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First attempts to control microbial contamination of strawberries by ZnO nanoparticles

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Introduction: It is well documented that most of the harmful and pathogenic microorganisms are able to develop high resistance to many conventional chemical fungicides and disinfectants. During the past decade the emphasis in food protection has shifted from using chemicals to various alternative techniques. Recently antimicrobial nanotechnologies have the potential to play a critical role in crop protection, water disinfection and food safety.

Objective: Evaluation of antimicrobial properties and mechanism of action of nano-sized light-activated ZnO particles with aim to apply them for preservation of strawberries.

Methodology: The antibacterial activity of photoactivated ZnO nanoparticles (ZnO NPs) (λ=400 nm) against *Escherichia coli* O157:H_7, *Listeria monocytogenes* $ATCL_3C$ 7644 and *Botrytis cinerea* was investigated *in vitro*. Strawberries were sprayed ZnO nanoparticles ($4x10^{-5}$M and illuminated with visible light (λ=400 nm, 76 J/cm^2).

Results & Discussion: Data indicate that photoactivated ZnO NPs (200 nm) have strong bactericidal activity against Gram (+) and Gram (-) bacteria, achieving more than 7 log reductions in bacterial counts. Scanning electron microscopy (SEM) images of treated bacteria indicated cell wall disintegration and cell lysis. Results obtained on examinations of antifungal activity of ZnO NPs reveal remarkable photoinactivation (58%) of *B. cinerea* growth at concentration $1×10^{-3}$ – $5×10^{-3}$ mol l-1 and incubation time 24h. SEM data analysis confirmed substantial morphological changes in microfungus. Photoactivated ZnO NPs, sprayed on the surface of strawberries can reduce the microbial contamination by 95%. No impact on strawberry antioxidant activity, amount of total phenols, anthocianins, ascorbic acid have been found. Moreover, no harmful effects were observed on strawberry visual quality and color. Just fruit firmness reduced by10%.

Conclusion: Such ZnO NPs properties obviously could be used for the development of effective fungicides in agriculture or innovative non-thermal antibacterial technique, so important in food microbial control.

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Electrical properties of graphene/CNT hybrid films

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Graphene (G) and graphene oxide (GO)/carbon nanotubes (CNTs) hybrid films were fabricated as high performance electrode materials by a simple water solution casting method with different contents of single-wall CNT (SWCNT), multi wall CNT (MWCNT) and multi wall CNT with hydroxyl group (MWCNT- OH). The films with MWCNTs showed a layered, interconnected and well entangled structure at nano- scale. Such layer structures resulted in excellent surface finish and good mechanical properties. With increasing CNT contents, the capacitance of the G/MWCNT and GO/MWCNT films raised almost linearly and their resistance reduced. G/SWCNT and GO/SWCNT films did not form layered structures leading to a very low capacitance. The film length and thickness of the G/MWCNT and GO/MWCNT films have significant influences on the capacitance. As the length increased, the maximal capacitance and conductivity values decreased. However, both were found to be increased with increasing thickness. The maximal specific capacitance reached 130.68 F/g when the thickness of the G/MWCNT hybrid thin film was 96 μm. It also showed a maximum conductivity of 44 S/cm in the 60wt% graphene/40wt% MWCNT film. On the other hand, nonlinear behaviour which could be quantum effect of capacitance during scanning with voltage was observed in the G/MWCNT and GO/MWCNT films.

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