

**Summary of the PhD thesis No:10603, Faculty of Veterinary Medicine, Urmia University.**

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**Title:** Antibacterial and antioxidant properties of carbon quantum dots synthesized from whey and its application in salep-based edible coating for red meat packaging

## **Abstract**

Whey protein is rich in proteins such as beta and alpha lactoglobulins and all essential amino acids, which are a natural source of carbon and nitrogen and can be used to prepare carbon quantum dots (CQDs). CQDs were synthesized from sour whey by hydrothermal method. CQDs were characterized by FTIR, UV-Vis, XRD and XPS. The particle size and shape of CQDs were also obtained by PSA and TEM analysis. CQDs synthesized from sour whey showed high antimicrobial activity against foodborne pathogens. The antioxidant properties of CQDs were investigated using DPPH, FRAP and ABTS methods and they showed high antioxidant properties. Cytotoxicity of CQDs was investigated by MTT method and they were known to be toxic on human colon cancer cell line (HCT-116) at concentrations higher than 5 mg/ml. The minimum inhibitory concentration and the minimum bactericidal concentration of CQDs on Gram-positive bacteria (*Listeria monocytogenes* and *Staphylococcus aureus*) and Gram-negative bacteria (*Escherichia coli* and *Salmonella Typhimurium*) were 1000 and 5000 ppm, respectively. In addition, the evaluation of the inactivation kinetics of 4 foodborne pathogens was done using two Log-Linear and Weibull models and it led to a decrease of 2 logarithmic cycles in all bacteria. Also, CQDs were used in combination with Salep as an antimicrobial coating. Salep coating containing CQDs in concentrations of 2500 and 5000 ppm showed antimicrobial effect against four foodborne pathogens. The effect of Salep coating containing CQDs with two concentrations of 2500 and 5000 ppm on the shelf life and population of *E. coli* O157H7 inoculated in beef meat for 16 days at 7 °C was investigated. The treatment containing 5000 ppm CQDs reduced the population of mesophilic and psychrotrophic bacteria by 4.82 and 4.04 logarithmic cycles, respectively, compared to the control treatment. Also, the population of *E. coli* bacteria decreased by 1.8 logarithmic cycles during 16 days of storage at a concentration of 5000 ppm CQDs compared to the control treatment. In addition, it reduced the levels of TVB-N and TBA on the 16th day of storage by 6.77 mg per 100 g of meat and 1.3 mg of malondialdehyde per kg of meat, respectively. CQDs synthesized from sour whey and Salep coating containing CQDs can be used as an antimicrobial and antioxidant compound in food coating as antimicrobial packaging.

**Keywords:** Green synthesis, CQDs, Dairy by-products, sour whey, antimicrobial activity, active packaging