JOURNAL OF BIOMOLECULAR STRUCTURE AND DYNAMICS
https://doi.org/10.1080/07391102.2023.2202279

Preparation and evaluation *in vitro* release of sodium alginate/chitosan polyelectrolyte microparticles containing rifampicin and theoretical study using DFT methods

Nadia A. Hussein Al-Assady[a], Hussain A. Badran[b], Sarah A. Kamil[a] and Ryadh Ch. Abo-Alhal[b]

[a]Department of Chemistry, College of Education for Pure Science, University of Basrah, Basrah, Iraq; [b]Department of Physics, College of Education for Pure Science, University of Basrah, Basrah, Iraq

Communicated by Ramaswamy H. Sarma

ABSTRACT

In this work, rifampicin-loaded sodium alginate/chitosan polyelectrolyte microparticles were prepared by the ionotropic gelation technique using $CaCl_2$ as a cross-linking agent. The influence of different sodium alginate and chitosan concentrations on particle size, surface properties, and *in vitro* release behavior was studied. An infrared spectroscopy investigation verified the lack of any drug–polymer interaction. The microparticles prepared using (30, 50) mg of sodium alginate were spherical while when using 75 mg of sodium alginate, vesicles with round heads and tapered tails were formed. The results showed that the microparticle diameters were between (11.872–35.3645) μm. The amount of rifampicin released and the kinetics of drug release from microparticles were studied, and the results showed that by increasing the concentration of the polymer, the release of the rifampicin from the microparticles decreased. The findings showed that rifampicin release followed zero-order kinetics and that drug release from these particles is frequently influenced by diffusion. The electronic structure and characteristics of the conjugated polymers (sodium alginate/Chitosan) were examined using density functional theory (DFT) and PM3 calculations with Gaussian 9, using the B3LYP, and electronic structure calculations using 6–311 G (d,p). The HOMO and LUMO energy levels are determined as the HOMO's maximum and the LUMO's minimum, respectively.

ARTICLE HISTORY
Received 15 October 2022
Accepted 8 April 2023

KEYWORDS
DFT; HOMO & LUMO; rifampicin; sodium alginate/chitosan polyelectrolyte

1. Introduction

With the progress in the field of biotechnology and combinatorial chemistry, and due to the problems associated with many new medicines such as low solubility rate, high efficacy, and poor stability of many of them, the most effective and targeted treatments are currently being created (Patel et al.,2016, Sabzini et al., 2023, Maryam et al., 2022). The means of medicine delivery can affect the effectiveness and marketability of the medicine as much as the drug itself (Fatemeh et al., 2022, Narges et al., 2022). Therefore, it has become necessary to deliver therapeutic agents to the target tissue in an ideal quantity and the correct period, with less toxicity and fewer side effects. There are different methods for delivering the therapeutic substance to the target site in constant controlled release patterns (Sohrab et al., 2022) and one of these methods is the use of microparticles as drug carriers (Mari et al., 2014). Microparticles are minuscule spherical particles that range in size from (1–1000 m) and are made up of one or more immiscible polymers with drug particles scattered throughout (Vos et al.,2014). Chemotherapy, cardiovascular illness, hormone treatment, therapeutic proton delivery, and vaccine research are just a few uses of microparticles in controlled drug-release systems (Patra et al., 2018).

Electrostatic interaction between two oppositely charged polyelectrolyte solutions produces sodium alginate/chitosan polyelectrolyte (SA/CH PE) (Kumar et al., 2018). Many investigations have been conducted on the use of (SA/CH PE) in medicine (Hamid et al., 2019; Buriuli &Verma 2017). Based on the electrostatic interactions between carboxylate alginate groups (COO^-) and ammonium chitosan groups (NH_3^+), chitosan, a polysaccharide formed by alkaline deacetylation of chitin, has been used to support alginate microparticles. (SA/CH PE) erode slowly in phosphate buffer and this behavior leads to suppression of the initial release of drugs occurring in uncoated microparticles (Meng et al., 2010). These microparticles are usually made in two stages, with premade alginate microparticles being recovered and then coated with chitosan (Luo &Wang, 2014). Chitosan coating of low-sizing alginate microparticles is a cumbersome operation, thus doing it during the procedure using a simple approach might be a viable option (Moghimi et al., 2016). It would also aid in the retention of encapsulation during emulsification.

Rifampicin ($C_{43}H_{58}N_4O_{12}$) Figure 1 is an antibiotic with activity against many types of bacteria that cause tuberculosis, leprosy, meningitis, and brucellosis. Common side effects include nausea, vomiting, loss of appetite, and diarrhea. It has the most serious side effects, including

CONTACT Hussain A. Badran hussain_badran@yahoo.com