Mutual Citation

Beaded molecule imprinted polymer for stereo isomer separation

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Abstract

Beaded Molecule imprinted polymer (MIP) for cinchonan-9-R-ol (cinchonidine) was prepared by suspension polymerization. Particles with the size of 50-70 μm in diameter were collected and evaluated in HPLC mode to separate stereo isomers. Stereo isomers cinchonine and cinchonidine were successfully discriminated with selectivity factor of 2.89 and resolution factor of 0.76. Stereo selectivity of the MIP was found to come from both the interactions between the analyte and carboxyl group on the MIP and the complementary between the stereo structure of imprinted molecule and the MIP. The thermal analysis results showed that the MIP had high thermal stability with initial thermal decomposition temperature of 320 ˚C. The pore volume of MIP was 0.1849 mL/g, the specific surface area was 126.84 sqm/g and the average pore diameter was 5.8 nanometer. Scanning electron microscropy showed that MIP had perfact spherical morphology.

Key words : molecule imprinting, suspension polymerization, stereo isomer

INTRODUCTION

Molecular imprinting has made great progress in chromatography for highly selective stereo separation and enantiomer separation[1-4]. Traditional MIP was made by bulk polymerization. The polymer should be ground, sieved, and sedimented before packed into the HPLC column. It was a very tedious process and irregular particles lead to bad chromatography performance and low column efficiency. Now we report here the preliminary results of making spherical MIP imprinted with cinchonidine by suspension polymerization directly. The structure and thermal stability for the beaded MIP were also investigated.

EXPERIMENTAL

Material

Isomers (-)-cinchonidine and cinchonan-9[S]-ol ((+)-cinchonine) were purchased from Sigma. Methacrylic acid (MAA), chloroform, Polyvinyl alcohol (PVA, 1788) and azobisnitrile (AIBN) were bought from Beijing Chemical Plant. Ethylene glycol dimethacrylate (EDMA) was got from Anli Chemical Plant (Suzhou, China). All materials were purified before use and the inhibitors in monomer and

crosslinker were removed by active carbon.

Preparation of polymer

Molecule imprinting polymer for cinchonidine was made by suspension polymerization. in 15g chloroform were dissolved 2.5mmol cinchonidine, 10 mmol MAA, 50mmol EDMA and 120mg AIBN. The organic phase was poured into 125ml distilled water in which 0.8g PVA was dissolved. The mixture was stirred at 300 rmp at 60˚C for 24 hr. Particles with diameters between 50~70 μm were slurried into distilled water and packed with methanol at 300 bar into 200×4mm column.

High Performance Liquid Chromatography

High performance liquid chromatographic analyses were performed using LC-890A system from Beijing Xingda Technology Development Company comprising two LP-05 HPLC pumps, a LC-830 UV-VIS detector (Soma Optics LTD, Japan) was used to monitor the elution, the HPLC was controlled by JS-3030 chromatographic working station.

The column was washed on-line with methanol/acetic acid(7/3, v/v) at 1ml/min until a stable baseline was obtained. HPLC analyses were performed using isocratic elution with chloroform/acetic acid (93.25/6.75, v/v) at 1 mL/min and detection wave length at 280 nm. One hundred μg isomers in 20 μL solution was injected with chromatogram shown in Figure 1 . The resolution factor was calculated according to ref.[5]

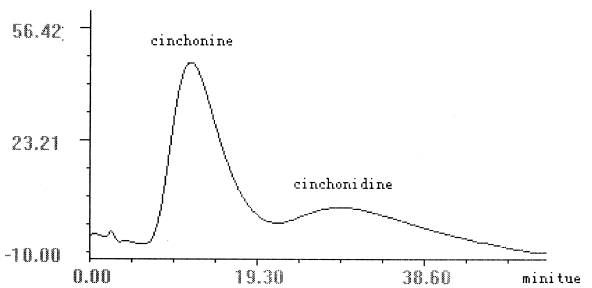

Figure 1. Chromatogram of cinchonine and cinchonidine on beaded MIP.

