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Synthesis and characterization of carbohydrate-based ionic hydrogels

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PURPOSE OF THE ABSTRACT

Hydrogels are a three-dimensional polymer networks that swell but do not dissolve in water. They are either prepared by polymerizing water-soluble monomers in the presence of a crosslinker or by crosslinking hydrophilic polymers. An established method is the use of the redox system with ammonium peroxodisulfate (APS) as initiator and N,N,N',N'-tetramethylethylenediamine (TEMED) as activator. Hydrogels have many different applications, for example as superabsorbents in diapers, irrigation and dehydration of culture media for plants, or as ion exchangers in reaction engineering. Hydrogels are particularly interesting in medicine as drug delivery systems, for tissue engineering, or in implant technology due to their biocompatibility.

Hydrogels with an intact carbohydrate moiety can have anti-fouling properties and are very promising materials for biomedical applications. Carbohydrate-based hydrogels based on polysaccharides (e.g. cellulose, hyaluronic acid, chitosan) are well known. Hydrogels produced from monosaccharides are also known, but far less represented. In addition, none of these carbohydrate-hydrogels have carried an ionic charge so far. The carbohydrate moiety in this research is methyl-a-D-glucopyranoside (MeGlu). MeGlu is based on glucose, the most common and ubiquitous monosaccharide, which can be obtained from natural, renewable sources.

We converted MeGlu as starting material into an iodine leaving group using an optimized Appel reaction. The iodinated compound was then quarternized using 1-vinylimidazole, balancing the charge of the nitrogen cation with the iodine anion. To prepare the hydrogel, the iodine salt is dissolved in water and N,N'-methylenebisacrylamide (MBis) and APS solution are added. After complete dissolution, TEMED is added and the solution is transferred to a mold where the hydrogel gels out.

An advantage of this synthetic route is the possibility to modify the sugar at any point. This gives many options to change the properties of the hydrogel. Another major advantage is the presence of the ionic component in the molecule. The ionic component promotes swelling of the hydrogels in water and allows the gels to be used as drug delivery systems, as the hydrogel and drug interact with each other.

FIGURES

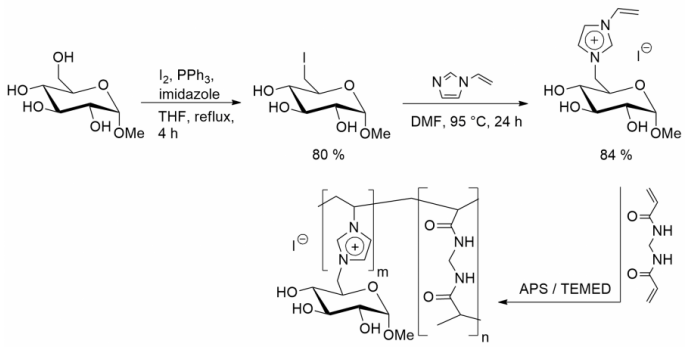

FIGURE 1

3-step synthesis of glucosylvinylimidazolium-based hydrogels

This figure shows the 2-step synthesis of glucosylvinylimidazole-based ionic liquid with an overall yield of 84 % and the following step of the hydrogel synthesis with Mbis as crosslinker and APS/TEMED as initiator system.

FIGURE 2

Example of a hydrogel

This figure shows an example of a glucosylvinylimidazolium-based hydrogel with an imprint.

KEYWORDS

carbohydrates | glucose | polymers | hydrogels

BIBLIOGRAPHY

[1] P. Calvert, Adv. Mater. 2009, 21, 743-756.

[2] J. Claus, A. Jastram, E. Piktel, R. Bucki, P.A. Janmey, U. Kragl, J. Appl. Polym. Sci. 2021, 138, 50222.

[3] S.G Abd Alla, M. Sen, A.W.M El-Naggar, Carbohyr. Polym. 2012, 89, 478-485.

[4] J. Akhter, K. Mahmood, K.A. Malik, A. Mardan, M. Ahmad, M.M. Iqbal, Plant, Soil Environ. 2004, 50, 463-469.

[5] L.E. Meyer, K. Plasch, U. Kragl, J. Vom Langermann, Org. Process Res. Dev. 2018, 22, 963-970.

[6] S. Liu, H. Li, J. Zhang, X. Thian, X. Li, RSC Adv. 2020, 10, 33642.

[7] S. Farrukh, K. Hussain, M. Ayoub, Synthesis and Application of Carbohydrate-Based Hydrogels, Springer, Cham, 2018.

[8] J. Morris, J. Bietsch, K. Bashaw, G. Wang, Gels, 2021, 7, 24.

[9] J. Schnegas, S. Jopp, Compounds 2021, 1, 154-163.

[10] J. Bandomir, A. Schulz, S. Taguchi, L. Schmitt, H. Ohno, K. Sternberg, K.-P. Schmitz, U. Kragl, Macromol. Chem. Phys. 2014, 215, 716.