Synthesis and characterization of chitosan/PVA/starch/ZnO/camphor and chitosan/PVA/carboxymethyl cellulose/ZnO/camphor patches for potential hemostatic application

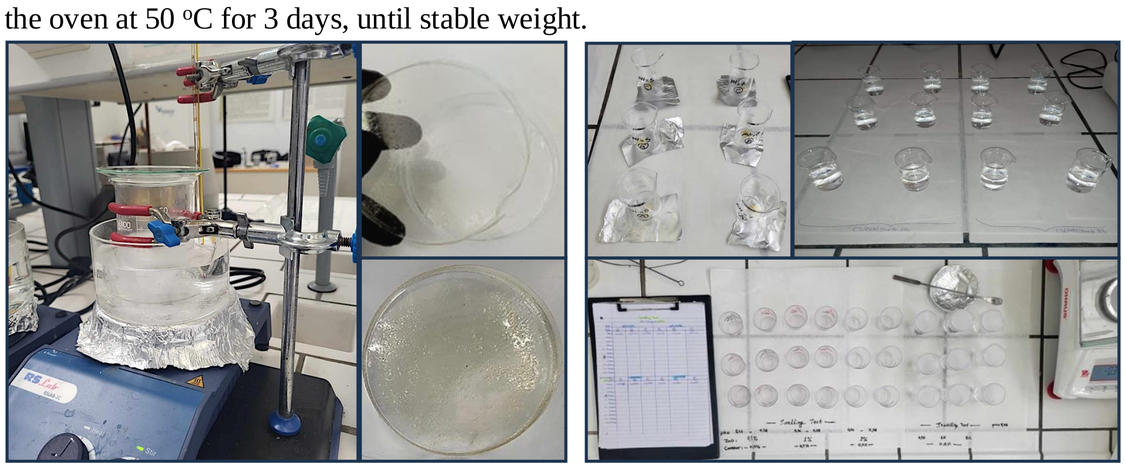
Theodora Adamantidi, Marios Argyrios Finos, Anastasia Meretoudi, Ionnna Koumentakou*, George Z. Kyzas*
Hephaestus Laboratory, School of Chemistry, Faculty of Sciences, Democritus University of Thrace, GR-65404 Kavala, Greece
Presenting author Email: ameretou@chem.duth.gr

ABSTRACT

Biopolymers are used globally as a material component for transdermal drug release systems. Such systems constitute polymeric matrices that are characterized by high swelling capacity, stability and satisfactory water absorption capacity [1,2]. The scope of this research is to study the impact of a different crosslinking agent in various zinc oxides' concentrations on the pores of the subsequent composite hydrogel films synthesized along with the observed effect on their swelling profile. Starch is shown to potentially lower water adsorption when compared to the base material of CS/PVA (Chitosan/Poly(vinyl) alcohol), in all ratios except that of 1.5% and 2 %. Similarly, carboxymethyl cellulose (CMC) also decreased such behavior except for the 2 %. Starch and CMC with the ratio of 1.5% exhibited the most favorable profile for further study. Increasing crosslinker amount induced greater stability, restraining their swelling capacity potential as expected in CS/PVA/Starch(1.5%)/ZnO(2%)/Camphor(0.5%) – while the accompanied choice was CS/PVA/CMC(1.5%)/ZnO(1%)/Camphor(0.5%). Characterization with FTIR showed all the expected peaks except that of ZnO and camphor encapsulation was confirmed through the C-H stretching FTIR peaks at 2922 and 2864 cm^{-1} and the intense presence of the carbonyl group at 1718 cm^{-1} [3].

