Evaluation of processed food waste as bioadsorptive material in packed bed filters for emerging contaminants in water

Lagos, Andrés S.[1], Landázuri, Andrea C.[1]

[1] Applied Circular Engineering & Simulation Group, Department of Chemical Engineering, College of Science and Engineering, Universidad San Francisco de Quito USFQ. Quito, Ecuador.

Abstract

One of the least considered problem in the treatment and decontamination of wastewater is the removal of emerging pollutants, which are present in water bodies such as rivers. These contaminants include substances such as caffeine (CAF), acesulfame K (ACSK), and irgasan (triclosan) (IRG). Additionally, wastes from food processing plants are thrown in garbage dumps. A viable solution is taking advantage of these residues in further decontamination processes. Due to this, it is intended to study the efficiency of bioadsorption using mango and moringa seed husk, rice husk biochar (synthesized via traditional pyrolysis for 60 min) and granular activated carbon (as a control group) in packed bed filters.

Introduction

Our way of production is clearly linear today. This way of conceiving production takes natural resources, processes them and obtains products, which we consume, and waste, which are thrown away. A new model proposes a form of circular production in which the waste from a production process is raw material for new products or the remediation of the environment. This is the challenge of circular engineering, and that goes hand in hand with sustainable production and responsible consumption.

Pollution in water has been investigated and evaluated widely for many years. However, emerging pollutants are not monitored in treatment plants, but their presence has been observed in bodies of water that can be used by humans (i.e., rivers and underground aqueducts). Bioremediation has been evaluated with other more common contaminants such as heavy metals.

Waste from the food industry has been used for some minor processes such as compost production. Another example that we wanted to take advantage of is the ability to process these products for use in environmental remediation activities, especially water. Thus, the objective of this research is to search for discarded materials that offer an optimal and viable removal of pollutants for a generalized use, using final and processed waste and its respective comparison with methods that have been widely tested and used for a long time.

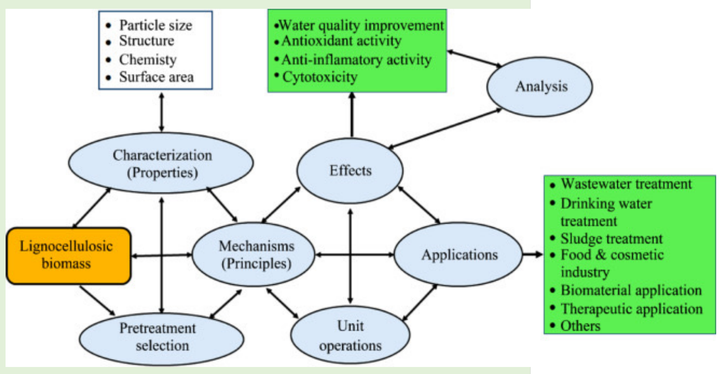

Figure 1. Process engineering perspective of lignocellulosic biomass use.

Methodology

Packed bed filters produced using food waste such as mango and moringa seed husk and further processed material such as rice husk biochar. They were contrasted with granular activated carbon. Filters were able to remove efficiently caffeine, acesulfame K and irgasan with initial concentration of 5 mg/L and 10 mg/L (ppm).

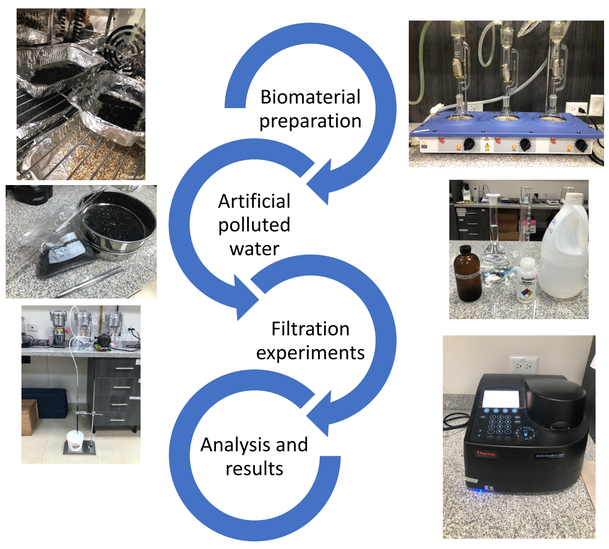

Figure 2. Methodology used in filtration experiments.

