Review Article

Biological synthesis and applications of ZrO_2 nanoparticles (ZrO_2 NPS)

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ABSTRACT

The synthesis of nanoparticles using biological materials is highly efficient, low cost and very simple. Biologically synthesised nanoparticles have been attracted a great attention due to their many advance properties. The green synthesis of nano particles is also an environmentally friendly method.Recently, researchers are focussed in the green or biological synthesis of metal and metal oxide nanoparticles using the extracts of different parts of plants and other bioorganic materials. The inorganic metal and metal oxide nanoparticles have great importance in the fields of biomedicine, electrical, optics, sensors, environment, photo-catalysis etc. Among the inorganic metal oxide nanoparticles, zirconium oxide nanoparticles (ZrO_2 NPS) are known for their thermal stability, photo-catalytic activity, corrosion resistance, microbial resistance and excellent optical and electrical properties.

Key words: *Nanoparticles, Green or biological synthesis, ZrO_2 NPS, Applications*

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Article Info: Date received: 02 Jan. 2020 **Date accepted:** 07 Mar 2020

Cite this Article: Naveen C.J., Nishtha C., Vishakha S., Biological synthesis and applications of ZrO2 nanoparticles (ZrO2 NPS). *Int. J. of Pharmacy Res.*, 2020; 11(1):11-14.

INTRODUCTION

Nanotechnology is the practices of production, performances and uses of materials under the particle size ranges 10-100 nm in the fields of science, engineering and medical. Green or biological approaches used in the synthesis of inorganic nanoparticles have been recently emerged a new field of research. The conventional physical and chemical methods used in synthesis of metal and metal oxide nanoparticles are suffering with the use of hazardous chemicals, low efficiency, high cost and not eco-friendly [1]. A green or biological method used in the synthesis of nanoparticles is characterized by low cost, environmentally friendly, high efficiency, simple and no additional cost in instrumentations. Therefore, such methods are good alternatives over other physical and chemical methods [2]. A number of methods have been developed for the synthesis of zirconia or zirconium oxide nanoparticles (ZrO_2 NPS) such as thermal decomposition, microwave plasma, sol-gel methods, laser ablation, microwave plasma, hydrothermal and biological methods [3-7]. Among these green or biological methods have been found a better alternative to synthesize ZrO_2 NPSin different point of view like high yielded, low cost, better quality of products and very simple and environmentally friendly [6,7]. ZrO_2 NPSare consisted of high strength, high fracture toughness and hardness. In pure form, zirconia is existed in three forms i.e. monoclinic, tetragonal and cubic. This classification is based on temperature and thermodynamics; monoclinic form is found at room temperature and transforms into tetragonal forms above 1170 ^oC. After 2370^o, it transforms into tetragonal and cubic forms [9].

BIOLOGICAL OR GREEN SYNTHESIS, CHARACTERIZATION AND USES OF ZrO_2 NPS

The plant derived ZrO_2 NPS have been synthesized by using the extract of different parts of the plants such as leaves, roots, floral, stem and bark. The plant materials are crushed into possible small pieces and washed with distilled water and then boiled at suitable temperature. After boiling, the content will be filtered and the filtrate known as plant extract. A suitable amount of plant extract is mixed with a requisite amount of the inorganic salts of zirconium and then stirred for several hours at constant stirring over the magnetic stirrer. After that, a suitable amount of alkali bases is added in this mixture and ZrO_2 NPS are precipitated out. This precipitate of ZrO_2 NPS is washed and then completely dried. Finally, the ZrO_2 NPS are calcined in muffle furnace at suitable temperature for more than at least one hour (Fig. 1)[6-8]. After a successful synthesis of nanoparticles, the common characterization methods are necessary to explore the physical and chemical properties of nanoparticles. The common characterization methods used to investigate ZrO_2 NPS are UV-Visible, FTIR, XRD, FESEM, SEM, EDX and PL-spectroscopy [9-18]. The synthesized ZrO_2 NPS have many applications as ceramic pigments, abrasive, antimicrobial, optical, electrical and environmental remediations [9-13].

