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Green Synthesis of ZNO Nanoparticles using *Aloe Vera* Leaves Extract

Bayader Abdel Mohsen[1], Asma Ghatea[2], Mohsen Hashim Risan[3]

[1,2,3] College of Biotechnology, Al-Nahrain University, Jadriya, Baghdad, Iraq.

Corresponding Author Email: m_risan@yahoo.com

Keywords:

Green synthesis,

ZNO,nanoparticles, *Aloe vera*, FTIR,

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Abstract

Characterization of the created ZnO nanoparticles using the following techniques: Fouriesr Transform Infra RedSpectrum (FTIR), Scanning Electron Microscopic (SEM), Atomic Force Microscope (AFM). Atomic Force Microscopy (AFM) was employed to describe the surface morphology, particle size in nanoscale, dimeter and roughness of the surface for zinc nanoparticles prepared from plant extraction. The morphology images of pure plant extract and biosynthesised zinc nanoparticles that explains the 3D image of the surface morphology.The particle size in nanoscale of pure plant extraction was 87.22nm and zinc nanoparticles were found to have a particle size of 36.42nm. height cumulation distributions that determine the volume percentage of plant extract's grain size particles and biosynthesised zinc nanoparticles, recording 50.269 nm average hight of plant extraction and 21.515 nm average height of synthesized zinc nanoparticles, displays the Granularity Cumulation Distribution, which calculates the volume percentage of the diameter of plant extract and synthetic zinc nanoparticles. The average diameter of plant extract was 133.77 nm, whereas the average diameter of synthetic zinc nanoparticles made by plants extract was 52.84 nm. The roughness of the surface RMS (Root mean square) of pure plant extraction and the synthesized zinc nanoparticles that that RMS of plant extract was 13.2nm, while the RMS of synthesized zinc nanoparticles was 5.21nm. Scanning electron microscope (SEM) analysis explained the morphology of the surface and shape formation of plant extract and synthesized zinc nanoparticles , that exhibits the micrograph of plant extraction and synthesized zinc nanoparticles and shows that the zinc nanoparticles were formed as nanosheets and hierarchical shape in huge quantities and different lengths nanosheets. Scanning electron microscopy (SEM) element mapping at the microstructural level shows the distribution and quantities of zinc nanoparticles elements prepared from the plant extract and oxygen.It is noticed that the high amount of zinc prepared. FTIR findings for the crude The appearance of a broad peak at (2320.47 cm-1) in an Aleo vera extract is due to the stretching O-H groups of phenolic groups and carbohydrate monomers.

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Introduction

Today, nanotechnology is one of the most important fields of investment between modern science. Because of the rapid development of its concepts, the comprehensiveness and breadth of its applications cover all aspects of human life. This has created a sense of excitement and competition among countries, research institutions and researchers to invest effort and money, in further research on nanotechnology development [1], especially in the field of biotechnologies, health, equipment and treatment [2].

In the mid-20th century, the concepts of nanotechnology emerged from the principles of physics that witnessed the possibility of manipulating these particles. These particles can be prepared easily by different chemical, physical, and biological approaches [4]. Nanotechnology products are characterized by the properties of the structure of their nanomaterials, typically mono- or multi-phase crystalline solids of a typical size of 1-100 nm (109 nm), and a large number of surfaces with atomic arrangements different from those of the crystalline lattice [4], due to the change in the mechanical and thermal properties of the nanoparticle Because of its ease of use, environmental friendliness, and robust antimicrobial activity, plant-mediated biological synthesis of nanoparticles is currently gaining popularity. It is well known that all bodily tissues, such as the brain, muscle, bone, and skin, contain significant amounts of zinc, an essential trace element. In addition to contributing to the body's metabolism, zinc serves as the primary component of numerous enzyme systems and is essential for the synthesis of proteins, nucleic acids, hematopoiesis, and neurogenesis. Small particle size nano-ZnO makes zinc easier for the body to absorb. The use of nano-ZnO as a food additive is therefore widespread. This study was aimed to green synthesis, chracterization of ZNO nanoparticles. The surface chemistry, volume, volume distribution, shape, particle morphology, particle structure, coating or coverage, agglomeration, solubility rate, particle reaction in solution cell, and finally the type of reduction agents used all affect how biologically active nanoparticles are [5]. Jo *et al.* [6] found that the physical characteristics of nanoparticles improve the biological availability of therapeutic agents and have the potential to influence cell uptake, biological distribution, the penetration of biological barriers, and the subsequent therapeutic effects [7]. The Aloe family (Aloaceae), which includes about 400 distinct species, includes the genus Aloe. One of the most prevalent and widespread species is aloe vera. 2009's Ombrella. The plant has thick leaves with long veins and a succulent form moving the water. When the green skin is removed, a clear mucus known as "gel" is left behind. This gel is packed with fiber, water, and vital components that help the paper retain moisture. In the assessment of manufactured nanomaterials, many analytical techniques are used, including UV spectroscopy of UV-vis UV-visible spectroscopy, x-ray diffraction (XRD), infrared spectroscopy Fourier Transform Fourier Transform Spectroscopy (FTIR), x-ray spectroscopy (XPS), dynamic light scattering (DLS), electron microscopy Scanning electron microscopy (TEM), Atomic Force Microscop (AFM) [8 and 9].