The evaluation and characterization of the biomaterial used in experiments is still carrying out using techniques such as SEM and FT-IR. Analysis of amount of contaminant removed was performed using UV-VIS spectroscopy.

Results

Finally, it was found that the best material to use in the filter is the mango seed husk, with yields of 28.63% for CAF, 50.47% for ACSK and 74.08% for IRG at 10 mg/L initial concentration and 45.76% for CAF, 76.83% for ACSK and 92.69% for IRG at 5 mg/L initial concentration.

Table 1. Maximum percentage removal of the studied contaminants achieved for different materials.

Contaminant	Bed material	Maximum % removal [%]			
		Mango seed husk	Moringa seed husk	Rice husk biochar	Control: GAC
Caffeine	C_0 5 mg/L	45.76 ± 2.19	10.80 ± 1.12	48.80 ± 0.69	94.98 ± 0.95
	C_0 10 mg/L	28.63 ± 0.14	12.65 ± 0.93	28.55 ± 0.66	90.05 ± 1.27
Acesulfame K	C_0 5 mg/L	76.83 ± 0.60	26.41 ± 1.40	38.72 ± 0.28	41.70 ± 2.08
	C_0 10 mg/L	50.47 ± 0.49	20.19 ± 0.31	20.53 ± 0.61	37.75 ± 1.01
Irgasan	C_0 5 mg/L	92.69 ± 3.03	66.40 ± 5.47	56.11 ± 1.74	94.25 ± 4.01
	C_0 10 mg/L	74.08 ± 0.92	48.35 ± 4.85	9.232 ± 2.04	84.77 ± 1.60

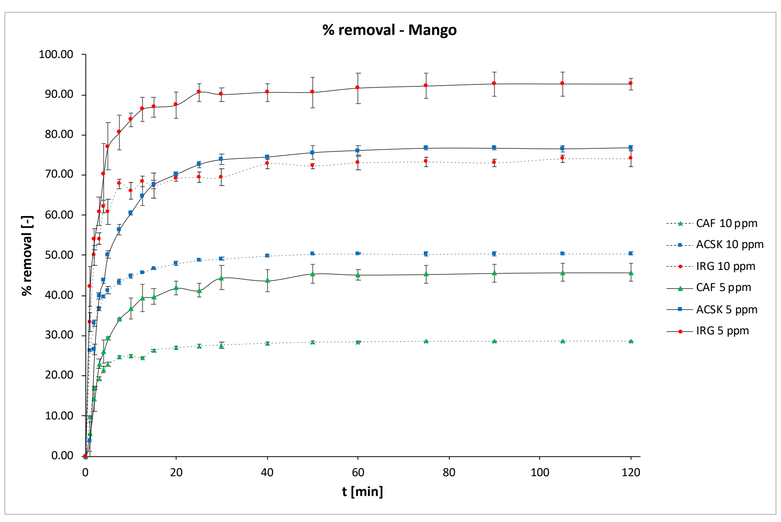

Figure 3. Percentage removal of mango achieved in 2 h of the experimental run. Mango seed husk was the best material to be used for emerging organic contaminants.

