Removal of antibiotics from wastewater using anaerobic treatment

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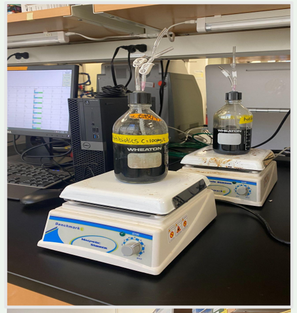
Introduction

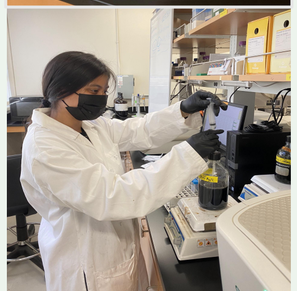
Antibiotics are a very powerful tool to combat disease and commonly used to treat bacterial infections. Antibiotics that are not fully metabolized in the human body reach wastewater and contribute to antibiotic resistance genes (ARGs) proliferation. ARGs proliferation pose a risk since bacteria learn how to survive or become resistant to antibiotics, making the treatment of disease harder. One potential solution for the degradation of antibiotics in the environment is anaerobic digestion. Previous studies showed anaerobic digestion process could help in reducing the concentration of antibiotics and thus ARGs in different environmental streams such as wastewater. This study focused on evaluating anaerobic digestion for the treatment of antibiotics in wastewater. Furthermore, Anaerobic digestion of wastewater can have useful byproducts like biosolids used as fertilizers, biogas like methane used to produce energy and volatile fatty acids.

Materials and Methods

Objective
Determine the degradation of antibiotics using anaerobic digestion

Methods
- Constructed anaerobic bioreactor
- Reactors had 500 mL of total volume with 400ml of working volume consisted 20 mL of sludge, 17 mL of synthetic wastewater concentrate, and 363 mL water. Reactors were spiked with 50 µg/L and 125 µg/L of Erythromycin
- Analysed Chemical Oxygen Demand (COD), concentration of Erythromycin using Liquid Chromatography Mass Spectrometry (LC-MS), and Mixed Liquor Suspended Solids (MLSS)





Photos and graphs created by me and my mentors. Top left picture shows that I'm mixing the sample; Bottom left: I am removing the sample; Right is a picture with me and my labmates Gizel and Kevin from left to right.

Results

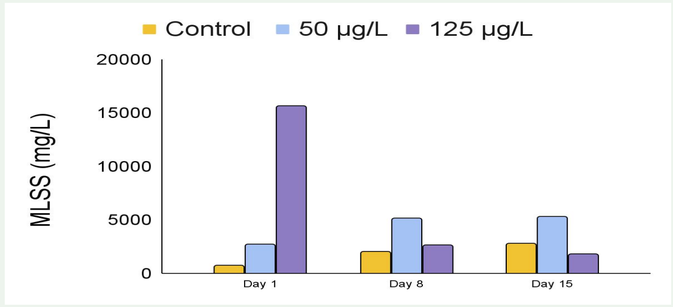


Figure 1. MLSS over time for bioreactors

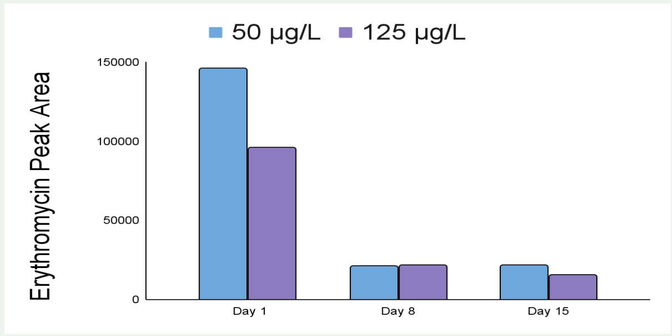


Figure 2. Concentration of Erythromycin over time for bioreactors

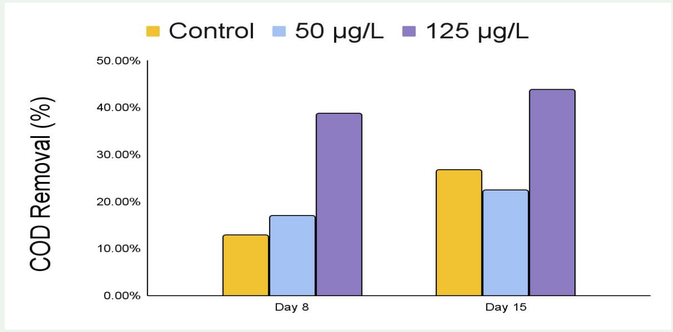


Figure 3. COD data of three bioreactors

Skills Learned

- Strengthened my understanding for laboratory instrumentation
- Solidified pipetting and filtering technique
- Successfully operated anaerobic bioreactors
- Expanded my knowledge in data processing
- Managed anaerobic sampling
- Learned reactor construction skills

Discussion & Conclusion

Three reactors were constructed: the control contained all liquid media as described in the methods section, but had no antibiotics, while Reactor 1 contained 50 µg/L of Erythromycin and Reactor 2 contained 125 µg/L of Erythromycin.

As seen in Figure 1, the suspended solids in Reactor 1 increase over time, while they decrease over time in Reactor 2. These trends show that the microorganisms in Reactor 1 failed to consume the suspended solids, indicating the microorganisms failed to survive with the antibiotics. The decreasing trend seen in Reactor 2 shows that the microbes consumed the organic solids.

The two reactors that were mentioned in Figure 1 are being compared of the amount of Erythromycin. In Figure 2, Reactor 1 and Reactor 2 of the LCMS erythromycin concentration drastically decreased. There are less antibiotics overtime because they are likely consumed by the microorganisms and possibly absorbed to the biofilm.

As shown in Figure 3, in both the reactors and the control there was a high percentage of C0D removal. This was expected because during anaerobic digestion there should be low results of COD because bacteria has been eating away the organic solids. COD only measures what the microbes have been eating. We used three measurements to determine the amount of food and antibiotics there were in my two bioreactors.

Acknowledgements

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References

Zarei-Baygi, A., Harb, M., Wang, P., Stadler, L. B., & Smith, A. L. (2019). Evaluating antibiotic resistance gene correlations with antibiotic exposure conditions in anaerobic membrane bioreactors. Environmental science & technology, 53(7), 3599-3609.