Isolation of Microplastics with a Common Commercial Enzyme

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Introduction

Microplastic contamination is a constant issue as industries continue to be reliant on them for cost and construction efficiency. Microplastics can contaminate food and water supplies and are resilient to most types of waste remediation. This is due to microplastics' small size (5 mm-100 nm) that infiltrates a myriad of biological systems. As research is done in laboratory settings, new isolation techniques are developed to improve experimental performance. The goal of this project was to gauge the differences between the efficiency of meat tenderizer (used in medical applications) versus trypsin (used in water treatment plants) and Bio-Clean (a septic tank cleaner used in previous research) as the cheapest and most efficient choice for isolating microplastics from environmental substrates. The main benefit of this project will be to free up funding and time in lab settings to further develop filtering techniques.

Procedure

Ten Pure Samples Created (0.57g) -

- 0.25 g of organic material
  - Collected from dead leaves and grass
  - Moisture removed by heating
  - Tumbled and sifted to <70 microns
- 0.25 g of Inorganic material
  - Collected from Maumee River estuary
  - Tumbled and sifted to <70 microns
  - Density separated in NaCl to remove organics and plastics
- 0.07 g Microplastics (0.01 g each)
  - Polyester (**PE**)
  - Polypropylene (**PP**)
  - Polystyrene (**PS**)
  - Nylon
  - Polybutadiene Rubber (**PBR**)
  - Polyethylene terephthalate (**PETE**)
  - Polyvinyl Chloride (**PVC**)

- All samples treated with Fenton's Reagent for initial oxidation and vacuum filtered (Ingredients:10 mL Hydrogen peroxide (H_2O_2) + 0.25 g Iron (II) sulfate ($FeSO_4$))
- Samples treated to three enzyme sources: Bio-Clean, Meat Tenderizer, and Trypsin
- Samples floated in NaI brine for density separation (12.9 g NaI: 10 mL H2O)
- Samples were vortexed and sonicated for ~24 hours
- Samples collected (pipette extraction of floating materials), dried, and weighed
- Samples to be examined with scanning electron microscope (SEM) to determine degradation and purity of microplastics

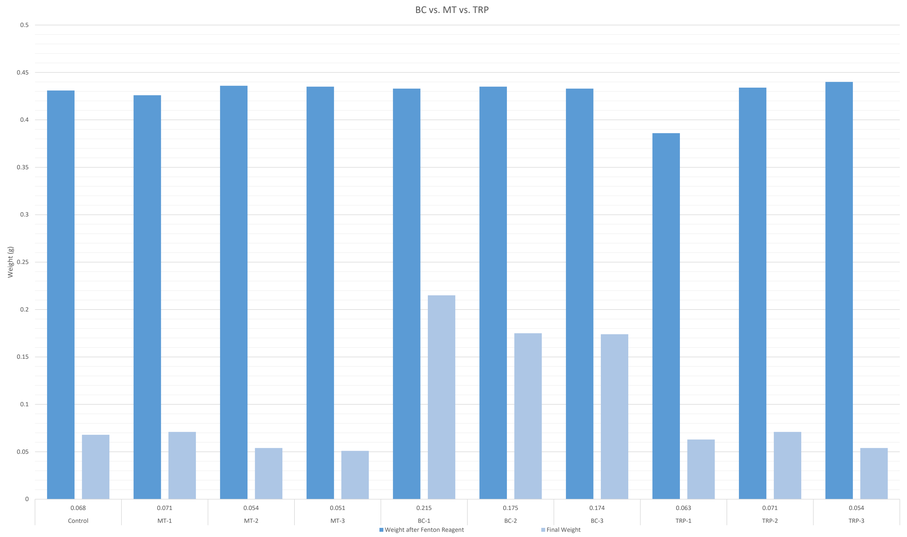
Conclusion

There is a positive correlation between the concentration of enzymes and the breakdown of organic substrates. Meat tenderizer is more efficient at isolating microplastics than Bio-Clean, and while Trypsin had similar results in organic breakdown, Meat Tenderizer is a much more cost-effective option. After application of Meat Tenderizer, microplastics showed no signs of degradation or alteration which would have released smaller plastic molecules into the media.

