RESEARCH ARTICLE

Fabrication and Characterization of Zinc Nanoparticles of *Cryptostegia grandiflora*

Inamdar A[1], Jadhav RS[2*], Mohite SK[1], Kadam AB[2], Gavali R[1]

[1]*Department of Pharmaceutical Chemistry, KE'S, Rajrambapu college of Pharmacy, Kasegaon Maharashtra, India*
[2]*Department of Pharmaceutical Chemistry, Krishna Institute of Pharmacy, Krishna Vishwa Vidyapeeth, Deemed to be university, Mahararastra, India*

Received: 3rd Aug, 2024; Revised: 27th Sep, 2024; Accepted: 28th Oct, 2024; Available Online: 25th Dec, 2024

ABSTRACT

The goal of this work was to use plant extract from Cryptostegia grandiflora to examine the green production of zinc nanoparticles and their pharmacological evaluation. Green synthesis and other techniques are more advantageous than chemical and physical procedures because they produce nanoparticles in an environmentally responsible and economically viable manner.

Method: An ethanolic extract of *Cryptostegia grandiflora* was obtained through the use of Soxhlet extraction. Additionally, an ethanolic extract of *Cryptostegia grandiflora* is made using a microwave-assisted process. After mixing plant extract (*Cryptostegia grandiflora*) with zinc acetate and letting it sit for a while, UV-visible spectroscopy was employed to examine the development of nanoparticles. Nanoparticles were characterized using FTIR and SEM.The nanoparticles had a haphazard, round, and rectangular shape. FTIR studies revealed that phytoconstituents are used to make zinc nanoparticles. Synthesized zinc nanoparticles characterize.

Conclusion: Zinc nanoparticles made using green synthesis were demonstrated to have enhanced pharmacological characteristics. It could be applied as a preventative measure against bacteria.

Keywords: Green synthesis, phytoconstituents, Nanoparticles., Zinc nanoparticles, ethanolic extract.

How to cite this article: Inamdar A, Jadhav RS, Mohite SK, Kadam AB, Gavali R. Fabrication and Characterization of Zinc Nanoparticles of Cryptostegia Grandiflora. International Journal of Drug Delivery Technology. 2024;14(4):2209-13. doi: 10.25258/ijddt.14.4.36

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

In a 1974 paper scattered by Tokyo Science College, Norio Taniguchi, the word "nanotechnology" was to begin with characterized. Nanotechnology is the taking care of of materials by one atom or one iota, counting combination, divide, and miss hapening. With the approach of cluster science and the STM investigate, two fundamental moves interior the early 1980s gave nanoscience and nanotechnology a pushed. It was much recognized to these progressed zones that fullerenes were found in 1958.This strategy suggests to the "manhandle," "creation," and "blends" of any substance with a thickness between one and one hundred microns. The word "nano" may be a interpretation of the Greek word "Nanos." "Tiny/very small/dwarf" is the definition of nanos.[1] In common, there are three sorts of nanotechnology: dry, sodden, and computational. Physical chemistry and the creation of inorganic materials like silicon and carbon are related to dry nanotechnology. Damp nanotechnology is related to components found in living things like tissues, chemicals, motion pictures, and other characteristic parts. Reenactments of nanometer-sized structures are related to computational nanotechnology. For culminate esteem, these three dimensions—dry, drenched, and computational—depend on one another.[2] Due to its potential applications in a gathering of districts, counting chemistry, hardware, essentialness, water treatment, and medicinal look at, nanoparticle blend is time- and resource-intensive. Physical and chemical strategies are customarily utilized for metal nanoparticle blend and change; chemical techniques such chemical diminishment, electrochemistry, and photochemistry are without a address in utilize. Most of the businesses of nanotechnology in pharmaceutical are for accommodating pharmaceutical transport, suffering confirmation, and treatment. The explore and organize of different unmistakable exceptional stock offer astonishing guarantee much recognized to the colossal control of nanotechnology, which as well has potential accommodating businesses for the early confirmation, desire, and treatment of sickness. Analysts have been paying more thought to the biosynthesis pathway of nanoparticles, which risen at the crossing point of nanotechnology and biotechnology, as a result of the making inquire for really kind materials union techniques.[3] Wide numbers of bioactive components from plants may be utilized as a key asset for eco neighborly nanoparticle mix, supplanting the current physical and chemical shapes. Interior the early a long time, unmistakable methods for synthesizing nanoparticles are made. Since they are cost-effective, actually welcoming, and don't join the utilize of any unsafe chemical interior the blend of nanoparticles, characteristic strategies are right by and by of most exceptional essential. A short time later inquire nearly shows up that plants with tall levels of tannic dangerous

