

## Research Article

# Synthesis and Characterization of Molecular Imprinting Polymer Microspheres of Piperine: Extraction of Piperine from Spiked Urine

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Molecularly imprinted polymer (MIP) microspheres for Piperine were synthesized by precipitation polymerization with a noncovalent approach. In this research Piperine was used as a template, acrylic acid as a functional monomer, ethylene glycol dimethacrylate as a cross-linker, and 2,2'-azobisisobutyronitrile (AIBN) as an initiator and acetonitrile as a solvent. The imprinted and nonimprinted polymer particles were characterized by using Fourier transform infrared spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM). The synthesized polymer particles were further evaluated for their rebinding efficiency by batch binding assay. The highly selected imprinted polymer for Piperine was MIP 3 with a composition (molar ratio) of 0.5:3:8, template: monomer: cross-linker, respectively. The MIP 3 exhibits highest binding capacity (84.94%) as compared to other imprinted and nonimprinted polymers. The extraction efficiency of highly selected imprinted polymer of Piperine from spiked urine was above 80%.

## 1. Introduction

Piperine, a nitrogenous pungent substance, is an alkaloid found in important and oldest spices, namely, *Piper nigrum* (black peppers) and *Piper longum* (long peppers) [1]. It is also known as 1-piperoylpiperidine with the chemical formula of  $C_{17}H_{19}NO_3$ . Hamrapurkar et al. [2] stated that Piperine is naturally occurring organic compound that belongs to family Piperaceae. The fruits of Piperine possess antidepressant effects, hepatoprotective effects, antioxidant activity, antitumour effects, antibacterial effects, and anticonvulsant effects [2, 3]. Piperine also has the capability of reducing inflammation, relieving pain, improving digestion, and enhancing the bioavailability [4]. Piperine is extensively used in medicinal field for years due to various medicinal properties including painkiller, antioxidant, and bioavailability enhancer.

Molecular Imprinting Technology (MIT) is used to design molecular recognition materials because it is capable of mimicking natural recognition entities like antibodies and

biological receptors [5–14]. The original concept of molecular imprinting is developed by Linus Pauling in 1940s, but Wulff and Sarhan stimulated the interest in imprinting materials [6]. According to Vlatakis et al. [15], in the early 1980s, the molecular imprinting polymers (MIPs) were successfully prepared by using noncovalent MIT.

Molecular imprinting is a universal method to produce polymers with high affinity binding sites for organic, inorganic, biological, and chemical molecules or ions. MIPs allow the functional and crosslinking monomers to copolymerize in the presence of the target compound or known as template [16]. Molecular imprinting polymers [17] can be prepared by various methods such as bulk polymerization [18], electropolymerization [19], suspension polymerization [20], emulsion polymerization, two-step polymerization [21], and precipitation polymerization [22]. Zhou et al. [23] mentioned that the controlled/living radical polymerization (CRP) is used to prepare MIP microspheres as it permits more precise control over the molecular weight, composition, and end