THE EFFECTS OF SOME SOLUTES ON THE HYDRATION OF POLY(HEMA)HYDROGELS PREPARED BY CHEMICAL OR RADIATION PROCEDURES

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Poly(2-hydroxyethyl methacrylate) (poly(HEMA)) hydrogels have been investigated recently as implants for the controlled release of drugs. Their preparation involves a free radical induced polymerization of monomer, initiated either by chemical agents such as peracids or by radiation. Implanted gels are likely to swell or dehydrate in the presence of biological substances, and thus the dimensions of the implant, and the release characteristics of embedded drug will be affected. A further problem associated with gels produced by chemical means is that residual chemical initiator may cause bioincompatability and alter the drug's diffusion characteristics. The aim of the present work is to investigate the influence of the method of preparation and of different solutes on the swelling properties of gels.

Poly(HEMA)gels were prepared using 2-hydroxyethyl methacrylate as the monomer with 0.875% ethylene glycol dimethacrylate as the crosslinking agent and 40% water. Chemically initiated gels contained 0.2%^{w}/v ammonium persulphate. Those prepared by γ-irradiation were given a dose of 300k.rad. Swelling properties and degrees of hydration were estimated from measurements of weight changes of gels immersed in water, and 0.5M aqueous solutions of some substances of biological interest, viz sodium chloride, urea and sucrose.

Table 1: Rates of water uptake or loss, and equilibrium hydration values of poly (HEMA) gels in 0.5M aqueous solutions.

	Solute							
	Sodium chloride		Urea		Sucrose		Water	
Rate(day^{-1}) after 24 hr	-1.79[a]	-0.51[b]	0.49[a]	1.63[b]	-2.63[a]	-1.29[b]	0.00[a]	0.82[b]
Equilib.Hydration (%wt loss/gain)	-6.8[a]	-3.2[b]	9.3[a]	11.0[b]	-11.0[a]	-6.8[b]	1.8[a]	3.4[b]

a = radiation polymerization b = chemical polymerization

The results in Table 1 show that sodium chloride and sucrose caused dehydration of the gels,which is likely to be primarily an osmotic effect,whereas urea increased the hydration. Urea is thought to penetrate into the gel and disrupt the hydrogen bonded regions of the network,thereby reducing network cohesion and allowing more water to penetrate (Ratner & Miller,1972). The presence of persulphate initiator increased the hydration rates and equilibrium water contents,compared with those seen in gels produced by irradiation.

Since persulphate was found to exert an additional effect on the swelling characteristics,further work was carried out using radiation polymerised gels. Swelling in aqueous equimolar solutions of a wide range of structurally related organic substances was examined in order to obtain information on the way in which different solutes affect the internal structure of the polymer network. Table 2 shows some of the results.

Table 2: Rates of water uptake and equilibrium hydration values of radiation polymerised poly(HEMA) gels, in 0.5M solutions of structurally related compounds.

	Sodium Acetate	Acetic Acid	Acet-amide	Ethanol	Cyclo-hexanol	Sodium Salicylate	Sodium Benzoate
Rate(day^{-1}) after 24hr	0.37	0.66	1.75	1.00	2.27	33.11	10.67
Equilib.Hydration (%wt loss/gain)	1.8	7.5	7.5	3.7	6.2	120.0	75.0

Aryl compounds have a greater effect on the hydration of the gel than do aliphatic compounds. The effects of these solutes on the swelling behaviour of the polymer can be explained in terms of the amphiphilic nature of the polymer network, and the size and lipophilicity of the solute molecule. The hydrogen bonding capacity of the solute molecule also appears to exert an effect.

Ratner, B.D. & Miller, I.F. (1972) J. Polym. Sci. A-1, 10: 2425-2445