MICROBIAL DEGRADATION OF POLYSTYRENE BY MEALWORM ISOLATED BACTERIA

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The proliferation of plastic waste has become a significant environmental issue in the 21st century, and finding effective ways to biodegrade plastic has become a critical strategy to tackle this problem. While microbial degradation experiments on non-hydrolysable or vinyl plastics have a low rate of plastic degradation, hydrolysable plastics, on the other hand, have a much higher rate of plastic degradation. However, the limited bioavailability of plastics to microorganisms poses a fundamental challenge to microbial biodegradation.

A recent study investigated whether the egg, larva, pupa, and adult stage of the brown mealworm, known as honeymoon, can biodegrade plastic. The study found that the biodegradation and mineralization of polystyrene (PS) occurred in the intestine of the mealworm for 15 to 20 hours. The researchers also examined the amount of plastic decomposition in honeymoon at different levels of humidity and temperature and identified the microorganisms in the intestines of mealworms using PCR and DGGE techniques.

In the experiment, the mealworms were supplied with bran for two days before being used. The researchers analyzed the microbial community in the intestine of the mealworms using DNA extracted and 16S rDNA variable part-in-law V3 region amplification using nested PCR. They also analyzed a range of major functional groups using FTIR and nuclear magnetic resonance, with triplicate analyses performed for each sample.

Statistical analysis of the amount of consumed PS decomposition showed that mealworms consumed 12.22 grams and 15.72 grams of PS when cultured at 25°C and 30°C, respectively, under 70% and 80% humidity conditions. The study found that the higher the temperature, the lower the PS loss, and the consumption rate of PS by mealworms was relatively slow, with a range of 0.15 mg PS/d/mealworm in the experiment. The researchers found that maintaining a relative humidity of 80% was more effective in maintaining maximum consumption.

When bran and PS were supplied as sole nutrients, the growth pattern of mealworms was measured by measuring the length of the wheatgrass body. The study observed that the growth of mealworms was slower when PS was supplied, and the maximum growth was slower than the general growth cycle of 3 months.

The study identified the microbial community in the intestines of mealworms as *Acinetobacter, Citrobacter, Klebsiella, and Exiguobacterium, with Citrobacter, Enterococcus, Klebsiella*, *Lactococcus*, and *Serratia* being the dominant species contributing to the degradation of PS in mealworms. However, the distribution of intestinal microorganisms contributing to decomposition of PS appears to be different depending on the region or experimental environment.

The study found that mealworms degrade PS by secreting it into their secretions. The FTIR and 13C solid-state NMR spectra showed that the degradation process involved the pulverization and oxidation of the PS ring structure. The 13C NMR spectrum of the secretion

ISSN (Print):2663-2381, ISSN(Online):2663-4007
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of PS-fed mealworms showed distinct new peaks, which were attributed to chitin and a phenyl derivative. These new aromatic resonance signals were generated during the depolymerization or oxidation of PS.

The study concludes that the consumption rate of PS by domestic Mealworm larvae is most active at 30°C and 80% humidity, and the growth pattern of mealworms due to PS supply lasts longer than the ecological cycle of normal nutrient supply. Additionally, the research suggests that different kinds of microbes in the human gut, including Bacillus, Citrobacter, Enterococcus, Klebsiella, Lactococcus, and Serratia, may play a role in the degradation of plastics.