Title: *Microbial Valorization of Industrial Waste for the Production of Value-Added Metabolites*

Abstract:

Industrial waste, particularly from tanneries and agro-industries, poses serious environmental challenges due to its high organic and chemical load. Transforming such waste into valuable biochemicals through microbial processes offers a sustainable and eco-friendly alternative to conventional waste disposal. This research proposes to develop an optimized microbial bioprocess for converting organic-rich industrial wastes into **volatile fatty acids (VFAs)** and other **bioactive metabolites**, which can serve as precursors for bioplastics, bioenergy, and other industrial applications.

Background and Rationale:

Tannery and agro-industrial wastes are rich in proteins, lipids, and carbohydrates — potential substrates for microbial fermentation. Conventional anaerobic digestion leads primarily to methane production, but by **arresting methanogenesis**, the pathway can be redirected toward VFA accumulation. These VFAs can act as intermediates for the synthesis of **polyhydroxyalkanoates (PHAs)** and other valuable compounds. The study aligns with the principles of the **circular bioeconomy**, addressing both environmental pollution and resource recovery.

Objectives:

1. To isolate and characterize efficient microbial strains capable of converting industrial waste into VFAs.

2. To optimize process parameters for maximum metabolite yield using controlled anaerobic conditions.

3. To analyze and quantify metabolites using FTIR, HPLC, and GC-MS.

4. To evaluate the potential conversion of VFAs into high-value bioproducts such as PHAs.

Methodology:

- **Sample Collection & Pretreatment:** Collection of industrial waste (e.g., tannery or food waste) and removal of inhibitory compounds.

- **Microbial Cultivation:** Use of mixed and pure cultures under arrested anaerobic conditions to favor acidogenesis.

- **Optimization:** Experimental design using parameters such as pH, temperature, inoculum type, and retention time.

- **Analytical Studies:** Monitoring metabolic changes via FTIR, SEM, and quantification using HPLC and GC-MS.

- **Data Analysis:** Kinetic modeling to understand substrate-to-metabolite conversion efficiency.

Expected Outcomes:

The study is expected to develop an efficient microbial system for transforming industrial waste into VFAs and other metabolites, contributing to sustainable waste management and green biochemical production. The outcomes could support industrial-scale biorefinery applications and reduce the environmental burden of waste disposal.