

## Adsorption of Lead (II), Cobalt (II) and Iron (II) From Aqueous Solution by Activated Carbon Prepared From White Lupine (GIBITO) HSUK

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### ABSTRACT

One of the main environmental problems is the contamination of water by heavy metals. There are different methods for removing toxic metals from wastewater such as membrane filtration, electrochemical precipitation, photo-chemical oxidation, coagulation, fertilization, adsorption and ion exchange methods. Nevertheless, based on environmentally friendly, easy to operate and cost-effectiveness adsorption technique is very important as it compared to other technique according to different studies. The investigation and use of low-cost and eco-friendly adsorbents is better to avoid expensive methods of removing Pb (II), Co (II) and Fe (II) from aqueous solution. This study explores feasibility of using AC from WLH is an agricultural waste for removal of each metal ion from aqueous solution of industrial wastewater. AC was prepared from WLH with Furnace. The moisture content, ash content, volatile matter and carbon content are characterized by different physical and chemical properties. The properties of initial concentration, adsorbent dose, shaking time, temperature and effect of pH on adsorption efficiency were examined; therefore the removal efficiency of Pb (II), Co (II) and Fe (II) was 91.9, 90.36 and 90.28% respectively. UV-Visible spectrophotometer technique was used for determining the concentration of heavy metal ions before and after adsorption. Adsorption isotherm was also studied using Langmuir and Freundlich, the experimental results have been fitted with the Freundlich isotherm model with higher correlation coefficients of  $R_2 = 0.981, 0.965$  and  $0.963$  for Pb (II), Co (II) and Fe (II) respectively. Pseudo first-order and pseudo second-order models determined the adsorption kinetics but the adsorption process was fit pseudo second-order model.

**Keywords:** Adsorption; Activated carbon; Toxic chemicals; WLH; Isotherm and kinetics; Toxic chemicals

### INTRODUCTION

Rapid growth and development of industries on the universe causes increased concentration heavy metal's ion in water bodies, which is a major environmental problem. Because of the toxicity of heavy metal ions it is expose human health when it was interred in to food chains [1]. The existence of heavy metal's ion in water bodies is becoming the main environmental and public health problem [2]. The existence heavy metals ions in water were generated from the wastewater of different industries. This study categorizes about 20 metals as heavy metals, which half of them has hazardous effects on the environment and human health because of their toxicity [3]. The elimination and regaining of toxic heavy metal ions from industrial by-product is

great importance from an environmental point of view. They commonly use the conventional treatment methods are commonly for the exclusion of metal ions from industrial wastewater. Most common antiseptic approaches for the removal of toxic metal ion from aqueous solution is membrane filtration technology, electrochemical precipitation, photo-chemical oxidation, and coagulation, fertilization, adsorption and ion exchange methods [4,5]. These conventional methods are expensive because non-recycle materials used, not cost effective and generation of toxic sludge as by-product often unsuccessful for the confiscation of heavy metal ions from industrial waste water.

Current technologies for heavy metal's elimination from waste water are ineffective (particularly at cost and environmental

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issue) and unavailable for developing countries. By considering inexpensiveness and effectiveness of heavy metal's removal from waste water, adsorption method is one of the fanciful techniques used for eliminating heavy metals from waste water [6]. Adsorption of heavy metal's ion is novel knowledge for the management of industrial effluents containing diverse sorts of heavy metals ions. Adsorption method is the deviation of adsorbate onto the surface of adsorbent. It activates the most commonly used adsorbent in adsorption process carbon, which is widely used for the removal of heavy metal ion in aqueous solution of waste water. The adsorbents used in the adsorption process are usually in the form of spherical pellets, rods; mouldings with diameters between 0.5 and 10 mm. Adsorbents are must be higher exposed surface area and hence the high surface capacity for adsorption because They have high abrasion resistance, high thermal stability and small pore diameters [7]. Actually two different processes such as physical and chemical process can perform the activation of adsorbent. In fact, chemical activation is helpful as a comparison to physical activation, but common of activated carbon used all over the world is produced by physical activation. The most frequently used activating agents are phosphoric acid, zinc chloride, sodium hydroxide and salts of sodium and magnesium. The manufacturing of adsorbent at subordinate temperatures encourages the progress of a porous structure because under these circumstances basic crystallites of reduced proportions are designed [8]. In this study White lupine husk was used to harvest activated carbon. The activated carbon was formed via chemical activation using NaOH as an activating agent and categorized by several methods. They employed the prepared activated carbon for the elimination of Pb (II), Co (II) and Fe (II) from industrial waste water.

