Cyclodextrin-based Nanosponges: Smart Nanocarriers for Various Applications

Francesco Trotta
Fabrizio Caldera, Claudio Cecone, Adrián Matencio, Gjylije Hoti
Department of Chemistry, University of Torino, Via P. Giuria 7, 10125 Torino, Italy
francesco.trotta@unito.it

Nanotechnology has been emerging as one of the most promising technologies of the 21st century with high applicability of the materials at the nanosize scale in many industrial fields ranging from electronics and ICT, energy, agriculture, and environment to the highly rewarding field of nanomedicine [1,2]. Recent advances in the fields of materials science, physic, and chemistry have presented many nanomaterials with distinctive properties capable of acting as nanocarriers [1]. Cyclodextrin-based nanosponges (CD-based NSs), with flexible and cost-effective production, have shown their full potential as the most promising, advanced, and biocompatible nanocarriers. CD-based NSs are cross-linked cyclodextrin-based polymers nanostructured within an insoluble three-dimensional network. They can easily be obtained by reacting the nucleophilic hydroxyl group of the selected cyclodextrin (CD) with a relevant cross-linking agent, containing two electrophilic sites using organic solvents or water. Having a highly porous nanomeric nature, CD-based NSs can encapsulate a variety of hydrophilic, lipophilic, large-sized, or small-sized substances. They are acclaimed to increase the solubility of poorly water-soluble compounds, prolonging their release, and improving their bioavailability and stability. Despite their potential for drug delivery, because of the unique features they possess, CD-based NSs are widely applicable for the delivery of genes, proteins, enzymes, gaseous compounds, etc. The list of their applications further widens in chemistry, environment, agriculture, cosmetics, food, biomedicine and biotechnology, biocatalysis, flame retardancy, additives for the preparation of mixed matrix membranes for gas separation, etc [3–7]. Therefore, it is no wonder that the demand and the need for an explosive scientific and technological revolution have increased over the years, and more advanced and innovative nanocarriers will come out year after year and outreach the market that has indicated strong growth of the nanotherapy sector.

References

[1] Bayda, S.; Adeel, M.; Tuccinardi, T.; Cordani, M.; Rizzolio, F. *Molecules*, *25 (2020)*, 1–15.
[2] Matteucci, F.; Giannantonio, R.; Calabi, F.; Agostiano, A.; Gigli, G.; Rossi, M. *AIP Conf. Proc.*, *020001* (2018), 1–25.
[3] Trotta, F.; Zanetti, M.; Cavalli, R. *Beilstein J. Org. Chem.*, *8 (2012)*, 2091–2099.
[4] Krabicová, I.; Appleton, S.L.; Tannous, M.; Hoti, G.; Caldera, F.; Pedrazzo, A.R.; Cecone, C.; Cavalli, R.; Trotta, F. *Polymers (Basel)*, *12 (2020)*, 1–23.
[5] Caldera, F.; Tannous, M.; Cavalli, R.; Zanetti, M.; Trotta, F. Evolution of Cyclodextrin Nanosponges. *Int. J. Pharm.*, *531 (2017)*, 470–479.
[6] Cavalli, R.; Trotta, F.; Tumiatti, W. Cyclodextrin-Based Nanosponges for Drug Delivery. *J. Incl. Phenom. Macrocycl. Chem.*, *56 (2006)*, 209–213.
[7] Trotta, F.; Cavalli, R. Characterization and Applications of New Hyper-Cross-Linked Cyclodextrins. *Compos. Interfaces*, *16 (2012)*, 39–48.