CHAPTER 1: INTRODUCTION

1.1 Overview

Advanced technology in the field of petrochemical based polymers has brought many benefits to humankind. However, it is evident that the ecosystem is considerably disturbed and damaged resulting from environmental problems associated with their disposal. The tremendous production and use of synthetic plastics in every segment of our lives has increased the plastic waste in huge scales. This poses a serious challenge to waste management because these synthetic polymers are non-biodegradable and plastic waste management such as land filling, recycling, incineration have proved inadequate. In order to reduce the environmental load generated from the disposal of used plastic products, efforts have been made to develop environmentally compatible plastic products as an alternative to petroleum derived polymers. Replacement of these synthetic polymers with materials from annually renewable agro resources such as cellulose and starch, has received much attention from the standpoint of providing biodegradation properties to the end product. The renewable polymers are relatively inexpensive, environmentally friendly, and also naturally biodegradable. Biodegradable polymers are a new family of polymers designed to be degraded by the action of naturally occurring microorganisms such as bacteria, fungi and algae and will decompose in natural aerobic (composting) and anaerobic (landfill) environments producing inert humus like material that is less harmful to the environment.

Biodegradable polymer can be classified into three broad categories: (Briassoulis, 2004)

1. Natural polymers or biopolymers: polysaccharides such as starch, cellulose, chitin, and chitosan, polypeptides of natural origin and bacterial polyesters.
2. Polymers with hydrolyzable backbones: polyesters, polycaprolactone, polyamides, polyurethanes, polyanhydrides and etc.
3. Polymers with carbon backbones: polyvinyl acetate, polyvinyl alcohol and polyacrylates.

The production of 100% natural biodegradable polymers such as polyvinyl alcohol and polyacrylates as substitute for petroleum based products is not an economical solution. This is because natural biodegradable polymers are still much more expensive than standard synthetic polymers, and so a more viable solution would be to combine petroleum and biobased resources to develop a cost effective product having immense applications.

Among all biodegradable polymeric materials that are nowadays commercially available, biocomposites with starch and natural fibers (cellulose) has received considerable attention and offered an interesting alternative for synthetic polymers where long term durability is not needed and rapid degradation is an advantage. These natural biopolymers that are incorporated into polymer matrices can be completely converted into water and carbon dioxide by the action of microorganisms, when disposed off in the soil. Biodegradable polymers incorporated with natural materials, sequester CO_2 during the phase when they're growing, only to release CO_2 when they're decomposing, so there is no net gain in carbon dioxide emissions. The advantages of using natural renewable resources in biodegradable polymers are mainly because they are degradable, low cost, possess high electrical resistance and the production of these polymers are non-abrasive to mixing and moulding equipment, which can contribute to significant cost reductions and the processing atmosphere is friendly with better working conditions and therefore there will be reduced dermal and respiratory irritation. The concept of biodegradability enjoys both user friendly and eco friendly attributes, and the raw materials are essentially derived from replenishable agro resources, and therefore it capitalizes on natural resource conservation with an underpinning on environmentally friendly and safe atmosphere. An additional advantage of biodegradable packaging materials is that disintegration or composting of these materials may act as fertilizer or soil conditioner, facilitating better yield of crops (Tharanathan, 2003).

Blending degradable synthetic polymers such as polyvinyl alcohol with agricultural products such as cellulose and starch will combine advantages from the three elements i.e. degradable synthetic polymers and natural fibers have high strength and high water resistance and starch is low cost and possesses high rate of biodegradability. The results analyzed from this study can be a platform to improve the characteristics of a biocomposite. The market potential of these biocomposites could be huge in the near future leading to a major new use of agricultural products, saves petroleum energy and adds greater value to agricultural commodities.

1.2 Research Objectives

From the review given on biodegradable polymers, it can be noted that characterizing the physical, morphological, thermal, mechanical and biodegradability of a biocomposite is very important in determining that these properties comply to the characteristics of the synthetic polymers that the biocomposite is going to replace. The novelty of this research work involves the fabrication of a fully biodegradable biocomposite by using natural fillers that can be obtained locally such as native tropical starches (rice, tapioca and sago) and native tropical fibers (bamboo, kenaf, roselle and Napier grass). This research work also aims to develop a biocomposite that possess adequate thermal, mechanical and biodegradable properties that comply with the standard values set for commercial biodegradable products such as agricultural mulch film, packaging and others.

The objectives of the present study are:

- To synthesize and prepare two sets of biocomposites: PVA/different starches and PVA/different starches/different fibers composites and to investigate the compatibility of the different starches and different fibers with PVA and to compare the effects produced by the incorporation of the different concentrations of starches and fibers in PVA.
- To alter or modify the surface of the natural fibers (bamboo, kenaf, roselle, and Napier grass) used so that the fibers produces a better interfacial adhesion with the polymer matrix.

- To characterize the morphological, thermal, and mechanical properties of the two sets of biocomposites, PVA/starches and PVA/starches/fibers blends by using different experimental techniques such as X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Differential Scanning Calorimetry (DSC), Dynamic Mechanical Thermal Analysis (DMTA), and Mechanical Testing and to determine the biodegradability of the PVA/starches and PVA/starches/fibers blends using the soil burial test method.

1.3 Thesis Layout

This thesis is written as a compilation of five chapters. The first chapter on introduction includes a brief review describing the properties of biodegradable polymers and the scope and objectives of this research. Literature review of the research is discussed in chapter two. The chapter describes a detailed general description of the materials used in the research and the chemical treatment done to modify the surface of the natural fibers. The third chapter focuses on the properties of starches (rice, tapioca and sago), natural fibers (bamboo, kenaf, roselle, and napier grass), and general information on the different experimental techniques used on the biocomposites. The fourth chapter presents the experimental procedure done for the samples preparation and also gives an in-depth analysis on the results of different experimental techniques done on the biocomposites. Finally, chapter five concludes the research findings and highlights on the problems and limitations of the biocomposites as well as recommendations for future work.