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ARTICLE

Yummy Purification

By: Zia Kuruvilla | Edited by: Hannah Ramsay | Layout by: Ahmed Nadeem

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Developing nations around the world encounter the crisis of contaminated water daily. According to data from UNICEF Canada (n.d.), nearly 800 children die daily due to the lack of clean water. Lead is one of the most common heavy metals in drinking water and can harm humans (Government of Nova Scotia, n.d.). In 2019, exposure to lead accounted for 900 000 deaths, and it was the cause behind 62.5% of developmental and intellectual disabilities worldwide (World Health Organization, n.d.). Communities that do not have access to clean water and those that cannot afford it need effective yet inexpensive and convenient water purifying. Although filtration methods such as reverse osmosis can remove heavy metals, these techniques are not frequently used in developing nations because of their complexity (Zinn et al., 2018). Therefore, it is essential to develop water purification methods utilizing resources that are easily accessible, and such methods may be applied in developing nations. Bioadsorbents are natural substances that can adsorb contaminants (Lee et al., 2019). It refers to the processes that occur before biodegradation in the cell wall (Derco & Vrana, 2018). Ion exchange, physical and chemical adsorption and other processes are involved in bioadsorbtion (Derco & Vrana, 2018). This experiment examines how fruit and vegetable wastes can be used as bioadsorbents to decrease lead content in contaminated water. This experiment tests whether banana, orange, mango, and carrot peels effectively reduce the lead concentration in contaminated water. The hypothesis for this experiment was that orange peels, carrot peels, banana peels, and mango peels, all of which are bioadsorbents, can be used to reduce the lead content in contaminated water.

MATERIALS AND METHOD

In Canada, lead contamination in water is uncommon. Therefore, this experiment used battery acid, which contains lead, to make water samples with lead. The instruments and materials used in this experiment were SRSE water test strips, five test tubes, a test tube rack, safety gloves, safety goggles, a syringe, contaminated water (75 mL), orange peels (1.5 mg), mango peels (1.5 mg), banana peels (1.5 mg), carrot peels (1.5 mg) and a weighing scale.

The method employed in conducting this experiment is explained as follows. Personal protective equipment was worn. The test tubes were labelled from 1 to 5. Orange peels, mango peels, banana peels, and carrot peels were collected, and the peels were air dried for 72 hours. The peels were ground separately into a fine powder. Battery acid was added into tap water (225 mL) to prepare the water sample with lead contamination. The water sample was tested for impurities using a water test strip, and the results were noted. 75 mL of contaminated water was measured using a syringe and divided into 5 test tubes so that each tube had 15 mL of contaminated water.

Test tube number 1 was the control sample. 1.5 mg of the powdered orange peel was added to test tube number 2, 1.5 mg of the powdered mango peel to test tube number 3, 1.5 mg of the powdered banana peel to test tube number 4, and 1.5 mg of the powdered carrot peel to test tube number 5. The test tubes were agitated frequently for 1 hour. A test strip was dipped into the control test tube and stirred for 2 seconds. The solution sat for 30 seconds before determining the lead content in the sample. The test strips were compared with the manufacturer-provided data chart. The lead content in the sample was compared to the lead content of the control sample, and the data was recorded. The experiment was repeated three times for each sample, using a different water test strip each time. After the experiment, the test strips and water samples were disposed of through the following procedure. The test strips were placed in a zip lock bag and sealed. The water samples were collected in a container and sealed. A label with the title lead-contaminated water was placed on the container before taking them to an eco-station for disposal.

Results

The average lead content data from three trials were plotted against the corresponding samples (control, orange peel, carrot peel, banana peel, and mango peel) using a bar graph, as shown in Figure 1. Based on the data retrieved, orange peels, carrot peels, banana peels, and mango peels reduced the lead content in the contaminated samples. Furthermore, orange and mango peels showed the highest absorbency compared to banana and carrot peels.

Discussion

The adsobency of lead may be due to specific components in orange peels, carrot peels, banana peels, and mango peels. Research has proven that lignocellulosic matter, such as cellulose and hemicelluloses, effectively removes heavy metals from water (Lee et al., 2019). Kamsonlian et al. (2012) state that bananas contain cellulose, and Dey et al. (2012) points out that cellulose is present in oranges (Dey et al., 2021). Mango peels also contain cellulose (Yingkamhaeng & Sukyai, 2014). Carrots are high in

