DEVELOPMENT OF POROUS BIONANOMATERIALS BASED ON POLYMERS AND CYCLODEXTRINS WITH POSSIBLE BIOMEDICAL AND ENVIRONMENTAL APPLICATIONS

Lizbeth Quiroz Oregón[a], L. Mónica Bravo Anaya[b], Josué D. Mota Morales[c], J. Betzabe González Campos[a]*

[a] Institute of Chemical and Biological Research, Michoacan University of Saint Nicholas of Hidalgo

[b] Institut des Sciences Chimiques de Rennes, Centre National de la Recherche Scientifique

[c] Center of Applied Physics and Advance Technology, National Autonomus University of Mexico

*betzabe.gonzalez@umich.mx

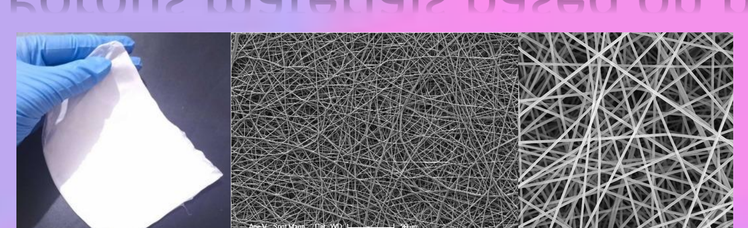
ABSTRACT

The low bioavailability of widely used drugs, such as metformin (MFH), makes it necessary to administer constant doses to achieve the desired therapeutic effect, which leads to an increase in adverse effects and toxicity. In addition, their disposal also causes an environmental impact on both the ecosystem and organisms [1,2]. The development of materials based on biocompatible polymers is one of the most promising alternatives to reduce the dosage of active ingredients. Besides, these materials can function as adsorbents of micropollutants in the wastewater treatment [3]. In this research project, nanofibers and aerogels based on polyvinyl alcohol (PVA), gelatin (GLN) and β-cyclodextrin (β-CD) are obtained, as well as the functionalization of chitosan (CS) with β-CD for the development of porous materials with biomedical and environmental applications.

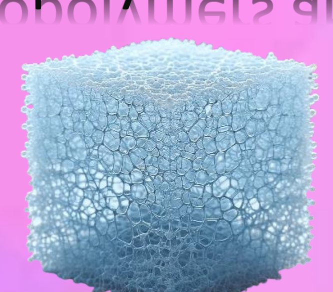
Low bioavailability

Metformin hydrochloride

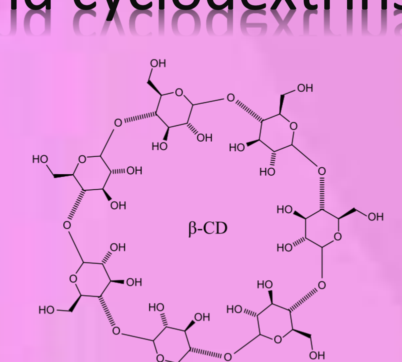
Porous materials based on biopolymers and cyclodextrins

