Name(s)
Christopher Fakhimi; James Jolin

Project Number
S1109

Project Title
Worms: The Bioremediation Solution of the Future

Abstract

Objectives/Goals
The purpose of this experiment was to determine which type of worm - Z. morio, T. molitor, T. obscurus or G. mellonella - is most effective at degrading polystyrene (PS) and if, in fact, gut bacteria are depolymerizing the PS molecules.

Methods/Materials
We set up terrariums with worms and polystyrene (PS) in each and monitored consumption and worm attrition over a period of 31 days. Then, we measured the CO2 emissions of worms reared on antibiotics and PS, using CO2 sensors and biochambers, to determine if bacteria were degrading PS molecules. Finally, we cultured worm gut bacteria in bacterial cell culture flasks with a carbon-free medium and PS, plated the bacteria on agar plates, incubated the bacteria for 48 hours at 37C, extracted the bacterial DNA with a DNA extraction kit, and amplified the Exiguobacterium sp. strain YT2 bacterial DNA using universal 16s primers, TAQ Master Mix, and Thermal Cycler. Amplicons were sequenced at an off-site sequencing facility.

Results
An analysis of variance (ANOVA) data test of PS consumption (n=4) and worm attrition (n=4) resulted in p-values lower than the alpha standard ($p<0.05$), showing a significant difference in both tests. Z. morio consumed the most polystyrene, with 25.23% consumption, and also had the least death, with 12% attrition. DNA sequencing revealed that 40% of Z. morio gut bacteria DNA is similar to Exiguobacterium sp. strain YT2. Additionally, Z. morio, reared on PS, ceftriaxone and gentamicin antibiotics, produced on average 36.5% less CO2 (ppm/h) than specimens without antibiotics. Microbes were present in the Z. morio guts and were suppressed by antibiotics.

Conclusions/Discussion
The alternative hypothesis was supported; worms, specifically Z. morio, can serve a viable role in bioremediation. Hypothetically, 10,000 Z. morio specimens, which are not difficult to rear, could eat 150 grams of PS. Effective and fast bacterial cell culturing could provide a means of polystyrene degradation. Easy PS-degrading microbe DNA isolation and amplification could provide further research about the proteins that encode PS degradation.

Summary Statement
This project supported, using various scientific disciplines, the conclusion that Z. morio most effectively degrade PS and gut microbes play a role in PS molecule depolymerization.

Help Received
We received no institutional assistance in our project. Thomas Reynolds, PSM did mentor and assist us in our school laboratory during the implementation of biotechnology. Otherwise, we performed all other procedures.