Materials and Methods

Plant Sample Collection

Aloe vera plants were collected from the markets and local nurseries in Baghdad during the month of October 2018, and confirmation of their classification was done by the National Herbaceous / General Authority for Agricultural Research.

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Preparation of Plant Aqueous Extracts

The aquatic extracts of *Aloe vera* leaves were obtained using traditional method by washing the fresh leaves with water, which is well run to remove the contaminants on the surface and soak them for 30 min after removing the moisture from them and drying them thoroughly with dry air, 10 g of dried plant leaves was placed in a 250ml glass flask containing 100 ml of deionized water and then heated in a 45 °C water bath for about 30 min, The extracts were then stored at a temperature of 4°.

Zinc oxide nanoparticles biosynthesis

Zinc oxide particles of the *Aloe vera* extract were prepared according Vidya *et al* [10] method by heating 50 ml of the water extract using a hot plate at a temperature of 40 - 45 ° C. At a temperature of 45 ° C, add 5 grams of zinc acetate to the solution and continue heating until it becomes a bright yellow paste. The dough was gathered in a glass petri dish and heated at 300° C for two hours to dry it out. The dried substance was then broken down into a light yellow powder using a mortar, which was then carefully packaged for further characterization and treatment needs.

Detection and Characterization of Zinc oxide Nanoparticles.

The biosynthised ZnO Nanoparticles were characterized by adding 100 ml of deionized water to 1 g of light yellow powder, then filtration was done using Millipore filter (0.22 μm), for samples ready for testing using the following methods:

Fourier Transform Infra Red Spectrum(FTIR)

The spectrum of the infrared spectrometers at the wavelengths (1350-500 -cm) with a SHIMA DZU-Japan device, for all samples tested in liquid and at room temperature.

Scanning Electron Microscopic (SEM)

The size and shape of the particles in the ready samples were determined using the Japan Meiji SEM scanner [11]. By placing approximately 5 microliters of ready-made solutions for examination on the electronic microscope holder made of gold and carbon buckle, leaving them at room temperature to dry and testing using different magnifying forces.

Atomic Force Microscope (AFM)

The surface morphology, size, and diameter of the prepared ZnO nanoparticles were all determined using the USA-based Angstrom Advanced AA2000 AFM scan. The contact pattern under typical weather conditions served as the basis for the AFM pattern. A small drop of the sample solution was placed on a 1 x 1 cm glass slide and allowed to air dry before being tested.

Results and Discussion

Green synthesis of ZNO nanoparticles using *Aloe vera* leaves extract

Characterization of ZNO nanoparticles using Atomic Force Microscopy (AFM)

Surface morphology was assessed using atomic force microscopy (AFM), particle size in nanoscale, dimeter and roughness of the surface for zinc nanoparticles prepared from plant extraction. The morphology images of pure plant extract and biosynthesized zinc nanoparticles shown in Figure (1) that explains the 3D image of the surface morphology. Zinc nanoparticles found to have a particle size of 36.42 nm, and pure plant extraction had a nanoscale particle size of 87.22 nm.

