Chapter 1
Introduction

Abstract Polyhydroxyalkanoate (PHA) is a plastic-like material synthesized by many bacteria. PHA serves as an energy and carbon storage compound for the bacteria. PHA can be extracted and purified from the bacterial cells and the resulting product resembles some commodity plastics such as polypropylene. Because PHA is a microbial product, there are natural enzymes that can degrade and decompose PHA. Therefore, PHA is an attractive material that can be developed as a bio-based and biodegradable plastic. In addition, PHA is also known to be biocompatible and can be used in medical devices and also as bioresorbable tissue engineering scaffolds. In this chapter, a brief introduction about PHA and the fermentation feedstock for its production are given.

Keywords Bio-based • Biodegradable • Microorganism • Palm oil • PHA Plastics • Polyhydroxyalkanoate • Polymer

Petroleum-derived plastics have contributed significantly to our modern lifestyle due to their favorable stability, durability, and suitable mechanical and thermal properties. Plastic materials have now become an integral part of our daily life. In fact, it is almost impossible to lead a normal life without plastics. From the clothes that we wear to the cars that we drive there are numerous components that are made of plastics. The food that we eat comes in plastic packages or containers. We pay for the food and almost everything else using plastic credit cards. When we fall sick and visit the doctor, we are prescribed medicines that come in plastic bottles or plastic zip lock bags. Many medical devices are made of plastics. Almost all electronic devices contain plastic components. Our children play with plastic toys and spend the first few years of their life with plastic diapers. We might also need similar diapers during the last few years of our life. Our dependence on plastics shows that plastics are preferred because of their safety, versatility, durability, and affordability. However, synthetic plastics are difficult to be disposed due to the lack of natural enzymes and biological processes that can efficiently degrade synthetic plastics. Incineration of plastics releases hazardous gases into the environment. Harmful chemical such as hydrogen cyanide can be formed from acrylonitrile-based plastics during the combustion of these plastics (Johnstone 1990;

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Atlas 1993). On the other hand, recycling might be a better alternative but it is a labor-intensive process. Categorization of a wide variety of plastics is a time-consuming process. This process becomes worse with the presence of additives such as pigment, coating, and fillers (Fletcher 1993).

The ever-growing need to curb plastic waste management problem has resulted in the search for an alternative to petroleum-based synthetic plastics. In addition, the fact that petroleum is a non-renewable resource, which would be depleted sooner or later, has also motivated the search for bio-based plastics from renewable resources. Bio-based plastics that are also biodegradable may offer a solution to the plastic waste management problem. Therefore, biodegradable polymers are investigated to replace common plastics (Song et al. 1999). Biodegradable plastics can be classified into three categories which are; chemically synthesized polymer, starch-based biodegradable plastics, and polyhydroxyalkanoates (PHAs) (Khanna and Srivastava 2005a). PHA is a microbial storage polyester, synthesized naturally by many types of bacteria. PHA is being considered as a potential renewable alternative to some petrochemical plastics. This is because the properties of PHA resemble the properties of some commercially available plastics (Sudesh et al. 2000). In addition, PHA is completely biodegradable in nature. The bio-based and biodegradable nature of PHA would have the long-term benefits of reducing plastic waste accumulation, global warming, pollution, and dependence on fossil fuels. The availability of cheap and renewable carbon feedstock, preferably bio-based, for efficient conversion into PHA would make the PHA products' prices competitive with their petroleum counterparts. For this purpose, plant oils have been investigated and were found to be very attractive carbon sources for large-scale PHA production. Plant oils yield higher PHA content in comparison with other tested substrates such as sugars, because of their complex mixture of triglycerides (Akiyama et al. 2003). Among the various plant oils, palm oil is the world's most efficiently produced oil. Malaysia and Indonesia are both major producers and exporters of palm oil in the world. The versatility of palm oil suggests its usage as edible oils as well as for the production of oleochemicals. The palm oil industry generates large quantities of by-products composed of triglycerides and fatty acids which are suitable for microbial utilization. As is the case for almost all new technological innovations, there are pros and cons in using plant oils for the commercial production of PHA. Numerous concerns have been raised about the merits of diverting food grade oil for PHA production at the expense of food supply on a global scale. In addition, an increase in the demand for plant oils may result in further expansion of oil palm plantations into forests and subsequently threatening wild life habitats and destroying precious biodiversities. This book reviews the use of palm oil and its by-products as renewable feedstock and to provide a future outlook on the sustainability of palm oil for PHA production. The production of PHA from other plant oils is also described. Finally, discussions on the production and characteristics of the various types of PHA produced from palm oil products and some new applications of the resulting polymers are also included in this book.

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