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SYNTHESIS AND BIOMATERIAL CHARACTERIZATION OF ZINC NANOPARTICLE FROM SEA GRASS OF *CYMODOCEA SERRULATA* AND THEIR ANTIOXIDANT POTENTIAL

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Abstract

Introduction

The present study investigates the green synthesis of zinc nanoparticles using sea grass (Cymodocea serrulata) extract as both a reducing and stabilizing agent. The synthesized nanoparticles were thoroughly characterized for their biomaterial properties, including size, morphology, crystal structure, stability, and surface chemistry. Furthermore, their antioxidant potential was evaluated through standard antioxidant assays.

Materials and methods

Results

These findings suggest that sea grass-derived zinc nanoparticles possess attractive biomaterial characteristics and remarkable antioxidant potential, positioning them as promising candidates for diverse applications in fields ranging from biomedicine to environmental science. The green synthesis approach employed in this study underscores their eco-friendly and sustainable nature. Future research should delve into specific applications, biocompatibility assessments, and potential mechanisms underlying their antioxidant activity.

Conclusion

This study contributes to the expanding knowledge of green synthesis methods for nanoparticles and underscores the potential of sea grass-derived zinc nanoparticles as multifunctional biomaterials with significant antioxidant properties.

Keywords: *Cymodocea serrulata***,** Antioxidants activity, Zinc , Nanoparticle, Green synthesis, Plant extract.

INTRODUCTION :

Growing interest in the synthesis and characterisation of biomaterials for diverse medical applications, notably in the area of nanotechnology, has been observed in recent years[1]. Zinc nanoparticles (ZnNPs), which have demonstrated considerable potential due to their distinct physicochemical features and biocompatibility, are one promising class of biomaterials[2]. The investigation of natural sources for the synthesis of ZnNPs has also drawn interest because it provides a sustainable and environmentally beneficial method[3].

With the atomic number 30 and the symbol Zn, zinc is a chemical element. When the oxidation is removed, zinc transforms into a shiny-grayish metal that is slightly brittle at normal temperature[4]. It is the first element in the periodic table's group 12 (IIB). Zinc and magnesium share a few chemical characteristics, including a single normal oxidation state (+2) and similar-sized Zn2+ and Mg2+ ions. There are five stable isotopes of zinc, the 24th most common element in the crust of the Earth. Sphalerite, a zinc sulfide mineral, is the most typical zinc ore. Australia, Asia, and the United States have the biggest working lodes. By froth flotation of the ore, roasting, and subsequent[1].

It has been acknowledged that sea grasses like *Cymodocea serrulata* are a valuable source of bioactive substances with a range of medicinal effects. Numerous phytochemicals, such as polyphenols, flavonoids, and alkaloids, which have antioxidant properties, are present in these marine plants. Utilizing sea grasses as a source of zinc for the production of ZnNPs not only creates a renewable supply, but also imparts antioxidant characteristics into the nanoparticles.

ZnNPs are synthesized from sea grass using a straightforward, economical, and sustainable process[4]. As a reducing and stabilizing agent, Cymodocea serrulata-derived plant extracts are frequently used. ZnNPs are produced as a result of the extract's bioactive components' efficient reduction of zinc ions to their nanoparticulate state[5]. By adjusting the reaction parameters, such as the concentration of the plant extract and reaction time, one may regulate the nanoparticles' size, shape, and surface features[6].

METHODS AND MATERIALS

The research was conducted in the Department Of Forensic Odontology, SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCE. Thisresearch was done over a period of 3 months in the research department.

Materials:

Cymodocea serrulata : Gather fresh sea grass samples from a pristine coastal area for Cymodocea serrulata (sea grass). Make sure Cymodocea serrulata is the correct identification of the species.

Zinc precursor : As the source of zinc ions, you'll need an appropriate zinc salt like zinc chloride ($ZnCl2$) or zinc sulfate ($ZnSO4$).

Reducing agents : Select a natural reducing agent like plant extracts like ascorbic acid or green tea extract that may efficiently reduce zinc ions to produce nanoparticles.

Stabilizing agent : Gum arabic or polyvinylpyrrolidone (PVP) are two stabilizing agents that can be used to stop the aggregation of nanoparticles.

Solvents: For the creation of solutions, use distilled water or a suitable solvent.

Tools for Characterization: Access to numerous analytical tools for characterisation, including as X-ray diffraction and Transmission Electron Microscopy (TEM).

Methods:

Preparation of the extract :

Sea grass samples should be cleaned and dried.Make a fine powder by grinding the dried sea grass.Utilize maceration or Soxhlet extraction to extract bioactive chemicals with a suitable solvent (such as ethanol or methanol).Utilize a rotary evaporator to concentrate and purify the extract.

Synthesis of zinc nanoparticle :

By dissolving zinc chloride or zinc sulfate in distilled water, you can make a zinc precursor solution.Zinc precursor solution should now contain sea grass extract (a reducing agent).Under regulated circumstances (such as temperature and pH), stir the mixture.Keep an eye on the solution's color to see whether zinc nanoparticles start to form.

