Glucose Recognition Capabilities of Hydroxyethyl Methacrylate-Based Hydrogels Containing Poly(ethylene glycol) Chains

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ABSTRACT: A configurational biomimetic imprinting technique was used to prepare recognition sites for glucose in copolymers of 2-hydroxyethyl methacrylate (HEMA) and methacrylic acid (MAA) prepared with crosslinking agents containing poly(ethylene glycol) (PEG). We report on the structure, diffusive, and recognition characteristics of these gels, the effect of the type and ratio of crosslinking agent, as well as the template/comonomer ratios on glucose binding ability. The highest equilibrium glucose binding was found as 2.67 mg/g dry polymer when PEG monomethacrylate (PEGMMA) was used in combination with tetra ethylene glycol dimethacrylate (TEGDMA) (50%) as a crosslinking agent. © 2007 Wiley Periodicals, Inc. J Appl Polym Sci 103: 432–441, 2007

Key words: configurational biomimetic imprinting; 2-hydroxyethyl methacrylate (HEMA); methacrylic acid (MAA); poly(ethylene glycol)PEG); glucose

INTRODUCTION

Molecular recognition calls for preferential binding of a chemical entity (biological template) to a receptor with high selectivity over its close structural analogs. Specific recognition of target molecules is a fundamental step in biological systems.

In natural enzymes or antibodies, functional moieties of amino acid residues are precisely placed at the binding sites complementary to the target molecules and bind them strongly through noncovalent interactions.[1] The remarkable examples of molecular recognition in nature have inspired chemists to the design and construction of synthetic receptors that mimic biological systems in terms of their selective interaction with ligands.[2] Molecular imprinting is a powerful way to achieve three-dimensional molecular recognition via template-directed synthesis of polymer matrices.

Molecularly imprinted polymers (MIP) have attracted considerable interest and have been developed for applications in chromatographic adsorbents, membranes, sensors, and as enzyme or receptors mimics. In our laboratory, we have developed configurationally biomimetic imprinted polymers (CBIPs) that have potential in a wide range of biomedical and pharmaceutical applications.

Potential advantages offered by CBIP in molecular recognition include:

1. High affinity and selectivity, which are often similar to those of natural receptors.
2. The ability to produce reversible recognition matrices with robust and stable behavior even at extreme physical/chemical conditions, which is superior to that demonstrated by natural biomolecules.
3. Simplicity of preparation and ease in adaptability to different applications.

In configurationally biomimetic imprinting techniques, one or more functional monomers and a crosslinking agent are copolymerized in the presence of a molecule that acts as a molecular or biological template. Subsequent extractive removal of the template leaves behind binding sites that are complementary to the target analytes in the resultant MIP or CBIP. The stronger the specific interaction between monomers and template, the more stable the resultant complex, and therefore better recognition is obtained.[3]

In general, MIP techniques have been used in imprinting drugs,[4–10] steroids,[11,12] nucleic acids[13] and derivatives, amino acids,[14] or metal ions.[15,16] The major problems involved with MIP and the reason why CBIP was developed have been the heterogeneity of binding

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sites created with noncovalent bonding, the presence of water as a hydrogen-bonding solvent, and polymer morphology limitations to diffusion.[17] We address these questions in this work by choice of the functional monomers and polymerization medium.

In our laboratory, Oral and Peppas[18] used 2-hydroxyethyl methacrylate (HEMA)-based hydrogels as excellent candidates for CBIP. Kugiyama and Takeuchi[19] investigated the effect of HEMA content in a copolymer of HEMA with methacrylic acid (MAA).

In this study our goal was to produce configurationally biomimetic imprinted networks that contain both HEMA and MAA, aiming to create stereospecific 3D cavities for the binding of glucose based on hydrogen bonding between the polymer and the template.[20,21] Since the crosslinking agent plays a key role in establishing the shape and dimensions of the resulting nanovacuoles, three different poly(ethylene glycol) (PEG)-containing crosslinking agents were used; tetra ethylene glycol dimethacrylate (TEGDMA), poly(ethylene glycol)600 dimethacrylate (PEG600DMA), or a mixture of 50% tetraethylene glycol dimethacrylate (TEGDMA) with 50% poly(ethylene glycol) monomethacrylate (PEGMMA). For biomedical applications, the use of PEG moieties provides added biocompatibility, stealth properties with respect to reticuloendothelial recognition, and the ability to protect protein over a long period of time.[22–24] Thus, we developed PEG-containing recognition networks for such applications.

EXPERIMENTAL

Materials

HEMA, PEG600DMA, and PEGMMA were used as comonomers (Polysciences, Warrington, PA). MAA, TEGDMA, and Irgacure 184 (1-hydroxy cyclohexyl phenyl ketone) were purchased from Aldrich (Milwaukee, WI).

Methods

For the preparation of glucose-imprinted HEMA and MAA copolymers, vacuum-distilled HEMA and MAA monomers were polymerized with different types of crosslinking agent (TEGDMA, PEG600DMA, PEGMMA) to give a crosslinking ratio between 33–75% moles of crosslinking agent per total moles of HEMA + MAA and crosslinking agent. D-Glucose was mixed with the monomer and the crosslinking agent at a glucose/comonomer ratio of 0.16, 0.5, 1.0, and 2.0 mol/mol to allow complexation, and the solution was placed in a sonic bath. The mixture was diluted with deionized water so that the final mixture had 50 wt% water. A quantity of 1 wt% initiator, Irgacure 184 (1-hydroxy cyclohexyl phenyl ketone) was added. Table I shows the chemical structures of materials used in this study.

