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Enhanced Photodynamic Antibacterial Activity of Hydrogels Containing Silver Nanoprisms and Methylene Blue

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Photodynamic Inactivation (PDI) uses photosensitizers, light, and oxygen to generate toxic reactive oxygen species that promote cell death. Methylene blue penetrates membranes and attracts organelles, effective against bacteria and fungi. Silver nanoparticles are antimicrobial and useful in therapy and drug delivery. The conjugate incorporates these agents into hydrogels, enhancing their efficacy. The main objective of this study was to develop hydrogels containing silver nanoprisms/methylene blue conjugates and evaluate their use in the photodynamic inactivation of pathogenic bacteria. Silver nanoprisms (AgNPs) were prepared using a known method[1]. Methylene blue (MB) was attached to the AgNPs via electrostatic interaction. The conjugates were then incorporated into hydrogels using a modified method[2]. ROS were detected using a chemical method involving N,N-dimethyl-4-nitrosoaniline (RNO) and L-histidine[3]. Inocula were obtained from the Microorganism Culture Collection at the Laboratory of Microbiological Analysis/UFPE. A specific method[4] was employed for microorganism inactivation. Hydrogels containing 5 µM MB and MB/AgNPs, irradiated with 660 nm LED, showed high ROS production (70% and 75% respectively). PDI in *P. aeruginosa* revealed that MB alone cannot deactivate the bacteria within the proposed timeframes, but in the presence of AgNPs for 120 s, the pathogen is completely inhibited. This was achieved under LED irradiation (22.94 $mW.cm^{-2}$) for periods of 60, 90, and 120 s (light doses of 1.04, 2.00, and 2.08 $J.cm^{-2}$, respectively). The results are presented in Figure 1 as mean ± standard deviation (SD) of three independent experiments (n = 3) with * $p < 0.05$ *vs.* control group, ** $p < 0.05$ *vs*. 90 s LED irradiation, and *** $p < 0.05$. 120 s LED irradiation. These findings suggest the potential application of these PS in hydrogels for PDI, due to their efficient ROS generation and as well as photodynamic inactivation capability.

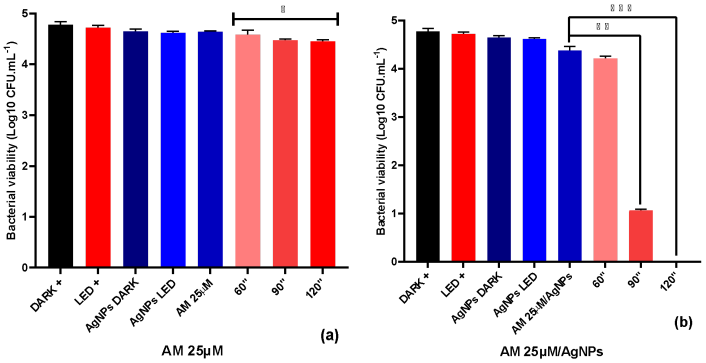

Figure 1: PDI of *P. aeruginosa* at 60, 90, and 120 s Carbopol® hydrogel (a) 25 µM MB; (b) 25 µM MB/AgNPs.

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