VILNIUS TECH
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THE APPLICATION OF WHEAT BRAN IN THE REMOVAL OF COPPER IONS FROM POLLUTED WATER

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INTRODUCTION

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WORK PROBLEM

- In many developing countries, 90% of waste water end up in fresh water bodies untreated making it dangerous for human consumption and the aquatic environment
- Water bodies and aquatic environment are being polluted by several organic and inorganic pollutants and among these are heavy metals
- Electroplating, textile, battery manufacturing, tanneries, petroleum refining, paint manufacture, pesticides, pigment manufacture, printing and photographic industries are sources of heavy metal pollution
- Heavy metals which can be toxic or carcinogenic and can cause harm to humans and other living things in the environment even at very low concentrations

ACTUALITY OF WORK

- Heavy metal pollution and the increase in agricultural waste are environmental problems in current years
- The use of agricultural waste to improve water quality and remove heavy metals as a solution is necessary because it is available in abundance, cheap, environmentally friendly and highly efficient compared to the conventional methods

INTRODUCTION

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AIM OF WORK

- To perform experimental research and to determine the ability of wheat bran as adsorbent to remove copper ions from aqueous solutions

OBJECTIVES

- To carry out literature review on heavy metals and wheat bran
- To carry out experimental investigation on adsorption efficiency of wheat bran for copper ions in aqueous solution
- To evaluate the influence of pH, contact time, adsorbent dose and metal ion concentration using wheat bran as adsorbent

PRACTICAL VALUE

- The studies from the experiment will indicate whether wheat bran can successfully remove copper ions from polluted water
- The research data could be used to model and create a filter which can be used to remove heavy metals (copper ions) from wastewater using wheat bran as adsorbent

