

The Potential Anticancer Activity of 5-Fluorouracil Loaded in Cellulose Fibers Isolated from Rice Straw

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Introduction: Green-based materials have been increasingly studied to circumvent off-target cytotoxicity and other side-effects from conventional chemotherapy.

Materials and Methods: Here, cellulose fibers (CF) were isolated from rice straw (RS) waste by using an eco-friendly alkali treatment. The CF network served as an anticancer drug carrier for 5-fluorouracil (5-FU). The physicochemical and thermal properties of CF, pure 5-FU drug, and the 5-FU-loaded CF (CF/5-FU) samples were evaluated. The samples were assessed for in vitro cytotoxicity assays using human colorectal cancer (HCT116) and normal (CCD112) cell lines, along with human nasopharyngeal cancer (HONE-1) and normal (NP 460) cell lines after 72-hours of treatment.

Results: XRD and FTIR revealed the successful alkali treatment of RS to isolate CF with high purity and crystallinity. Compared to RS, the alkali-treated CF showed an almost fourfold increase in surface area and zeta potential of up to -33.61 mV. SEM images illustrated the CF network with a rod-shaped structure and comprised of ordered aggregated cellulose. TGA results proved that the thermal stability of 5-FU increased within the drug carrier. Based on UV-spectroscopy measurements for 5-FU loading into CF, drug loading encapsulation efficiency was estimated to be $83 \pm 0.8\%$. The release media at pH 7.4 and pH 1.2 showed a maximum drug release of 79% and 46%, respectively, over 24 hours. In cytotoxicity assays, CF showed almost no damage, while pure 5-FU killed most of the both normal and cancer cells. Impressively, the drug-loaded sample of CF/5-FU at a $250 \mu\text{g}/\text{mL}$ concentration demonstrated a 58% inhibition against colorectal cancer cells, but only a 23% inhibition against normal colorectal cells. Further, a $62.50 \mu\text{g}/\text{mL}$ concentration of CF/5FU eliminated 71% and 39% of nasopharyngeal carcinoma and normal nasopharyngeal cells, respectively.

Discussion: This study, therefore, showed the strong potential anticancer activity of the novel CF/5-FU formulations, warranting their further investigation.

Keywords: rice straw, cellulose fibers, 5-fluorouracil, drug delivery, cytotoxicity assays, cancer treatment

Introduction

Over the years, researchers have been continuously interested in using agro-waste for producing eco-friendly materials to decrease environmental issues, including toxicity and a reduction in landfill space.^{1,2} For example, burning rice straw (RS), which represents the second highest agro-waste, causes health risks from air pollution and effects organic matter with large nutrient losses.³ It should be noted that similar to other plant-based resources, RS contains a high ratio of cellulose fibers (CF) ($\text{C}_6\text{H}_{10}\text{O}_5$).⁴ CF as one of the unique and abundant organic polymers on earth, is becoming more and more popular for different applications. It contains a high

