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Original Research Article

Facile and Eco-Friendly Method for Synthesis of Calcium Oxide Nanoparticles Utilizing *Pistacia Atlanica* Leaf Extracts and Its Characterization

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ABSTRACT

The disadvantages of conventionally utilized techniques for the synthesis of organic and inorganic compounds include costliness, non-eco-friendliness, less effectiveness, and unsuitability in large-scale procedures. Green procedures minimize injurious chemical compounds and equipment, are inexpensive, facile, produce no detrimental chemicals, and are highly efficient. Nano-scale significantly raises the potentiality of compounds and the green methods of synthesis in synthetic chemistry are superior alternates and effective relative to conventionally used techniques. Calcium oxide nanoparticles (CaO-NPs) are of value in adsorption, antimicrobial activities, catalysis, and adsorption. Green synthesis is the most preferable formulation technique because of using contamination-free chemical compounds and encouraging the application of non-toxic solvents, including water and plant extracts. This investigation aimed to propose the synthesis of CaO nanoparticles by an environmental-friendly green synthesis by *P. atlantica* leaf extract. The CaO-NPs were characterized in detail. In our investigation, the UV-Vis spectrums were determined in wavelengths ranging from 270 to 350 nm, suggesting

Keywords: CaO nanoparticles; Green Synthesis; Pistacia Atlantica;

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Introduction

Nanotechnology is a critical investigational field in the 21st century, which is increasing under development due to its numerous utilizations in nearly all sectors [1]. Most of the techniques utilized in the preparation of nanomaterials are atmospheric pollutants. Green synthesis of nanomaterials is now gaining ground and reputation [2]. There are reports of diverse synthesized nanoparticles, including palladium, selenium, platinum, gold and silver, by algal, fungal, bacterial, and herbal extracts in recent years [3-10]. Phytochemicals such as poly phenols and flavonoids are found in herbal extracts to function as reductions by the use of metal salts for synthesizing nanoparticles [11]. Chemically, nanotechnology is mainly applied to synthesize metal and metal oxide nanoparticles (MONPs) [5-6]. The increasing popularity of green synthesis of MONPs results from using eco-friendly reactants and synthesizing at ambient temperatures. CaO-NPs are of value in adsorption, antimicrobial activities, catalysis, and adsorption. Green syntheses are mainly adopted for synthesizing nanoparticles from various metal and metal oxides to minimize harmful chemical compounds and prevent wastages, as well as their effectiveness, inexpensiveness, and high-yielding products [6]. Nanomaterials with a variety of forms, dimensions, and biological activities are producible through variabilities in the bioreducing materials. Nanomaterials synthesized via the green route are affected by multiple factors [7-8]. Several procedures have been under discussion to characterize fabricated nanomaterials. Thus, nanoparticles as account for construction units of the future generation of technology to be applied in lots of industrial sectors [9]. Particularly, the interest in MONPs is on the rise in a vast range of applied fields. The popularity of MONPs is owing to their exclusive features optically, electronically, and magnetically [10 -12]. CaONPs are applied diversely, for example, in catalysis, adsorption, and water purification, as well as antibacterial substances [13]. Particularly, CaO is interesting due to being considered a benign chemical to human and animal species. Although CaONPs are frequently reported to be prepared chemically, there are only scarce reports of biogenic synthetic procedures [14-16]. Pistacia atlantica leaf extract was utilized to synthesize CaONPs in the current research. The characteristics of the produced CaONPs was then determined by UV spectroscopy, Fourier Transform Infrared, Powder X-ray Diffraction studies and Scanning Electron Microscopy procedures. P. atlantica or P. terebinth, also known as the turpentine tree, is a deciduous tree species of the genus Pistacia, endemic to the Mediterranean area from the west of Morocco, Spain, and Portugal to Greece and the west and southeast of Turkey, as well as to Iran.

Figure1. Pistacia Atlantica

Material and Method

The leaves P. atlanica plant was procured from Zagros Mountain, the western part of Iran. Calcium nitrate tetrahydrate and sodium hydroxide pellets were procured from Merck Company, Germany. UV-Vis spectra were analyzed through spectrophotometry (Phystec-miniature UVS-2500). UV-Visible absorption spectrophotometer was employed with in the range of 190-1100 nm. An Avatar Thermo Spectrophotometer system was used to record FTIR spectrums. Analyses of the particle size and surface were done by Scanning Electron Microscopy with FEI Quanta 200 SEM Tescan Mira3. Gold-coating of the sample disc was performed in an ionization compartment. The XRD spectra were analyzed by a system (Philips PW 1730). Analyzing the XRD in an angle range of 20º-80º and X-ray diffraction confirmed the amorphicity of the fabricated Ca nanoparticles. An advanced diffract meter was used with Ca (Kα) and (wavelength: 1.5406 Å) at 40 kV and 40 mA at ambient temperature in a 2θ at a range of 20-80º.