Characterisation of zinc Nanoparticles :

To determine the nanoparticles' size and shape, use TEM.To determine the nanoparticles' crystal structure, run an XRD investigation.By examining the distinctive absorption peak, use UV-Visible spectroscopy to determine the existence of zinc nanoparticles.Determine the functional groups in

FTIR spectra that are capping or stabilizing the nanoparticles.DLS can be used to evaluate the stability and hydrodynamic size of the nanoparticles in solution.

Antioxidant potential assessment :

Use standardized procedures to perform DPPH or ABTS assays to gauge the antioxidant capacity of the produced zinc nanoparticles.

Contrast the nanoparticles' antioxidant potential with that of conventional antioxidants.

Data analysis:

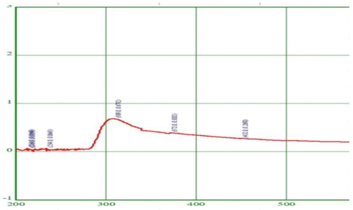
Use standardized procedures to perform DPPH or ABTS assays to gauge the antioxidant capacity of the produced zinc nanoparticles.

Contrast the nanoparticles' antioxidant potential with that of conventional antioxidants.

Cymodocea serrulata **2) Powdered sample 3) Extraction of seagrass sample 4) Initial stage of synthesis 5) Final stage of synthesis**

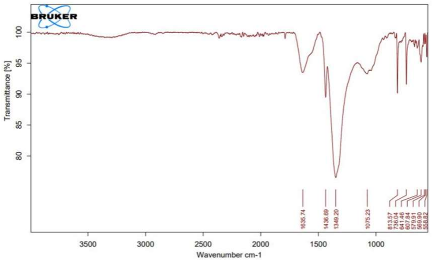
RESULTS

Graph 1



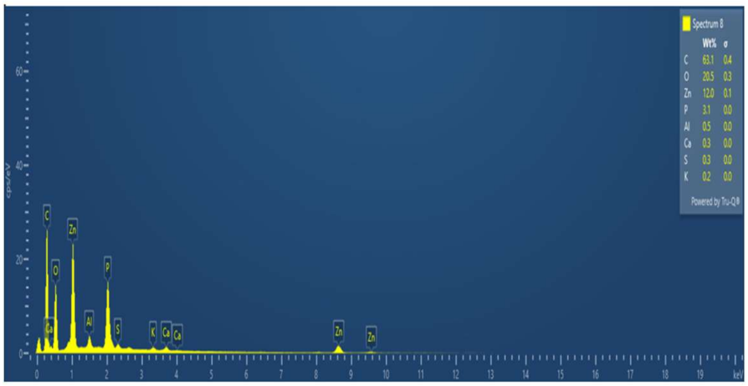
UV Spectrophotometer

Graph 2



FTIR analysis

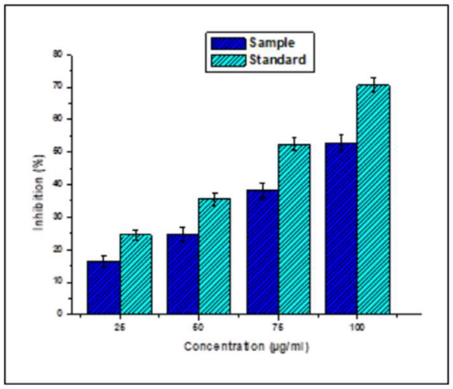
Graph 3



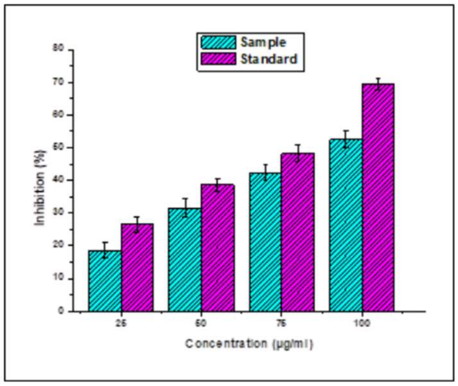
Spectrum 8

	Wt%	σ
C	63.1	0.4
O	20.5	0.3
Zn	12.0	0.1
P	3.1	0.0
Al	0.5	0.0
Ca	0.3	0.0
S	0.3	0.0
K	0.2	0.0

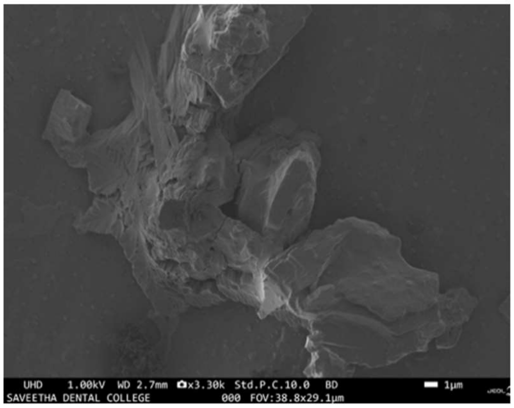
Graph 4



Graph 5



SEM image



1) UV spectrometer, 2) FTIR, , 3) EDS , 4) H2O2 assay, 5) DPPH assay 6) SEM

UV spectrophotometry, shown in Graph 1, is a quantitative method for calculating how much a chemical compound absorbs light. The most popular type of infrared spectroscopy is represented by Graph 2 and is called Fourier transform infrared (FTIR). It is used to identify functional groups as well as to confirm production material and identify unknown materials. In graph 2, the peak of this has a carboxylic acid functional group. In the research of pharmaceuticals, such as in the investigation of drug distribution, the EDX technique is helpful since it may be used to identify nanoparticles. Here, we formally establish the existence of zinc nanoparticles. H2O2 (hydrogen peroxide) and DPPH (2,2-Diphenyl-1-picrylhydrazyl) assays are shown in graphs 4 and 5. This graph indicates that the plant has a good antioxidant property.

