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THE EFFECT OF ALGINATE CONCENTRATION ON THE ELASTIC AND VISCOELASTIC PROPERTIES OF ALGINATE HYDROGEL FOR TISSUE ENGINEERING APPLICATIONS

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ABSTRACT

Background: Alginate is a biomaterial that has numerous applications in bio-printing and tissue engineering. The design and development of tissue scaffolds for the regeneration of biological tissues strongly depends on the mechanical compatibility of these scaffolds after implantation. The tailored elastic and viscoelastic properties of alginate hydrogel can be achieved by changing the material concentration of alginate. However, limited studies have been conducted in this direction. The present study has been conducted to investigate the effect of alginate concentration on the elastic and viscoelastic responses of alginate hydrogel.

Methods: The alginate solutions of alginate with 4 % and 5 % w/v concentrations were prepared by adding respectively 1.0 and 1.25 gm of alginate in 25 mL volume of distilled water. The solution was mixed properly for about 3 hrs using magnetic stirring machine and later was cross linked with 50 mM CaCl2 solution for 24 hrs inside the refrigerator. A static compression test was conducted with a displacement rate of 0.01 mm/s while a dynamic test, with sinusoidal displacement, was performed with frequency of 0.5 Hz. The viscous and elastic responses from the static test were determined in terms of energy stored during the initial curved toe-region region and via the linear region of the stress-strain curve, respectively. The dynamic test determined loss and storage moduli.

Results: The elastic modulus values for 5% alginate hydrogel are observed to be about 3.2 to 4.5 times higher than the corresponding values for 4% alginate hydrogel. The values of loss angels between stress and strain curves obtained from the cyclic test are recorded to be respectively 1.07 and 0.72 for 4% and 5% alginate hydrogel. The loss and storage moduli values for 5% alginate are found to be respectively 4.6 and 9.6 times higher then the corresponding values for 4% alginate hydrogel. The energy absorbing capacities of alginate hydrogel during elastic and viscous responses are also increased by 8.3 and 7.0 times respectively for 5% alginate hydrogel. Interestingly, strong sinusoidal correlations (R^2 from 0.82 to 0.85) are identified between the corresponding amounts of energy determined from static and dynamic testing.

Conclusions: The Study presented experimental procedure to prepare different concentrations of alginate hydrogel and testing protocols to evaluate both elastic and viscoelastic properties. It has been observed that the elastic and viscoelastic properties of alginate hydrogel can be significantly improved for different applications in tissue engineering by changing the concentrations of alginate.