RESEARCH PAPER

Green Synthesize of Zinc Oxide Nanoparticles and Nano-Fluids with Pomegranate Extract Used in Mouthwash Solutions

Masomeh Nasiri Moghadam [1], Yasaman Eynalghozati [1], Ziba Sorinezami [2], Sara Saremi Nouri [3], Maryam Ahsani Irvani [4]*

[1] Department of Agronomy, Faculty of Agriculture, University of Kurdistan, Sanandaj, Iran

[2] Department of Chemistry, University of Zabol, Zabol, Iran

[3] Department of Biology, Faculty of Basic Sciences, Azarbaijan Branch, Azarbaijan Shahid Madani University, Azarbaijan, Iran

[4] Department of Horticultural Sciences, Faculty of Agriculture and Natural Resources, Arak University, Arak, Iran

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ABSTRACT

Zinc oxide nanoparticles were synthesized with a green procedure applying pomegranate extract. Hydrothermal reactions with the help of stainless steel autoclave at various temperatures and times were used. Results confirmed by adjusting temperature and time reaction, uniform star-like and flower-like zinc oxide nanostructures were synthesized. For preparation of mouthwash nano-fluid, nanoparticles with the aid of ultra-sound wave (200W, 60 min) irradiation were dispersed to the pomegranate extract. The phase of prepared products were examined by X-ray diffraction pattern (XRD), band gap and optical were measured by UV–visible absorption spectroscopy, the bonds using the (FTIR) spectrometry and morphology via scanning electron microscopy (SEM). The antibacterial exam of flower like nano-structures was performed applying the non-growth halo (diffusion disk) test. Streptococcus mutans bacteria were chosen as suitable bacteria for this investigation.

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INTRODUCTION

The use of nanoparticles in various household applications and various industries has dramatic changes in reducing costs and increasing efficiency. In nanotechnology, with decreasing dimensions, the surface-to-volume ratio increases greatly, which reduces the consumption of materials. And have critical sizes and allowable limits have been considered[1-5].

Also, as we know, with smaller dimensions than the critical size, new properties and properties are observed for nanoparticles that can be shown by manipulating atoms to show new properties and properties. Due to the increasing problems of pollution in wastewater, the use of green and biocompatible materials instead of toxic chemicals has received much attention in recent decades [6-10].

New syntheses have recently been reported using plant and fruit extracts. The use of extracts is biocompatible, cost-effective and innovative. Traditionally produced mouthwashes use a

* Corresponding Author Email: Msnr88827@yahoo.com

variety of chemicals if many of the pathogens and potential carcinogens can be eliminated instead of using hazardous and harmful chemicals made from green methods. Zinc oxide is a semiconductor, non-toxic substance used in many electronics and cosmetics. The aim of this study was to make zinc oxide nanoparticles using pomegranate extract and nanofluid in aqueous solution and used as a mouthwash. is a round bacterium, facultatively anaerobic, gram-positive coccus, it is a main contributor to tooth decay usually found in the human oral cavity [11-18].