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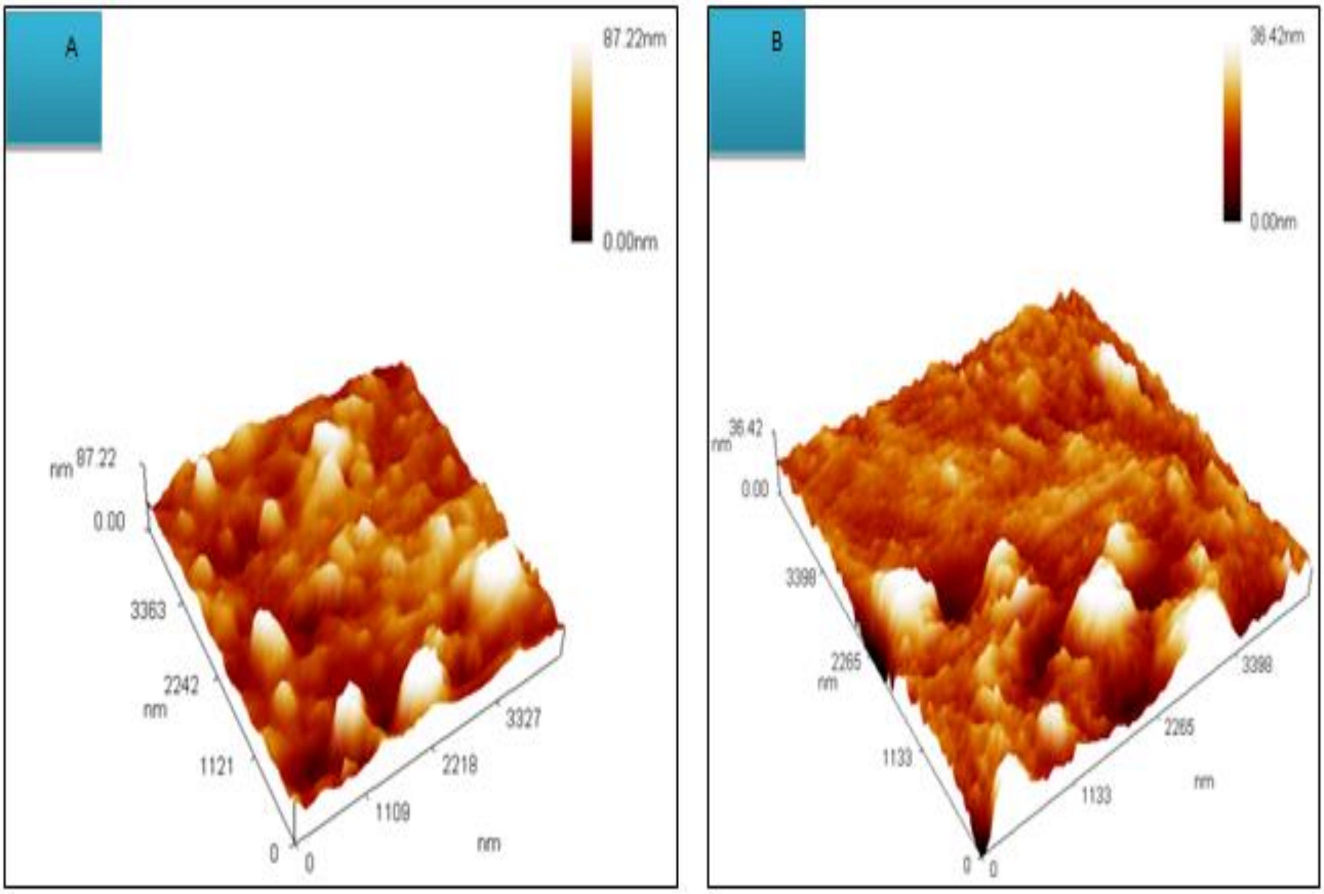

Figure (1): A: AFM of Plant extract, B: biosynthesized zinc nanoparticles

Results in figure (2) show the height accumulation distributions that determine the volume percentage of plant extract particles and bio-made zinc nanoparticles with respect to grain size, recording 50.269 nm average height of plant extraction and 21.515 nm average height of synthesized zinc nanoparticles.