Preparation of extract from Crataegus pontica leaves

To prepare P. atlanica leaf extract, 20 g of the leaf was fully rinsed with tap water and then by deionized water. After boiling in 100 mL of deionized water for 30 min, it was passed through a Whatmann No. 1 filter paper, the resultant extract was chilled and utilized to synthesize MONPs.

Synthesis of CaO NPs by plant extracts

After adding 100 mL of Calcium Cloride solution to 30 mL of P. atlanica leaf extract, the admixture was agitated on a magnetic stirrer for circa 30 min. NaOH was added in drops and stirred until obtaining white precipitation of calcium hydroxide, followed by filtering the precipitation and then drying in an air oven for 60 min. The basic property of the solution was removed by repeated washing the content two times by distilled water, after which it was rinsed using ethanol. Furthermore, the calcination was performed in a furnace at 500 °C for 3 h. (Fig 2).

Figure 2. 1-plant extract, 2- $CaCl_2$, 3- Cao NPs

Result and Discussion

UV- Spectroscopy

UV-Vis spectroscopy is a frequently-used and helpful instrument in analytic chemistry, which is principally utilized to identify chemical products and to analyze them qualitatively. In the UV-visible spectroscopy as a typically employed procedure, the applied light wavelength typically ranges from 190 to 1100 nm. To characterize the CaO-NPs, absorptions of the spectrophotometry were measured in sizes ranging from 400 to 450 nm and 260-410 nm, respectively [17-18]. In our investigation, the UV-Vis spectrums were determined in wavelengths ranging from 270 to 350 nm, suggesting that calcium oxide nanoparticles formed in this wavelength (Fig. 3).

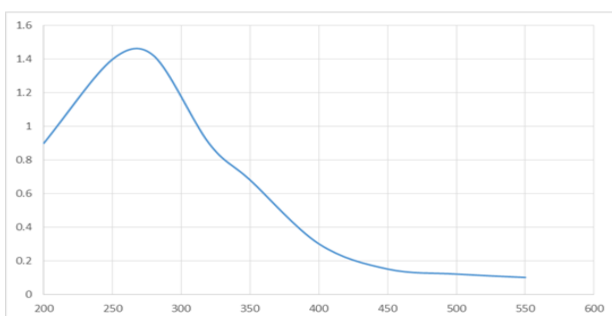

Figure 3. UV-vis specra of CaONPs

Infrared Spectroscopy

FT-IR principally gathers high-resolution data over a range of wide spectra [12]. FTIR spectroscopy is utilized for evaluating chemical coupling between extract and metal atoms on the surface of NPs and is also usable for analyzing the physical specifications of NPs and their activities [19]. using An avatar Thermo Spectrophotometer FT-IR spectrometer was employed to characterize the produced CaNPs. The FT-IR spectrums of the sample is depicted in Figure 4 and 5. The sharply visible peak at 872cm-1 belongs to the presence of Ca-O bonding and the peak at 712cm-1 is owing to the existing Ca-O bonding, identifying that calcium oxide is present [21-22]. Wide IR bands at 3417, 2514 , 1616 , 1425 , 1072 , 712 and 597 cm-1 reveal the existence of –N-H, -O-H , -CN, C=O, C=N, C=C, C-O, C-C, Ca-O (linkages), and so on in the nano-powder of calcium oxide. The FT-IR spectrums of P. Atlantica leaf extract was determined in the scope of 4000-400 cm-1 (Fig. 3). Wide peaks seen at 3426, 1628 , 1384 , 1352 , 1046 , 779 , 667 , and 511 cm-1 represent that hydroxyl group, carboxylic group, amines, and amides exist in the extract, confirming that the phyto-ingredients probably improved the stabilization of CaO-NPs.

