PHA – Polyhydroxyalkanoate

The conventional plastic materials used in the packaging are very inexpensive, lightweight, durable, strong, corrosion-resistant, thermal and electrically insulated. These are the properties of the synthetic plastic that make them suitable material for the packaging. This ubiquitous plastics accumulated in the natural environment and in form of landfills and crate lots of problem for marine as well as terrestrial life. Fragments of plastic contaminating compost prepared from municipal solid waste and of plastics mix with streams, rivers and ultimately the sea with rain water and flood events, deteriorate the natural habitats poorly. Many groups are currently focusing on biodegradable polymers as an alternative to conventional plastic to solve this problem. Polyhydroxyalkanoate is one of the alternative for these non-biodegradable synthetic plastic. The biologically synthesized polymers are quite expensive in comparison of synthetic polymer hence the selection of carbon source for PHA production is big challenge to control the cost of production. Utilization of agricultural and municipal waste for the production of PHA significantly reduce the cost of production.

PHA is naturally synthesized biodegradable polymer produced by the micro-organism intracellularly. PHA served as a carbon and energy reserved material for micro-organism to survive in stress condition. Molecule of a PHA contains the 600 to 35,000 monomer units of (R)-Hydroxy fatty acids. Monomer unit of a hydroxy group usually contains a saturated R group but unsaturated alkyl group, branched alkyl group and substituted alkyl group also present less commonly. PHA is water insoluble, UV-resistant, non-toxic, biocompatible, biodegradable and thermoplastic polymer. Molecular weight of PHA can be determined using the GPC and it is span over a wide range from 50 kDa to 10,000 kDa. The Thermal properties of PHA can be determined using the Differential Scanning Calorimetry (DSC) and Differential Thermal Analysis (DTA). T_g, T_m, and T_d of PHA usually found within the range of −52 to 4 °C, non-observable to 177 °C, and 227 to 256 °C, respectively. Crystallinity of this thermoplastic polymer determined using x-ray diffraction and found non-crystalline to highly crystalline in nature over the range from 0 – 70% crystallinity. PHA polymers show a wide elongation at break values of between 2% and 1000%. These value determine that PHA can be found in form of a hard rigid material or a soft elastomeric material.

PHA can be classified into three types depending on the side chain of the PHA monomer and number of carbon present in the monomer unit. Short-Chain Length PHA (SCL-PHA contain 3 to 5 carbon), Medium-Chain Length PHA (MCL-PHA contain 6 to 14 carbon) and Long-Chain Length PHA (LCL-PHA contains more than 15 carbons). SCL-PHA poly-R-hydroxybutyrate (PHB) have been restricted for industrial applications due to its low thermal stability and excessive brittleness upon storage. MCL-PHAs have greater thermal, and mechanical properties similar to other synthetic polymer like low density polyethylene (LDPE), polypropylene (PP), and polyethylene (PE), depends on the composition of SCL and MCL monomer unit. The bacterial species such as *Aeromonas caviae*, *Rhodococcus ruber*, *Nocardia corallina*, *Bacillus megaterium* and some species of *Pseudomonas*, *viz*. *P. fluorescens*, *P*. sp. are able to produce the

SCL-MCL PHA. Literature reported that *P. aeruginosa* Microbial Type Culture Collection (MTCC) 7925 is able to accumulate a novel SCL-LCL-PHA.