Biodegradation of Triclosan by Bacteria Isolated from Thibodaux Sewage Treatment Plant

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Introduction

Personal care products are household products used for personal hygiene and disinfection. Personal care products from hospitals and healthcare facilities, domestic and industrial sources and landfill leachates can enter ecosystems via effluents/wastewaters and cause harmful effects on organisms (Miazek & Brozek-Pluska 2019. Triclosan (5-chloro-2-(2,4-dichlorophenoxy)phenol) is an antibacterial and antifungal agent that is present in many antibacterial detergents and surgical cleaning treatment products.

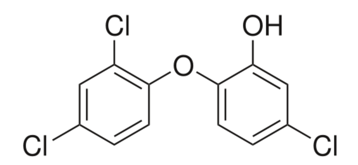


Figure 1. Structure of triclosan

It is slightly water-soluble (10 mg/L at 20°C) and readily soluble in organic solvents. This antimicrobial compound is typically discharged from households and collected at the local sewage treatment plant. Because triclosan inhibits phospholipid biosynthesis, it will affect the microbial population that perform waste degradation. When bacteria are exposed to triclosan, it enters the cell and inhibits the enzyme enoyl-acyl carrier protein reductase, which is essential for phospholipid biosynthesis. Triclosan mimics the natural substrate of this enzyme and blocks the active site, which terminates the production of fatty acids (Lubarsky et al. 2012). The purpose of this experiment is to determine the triclosan biodegradation potential of native bacteria in the Thibodaux sewage treatment plant and the surrounding environment.

Objectives:

1. **Determine whether triclosan inhibits bacterial growth in bacteria collected from the Thibodaux sewage treatment plant.**
2. **Isolate and identify pure culture that can utilize triclosan as the sole carbon source by determining the best electron acceptor condition for triclosan biodegradation.**
3. **Analyze the triclosan degradation pathway using high-performance liquid chromatography (HPLC).**

Methods

1. **Samples were collected and bacterial consortia were made.**
   a. Anaerobic digester sludge was collected from the Thibodaux sewage treatment plant.
   b. Cultures were inoculated using Basic Mineral Salt Medium under various electron acceptor conditions.
2. **Bacterial growth and carbon removal were observed using a spectrophotometer.**
   a. Optical density was measured every 24 hours
   b. COD, nitrate, and ammonia concentration was measured on days 0 and 14
3. **Metabolic pathway was analyzed using HPLC.**

