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Biosynthesis of CeO_2 NPs using the optimal extract of *Moringa olifera*

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Abstract

The CeO_2 NPs were green synthesized using the antioxidant potential of *Moringa olifera* extract through an economic, simple, fast and ecofriendly method. The morphology and crystalline pattern of the biosynthesized nanoparticles were identified using the X-ray diffraction (XRD), scanning electron microscopy (SEM), electron dispersive spectroscopy (EDS) and elemental mapping analysis.

Key words: *Moringa olifera*, Optimal extract, Antioxidant activity, Green synthesis, CeO_2 NPs

Full length article **Corresponding Author*, e-mail: Sarbast.bradosty1@gmail.com

1. Introduction

Phytosynthesis of metal and metal oxide NPs is a new emerging issue in nanoscience and technology. CeO_2 nanoparticles (NPs) have received much attention in nanotechnology due to their useful applications as catalysts, fuel cells and antioxidants in biological systems. Recently, phytosynthesis of CeO_2 NPs was reported using different plants, such as *Gloriosa superba*, *Acalypha indica* and even *Aloe vera* plant leaf extract as the plant extracts acted as stabilizing and capping agents in the CeO_2 NPs synthesis process [1-3].

Moringa olifera (Moringaceae) is one of the best sources of bioactive phytochemicals especially anti-oxidant flavonoids, phenolics and phenolic acids. Besides, the plant has numerous applications in medicine and industry which its employment as herbal drugs to relieve human deficiencies and sicknesses and also its anti-inflammatory, antioxidant and antimicrobial effects are of great importance [4-6]. Recently the phytochemical contents of the plant were attracted the interest of many researchers in which some reports presented the utilization of the plant extract in the biosynthesis of nanostructures through an economic and ecofriendly method [7]. Due to the excellent bioreducing potential of the plant extract, in continuation of our previous work described the optimum extraction conditions of antioxidant flavonoids from the seeds of *Moringa olifera* using the colorimetric Emerson reaction [8], we used the optimum extract of the plant as stabilizing, capping and reducing biomedia to green synthesis of CeO_2 nanoparticles via a green, simple, fast, efficient and economic method. The resulted nanoparticles were structurally elucidated using the spectroscopic and micrograph analysis.

2. Experimental

2.1. Instruments and Reagents

High-purity chemicals were purchased from the Merck and Aldrich chemical companies. X-ray diffraction (XRD) measurements were carried out using a Philips powder diffractometer type PW 1373 goniometer with scanning rate of 2º/min in the 2θ range from 0 to 90˚. UV-visible spectral analysis was recorded on a double-beam spectrophotometer (Super Aquarius) to monitor the surface plasmon resonance (SPR) signals of nanoparticles. Morphology, particle dispersion and chemical composition of the prepared nanostructures were investigated by fast emission scanning electron microscopy (FE-SEM) (Quanta 450) equipped with EDS (Energy Dispersive X-ray Spectroscopy).

2.2. Preparation of the optimum extract of the Moringa olifera seeds extract

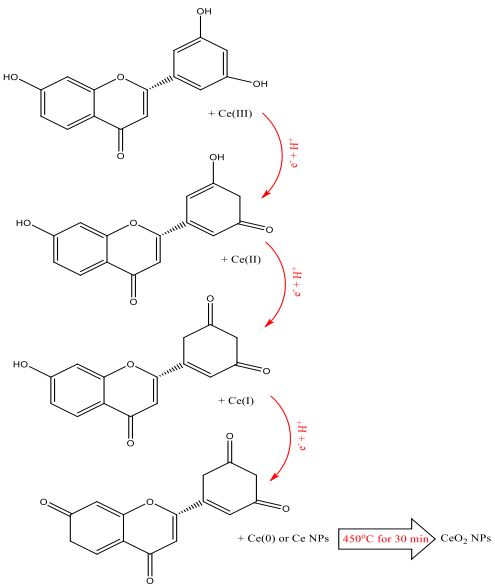
The optimum extraction of the plant was obtained according our previous report, [8]. Briefly, 20 g of the Moringa olifera seeds powder was dissolved in 100 mL distillated water at 80°C for 60 min while stirring at neutralized pH. The obtained extract then was filtered and kept in refrigerator for more applications in next steps of the study.

2.3. Biosynthesis of CeO_2 NPs using the optimal extract of the Moringa olifera

50 mL of the optimum plant extract was added dropwise to 50 ml of 0.008 M aqueous solution of $CeCl_3$ under reflux condition at 80 °C until changing the color of the mixture to black brown due to SPR indicating the reduction of Ce(III) to Ce (0). The black precipitations of Ce NPs were separated from the reaction media using the centrifugation at 7000 rpm then was heated at 450 °C for 30 min to production of CeO_2 NPs. The biosynthesized NPs was absolutely characterized using the SEM, XRD, EDS and elemental mapping analysis.

