Ultrafast and Green Design of Luminescent Nanoclusters for Photodynamic Therapy

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The discovery of luminescent nanoclusters (NCs) takes photodynamic therapy closer to becoming a mainstream form of cancer treatment that is non-invasive and more targeted. With ultrafine sizes, two-photon absorption and versatile conjugation for specificity, NCs are ideal photosensitizers that drive singlet oxygen production for effective cancer cell destruction. However, developing an economically efficient approach to synthesize NCs of tunable emissions remains a challenge, especially at the near-infrared regions within the biological optical window for improved cellular imaging. In this study, the as-in developed ultrafast and green microwave-assisted approach synthesized mono-disperse NCs with relatively high quantum yields of up to 5%. Gold (Au) NCs, designed to be protected and reduced by glutathione (GSH), were synthesized in 4 min instead of conventional 24 h, with emissions of orange, red and highly desirable near-infrared. NCs were characterized with TEM, DLS and PAGE separation. The applicability to other ligands was demonstrated by red-emitting lysozyme-Au NCs synthesized in 2 min. More interestingly, the discovery of a simple and fast fluorimetric method to detect thiamine, an essential vitamin, with Au3+ was made. Both orange and near-infrared emitting GSH-Au NCs exhibited appreciable generation of singlet oxygen detected with ABDA. Notably, the orange-emitting NCs have high photo-stability, enhanced fluorescence in physiological conditions and plausible photodynamic effect on MCF-7 breast cancer cells in-vitro with low cytotoxicity using MTT assay. This facile microwave-assisted approach bridges the synthesis gap of NCs with the potential to revolutionize cancer treatment, among other applications in anti-bacterials, bio-sensing and solar cells.