CHARACTERISTICS OF PHYSICOCHEMICAL AND RHEOLOGICAL PROPERTIES OF CHITOSAN HYDROGELS BASED ON SELECTED HYDROXYACIDS

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[Engineering of Biomaterials 163 (2021) 92]

Introduction

Chitosan is a natural cationic polymer that dissolves in an acidic environment and forms gels. Its properties depend on the degree of deacetylation and molecular weight. It is a bioactive compound which increases the regenerative abilities of the skin by stimulating the division of fibroblasts. Chitosan has antibacterial and film-forming properties. Moreover, it is biodegradable, biocompatible, non-toxic and stable. In the research mandelic and lactobionic acids were used. They are characterized by biological activity and low toxicity. This combination not only has a positive effect on the solubility of the polymer but also allows to obtain new biomaterials in which the positive features of the base ingredients are enhanced by their synergistic effect. The obtained hydrogels were assessed for the interaction of chitosan and hydroxyacid molecules, and the stability of the resulting structures was examined. The research was performed by using rheological methods and IR spectroscopy. [1-4]

Materials and Methods

Chitosan powder (low molecular weight, degree of deacetylation DD = 78%, M_v = 1.4×10^6 g/mol) was obtained from Aldrich and used without further purification [1]. Hydrogels were prepared by dissolving chitosan (2.6% w/v) in 30 mL of aqueous solutions of mandelic acid and lactobionic acid. The content of hydroxyacids was 0.002 mol [1]. The samples were mixed on a magnetic stirrer until clear solutions were obtained. After 24 hours of incubation, viscosity measurements were made at the temperature of 25°C in the range of the shear rate from 0.1s^{-1} to 35s^{-1}. The rotational viscometer SMART series (Fungilab) and a set of appropriate spindles were used for measurements.
The structure of chitosan, mandelic and lactobionic acid as well as the interaction between them were confirmed by infrared spectroscopy using Nicolet iS10.

Results and Discussion

As a result of rheological studies, the dependence of dynamic viscosity on the shear rate (viscosity curves) was obtained, which allowed to conclude that hydrogels based on chitosan and mandelic acid are characterized by higher viscosity values compared to those containing lactobionic acid.
After a week of observations of the prepared hydrogels and measurements of viscosity parameters, it was noticed that the viscosities of the hydrogels were constantly increasing (FIGs. 1 and 2).

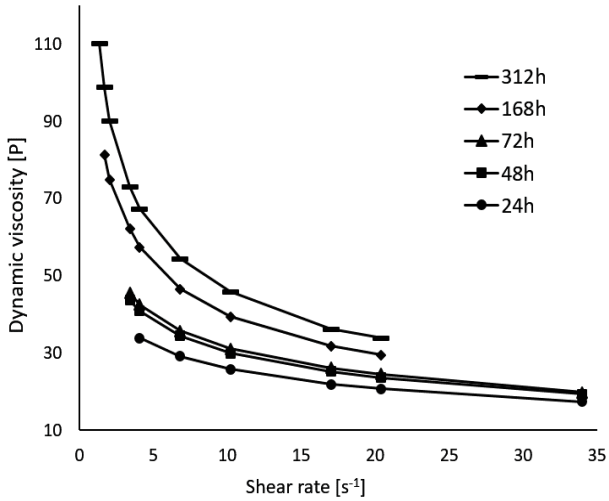

FIG. 1. Comparison of dynamic viscosity of chitosan gel with mandelic acid depending on the time

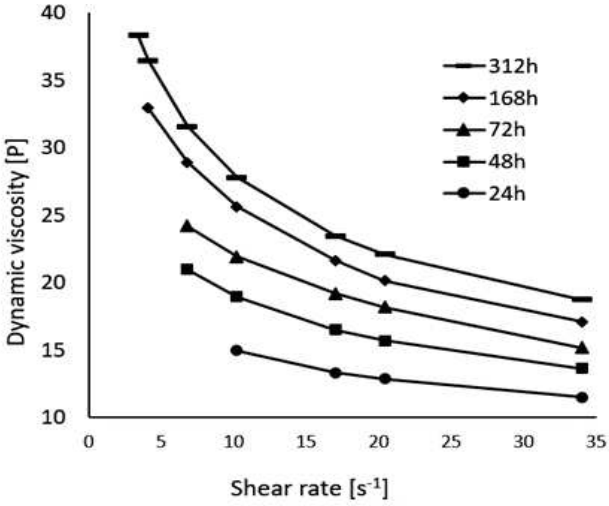

FIG. 2. Comparison of dynamic viscosity of chitosan gel with lactobionic acid depending on the time

It proves the ongoing process of creating new bonds between hydroxyacids molecules and chitosan chains. After this time, the hydrogels with mandelic acid showed higher viscosity values compared to hydrogels made with lactobionic acid.
Based on the obtained IR spectra, the shifts of the characteristic chitosan bands as a result of interaction with the tested hydroxyacids were analyzed.

Conclusions

Chitosan hydrogels made with the use of mandelic acid are characterized by higher viscosity values compared to hydrogels containing lactobionic acid. The samples of the obtained hydrogels stored for 7 days show no signs of degradation and their viscosities are constantly increasing.

Acknowledgments

Financial support from a student mini-grant obtained from Collegium Medicum, Nicolaus Copernicus University is gratefully acknowledged.

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