The mixture was further sonicated and transferred to a UV glove box. It was purged with dry nitrogen for 15 min to remove oxygen, which acts as a free radical scavenger in the polymerization reaction. The solution was then pipetted between two glass slides separated by 0.7 mm Teflon spacers and placed under UV light (Acticure, Efos, Mississauga, ON, Model 2000 Flood, Dymax, Tarrington, CT) of 10–16 mW/cm^2 intensity for 15 min. The thin films of polymer gels were taken out of the glass slides and washed for 1 week in deionized water, changing the solution twice daily to remove unreacted monomers. The polymers were then dried under air and under vacuum for 24 h.

In order to determine the amount of solvent taken up by the polymer in the binding studies, dynamic swelling studies were performed. Dry discs were placed in different solutions, ranging in concentration from 0 to 0.005, 0.01, 0.1, 1, and 3 mg/dL of glucose.

In order to determine the amount of glucose taken up by the CBIPs, binding/recognition studies were performed using high-pressure liquid chromatography (HPLC) (Shimadzu, Tokyo, Japan, with a Rezex RPM monosaccharide column, Phenomenex, Torrance, CA). The mobile phase was 100% water at a flow rate of 0.6 mL/min. The operating temperature for this column was 80°C.

Dry discs were placed in different solutions, ranging in concentration from 0 to 0.5, 1.0, 10, 100, and 300 mg/dL of glucose. In dynamic experiments, a 1-mL sample was taken out of the glucose solutions at constant time intervals of 3, 20, 36, 52, and 72 h. In equilibrium experiments, a single 1-mL sample was taken at the end of the experiment.

RESULTS AND DISCUSSION

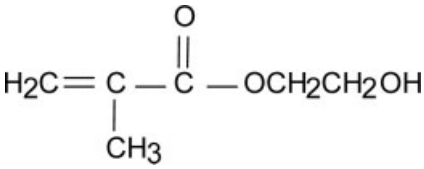
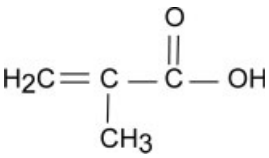
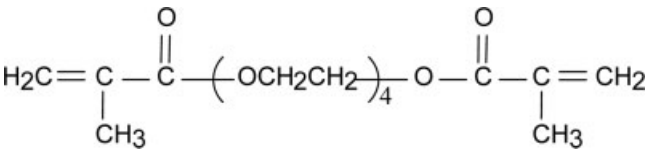
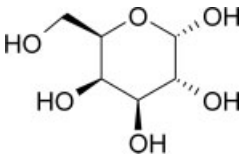
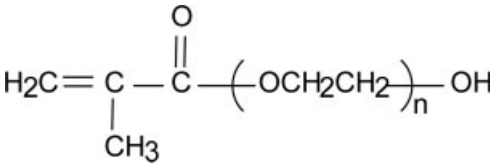
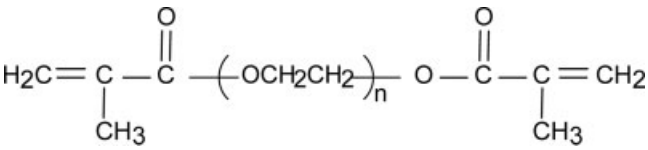
Swelling and diffusion characteristics of CBIPs

The swelling behavior of imprinted gels was investigated as a function of the type and amount of crosslinking agent used as well as the amount of template in the imprinted networks. The diffusional rate constant, k, and the exponent, n, were calculated[24] using an empirical experimental equation and analyzing the first 60% of penetrant diffusion as a function of time:

$$\frac{M_t}{M_\infty} = kt^n \tag{1}$$

Here M_t and M_∞ are the penetrant weights taken up by the polymer sample at time t and infinity; t is time, and k and n are the diffusion constants.[25]

TABLE I
Molecular Weights and Chemical Formulae of the Materials Used

Name	Molecular weight (g/mol)	Chemical formula
Hydroxyethyl methacrylate (HEMA)	130.14	
Methacrylic acid (MAA)	86.09	
Tetra ethylene glycol dimethacrylates (TEGDMA)	330.38	
Glucose	180.25	
Poly(ethylene glycol) (200)monomethacrylate	354	
Poly(ethylene glycol) 600 dimethacrylate	754	

The parameter k indicates the relative rate at which the penetrant is transported into the polymer, while n is indicative of the transport mechanism of the penetrant into the polymer. For film samples, the parameter n is 0.5 for Fickian diffusion, between 0.5 and 1 for non-Fickian diffusion, and $n = 1$ for Case II transport.

When penetrant transport into the polymer is solely driven by a concentration gradient, Fickian diffusion predominates. If the driving force is a combination of concentration difference and polymer relaxation as a result of thermodynamic interaction of the solvent with polymer, non-Fickian diffusion results. In extreme cases, especially when the gels are nonporous, the only mechanism of solvent (penetrant) diffusion is by relaxation of polymer chains, which is termed Case II transport.

The mechanism of penetrant diffusion of imprinted and nonimprinted polymers is important because it defines the network structure created by the imprinting process.

It is expected that in an ideal recognition network: 1) the template should diffuse through easily, and 2) it should contain imprinted sites that do not swell and change configurationally with penetrant diffusion. The rate at which template is bound in the system, i.e., ''the response rate'' of the sensing material, would be dependent on the rate of swelling of the network. The binding or recognition rate is directly related to mass transfer to the recognition sites.

