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Laser Ablation in Liquid Based on Metallic Nanoparticles for Antibacterial Effects *"Streptococcus mutans"*

Silver nanoparticles, gold nanoparticles, and copper oxide nanoparticles (Au, Ag, and CuO NPs) were synthesized by pulsed laser ablation of the gold, silver, and copper targets immersed in distilled deionized water (DDW), sodium dodecyl sulfate (SDS), cetrimonium bromide (CTAB), and sodium hydroxide (NaOH), respectively. Each target was irradiated with a pulsed Nd:YAG laser with a wavelength of 1064 nm, an energy of 600 mJ, a pulse duration of 10 ns, and a repetition rate of 5 Hz. The prepared NPs were characterized using UV–Vis spectroscopy, zeta potential (ZP), field emission scanning electron microscopy (FESEM), and transmission electron microscopy (TEM). The absorption spectra of Ag and Au NPs showed peaks at 400 nm and 500 nm, respectively, while the absorption spectra of CuO NPs showed around 200 nm and a low intensity peak at 600 nm. The TEM results revealed spherical nanoparticles with particle size distributions ranging from 10–70 nm, 10–50 nm, and 10–200 nm for Au, Ag, and CuO NPs, respectively. FESEM images of all produced samples show the formation of spherical nanostructures as well as the presence of large particles due to aggregation. Ag, Au, and CuO NPs' colloidal surfaces were neutrally, positively, and negatively charged by DDW, CTAB, SDS, and NaOH, respectively. The concentrations

(0.0, 25, 50, 100, and 200) µg/mL of each prepared metal NP were tested for antibacterial activity against bacterial dental caries (*Streptococcus mutans*) alone by using the well diffusion method. The cellular viability of white blood cells was studied using the MTT method, and the viability of red blood cells was measured using the hemolysis rate. Au, Ag, and CuO NPs at a concentration of 200 µg/mL showed a greater inhibition rate and moderate toxic effects against white blood cells. Pre-activated bacteria (1×10^6 CFU/mL) were treated with the prepared NP concentrations of (0.0, 25, 50, 75, and 100) µg/mL and exposed simultaneously with diode lasers of 635 nm wavelength at 1000 mW and wavelengths of 445 nm and 650 nm at 100 mW, respectively, for a combined treatment of *Streptococus mutans* at different exposure times of 2, 3, and 4 minutes, respectively. The prepared metal NPs combined with the diode lasers showed a greater inhibition rate against *Streptococcus mutans*.