## MATERIALS AND METHODS

### Chemicals and reagents

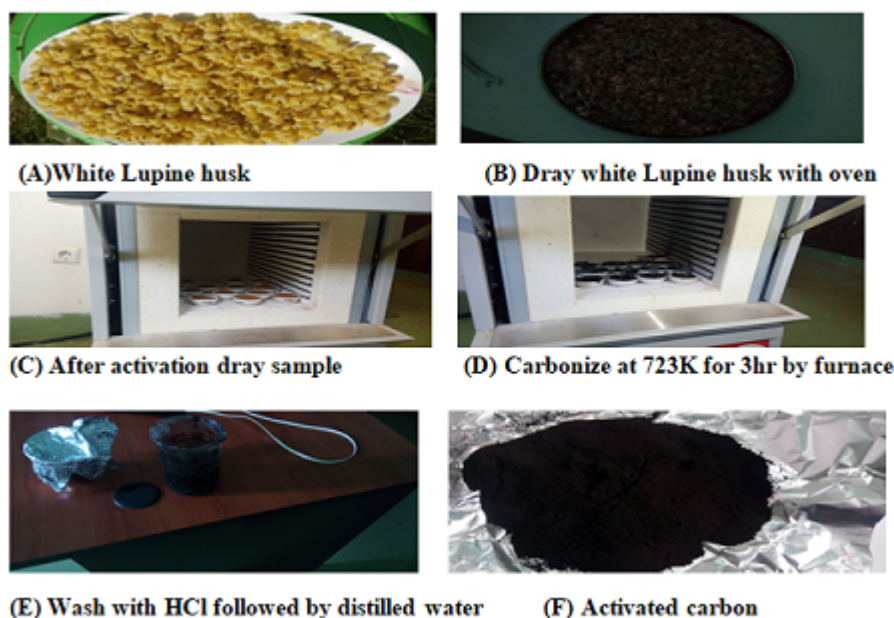
The chemical and reagents used in this study were analytical grade. The chemicals used for this study were including 99% Pb (NO<sub>3</sub>)<sub>2</sub>, 97% CoCl<sub>2</sub>·6H<sub>2</sub>O and Cl<sub>2</sub>FeH<sub>8</sub>O<sub>4</sub> for standard Pb (II), Co (II) and Fe (II) metal ion sample preparation, respectively. Sodium hydroxide (NaOH) an activating agent, 35 to 38% 0.1 M HCl (Fine chemical industries, Mumbai, India) and 0.1 M NaOH for PH change. Then, fresh dilutions and metal solutions in each adsorption study were used. Distilled water was used in all experiments. White Lupine husk sample used as the adsorbent.

### Apparatus and instruments

The following equipment was used in this study: Analytical sieves with shaker (Germany) was used for sample sieving. Drying Oven and hot plate and analytical balance were used for drying and weighing standard samples respectively. Micropipettes (100, 250, 500, 1000 ml) and volumetric flasks (50, 100, 250, 500, 1000 ml) were used for measuring the volume of standard solutions and preparing working standard solutions and stock solutions respectively. UV-Spectrophotometer (Jenway 6705, Germany) was used for metal analysis.

### Preparation of the activated carbon

Generally, the method of preparations is shown in Figure 1 below.



**Figure 1:** Schematic diagrams for preparation of activated carbon from white lupine husk

All the experiments were carried out with white lupine husk. The raw material was used for the thesis; white lupine husk was collected from W/Gojjam in Dembechaworda. It was crushed using a crushing machine and sieved mechanically to get a

uniform size distribution (1mm) and wash with distilled water by using filtration paper. The white lupine husk sample was dried in an oven at 105°C for 12hrs to reduce its moisture content. The dried sample was stored in airtight plastic bags and

stored in clean space for further experiments. A 200 gram of pre-treated sample (1 mm size) was immersed into the 400 mL aqueous solution containing the desired amount of activating agent or NaOH.

The impregnation ratio between the sample and the activating agent was maintained at 1:1 (wt/v) and the mixture was dry in an oven at 105°C for 12 hrs. The dried mixture was placed on a crucible and carbonized by electrical furnace. The carbonization was accomplished at activation temperatures 450°C for 3 hrs. Final product is temporarily stored in a dissector for some time and cool at room temperature. Then to remove the remaining impurities ash, the activated carbon was washed for 0.1 M HCl solution and wash with distilled water for several times pending neutral pH of the solution was obtained. After washing, the product was dry in the oven at 105°C for 12 hrs and kept in airtight plastic bags [9]

### Characterizations of adsorbent

The activated carbon prepared from white lupine husk was analysed in order to define its Ash content, volatile content, carbon yield, moisture content, and fixed carbon responsible for the removal of Pb (II), Co (II) and Fe (II) by white Lupine husk as listed in the above instrument.