In order to determine the amount of water taken up by the polymer, dynamic swelling studies were performed. The weight swelling ratio, q, was expressed as:

$$q = \frac{W_s}{W_d} \tag{2}$$

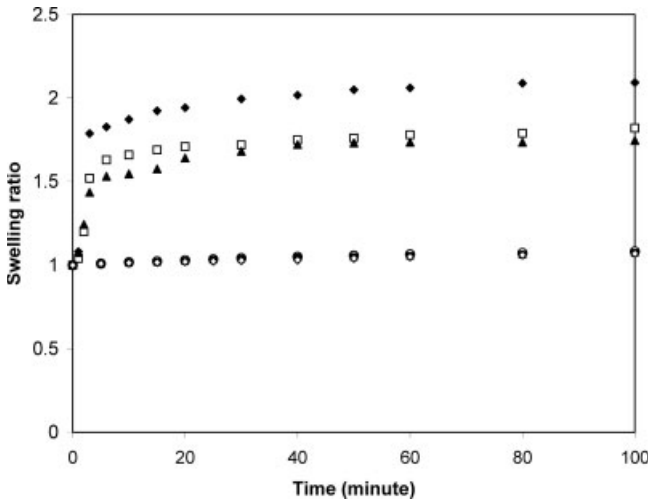


Figure 1 Water swelling of imprinted and nonimprinted polymers crosslinked with various amounts of TEGDMA: (◆) 33% TEGDMA imprinted polymer; (□) 60% TEGDMA imprinted polymer; (▲) 75% TEGDMA imprinted polymer; (○) 33% TEGDMA nonimprinted polymer; (■) 60% TEGDMA nonimprinted polymer; (◇) 75% TEGDMA nonimprinted polymer.

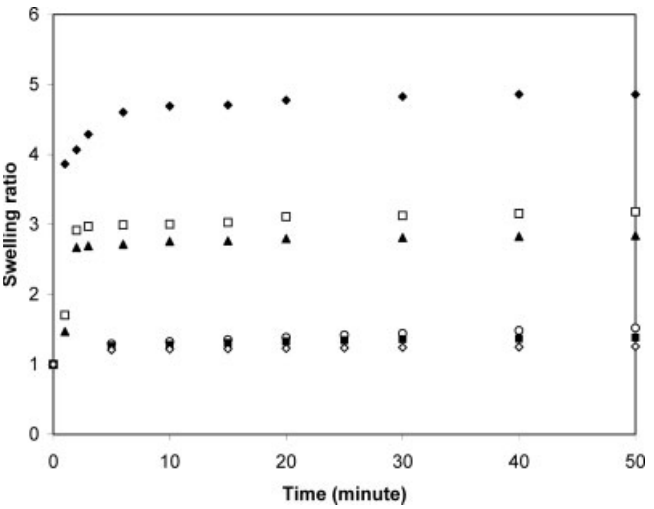


Figure 3 Water swelling of imprinted polymers crosslinked with various percentages of PEG600DMA: (◆) 33% PEG600DMA imprinted polymer; (□) 60% PEG600DMA imprinted polymer; (▲) 75% PEG600DMA imprinted polymer; (○) 33% PEG600DMA nonimprinted polymer; (■) 60% PEG600DMA nonimprinted polymer; (◇) 75% PEG600DMA nonimprinted polymer.

where W_s is the swollen weight of the polymer in grams and W_d is the dry weight.

Figures 1–3 show the swelling ratios, while Tables II–V indicate the k and n values calculated from Equation (1) for imprinted and nonimprinted polymers containing TEGDMA, TEGDMA and PEGMMA, and PEG600DMA. When the swelling behavior of the imprinted gels is compared with that of nonimprinted samples it can be seen that the imprinted gels swelled at faster rates than the nonimprinted ones. In addition, they exhibited a higher degree of equilibrium swelling value. For imprinted samples crosslinked with a crosslinking ratio of 33%, the water transport in the networks was Fickian for all types of crosslinking agent. The networks with the highest crosslinking densities displayed non-Fickian behavior.

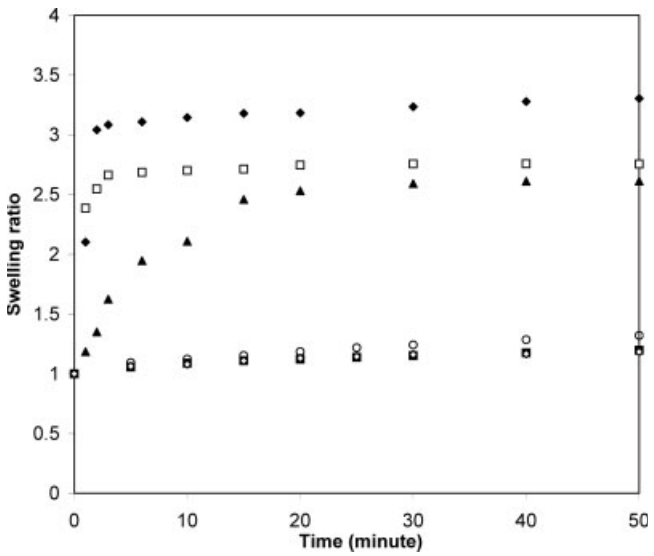


Figure 2 Water swelling of imprinted polymers crosslinked with various percentages of PEGMMA + TEGDMA (50 : 50): (◆) 33% TEGDMA + PEGMMA imprinted polymer; (□) 60% TEGDMA imprinted polymer; (▲) 75% TEGDMA + PEGMMA imprinted polymer; (○) 33% TEGDMA + PEGMMA nonimprinted polymer; (■) 60% TEGDMA + PEGMMA nonimprinted polymer; (◇) 75% TEGDMA + PEGMMA nonimprinted polymer.

