

# "Engineering the rhizosphere": Multi-functional Biocomposites for Green Agriculture

## 1 Project Goal

The project aims to develop next-generation biocomposite fertilizers combining fungal-bacterial interkingdom consortia (FBIC) with nutrient-rich wastes such as sewage sludge ash and fish meal. The innovative approach involves the use of alginate-based controlled-release biocomposites to enhance plant growth, phosphorus bioavailability, and reduce heavy metal uptake in crops.

## 2 Description of Research

The study includes several stages. First, a high-throughput screening of microbial cultures will identify strains with beneficial traits (phosphate solubilization, auxin and siderophore production, nitrogen fixation, potassium and zinc solubilization, enzyme activity, and metal resistance). Based on functional clustering, stable FBICs will be assembled. These consortia will be combined with waste substrates and alginate, crosslinked with calcium chloride to form controlled-release biocomposites. Their physical properties (structural stability, nutrient release, microbial viability) will be characterized using rheological, spectroscopic, and microbiological methods. Agronomic efficiency will be validated in pot trials on both clean and metal-contaminated soils by measuring plant growth, nutrient and metal uptake, and gene expression related to nutrient cycling.

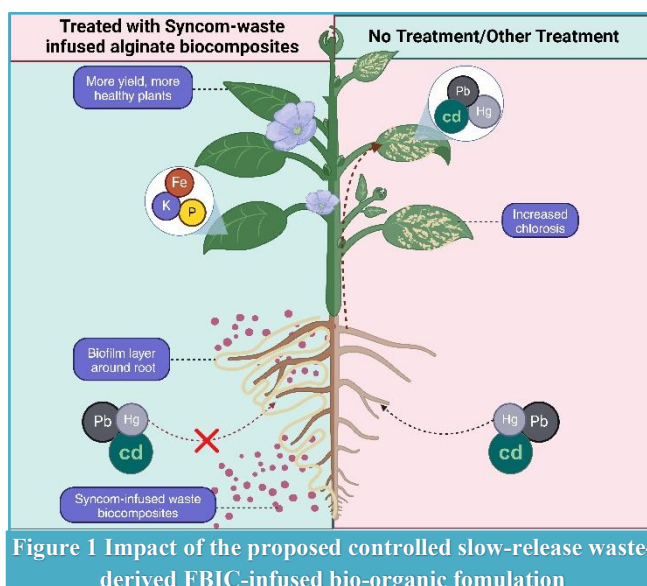


Figure 1 Impact of the proposed controlled slow-release waste-derived FBIC-infused bio-organic formulation

## 3 Reasons for Attempting the Research

Conventional fertilizers and microbial inoculants often fail under field conditions due to limited functional complexity and ecological resilience. FBICs enable synergistic combinations of bacterial and fungal functions, ensuring improved nutrient mobilization, metal detoxification, and soil health enhancement. The project also addresses the underutilization of nutrient-rich waste materials, limited by poor bioavailability and heavy metal contamination risks.

## 4 Substantial Results Expected

The research is expected to deliver stable, biodegradable, controlled-release fertilizers that improve phosphorus use efficiency, reduce heavy metal accumulation, and enhance plant stress resilience. The project will provide novel solutions for waste biorefining, biological soil remediation, and sustainable agriculture, contributing to the EU Green Deal ("From Farm to Fork").

**Keywords:** Synthetic microbial consortia (SynCom), Biocomposite fertilizers, Alginate-based materials, Microbial inoculants, Slow-release fertilizers