#### Determination of moisture content

To control the present of moisture contents of the laboratory prepared adsorbent material, 3.5gram of the white lupine husk was taken in a clean and dry container ( $W_1$ ) and kept in an oven at 105°C for 2 hrs. The white lupine husk was reserved in desiccators to cool and weight and constant weight after drying was obtained ( $W_2$ ). Heating and weighing were continued until obtaining value and the weight loss of the product gave the proportion of the moisture content in the sample of activated carbon used for adsorption. Then percentage of moisture content was determined by using the following formula.

$$\text{Moisture(percentage)} = \frac{(W_1 - W_2)}{(W_1)} \times 100 \quad (1)$$

Where:  $W_1$  = Weight of non-dried sample in the crucible (in gram),  $W_2$  = Weight of oven-dried sample in the crucible (in gram)

#### Determination of volatile matter

About 2 g of the thrashed dried activated carbon prepared from white lupine husk was taken in the previously weighed container and stored in a furnace maintained at 550°C for 1 hr. The crucibles were been cool in desiccators and weighed again.

$$\text{Volatile (percentage)} = \frac{(W_1 - W_2)}{(W_1)} \times 100 \quad (2)$$

Where:  $W_1$  = weight of non-dried sample (in gram) and  $W_2$  = weight of dried sample (in gram)

#### Determination of ash content

2.5 grams of the remaining activated carbon powder from the above step was employed in a crucible and shifted into a furnace at a temperature of 450°C for 2 hrs. The crucible was cooled in desiccators and then weighed over. The heating, cooling and weighing cycle was frequent until a constant weight was gained, then the weight lost was recorded the ash content of the activated carbon sample.

$$\text{Carbon Yield} = \frac{W_2}{W_1} \times 100 \quad (3)$$

Where  $W_2$ =Weightdried sample and  $W_1$  = weight of un dried sample

#### Determination of carbon harvest

The whole carbon yield was resolute after sample dispensation 3.0 gram of raw material or before impregnation is the initial weight of the sample ( $W_1$ ) and this 3g of sample was put on crucible and ignited for 2hrs at 450°C is the last mass of the dried saturated sample at the end of activation progression is ( $W_2$ ) [10]. It was calculated by taking the ratio of carbon weight retrieved from the furnace to the weight of the dried carbon sample.

$$\text{Carbon Yield (Percentage)} = \frac{W_2}{W_1} \times 100 \quad (4)$$

Where,  $W_1$  = the initial mass of the sample before the activation procedure and  $W_2$ =the ultimate mass of the dry permeated sample at the culmination of the activation process

#### Fixed carbon content

The standing carbon content was resolute by withdrawing the sum of percentage configuration of moisture content, impulsive content and ash content from 100. The value acquired the amount of fixed carbon present in the sample uttered in percentage.

$$\text{Fixed Carbon (Percentage)} = 100 - (\text{AC} + \text{VC} + \text{MC}) \quad (5)$$

#### Preparation of the adsorbate [Pb (II), Co (II) and Fe (II)]

Stock solutions of Pb ( $\text{NO}_3$ )<sub>2</sub>, CoCl<sub>2</sub>.6H<sub>2</sub>O and Cl<sub>2</sub>FeH<sub>8</sub>O<sub>4</sub> were equipped from their respective metal salts with distilled water. The standard solutions of Pb (II), Co (II) and Fe (II) ions were set by disbanding 0.795, 2.03 and 1.78 gram of Pb ( $\text{NO}_3$ )<sub>2</sub>, CoCl<sub>2</sub>.6H<sub>2</sub>O and Cl<sub>2</sub>FeH<sub>8</sub>O<sub>4</sub> in 500 ml of distilled water respectively. All solutions of Pb (II), Co (II) and Fe (II) ions with concentrations 40, 50, 60, 70 and 80 mg/L were prepared as working solutions by serial dilution of the stock solutions. The prepared working solutions were used to prepare the calibration curve which was used to determine the final concentrations after recording the absorbance from the U-Visible spectrophotometer instrument. The pH was preserved using 0.1 M HCl and 0.1 M NaOH solutions.

#### Batch adsorption study

The adsorbate concentrations under investigation were sedate using UV-Visible spectrophotometer (Model Jenway670

(Germany). The calibration curves were developed by using UV-Visible spectrophotometer standard solutions containing known five concentrations; 40, 50, 60, 70 and 80 mg/L of Pb (II), Co (II) and Fe (II) ions solutions respectively. The standard solutions of the metals such as (Pb, Co, and Fe) were prepared to determine the absorption of each solution and the water samples against the calibration curve. Distilled water was used as blank reagent and run before the development of the calibration curve and during the interval of each sample.

Batch experiments were directed to examine the effect of dose of adsorbent, pH, shaking time, temperature and original concentration of lead, cobalt and iron ions on the removal efficiency and adsorption capacity white Lupine husk activated carbon (WLHAC). Heavy metal Lead (II), cobalt (II) and iron (II) ions from aqueous solution by varying any one of the limitations and protection the other constraints constant. For each trial, a sample was occasionally taken out of the flask and filtered through the process. The batch experiments were run in different Erlenmeyer flasks of 250 ml containing container.

