CHAPTER I

INTRODUCTION

Plastics have become an integral part of every day life, and have been used or multitude of purposes. They are ordinarily light weight, durable, and easy to formulate. The ever-growing production and use of plastic have led to an increase in the amount of plastic waste. Unlike natural polymers, most synthetic macromolecules can not be assimilated by microorganisms. They are designed and manufactured to resist environmental degradation. Since plastics are economical than metal, wood, and glass in terms of manufacturing cost, weight-to-strength ratio and the amount of energy and water required, the use of plastics are likely increase. This makes polymer waste management an urgent problem, needing environmentally compatible and friendly solutions both short and long term, as soon as possible. Total management of polymer wastes requires complementary combinations of incineration, recycling, landfill and biodegradation. However, incineration, recycling and landfill methods have their own limitations. Recycling method is faced with the high cost of gathering and sorting. Otherwise, the products from this method are downgraded. In other case such as packaging materials and plastic bags, recycling is simply impossible or impractical. Because of the low-weight-to-volume ratio, plastics tend to occupy more space in landfill. For incineration, they require high energy and cost and produce high water and gas pollution.

Since biodegradation is potentially the most environmentally friendly of all these practices, there is increasing activity in the area of biodegradable polymer as packaging materials. The synthesis of biodegradable polymer such as polycaprolactone (PCL), poly(hydroxybutyrate) (PHB), poly(lactic acid) (PLA) and poly (hydroxylvalerate) (PHV) was developed to replace non-biodegradable polymer, especially those used in packaging materials. However, these polymers are more expensive than polyethylene (PE) or polypropylene (PP), which are the most widely used

plastics for packaging application, by four to six times [1]. Hence, they are not widely used. Many studies have been focused on the use of natural biopolymer such as starch, cellulose, lignin, chitin and chitosan, which are fully biodegradable [1]. They are produced from renewable and natural resources.

Starch is a natural biopolymer. It is totally biodegradable in a wide variety of environments. It is abundantly produced by photosynthesis of plants and therefore is renewable and cheap. All these reasons aroused the interesting in the preparation of starch-based plastics. The addition of starch to synthetic plastic has been reported to enhance its biodegradability. When the plastic blend is exposed in a biologically active environment, starch is thought to accelerate the degradation rate by microbial attack on the polysaccharide molecules. In the process, the microbes subsequently invade the plastics by consuming starch and creating pores. The greater surface also increases the accessible to oxygen and moisture. Then, the oxidative degradation of polymer matrix is facilitated.

In Thailand, banana is considered as a native plant, thriving in all parts of the country since Sukhothai period, more than seven centuries age. It is likely the most popular tropical fruit, and there are around 20 varieties of bananas in Thailand [2]. All parts of the plant can be used. The giant leaves of naturally growing banana trees are used in Thai food preparation and decoration. The fruit is highly versatile in terms of how to eat. It is rich in starch content (14-23% on fresh weight basis or 62% on a dry weight basis) [3,4]. However, banana is easy to ripe. It begins the ripening process as soon as it is harvested. So, starch extracted from banana is another choice to use as a filler in synthetic polymer.

Besides the production and use of biodegradable polymer, another possible way of increasing sensibility to environmental degradation of synthetic polymer is the production of photodegradable polymer. Since Thailand is a tropical country, there are sunshine all year long. Therefore, sunlight is another significant source of degradative energy. The photodegradation of plastics can be enhanced by two basic routes. First,

the introduction of chromophoric groups in the backbone of the polymeric chain, and secondly, the addition of low-molecular-weight chemicals or photosensitizer in polymer [5].

A photosensitizer usually has a high absorption coefficient for light. In photosensitization, it absorbs the light energy and then changes the state into the excited photosensitizer. This excited photosensitizer decomposes into free radicals through intermolecular H-abstraction process or intramolecular photoclevage process. These free radicals initiate oxidation or degradation of polymer. Apart of that, the excited photosensitizer can transfer the excitation energy to polymer molecule and turn itself into free radicals which can initiate degradation of polymer like the first case.

A good sensitizer should be easily admixed with the polymer and must not decompose thermally or in the dark [6]. The examples of a photosensitizer are aromatic carbonyl compound such as benzophenone and 10-thioxanthone, or organosulfur compound such as benzyl disulfide and phenyl disulfide [7]. Both organic and inorganic metal oxide and salts can sensitize photodegradation as well [6].

This study focuses on the capability of developing photo-biodegradable polymer film by incorporating banana starch and photosensitizer into low-density polyethylene (LDPE). Two types of photosensitiser, benzophenone and zinc oxide, were studied. In addition, polyethylene/maleic anhydried graft copolymer (PE-g-MA) was used as a compatibilizer. The amount of banana starch and photosensitizer were varied from 0-20% and 0-1%, respectively. The biodegradation of LDPE blend films was assessed by soil burial test and microbial degradation method, while the photodegradation was estimated by outdoor exposure test and accelerated weathering test. The effects of banana starch content, type and amount of photosensitizers on the degradation behavior were followed by observing the changes in weight loss, tensile properties, and carbonyl index of the films. Furthermore, the thermal properties of the film were investigated by the differential scanning calorimeter (DSC) and thermalgravimetric analyzer (TGA).