SOURCES OF HEAVY METALS

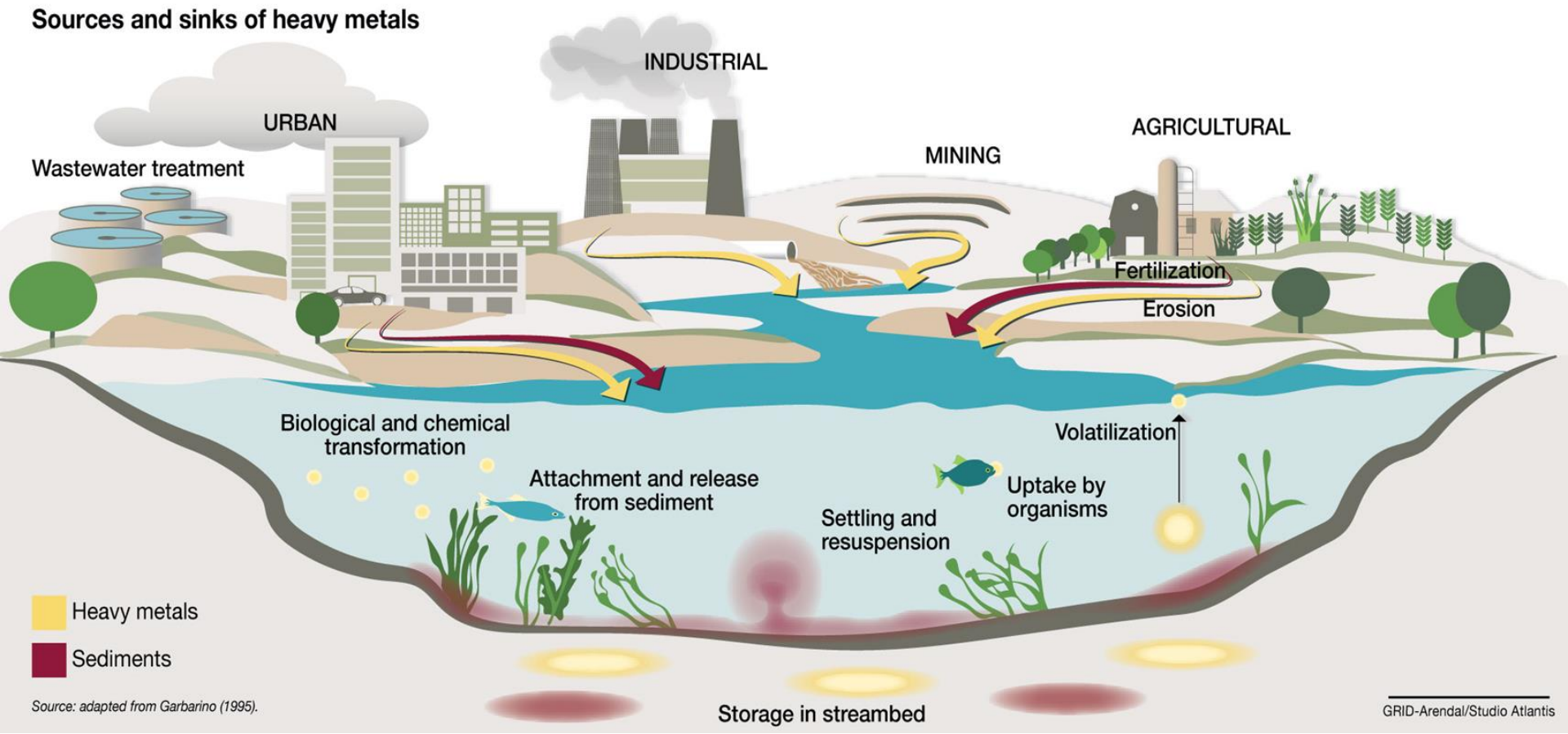

Figure 1. Sources of heavy metals and how they are released into the environment

WHEAT BRAN

- The production of wheat is increasing every year and subsequently, the amount of the by-products from wheat processing is also increasing.

- The basic components of agricultural waste products are hemicellulose, lignin, lipids, starch, hydrocarbons, water, simple sugars, and proteins which contain a number of functional groups

- The component distribution in wheat bran are 55-60% non-starch carbohydrates, 14-25% being starch, 13-18% making up proteins, 3-8% making up minerals and 3-4% of fat.

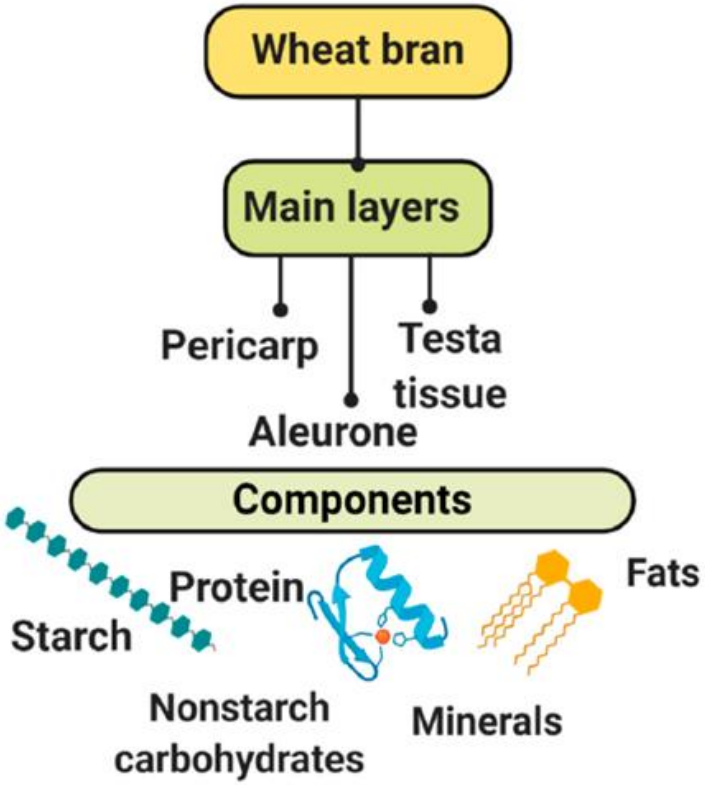

Figure 2. Wheat bran layers and component distribution Katileviciute et al., 2019)

RESEARCH METHODOLOGY

The objective of the research on the adsorption parameters is to determine the ability of wheat bran used as an adsorbent to remove copper ions from aqueous solutions.

