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Modification of acrylamide-*N*,*N*'-methylenebisacrylamide hydrogel with quaternary ammonium monomethacrylate.

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INTRODUCTION & AIM

Wound hydrogel dressings are valued for maintaining a moist environment that promotes tissue regeneration. Incorporating antibacterial components may reduce infections and accelerate healing. This study evaluated the visual integrity of hydrogels by varying quaternary ammonium monomer and crosslinker content. Additional optimization of these parameters may support the development of more durable and effective wound dressings. Understanding the relationship between composition and structural integrity is essential for designing hydrogels with both antibacterial functionality and mechanical stability.

METHOD

Hydrogels were synthesized using two quaternary ammonium monomers 2-(methacryloyloxy)ethyl-2-hydroxyethylmethyl-octylammonium bromide (QAHAMA-8) (Figure 1a), and 2-(methacryloyloxy)ethyl-2-decylhydroxyethylmethylammonium bromide (QAHAMA-10) (Figure 1b), added in amounts ranging from 2.5 to 100 mol.%. As a crosslinking agent, N,N′-methylenebisacrylamide (bis-AA) was used at 0.5–5 mol.%. Acrylamide (AA) served as the base monomer, with its content varying from 0 to 97.5 mol.% relative to QAHAMA-8 and QAHAMA-10. To prepare the hydrogel compositions, the required amount of QAHAMA-8 or QAHAMA-10 was first mixed with 10 mL of an aqueous potassium persulfate solution (0.15 wt.%), which acted as the photopolymerization initiator. Subsequently, the appropriate amount of bis-AA was added, and the mixture was stirred until complete homogenization. The resulting liquid formulations were photopolymerized under a UV-VIS lamp (Ultra Vitalux 300, Osram, Munich, Germany; wavelength range 280–780 nm). The obtained hydrogel specimens were visually evaluated to assess their structural stability after one week of storage in distilled water.

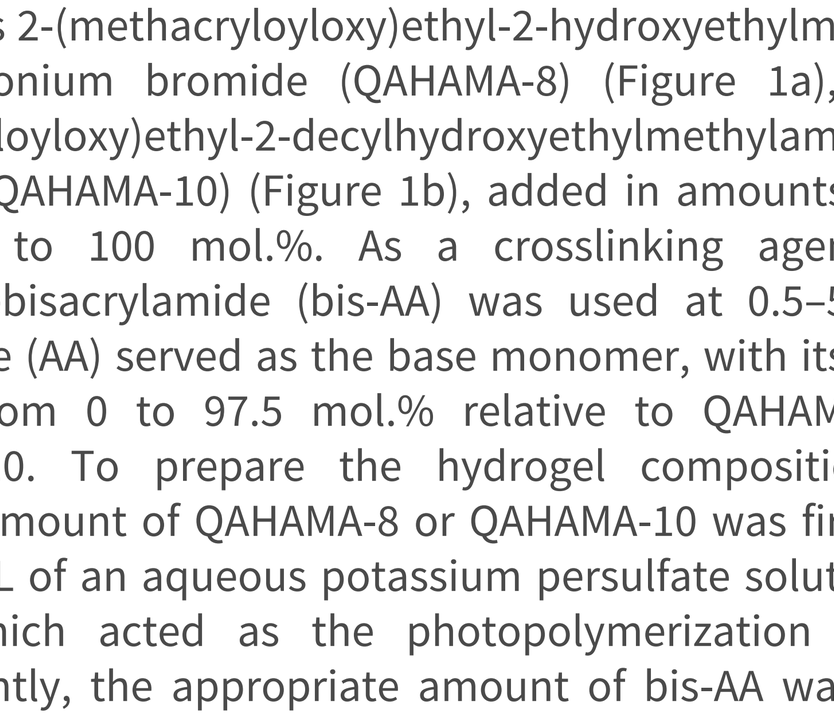
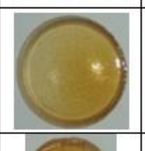


Figure 1. Chemical structure of QAHAMA-8 (a), and QAHAMA-10 (b).

RESULTS & DISCUSSION

Significant differences in sample integrity were observed (Figure 2). Mechanical integrity depended on both the quaternary ammonium monomer content and the cross-linker concentration. At low QAHAMA-8/10 contents, hydrogels with 0.5–1 mol% bis-AA remained integral. At higher quaternary ammonium contents, higher bis-AA concentrations were required to maintain integrity. For example, with 0.5 mol% bis-AA, integral hydrogels formed only at 2.5–30 mol% quaternary ammonium monomer. At 50–100 mol% QAHAMA-8/10, integrity was maintained only at 5 mol% bis-AA. Some of the hydrogel constructs underwent degradation in water, e.g., at 2.5 mol% bis-AA.

- The best visual quality hydrogels were obtained for:
  - ✓ QAHAMA-8: 5–30 mol% with 1 mol% bis-AA
  - ✓ QAHAMA-10: 2.5–30 mol% with 1 mol% bis-AA

Bis-AA content [mol.%]	QAHAMA-8/AA content [mol.%]							
	2.5/97.5	5/95	10/90	20/80	30/70	40/60	50/50	100/0
0.5						-	-	-
1	-					-	-	-
1.5	-	-		disintegrated in water	disintegrated in water	-		-
2.5	-	-	-	disintegrated in water	disintegrated in water	disintegrated in water	-	
5	-	-	-	-	disintegrated in water	disintegrated in water		

Bis-AA content [mol.%]	QAHAMA-10/AA content [mol.%]							
	2.5/97.5	5/95	10/90	20/80	30/70	40/60	50/50	100/0
0.5						-	-	-
1						-	-	-
1.5	-	-		disintegrated in water	disintegrated in water	-	-	-
2.5	-	-	-	disintegrated in water	disintegrated in water	disintegrated in water	-	-
5	-	-	-	-	disintegrated in water	disintegrated in water		

Figure 2. Visual assessment of hydrogels with varying monomer and crosslinker content.

CONCLUSION

The higher the bis-AA content, the greater the hydrogel brittleness. Only hydrogels cross-linked with 0.5 and 1 mol.% bis AA maintained their integrity over the entire concentration range of QAHAMA-8 and QAHAMA-10.

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