MATERIALS AND METHODS

Materials and Physical Measurements

All of the chemicals were used as received

Fig. 1. Schematic of green synthesis of zinc oxide with hydrothermal reaction

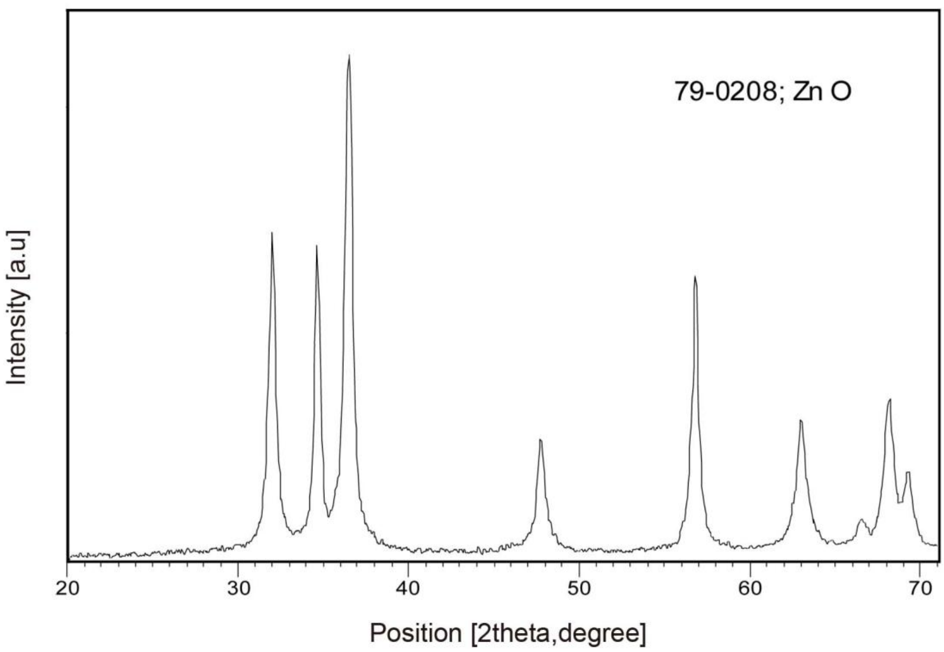

Fig. 2. XRD pattern of ZnO nanostructures

without further purifications. All precursors were purchased from Merck and Sigma- Aldrich. A multiwave ultrasonic generator (Sonicator 3000; Bandeline, MS 72, Germany), equipped with a converter/transducer and titanium oscillator (horn), 12.5 mm in diameter, operating at 20 kHz