#### The effect of adsorbent quantity

The dose of adsorbent was studied by adding different amounts of the standards (1, 1.5, 2, 2.5 and 3) g of the adsorbent at 50mg/L of Pb (II) Co (II) and Fe (II) solutions to 250mL flask. Shake with 150-rpm and the other parameter were kept constant. To determine the adsorbent dose, the maximum metal ion removal efficiency and adsorption capacity achieved [11].

#### The effect of pH

A 50 ppm Pb (II), Co (II) and Fe (II) was taken from the standard stock solution for each five Erlenmeyer flasks (250 ml) containing and the optimum dose of WLH was poured in each conical flask with the pH of the solution in each container is adjusted using NaOH and HCl is 3, 5, 6, 8 and 10 respectively.

Each solution in the flask is shaken at 150 rpm for the other parameter was reserved constant. The samples were filtered by using what man filter papers and the supernatant was analyzed for Pb (II), Co (II) and Fe (II) ion using UV-visible spectroscopy [11].

#### The effect of contact time

With the optimum dose of WLH and 50 mg/L of preliminary metal ion concentration at optimum pH for Pb (II), Co (II) and Fe (II) were mixed in a 250 ml flask and the mixtures were disturbed on a shaker at a speed of 150 rpm for 10, 20, 30, 40 and 50 min shaking times.

This parameter was examined by using optimum values of the adsorbent quantity, pH and metal ion concentration keeping the agitation speed 150 rpm. The contact time was varied as 10, 20, 30, 40 and 150 min [11].

#### The effect of temperature

The optimum values of the adsorbent dose were placed into the different conical flask (250 mL) and 50 mg/L of Pb (II), Co (II) and Fe (II) was added to each sample. The flask was agitated at speed of 150-rpm and kept at 45, 50, 60, 65 and 70 degrees

temperature by the hot plate. The solution was adjusted by 0.1 M NaOH and 0.1 M HCl at optimum pH.

#### Outcome of initial metal ion concentration

The consequence of initial Pb (II), Co (II) and Fe (II) meditations was carried out the metal solutions of desired concentrations (40, 50, 60, 70 and 80 mg/L) with the constant amount of the adsorbent. All the samples were adjusted to optimum pH prior to adding the adsorbent for optimum temperature. The test solution samples were then, inhibited from the shaker at a prearranged time for 150rpm. The metal ion concentration that showed maximum removal efficiency for each metal was selected [11].

Generally from the above parameters, the samples were filtered by using what man filter papers and the supernatant was analysed for each metal ion using UV-visible spectroscopy. So, adsorption ability and removal competence based on the effect of the above parameters as follows:

$$q_e = \frac{(c_0 - c_t)}{m} \cdot v \quad (6)$$

Where,  $C_0$  = Initial concentrations of the metal ion in solution (mg/L),  $C_e$  = Final concentrations or equilibrium concentration of metal ion solution (mg/L) and  $V$  = solution volume (L) and  $m$  = mass of the sorbent (g)

$$\text{Adsorption (Percentage)} = \frac{(c_0 - c_t)}{m} \times 100 \quad (7)$$

Where  $C_0$  = the initial concentration (mg/L) and  $C_f$  = final concentration (mg/L) of the metal ions being studied

#### Adsorption isotherms

To study adsorption isotherms the optimum conditions which were found from previous optimization experiments were applied only by varying the initial concentration or the absorbance, final concentration and adsorption capacity were directly taken from the effect of initial concentration. The data from the experiment was fitted into Langmuir and Freundlich adsorption isotherm models.

#### Adsorption dynamics

Kinetics and equilibrium are the two foremost constraints for estimating adsorption dynamics. Final concentration and adsorption capacity were taken from the result of the consequence of shaking time under optimization experiment. To govern the adsorption capacity and correlation coefficient pseudo-first and second-order kinetics models the above literature equation was undermined.

## RESULTS AND DISCUSSION

This section delivers the outcome with investigation prepared from white lupine husk as activated carbon and the study on some factors affecting Lead (II), cobalt (II) and Iron (II) adsorption such pH, adsorbent dosage, initial of each metal ion concentration shaking time and temperature by AC prepared from WLH in aqueous solution.



The various physicochemical composition WLH was characterized and compared with other investigations as shown in Table 1.

**Table 1:** Proximity analysis result of AC prepared from a different substance.

Adsorbent	Adsorbent characteristics				
	MC (%)	AC (%)	VC (%)	FC (%)	CY (%)
Coffee husk	6.03	2.01	24.62	67.34	-
durian shell	5.53	2.52	69.59	22.36	-
Coffee husk	1.07	5.98	64	28.98	69
Bamboo stem	7.6	5.55	24.2	62.65	-
tea waste	4.91	2.97	80.24	11.88	-
BW	9.56	21.66	4.6	64.12	-
WLH	5.71	8.8	39.5	45.99	43.5

### Characterizations of adsorbent

Low ash content results in an increased efficiency on the adsorptive capacity of the Carbon; this could be another reason for obtaining very high percentage adsorption from the base treated AC.