Adsorption parameters considered for this experiment: pH, contact time, adsorbent dose and initial metal ion concentration

EXPERIMENT

- Preparation of wheat bran

➢Wheat bran from Malsena-Vievis, a milling industry in Lithuania was collected and used for the experiment

➢Placed in the oven and heated at 105 degrees

➢Allowed to cool to ambient temperature and sieved through a 1mm sieve

➢Samples measured using the "Radwag" analytical balance in the Laboratory

- Preparation of adsorbate solution

➢ Deionised water was manually contaminated with Cu (II)

➢ Initial concentration of copper for the experiment was prepared according to the maximum permitted concentration in the sewage collection system which is 2.0mg/L

➢Initial copper ions concentrations used for experiment (2mg/L, 5mg/L, 10mg/L & 20mg/L)

Figure 3. Wheat bran in oven

Figure 4. Sieved wheat bran

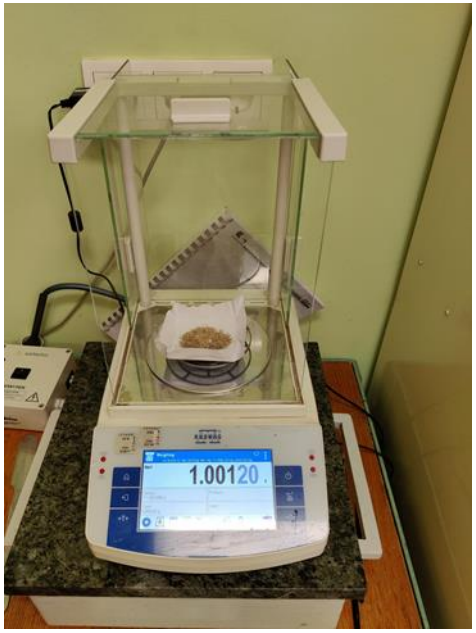

Figure 5. "Radwag" analytical balance

Figure 6. Adsorbate solutions

EXPERIMENT

- Effect of pH
  - pH values: (2.0, 3.0, 4.0, 5.0, 6.0, 7.0)
  - 0.1M concentration of HNO3 and 0.1M concentration of NaOH was used to control the pH of each adsorbate solution
  - Concentration of 5mg/l
  - Contact time : 60mins

- Effect of contact time
  - Contact time: 5, 10, 15, 30, 60, 120mins
  - Concentration of 5mg/l
  - At ambient temperature and optimal conditions

Figure 7. Hanna pH meter

Figure 8. pH adsorbate solutions

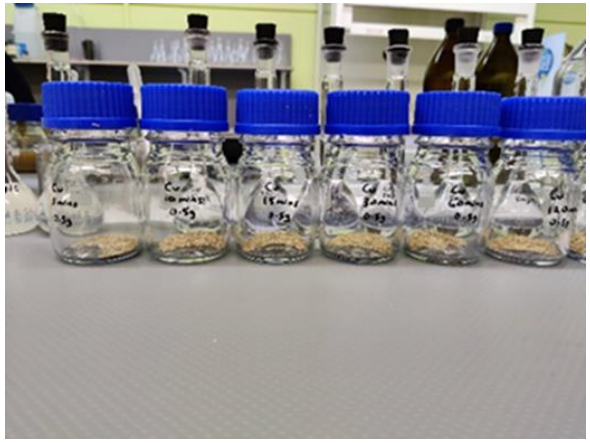

Figure 9. Samples for contact time

Figure 10. “Labos shake-Gerhardt”

EXPERIMENT

- Effect of adsorbent dose
  - Masses used: 0.5g, 1.0g 2.0g
  - Concentration of 5mg/l
  - Contact time: 60mins

- Effect of metal ion concentration
  - 2mg/L, 5mg/L, 10mg/L & 20mg/L
  - Contact time: 60mins
- Metal ion concentration determination
  - Buck scientific 2010 VGP Atomic Absorption Spectrometer

- The quality of results was ensured by:
- repeating three times
- using blank sample
- processing results with statistical parameters