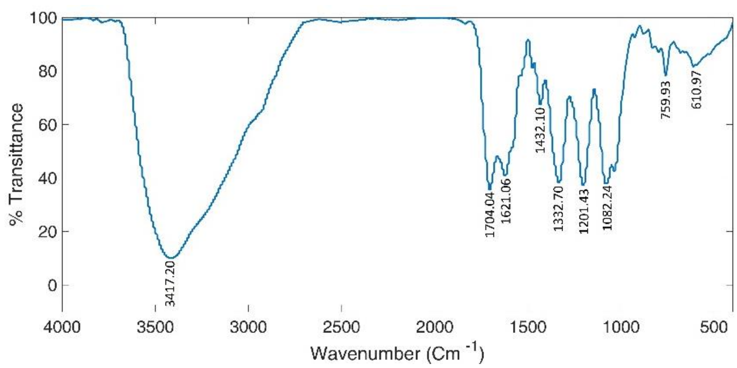

Figure 4. FT-IR spectrums of P. atlantica leaf extract

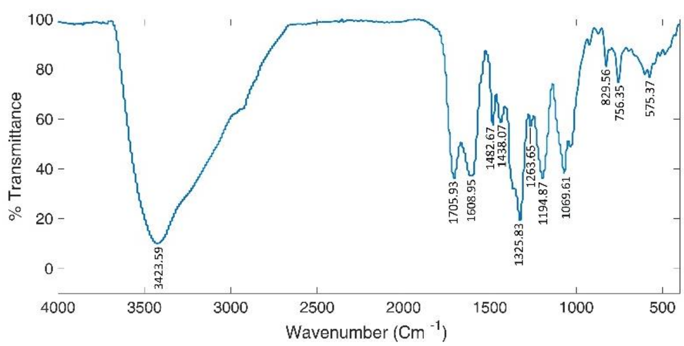

Figure 5. FT-IR spectrums of Calcium oxide NPs

X-Ray Diffraction studies

The structure and particle size of the CaO-NPs were scrutinized by the XRD pattern (Fig. 6) [17]. Overall, the solid and slender diffraction peaks denote the good crystallinity of the produced CaO-NPs. The XRD pattern of CaO-NPs displays that it agrees well with the standard JCPDS NO. 77-2376 [19-20]. The XRD pattern of CaO a various sets of diffraction peaks (2θ) at 32.02, 37.12, 53.80, 64.17, and 67.26 represent the indexes (111), (200), (202), (311), and (222), respectively, of crystal planes.

The pure cubic phase of CaO was created in CaO-NPs composite. Figure 4 illustrates the XRD pattern of Calcium oxide NPs.

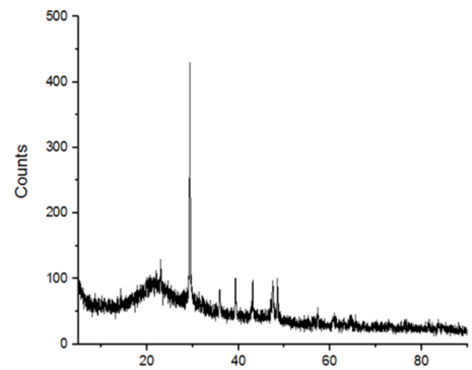

Figure 6. XRD pattern of Calcium oxide NPs

Scanning Electron Microscopy

The SEM procedure utilizes electrons rather than light for the formation of an output image. SEMs have provided insights into lots of novel investigational fields, such as material science and nanotechnology [23 -25], and enabled investigators in examining very diverse samples. As analyzed by SEM the spheroid morphology and uniformly sized particles are exhibited in Figure 5. The source of precursors to prepare CaO-NPs is in the range of 40-130 nm (in length) and 30-100 nm (in width).

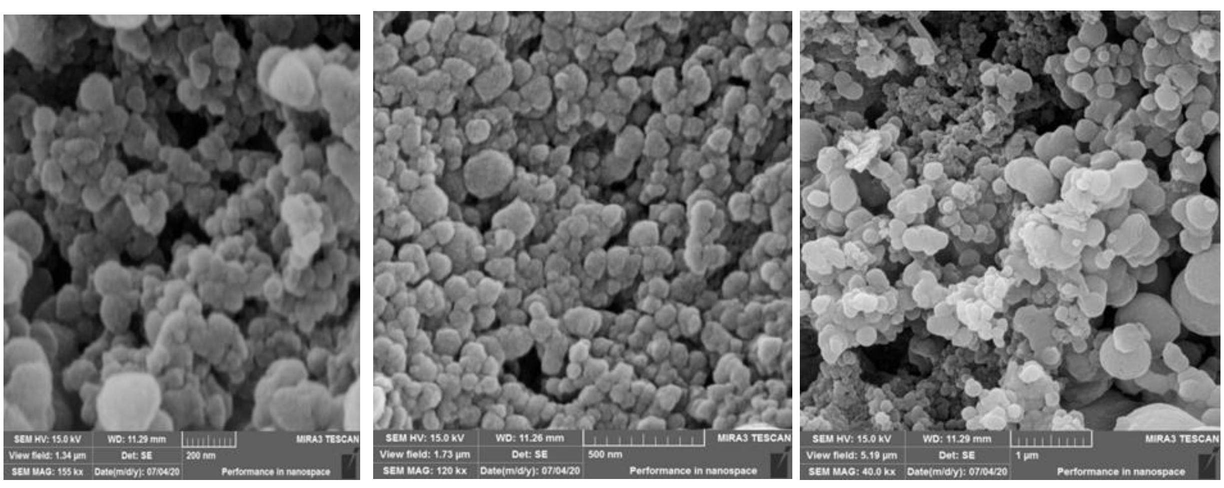

Figure 7. SEM image showing surface of the Cao nanoparticles

Conclusion

In the present investigation, Calcium oxide -NPs were biosynthesized with simplicity, non-toxicity, and eco-friendliness by aqueous extract of P. atlantica. Functional groups, including carboxylic acids, phenols, alkene, amine, and aromatic, were present in the crude extract possibly because of the main constituents of reduction and stabilization agents in the fabrication of CaO-NPs, the produced nanoparticles were properly analyzed with several analytic techniques, i.e., FTIR, UV-Vis, XRD, and SEM. Biosynthesised CaO-NPs were spheroid and their size averaged 30-100 nm. All analytic techniques revealed that the CaO-NPs formed under a laboratory scale. The offered research was carried out to develop environmental-friendly technique for the production of CaO-NPs.

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