

# Assessing the Efficacy of Biochar of Okoubaka Seed in Removing Heavy Metals from Contaminated Water

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**Abstract:** Heavy metal contamination of water sources is an increasing human health concern due to industrial activities and the persistence of metals such as Pb (lead) and Zn (zinc). This study looks at the adsorption efficacy of a low-cost and eco-friendly COS (charred okoubaka seed) adsorbent for the removal of Pb(II) and Zn(II) ions from contaminated water. The standard solutions (1,000 ppm) of Pb(II) and Zn(II) prepared from appropriate weight of lead and zinc nitrate, respectively. Each metal solution was treated with 2.0 g of adsorbent. A comparative study using ACC (commercial activated carbon) was investigated and residual metal concentrations were analyzed using EPA (Environmental Protection Agency) 6010 (ICP-AES). The results showed that the biochar of okoubaka seeds removed an average of 82% of Pb and 68% of Zn, whereas activated carbon removed 99.9% of Pb but only 68.3% of Zn. These results indicate that biochar of okoubaka seeds as adsorbent has a strong affinity for Zn, while activated carbon is significantly more effective in Pb removal. The results suggest that the biochar of okoubaka seed is a potential and sustainable alternative for selective heavy-metal remediation in water treatment.

**Key words:** Biochar, okoubaka, heavy metal, remediation, water contamination, adsorption, pollution, plant materials.

## 1. Introduction

Over the past two decades, water contamination by heavy metals has led to a global public health concerns as contaminated water posed a serious harm to both humans and animals. Metal water contamination may result from a variety of human activities such as industrialization, mining, and anthropogenic activities. These heavy metals accumulate in our water sources and, over time, start to increase their concentration as they are not degradable [1-4]. Although these metals are essential and found in the human body, they are found in small amounts. If high concentrations of lead and zinc are consumed, they can cause many fatal and harmful health conditions. Excess Pb (lead) and Zn (zinc) can cause conditions such as brain damage and kidney damage [5-6]. These health implications are the reasons why scientists are trying to find ways to reduce

the amount of heavy metals in our water sources. Many people do not have access or cannot afford to properly treat their water; thus, many families are left consuming metal-contaminated water. As a result of this, professionals are investigating cheaper and more eco-friendly methods for removing these heavy metals from water to concentrations below permissible levels [6-9]. By using agricultural plant and natural materials, researchers not only utilize sustainable resources, but they also eliminate the chances of secondary pollution. Thus, the project reported here examines the efficacy of using bio-char of okoubaka seeds to remove lead and zinc from contaminated water.

## 2. Methods and Materials

A standard solution of 1,000 ppm of Pb(II) and Zn(II) ions was prepared using their respective nitrate salts.

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Corresponding amounts of each salt was dissolved in deionized water to a final volume of 1,000 mL. The okoubaka seeds were prepared by heating the seeds at a high temperature until charred. ACC (commercial activated carbon) was purchased from Fisher Scientific and used as received. Duplicate samples of 2.0 g of each adsorbent (activated carbon and charred okoubaka seeds) were weighed and placed into different labeled centrifuged tubes for lead and zinc, respectively. The metal-contaminated water solutions (40 mL) were then added to each adsorbent centrifuge tube labeled with the corresponding metals. The samples were then vortexed for 30 seconds and then placed in a shaker for 16 hrs. After shaking, the samples were centrifuged for 10 min at 3,000 rpm. The supernatant of each sample was decanted and placed into new labeled centrifuge tubes. The samples were then analyzed for residual metal ion concentration using EPA (Environmental Protection Agency) Method 6010 (ICP-AES).

