Green synthesis, characterization and applications of TiO_2 nanoparticles using aqueous extract of *Erythrina variegata* leaves

Jayaram Mari Selvi[1], Mariappan Murugalakshmi[1,*], Ponnusamy Sami[2], Mariappan Gnanaprakash[3] and R. Thanalakshmi[1]

[1]PG & Research Department of Chemistry, The Standard Fireworks Rajaratnam College for Women, Sivakasi 626 123, India
[2]PG & Research Department of Chemistry, Virudhunagar Hindu Nadar's Senthikumara Nadar (VHNSN) College, Virudhunagar 626 001, India
[3]Mepco School of Management Studies, Mepco Schlenk Engineering College (Autonomous), Sivakasi 626 001, India

Green synthesis is a simple, non-toxic, economical and eco-friendly approach for the synthesis of nanoparticles (NPs). The implementation of new technologies has led to the new area of nano revolution which unfolds the role of plants in bio- and green synthesis of nanomaterials. The plant extracts employed are neem, lemon grass, aloe vera, Indian gooseberry, etc., focusing on the green chemistry principles. In the present work, NPs of titanium dioxide (TiO_2) were synthesized using an aqueous extract of *Erythrina variegata* leaves as a capping agent. The leaf extract was utilized as a reducing agent for the conversion of metal precursors into metal-oxide NPs. *E. variegata*-mediated TiO_2 NPs were characterized by UV–Vis absorption spectroscopy, Fourier transform infrared spectroscopy, X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy and morphological studies were conducted by scanning electron microscopy. The UV–Vis absorption spectrum showed an absorption band at 317.6 nm, which supports the formation of TiO_2 NPs. The optical band-gap energy was determined to be 2.35 eV. Further characterization by XRD supported the crystallinity and purity of the synthesized TiO_2 NPs. These NPs may have effective dye degradation ability. The green-synthesized TiO_2 NPs exhibited interesting photocatalytic efficacy on methylene blue dye under UV irradiation (using a multi-lamp photo reactor) and antibacterial activity against pathogenic organisms like *Streptococcus*, *Staphylococcus*, *Escherichia coli* and *Pseudomonas aeruginosa*.

Keywords: Antibacterial activity, *Erythrina variegata*, green synthesis, nanoparticles, photocatalytic efficacy, titanium dioxide.

IN the last few years, nanoparticles (NPs) have gained importance in the scientific field due to their typical size, shape, surface area and technological applications like electrical, optical, magnetic, catalytic, biomedical and antibacterial activities which cannot be achieved by their bulk counterparts[1–9]. Several traditional synthetic methods have been developed by various research groups to synthesize NPs using physico-chemical methods[10,11].

NPs are defined as a cluster of atoms between 1 and 100 nm in size that behave like a whole unit with respect to all their properties[12]. NPs are one of the most important gifts of science in the modern era. Nanotechnology mainly deals with the synthesis of NPs of variable size, shape, chemical composition and their potential use for the benefit of humanity[13]. The preparation of NPs can be done under three main conditions: (i) choice of environment-friendly solvent medium, (ii) reducing agent and (iii) a non-toxic material for their stabilization[14]. NPs are the building blocks of the next generation of technology with applications in several other fields[15].

Nanotechnology is an important branch of science. It deals with the synthesis and development of various types of NPs in sizes ranging from 1 to 100 nm (ref. 16). It has been noted that the physical and chemical properties of any material change when its size decreases to nanoscale[17,18]. The characteristics depend on certain traits such as size, particle distribution, morphology and high surface/volume ratio[19]. Metal-oxide NPs have gained attention for their potential applications in optoelectronics, nanodevices, nanoelectronics, nanosensors, information storage and catalysis[20]. Various metal-oxide NPs have been implemented in a wide range of applications. They can be used as catalysts in reduction, oxidation electrocatalysis, photocatalysis and gas-phase reactions[21].

Green synthesis is eco-friendly and manufactures stable and multiuse nanomaterials which involves on the action of biomolecules and works as a reducing and capping agent without toxicity, and supports the ease in manufacturing. The physical and chemical techniques are cost-effective and they involve the usage of instruments or chemical agents. Another limitation is low stability, contamination with residuals of agents and less compatibility in the pharmaceutical and cosmetics industry[22,23]. Moreover,

*For correspondence. (e-mail: m_murugalakshmi@yahoo.com)