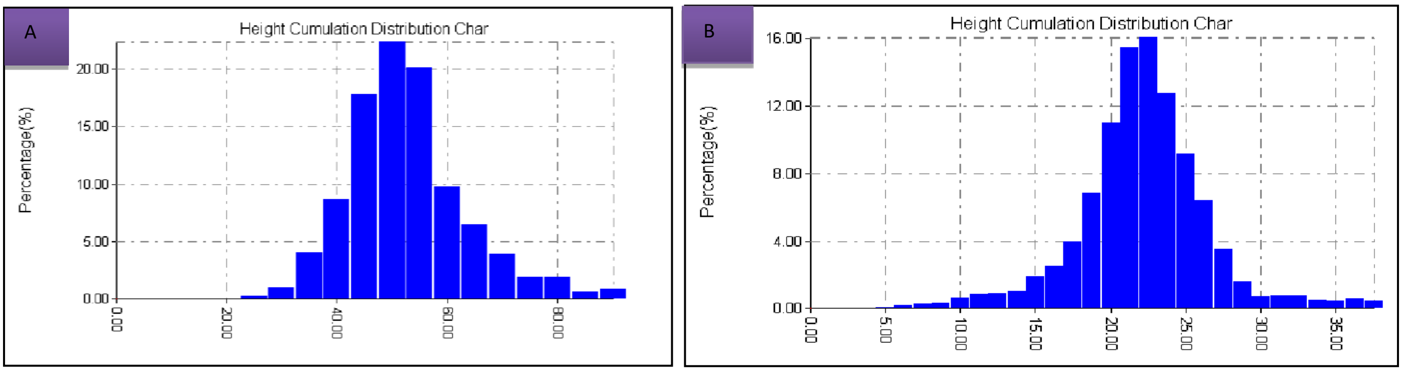

Figure (2): Height Cumulation Distribution of A) Plant Extract.
B) synthesized Zinc Nanoparticles

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The average diameter of plant extract was 133.77 nm, while the average diameter of synthesized zinc nanoparticles by plants extract was 52.84 nm as shown in figure (3) that illustrates the Granularity Cumulation distribution that determines the volume percentage of dimeter for plant extract and synthesized zinc nanoparticles.

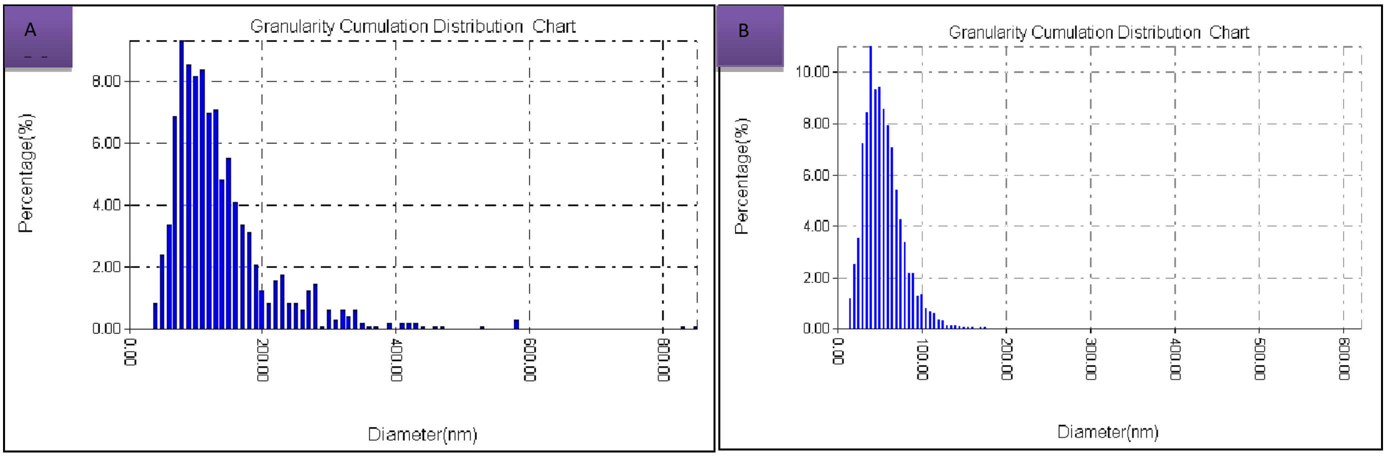

Fig (3): (A) Plant extract (B) synthesized zinc nanoparticles have different granularity cumulation distributions.

The roughness of the surface RMS (Root mean square) of pure plant extraction and the synthesized zinc nanoparticles were shown in Fig (4) that that RMS of plant extract was 13.2nm, while the RMS of synthesized zinc nanoparticles was 5.21nm.

