Development of Environmentally Degradable Polymeric Material (Plastics) from Sago Starch for Agricultural and Medical Industries*

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Key words: degradable polymer, sago starch, agriculture, hydrogel, medical.

Introduction

Majority of synthetic polymers prepared from petrochemical-based monomers are usually tough and not easily degradable, which give rise to environmental problems. Sago starch is one bio-based material suitable for the production of environmentally degradable polymers (plastics). In order to increase the desirable qualities of the form polymers, starch can be modified lightly by cross-linking and grafting with other monomers. These types of biodegradable polymers could be used as polymeric hydrogels for possible application as matrices in the controlled release of agrochemicals and drugs, and as supersorbents in healthcare industry.

Materials and Methods

Materials: Sago starch was purchased from a Malaysian Company. Methyl acrylate (Fluka) was stored at –10 °C after being freed from its stabilizer by passing through a proper column of activated alumina. Ceric ammonium nitrate (CAN) was obtained from BDH (England). All solvents used were of analytical grade and obtained from Hamburg Chemicals. The commercial alpha-amylase enzyme produced from malt (type V-A, 2.7 units / mg solid at pH 6.9 at 20 °C) was obtained from Sigma USA. Preparation of Graft Copolymerization of Vinyl Monomers onto Sago Starch is given elsewhere [1]. Degradation Study of Sago Starch Grafted polymers as follows: The enzyme stock solution was prepared by dissolving 0.1 g of α-amylase in 1 L of 8.3 mM phosphate buffer at pH 7.2. Exactly, 0.50 g sago starch grafted polymer samples were immersed in 45 ml of different concentrations (10-50 ppm) of enzyme solution. Samples were incubated at 30 °C and shaken at speed of 150 rpm. One ml portion solution was pipetted every 24 hrs for the glucose content analysis by phenol sulphuric acid method.

Results and Discussion

Grafting of MA onto Sago Starch: The graft copolymerisation of methyl acrylate and acrylonitrile onto sago starch was carried out by free radical initiating process. The optimum yield of grafting was obtained when the concentrations of CAN, MA, AGU and H_2SO_4 were 8.77 x 10^{-3}, 0.803, 0.135, and 0.175 mol L^{-1}, respectively. The optimum temperature and period were 50 C and 60 min, respectively. Grafting of AN onto Sago Starch: The optimum yield of grafting was obtained when the concentrations of CAN, AN, AGU and H_2SO_4 were 9.52 x 10^{-3}, 0.506, 0.146, and 0.190 mol L^{-1}, respectively. The optimum temperature and period were 50 C and 90 min, respectively. Biodegradation study on the glucose production showed the rate of degradation for sago starch was higher than the grafted methyl acrylate onto sago starch.

Conclusions

The graft copolymerisation of methyl acrylate and acrylonitrile onto sago starch was performed. The study revealed that percentage of grafting and grafting efficiency were dependent upon the concentration of ceric ammonium nitrate, sago starch, methyl acrylate, acrylonitrile, mineral acid and as well as reaction temperature and period. Biodegradation study by using α-amylase showed that the rate of degradation of gelatinised sago starch was higher than that of sago starch graft copolymers and the highest rate of degradation was obtained by using 50-ppm concentration of α-amylase.

Benefits from the study

The graft copolymer of acrylic monomers onto starch may be used as biodegradable mulch in agriculture, medicine, and food packages.

Literature cited in the text

None.

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* *An update of the abstract published in UPM Research Report 1996.*

IRPA INTENSIFICATION OF RESEARCH IN PRIORITY AREAS

Research funded by the Intensification of Research in Priority areas (IRPA) - Supported by IRPA RM-7 (1996-2000), Cycle 1996, Grant 01-02-04-0069.