The result was obtained a low amount of moisture and ash content high-value of volatile matter and fixed carbon, indicating that high graphitization amount. This intern shows that the activated carbon of the studied sample can be an outstanding raw material as adsorbents to be used in the adsorption process. Ash content of activated carbon can also influence the overall movement of activated carbon and reduces the competence of reactivation. The higher value of fixed carbon shows that the adsorbent is having more efficiency and stability [12].

Lower moisture content the sample provides higher adsorption efficiency since water molecules can have the potential effect in the pores of an adsorbent through filling the adsorbent binding site before its contacts with the solution. Therefore, adsorption efficiency decreased with an increase in the moisture content of an adsorbent [13].

### Standard Pb (II), Co (II), and Fe (II) concentration and absorbance

The standard curve was plotted from a known concentration of standard Pb (II), Co (II) and Fe (II) solution reagent in digital spectrophotometer from 400 nm to 800 nm wavelengths respectively and the corresponding concentration of the sample was determined using the equation from the curve.

The calibration curve of the spectrophotometer for the blank solution of each metal ion is shown in Table 2 below.

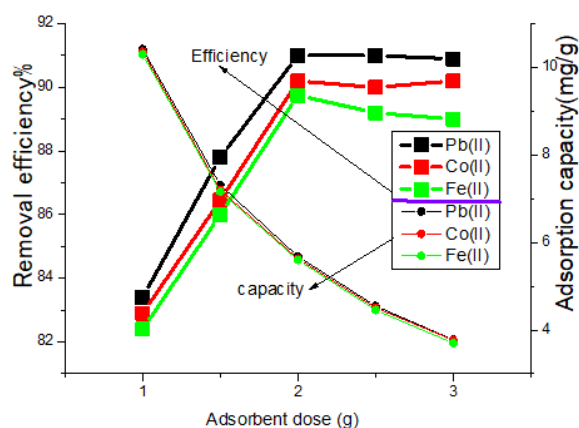
**Table 2:** Calibration of the spectrophotometer for the blank solution of each metal ion.

Concentrations (mg/L)	Absorbance of each metal ion respectively		
	Pb (II)	Co (II)	Fe (II)
40	0.508	0.801	0.413
50	0.628	1.18	0.603
60	0.795	1.706	0.76
70	0.948	2.09	0.904
80	1.07	2.601	1.04

### Batch adsorption studies

#### Consequence of adsorbent dosage

Percentage elimination of Pb (II), Co (II) and Fe (II) increased from 83.4% to 90.89%, 82.9% to 90.2% and 82.4% to 90% with increase in adsorbent dose 1g to 3 g respectively. When the amount of adsorbent was raised from 1 gram to 3 grams through holding the other parameters constant in the initial concentration of 50 mg/L the adsorption of metal ions were increased due to an increase in the surface area of adsorbent or an increased adsorbate adsorbent collaboration [14]. The metal confiscation efficiency was additionally increased the adsorbent dose from 1.0 to 2.0 g and increases less meaningfully more than 2 g. Therefore, the optimum dose was chosen for 2 g of adsorbent beyond which can change for removal was observed. Since adsorbent amount was sustained at 2.0 g in all the consequent experiments. At this value, the adsorbent surface is flooded with metal ions and after that, the amount of adsorption reduces or equilibrium between adsorbent and adsorbate phase [14].



**Figure 2:** Effect of adsorbent dosage on adsorption efficiency & capacity of Pb (II), Co (II) and Fe (II) by WLH

As shown Figure 2, the adsorption capability Pb (II), Co (II) and Fe (II) decrease from 10.42 to 3.78, 10.36 to 3.77 and 10.3 to 3.7 (mg/g) respectively. It is observed that the adsorbent prescription was increased from 1 to 3g, the adsorption ability for each metal ion was retarded due to the decrease in total adsorption surface area available to metal ion resulting from meeting or accretion of adsorption sites. Thus, with increasing adsorbent mass, the amount of metal ion adsorbed onto unit mass of adsorbent gets reduced, causing a decrease in  $q_e$  value with increasing adsorbent mass concentration [14].

**The effect of pH**

One of the most important parameter for adsorption process is pH. In my study the effect of pH was verified by altering pH of solution 3,5, 6, 8 and 10 in the concentration of 50 ppm from metal ions and the adsorbent dose 2 g and also the other parameter is constant. The maximum adsorptions were obtained at pH 5 and it decreases with further increase in pH from 6 to 10.