Figure 2. Thibodaux sewage treatment plant

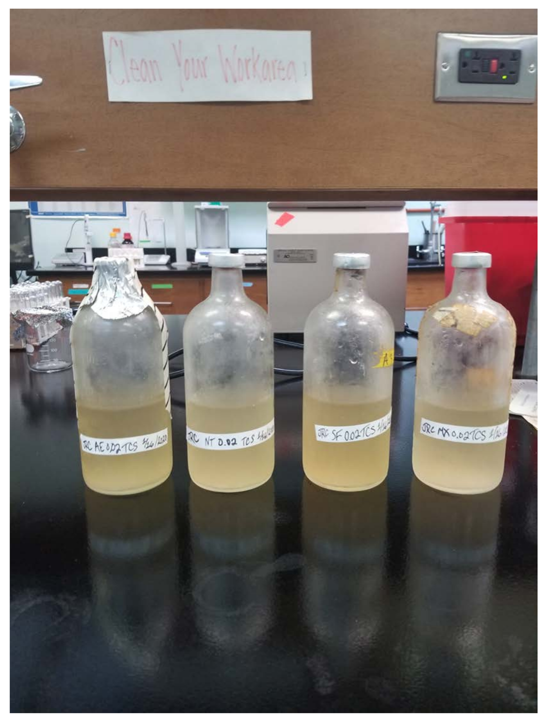


Figure 3. Enrichment consortia

Figure 4. Experimental consortia setup