Figure 4 shows the difference in swelling behavior of imprinted polymers prepared from three different types of crosslinking agents. It was observed that the equilibrium swelling values were in increasing order of PEG600DMA > TEGDMA and PEGMMA > TEGDM. The value of k decreased with increasing the amount of crosslinking agent. For highly crosslinked polymers, the diffusion of solvent was increasingly governed by relaxation, especially for nonimprinted polymers.

The effect of template concentration on the swelling behavior of a glucose-imprinted network has been investigated previously in our laboratories.[26,27] Here,

TABLE II
Variation of n Values with Respect to Type and Amount of Crosslinking Agents for Glucose-Imprinted Poly(hydroxyethyl methacrylate-*co*-methacrylic acid)

	Crosslinking agent (%)		
Type of crosslinking agent	33%	60%	75%
TEGDMA	0.42	0.63	0.68
TEGDMA + PEGMMA	0.47	0.57	0.62
PEG600DMA	0.48	0.67	0.76

TABLE III
Variation of *k* Values with Respect to Type and Amount of Crosslinking Agents for Glucose-Imprinted Poly(hydroxyethyl methacrylate-*co*-methacrylic acid)

	Crosslinking agent (%)		
Type of crosslinking agent	33%	60%	75%
TEGDMA	0.46	0.43	0.39
TEGDMA + PEGMMA	0.68	0.51	0.44
PEG600DMA	0.69	0.65	0.58

TABLE V
Variation of *k* Values with Respect to Type and Amount of Crosslinking Agents for Glucose Nonimprinted Poly(hydroxyethyl methacrylate-*co*-methacrylic acid)

	Crosslinking agent (%)		
Type of crosslinking agent	33%	60%	75%
TEGDMA	0.09	0.074	0.063
TEGDMA + PEGMMA	0.27	0.17	0.11
PEG600DMA	0.41	0.32	0.21

Figure 5 shows the difference in swelling behavior of imprinted polymers synthesized in the presence of varying amounts of template. TEGDMA was used as a crosslinking agent at a fixed amount of 75 mol%. It was observed that the polymers imprinted with high template concentrations swelled to a larger extent and displayed non-Fickian behavior. Table VI shows the values of n and k for these polymers. Although the increasing amount of glucose causes the n value to increase, leading to relaxation-controlled transport, it also causes the rate of solvent diffusion into imprinted polymers to increase. The mechanism of transport was similar for imprinted and nonimprinted gels.

Glucose recognition ability of CBIP systems

The network structure of CBIPs depends on the monomer chemistry, the interactions between monomers and pendant groups, the solvent, the crosslinking density, and the template/monomer (or comonomer) ratio. The stronger the specific interaction between monomers and template, the more stable the resultant complex and therefore the better the recognition is.[28–32] As an increase in crosslinking monomer content leads to a decrease of the average molecular mass between crosslinks, the macromolecular chains become more rigid. Thus, we expect there should be some optimal conditions with respect to crosslinker ratio for a given crosslinker, assuming all other parameters are held constant.

We addressed these questions by selection of three different crosslinking agents in length for the synthesis of glucose-imprinted HEMA- and MAA-based hydrogels. The effect of the molecular weight of the crosslinking agent on the imprinting properties was investigated. Table VII and Figure 6 show the glucose recognition capacity as a function of the molecular weight of the crosslinking agent. As the molecular weight (or chain length) of the crosslinking agent increased from 330 (TEGDMA) to 754 (PEG600DMA), the glucose binding and recognition capacity of the imprinted polymer decreased for a given amount of crosslinking agent and template/comonomer ratio. This result was contradictory to the expectation that a longer crosslinking agent would create a more open network, and thus would increase the capacity. On the other hand, the highest binding value was observed for the hydrogels that were synthesized by using both PEGMMA and TEGDMA (50%).

Since recognition requires 3D orientation, the crosslinking density plays a key role in designing CBIP by establishing the shape and dimensions of the resulting cavities. If crosslinking is too low it leads to high molecular weight between crosslinks. This in turn is too large for an imprinting process to be successful, as it creates a very large cavity, causing nonspecific binding.

TABLE IV
Variation of *n* Values with Respect to Type and Amount of Crosslinking Agents for Glucose Nonimprinted Poly(hydroxyethyl methacrylate-*co*-methacrylic acid)

	Crosslinking agent (%)		
Type of crosslinking agent	33%	60%	75%
TEGDMA	0.48	0.74	0.85
TEGDMA + PEGMMA	0.54	0.73	0.87
PEG600DMA	0.66	0.81	0.91

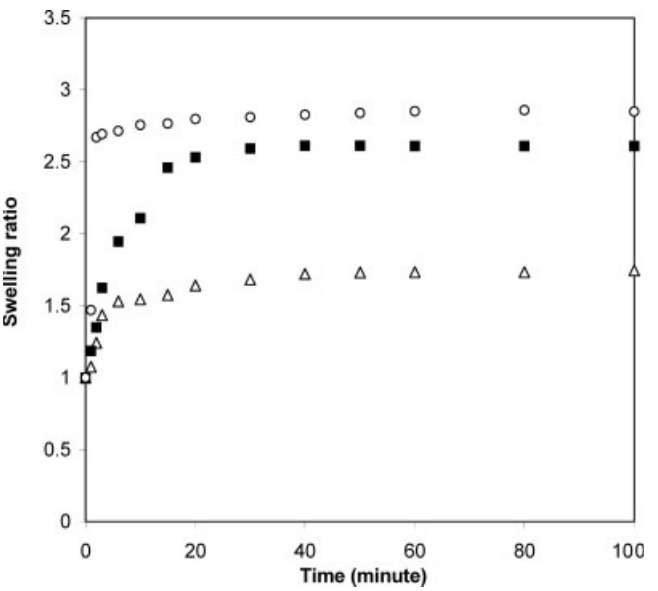


Figure 4 Water swelling of imprinted polymers with different type of crosslinking agents at 75% crosslinking: (△) TEGDMA; (■) PEGMMA + TEGDMA; (○) PEG600DMA.

