Graphene Oxide pegylated as antimicrobial against skin infections

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Since the discovery of penicillin, medicine has been developed around the availability of antibiotics to fight infections [1]. However, the adaptive capacity of bacteria and their rapid multiplication have led to the emergence of antimicrobial resistance (AMR) as a survival mechanism, which represents the greatest health challenge nowadays. A study published in 2018 by Upreti *et al*. revealed that 56.9% of skin infections were caused by Staphylococcus aureus [2]. *Staphylococcus aureus* is a clear example of the result of decades of indiscriminate antibiotic use and represents the connection between the treatment of wounds or skin lesions with antibiotics and nosocomial infections associated with long-stay hospital patients [3]. This bacterium can enter the bloodstream leading to circulatory, respiratory, and even bone infections, which is not only a skin problem but a potential systemic problem.

Therapeutic strategies against bacteria, such as the use of nanomaterials, are currently being investigated. In this work graphene oxide (GO) is used. This nanomaterial has a two-dimensional structure with carbon atoms distributed hexagonally, and contains several oxidized functional groups, which improves its dispersion and stability. Several studies have demonstrated some antimicrobial activity of carbon-based nanomaterials against both Gram-positive and Gram-negative bacteria, due to the physical and chemical interactions that occur when GO layers come into direct contact with bacterial cells. On the other hand, polyethylene glycol (PEG) increases the biocompatibility and water solubility of nanomaterials, so its use in biomedicine is very common. The main objective of this study is to determine the efficacy of two different combinations of carbon-based nanomaterials, GO and GO-PEG, against *Staphylococcus aureus*, one of the bacteria species with the highest rate of multidrug resistance worldwide [4].

A complete characterization of these nanomaterials was performed before analyzing their efficacy against *S. aureus*. The techniques used for the complete characterization were Atomic Force Microscopy (AFM); Transmission Electron Microscopy (TEM); Scanning Electron Microscopy (SEM); Ultraviolet-Visible Spectroscopy (UV-Vis); Zeta Potential; and Fourier Transform Infrared Spectroscopy (FTIR) [5]. Electron microscopy provides 2D and 3D images of the synthesized nanomaterials (Figure 1 shows SEM images of GO and GO-PEG). AFM supplies images of the surface and information on its roughness. The Zetasizer Nano-ZS equipment was used to measure the zeta potential, which provides information on the stability of the nanoparticles (Figure 2 reveals the zeta potential at different pH values). By means of FTIR and UV-Vis is possible to characterize the functional groups present in the nanomaterial. These techniques have great importance mainly after pegylation to know how the polyethylene glycol has bonded to the surface of the carbon-based nanomaterial.

Finally, the antimicrobial potential of GO and GO-PEG against S. aureus is assessed regarding the Müeller Hinton broth microdilution method, one of the most widely used quantitative methods for defining bacterial susceptibility to antimicrobials. This standardized method allows the calculation of the minimum inhibitory concentration (MIC) of antibiotic, in this case GO and GO-PEG, for the strain tested [6]. In this sense, four different concentrations of both nanomaterials are analyzed.

References

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Figures

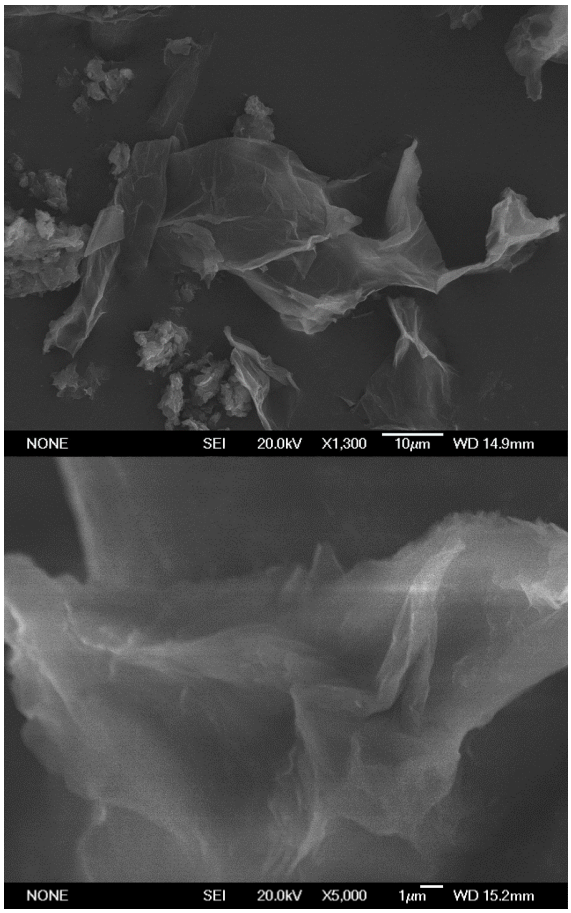

Figure 1. Scanning Electron Microscope images of the GO (top) and GO-PEG (down).

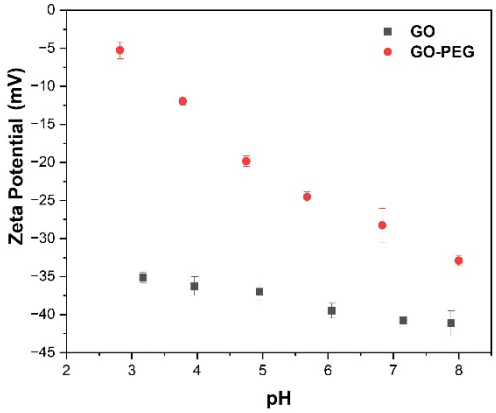

Figure 2. Zeta potential of GO and GO-PEG in aqueous dispersions at 0.1 mg/mL versus pH.