Results and Discussion

Stereo recognition for cinchonine and cinchonidine

During the preparation process of MIP, stable complexes between print molecules and the complexes were solidified by crosslinker. After the extraction of print molecule, recognition sites with predetermined selectivity to the print molecule were left and the structure information for print molecule was recorded.

Stero isomers (-)-cinchonidine and (+)-cinchonine were separated with an α value (stereo selectivity) of 1.84 and resolution factor of 0.76. Selectivity and resolution would decrease with the increase of AcOOH in the mobile phase for the interaction between AcOOH and MIP. MIP was made by suspension polymerization in water phase. Water molecules would reduce the stability of the complex between the print molecule and monomer, so the stereo selectivity for the beaded MIP was lower than that of MIP made by bulk polymerization [6].

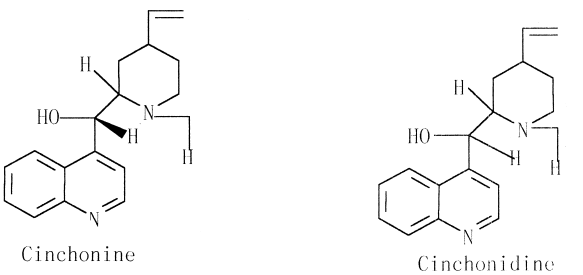

Figure 2. The stereo structure for cinchonine and cinchonidine.

As a print molecule, cinchonidine has a big and rigid molecule structure (Figure 2), so the rigidity and homogeneity for the recognition sites on MIP were quite well. As organic bases, cinchonine and cinchonidine could interact with MAA via ionic strength in polar solvent. So we conclude that the stereo selectivity of MIP might come from the complementary interaction between the structure of cinchonidine and MIP, and that between cinchonine or cinchonidine and carboxylic group on MIP.

The physical properties of MIP

The result of thermal analysis show that beaded MIP has perfect thermal stability, the initial decomposition temperature was 320 ˚C and the finial decomposition temperature was 735 ˚C. The data for pore structure is shown in Table 1. The total pore volume, the specific surface and the average pore radius are 0.1849 mL/g, 126.84 m2/g, and 5.8 nm respectively. The pore structure was similar with that of polymers made by bulk polymerization [7]. Scanning electron

Table 1. The pore structure of P1

Pore radius (nm)	Pore volume (mL/g)	Volume fraction (%)
20~10	0.01541	8.36
10~5	0.02969	16.11
5~4	0.00948	5.14
4~3	0.00887	4.81
3~2	0.09151	49.65
2~1	0.02991	16.23

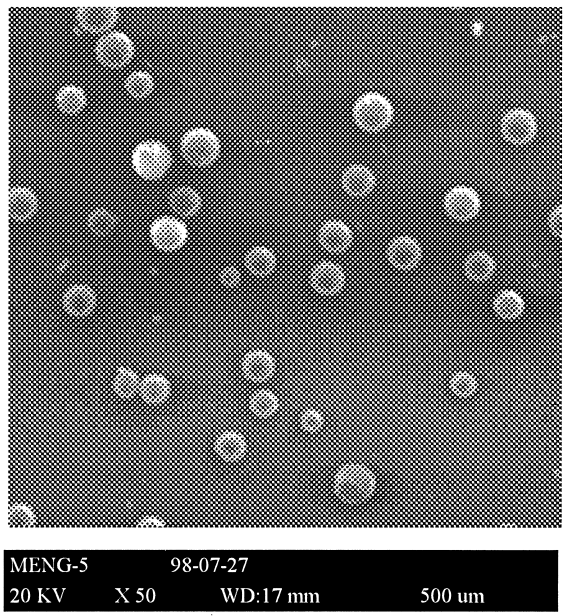

Figure 3. The apparent morphology for the beaded MIP.

microscropy was used to investigate the appearance and structure of MIP. From Figure 3 obtained by SEM, we can see that most of MIP particles obtained by suspension polymerization are spherical and show great uniformity. Particles with radius of 50-70 μm can be collected for HPLC analysis.

Conclusion

Beaded MIP suitable for HPLC package could be obtained by suspension polymerization with high stereo selectivity and thermal stability. Now suspension polymerization for MIP with chiral selectivity are under investigation in our Lab.

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