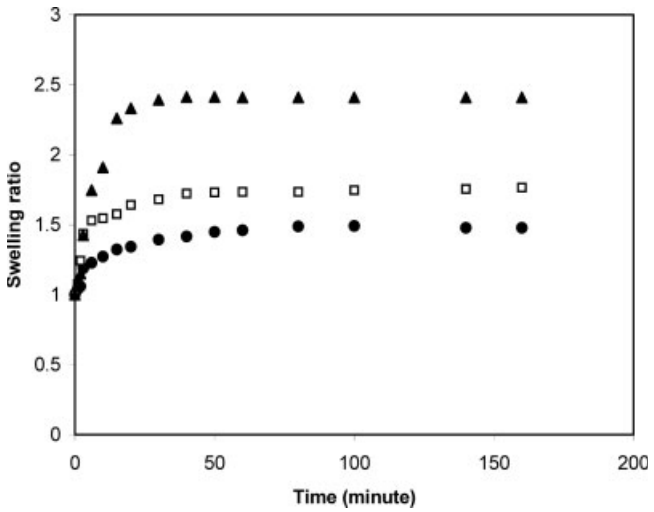


Figure 5 Water swelling of imprinted polymers in water as a function of the molar ratio of template to monomer in the feed (glucose/HEMA + MAA, crosslinked with 75% TEGDMA): (●) 0.5; (□) 1.0; (▲) 2.0.

It is clear that a minimum crosslinking ratio is required in order to create specific sites with appropriate volumes. These sites are not created at low crosslinking ratios because the structure is not sufficiently constrained. However, the constraints of the structures should not hinder solute diffusion in and out of the network. Therefore, it can be concluded that not only the choice of components, but also the composition of the network are important in obtaining a satisfactory molecular imprinting capacity.[33–37]

The dynamic glucose binding behavior of poly (HEMA-*co*-MAA) hydrogels is shown in Figure 7 as a function of the amount of crosslinking agent during the polymerization process. There was an increase in the rate of uptake as well as the equilibrium value of uptake as the percentage of crosslinking agent (TEGDMA) increased to 75%. This observation was valid for all other types of crosslinking agent.

The dynamic glucose binding behavior of poly (HEMA-*co*-MAA) hydrogels was studied as a function of template concentration during polymerization, as shown in Figure 8. There was an increase in the rate of uptake as well as the equilibrium value of uptake as the template concentration increased up to the value of glucose/comonomers of one. Specifically, for a glucose/comonomer ratio of 1.0, there was an increase of 143% of glucose binding over nonimprinted polymer at equilibrium binding conditions. This result was consistent with an increase in volume and with an increase in specific sites with an increase in template concentration. For glucose/comonomer ratios exceeding unity, a decrease was observed, caused by nonspecific template–functional monomer interactions during polymerization due to the excess amount of template.[26,27,38–42]

TABLE VI
Variation of *n* and *k* Values with Respect to Template Ratio at Feed for Glucose-Imprinted Poly(hydroxyethyl methacrylate-*co*-methacrylic acid)

Molar ratio of glucose at the feed (Glucose/HEMA+MAA)	*n*	*k*
0.5	0.61	0.26
1.0	0.68	0.39
2.0	0.87	0.51

The equilibrium glucose binding was also investigated with respect to the concentration of glucose solution in which the binding experiment was carried out, as shown in Figure 9. Increasing the concentration of glucose solution resulted in an increase of the binding value. Glucose binding efficiency (GBE) of the imprinting process was calculated as:

$$\text{GBE} = [\text{mg glucose/g dry imprinted polymer}] \times [\text{mg glucose/g dry nonimprinted polymer}]$$

Figures 10 and 11 show the variation of glucose binding efficiency with respect to the amount of crosslinking agent and template/comonomer ratios. It can be seen that increasing the percentage of crosslinking agent increases the GBE.

Finally, the selectivity of the CBIP network in binding the template over structurally similar sugars is the utmost goal of a molecular printing study. To investigate the selectivity of the prepared CBIPs,

TABLE VII
Equilibrium Binding Values of Glucose from 10 mg/dL for Glucose-Imprinted and Nonimprinted Poly(HEMA-*co*-MAA) Polymers Crosslinked with Different Amounts of PEGMMA + TEGDMA, PEG600DMA, and TEGDMA

Percentage of crosslinking agent	Equilibrium binding amount of glucose (mg glucose/g dry polymer)					
	PEGMMA + TEGDMA		PEG600DMA		TEGDMA	
	ni	imp	ni	imp	ni	imp
33	0.12	1.64	0.74	1.21	0.69	1.30
60	0.19	1.96	0.87	1.44	0.87	1.73
75	0.50	2.67	0.93	1.55	0.89	2.17

Ni, nonimprinted hydrogel; imp, imprinted hydrogel.