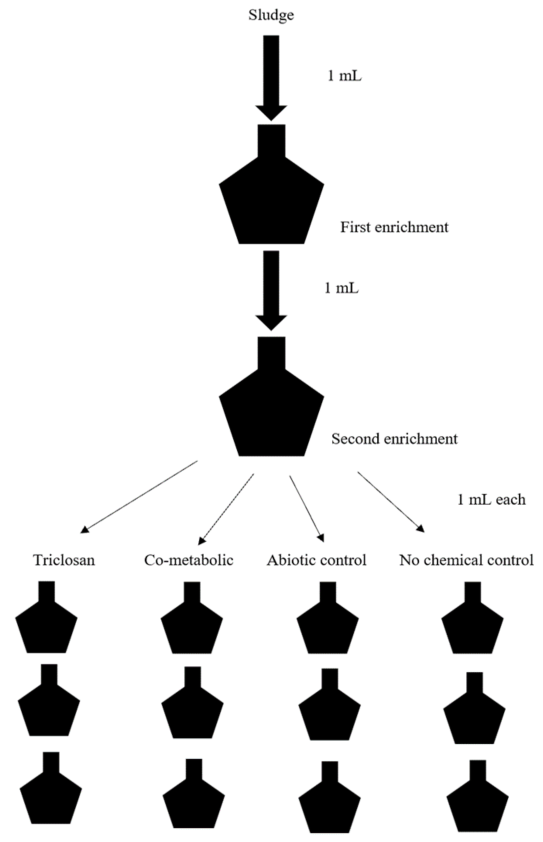
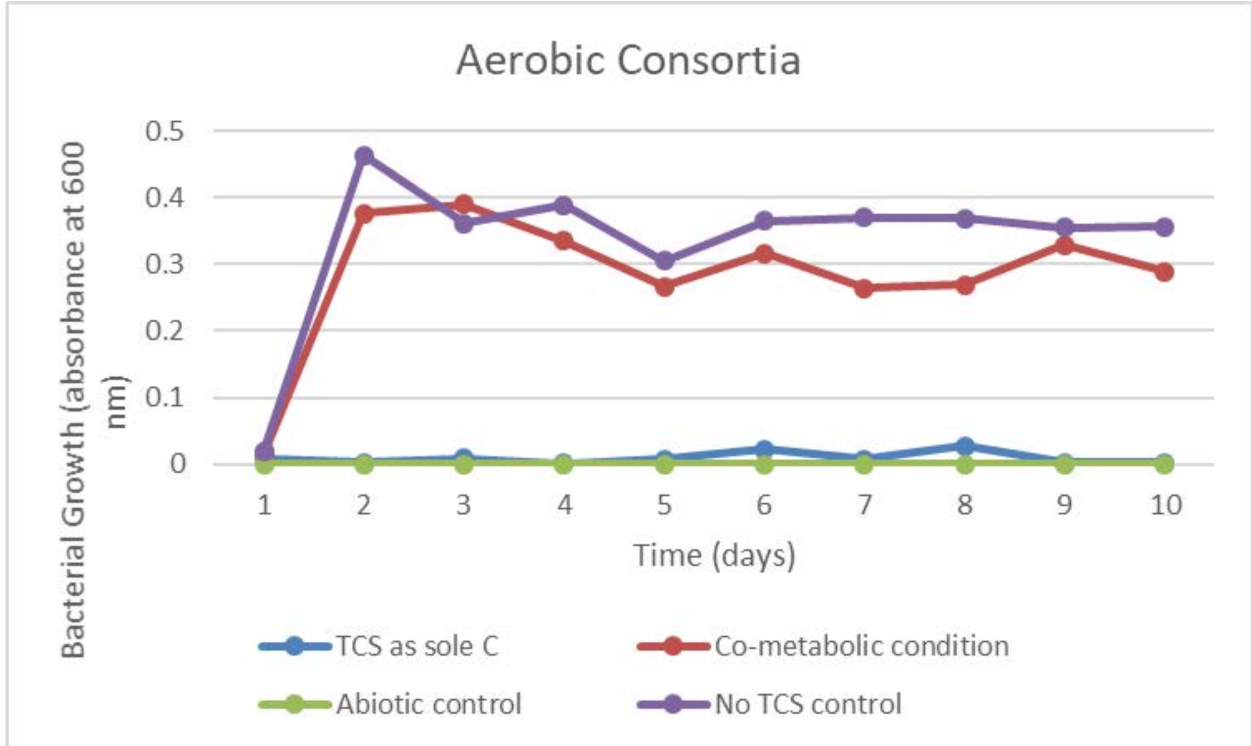
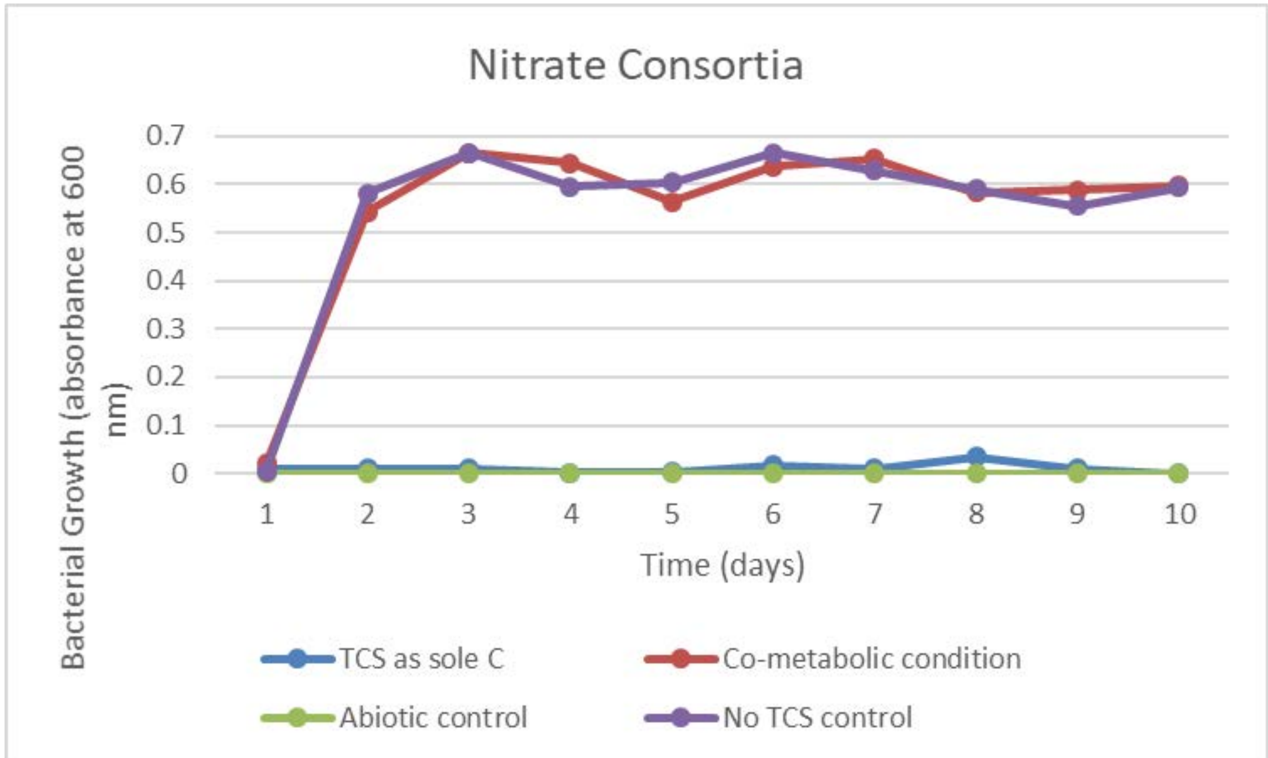
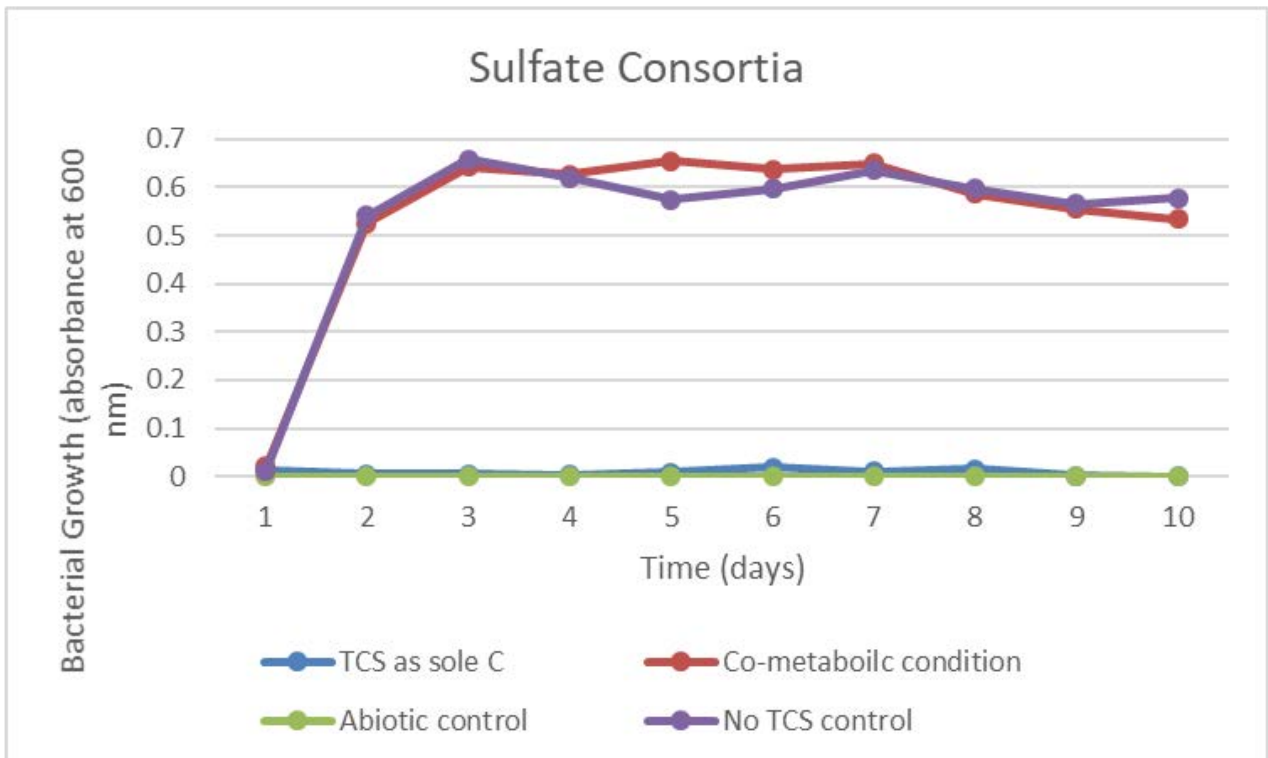


