XIV CICTED
CONGRESSO INTERNACIONAL DE CIÊNCIA, TECNOLOGIA E DESENVOLVIMENTO

APPLICATION OF CuO AND ZnO NANOPARTICLES AND ZnO–CuO HETEROSTRUCTURES IN PECTIN FILMS: AN APPROACH TO ANTIMICROBIAL ACTIVITY

SDG 9

Industry, Innovation and Infrastructure

Natália Vitória Garcia Mendes (University of Sao Paulo - EEL USP),
Nicoly Milhardo Lourenço Nohara (University of Sao Paulo - EEL USP),
Maria Clara Sinibaldi Suffredini De Marchi (University of Sao Paulo - EEL USP) and
Eduardo Rezende Triboni (University of Sao Paulo - EEL USP)

Introduction

Microbial resistance to antibiotics is a recurring problem in infectious processes. Therefore, it becomes important to study materials that possess a broad spectrum of antimicrobial activity. Nanoparticles (1-100 nm) have drawn much attention due to their morphology, size and distribution (Buzea et al., 2007). Metallic nanoparticles can be made of many metals, as Au, Ag, Cu, Fe, Zn, Cu etc (Król et al., 2017), one of their application is as antimicrobial agents (Hanley et al., 2008; Król et al., 2017). Some studies have shown their activity against different microorganisms. Nanoparticles made of copper and zinc, in turn, are interesting because of their accessibility and affordability, comparing to gold and silver (Usman et al., 2013; Król et al., 2017). This study aims to compare the antimicrobial activity of pure ZnO, CuO and heterostructures of ZnO and CuO.

Literature review

Nanoparticles, mainly metal and metal oxide nanoparticles have effectively treated infectious diseases in response to antibiotic failure due to microbial resistance. Studies have shown that metal nanoparticles such as silver (Ag), copper (Cu), copper oxide (CuO), and gold (Au) display broad antimicrobial effects against a variety of microorganisms, including fungi as well as Gram-positive and Gram-negative bacteria. In particular, antibacterial effects have been observed against *Escherichia coli* (Cho et al., 2005; Chatterjee et al., 2012) and non-resistant strains of Gram-positive bacteria like *Staphylococcus*

aureus (Durán et al., 2007) with findings indicating that the presence of these nanoparticles can inhibit microbial growth.

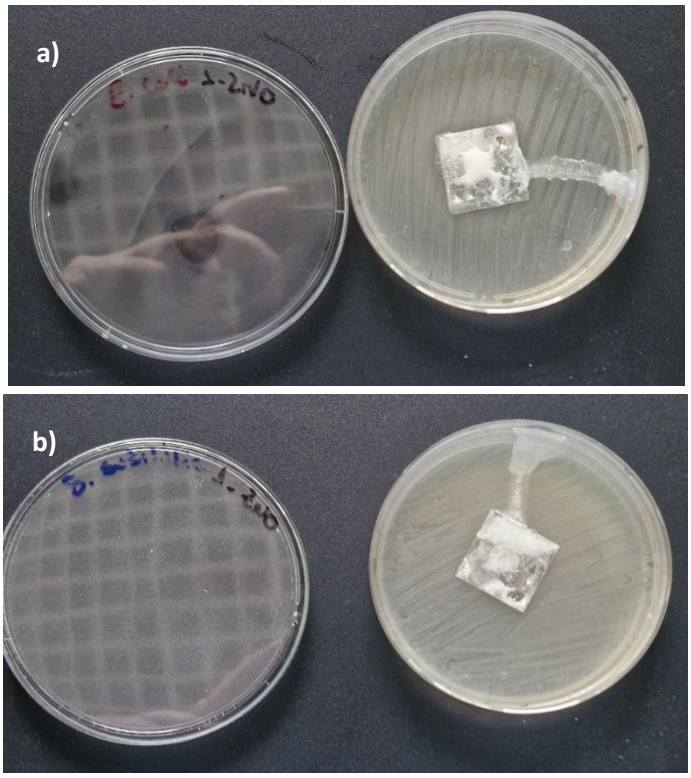
Method

Nanoparticles were synthesized using the glycerol–solvent method (Triboni et al., 2023), and films were prepared by the casting method. The film-forming solutions were produced by adding 1 g of pectin to 45 mL of distilled water, followed by the addition of glycerol at a 1:0.7 ratio. Nanoparticles were then incorporated at a 1:0.6 ratio relative to the polysaccharide under stirring at 20,000 rpm. The antimicrobial activity was evaluated using the halo inhibition test.