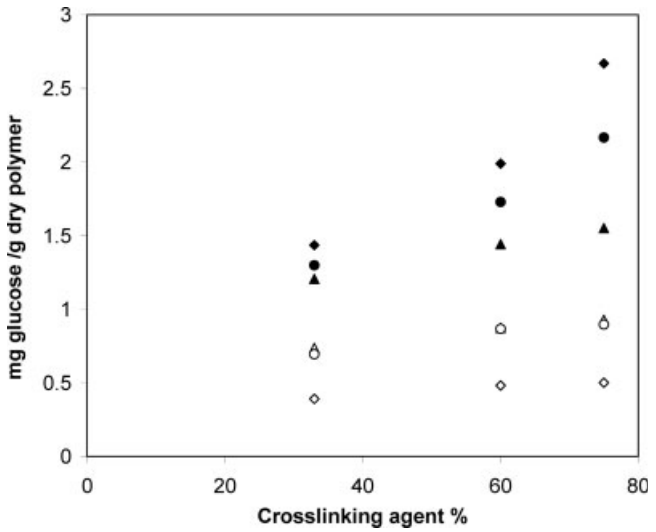


Figure 6 Variation of equilibrium binding values for glucose-imprinted and nonimprinted poly(HEMA-*co*-MAA) polymers crosslinked with different amounts of PEGMMA + TEGDMA, PEG600DMA, and TEGDMA. Binding experiments were performed in 10 mg glucose/dL solution: (◇) PEGMMA + TEGDMA nonimprinted polymer; (◆) PEGMMA + TEGDMA nonimprinted polymer; (△) PEG600DMA nonimprinted polymer; (▲) PEG600DMA imprinted polymer; (○) TEGDMA nonimprinted polymer; (●) TEGDMA imprinted polymer.

equal amounts of three different molecules, glucose, galactose, and theophylline (which has the same molecular weight as glucose), were dissolved in 100 mL deionized water and equilibrium binding studies were carried out for the glucose-imprinted Poly

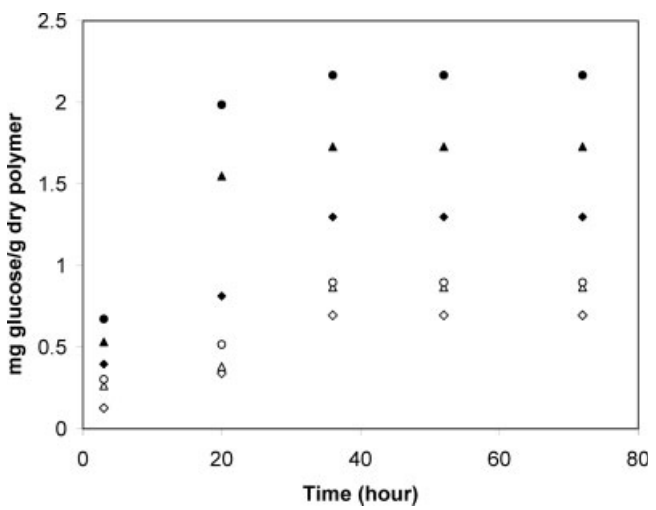


Figure 7 Binding values of glucose in a 10 mg glucose/dL solution for imprinted and nonimprinted poly(HEMA-*co*-MAA) polymers crosslinked with different amounts of TEGDMA: (◇) 33% nonimprinted polymer; (◆) 33% imprinted polymer; (△) 60% nonimprinted polymer; (▲) 60% nonimprinted polymer; (○) 75% nonimprinted polymer; (●) 75% nonimprinted polymer.

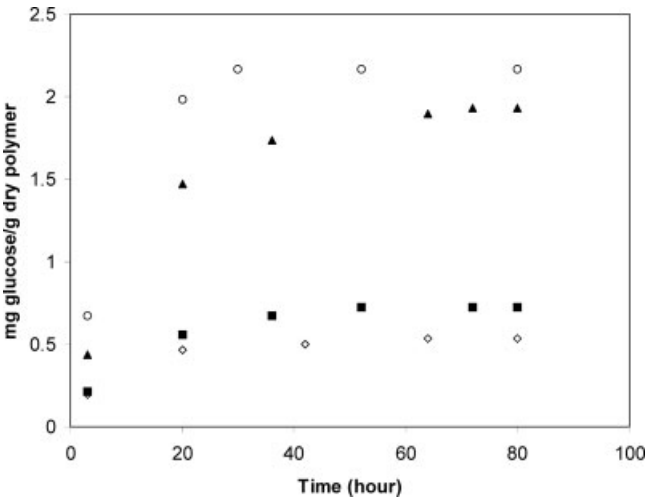


Figure 8 Equilibrium binding values for glucose-imprinted poly(HEMA-*co*-MAA) polymers crosslinked with 75% TEGDMA in a 10 mg glucose/dL solution with different glucose/HEMA + MAA (comonomers) ratios: (◇) 0.2; (■) 0.5; (○) 1.0; (▲) 2.0.

