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Characterization of cubosomes, nanoparticles for drug delivery applications and its interaction with miltefosine, a model drug

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Nanomedicine is a growing research field nowadays. The use of nanoparticles is hoped to improve the bioavailability of drugs while decreasing undesired side effects. Therefore, nanoparticles offer both a protection for the active molecules and drugs as a carrying vehicle. Cubosomes are nanoparticles capable of storing both hydrophilic, hydrophobic and amphiphilic molecules within its structure. They have approximately 50% hydrophobic area, being able to carry more molecules than liposomes or micelles for instance. Particularly, cubosomes are quite easy to fabricate in which lipids (mainly monoglycerides (monoolein-GMO), glycolipids, urea amphiphiles, phytantriol (PHY), etc.) self-assembly in water medium. A model drug, miltefosine (MILT), was chosen as study case for the interaction with the nanoparticles, in concentrations ranging from 1% w/w to 15% w/w, added after queue cubosomal dispersion was formed. The aim was to obtain cubosomes in sizes smaller than 500nm, with controlled polydispersion. PHY-based cubosomes were reproducible from the chosen bottom-up approach protocol and studied in PBS and AcPhBo (pH 4.5) buffer. SAXS reveals nanoparticles with crystallographic structure Pn3m and lattice parameter 6.74(07)nm. DLS presents particles with mean diameter ~450nm and moderate polydispersion 0.161(10). TEM and cryo-EM reveals particles with internal structure and varied sizes, confirming DLS polydispersion. NTA measurements reveal particle concentration approximately 10^16 particles/mL. Up to 5% w/w the cubosomes incorporated MILT without loss of crystallographic structure, but at 10%, 15% and 20% w/w, the drug provoked phase change for Im3m symmetry. At the lower concentrations, MILT enlarged the lattice parameter of cubosomes and it was hypothesized that MILT inserted itself into the bilayer of the nanoparticles. GMO-based cubosomes were produced by a proposed bottom-up approach, in both PBS and AcPhBo (pH 4.5) buffer. Nanoparticles presented crystallographic structure Im3m and lattice parameter ~12.30(12) nm, differently from PHY-cubosomes. DLS revealed particle mean diameter ~300nm an low polydispersion 0.100(21). TEM presents particles with varied size. Up to 4% MILT incorporated into the cubosomes and enlarged the lattice parameter, also being hypothesized to be in the lipidic bilayer of the water channels. Experiments to encapsulate higher amounts of MILT are undergoing, as well as encapsulation efficiency for both GMO and PHY cubosomes.

Biography

Barbara Malheiros is a physicist by the University of Sao Paulo (Brazil), during her undergraduate, she had an exchange period at University of Groningen, working with thermal simulations for a slit system at the FAIR facility. After finishing her undergraduate, she followed a master in sciences through the Faculty of Pharmaceutical Sciences in a very interdisciplinary project, in which a nanoparticle was characterized by biophysical experiments. There, she gained some experience with both nanoparticle production and electron microscopy (conventional and cryo-EM). Some biophysical techniques were learned in the master, like small angle X-rays scattering (SAXS) and dynamic light scattering (DLS), along with electron microscopy. She also has some experience with programming in python for data analysis. Today, she is already enrolled for a PhD at University of Antwerp for working with polymorphism of organic molecules in order to better understand these structures and their potential medical applications.

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