Author for Correspondence:

have amazing capacity to synthesize nanoparticles. besides donate the nanoparticles soundness. The utilize of plants for the amalgamation of nanoparticles is legitimized not since it were by the truth that it is fundamental, speedier, and less asking, but other than since the passed on particles were more solid, steady, and traditionalist than those passed on utilizing other standard procedures.[4] One-time materials are organized interior the shape of fantastically little particles, physicochemical characteristics as a result, their are fundamentally changed. Nano-dimension highlights the another rate of surface particles than colossal particles, which boosts the particle's improvement there as well as its standard properties like catalytic action, mass exchange, warm treatment, etc. Non-metal nanoparticles, in any case, have more mechanical vocations when compared to metal nanoparticles4. In biochemical shapes, synthesized nanoparticles have antioxidant, antimicrobial, and anticancer properties. which outlines interest with unmistakable ranges of conventional science. These nanotechnologies pass on novel gadgets for the examination and creation of present day, secure, and sensible consistent formulations.[5] One case is nanoparticle biotechnology, which combines inquire around and improvement from a number of zones of science, counting texture science, chemistry, surface science, biotechnology, and nanotechnology. The reason for this field's investigate center is that these particles have boundlessly overwhelming qualities to those of their gigantic scale scale corelative. Nanoparticles are being made open as of late inside the zones of biosensors, biomedicine, and bionanotechnology, particularly interior the taking after areas.[6]

MATERIAL AND METHOD

Materials and equipment's used for the synthesis of zinc Nanoparticles are enlisted in Tables. An ethanolic extract of *Cryptostegia grandiflora* was obtained through the use of Soxhlet extraction. Additionally, an ethanolic extract of *Cryptostegia grandiflora* is made using a microwave-assisted process, and components from the extract were identified using GC-MS research. After mixing plant extract (*Cryptostegia grandiflora*) with zinc acetate and letting it sit for a while, UV-visible spectroscopy was employed to examine the development of nanoparticles. Nanoparticles were characterized using FTIR and SEM.

Characterization of zinc nanoparticle

Fourier Transformer Infrared spectroscopy, GC-MS, Particle Size Analyzer, Zeta Potential Analyzer

EXPERIMENTAL WORK

Collection of Plant Material

The plant selected for the present work is *Cryptostegia grandiflora (*Family: Apocynaceae) was collected from Sangola District-solapur, Maharashtra in August-September.

Macroscopic Examination

The detail macroscopic characters of fresh plant was noted including special features such as color, shape, size etc (Khandelwal,2014).

Drying of Plant Material

Figure 1: Soxhlet Extraction.

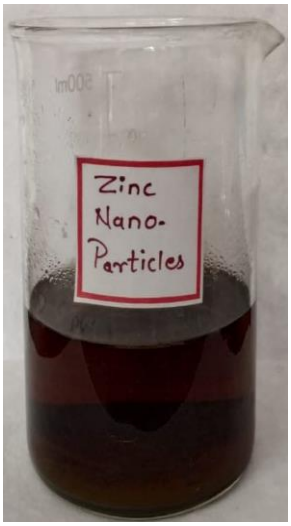

Figure 2: Zinc nanoparticles of *Cryptostegia grandiflora* crude extract.

Table 1: Effect of on absorption signal intensity at 268 nm of Zinc nanoparticles (ZnNPs).

Wavelength	Absorption
268.00	1.459

In order to remove any impurities for the current experiment, the collected plant material was thoroughly cleaned and sorted. The plant took around two weeks to air-dry naturally. After being sparsely layered, the plants were left to dry in the shade.

Method of extraction of *Cryptostegia grandiflora*

Soxhlet Extraction

The extraction of plant material was done using a Soxhlet extractor with 1 litter capacity. For the extraction *of Cryptostegia grandiflora*, ethanol (95%) was utilized. Using a mechanical grinder, the dry plant material was crushed. The 250 gm of coarse *Cryptostegia grandiflora* powder was added to the RBF. The plant powder was initially wetted by the addition of enough solvent. To prevent bumping, certain bits of porcelain were added before the heating process began. The water flowed continuously through the condenser throughout. Extractor's mouth was attached to a bulb-style condenser, and the necks were filled with sealing wax. The temperature was kept closer to the boiling point of the appropriate solvent for all extractions. By distilling the solvent, the extract was recovered, and the whatman filter no. 42 was used to filter it. On heating mental extracts were concentrated. Finally, weighted dried extract was placed in airtight containers for storage.

