INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Conversion of Methane into Polyhydroxybutyrate using *Methylosinus trichosporium* NCIMB 11131: Applications in Food Packaging, Bone Tissue Engineering, and Electronics

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SHORT ABSTRACT

The Industrial Revolution led to significant increases in atmospheric greenhouse gases, with methane, the second most harmful, rising from 700 ppb to 1922 ppb by 2022. Methane has a 25-fold greater infrared absorption potential than CO2, contributing significantly to global warming. At current emission rates, the planet is on track for a 2°C temperature rise by 2036, highlighting the urgency for innovative solutions. Simultaneously, plastic pollution has emerged as a critical issue, with over 450 million tons produced annually, of which only a small fraction is recycled. As both methane emissions and plastic waste continue to rise, sustainable alternatives are required. This study addresses these challenges by utilizing *Methylosinus trichosporium* NCIMB 11131, a Type-II methanotrophs, to convert methane into polyhydroxybutyrate (PHB), an eco-friendly, biodegradable bioplastic. PHB production is induced under nitrogen-starved conditions, using methane as a carbon source. This dual-purpose approach mitigates methane emissions while producing a sustainable alternative to traditional plastics. Optimal conditions yielded PHB content of 57.3% (w/w), with a production rate of 1.11 $g.L^{-1}.d^{-1}$ in a 5-L bioreactor, demonstrating scalability. Further process optimization included maximizing methane mass transfer using sparger and silicone oil vectors in airlift reactor. Applications of PHB were explored in three sectors: food packaging, bone tissue engineering, and electronics. PHB films exhibited excellent mechanical properties, degradability, and moisture resistance, making them suitable for sustainable packaging. In bone tissue engineering, a composite of PHB and hydroxyapatite derived from waste eggshells demonstrated biocompatibility and osteo-conductivity, promoting cell attachment and proliferation. In electronics, PHB films served as insulating covers for batteries, displaying significant electrical insulation and heat resistance. This research highlights the potential of *M. trichosporium* NCIMB 11131 for PHB production using methane as a carbon source, with diverse industrial applications. The study advances sustainable bioplastic production, contributing to both greenhouse gas reduction and a circular economy.