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Comparative photostability of curcumin in its free, zein-encapsulated, and β-cyclodextrin-complexed forms

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Highlights

- The photostability and degradation kinetics of free curcumin (CUR) were evaluated under exposure to 365 nm and 465 nm light.
- CUR was encapsulated in zein nanocapsules (NCUR) to enhance its photostability under 465 nm light exposure.
- Encapsulation significantly improved CUR photostability, particularly when assessed using remission spectrophotometry in solid-state materials.

Abstract

Curcumin (CUR), a bioactive compound derived from turmeric (a plant widely used in culinary and medicinal contexts), has many biological effects. However, CUR exhibits poor photostability and bioavailability, limiting its practical applications. This study investigates two strategies to enhance CUR photostability: the formation of an inclusion complex with β-cyclodextrin (IC) and encapsulation in zein-based nanocapsules (NCUR). CUR was extracted from dry rhizome powder via Soxhlet extraction using ethanol and characterized by UV-Vis, fluorescence, infrared spectroscopy, and thin-layer chromatography (TLC). Its antioxidant activity was assessed using the DPPH assay, yielding a CE_{50} of 4.67 μmol L^{-1} . The IC was prepared by stirring β-cyclodextrin in water with gradual addition of ethanolic extract of CUR, while NCUR was obtained via nanoprecipitation with zein in ethanol: water, 85% v/v. Photostability of free CUR and NCUR was evaluated under LED irradiation at 465 nm by measuring the colour changing using UV-Vis and reflectance spectroscopy.Characterization confirmed that the extracted CUR matched commercial standards. Photodegradation kinetics of free CUR followed a first-order model (Fig. 1a and 1b). DLS analysis revealed zein nanocapsules with an average size of 259.7 nm (PDI: 0.152), and Zeta potential of –6.49 mV, while NCUR measured 445.3 nm (PDI: 0.419, Zeta potential: –29.70 mV), with encapsulation efficiency close to 100%. Photodegradation studies showed that encapsulated CUR retained its yellow coloration significantly longer than free CUR, indicating effective protection (Fig. 1c) . In contrast, the IC degraded more rapidly, suggesting that zein encapsulation offers superior photostability enhancement. Future work will explore additional parameters to further optimize CUR stabilization.

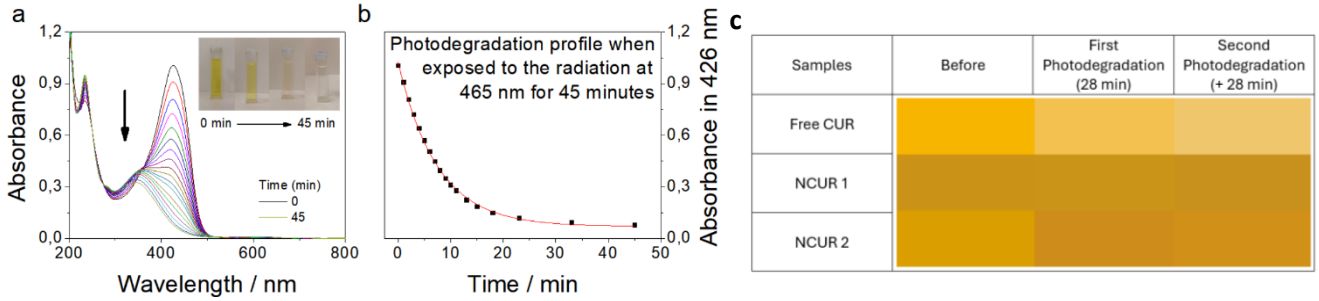

Figure 1: a) Photodegradation of CUR exposed to 465 nm radiation for 45 minutes; b) Photodegradation profile of "a" graph and data fitting for first-order kinetics; c) Table relating measures of reflectance spectroscopy during NCUR photo expositions at 465 nm.

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