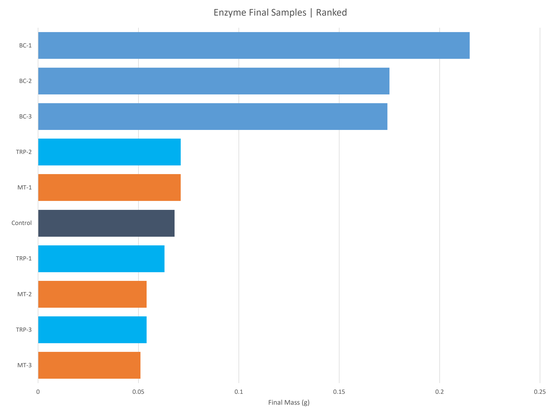
Acknowledgements

- Valerie Hallowell, FNP

Results



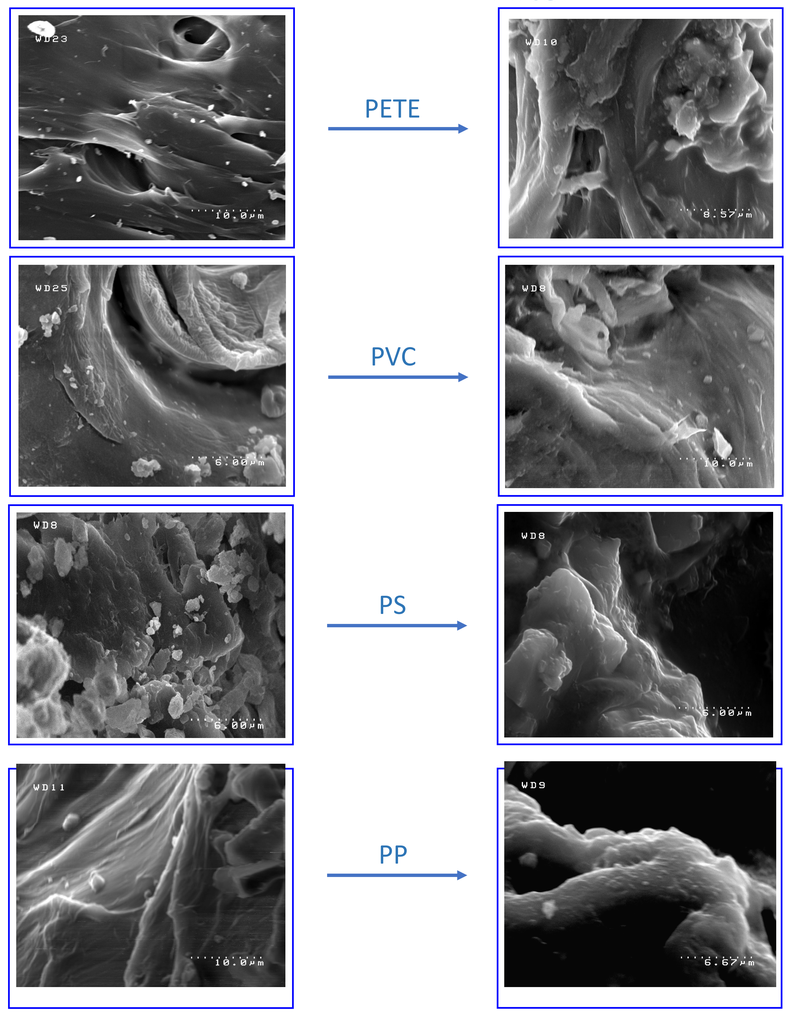
Enzymes	Amount (mg)	Total Starting Weight (g)	Starting Weight No Inorganics (g)	Weight after Fenton Reagent	% Retained after Fenton Reagent	Final Weight (g)	% Retained FINAL
Control	N/A	0.56	0.31	0.431	0.769642857	0.068	0.219354839
MT-1	20	0.56	0.31	0.426	0.760714286	0.071	0.229032258
MT-2	40	0.56	0.31	0.436	0.778571429	0.054	0.174193548
MT-3	60	0.56	0.31	0.435	0.776785714	0.051	0.164516129
BC-1	20	0.56	0.31	0.433	0.773214286	0.215	0.693548387
BC-2	40	0.56	0.31	0.435	0.776785714	0.175	0.564516129
BC-3	60	0.56	0.31	0.433	0.773214286	0.174	0.561290323
TRP-1	20	0.56	0.31	0.386	0.689285714	0.063	0.203225806
TRP-2	40	0.56	0.31	0.434	0.775	0.071	0.229032258
TRP-3	60	0.56	0.31	0.44	0.785714286	0.054	0.174193548




Microplastic collection under 200x magnification

Plastic Degradation

Images were taken via SEM to investigate possible MP degradation by the enzymes by Meat Tenderizer.



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