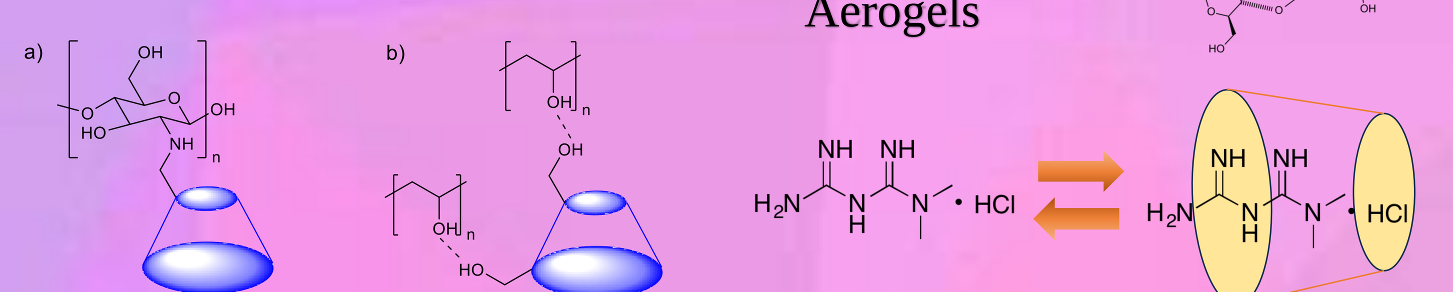


Nanofibers



Aerogels





a) β-CD-grafting-CS and b) β-CD functionalized PVA

Inclusion complex β-CD/MFH

METHODS

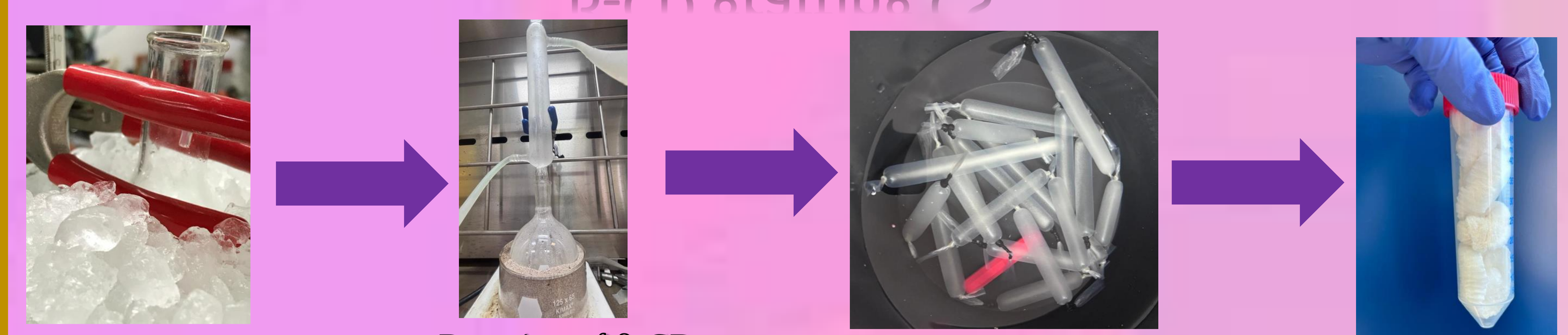
Active pharmaceutical ingredient (API) extraction from commercial pharmaceutical form

Commercial pharmaceutical form

Trituration

Solid-liquid extraction

β-CD grafting CS



Tosilation of β-CD with TsCl

Reaction of β-CD grafted with CS

Dialysis

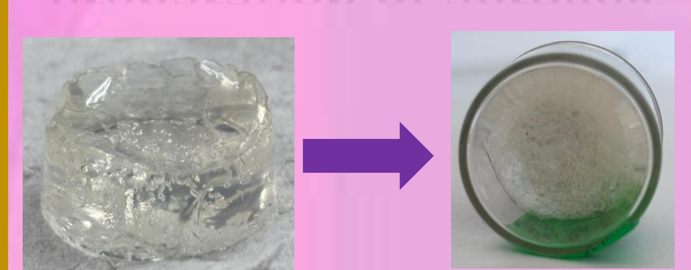
Freeze-drying

Electrospinning of β-CD/PVA

Obtaining of the polymeric dissolution containing β-CD

Electrospinning process

Preparation of aerogels



Preparation of hydrogels of β-CD/GLN

Freeze-drying of the hydrogel

Inclusion complex β-CD/MFH formation

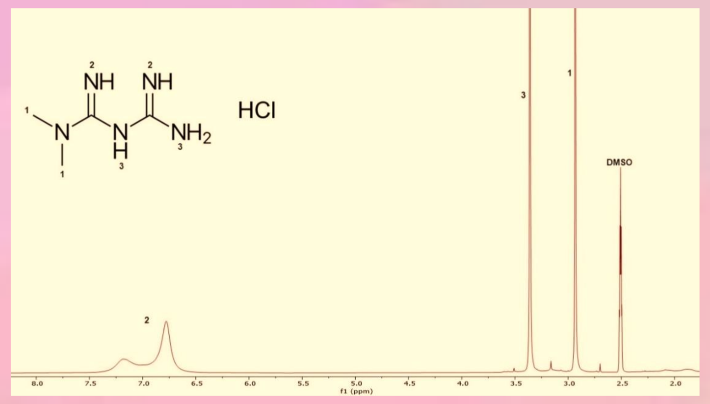
Preparation of the β-CD/MFH in a ratio of 1:1

Evaporation of the solvent

RESULTS

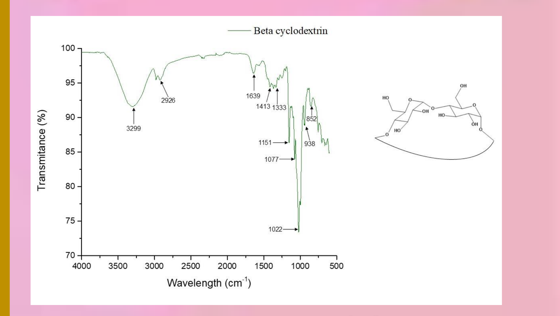
API extraction from commercial pharmaceutical form

Crystals of MFH.

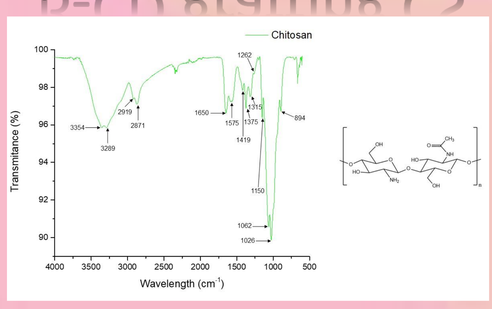


1H NMR spectra of MFH.

