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Synthesis of molecular imprinting polymers for extraction of gallic acid from urine

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Abstract

The molecularly imprinted polymers for gallic acid were synthesized by precipitation polymerization. During the process of synthesis a non-covalent approach was used for the interaction of template and monomer. In the polymerization process, gallic acid was used as a template, acrylic acid as a functional monomer, ethylene glycol dimethacrylate as a cross-linker and 2,2′-azobisisobutyronitrile as an initiator and acetonitrile as a solvent. The synthesized imprinted and non-imprinted polymer particles were characterized by using Fourier-transform infrared spectroscopy and scanning electron microscopy. The rebinding efficiency of synthesized polymer particles was evaluated by batch binding assay. The highly selective imprinted polymer for gallic acid was MIPI1 with a composition (molar ratio) of 1:4:20, template: monomer: cross-linker, respectively. The MIPI1 showed highest binding efficiency (79.50%) as compared to other imprinted and non-imprinted polymers. The highly selective imprinted polymers have successfully extracted about 80% of gallic acid from spiked urine sample.

Keywords: Gallic acid (GA), Human urine, Molecular imprinting polymers (MIPs), Acrylic acid, Ethylene glycol dimethacrylate

Introduction

Gallic acid (GA) is a polyphenolic naturally occurring compound in fruits such as blueberries, strawberries, apples, and bananas or other variety of plants and herbs such as oak bark, tea leaves and witch hazel. Gallic acid is diversely used in various applications because of various pharmacological properties like antitumor and anti-inflammatory [1]. Gallic acid is main member of the polyphenolic family that provides vital antioxidant properties [2]. The extensive usage of gallic acid made an emphases on the researchers to design and develop new materials and/or approach for monitoring GA from different real samples. Molecular imprinting technology is a promising approach for the monitoring of gallic acid in real samples.

Molecularly imprinted polymers are the cross-linked polymeric materials and are able to resist chemical and physical stresses such as organic solvents, heat, acid, bases and others [3]. The concept of polymer that can selectively recognize desired molecules have captured many attentions from scientific community over recent years. These recognition systems in polymers are analogue of the biological recognition systems in the body such as enzymes, DNA, antibodies and aptamers. The imprinted polymers produced from the polymerization process have cavities that can complement to the shape of the desired molecules. The developments in molecular imprinting polymers as chromatography stationary phases especially in high performance liquid chromatography have been driven by the advantage of physicochemical stability and high selectivity in the polymers [4].

The three binding approaches have been used in the synthesis of MIPs such as, covalent method, non-covalent method and semi-covalent method. The most widely used is the non-covalent approach. In non-covalent imprinting method, templates bond to monomers with a non-covalent intermolecular bonding which can be destroyed and created easily. Weak metal coordination, electrostatic interactions, hydrogen bonds and hydrophobic interactions are included in non-covalent forces used by both molecules of chemically and geometrically

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