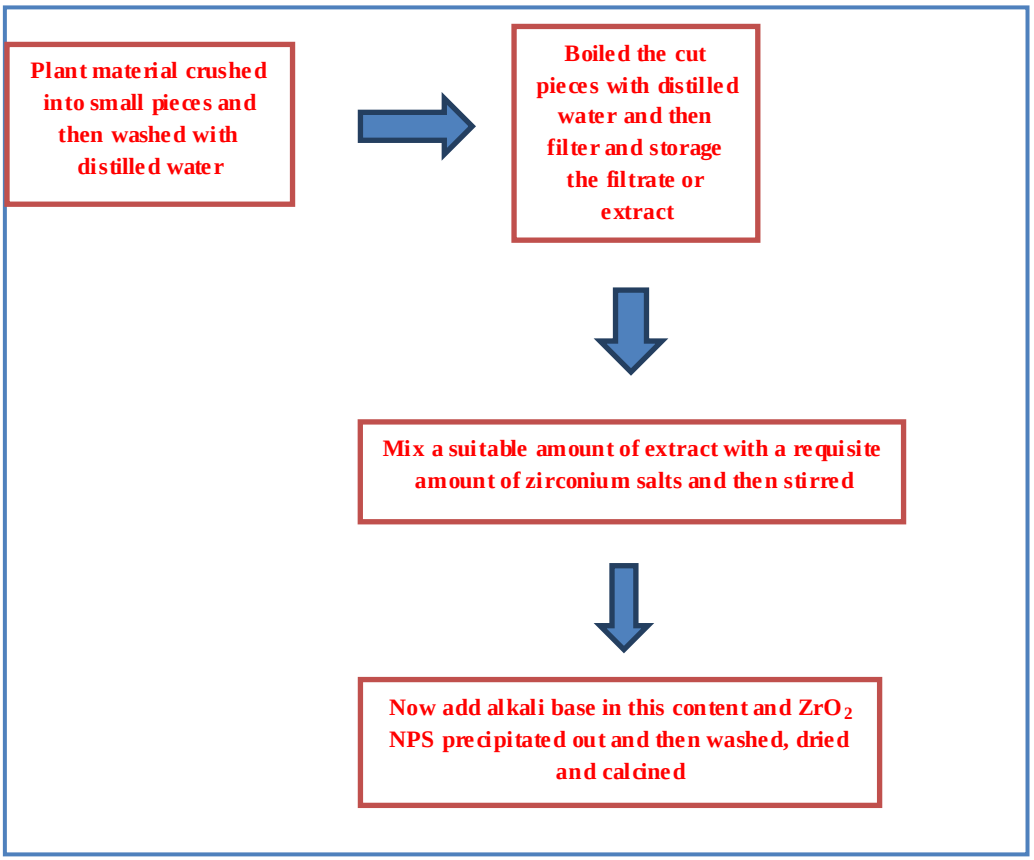

Fig.1: Biological synthesis of ZrO_2 NPS

CURRENT STUDIES

Majedi and coworkers [6]have considered the synthesis of ZrO_2 NPS by using zirconium acetate and lemon juice. The synthesised ZrO_2 NPS have been characterised by using FESEM, EDS, XRD, UV–Vis, and PL spectroscopy. They studied ZrO_2 NPS as an electrolyte material in fuel cells.Raghad et al. [14] have reported a biological synthesis of ZrO_2 NPS by using

different plants extracts of*Capsicum annum*, *Allium cepa* and *Lycopersiconesculentum*. These biologically synthesized nanoparticles were found good antibacterial and antifungal agents.

Nikam and other [15]reported the biologically synthesised ZrO_2 NPS have biocompatible, electrical, mechanical, and optical properties. The biomolecules such as amino acids, alkaloids, enzymes, proteins, carbohydrates, phenols, steroids and vitamins are involved in the reduction, formation, and stabilization of ZrO_2 NPs. Such particles show many unique properties as compared to chemically synthesized ZrO_2 NPS. Kumaresan et al. [16] have developed a unique green synthetic approach ofZrO_2 NPS by using the extract of *Sargassum wightii*. The physical and chemical characteristics of ZrO_2 NPS have been observed by using different analytical methods such as XRD, FTIR, HR-TEM, UV-vis and PL spectroscopy. The antimicrobial activities have been observed by using well diffusion method against*Bacillus subtilis*, *Escherichia coli* and *Salmonella typhi*.

Shanthi and Tharani [17] have considered the green synthesis of ZrO_2 NPS by using leaf extract of *Acalyphaindica*. The ZrO_2 NPS have been characterised by using FTIR, SEM, XRD and EDX methods. Different important physical and chemical properties of ZrO_2 NPS were investigated by using these analytical techniques.Felipe and coworkers [18] have developed a low cost and highly efficient method for the synthesis of ZrO_2 NPS by using plant extract of *Eucleanatalensis*. The ZrO_2 NPS have been characterized by using the XRD, FTIR and TEM techniques. These ZrO_2 NPS were found highly effective adsorbents for the removal of tetracycline from different aqueous solutions.

CONCLUSIONS:

This mini review is focusing on the effectiveness of green or biological synthesis of ZrO_2 NPS using different plant extract. The briefly given synthetic method will definitely be useful in the field of green nanotechnology. Current study section comprises with the works related to synthesis and characterization of synthetic methods.

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