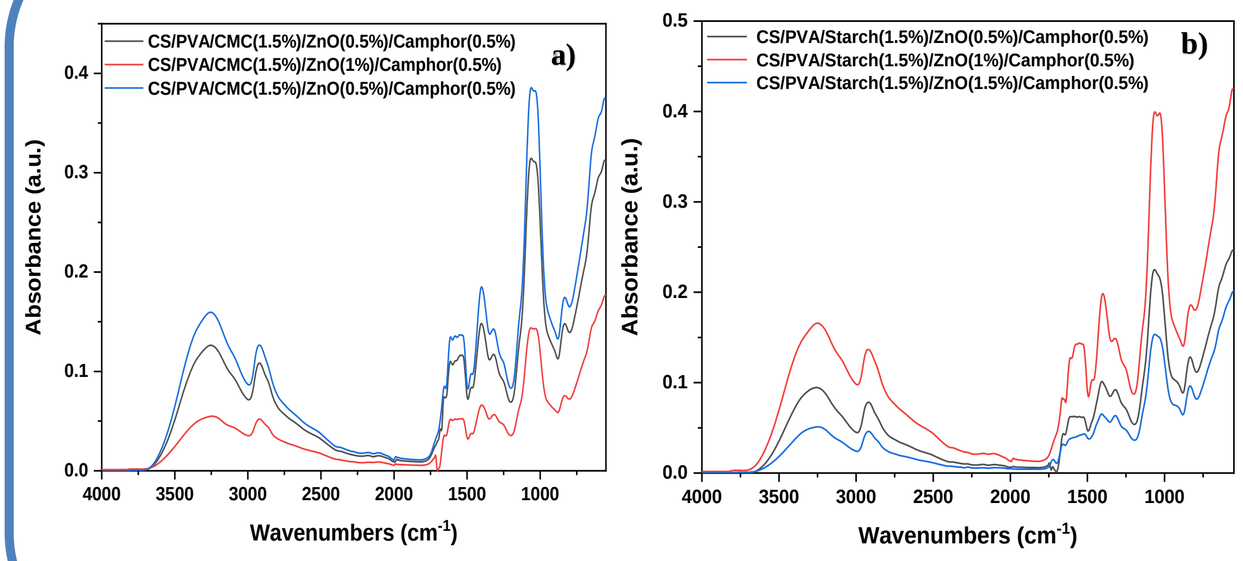
EXPERIMENTAL PROCEDURES

Synthesis: All materials were used as received. All samples were prepared via the same procedure (One Pot method). The initial materials were prepared using 98 mL D.I. water, 1 g of Chitosan, 1 g of PVA and 0.5, 1, 1.5 & 2 % Starch/CMC, (8 different hydrogels) and 2 mL acetic acid. In the samples that displayed the best swelling/stability behavior CS/PVA/Starch(1.5%) and CS/PVA/CMC(1.5%), respectively, 0.5, 1 & 2 % ZnO was added along with 0.5 % Camphor as a acetic solution (6 new hydrogels). All hydrogels were dried in the oven at 50 °C for 3 days, until stable weight.



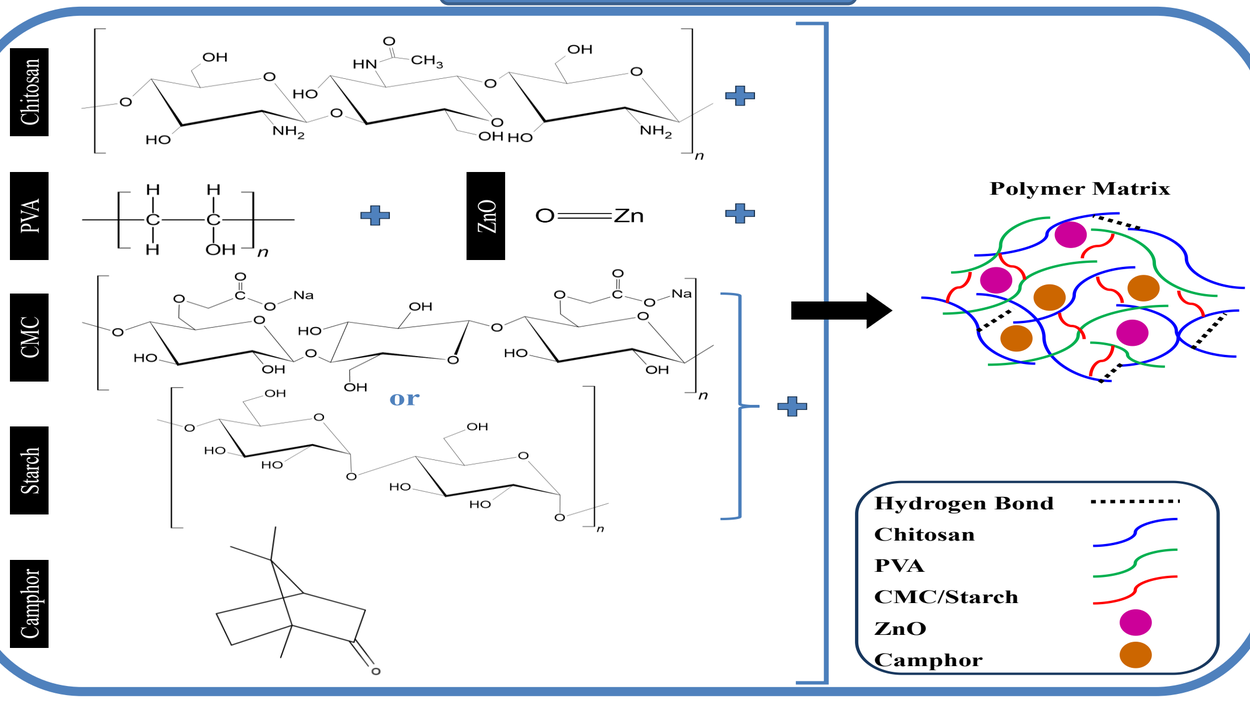
Synthesis of biomaterials (left) and Swelling Stability procedures (right)

