462b Enzymatic Polymerization and Curing of Natural Phenolic Compounds

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Recently enzymatic polymerization has gained considerable importance as a new method of polymer synthesis. New polymeric materials which are difficult to be obtained by conventional methods can be prepared using enzymes in an environmentally benign way. Mild reaction conditions and high yields are other advantages of using enzyme based polymerization. Polymers derived from phenols and phenol derivatives have numerous applications. Enzymatic polymerization of phenols and phenol derivatives has been examined by many researchers recently. For example, phenolic resins, which are widely used in construction materials and surface coatings, can be synthesized without using formaldehyde.

In this study, we have used natural phenolic compounds as a monomer in enzymatic polymerization. Natural phenolic compounds, such as anacardic acid, ginko biloba, and flavonoid, are abundant in plants and fruits, and known to have anti-oxidant, antibiotic activities. Cardanol and anacardic acid, two natural phenolic compounds which have been extracted from biomass wastes are used as model compounds for enzymatic polymerization and for producing surface coating. Anacardic acid has a relatively simple structure compared to other natural phenols, and is reported to have high anti-oxidant, antibiotic activities. Cardanol is a phenol which has a C15 unsaturated alkyl chain with 1-3 double bonds at m-position and anacardic acid is a phenol which has a -COOH group at o-position and a C15 unsaturated alkyl chain with 1-3 double bonds at p-position.

Enzymatic polymerization of cardanol and anacardic acid proceeded in the presence of an organic solvent: buffer system with soybean peroxidase and H2O2 being added as an oxidizing agent. Various oxidoreductases (Laccase, Horseradish peroxidase, polyphenol oxidases) are known to catalyze oxidative polymerization of phenol derivatives, but peroxidases are the most often used catalysts. In this study, peroxidases are used to induce oxidative polymerization of cardanol and anacardic acid. Peroxidase catalyzed only the phonetic moiety in the phenols to produce soluble cross-linkable polyphenolic derivatives. NMR and IR were used to analyze the structure of the polymers.

Curing of the polymer was achieved by adding cobalt napthenate to give a glossy film on a solid surface. The polymers and polymer-coated surface showed anti-microbial activities for both Gram-positive and negative bacteria species. In this study, the starting materials for polymerization were obtained from renewable bio-wastes and the polymers were cured in the absence of organic solvents under open air at mild conditions. Therefore, the resulting polymers and coatings were produced via not only environmentally benign methods of producing polymer coatings, but also enabled precision polymerization with high selectivity and low undesired byproducts.