DUAL CROSS-LINKING AS A METHOD OF IMPROVING MECHANICAL PROPERTIES OF GELATIN-ALGINATE HYDROGELS

Marta Tuszyńska*, Joanna Skopińska-Wiśniewska

Faculty of Chemistry,
Nicolaus Copernicus University In Torun, Poland
*e-mail: martatuszynska96@gmail.com

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Introduction

Gelatin exists as a mixture of water soluble protein fragments, with the same amino acid sequences as collagen, from which it is derived [1]. Alginate is a naturally occurring anionic polymer typically obtained from brown seaweed. Both, gelatin and alginate, have been extensively investigated and used for many biomedical applications, due to their biocompatibility, low toxicity, relatively low cost, and mild gelation process [2]. That is why the hydrogels based on their mixtures have been particularly attractive in wound healing, drug delivery, and tissue engineering applications [3].

Materials and Methods

Both gelatin and alginate were dissolved in water and then mixed in different volume ratios, to finally obtain solution 6% gelatin and 2% or 1,5% sodium alginate in one mixture. Then two different crosslinkers were prepared. Squaric acid (SQ) and N-(3-Dimethylaminopropyl)-*N′*-ethylcarbodiimide hydrochloride and N-Hydroxysuccinimide (EDC-NHS) both at 1% and 2% (weight percent based on dry weight of the protein) were dissolved in water and added to final mixtures. Then the hydrogels were immersed in calcium chloride solution to cross-link alginate.
Elongation tests were carried out on fresh hydrogel samples cut into pieces about 1 cm thick. The mechanical properties were determined using Zwick & Roell Z 0.5 machine (Germany).

Results and Discussion

The presented method allowed to obtain stable gelatin/alginate hydrogels.
Mechanical tests show that the tensile strength of materials containing 2% sodium alginate cross-linked with EDC-NHS and SQ increased. However, the tensile strength of hydrogels based on gelatin and 1,5 % sodium alginate undergo irregular changes after cross-linking.
The hydrogels with higher amount of sodium alginate are more rigid. The elongation at breaking point is lower while the Young Modulus is much higher. Interestingly, the materials containing 2% sodium alginate became more elastic, but for hydrogels containing 1.5% polysaccharide, the cross-linking effect is the opposite in most cases.

Conclusions

Mechanical tests confirm the mixing of gelatin and 2% sodium alginate form strong, relatively rigid materials. The cross-linking process additionally increases mechanical properties of these gels. EDC-NHS as a crosslinker is more appropriate for creation of gelatin/alginate hydrogels with improved mechanical properties.

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