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Systematic approach for preparation of chitosan nanoparticles via emulsion crosslinking as potential adsorbent in wastewater treatment

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Highlights

- Synthesis of narrowly distributed crosslinked nanoparticles of different chitosans.
- Emulsion stability and particle yield increased by adding a hydrophile.
- Particle size depends on chitosan molecular weight.
- Adsorption of Diclofenac increases with decreasing nanoparticle particle size.

Abstract

This study investigates the impact of glutaraldehyde (glut) concentration and molecular weight (MW) of six commercially available, highly deacetylated chitosans (Chi) on nanoparticle (Chi-NP) formation by emulsion crosslinking technique and their use as potential adsorber for diclofenac (DCL) and carbamazepine (CBZ). With a glut:primary amine ratio of 1:1 and NaCl as a hydrophile, it was possible to reproducibly synthesize narrowly distributed, spherical Chi-NPs over a broad range of chitosan MW with a high yield. Increasing Chi MW resulted in larger particle sizes ranging from 109.9 nm, for lowest MW, up to 200.3 nm for the highest MW, measured by DLS. To evaluate the static adsorption behavior of the Chi-NPs, CBZ and DCL were used in single point adsorption experiments. An adsorption capacity of up to 351.8 mg g⁻¹ DCL for low MW Chi-NPs was observed and all Chi-NPs showed superior adsorptions when compared to untreated Chi.

Keywords: chitosan nanoparticles; emulsion crosslinking; adsorption; active pharmaceutical ingredients (API); wastewater treatment

Introduction

Providing clean water will be one of the major challenges of the next decades to come. Beside oxidation processes, one of the main ways for water remediation is adsorption of the pollutants by activated carbon (Westerhoff, Yoon, Snyder, & Wert, 2005). Since the beginning of the 21st century, the appearance of active pharmaceutical ingredients (APIs) in the aquatic environment, particularly in drinking water, has been a major concern. Several priority lists for APIs have been established using different prioritizing parameters (Singer, Wössner, McArdeall, & Fenner, 2016). Two of these substances – namely diclofenac (DCL) and carbamazepine (CBZ) – are the most frequently detected ones (Y. Zhang, Geißen, & Gal, 2008). The development of a recyclable adsorber system with a high adsorption capacity could be a viable alternative for the

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