From the Figure 3, maximum removal efficiency at optimum pH of Pb (II), Co (II) and Fe (II) is about 91.86%, 90.36% and 90.28% respectively because at pH values below 4.0 the surface of the adsorbent is surrounded by more  $H^+$  ions which decrease metal ion interaction with binding sites of WLH by greater repulsion force or the electrostatic force of repulsion between adsorbent and adsorbate is constant, therefore, the removal efficiency is low. At pH above 6.0, the competing effect of  $H^+$  ion is decreased or  $OH^-$  ion increased and adsorption sites could be available, there is a opportunity of adsorbate precipitation on the surface of the adsorbents by nucleation [15].

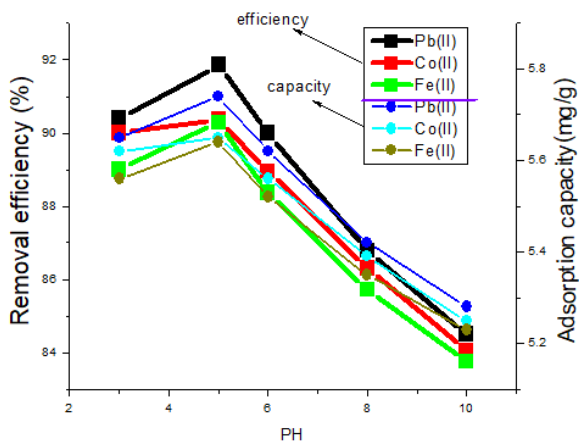


Figure 3: Effect of pH on adsorption Efficiency and capacity of Pb (II), Co (II) and Fe (II) by WLH (Co 50mg/L, adsorbent dose 2g and agnation speed 150rpm)

**Consequence of shaking time**

The percentage elimination competence and the adsorption ability of lead cobalt and iron metal ions by WLH as shown in Figure 4. It observed that high rate of Pb (II), Co (II) and Fe (II) ions adsorption happened in the first 10 to 30 min for all the adsorbents and the rate of adsorption of the adsorbate component into the adsorbent was found to be deliberate.

The time required to reach equilibrium on adsorption was 30 min. The initial rapid adsorption is due to the obtainability of the negatively charged surface of the adsorbents for adsorption of cationic Pb (II), Co (II) and Fe (II) sorts present in the solution. The later slow adsorption is probably due to the electrostatic interferences between adsorbed positively charged adsorbate species into the surface of adsorbents and the slow pore diffusion of the solute ion into the bulk of the adsorbent [15].

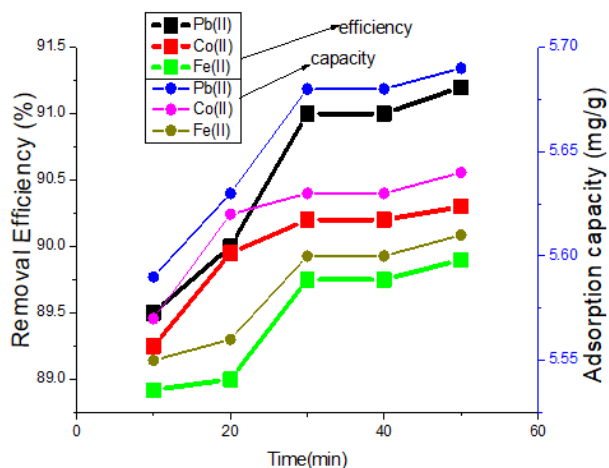


Figure 4: Effect of contact time on the adsorption Efficiency and capacity of Pb (II), Co (II) and Fe (II) by WLH (at constant pH 5, Co 50 mg/L, adsorbent dose 2 g and agnation speed 150 rpm).

**Effect of temperature**

Consequence of temperature on adsorption of Pb (II), Co (II) and Fe (II) on WLHAC was studied by accompanying diverse sets of try outs at altered temperatures including (318, 323,328, 333, and 338)K. From the Figure 5, the adsorption efficiency of Pb (II), Co (II) and Fe (II) increases from 88.6% to 91.2%, 87.65% to 89.91% and 87.25% to 90.3% respectively with rising temperature from 318 to 338 K.

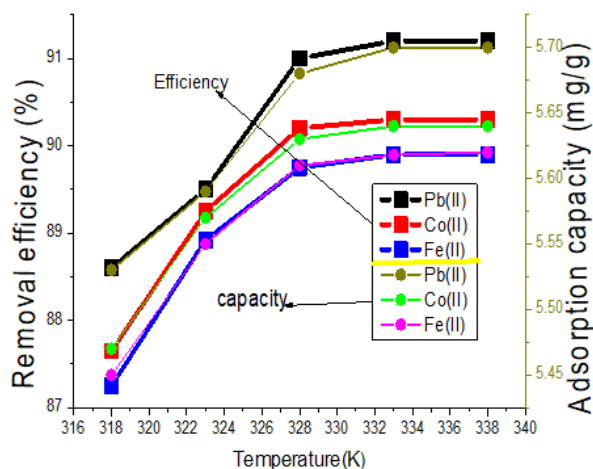


Figure 5: Outcome of temperature on the adsorption Efficiency and capacity of Pb (II), Co (II) and Fe (II) by WLH (pH 5, initial concentration. 50 mg/L, adsorbent dosage 2 g contact time 30 min and agnation speed 150 rpm).