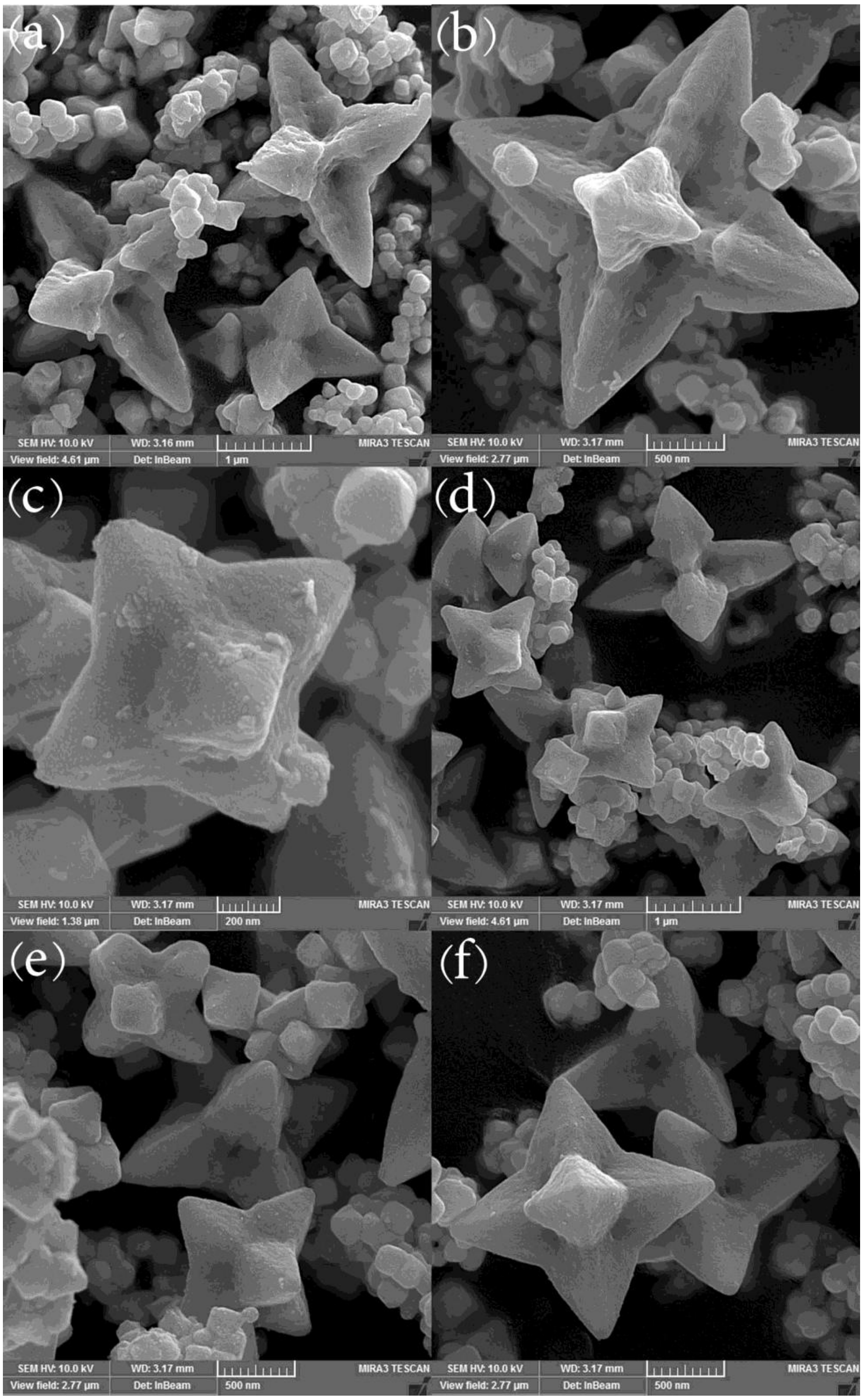

Fig. 3. SEM images of ZnO nano-stars at (a,b) 120^0C (c,d) 180^0C (e,f) 200^0C

with a maximum power output of 100 W, was used for the ultrasonic irradiation. The ultrasonic generator automatically adjusted the power level. The wave amplitude in each experiment was adjusted as needed. XRD patterns were recorded by a Philips, X-ray diffractometer using Ni-filtered Cu Kα radiation. SEM images were obtained using a LEO instrument model 1455VP. Prior to taking images, the samples were coated with a very thin layer of Pt to make the sample surface conducting and prevent charge accumulation, and obtaining a better contrast. FT-IR spectra were recorded on Galaxy series FTIR5000 spectrophotometer. Room temperature photoluminescence was studied by a Perkin Elmer fluorescence instrument.

Green synthesize of zinc oxide nanoparticles

Firstly 1g of zinc nitrate was dissolved in 100 ml of pomegranate extract with mixing on the stirrer. Then the solution was put to autoclave reactor for different times from 2 to 24h at 100 to 200 0C. Finally the white precipitate was washed and centrifuged and was dried at oven f0r 24 h at 60 0C. Fig. 1 shows green synthesis of zinc oxide with hydrothermal reaction schematically. For preparation of mouthwash nano-fluid, nanoparticles with the aid of ultra-sound wave (200W, 60 min) irradiation were dispersed to the pomegranate extract.

RESULTS AND DISCUSSION

Fig. 2 illustrate XRD pattern of ZnO nanostructures, as a results confirmed the pattern has suitable agreement with standards peaks (JCPDS code: 79-0208). It is indexed as a pure hexagonal structure with suitable agreement to literature value (Space group: P63mc).

Figs. 3a, 3b show scanning electron microscopy images of ZnO nano-structures at 120^{0}C that confirmed formation of nano-flower structures. Figs 3c, 3d illustrate product that were synthesized at 180^{0}C that approve star-like structure were obtained. Figs 3e, 3f depict nano-products that were made at 200^{0}C which results also confirm nano-star zinc oxide were achieved.

Fig. 4 illustrates FT-IR spectrum of zinc oxide nano structures with pomegranate extract, as we expected there are some weak absorption because of presence of organic compound (pomegranate extract) on the zinc oxide nanoparticles.