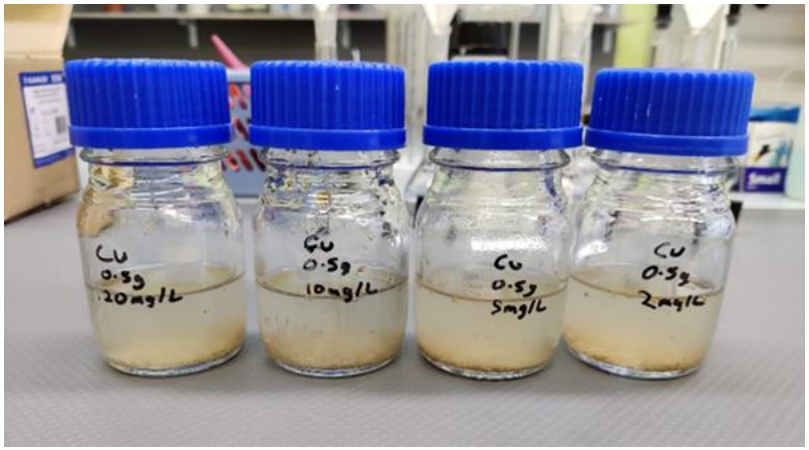

Figure 11. Samples for initial metal concentration effect

Figure 12. Buck scientific 2010 VGP Atomic Absorption Spectrometer

RESEARCH RESULTS (pH)

Table 1. Experimental results for copper ions removal by adsorbent

Experimental pH values	Cu (II) ion concentration (mg/L)	Wheat Bran Adsorption (%)	Wheat Bran Adsorption (mg/g)
2.0	2.50	50.1	0.125
3.0	1.87	62.5	0.156
4.0	1.82	63.7	0.159
5.0	1.71	65.8	0.165
6.0	1.60	68.1	0.170
7.0	1.55	69.0	0.173

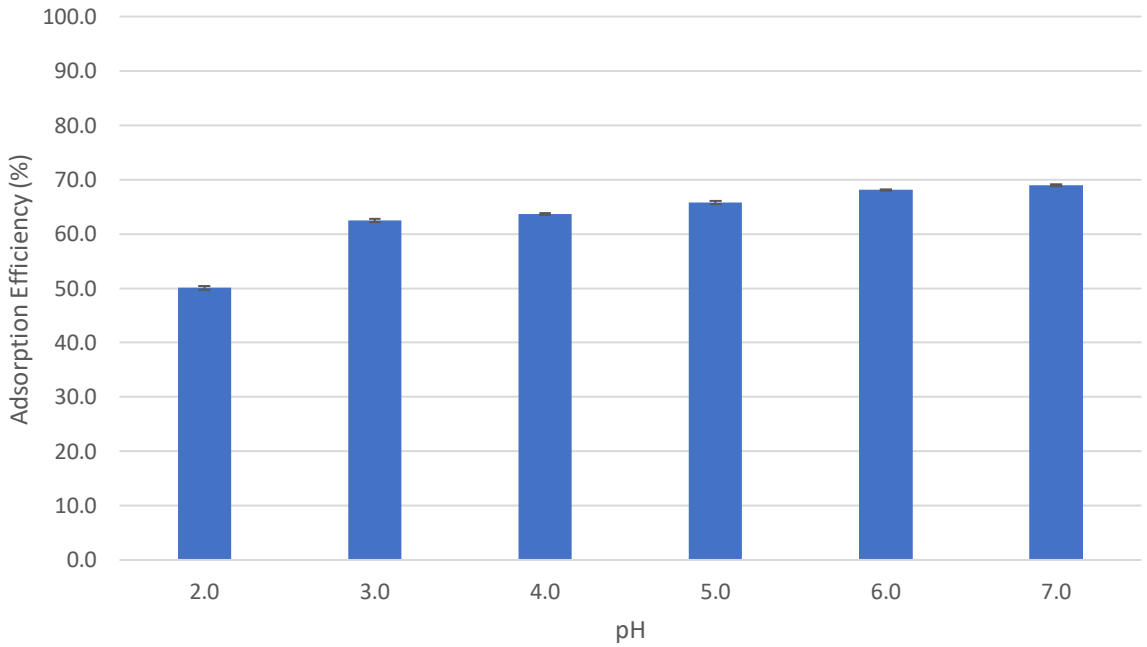

Figure 10. Relationship between copper ion adsorption efficiency and pH of solution, n=3, ±SD

The highest adsorption efficiency was recorded at pH 5.0.

According to Ozer et al., (2004) other experimental studies showed that copper cations around pH 5.0 interact more strongly with negatively charged sites of wheat bran.

pH greater than 6.0 results in adsorption as well as precipitation.

This efficiency was 65.8%.