However, the adsorption capacities also increase with increasing temperature from 5.53 to 5.7 mg/g, 5.47 to 5.64 mg/g and 5.45 to 5.62 mg/g respectively, due to increasing the kinetic energy of the adsorbent particles. Thus, the smash frequency between adsorbent and adsorbate increases, which results in the improved adsorption of surface of the adsorbent [16].

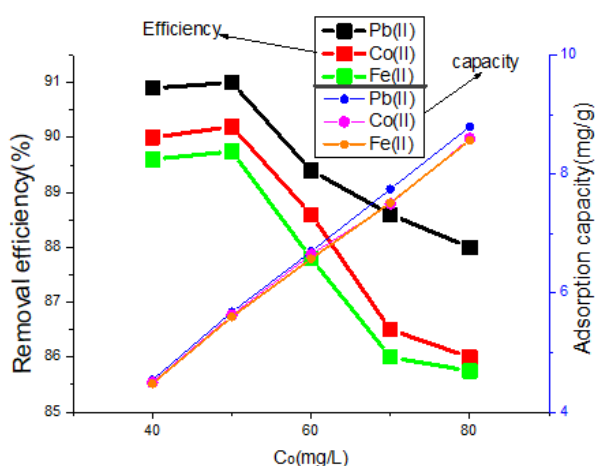
#### Effect of adsorbate initial concentration

The % removal effectiveness of lead, cobalt, and iron is decreased from 90.9% to 88%, 90% to 86% and 89.6% to 85.75% as the initial concentration is amplified from 40 mg/L to 80mg/L at a fixed adsorbent dose 2 g. The outcome designated the percentage of metal ion exclusion reductions with an increase in the initial heavy metal ion concentration, at subordinate metal ions concentration.

The larger surface area of adsorbent being available for adsorption provides higher percentage uptake of heavy metal ion in aqueous solution of metal ion, but the percentage elimination of heavy metal ion diminished, since the existing spots for adsorption became fewer at higher metal concentration and results the ratio of an initial number of moles of metal ions to the adsorption sites available was higher and lower adsorption percentage..

At lower concentrations, greater part of the metal ions were adsorbed very rapidly on the outer surface, but additional increase in initial concentrations leads to fast saturation of the adsorbent and more metal ions are remained in solution [17].

Instead, the rise in initial concentration of Pb (II), Co (II) and Fe (II) has been improved the ability of the adsorbent to capture adsorbate due to the high driving force for mass transfer at a high initial metal ion concentration. The intensification of initial metal ions concentration also enriches the interaction between the adsorbate on adsorbent surface and resulted in a higher uptake of metal for the given amount of adsorbent shown in Figure 6.



**Figure 6:** Effect of initial Pb (II),Co (II) and Fe (II) concentration on adsorption efficiency and capacity at pH 5, shaking time 60 min, adsorbent dosage 2g, agnation speed 150 rpm, and T 328 K.

There for initial concentration affords an important driving force to astound all mass transfer resistance of metal ions

between the aqueous and solid phases [17]. The properties of the metal ion and selectivity of the adsorbent are significant aspects in the adsorption progression. The extreme adsorption efficiency of Pb (II), Co (II) and Fe (II) at optimum pH 5, initial concentration 50 mg/L contact time 30 min at 150 rpm for 328 K was 91.9%, 90.36% and 90.28% respectively. Properties of the metal ion and fussiness of the adsorbent are imperative issues in the adsorption process. Generally, the experimental result based on the above each parameter indicates both the adsorption efficiency and capacity of Pb (II) Co (II) Fe (II) due to its larger ionic radius of Pb (II) is larger than cobalt and iron. Some various trends have been also in other studies [18].

## CONCLUSION

In this study, AC prepared from white Lupine husk was activated using NaOH. Then the powder was characterized using selected physico-chemical parameters and the result that was obtained is comparable with other studies. From characterization, it was found that, the value of moisture content (5.7%), ash content (8.8%) volatile matter (39.5%), fixed carbon (45.99%) and carbon yield (43.5%).