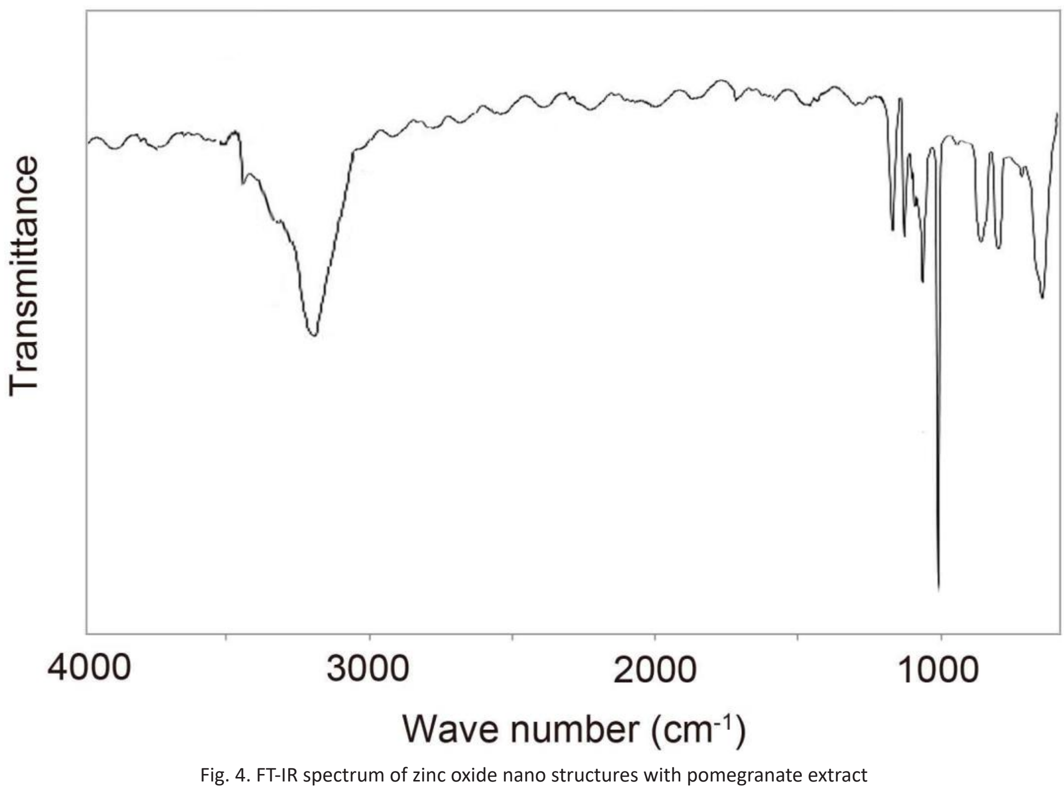

Fig. 4. FT-IR spectrum of zinc oxide nano structures with pomegranate extract

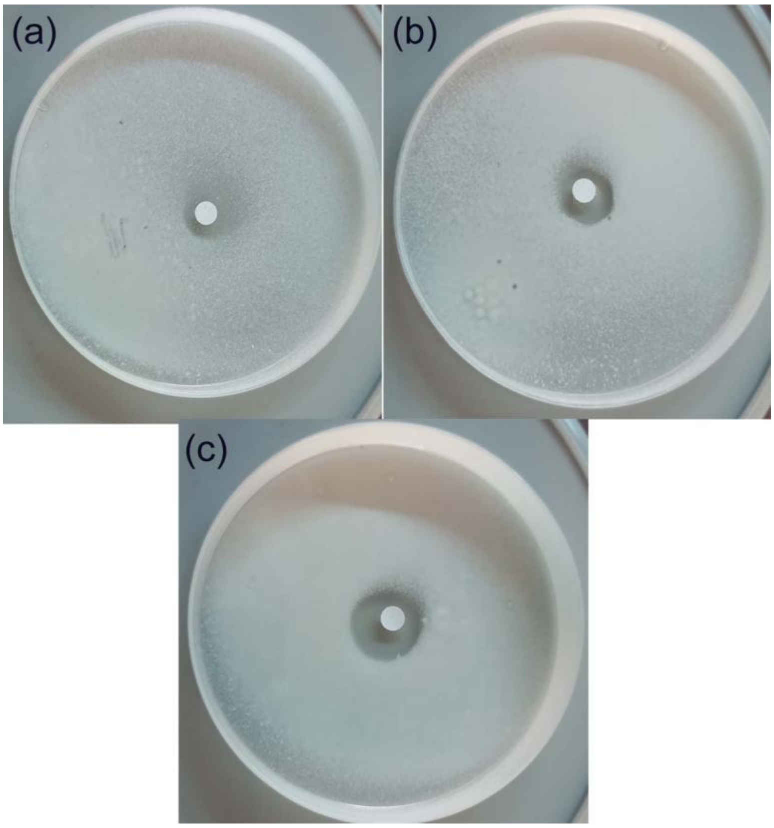

Fig. 5. Disc diffusion antibacterial test against Streptococcus mutans(a) ZnO prepared at 120^{0}C (b) ZnO prepared at 180^{0}C , c) ZnO prepared at 200^{0}C

The antibacterial test of nanomaterials was performed using the non-growth halo test (diffusion disk). Streptococcus mutans bacteria were chosen as suitable bacteria for this test. As the Fig 5 confirm, we see the lack of growth of bacteria around the disc containing nanoparticles.

CONCLUSION

ZnO nanostructures were prepared by a simple hydrothermal process at low temperature. The effect of different surfactants such as time and temperature on the morphology of zinc oxide nanostructures was investigated. The antibacterial test of nanomaterials was performed using the non-growth halo test (diffusion disk). Streptococcus mutans bacteria were chosen as suitable bacteria for this test. Nanostructures were characterized by X-ray diffraction, scanning electron microscopy. Fourier transform infrared spectrometer, the purity of the material was also determined.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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