

Rheological characterization of zein gels containing probes

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Abstract

Biopolymer-based gels have a significant impact in a number of industrial processes. The current study was designed to investigate the influence of different probes on the rheological properties of gels made up of zein, in order to provide useful formulations for several applications. Diffusing wave spectroscopy (DWS) in association with dynamic rheology was used to perform a full physico-chemical characterization of zein dispersions; the obtained data were expressed by the following parameters: Mean Square Displacement (MSD), Elasticity Index (EI), Solid-Liquid Balance (SLB), Macroscopic Viscosity Index (MVI), storage or elastic (G') and viscous or loss moduli (G''). The morphology of zein formulations was evaluated by Scanning Electron Microscopy (SEM) (**Figure 1**). The formulations prepared with a protein concentration of 15% and 20% w/v favored the formation of stable dispersions especially at 37 °C. The samples were characterized by a decrease in SLB and higher EI and MVI when the zein concentration was increased, exhibiting a viscoelastic behavior (**Figure 2**) [1]. The evaluation of the frequency sweep, especially at 37 °C, showed a greater storage modulus of the formulations containing 15% and 20% w/v of zein with respect to the viscous modulus and a low phase angle ($<20^\circ$), demonstrating the prevalence of their elastic character. Furthermore, the encapsulation of model compounds, characterized by different physico-chemical characteristics influenced the rheological properties of zein-based gels (**Figure 3** and **Figure 4**). In **Figure 5** it is possible to observe the release profiles of rhodamine B and bromophenol blue from zein-based gels. The obtained results showed different trends as a result of the different chemical features of the entrapped compounds. In detail, the hydrophilic probe (rhodamine B) was gradually released by the polymeric matrix, while the hydrophobic one (bromophenol blue) was strongly retained by zein gels and a very slow leakage was obtained. These results highlight the peculiar properties of zein gels that can be potentially used as films for biomedical and pharmaceutical applications with the aim of modulating the release profiles of several bioactive compounds [2].