Figure 5. Experimental setup

Results







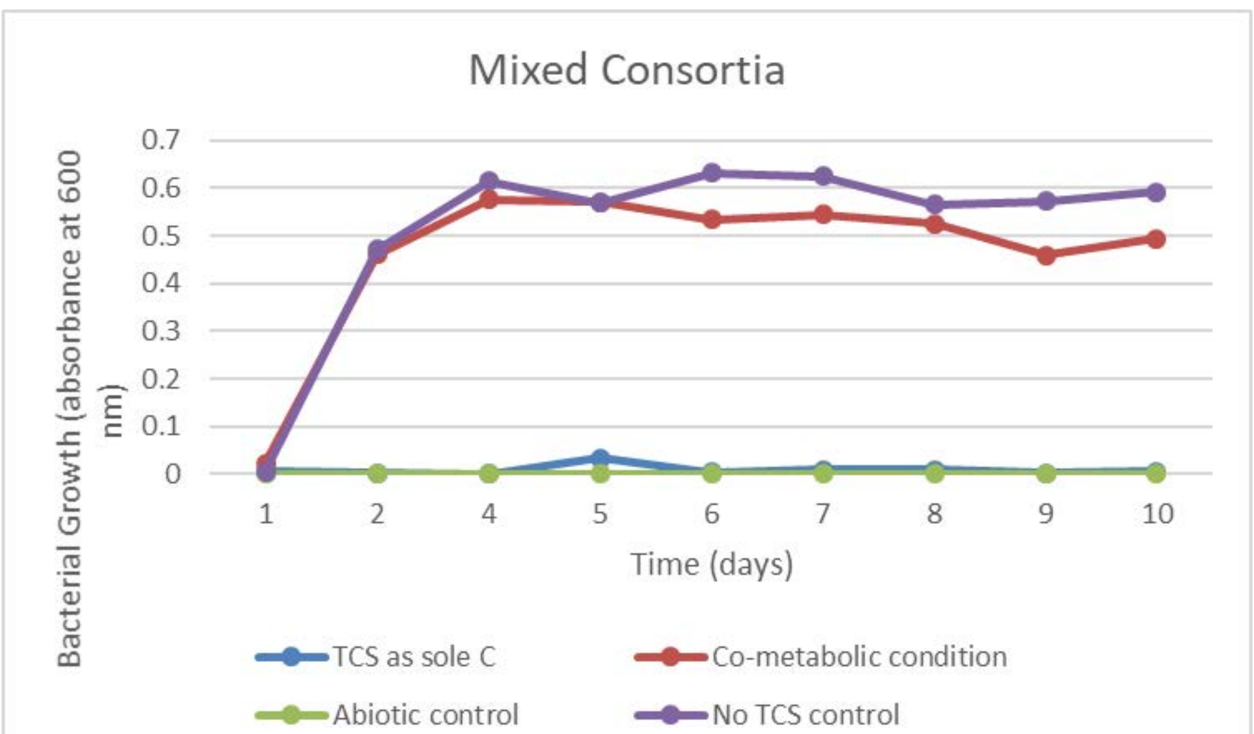


Figure 6. Bacterial growth curves under various conditions

Results (cont.)