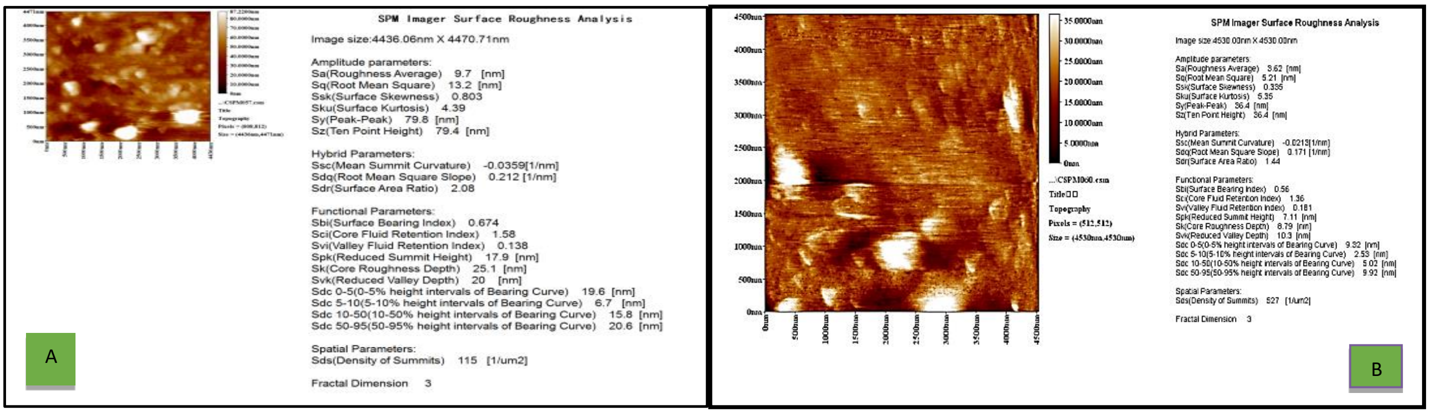

Fig (4): Roughness of the surface; A) Plant extract, B) Synthesized zinc nanoparticles.

Characterization of Zno nanoparticles using SEM analysis

Illustrates the morphology of the surface and shape formation of synthesized zinc nanoparticles and plant extract as explained by scanning electron microscope (SEM) analysis that exhibits the micrograph of plant extraction and synthesized zinc nanoparticles and shows that the zinc nanoparticles were formed as nanosheets and hierarchical shape in huge quantities and different lengths nanosheets. Figure (5).