Characterization of Ethanolic Extract of *Cryptostegia grandiflora*

The ethanolic extract subjected to measuring properties for the identification and confirmation of extract such as

Physical properties

Melting point

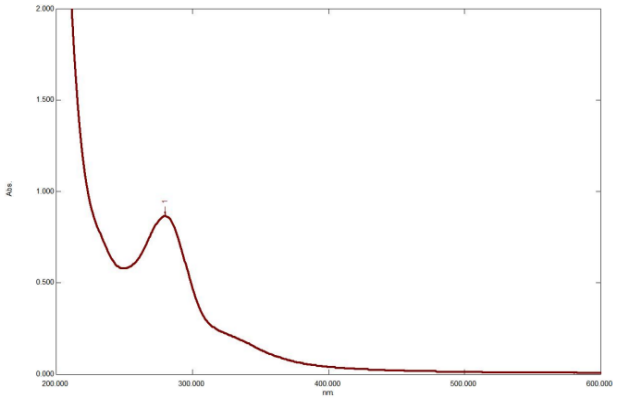

Figure 3a: UV-visible absorption spectra of study of effect of concentration on the synthesis Zinc nanoparticles (ZnNPs).

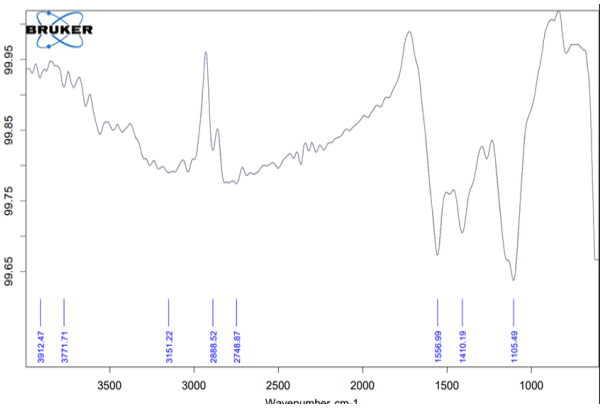

Figure 3b: FT-IR analysis of Zinc nanoparticles (ZnNPs).

Table 2: FT-IR interpretation of Zinc nanoparticles (ZnNPs).

Functional Groups	IR Frequencies standard Peak (cm-1)	IR Frequencies observed Peak (cm-1)
C-O	900-1200	1105.49,
C=C aliphatic	1200-1400	1410.19,
C=C aromatic	1450-1600	1556.99
O-H	3200-3400	3152.22,
N-H	3200-3600	3771.71

Solubility
Color

Synthesis of Zinc nanoparticles (ZnNPs)

Cryptostegia grandiflora plant extract was used as a reducing agent for the synthesis of zinc nanoparticles and zinc acetate (Zn (CH3CO2)2) was used as a source of metal (zinc) for synthesis of zinc nanoparticles (ZnNPs). ZnNPs nanoparticles were prepared by refluxing precursor zinc acetate dihydrate (0.1 M) in diethylene glycol and triethylene glycol at 180 °C and 220 °C respectively. Reaction time varied for 2 and 3 h with and without sodium acetate (0.01 M). Before refluxing, the solution was kept on a magnetic stirrer at 80 °C for 1.5 h. After completion of reflux action, the samples were centrifuged at 8000 rpm for 15 min and washed with distilled water and ethanol for three times. Further, it was dried at 80 °C for overnight.

Effect of various conditions on the synthesis of nanoparticles

Danish chemist S.P.L. Sorensen defined pH in 1909, an enormous development of the theory and practical application of the pH concept has taken place. Today, the pH value is an important determining factor in a majority of chemical processes and the pH meter has, consequently, become the most widely used analytical laboratory instrument. The size, shape, stability and yield of synthesis of nanoparticles was affected by some conditions such as, pH, concentration, Temperature, incubation time etc.

UV-Visible Spectroscopy

UV- visible spectroscopy is most widely used technique for investigation of the optical properties of the particles. The color changes indicated the formation of nanoparticles. The formation of (Zn) nanoparticles using Ethanolic extract of *Cryptostegia grandiflora* was monitored at the time of reaction with the help of UV-visible spectroscopy (Systronic ET2705) in the range 200-800nm and maximum absorbance was recorded.