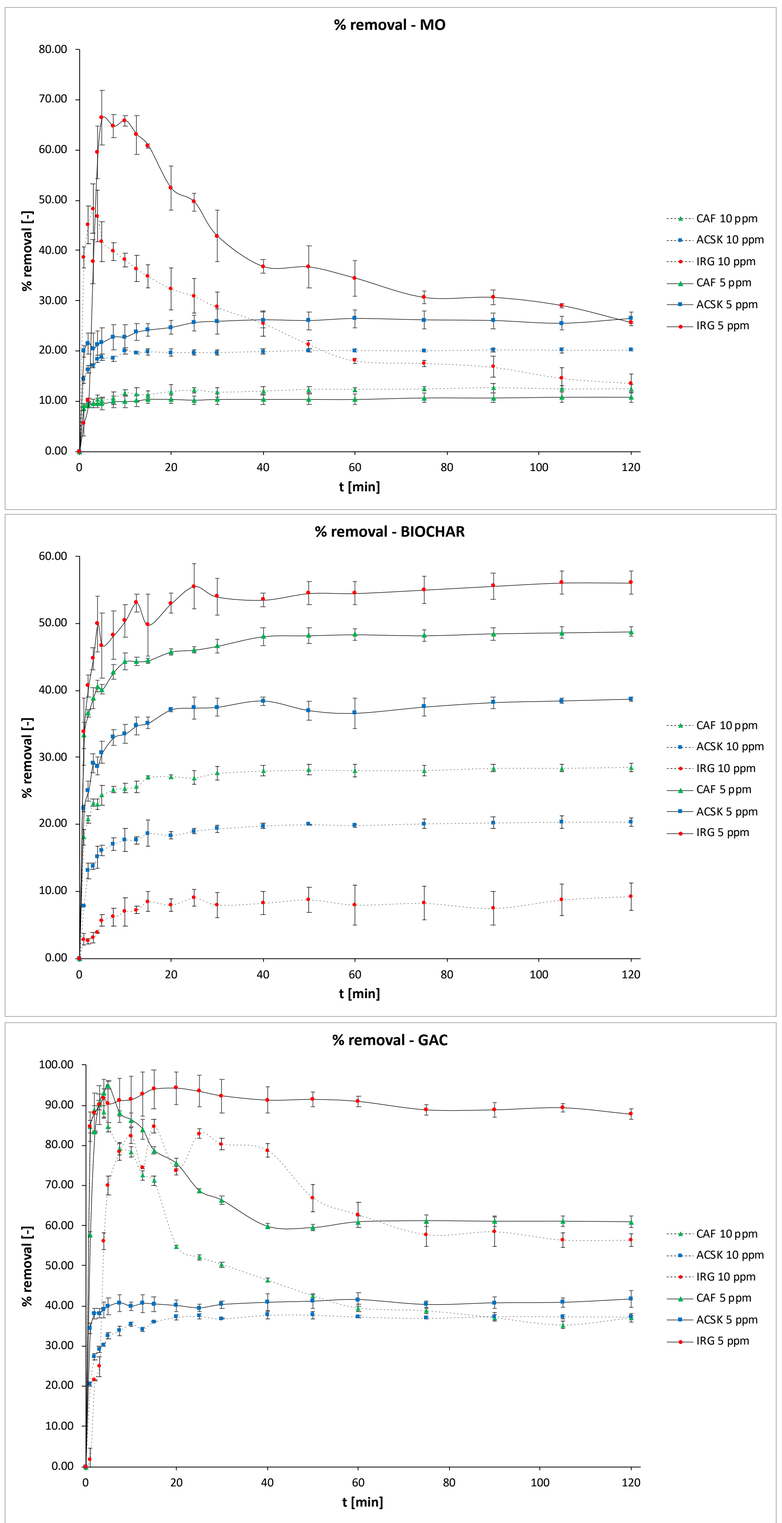

Figure 4. Percentage removal of moringa seed husk, moringa seed husk, rice husk biochar and GAC in 2 h of the experimental run.

Conclusions

- The current study demonstrates the efficiency of processed organic waste for the removal of emerging pollutants. Processed mango seed husk was very effective on remotion of these contaminants.
- Researches on pretreatment of wasted lignocellulosic material have originated a new chapter in the study of new bioprocesses for the treatment of polluted water.
- Sustainable Development based on Circular Engineering is possible since processes can be made environmental friendly.
- Green chemical engineering is emerging as a good solution on critical problems of the 21st century society such as economic, health, social and climate change crisis.

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Contact information

Coordinator: Andrea C. Landázuri
alandazuri@usfq.edu.ec
Research assistant: Andrés S. Lagos
alagos@usfq.edu.ec