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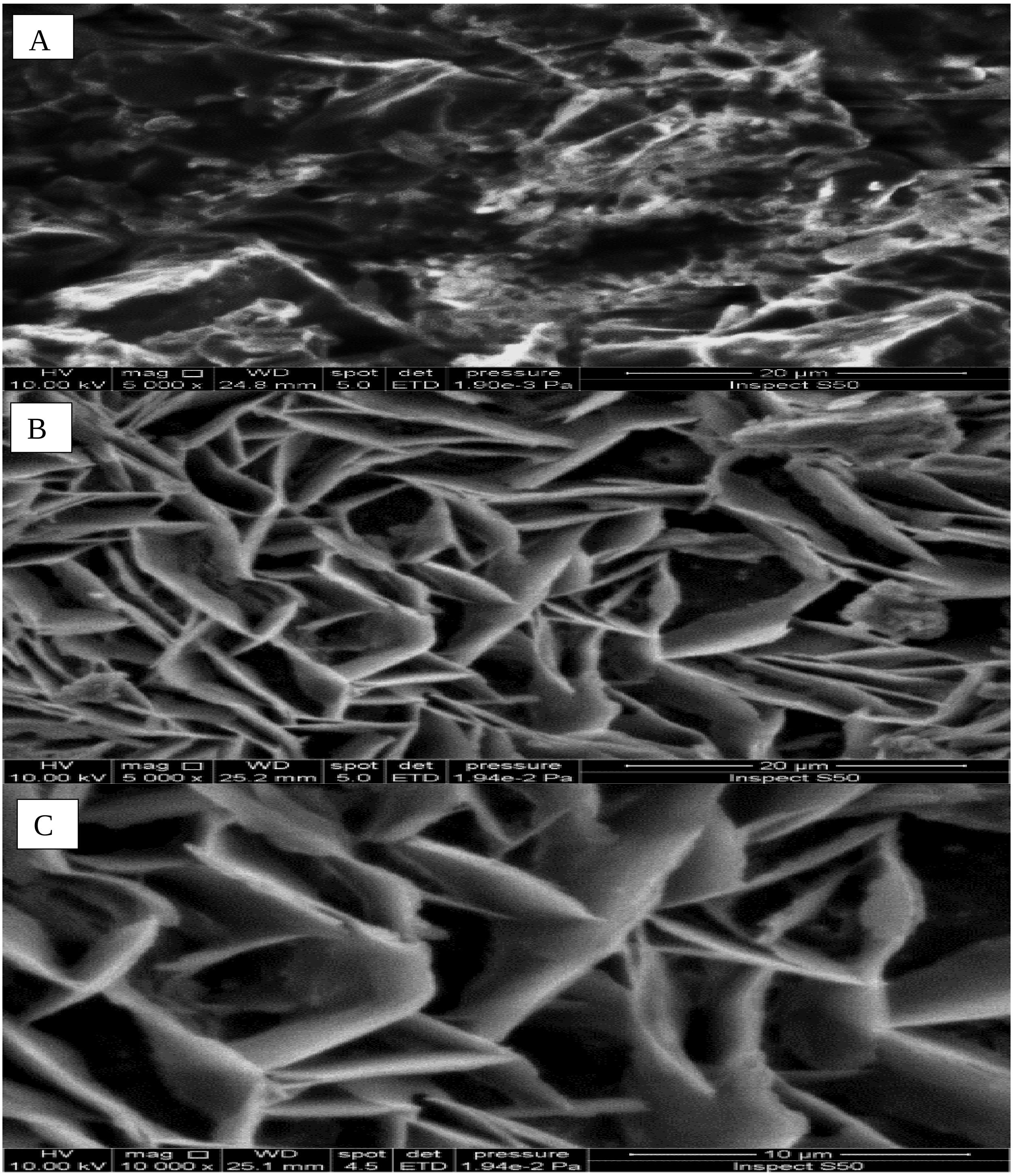

Figure 5: SEM images of A) plant extraction, B) hierarchical zinc Nanosheet prepared from the plant extraction at magnification 20µm, and C) hierarchical zinc Nanosheet prepared from the plant extraction at magnification 10µm.

Scanning electron microscopy (SEM) element mapping at the microstructural level reveals the distribution and quantities of zinc nanoparticle elements made from plant extract and oxygen. Figure (6) clearly displays the large amount of zinc that was prepared.