RESEARCH RESULTS (CONTACT TIME)

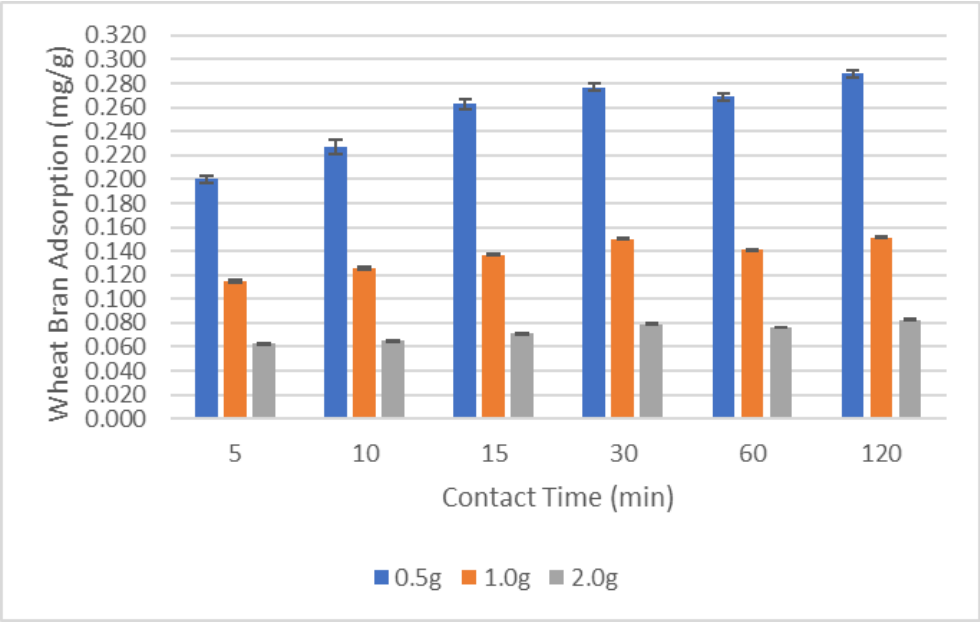

Figure 11. Influence of contact time on adsorption of wheat bran adsorbent, n=3, ±SD

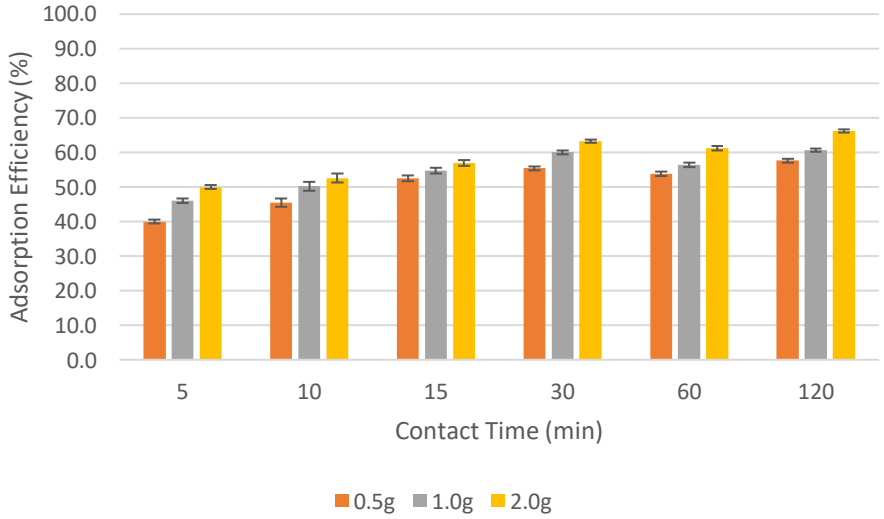

Figure 12. Influence of contact time on Cu (II) ions removal using wheat bran as adsorbent, n=3, ±SD

The adsorbed amount of copper ions slowly reached equilibrium at around 30mins. In view of this 120mins contact time was enough for the adsorption.

At equilibrium adsorbed amount of copper ions was 0.277mg/g with 0.5g adsorbent dose, 0.150mg/g with 1.0g adsorbent dose and 0.079mg/g with 2.0g.

Wang et al., (2009) also reports adsorption of Cu (II) ions by wheat bran, rice bran and walnut hull slowly reached equilibrium at around 30mins.

