

Hong Kong Student Science Project Competition 2022
Extended Abstract (Investigation)

Team Number: SBBC159

Project Title: (Eng) Puriwaste (Chi) 轉廢為水

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 21/06/2022, there are similar works. If there are, the reference links are as below:

https://www.researchgate.net/publication/340741966_ANTIMICROBIAL_EFFECT_OF_GARLIC_AND_GINGER_ON_Staphylococcus_aureus_FROM_CLINICAL_SPECIMENS_IN_MADONNA_UNIVERSITY_TEACHING_HOSPITAL_NIGERIA

<https://www.sciencedirect.com/science/article/pii/S1018364718308504>

https://www.researchgate.net/publication/329327155_Possibility_of_utilizing_from_lemon_peel_as_a_sorbent_in_removing_of_contaminant_such_as_copper_ions_from_simulated_aqueous_solution

The enhancement our project has made for the existing related products or research is summarized as below:

Instead of processed (e.g. dried, sieved, extracted) fruit peels and ginger, fresh food wastes are used in our research. This ensures a more affordable and easier method for bacteria inhibition and heavy metal ions removal, which is more applicable in developing countries.

I. Background

To this day, many developing countries do not have access to clean water. Water in these areas is often contaminated by bacteria, such as *Staphylococcus aureus*, and heavy metal ions, like copper, lead, and mercury. Water pollution can lead to adverse effects, including spreading of diseases, reduced crop production, and death of animals and plants.

In this investigation, we aim to find the best method to reduce water pollution and provide safe drinking water for people in developing countries. Lemon and orange peels as well as ginger were tested for their antimicrobial abilities, while the former two were also tested for their heavy metal adsorption abilities.

II. Objectives

The aim of our research is to find a primitive, affordable, and readily available method to inhibit the growth of bacteria and remove heavy metal ions in water in developing countries.

III. Hypothesis

First, lemon peels, orange peels and ginger can inhibit the growth of *Staphylococcus aureus*.
Second, lemon peels and orange peels can adsorb copper(II) ions, zinc ions and lead(II) ions.
Third, the adsorption ability increases as the velocity of the solution flowing through the adsorption column decreases.

IV. Methodology

In Section 1 - disinfection, *Staphylococcus aureus* was grown on mannitol salt agar. The colony was then extracted and grown on agars, each mixed with 15 g of lemon peels/ orange peels/ ginger, after serial dilution. The diameter of each colony on each plate was measured after three days.

Stage 1 of Section 2 tests the metal ion adsorption abilities of lemon and orange peels. Copper(II) ions, zinc ions and lead(II) ions were tested by putting 12 g of peels into solutions containing the respective ions. Testing papers were put into the solution after 3, 24 and 48 hours and the colour was compared.

Stage 2 of Section 2 tests the copper(II) ions adsorption abilities of lemon peels in an adsorption column with solutions flowing at different velocities. Velocities of 2.5, 5, 11 and 15 cm/min were tested. The solution passed through the column was collected at 1-minute intervals and the ion concentration was measured. Besides, the adsorption abilities of lemon peels in the column on Day 1 and Day 2 of using the column was measured and compared.

V. Results

In Section 1, it was found that all three fruit peels used can reduce the size of *S. aureus* colonies. Orange may have a slightly higher inhibitory ability (48% decrease in colony diameter on average), with the inhibition ability of ginger and lemon about the same (43% and 37% decrease in colony diameter on average respectively).

In Stage 1 of Section 2, it can be concluded that fresh lemon peels adsorb heavy metal ions faster than fresh orange peels.

In Stage 2 of Section 2, it was shown that an adsorption column with a slightly higher flow rate showed a higher adsorption rate than simply placing the peels in water.

Copper(II) sulphate solution flowing at a velocity of 2.5 cm/min shows a largest decrease in copper(II) ion concentration, followed by 5, 11, and lastly 15 cm/min. This indicates that the lower the velocity of the solution, the higher the adsorption of copper(II) ions by the lemon peels.

However, the overall rate of removal of copper(II) ions by the column in an hour is the greatest with the highest flow rate at 15 cm/min.

Besides, upon reusing on the second day at the beginning, the adsorption abilities of lemon peels in the column decreases. However, the amount of metal ions adsorbed will still be the same if the solution is run through the column for long enough.

VI. Conclusion

In conclusion, the fruit peels can be used in water treatment, with orange peels for disinfection and lemon peels removal of heavy metal ions.

An adsorption column can be set up to increase the adsorption rate. The actual flow rate for the adsorption column should be set based on actual practical needs, i.e. whether the elute concentration or the overall amount of removal is a more crucial factor.