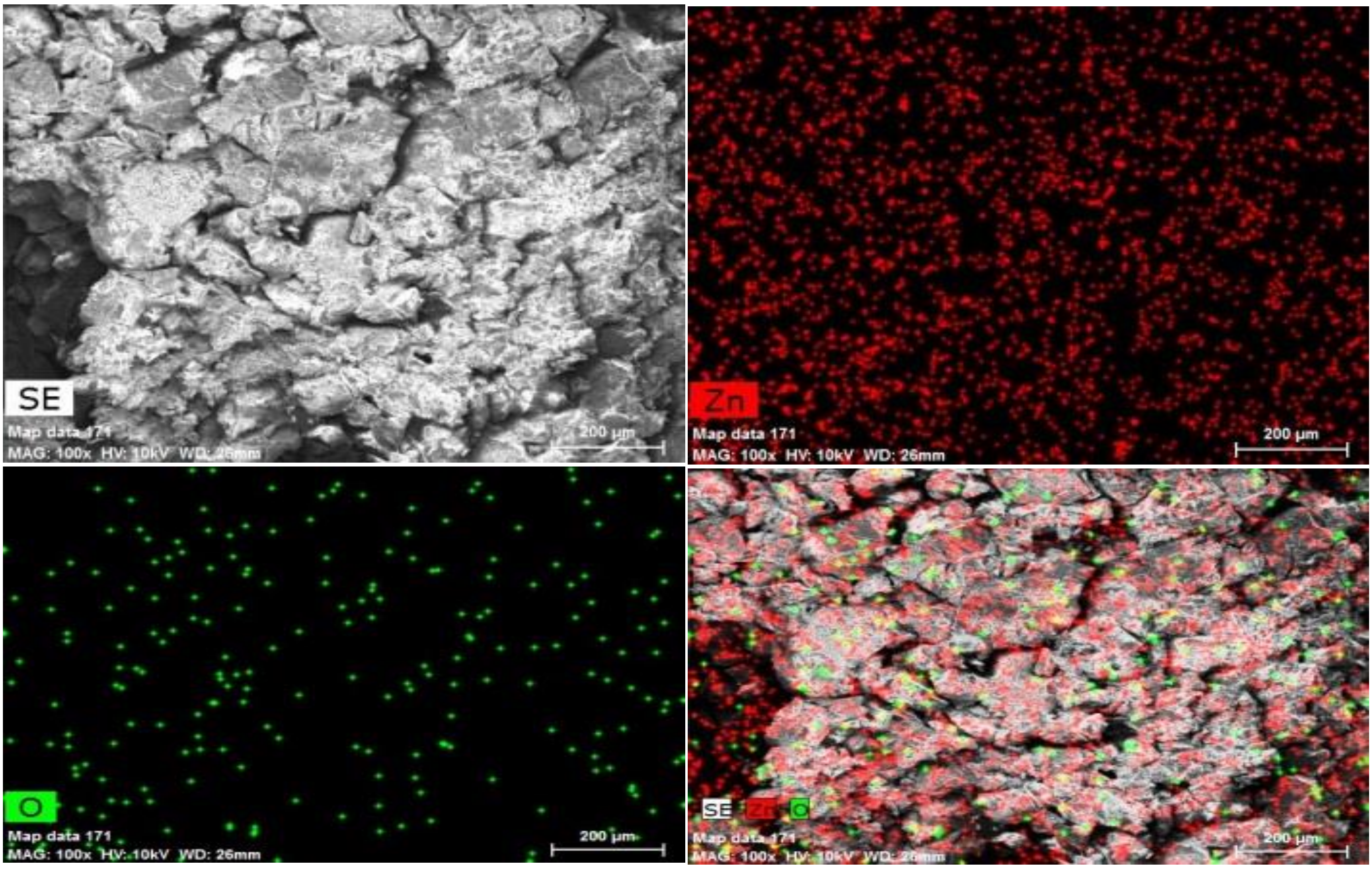

Figure 6: Elemental mapping of prepared zinc nanoparticles.

Characterization of ZNO nanoparticles using FTIR

Results of FTIR for the crude Aleo vera extract displays a broad peak at (2320.47 cm-1), which is associated with the stretching O-H groups of phenole groups and carbohydrate monomers. The -CC-stretch (alkynes) stretching vibrations are represented by the band at (2320.47cm-1). The carbonyl group of an amide's stretching -C=O is represented by the band at (1726.68cm-1). The nitro compound's -N=O stretching is represented by the band at (1315.67cm-1). Stretching C=C results in the band at (1418.59cm-1) distance. Stretching of C-N is represented by the band at (1260.27 cm-1). An amide's N-H bending is represented by the band at (1587.68 cm-1). The stretching -C-O corresponds to the band at (1075.15 cm-1).While the FTIR results for the prepared zinc nanoparticlesfrom plant extract shows that the band of -C=O carbonyl group change from (1726.68cm^{-1}) in plant extract to(1737.74cm^{-1}) which is assigned to the amide bond of protein of adsorbed strongly to Zn NPs and forms a layer along with the bio-organics, securing interacting with biosynthesized nanoparticles as shown in table (1) and figure (7).

The FTIR spectrum of prepared Zn nanoparticles from plant extract appearance band at (614.10cm^{-1}) corresponds to the stretch vibrations of ZnO nanoparticles. It is necessary for the ZnO nanoparticles to be stabilized by the present of phenolic group of molecules and the reduction process occurs of amide linkages in protein [12].

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The data accompanying the photogrammetry using AFM have been clear and sound, and can be inferred from their compatibility with the zinc nanoparticles imaging data for the *Aleo vera* water extract,using the SEM scanner, and Infrared Spectroscopy (FTIR) describing the formal properties of zinc particles prepared. These results agree with a number of previous studies that synthesized nanoparticles from various plant aquatic extracts [13, 14 and 15].

Table (1): FTIR Characterization spectrum of plant extract and the biosynthesized nanoparticles.