RESEARCH RESULTS (ADSORBENT DOSE)

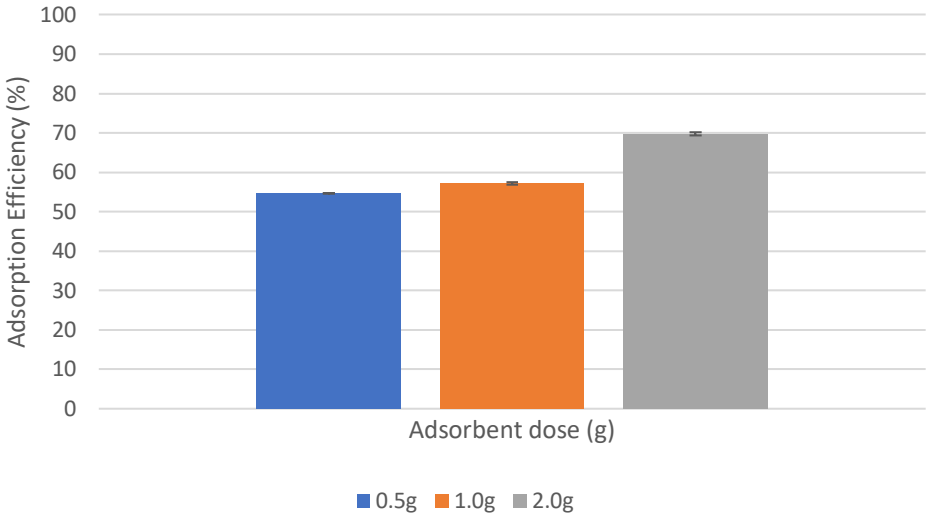

Figure 13. Influence of adsorbent dose on copper ions adsorption efficiency, n=3, ±SD

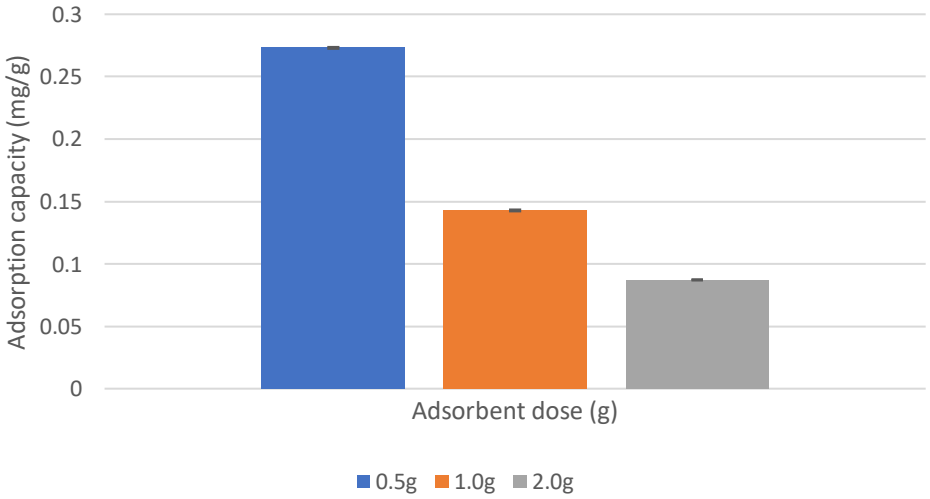

Figure 14. Influence of adsorbent dose on copper ions adsorption capacity, n=3, ±SD

The adsorption efficiency increases with increasing adsorbent dose. The amount of copper ions adsorbed increased from 54.6% to 69.8% with an increase of adsorbent dose from 0.5g to 2.0g.

The uptake of copper ions showed a reverse trend to the percentage adsorption.

As the adsorbent dose was increased from 0.5g to 2.0g, the adsorption of copper ions per unit weight of the adsorbent decreased from 0.273mg/g to 0.087mg/g.