(HEMA-*co*-MAA) 75% crosslinked with PEGMMA + TEGDMA. Figure 12 shows the equilibrium binding values of these three adsorbates. From this figure, equilibrium glucose binding values for all concentration were determined to be ~5.5 times higher than galactose binding. For theophylline, the equilibrium binding value was calculated to be 2×10^5 times smaller than that of glucose binding. This figure clearly shows that this Poly(HEMA-*co*-MAA) gel has a clear selectivity for glucose among the tested molecules. The kinetics of glucose binding of Poly (HEMA-*co*-MAA) 75% crosslinked with PEGMMA + TEGDMA network was also investigated in the presence of galactose and it was observed that glucose binding of CBIP shows the same behavior and

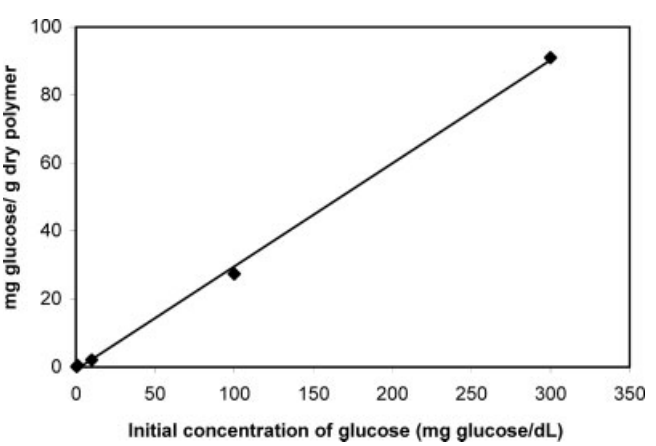


Figure 9 Equilibrium binding values for glucose-imprinted poly(HEMA-*co*-MAA) polymers crosslinked with 75% TEGDMA in 0 to 0.5, 1.0, 10, 100, and 300 mg/dL of glucose solution.

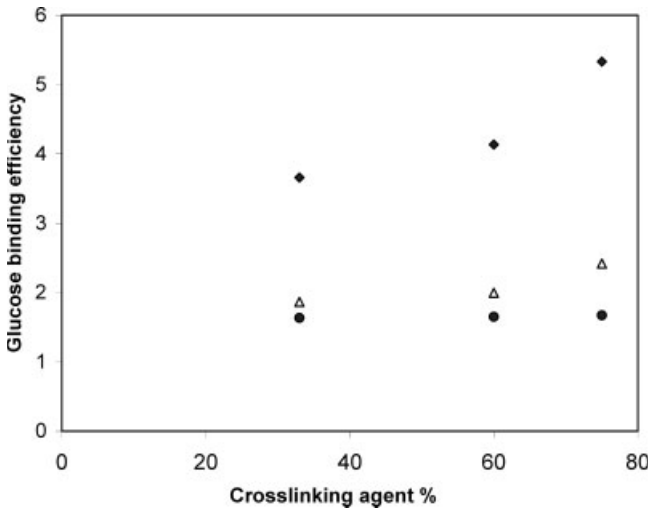


Figure 10 Glucose binding efficiency for glucose-imprinted poly(HEMA-*co*-MAA) polymers crosslinked with different types of crosslinking agent: (◆) PEGMMA + TEGDMA; (●) PEG600DMA; (△) TEGDMA.

the same binding values as in the absence of galactose (Fig. 13).

In order to investigate the interactions between the template and the hydrogel the FT-IR spectra of CBIPs with and without template were taken with a Nicolet 520 spectrometer (Nicolet, Madison, WI). Figure 14 shows the FT-IR spectrum of glucose-imprinted hydrogels crosslinked with PEGMMA and TEGDMA in the presence and absence of template. The fingerprint region shows some interaction between glucose and polymer. In the spectrum of the nonimprinted

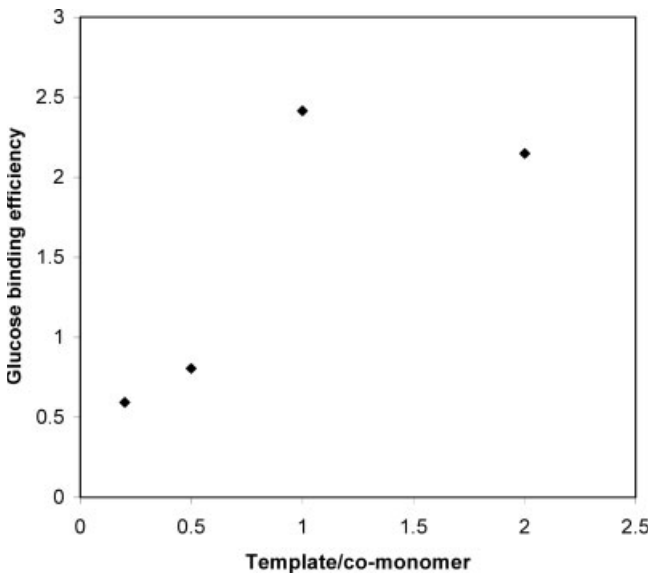


Figure 11 Glucose binding efficiency for glucose-imprinted poly(HEMA-*co*-MAA) polymers crosslinked with PEGMMA + TEGDMA prepared from different template/comonomer ratios.