Results or Expected Results

Preliminary results (Figure 1) were obtained regarding pure zinc oxide nanoparticles, showing good activity against *Escherichia coli*. Meanwhile, no significant antimicrobial activity was detected against *Bacillus subtilis*.

Figure 1 - Halo inhibition test of pure ZnO in pectin films



Halo inhibition test against: a) *E. coli; b) B. subtilis.*

Conclusions or Final considerations

Preliminary tests showed that the nanoparticles exhibited positive activity against Gram-negative *(E. coli)* bacteria; however, no significant activity has been detected against Gram-positive bactéria *(B. subtilis)* so far. Further studies will be conducted with ZnO-CuO heterostructures and CuO nanoparticles.

References

BASU, T.; CHATTERJEE, A. K.; SARKAR, R. K.; CHATTOPADHYAY, A. P.; AICH, P.; CHAKRABORTY, R. A simple robust method for synthesis of metallic copper nanoparticles of high antibacterial potency against *E. coli*. *Nanotechnology*, v. 23, n. 11, p. 111, 2012.

BUZEA, C.; PACHECO, I. I.; ROBBIE, K. Biointerphases, 2007; 2:17–71.

CHO, K. H.; PARK, J. E.; OSAKA, T.; PARK, S. G. The study of antimicrobial activity and preservative effects of nanosilver ingredient. *Electrochimica Acta*, v. 51, p. 1956–1960, 2005.

CHATTERJEE, A. K.; SARKAR, R. K.; CHATTOPADHYAY, A. P.; AICH, P.; CHAKRABORTY, R.; BASU, T. A simple robust method for synthesis of metallic copper nanoparticles of high antibacterial potency against *E. coli*. *Nanotechnology*, v. 23, n. 11, p. 111, 2012.

DURÁN, N.; MARCATO, P. D.; DE SOUZA, G. I.; ALVES, O. L.; ESPOSITO, E. Antibacterial effect of silver nanoparticles produced by fungal process on textile fabrics and their effluent treatment. *Journal of Biomedical Nanotechnology*, v. 3, p. 203–208, 2007.

HANLEY, C.; LAYNE, J.; PUNNOOSE, A.; REDDY, K. M.; COOMBS, I.; COOMBS, A.; FERIS, K.; WINGETT, D. Preferential killing of cancer cells and activated human T cells using ZnO nanoparticles. *Nanotechnology*, v. 19, n. 29, p. 295103, jun. 2008. DOI: 10.1088/0957-4484/19/29/295103.

KRÓL, A.; POMASTOWSKI, P.; RAFIŃSKA, K.; RAILEAN-PLUGARU, V.; BUSZEWSKI, B. Zinc oxide nanoparticles: Synthesis, antiseptic activity and toxicity mechanism. *Advances in Colloid and Interface Science*, v. 249, p. 37–52, 2017. DOI: 10.1016/j.cis.2017.07.033.

USMAN, M. S.; ZOWALATY, M. E. E.; SHAMELI, K.; ZAINUDDIN, N.; SALAMA, M.; IBRAHIM, N. A. Synthesis, characterization, and antimicrobial properties of copper nanoparticles. *International Journal of Nanomedicine*, v. 8, p. 4467–4479, 2013. https://doi.org/10.2147/IJN.S50837

TRIBONI, E. R. et al. Process for obtaining zinc oxide nanoparticles, obtained nanoparticles and their use, BR 102017011345-0, filed on 05/30/2017, granted on 11/07/2023.