Green Synthesis and Characterization of Zirconia Nanoparticles Using *Averrhoa bilimbi*

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Nanostructured materials have numerous breakthrough applications in the field of engineering, medicine and science due to their exceptional physical and chemical properties. These nanoparticles are interesting not only for their wide variety of physical and chemical properties, but also for their antibacterial activity. Zirconia (ZrO_2) nanoparticle is a ceramic material, which has attracted widespread scientific and industrial attention due to its interesting and useful properties such as higher strength, higher fracture, toughness, nonmagnetic, low thermal conductivity, wear resistance and corrosion resistance in acids and alkali. Synthesizing of nanoparticles from natural resources such as plant extracts or fruit juices have drawn significant attention due to many issues encounter from conventional methods of making nanoparticles.

The present investigation is a biogenic green synthesis of zirconia nanoparticles (ZrNPs) using the fruit juice of *Averrhoa bilimbi* as nontoxic and ecofriendly reducing material. This work focused on a facile, ecofriendly and sustainable method to synthesize zirconia nanoparticles by bilimbi juice extraction. Bilimbi juice is known to have a high content of oxalic, citric and ascorbic acids. The synthesized ZrNPs were characterized using mass spectrometry (MS), X-Ray diffraction spectroscopy (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM) and used to evaluate their antibacterial activity. MS results confirmed the presence of oxalic acid, ascorbic acid and citric acid in the *Averrhoa bilimbi* juice. The XRD pattern was used to characterize the structure of ZrO_2 nano particles which showed that nanoparticles are tetrahedral. The size range of synthesized ZrO_2 nano particles was found to be 10 to 50 nm from the SEM images and the energy dispersive X-ray spectroscopy (EDEX) confirmed the presence of elements, zirconium and oxygen in the nanoparticles. According to the antibacterial evaluation, the nanoparticle did not show any bactericidal or bacteriostatic activities. Therefore, the synthesized nanoparticles are more suitable for the dermatological preparation as an additive.

Keywords: zirconia; nanoparticles; averrhoa bilimbi; green synthesis; antibacterial activity

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