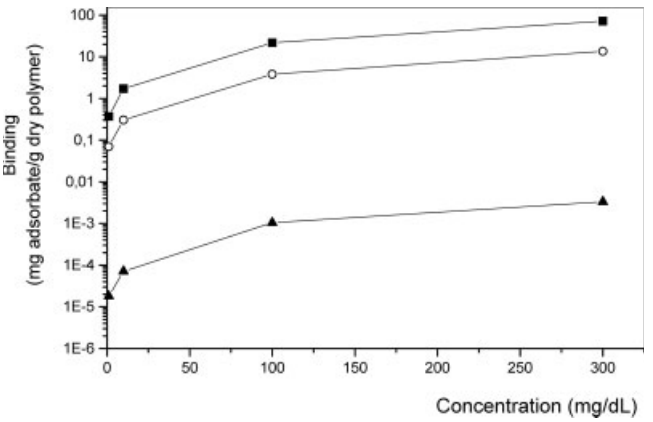


Figure 12 Equilibrium binding values of (ζ) Glucose; (○) Galactose; (▲) Theophylline; for glucose-imprinted poly (HEMA-*co*-MAA) polymers crosslinked with 75% PEGMMA and TEGDMA.

polymer, the peaks at 951 cm^{-1}, 853 cm^{-1}, and 748 cm^{-1} shifted to 942, 817, and 750 cm^{-1}, respectively, as compared with the original peaks of glucose appearing at 919, 836, and 771 cm^{-1}. Also, a sharp band can be observed in the spectrum of the imprinted polymer in the region of the 2990 cm^{-1} CH stretching, where a broad peak was observed.

CONCLUSIONS

Since the molecular weight of the crosslinking agent, the amount of crosslinking, and the nature of interactions of the template and template concentration during polymerization are the most important factors for molecular imprinting, we synthesized hydrogels by molecular imprinting based on HEMA and MAA with different types and amounts of crosslinking agents for the target molecule, glucose. We investigated the swelling behavior of these gels to

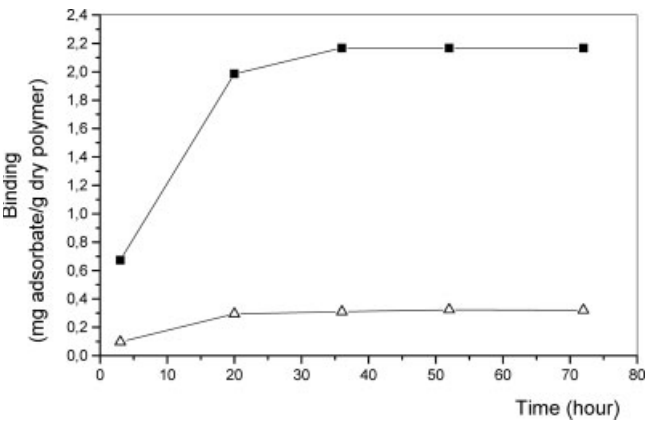


Figure 13 Kinetic binding values of (ζ) Glucose and (△) Galactose in 10 mg glucose + 10 mg galactose/dL solution for glucose-imprinted poly(HEMA-*co*-MAA) polymers crosslinked with 75% PEGMMA and TEGDMA.

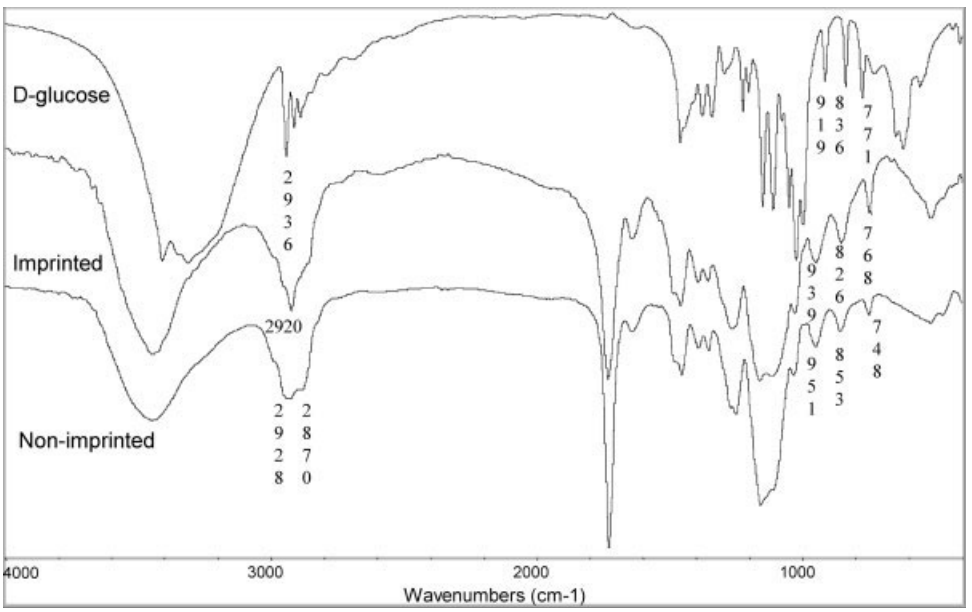


Figure 14 FT-IR spectra of glucose and glucose-imprinted and nonimprinted hydrogels crosslinked with PEGMMA + TEGDMA.

study the effect of these parameters on the structure and binding capacity of imprinted polymers. We observed that hydrogels crosslinked by PEG600DMA swells to larger volumes than those prepared using PEGMMA and TEGDMA. Increasing the amount of crosslinking agent resulted in a sharp change in the n values for PEG600DMA with respect to other crosslinking agents.

We also observed that when all parameters were kept constant, increasing amounts of template caused higher swelling values and faster solvent diffusion in imprinted networks.

The effect of molecular weight and concentration of the crosslinking agent, as well as the template/functional monomers ratio on imprinting, were investigated using three different PEG-containing crosslinking agents; TEGDMA, PEG600DMA, and TEGDMA combined with PEGMMA. At a molar crosslinking ratio of 75%, the polymers exhibited good glucose binding ability. We found that an increase in template concentration resulted in an increase of the equilibrium uptake of glucose up to an optimum value (glucose/functional monomers = 1). The highest glucose binding was found to be 2.67 mg/g dry polymer when PEGMMA was used in combination with TEGDMA (50%).

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