RESEARCH RESULTS (INITIAL METAL ION CONCENTRATION

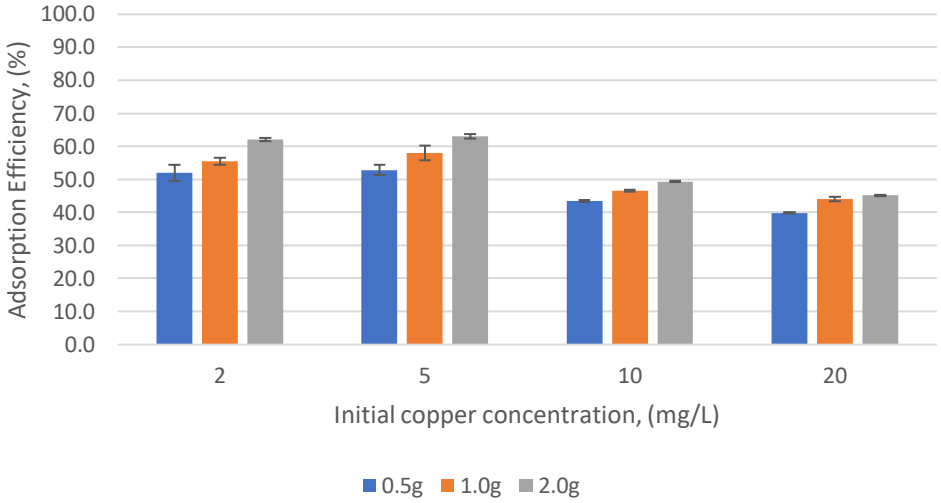

Figure 15. Influence of copper concentration on adsorption efficiency, n=3, ±SD

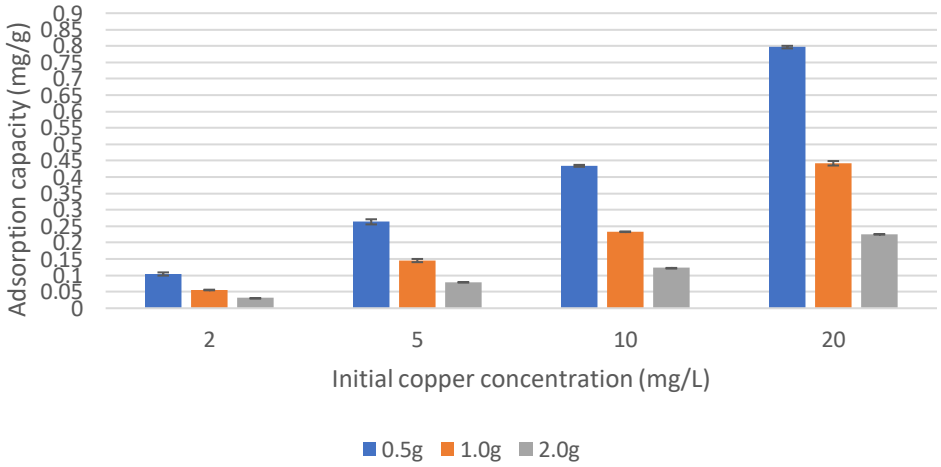

Figure 16. Influence of copper ions concentration on adsorption capacity, n=3, ±SD

The maximum removal of copper ions was found to be at a metal concentration of 5mg/L using wheat bran as adsorbent.

The percentage adsorption of copper ions by wheat bran decreased from 52.8% to 39.9% with increasing concentration when adsorbent dose was 0.5g

The uptake of copper ions from solution increased from 0.104mg/g to 0.797mg/g when the adsorbent dose was 0.5g with increasing metal ion concentration.

CONCLUSIONS

- The adsorption of copper ions was determined at a pH of 5.0 at room temperature with initial metal concentration of 5mg/L and adsorbent dose of 1.0g. Maximum removal of Cu (II) ion was 65.8%.
- The adsorption of copper ions slowly reached equilibrium at around 30mins and the uptake of Cu (II) ions was found to be 0.277mg/g for adsorbent dose 0.5g, 0.150mg/g for adsorbent dose of 1.0g and 0.079mg/g for adsorbent dose of 2.0g.
- The removal yield of copper ions increased from 54.6% to 69.8% when adsorbent dose was increased from 0.5g to 2.0g. The uptake capacity of Cu(II) ions decreased from 0.273mg/g to 0.087mg/g with the increased of adsorbent dose from 0.5g to 2.0g.
- The maximum removal of copper ions was found to be at a metal concentration of 5mg/L using unmodified wheat bran.
- The results showed that unmodified wheat bran can successfully be used to remove copper ions in polluted water and its availability in abundance and low-cost gives it an advantage over natural materials.

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