3. Results and Discussions

In this study, Ce^{+3} ions were reduced using the antioxidant potential of the optimized extract of *Moringa olifera* according the proposed mechanism presented in scheme 1. Heating the produced NPs at 450 °C caused to auto-oxidation of Ce NPs and produces the CeO_2 NPs.



Scheme 1. Reduction of Ce^{+3} ions using the antioxidant potential of *Moringa olifera* extract

The XRD pattern of green synthesized NPs which exactly assigned to the CeO_2 NPs showed their crystallinity and phase homogeneity and purity of green synthesized NPs, Figure 1. Also, the EDS and elemental mapping analysis of green synthesized NPs showed that the composition of green nanoparticles is including Ce and O elements. These results confirmed the formation of green synthesized NPs with no impurity in their composition, Figures 2 and 3.

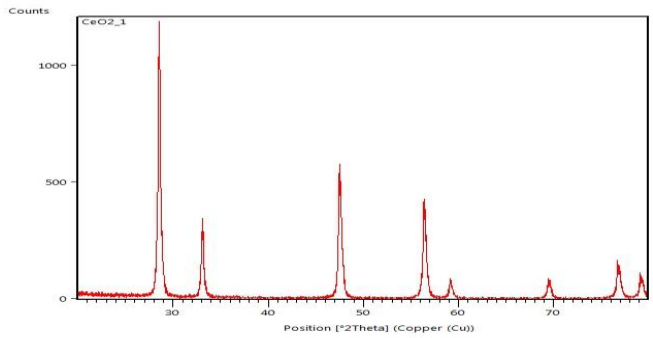


Figure 1 The XRD pattern of the biosynthesized CeO_2 NPs using the *Moringa olifera* extract

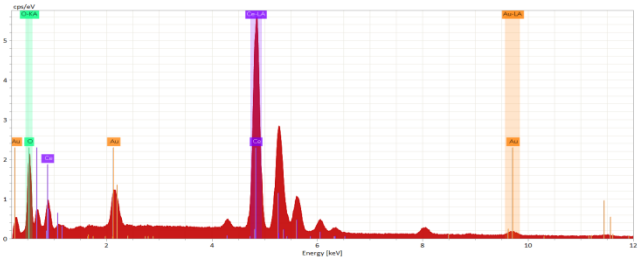


Figure 2 EDS analysis of green synthesized CeO_2 NPs

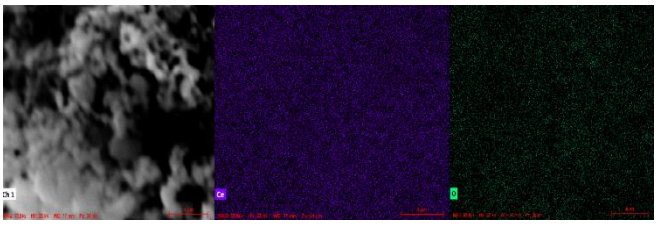


Figure 3 Elemental mapping analyses of green synthesized CeO_2 NPs

Figure 4 depicted the fast emission scanning electron microscopy (FE-SEM) analysis of biosynthesized NPs. The micrograph demonstrated the homogeneous spherical shapes of nanoparticles with average size around 30 nm. Also, some agglomerations are shown in accordance of micrograph. Therefore, the biosynthesis of CeO_2 NPs is easily confirmed using FE-SEM micrograph.

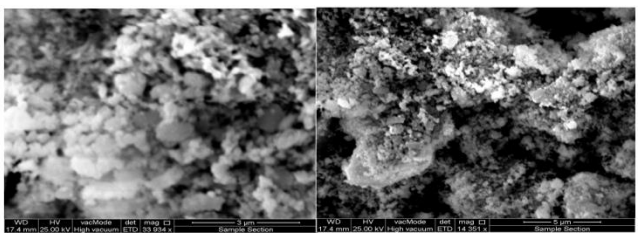


Figure 4 FE-SEM analysis of green synthesized CeO_2 NPs

4. Conclusions

The CeO_2 NPs were biosynthesized using the antioxidant phytochemicals content of the seeds of *Moringa*

olifera which played the stabilizer and reducing factor in the process. The method employed in this study has many benefits such as cost effectiveness, high efficiency, simplicity and high accessibility to the plant source. The obtained nanoparticles were well characterized using various identification techniques confirming the formation of a well crystalline shape of CeO_2 NPs.

5. Acknowledgments

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