Batch adsorption method is to evaluate the effects of adsorbent dose, pH, contact time, temperature and concentration of the components. The maximum adsorption efficiency of Pb (II), Co (II) and Fe (II) ions by using AC prepared from WLH was obtained at optimum condition (pH 5, adsorbent dose 2g, contact time 30min, temperature 328K and 50mg/L concentration) were 91.9%, 90.36 and 90.28% respectively. The extreme adsorption efficiency was largely pH reliant and the outcome of adsorbent quantity on the adsorption of metals revealed that the percentage of metal removed improved with increase in adsorbent amount due to increased adsorption surface area. Langmuir and Freundlich models were used to estimate model parameters but the overall data is mainly fitted to Freundlich isotherm. This indicates that adsorption capacity to applicability of multilayer coverage. The kinetic studies are accompanied using two models, but pseudo-second-order kinetic model was found to be a better fit for the adsorption of Pb (II),Co (II) and Fe (II) by AC prepared from WLH.

## AUTHOR CONTRIBUTIONS

Getasew Ketsela contributed in methodology, in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript and Alemu Talema contributed in formal analysis, in supervision and software work, Zenaw Animen contributed in result and discussion as well as conclusion writing.

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## CONFLICTS OF ATTENTIVENESS

The authors declare no conflict of interest

## REFERENCES

1. Khan S, Qureshi MS, Ahmed I, Shah SM. Milk composition and yield changes with advancing pregnancy in dairy buffaloes (*Bubalus bubalis*). *Turkish J Vet Anim Sci*. 2011;35 (6):375-380.
2. El-Shafey EI. Sorption of Cd (II) and Se (IV) from aqueous solution using modified rice husk. *J Hazard Mater*. 2007;147 (1-2): 546-55.
3. Amuda OS, Giwa A, Bello IA. Removal of heavy metal from industrial wastewater using modified activated coconut shell carbon *Biochem Eng J*. 2007;36 (2):174-81.
4. Chakravarti AK, Chowdhury SB, Chakrabarty S, Chakrabarty T, Mukherjee DC. Liquid membrane multiple emulsion process of chromium (VI) separation from waste waters. *Colloids Surf A Physicochem Eng Asp*. 1995;103 (1-2):59-71.
5. Naiya TK, Bhattacharya AK, Mandal S, Das SK. The sorption of lead (II) ions on rice husk ash. *J Hazard Mater*. 2009;163 (2-3): 1254-64.
6. Opeolu BO, Bamgbose O, Arowolo TA, Adetunji MT. Utilization of biomaterials as adsorbents for heavy metals removal from aqueous matrices. *Sci Res Essays*. 2010; (5):1780-1787.
7. Desta MB. Batch sorption experiments: Langmuir and Freundlich isotherm studies for the adsorption of textile metal ions onto teff straw (*Eragrostis tef*) agricultural waste. *J. ChemThermodyn*. 2013;9 (2):1-6.
8. Ruthven DM. Principles of adsorption and adsorption processes. John Wiley & Sons, NY, USA. 1984.
9. Aragaw, Temesgen (2015) Heavy metals removal from electroplating waste water using activated carbon of coffee husk. Diss, Addis Ababa University.
10. Chen JP, Yang L. Chemical modification of *Sargassum* sp. for prevention of organic leaching and enhancement of uptake during metal biosorption. *Ind Eng Chem*. 2005;44 (26):9931-42.
11. Asgher M. Utilization of citrus waste biomass for sorption of reactive dyes from aqueous solutions. *Int J Environ*. 2011; 3 (1): 179-191.
12. Dula T, Siraj K, Kitte SA. Adsorption of hexavalent chromium from aqueous solution using chemically activated carbon prepared from locally available waste of bamboo (*Oxytenanthera abyssinica*). *Int J Environ Chem*. 2014; 12 (1):1-9
13. Silgado KJ, Marrugo GD, Puello J. Adsorption of Chromium (VI) by Activated Carbon Produced from Oil Palm Endocarp. *Chem Eng Trans*. 2014;37 (2):721-726.
14. Mehrasbi MR, Farahmandkia Z, Taghibeigloo B, Taromi A. Adsorption of lead and cadmium from aqueous solution by using almond shells. *Water Air Soil Pollut*. 2009;199 (1-4):343-51.
15. Kumar PS, Kirthika K. Equilibrium and kinetic study of adsorption of nickel from aqueous solution onto bael tree leaf powder. *J Eng Sci and Techn*. 2009;4 (4):351-63.
16. Hu Z, Lei L, Li Y, Ni Y. Chromium adsorption on high-performance activated carbons from aqueous solution. *Sep Sci Technol*. 2003;31 (1):13-8.
17. SenthilKumar P, Ramalingam S, Sathyaselvabala V, Kirupha SD, Sivanesan S. Removal of copper (II) ions from aqueous solution by adsorption using cashew nut shell Desn. 2011;266 (1-3):63-71.
18. Kazemipour M, Ansari M, Tajrobehkar S, Majdzadeh M, Kermani HR. Removal of lead, cadmium, zinc, and copper from industrial wastewater by carbon developed from walnut, hazelnut, almond, pistachio shell, and apricot stone. *J Hazard Mater*. 2008;150 (2): 322-7.