This project aims to identify the effect of food particle size on reduction of biochemical oxygen demand (BOD) and total suspended solids (TSS) to maximize the functionality of aerobic digestion in collaboration with the Metropolitan Water Reclamation District (MWRD) and implement this bioprocess at Loyola University Chicago’s Lakeshore Campus. This research will contribute to the University’s sustainability goals by reducing produced food waste. Food waste (FW) will be collected from Damen Dining Hall and ground in a controlled environment to various particle samples. Samples will be tested for initial BOD and TSS values and seeded with a standard microbial community. Samples will then enter a lab-modeled aerobic digestion process where they will decompose and stabilize. Finally, the samples will be retested for BOD and TSS values to determine relative change. Our work will advance Loyola’s sustainability goals by reducing the costs of sending food waste through the sewer system.

Introduction

Food Waste
- The United States, generated 63.1 million tons of FW in 2018, representing 21.6% of the total municipal solid waste for that year.
- Loyola has several initiatives to reduce food waste. Composting from Lake Shore Campus (LSC) and Food Recovery Network.
- Aerobic digester at Health Sciences Campus (HSC).
- However, composting from LSC relies on long distance trucking, with no nutrient products returned to campus, causing the university financial cost.

Aerobic Digestion
- Aerobic digestion is a feature of the EPA’s 2019 Food Waste Initiative, which identifies feasible pathways to reduce food waste.
- Aerobic digestion uses micro-organisms and oxygen to decompose organic matter, reducing BOD and TSS.

Approach
- An efficient aerobic system at LUC could embody a circular economy approach.
- FW aerobically digested at LUC would be directed to anaerobic digesters at MWRD plants through the sewer system, expanding LUC’s coverage of FW sites and enabling a return of nutrients back into LUC landscaping and agriculture.
- MWRD charges $202.93 per 1,000 lbs. of BOD and $117.81 per 1,000 lbs. of TSS, reflecting the cost of lost product and additional water treatment chemicals necessitated by high TSS and BOD values.
- Research suggests that smaller particle sizes of organic matter increase the available surface area, contributing to faster biomass stabilization.
- Thus, investigating the effect of FW particle size on BOD and TSS values is logistically and economically beneficial to both organizations.
- Renovare Environmental, Inc. markets on-site waste management solutions, including a range of aerobic digestors, one of which is already stationed at the HSC.
- These digestors do not account for high TSS or BOD values, making investigation of particle size reduction worthwhile.

Food Waste Audit
- FW from Damen Dining Hall at LUC’s Lakeshore Campus was sorted into standardized categories.
- The sorted FW was reduced to a representative sample and divided into six variable sample groups.
- Three of the samples were placed in the drying oven at 40 D CELCIUS prior to being blended, and the remaining three samples were blended for 2, 4, and 8 seconds respectively before being placed in the drying oven.

Figure 2 (Left): Completed FW audit
Figure 3 (Right): Three wet representative FW samples

Particle Size Distribution
- Particle size distribution (PSD), was evaluated using standard methods.
- Sample groups that were blended prior to being dried are labeled by ‘W’.
- Sample groups that were dried prior to being blended are labeled by ‘D’.
- Five sieves of varying mesh diameter were used to determine PSD.

Graph 1 (Top): Stacked bar chart depicting differences in particle size characteristics among samples
Graph 2 (Bottom): Plot of distribution differences between samples

Discussion
- Initial PSD results indicate that the blending and drying variables result in different distributions.
- The following steps will generate corresponding data to further analyze the relationship and statistical significance between and among variable samples.
- This study is primarily focused on the effects of PSD on BOD and TSS values.

Spring 2022 Semester

Plans for the Spring
- Design a lab-scale aerobic digester to evaluate the effects of determined particle size on TSS and BOD values following digestion.
- Identify the means and method for acquiring appropriate aerobic microbes to facilitate digestion.

Questions to Answer
- By what means and method should aerobic microbes be collected?
- How can aerobic microbial populations be maintained over time?

Discussion with Dr. Greg Palmer
After discussing the logistics and feasibility of acquiring aerobic microbes with microbiologist Dr. Palmer, we came to the following conclusions for a path forward:
- A direct sample approach would be most beneficial to the scope of the project.
- A sample will be collected from the effluent of the aerobic digester at the HSC in Maywood.
- Maintaining the microbial community within a sample would provide a replicable environment across samples and trials.
- Insulation, consistent temperature and agitation are integral to maintaining a representative microbial community during and after transport.

Conclusion
- FW will continue to be an environmental concern for the foreseeable future.
- Aerobic digestion could be a viable solution to reducing FW at LUC.
- Additionally, collaboration with MWRD, expands the feasibility of incorporating aerobic digestion across LUC’s campuses, with minimal effort and cost incurred by the University.
- This study has not been completed, but the processes facilitating aerobic digestion have been established, paving the way for further research.

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References