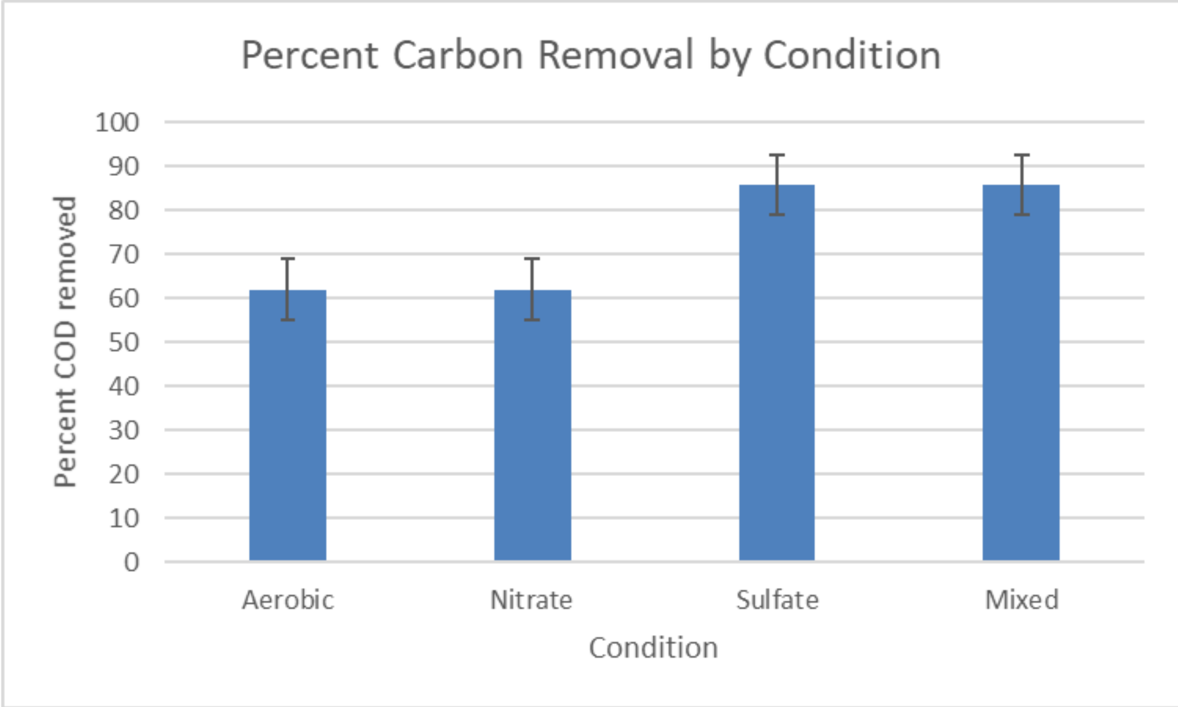


Figure 7. Carbon removal chart

Discussion/Conclusions

Based on the results for optical density, the anaerobic sulfate electron acceptor condition showed the best bacterial growth. Although the amount of carbon in triclosan was very little, the results indicate that bacteria isolated from the Thibodaux sewage treatment plant can degrade triclosan and use it as a carbon source (Figs. 6 and 7). The current data indicates that the best method for growth.

Upon analyzing the solution via HPLC, triclosan was found to have poor bioavailability. This is likely due to a solubility issue. As a result, the bacterial growth was poor when using triclosan as a sole carbon source. Future work will reconstitute triclosan in media from an evaporated methanol solution. I expect to see improved growth and carbon removal.

Because triclosan is discharged into aquatic systems from domestic and commercial sources, determining the best method to remove it from the environment is important. If left in solution, triclosan could accumulate to a toxic level for the aquatic ecosystem and other life. This experiment will identify any byproducts produced as a result of the degradation of triclosan. We expect to find which electron accepting conditions allow for optimal degradation of triclosan. We will also identify the wastewater bacteria that can degrade triclosan using LC/MS analysis, and the triclosan metabolic pathway will be constructed. This study will characterize the efficiency of how a rural sewage treatment plant in Southeast Louisiana operates in the presence of triclosan. This study will also enumerate the strains of bacteria in the sewage treatment plant that carry out the metabolism of triclosan in the sewage system.

References

Lubarsky, H. V., S. U. Gerbersdorf, C. Hubas, S. Behrens, F. Ricciardi, and D. M. Paterson. 2012. Impairment of the bacterial biofilm stability by triclosan. PLoS One. 7:e31183.

Miazek, K., and B. Brozek-Pluska. 2019. Effect of PHRs and PCPs on microalgal growth, metabolism and microalgae-based bioremediation processes: a review. International Journal of Molecular Sciences. 20:2492.

Acknowledgements

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