ABSTRACT

In recent years diatoms have gained the attention of scientists for their ability to accumulate triglyceride (TAG), polyunsaturated fatty acids (PUFA), fucoxanthin, chrysolaminarin, and their three-dimensional perforated siliceous shells called frustulse, which have various industrial and pharmaceutical applications. The presence of the frustule allows diatoms to successfully defend their cell from toxic compounds in the marine environment. As a result, diatoms have become the most studied group of microalgae in terms of water toxicological assessment. Water pollution from industrial processes is a major concern, as synthetic compounds could have negative effects on the ecosystems, aquatic organisms, and human health. This study focuses on investigating the potential of the porous diatom biosilica extracted from the marine diatoms *Nanofrustulum wachnickianum* (strain SZCZCH193), *N. shiloi* (SZCZM1342), *N.* cf. *shiloi* (SZCZP1809), *Halamphora* cf. *salinicola* (SZCZM1454), and *Pseudostaurosira trainorii* (BA170) for their dye and phenol removal potential.

The research investigates the growth of different diatom strains under various culturing conditions and develops a culturing protocol that will allow to yield the highest biomass. The porous nature of the biosilica was evaluated through SEM studies of the macropore and the low temperature nitrogen adsorption/desorption isotherm for the meso- and micropore distribution. Diatom Fe^{3+} reduction capacity has been examined, establishing a novel method for green biosynthesis of iron oxide nanoparticles. The assessment of the molecular and crystalline structure, surface charge, the thermal stability, and purity has been performed to further understand the nature of the biosilica. The adsorption capacity of the cationic and anionic dyes of the studied diatom biosilica was comparable to that of activated carbon, a widely used commercial adsorbent, suggesting its potential as an environmentally friendly adsorbent for wastewater treatment. The adsorption efficiency of the diatom biosilica was higher for the cationic dyes due to the formation of a strong electrostatic bond, while the anionic dye was repulsed by the negative charge on the surface of the frustule. The photocatalytic activity of the diatom biosilica was significantly enhanced through the decoration of the surface with iron oxide nanoparticles. Therefore, the non-modified diatom biosilica could be used as a novel eco-friendly bio-originated adsorbent of cationic and anionic dyes, while controlled green modification of the frustule presents a potential for photocatalytic degradation of phenolic compounds. Through modification of the diatom biosilica with various metals in a controlled manner, it was possible to obtain innovative biomaterial with new properties.

Keywords: *Nanofrustulum*, *Halamphora*, *Pseudostaurosira*, adsorption, photodegradation, methylene blue, congo red, crystal violet, malachite green, nitrophenol, iron nanoparticles, biosynthesis, growth rate

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