marine drugs

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Review

Novel Drug and Gene Delivery System and Imaging Agent Based on Marine Diatom Biosilica Nanoparticles

Hanaa Ali Hussein [1], Muhammad Shahid Nazir [2], Nizakat Azra [2], Zeenat Qamar [2], Azman Seeni [3], Tengku Ahmad Damitri Al-Astani Tengku Din [4,*] and Mohd Azmuddin Abdullah [3,5,*]

1 College of Dentistry, University of Basrah, Basrah 61004, Iraq; hanaazahraa85@gmail.com
2 Department of Chemistry, COMSATS University Islamabad, Lahore Campus, Lahore 54000, Punjab, Pakistan; shahid.nazir@cuilahore.edu.pk (M.S.N.); azranizakat@gmail.com (N.A.); zeenatqamar90@gmail.com (Z.Q.)
3 Department of Toxicology, Advanced Medical and Dental Institute, Universiti Sains Malaysia, Bertam Campus, Kepala Batas 13050, Malaysia; azmanseeni@usm.my
4 Department of Chemical Pathology, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian 16150, Malaysia
5 SIBCo Medical and Pharmaceuticals Sdn. Bhd., No. 2, Level 5, Jalan Tengku Ampuan Zabedah, D9/D, Seksyen 9, Shah Alam 40000, Malaysia
* Correspondence: damitri@usm.my (T.A.D.A.-A.T.D.); joule1602@gmail.com (M.A.A.); Tel.: +60-13-959-2636 (T.A.D.A.-A.T.D.); +60-16-698-3802 (M.A.A.)

Abstract: Mesoporous silica nanoparticles (MSNs) have great potential for applications as a drug delivery system (DDS) due to their unique properties such as large pore size, high surface area, biocompatibility, biodegradability, and stable aqueous dispersion. The MSN-mediated DDS can carry chemotherapeutic agents, optical sensors, photothermal agents, short interfering RNA (siRNA), and gene therapeutic agents. The MSN-assisted imaging techniques are applicable in cancer diagnosis. However, their synthesis via a chemical route requires toxic chemicals and is challenging, time-consuming, and energy-intensive, making the process expensive and non-viable. Fortunately, nature has provided a viable alternative material in the form of biosilica from marine resources. In this review, the applications of biosilica nanoparticles synthesized from marine diatoms in the field of drug delivery, biosensing, imaging agents, and regenerative medicine, are highlighted. Insights into the use of biosilica in the field of DDSs are elaborated, with a focus on different strategies to improve the physico-chemical properties with regards to drug loading and release efficiency, targeted delivery, and site-specific binding capacity by surface functionalization. The limitations, as well as the future scope to develop them as potential drug delivery vehicles and imaging agents, in the overall therapeutic management, are discussed.

Keywords: biosilica nanoparticle; diatoms; drug delivery system; gene therapy; imaging agent

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1. Introduction

A DDS-based on nanoparticles (NPs) is essential in cancer treatment. Compared to conventional DDS, a NP-based DDS shows enhanced efficacy by increasing the half-life of the drugs or proteins for a slow release from the carrier, improving the hydrophobic drug's solubility and allowing a controlled and targeted drug release at the diseased site [1]. Nanomaterials have found wide applications in synergistic platforms for cancer therapy such as photodynamic, immuno, chemo, and photothermal therapy, and for medical imaging, which includes computed tomography, magnetic resonance imaging, single-photon computed tomography, positron emission tomography, optical imaging, photoacoustic imaging, and ultrasound [2]. The major issues with the traditional pharmacological drug administration are a poor solubility, a short half-life, systemic toxicity, and drug disintegration before reaching the targeted site. The DDS therefore offers great potentials to overcome these constraints. Various types of nanocarriers have been developed for drug delivery as shown in Table 1, each with its own unique features, advantages, and disadvantages.