

Microalgae treatment of pharmaceutically active compounds in municipal wastewater

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Abstract and Objectives

The objective of the research was to determine the potential for using microalgae to remove pharmaceutically active compounds (PhACs) from wastewater. The City of Logan, Utah, utilizes a facultative lagoon system of 460 acres to treat municipal wastewater from a population of approximately 100,000, and microalgae grow naturally within the lagoon system. The approach involved identifying predominant microalgae and PhACs occurring in the lagoon system. LC/MS/MS was used to characterize and identify PhACs of interest that included acetaminophen, carbamazepine, bisphenol-A, sulfamethoxazol, and caffeine. Isotherm experiments were conducted to determine the sorption of PhACs to algae, and biodegradation experiments were performed to account for biotransformation of parent PhACs. Results for microalgae characterization showed that the dominant microalgae at the Logan lagoon system included *Scenedesmus obliquus* and *Chlorella vulgaris*, which were selected for experimentation. Sorption capacity and biodegradation potential varied among the target PhACs and the microalgae genus tested. Results describing the potential for treatment of PhACs by microalgae as functions of chemical characteristics and microalgae type will be presented.

Necessary Equipment



Figure 1. Triple-Quad LC/MS/MS instrument by Agilent.

The critical instrument in this investigation is the LC/MS/MS. Measuring concentrations as low as the ng/L level was not feasible at Utah State until the instrument was received this October. Initial tests with PhAC standards has shown accurate readings of carbamazepine as low as 13 ng/L. Standards for over 20 PhACs were used to familiarize those on the team with the specific challenges of measuring at the concentration levels typical to those found in natural circumstances.

Preparation

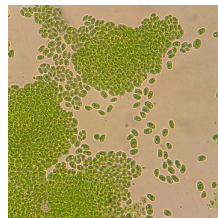


Figure 2. Isolated strain of *Scenedesmus* 6313 with high lipid content

Bioreactors were constructed to provide ideal conditions for modeling growth and sorption rates with measurable light exposure.

Various strains from the Logan Lagoons were isolated and sequenced. Lipid content was also determined. Several strains were selected as prime candidates for pharmaceutical sorption or degradation that would also be profitable biofuel producers.

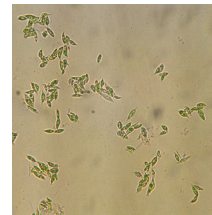


Figure 3. Unisolated algae from the Logan Lagoons

Innovative Research with Proven Methods

The innovation of the investigation is based on a firm base of proven methods used in examining wastewater and in identifying or quantifying the effect of introduced chemicals or even of the microbial life naturally present in bodies of water.

Biodegradation and sorption are two

means that PhACs are removed from water. Distinguishing between the two is important in determining the fate of the PhACs.

By measuring the concentration over time for sterilized cultures in contrast with disinfected cultures shows the amount of PhAC removal for which sorption is responsible. (See Figure 3)

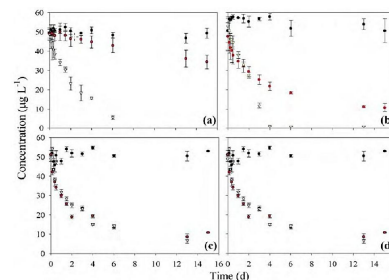


Figure 3. Sorption and combined sorption-biodegradation study of (a) acetaminophen, (b) caffeine, (c) propranolol, (d) acebutolol. (●) Control; (■) sorption; (○) combined sorption-biodegradation. (Lin, 2010)

Expectations for the Future

The findings of this investigation will identify or rule out a potential advantage to lagoon style treatment plants. With increasing environmental consciousness and even the possibility of government-imposed requirements on wastewater treatment for PhACs, it may be the benefit that pushes biofuel production from wastewater treatment into the mainstream.



Figure 7. Algae sampled from the RABR's (Rotating Algal Biofilm Reactor) biofilm is being isolated and sequenced for use in this investigation. Using algae from thoroughly researched sources such as this and the Logan Lagoons supports the viability of application of the investigation's results.

Due to the amount of unexplored potential regarding this investigation, it will inevitably lead to more questions. Further research will be able to target specific resolutions for specific dilemmas based on the PhACs involved, the climate, and design of the treatment facility.

Acknowledgments

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