(141)

Preparation of biodegradable polymer materials using agricultural waste

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Abstract

Polymer materials such as plastics, synthetic fibers and rubbers play an increasingly important role in our everyday lives. Most widely used polymeric materials developed in the past 50-60 years are durable and inert in the presence of microbes thus leading to a long term performance. However, in view of the current emphasis on environmental pollution problems and in conjunction with the land shortage problems for solid waste management and pending legislation, the need for biodegradable and 'environmentally friendly' polymers came up. There are a number of applications (packaging, agriculture, household use, and more) where biodegradable polymers and composites are particularly suitable as sustainable alternatives. The aim of this study was to prepare a biodegradable polymer material using agricultural waste. Rice straw is one of the main cereal straws and is produced in large quantities in Sri Lanka. Rice straw was used as a main ingredient in this research to prepare the biodegradable polymer material. At present, these waste streams are not economically re-used and will create even larger problems for air and surface water pollution and having therefore a negative effect on people and planet.

Rice straw which was an abundant biomass also consists of cellulose, hemicelluloses, lignin and others such as ash extractives and wax. Approximately 80% of yield of cellulose - hemicelluloses mixtures were extracted from rice straw using alkali extraction methods. Extracted products were identified and characterized by using Fourier Transform Infrared Spectroscopy (FTIR). Biodegradable polymer material was prepared by using Low Density Polyethylene (LDPE) and cellulose – hemicelluloses mixtures. Products were prepared by varying cellulose – hemicelluloses concentration. Biodegradable polymer mixtures were prepared by using laboratory scale internal mixture. Hydraulic press was used to prepare the LDPE - cellulose – hemicelluloses polymer products.

Degree of biodegradability of the developed LDPE - cellulose – hemicelluloses product was measured by using soil burial test. Time dependent stress and strain properties were evaluated by tensile test. Water absorption test was also performed to evaluate the degradability. Weight loss gradually increased in all cellulose – hemicelluloses containing samples with increase of time in soil burial test. Water absorption test results also showed similar pattern. Tensile strength and percentage elongation of LDPE – cellulose – hemicelluloses product gradually reduced with the time in the soil burial test. This study suggests that rice straw has a good potential in obtaining cellulose and hemicelluloses to prepare biodegradable polymer materials for different applications.

Key words: LDPE, biodegradable, cellulose, hemicelluloses