

Home / Biology / Cell & Microbiology

Home / Biology / Biotechnology

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Scientists develop artificial worm gut to break down plastics

by Nanyang Technological University



The NTU scientists fed the worms with different plastic diets and extracted the microbiomes from their gut, incubating them in flasks to form an "artificial worm gut." Credit: Nanyang Technological University

A team of scientists from Nanyang Technological University, Singapore (NTU Singapore) has developed an artificial worm gut to break down plastics, offering hope for a nature-inspired method to tackle the global plastic pollution problem.

By feeding worms with plastics and cultivating microbes found in their guts, researchers from NTU's School of Civil and Environmental Engineering (CEE) and Singapore Center for Environmental Life Sciences Engineering (SCELSE) have demonstrated a new method to accelerate plastic biodegradation.

Previous studies have shown that the *Zophobas atratus* worm—the larvae of the darkling beetle commonly sold as pet food and known as a "superworm" for its nutritional value—can survive on a diet of plastic because its gut contains bacteria capable of breaking down common types of plastic. However, their use in plastics processing has been impractical due to the slow rate of feeding and the rigors of worm maintenance.

The NTU scientists have now demonstrated a way to overcome these challenges by isolating the worm's gut bacteria and using them to do the job without the need for large-scale worm breeding.

NTU Associate Professor Cao Bin at the School of CEE, principal investigator at SCELSE, said, "A single worm can only consume about a couple of milligrams of plastic in its lifetime, so imagine the number of worms that would be needed if we were to rely on them to process our plastic waste.

"Our method eliminates this need by removing the worm from the equation. We focus on boosting the useful microbes in the worm gut and building an artificial 'worm gut' that can efficiently break down plastics."

The study is [published](#) in the journal *Environment International*.

Developing an artificial worm gut

To develop their method, the scientists fed three groups of superworms different plastic diets—High-density polyethylene (HDPE), Polypropylene (PP) and Polystyrene (PS)—over 30 days. The control group was fed a diet of oatmeal.

The scientists selected the plastics as they are among the most common plastics in the world, used in everyday items like food boxes and detergent bottles. HDPE is a type of plastic known for its high-impact resistance, making it difficult to break down.

After feeding the worms plastic, scientists extracted the microbiomes from their gut and incubated them in flasks containing synthetic nutrients and different types of plastics, forming an "artificial worm gut." Over six weeks, the microbiomes were left to grow in the flasks at room temperature.

Increase in plastic-degrading bacteria

The scientists found that compared to the control group, the flasks that contained the gut microbiomes from the plastic-fed worms showed a significant increase in plastic-degrading bacteria.

Furthermore, the microbial communities colonizing the plastics in the flasks were simpler and more tailored to the specific type of plastic than the microbes found on plastics that had been fed directly to the worms. When the microbial communities are simpler and targeted to a specific type of plastic, this translates to potential for more efficient plastic degradation when used in real-life applications.

First author of the study Dr. Liu Yinan, Research Fellow at the School of CEE and SCELSE, said, "Our study represents the first reported successful attempt to develop plastic-associated bacterial communities from gut microbiomes of plastic-fed worms. Through exposing the gut microbiomes to specific conditions, we were able to boost the abundance of plastic-degrading bacteria present in our artificial worm gut, suggesting that our method is stable and replicable at scale."

The researchers say their proof-of-concept lays the foundation for developing biotechnological approaches that use worms' gut microbiomes to process plastic waste.

For their next steps, the researchers want to understand how the bacteria in the superworm's gut break down the plastics at the molecular level. Understanding the mechanism will help scientists engineer plastic-degrading bacterial communities to break down plastics efficiently in the future.