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A model system to investigate drug loading and releasing using bacterial nanocellulose and bovine serum albumin

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In the present study, the applicability of freeze dried bacterial nanocellulose (fd-BNC) synthesized by Gluconacetobacter spp. as a drug delivery matrix for proteins using Bovine Serum Albumin (BSA) as a model drug was systematically investigated. BSA was chosen because of its high-water solubility, abundance, good stability, and wide acceptance. BNC possesses superior mechanical (high tensile strength), chemical (hydrophilicity, high degree of polymerization, crystallization), and biological (non-cytotoxic, non-biodegradable, high purity) properties. The study focused on investigating different drug concentrations of BSA—2, 5, 10, 20 (mg/ml)—dissolved in phosphate buffered saline (PBS) adsorbed and released from pre-swelled BNC hydrogel at predetermined time points under shaking conditions,at room temperature. The loading profile, determined byUV absorbance spectrometry at 278 nm,demonstrated mean loaded BSA amounts of 1.65 (± 0.11), 3.02 (± 0.41), 7.04 (± 0.66), and 13.52 (± 0.53) (mg) after 48 hours for 2, 5, 10, and 20 mg/ml, respectively. The regression coefficient (r^2) of the equilibrium loading isotherm was 0.9965. Higher BSA adsorption may be due to the fine network of nanofiber structure in BNC. Drug loading stabilized after the initial 8 hours, and was controlled mainly by diffusion, whereas no saturation effects were observed. The release profile indicated a 'burst release' during the initial 8 hours, followed by a controlled release. The mean released amount of 2, 5, 10, and 20 (mg/ml) BSA concentrations were 1.12 (± 0.19), 2.89 (± 0.27), 5.59 (± 0.44) and 10.37 (± 0.53) (mg) respectively. The release stabilized after 8 hours, with a constant amount of the drug being released. Diffusion exponent (n) values were 0.65, 0.67, 0.79, and 0.69 for 2, 5, 10, and 20 (mg/ml) BSA. The Ritger–Peppas Power law model suggested that the studied BSA-fd-BNC system's drug transport mechanism is Non-Fickian (anomalous), an overlay of diffusion and swelling controlled release being observed. The present study suggests BNC as an innovative and attractive biopolymer for controlled drug delivery.

Keywords: Bacterial nanocellulose, controlled release, bovine serum albumin, anomalous diffusion

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