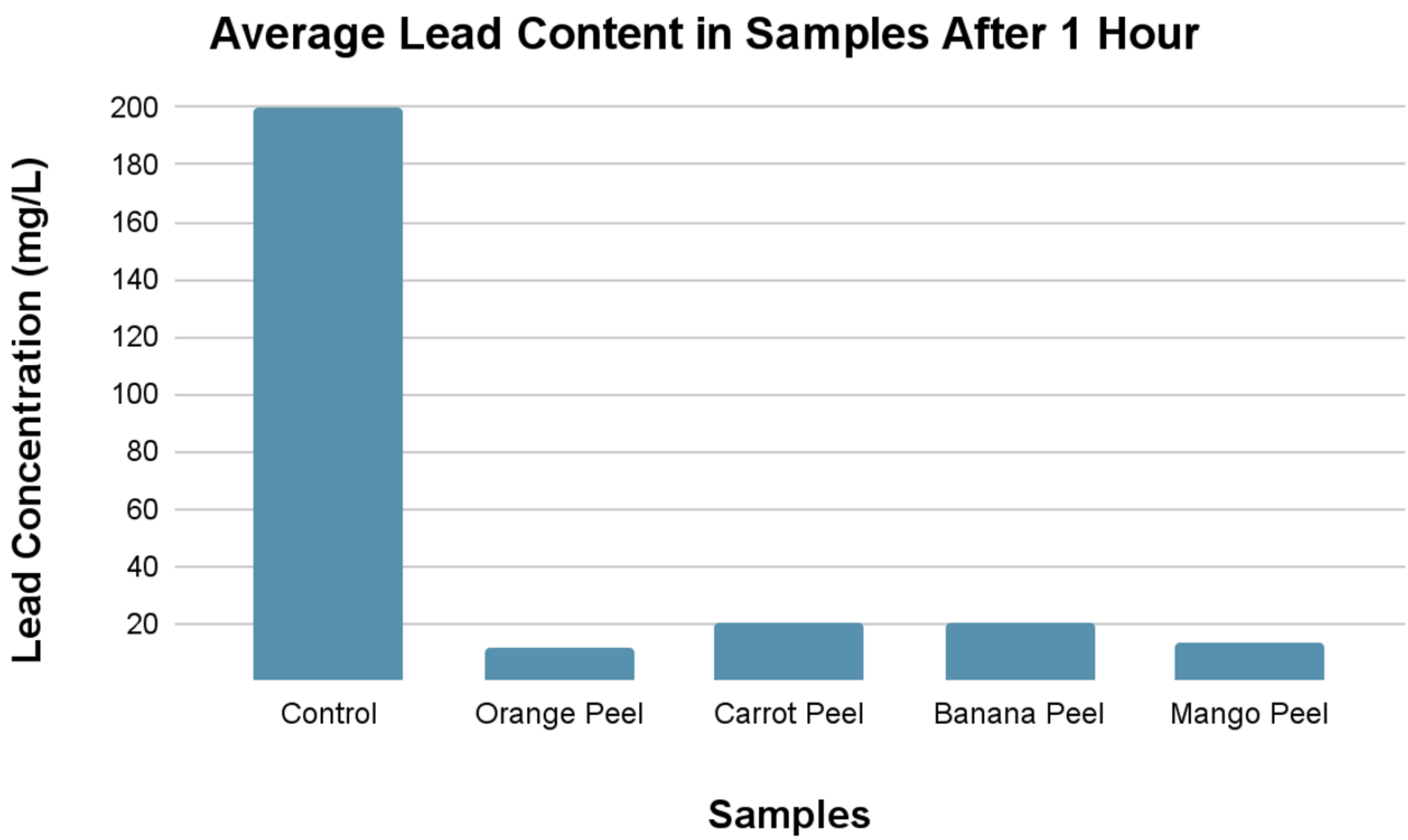

Figure 1: Average Lead Content in Samples After 1 Hour.

cellulose, hemicellulose, and lignin (Sharma et al., 2012). The varying quantities of each compound in the fruits and vegetables may have resulted in the different lead values found from the experiment.

Further research may be conducted to find other bioadsorbents in the natural environment. Testing the ability of natural bioadsorbents to reduce the amount of contamination in water by other heavy metals would also be beneficial. Research could be done to test the effectiveness of using several fruits and vegetables at once to purify water. Also, further testing could reveal the efficacy of hemicellulose, cellulose, and lignin in purifying water. A capsule or liquid solution can be developed with these compounds for water purification. Water purification tablets available in the market have chlorine, which forms chemicals in natural waters and pollutes these bodies. A water purification tablet made from natural compounds would remedy this concern. Developing nations can employ methods of water purification using bioadsorbents as they are inexpensive and accessible.

CONCLUSION

The results of this experiment indicate that the peels of oranges, carrots, bananas, and mangoes are effective bioadsorbents. Out of all the bioadsorbents tested, oranges removed the most lead, then mangoes, and finally, carrots and bananas were equally effective. The results of this experiment support the hypothesis that orange peels, carrot peels, banana peels, and mango peels are bioadsorbents that can be used to reduce the lead content in contaminated water.

These natural vegetable and fruit peels are generally discarded and may be used as efficient bioadsorbents. This research experiment also puts forth a sustainable method for purifying water that can be used worldwide. Water purification in developing countries is a significant issue, and finding economical solutions will protect people from deadly diseases. Lead contamination in water continues to be a prominent issue worldwide, and lead poisoning is extremely dangerous to human health. Finding a low-cost, effective, and accessible solution to treat water contaminated with lead will be beneficial around the globe.

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ABOUT THE AUTHOR - ZIA KURUVILLA

My name is Zia Kuruvilla and I am from Edmonton, Alberta! Currently, I am a grade 11 student at Lillian Osborne High School. I am passionate about the sciences, especially biology, and I try my best to get involved in STEM events! I have been participating in the Edmonton Regional Science Fair since grade 5! My hobbies include playing the piano and baking! I also enjoy volunteering as it helps me contribute to my community in a positive way.