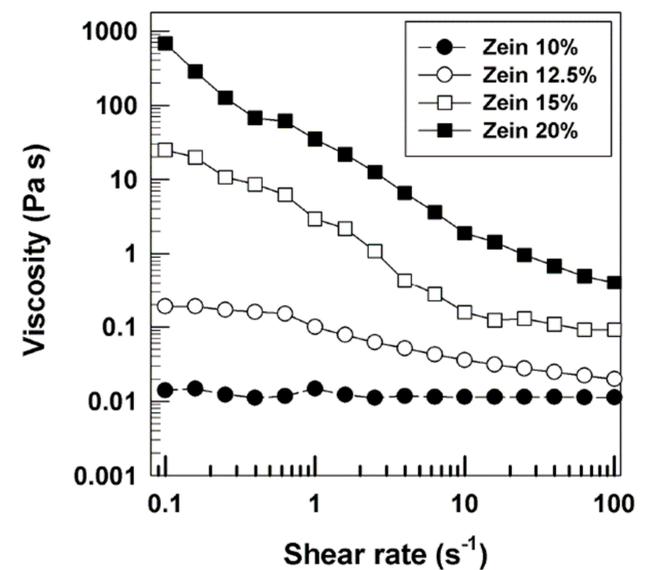
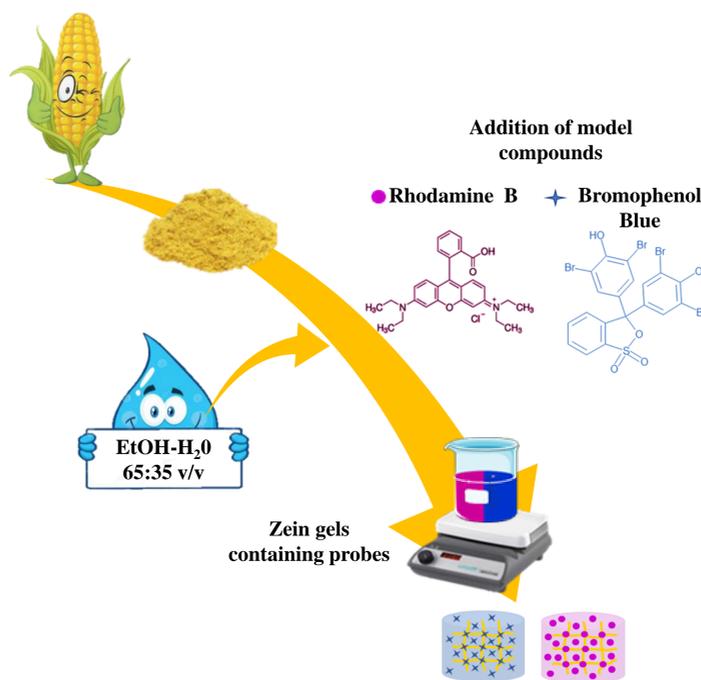
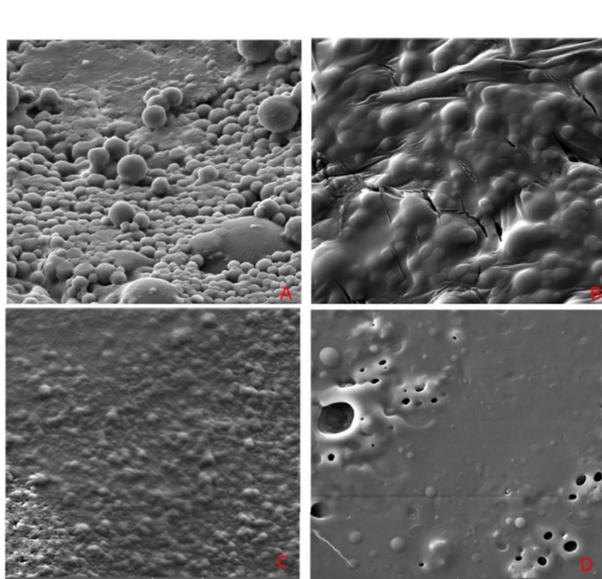


Figure 2. Evaluation of viscosity of zein samples at 37 °C as a function of the shear rate.

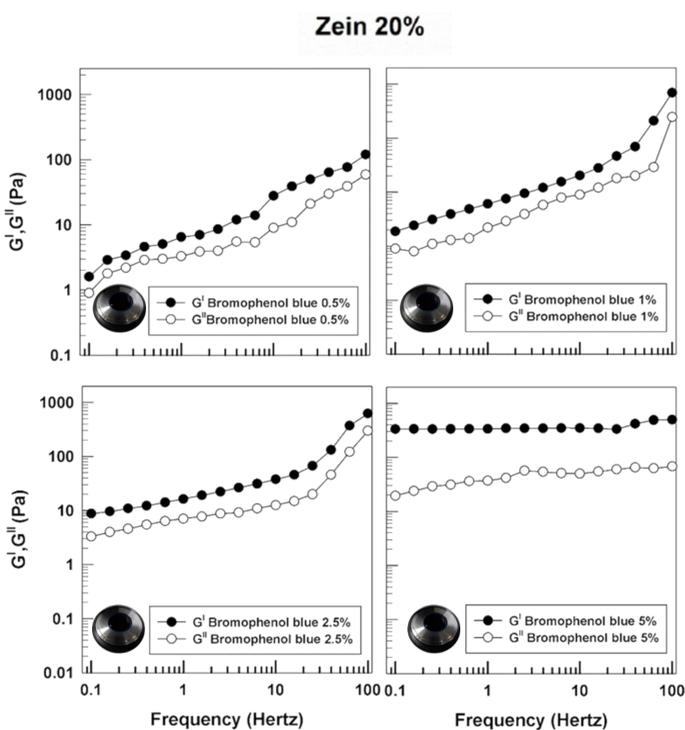


Figure 3. Frequency sweep test performed on 20% w/v zein gels containing Bromophenol Blue at 37 °C.

