Evolution of Cyclodextrin-based Nanosponges: Green and Versatile Materials

Francesco Trotta
Co-Authors (Calibri 10)
Department of Chemistry and NIS Centre, University of Turin, Via P. Giuria 7, 10125 Torino, Italy
francesco.trotta@unito.it

The design of sustainable chemicals and chemical processes is considered a central topic to control environmental hazards and pollution. Cyclodextrin-based nanosponges (CD-NSs) are highly promising nanocarriers, valued for their biocompatibility and versatility, which has led to significant research and application in various fields. CD-NSs are successfully synthesized through a simple approach by reacting cyclodextrin (CD) unit with appropriate multifunctional cross-linking agent under specific various synthetic conditions. Over the years (Figure 1), CD-NSs have evolved from simple reaction processes to more advanced methodologies, including functionalized CD-NSs, stimuli-responsive CD-NSs, and molecularly imprinted CD-NSs. Numerous surveys have highlighted a significant shift toward greener synthetic approaches for CD-NSs, such as using water as a solvent, natural deep eutectic solvents (NADES), or mechanochemistry (solvent-free synthesis). These nanocarriers exhibit remarkable properties to enhance the solubility, bioavailability, and stability of various compounds, making them ideal candidates for drug, protein, gene, natural compounds, and gas delivery. The versatility of CD-NSs extends beyond healthcare, impacting fields such as chemistry, environment, agriculture, cosmetics, biotechnology, batteries, and additives for the preparation of mixed matrix membranes for gas separation [1, 2, 3, 4, 5].
The synthesis, characterization, and application of CD-NSs demonstrate their immense potential to address the current century challenges by reducing toxicity and advancing industrial processes.

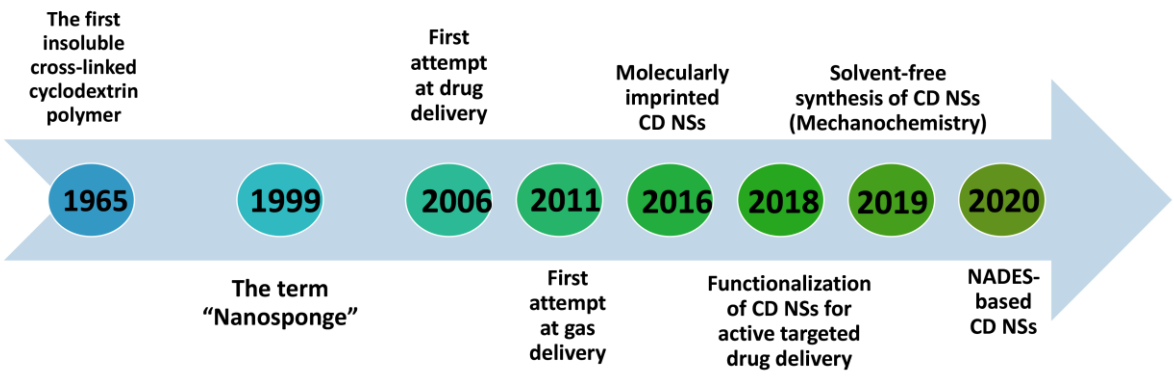

Figure 1: Timeline of the historical development of cyclodextrin-based nanosponges (CD-NSs).

References

[1] Sh. Malik, K. Muhammad, Y. Waheed, Molecules, 28, 661 (2023) 26.
[2] F. Trotta, M. Zanetti, R. Cavalli, Beilstein J. Org. Chem., 8 (2012) 2091-2099.
[3] F. Caldera, F. Trotta et al., Int J Pharm, 531, (2017) 470-479.
[4] C. Cecone, G. Hoti, F. Trotta et al., Green Chem, 22 (2020) 5806-14.
[5] A. Rubin Pedrazzo, F. Trotta, G. Hoti et al., Environmental Science and Pollution Research, 29 (2022) 251-263.