FTIR ANALYSIS

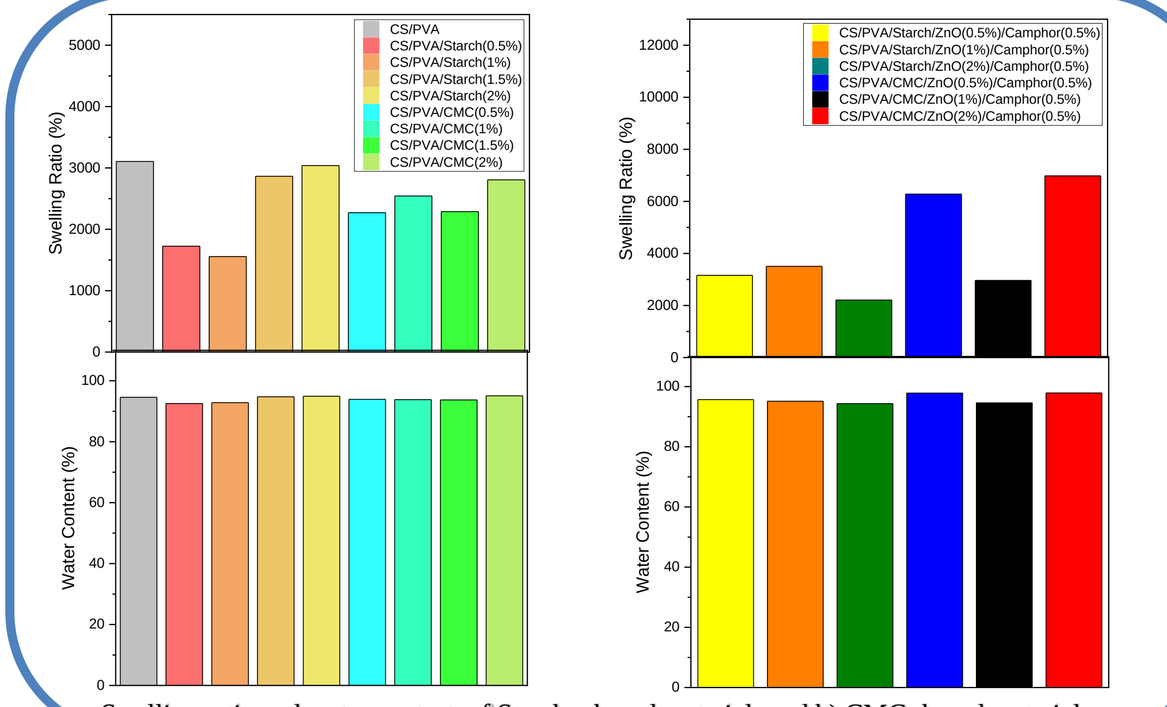


FTIR spectra of a)CMC-based materials and b) Starch-based materials

VISUAL ABSTRACT



RESULTS



Swelling ratio and water contact of Starch – based materials and b) CMC- based materials

CONCLUSIONS

- The starch and CMC enhanced the cross-linking between CS and PVA in the parent polymer at a rate of 1.5%, as shown by the swelling and stability experiments Hydrogels with 1.5 % Starch and 1.5 % CMC had the best swelling behavior
- At a lower percentage of CMC and Starch the swelling capacity and the stability of the polymer network is reduced. at a lower percentage of CMC and Starch the swelling capacity and the stability of the polymer network is reduced.
- The addition of ZnO (2%) and Camphor (0.5%) improved both the stability and swelling of polymeric network behavior of hydrogels, as it is noticed by experimental process
- Such synthesized hydrogels own great potential for future potential drug delivery systems.

REFERENCES

1. VS. Sivasankarapillai, SS. Das, F. Sabir, MA. Sundaramahalingam, JC. Colmenares, S. Prasannakumar, M. Rajan, A. Rahdar, G.Z. Kyzas, *Materials Today Chemistry*, 19 (2021) 100382.
2. I. Koumentakou, Z. Terzopoulou, A. Michopoulou, I. Kalafatakis, K. Theodorakis, D. Tzetzis, D. Bikiaris, *International Journal of Biological Macromolecules*, 162 (2020) 693–703.
3. A. Abdollahi, N. Fereydouni, H. Moradi, A. Karimivaselabadi, E. Zarenezhad, M. Osanloo, *BMC Complementary Medicine and Therapies*, 24(1) (2024) 138.