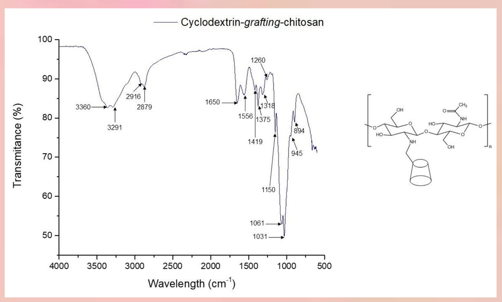
β-CD grafting CS



FT-IR spectra of β-CD.

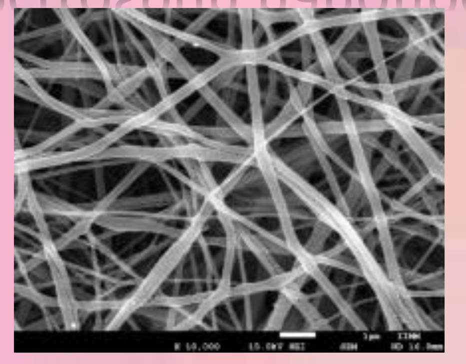


FT-IR spectra of CS.



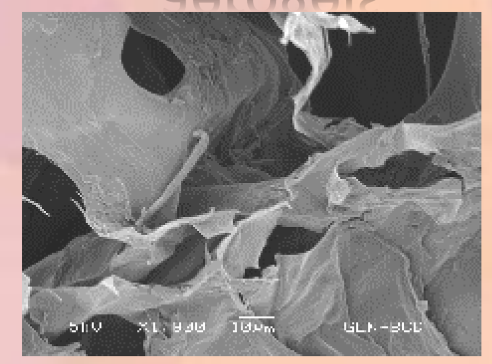
FT-IR spectra of β-CD *grafting* CS.

β-CD/PVA electrospun nanofibers



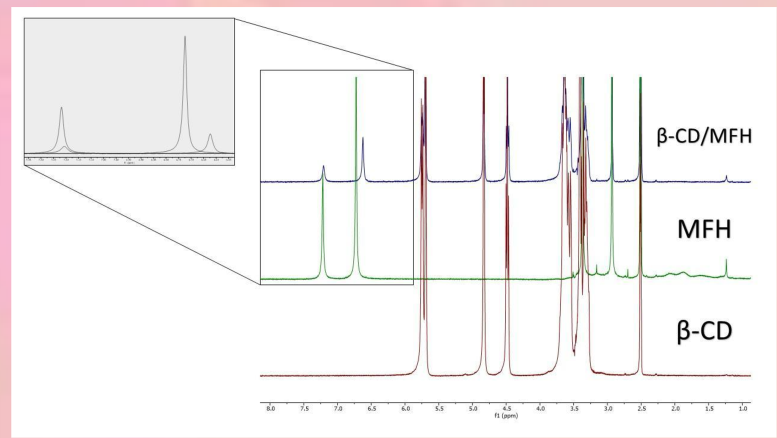
SEM micrograph of β-CD/PVA electrospun nanofibers.

β-CD/GLN aerogels



SEM micrograph of β-CD/GLN aerogel.

Inclusion complex β-CD/MFH formation



1H NMR spectra of inclusion complex of β-CD/MFH, MFH and β-CD.

CONCLUSIONS

The development of porous materials as drug delivery system of APIs with low bioavailability, like MFH, thorough the fabrication of electrospun nanofibers and aerogels based on polymers, such as CS, PVA and GLN is highly promising. Furthermore, the incorporation of inclusion complexes could stimulate the aqueous solubility, and chemical stability. Additionally, this kind of materials also work as adsorbent of microcontaminants.

BIBLIOGRAPHY

1. Bhalani, D. V.; Nutan, B.; Kumar, A.; Singh Chandel, A. "Bioavailability Enhancement Techniques for Poorly Aqueous Soluble Drugs and Therapeutics", *Biomedicines*, Vol. 10, No. 2055, 2022. Doi: 10.3390/biomedicines10092055
2. Fenyvesi, É.; Puskás, I.; Szente, L. "Applications of steroid drugs entrapped in cyclodextrins", *Environmental Chemistry Letters*, No. 17, p. 375-391, 2019. Doi: 10.1007/s10311-018-0807-7
3. Tsapis, N.; Bennet, D.; Jackson, B.; Weitz, D. A.; Edwards, D. A. "Trojan particles: Large porous carriers of nanoparticles for drug delivery", *PNAS*, Vol. 99, No. 19, p. 12001-12001. Doi: 10.1073/pnas.182233999