect of pH on Adsorption of Lead (II)

S. No	The value of pH	% Adsorption of Lead (II)
1	10	48.8
2	8	41.6
3	6	39.5
4	4	42.5
5	2	76.5

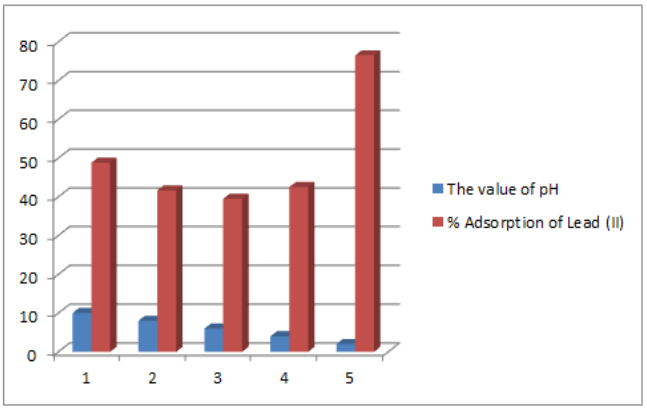

Figure 5: Bar graph of %Adsorption Vs. value of pH

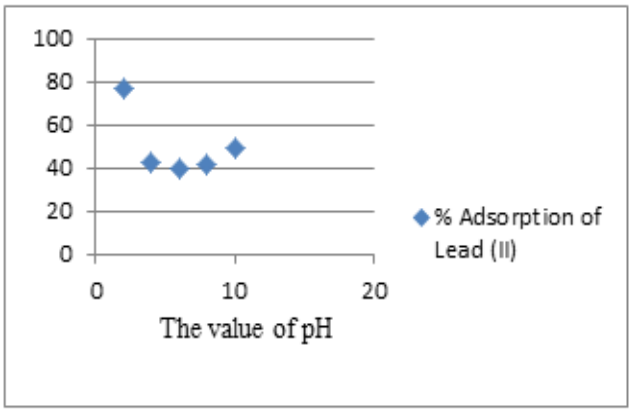

Figure 6: Scatter plot of %Adsorption Vs. value of pH

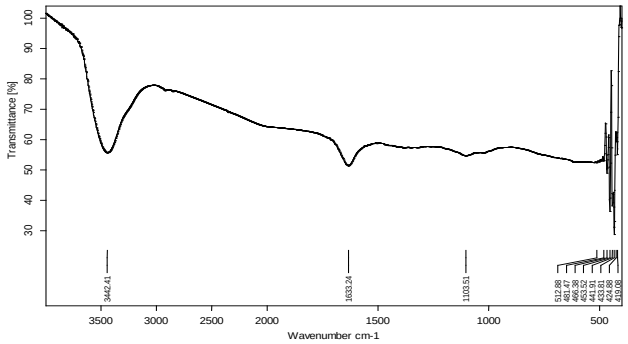

Figure 7: FTIR result of *Syzygium Jambos*leaf powder

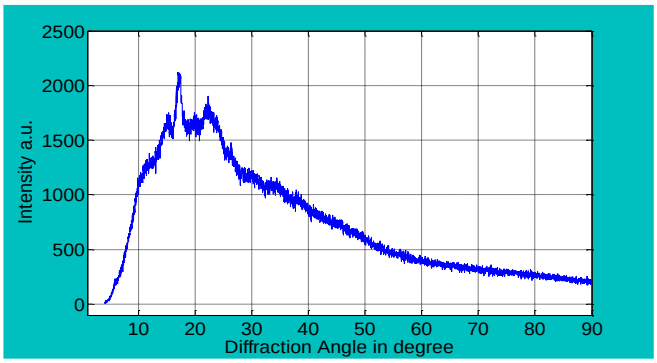

Figure 8: XRD result of *Syzygium Jambos*leaf powder

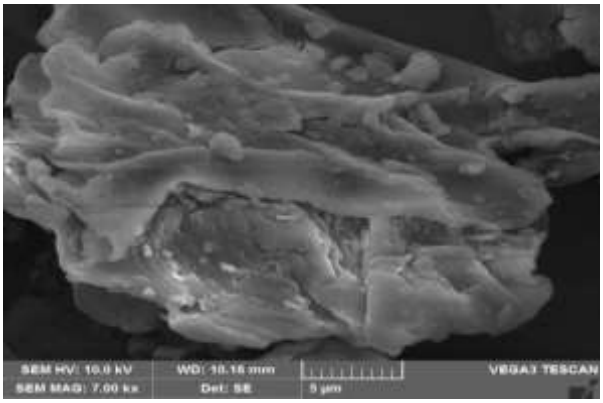

Figure 9: SEM result of *Syzygium Jambos*leaf powder

V. CONCLUSIONS

This paper proposed *Syzygium Jambos*leaf powder as an adsorbent for the removal of Lead(II) from aqueous solutions. This paper clearly discusses the significance of removal of Lead (II) and its health hazards with respect to living creaturesand environmental pollution. The results obtained through different analytical techniques such as AAS, FTIR, XRD, SEM and described the materials, methods used in the investigations to obtain the precise results. The maximum percentage removal of Lead(II) by *Syzygium Jambos* leaves powder found as 76.6% at 10 ppm of initial metal ion, 120 minutes of contact time, 1 g/L of adsorbent dosage and pH = 2. The percentage change in the maximumadsorption to minimum adsorption found as75.98% from pH=2 to pH=6 respectively. It indicates that *Syzygium Jambos* has maximum adsorption capacity at lower pH values and there is a significant change in % adsorption capacity of Lead (II) by *Syzygium Jambos* with respect to pH value.

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