The scientific community is extremely concerned about the development of drug resistance in several bacteria towards widely used antibiotics and the rising quantity of hazardous synthetic dyes in wastewater. In this regard, antibacterial and dye degradation applications of inorganic semiconductor-based nanomaterials have sparked great interest. This research sought to evaluate the catalytic and bactericidal effect of polymer-doped copper oxide (CuO). For this purpose, the CuO (pristine material) was synthesize, with chitosan grafted polyacrylic acid (CS-g-PAA) as a dopant to obtain CS-g-PAA doped CuO. The dopants were sequentially added to the same quantity of CuO at three different concentrations (2%, 4%, and 6%). The structural and optical characteristics were analyzed through different analytical techniques. XRD analysis revealed that CuO exhibited a monoclinic phase, and sample crystallinity was reduced after doping, resulting in a larger crystallite size. FTIR spectroscopy identified the presence of various functional groups during the synthesis process to validate the presence of CuO. Doping changed the surface morphology of CuO from agglomerated rods to produce nanoflakes (NFs), as per SEM and TEM micrographs. The optical spectra of the nanomaterials (NMs) exhibit red-shift after doping, according to UV-Vis spectroscopy. To test catalytic activity, the degradation capacity of acquired samples against toxic methylene blue dye was performed with sodium borohydride (reducing agent). Doping resulted in an improvement in bactericidal performance against *S. aureus* as measured by a change from 4.25 to 6.15 mm and 4.40 to 8.15 mm, while 1.35 to 4.20 mm and 2.25 to 5.25 mm against *E. coli* at the lowest and the highest dose, respectively.