Function group	Plant extract	Zn NPs (cm^{-1})
-C=O stretch of amide	1726.68	1737.74
–C≡C-stretch (alkynes)	2320.47	2381.84
O–H stretching	3223.02	3070.80
C-N stretching	1260.27	1150.91
N-H bending of amide	1587.68	1548.74
C-Ostretching	1075.15	1052.05
N=O symmetric stretching of the nitro compound	1315.67	1391.12
C-H Aromatic bending	862.32	848.38
Znnanoparticles	-	614.10

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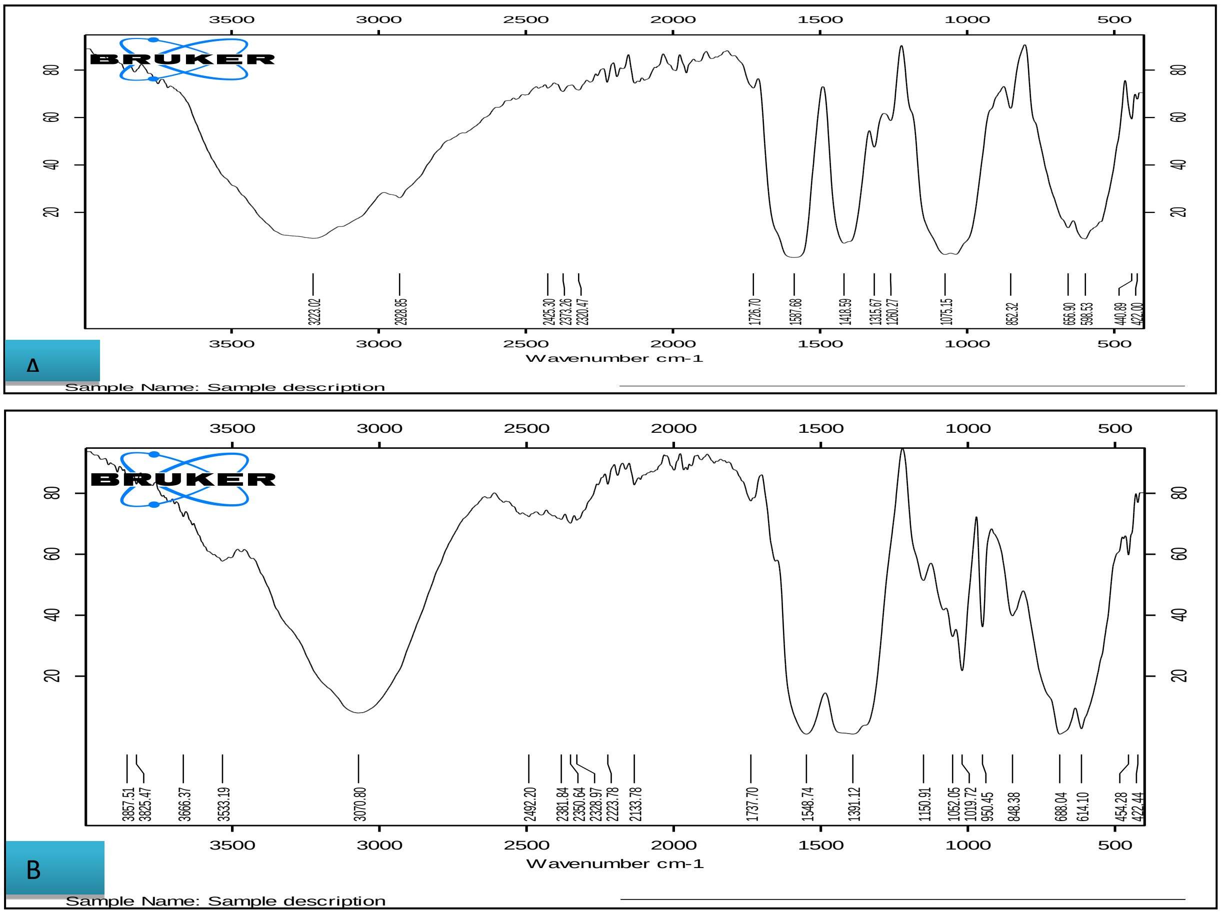

Figure(6): FTIR spectrum of A) plant extract, and B) prepared Zn nanoparticles.

Conclusion

ZNO nanoparticles synthesised using *Aloe vera* leaves extract detected and characterized using the following techniques: Fouriesr Transform Infra RedSpectrum (FTIR), Scanning Electron Microscopic (SEM), Atomic Force Microscope (AFM).

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