Fourier Transforms Infrared Spectroscopy (FTIR)

The synthesized Bimetallic (Zn) nanoparticles and extract of *Cryptostegia grandiflora* subjected to FTIR spectrometric analysis and spectra were recorded in the wave number frequency ranged from 4000 cm^{-1} to 600 cm^{-1} with a speed of 25 scan per spectrum by using JASCO FTIR-4600 equipped with ATR (Attenuated Total Reflectance) made in Japan.

Particle Size Analysis

The majority of a nanoparticle's qualities depend on its size. In actuality, nanoparticles' novel features do not take hold until their size decreases to the nanometer range.The total area of the exposed surfaces of the particles per unit mass is the specific surface area of theparticles. The connection between surface area and particle size is inverse. The specific surface area provides an average particle size if the particles are believed to be spherical and have a limited size distribution.

Zeta Potential Measurement

Zeta potential, which is connected to the surface charge of the nanoparticle. When the zeta potential of a nanoparticle is between 10 and +10 mV, it is said to be about neutral, however when it is larger than +30 mV or lower than 30 mV, it is said to be strongly cationic or anionic. Zeta potential can influence a nanoparticles propensity to penetrate membranes because the majority of biological membranes have a negative charge. Cationic particles typically exhibit more toxicity due to breakdown of cell walls.

RESULT AND DISCUSSION

Zinc Nanoparticles (ZnNPs)

The color of the solutions changed from light yellow to pale yellow on increasing crude extract concentration in the absence of Zinc acetate solution. But in the presence of Zinc acetate solution, with the increase of extract concentration the crude extract color change from yellowish to brown and further to deep brown due to excitation of surface Plasmon

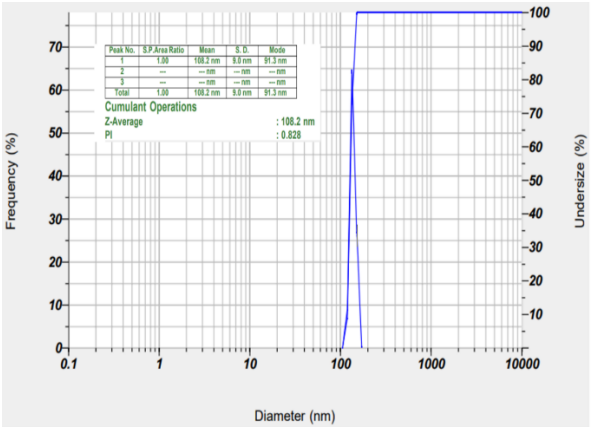

Figure 4: Particle Size Analysis of Zinc nanoparticles (ZnNPs).

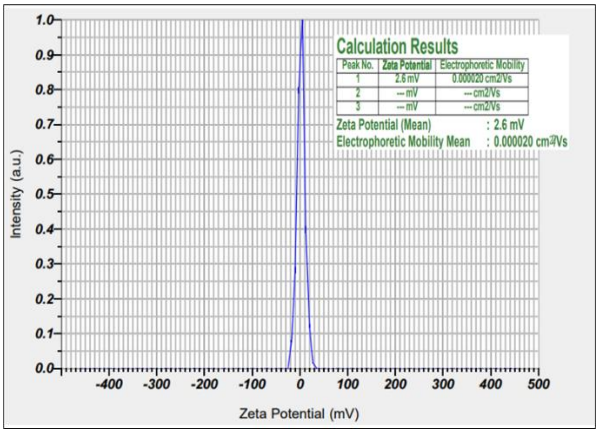

Figure 5: Zeta Potential Graph of Zinc nanoparticles (ZnNPs).

vibration, indicating formation in the Zinc nanoparticles. The UV-visible spectrophotometric analysis of *Cryptostegia grandiflora* extract showed synthesized Zinc nanoparticles (ZnNPs) showed the maximum absorption at a wavelength of 268 nm as shown in Figure 2.

Particle Size Analysis of Zinc nanoparticles (ZnNPs)

The particle size of prepared nano particles was measured using a particle size analyzer and light scattering-based Laser diffraction. (HORIBA SZ100). (figure 4) The average particle size is 108.2 nm.

Zeta Potential analysis of Zinc nanoparticles (ZnNPs)

The formulated nanoparticles have a zeta potential of 2.6 mv (figure 5). capping agent that consists of positively charged groups that coat the surface of Cryptostegia grandiflora.

