T.SAMEEHA FATHIMA
7TH.STD
I MAX GLOBAL SCHOOL

ENVIRONMENTAL SCIENCE

TOPIC NAME

PLASTIC EATING ENZYMES

Research Plan: Plastic-Eating Enzymes

a. Selection of Problem and Background Information

Plastic pollution has become one of the most urgent environmental problems worldwide. Every year, millions of tons of plastic waste are dumped into landfills and oceans, where it persists for centuries due to its non-biodegradable nature. Traditional recycling methods are inefficient and limited, leading to accumulation of plastic debris that threatens ecosystems, wildlife, and human health.

Recent scientific discoveries have identified specific enzymes, such as PETase and MHETase, produced by certain bacteria (e.g., Ideonella sakaiensis), which can break down polyethylene terephthalate (PET) plastics into simpler molecules. These enzymes present a potential eco-friendly solution for plastic waste management.

Exploring and enhancing plastic-eating enzymes could significantly reduce environmental pollution, improve recycling efficiency, and contribute to a sustainable future.

b. Problem

How can plastic-eating enzymes be utilized or engineered to efficiently degrade plastic waste, and what conditions optimize their activity for large-scale application?

c. Hypothesis

It is hypothesized that plastic-eating enzymes such as PETase, under optimized environmental conditions (temperature, pH, concentration), will accelerate the degradation of PET plastics into environmentally safe byproducts. Furthermore, genetically engineered variants of these enzymes may demonstrate higher efficiency than naturally occurring ones.

d. Procedure

The investigation will be conducted in phases:

1. Literature Review & Identification

Collect information on existing plastic-degrading enzymes (PETase, MHETase, cutinases).

Identify the organisms that produce them naturally.

2. Sample Preparation

Obtain PET plastic samples of uniform size and weight.

Prepare enzyme solutions in different concentrations.

3. Experimental Design

Set up controlled experiments to test degradation under different variables:

Temperature: (20°C, 30°C, 40°C)

pH levels: (5, 7, 9)

Enzyme concentration: (low, medium, high)

Control group: PET samples without enzyme exposure.

4. Observation & Data Collection

Measure weight loss of PET samples at weekly intervals.

Use spectroscopy (FTIR) or chromatography (HPLC) to analyze breakdown products.Record time taken for visible degradation.

5. Enhancement Phase (Optional)

Propose potential genetic engineering techniques to enhance enzyme activity.

Examples:

1. Pineapple Peel Juice – contains bromelain and organic acids that can aid in bioplastic formation and degradation.

2. Milk Protein (Casein) – forms bioplastics that are biodegradable and nontoxic.

3. Potato Starch – widely used for making bioplastic sheets, easily degradable.

4. Orange Peel Extract – contains pectin and natural compounds suitable for biofilm formation.

5. Aloe Vera Gel – used in blends for making flexible bioplastics.

e. Risk and Safety

Enzymes are generally safe, but standard laboratory safety protocols will be followed.

Proper disposal of degraded plastic residues will be ensured.

Risks include handling bacterial cultures if enzymes are produced in vivo. Biosafety Level 1 precautions will be followed.

f. Data Analysis

Collected data (weight reduction, degradation rate, concentration of breakdown products) will be analyzed statistically.

Graphs will be plotted to compare enzyme activity under different conditions.

The efficiency of enzyme-based degradation will be compared with natural degradation rates.

Future tense: The analysis will determine which conditions maximize degradation and whether enzyme modification will enhance efficiency.

g. Bibliography

Yoshida, S., et al. (2016). "A bacterium that degrades and assimilates poly(ethylene terephthalate)." Science.

Tournier, V., et al. (2020). "An engineered PET depolymerase to break down and recycle plastic bottles." Nature.

Journal articles on bioremediation and enzyme engineering.

Reference books on environmental biotechnology.

Articles from National Geographic and Scientific American on plastic pollution.