**Valorization of Dairy Byproducts into Polyhydroxyalkanoates (PHA) Bioplastics via Halophilic Fermentation**

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***Keywords*:** Whey Permeate, Circular Economy, Biopolymer Characterization, Sustainable Materials

***Abstract*:**

Cheese production generates large volumes of whey permeate, a lactose-rich byproduct that is often underutilized and represents both an environmental burden and a lost economic opportunity. While polyhydroxyalkanoates (PHAs) are promising biodegradable alternatives to petroleum-based plastics, their production cost remains heavily dependent on carbon feedstock price. Prior work demonstrated PHA production from delactosed permeate; however, systematic optimization and material characterization using whey permeate remained limited. In this study, whey permeate was converted into PHA using the halophilic archaeon Haloferax mediterranei under controlled batch fermentation conditions (Figure 1). The effects of sugar loading, nitrogen source, and aeration rate on cell growth and PHA accumulation were systematically evaluated. Following fermentation, biomass was harvested, and PHA was extracted and purified to over 90% purity. The purified PHA was characterized using compositional, structural, and thermal analyses. This work establishes a technically robust pathway for transforming lactose-rich dairy byproducts into high-purity biodegradable bioplastics. By converting a low-value waste stream into functional polymer materials, the study advances circular bioeconomy strategies and supports the development of climate-smart, value-added biomanufacturing within the dairy industry.

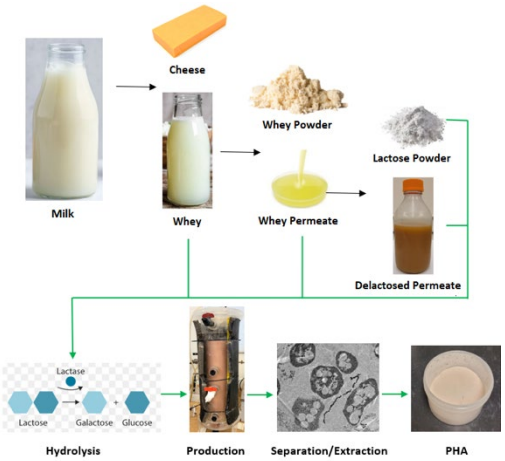


Figure 1. Bioconversion of whey permeate to polyhydroxyalkanoate (PHA).

***Funding Acknowledgements**: This work was supported by California Dairy Research Foundation.*

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