### 3. Results

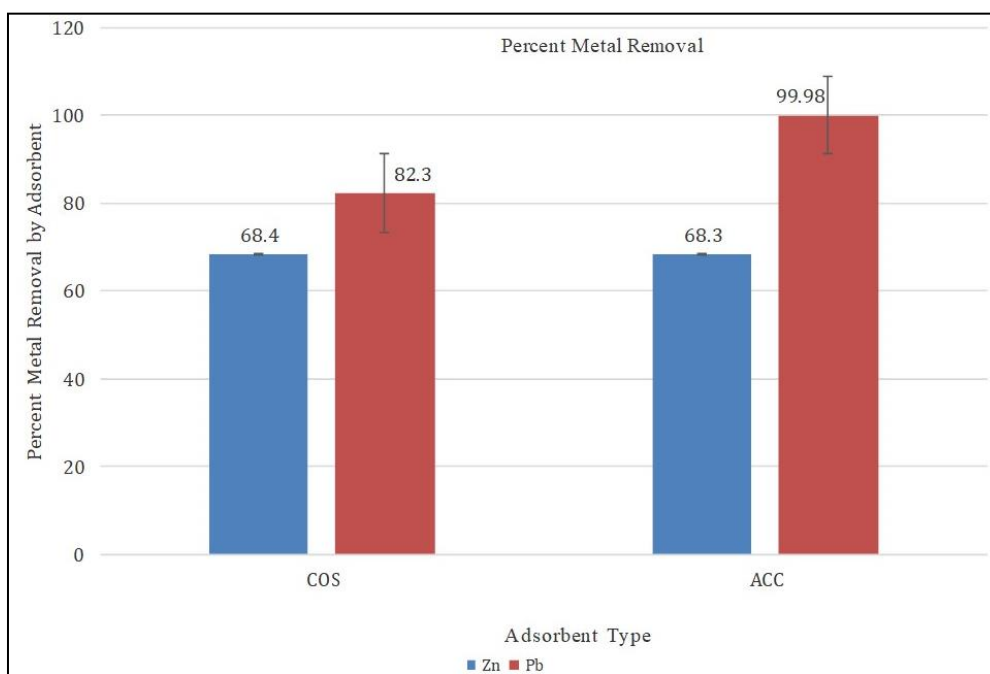
Table 1 above shows the residuals metal concentration after the treatment of contaminated water with the adsorbents compared to the lead and zinc control

samples. Residual zinc concentration upon treatment with COS (charred okoubaka seed) was 300.3 PPM with zinc control at 953 PPM while the residual concentration of lead was 301.5 PPM with lead control of 975.5 PPM.

Fig. 1 below shows that 68% of Zn and Pb from contaminated water was removed by both COS and ACC adsorbents respectively. However, COS removed 82% of Pb from the contaminated water while ACC removed about 99.9% of Pb.

**Table 1 Residual metal concentration after treatment with adsorbents.**

	[Zn]	[Pb]
Ctrl1	951	976
Ctrl2	955	975
Average	953	975.5
STDEV	2	0.5
COS-1	293	170
COS2	308	175
AV	300.5	172.5
STDEV	7.5	2.5
ACC-1	302	0.197
ACC-2	301	0.094
AV	301.5	0.1455
STDEV	0.5	0.0515



**Fig. 1 Percent metal removal by COS and ACC.**

#### 4. Discussion

The results of this study highlight notable differences in the adsorption behavior between the two adsorbents tested (COS (charred okoubaka seeds) and ACC (commercial Activated Carbon)). The two adsorbents interacted differently with Pb(II) ions while maintaining similar interaction with Zn(II) ions. Commercial activated carbon had a higher efficacy in lead removal than zinc removal (99.9% to 82%). This near-complete adsorption is consistent with the known high surface area and well-developed pore structure of activated carbon, which favor binding of heavier metal ions such as Pb(II). The extremely high efficacy in lead removal further supports its strong affinity for lead. However, both adsorbents removed about equal amount of zinc (68%), respectively. The results suggest weaker interactions between activated carbon (ACC) and Zn(II) ions, likely due to differences in ionic radius, charge density, or competition for binding sites. The difference in performance across metals also suggests that the charring process may have destroyed the surface characteristics favorable for Pb adsorption specifically.

#### 5. Conclusion

This study demonstrates that both charred okoubaka seeds and activated charcoal are effective, affordable adsorbents for removing heavy metals such as lead from contaminated water, but each material exhibits different strengths. Activated charcoal is highly efficient for lead removal, achieving nearly complete adsorption at 99.9%. Charred okoubaka seeds show strong potential as a sustainable and eco-friendly adsorbent for lead removal from contaminated water. Thus, these results indicate that natural plant materials such as okoubaka seeds can play an important role in heavy-metal remediation, especially in regions where cost, accessibility, and environmental impact are major concerns. Further research optimizing preparation methods, dosage, and contact time could enhance their

effectiveness and broaden their application in real-world water treatment cases.

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