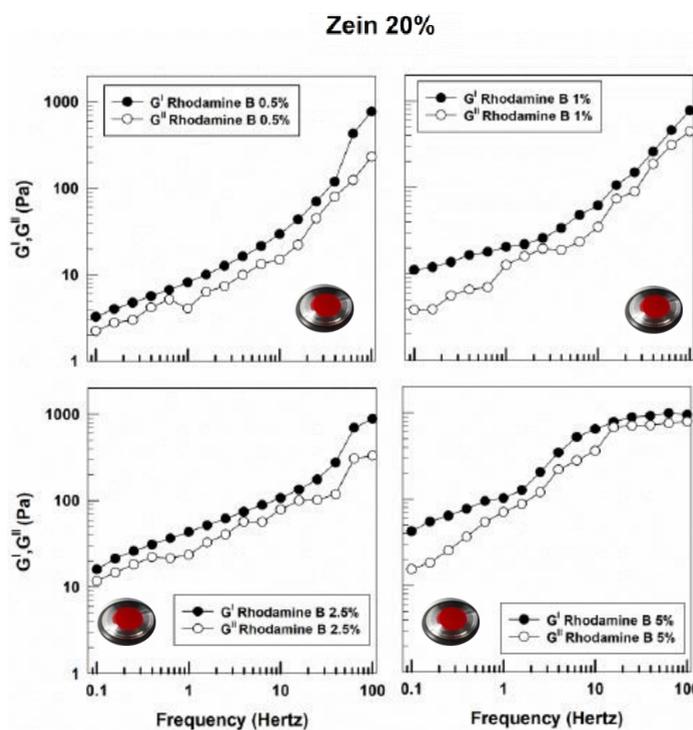


Figure 4. Frequency sweep test performed on 20% w/v zein gels containing Rhodamine B at 37 °C.

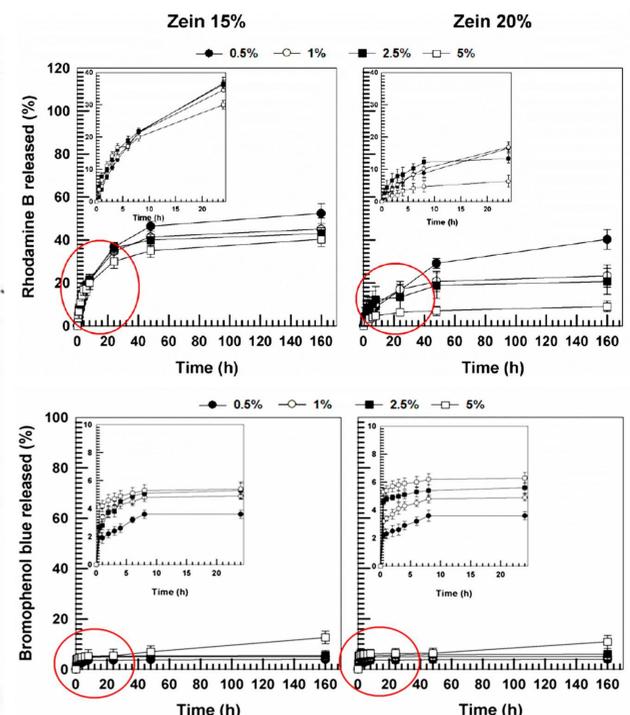


Figure 5. Release profiles of Rhodamine B and Bromophenol Blue from zein-based gels as a function of the probe concentration and incubation time.

References

- [1] Gagliardi, A., Froio, F., Salvatici, M.C., Paolino, D., Fresta, M., Cosco, D. Characterization and refinement of zein-based gels. *Food Hydrocolloids*, 101, 105555 (2020).
 [2] Gagliardi, A.; Voci, S.; Paolino, D.; Fresta, M.; Cosco, D. Influence of Various Model Compounds on the Rheological Properties of Zein-Based Gels. *Molecules*, 25 (14), 3174 (2020).