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Title: Synthesis and characterization of carbon quantum dots from postbiotics of *Saccharomyces cerevisiae* and its application in meat active packaging

Abstract

Carbon quantum dots were synthesized from postbiotic of Saccharomyces cerevisiae by hydrothermal method. The characterization of carbon quantum dots was confirmed and characterized by particle size analysis, transmission electron microscopy, UV-Visible spectroscopy, FTIR, and XPS spectroscopy. N and P doped carbon quantum dots (~4.1 nm) showed dose-dependent antimicrobial activity against Gram-positive, Gram-negative and fungal strains. Antioxidant properties of carbon quantum dots were investigated by DPPH and FRAP methods. Based on the MTT test, carbon quantum dots were non-toxic at less than 3.5 mg/mL concentrations in human colon cancer cell line (HCT-116) and TM4 cells (mouse Sertoli cell line). In addition, carbon quantum dots incoprated with bacterial nanocellulose were used as an antimicrobial film. This film showed toxicity only at 38.5 mg/cm3 compared to the control. The nanocellulose film containing carbon quantum dots showed antimicrobial activity against 9 selected microorganisms. Also, the effect of using nanocellulose film containing carbon quantum dots with different concentrations of 16.6 and 22.5 (mg/cm3) on the shelf life and inoculated Escherichia coli was evaluated in ground beef stored at 4°C for 9 days. The treatment which contain carbon quantum dots with a concentration of 22.5 mg/cm3 decreased the total count of psychrophilic and mesophilic more than 2 (Log10 CFU/g) compared to the control. The total contact of Escherichia coli bacteria in the nanocellulose film containing carbon quantum dots with a concentration of 22.3 mg/cm3 decreased by 5.3 (Log10 CFU/g) after 9 days of storage at 4°C compared to the control. The synthesized carbon quantom dots and nanocellulose film with incopration of carbon quantum dots can be considered as potential antimicrobial/antioxidant additive and antimicrobial packaging material, respectively.

Keywords: *Saccharomyces cerevisiae*, Active packaging, Carbon quantum dots, Postbiotics, Nanomaterials.