CONCLUSION

An examination of crude medicines using a potential approach verified the extract. Soxhlet extraction and microwave assisted extraction (MEA) both produced successful extracts. *Cryptostegia grandiflora* extract is used in the environmentally friendly manufacture of (zinc) nanoparticles. Subsequently, the antibacterial activity of these nanoparticles were assessed and they performed better than the extract. (zinc) nanoparticles from *Cryptostegia grandiflora*. This work shows that artificially produced nanoparticles can be used in a wide variety of applications.

REFERENCES

1. Hemant P. Borase, Bipinchandra K. Salunke, Rahul B. Salunkhe, Chandrashekhar D. Patil, John E. Hallsworth, Beom S. Kim, Satish V. Patil.Plant Extract: A Promising Biomatrix for Ecofriendly,Controlled Synthesis of Silver Nanoparticles.: Appl Biochem Biotechnol :(2014):173:1–29.
2. Bharat Bhushan,Introduction to Nanotechnology: History, Status, and Importance of Nanoscience and Nanotechnology Education,Springer International Publishing Switzerland (2016)
3. Sally D. Solomon, Mozghan Bahadory, Aravindan V. Jeyarajasingam, Susan A. Rutkowsky, and Charles Boritz, Synthesis and Study of Silver Nanoparticles,Journal of Chemical Education:(2007):Vol. 84- 2:322-325
4. Aswathy Ravindran, Preethy Chandran, S. Sudheer Khan Biofunctionalized silver nanoparticles: Advances and prospects. Colloids and Surfaces B: Biointerfaces, (2013):105: 342– 352.
5. Simin Wei, A Yinghui Wang, B Zhishu Tang,A Hongbo Xu,A Zhe Wangtian Yanga And Taiyan Zouaa; Novel Green Synthesis Of Silver Nanoparticles By The Residues Of Chinese Herbal Medicine And Their Biological Activities; RSC Adv.; (2021); 11, 1411–1419.
6. Jae Yong Song, Beom Soo Kim.: Rapid biological synthesis of silver nanoparticles using plant leaf extracts: Bioprocess Biosyst Eng: (2009): 32::79–84.
7. Monalisha Rath, Swati S Panda and Nabin K Dhal : Synthesis Of Silver Nano Particles From Plant Extract And Its Application in Cancer Treatment: A Review International Journal of Plant, Animal and Environmental Sciences: (2014) :4(3); 137-145.
8. Bhattacharyya A., Bhaumik A., Rani P.U., Mandal S. and Epidi T.T: Nanoparticles-a recent approach to insect pest control:. Afr. J. Biotechnol: 2010; 9:3489-3493.
9. Masumeh Noruzi. Biosynthesis of gold nanoparticles using plant extracts. Bioprocess Biosyst Eng Springer-Verlag Berlin Heidelberg (2014); 1-14.
10. Gopalasatheeskumar K.: Significant role of Soxhlet extraction process in phytochemical research. ;MJPMS; (2018);7(1):43-47.
11. Seo S.Y., Abbas Q., Saleem M., Phull A. R., Rafiq M., Hassan M.: Green Synthesis of Silver Nanoparticles using Bidens Frondosa Extract and their Tyrosinase Activity; Iranian Journal of Pharmaceutical Research; 2017, 16 (2), 760-767.
12. Shakeel Ahmed, Saif Ullah, Mudasir Ahmad, Babu Lal Swami Saiqa Ikram :Green synthesis of silver nanoparticles using *Azadirachta indica* aqueous leaf extract Journal of Radiation Research and Applied Science 2015 1-7. D.
13. Paramelle,A. Sadovoy, S. Gorelik,P. Free,J. Hobley, and D. G. Fernig,; Rapid method to estimate the concentration of citrate capped silver nanoparticles from UV-visible spectra ; RSC Publishing; (2012);00;1-3.

14. R. S. Rimal Isaac, G. Sakthivel, and Ch.Murthy Green Synthesis of Gold and Silver Nanoparticles Using *Averrhoa bilimbi* Fruit Extract,Journal of Nanotechnology, 2013, 45, 1-6
15. B. Akbari, M. Pirhadi Tavandashti, M. Zandrahimi. Particle size characterization of nanoparticles – a practicalapproach. Ijmse 2011; 8 (2) :48-56
16. Clogston JD, Patri AK. Zeta potential measurement. Characterization of nanoparticles intended for drug delivery. 2011:6