

Influence of morphology on functional activity and performance of ZnO NP for application in food packaging

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Abstract

Nanotechnology has been used in food packaging to improve material properties such as barrier to gases, thermal and light stability, and mechanical strength, offering active and intelligent functionalities that assure protection and preservation, in particular together with biobased materials due to requirements for using less plastic packaging.

Zinc oxide nanoparticle (ZnO NP) has received a positive safety evaluation from EFSA for packaging applications as transparent UV absorbers based on absence of significant migration in particulate form. It is also considered GRAS by the FDA. ZnO NP are also known to have good antimicrobial properties and therefore are suitable to be applied as active compounds. Despite the abundant literature addressing the use of ZnO NP as antimicrobial component in packaging materials, the effect of particles size and morphology on the activity against different microorganisms is still poorly studied.

In this project the impact of different shapes (spherical, sheet and flower) and sizes of nanoparticles was studied in their antimicrobial activity against *E.coli* and *S.aureus*. The effect of temperature (4, 10 and 22°C) in the antimicrobial activity was also studied. The performance of the nanoparticles on UV-VIS absorption, antioxidant activity (DPPH and ABTS assays) and ROS generation (EPR) was also studied.

The sheet shape nanoparticles showed the highest antimicrobial activity. The cell count reduction depends on shape, bacteria and temperature. The effect of temperature and time on the bacteria inhibition was simulated by the Weibull model ($R^2 \geq 0.970$). The absorption at 375 nm was highest for the flower shape and the EPR data showed equivalent ROS generation for the different shapes. Nevertheless, the antioxidant activity was not confirmed.

The incorporation of ZnO NP sheet shaped in packaging materials as antimicrobial can be a viable approach to increase the product shelf life.