DISCUSSION

Zinc nanoparticle synthesis using Cymodocea serrulata:

Seagrass Collection: The initial phase entails gathering Cymodocea serrulata from its native environment, which is often coastal locations. To have as little impact on the ecosystem as possible, it is essential to collect sea grass sustainably.

Extract Preparation: After being meticulously cleaned, dried, and turned into a fine powder, the sea grass. Then, using a suitable solvent (such as water, ethanol, or a mixture of them), an extraction procedure is performed on this powder to produce an aqueous or organic extract that contains bioactive chemicals.

Reduction of Zinc Precursor: The sea grass extract is combined with zinc salts, such as zinc nitrate or zinc chloride. The extract's bioactive components may function as capping and reducing agents, promoting the reduction of zinc.

Characterization of Biomaterials:

Size and Shape: Information regarding the size and shape of the ZnNPs can be found in TEM and SEM photographs. This is relevant because nanoparticles' physical characteristics have a big influence on their behavior and prospective uses.

Crystal structure: XRD analysis can show the nanoparticles' crystal structure. Typically, zinc nanoparticles have a crystalline structure with distinctive diffraction patterns.

Chemical Makeup: The functional groups of organic molecules that are present on the surface of the ZnNPs, which may have come from the sea grass extract, may be identified using FTIR spectroscopy.

Antioxidant potential :

Through a variety of assays, the antioxidant potential of ZnNPs made from Cymodocea serrulata can be evaluated.

DPPH test: This test employs 2,2-diphenyl-1-picrylhydrazyl (DPPH) to gauge the ZnNPs' capacity to scavenge free radicals. Reduced DPPH absorbance is a sign of active antioxidants.

Application Possibilities:

Zinc nanoparticles having antioxidant properties have a variety of uses, such as:

Biomedicine: They can be employed as possible therapies for conditions caused by oxidative stress, drug delivery systems, and wound healing.

Environmental Remediation: Because of their high surface area and reactivity, ZnNPs can be used to remove heavy metals and contaminants from water bodies.

Cosmetics: Due to their antioxidant and anti-aging qualities, they can be found in skincare products.

Food Industry: ZnNPs can be added to food packaging materials to prevent oxidation, extending shelf life.

In one of the investigations, zinc oxide nanoparticle-infused *Acacia caesia* bark extract was used for an antibacterial activity. Utilizing the bark extract of Acacia caesia (L.) Willd, zinc oxide nanoparticles were successfully created in this work utilizing the green synthesis assisted approach[7]. A non-toxic, affordable, and ecologically acceptable way of creating nanoparticles is described in the study[8]. Additionally, it demonstrates that at high concentrations of ZnO nanoparticles, antifungal activity against Aspergillus niger and Candida albicans displayed fungicidal properties[9]. The COX test was used to measure the anti-inflammatory activity in RAW 264.7 cells, which had a high ability to reduce inflammation. According to this research, ZnO nanoparticles may offer a viable alternative to conventional microbicide and anti-inflammatory drugs[10,11].

Another study evaluated the characteristics and anticancer, antioxidant, and antiglycemic indices of seagrass *Cymodocea serrulata* (R.Br.) Asch. & Magnus, which was used in the green manufacture of silver nanoparticles[12]. In this study, the antidiabetic effect of the AgNPs was evaluated through the inhibition of the a-glucosidase and amylase enzymes that break down carbohydrates[13]. Additionally, it may have anticancer properties against MDF7 breast cancer cells[14,9].

CONCLUSION

As a result, this study's green synthesis method was successful in creating zinc nanoparticles from *Cymodocea serrulata* extract. The hexagonal wurtzite zinc oxide nanoparticles' size, shape, and crystal structure were analyzed to confirm their production. The synthesized zinc nanoparticles also displayed strong antioxidant capability, making them attractive for further investigation in a variety of biological and industrial applications. To comprehend their mode of action and maximize their potential advantages, more research is necessary.In this study, we used sea grass (*Cymodocea serrulata)* extract as a natural reducing and stabilizing agent to successfully produce zinc nanoparticles. The created zinc nanoparticles showed significant antioxidant activity and positive biomaterial characteristics.

FUTURE SCOPE

Our present study was done in invitro condition. Optimization of Synthesis Mechanistic Studies Structural and Morphological Analysis Biocompatibility and Toxicity Assessment Antioxidant Mechanism: Investigating the antioxidant mechanism of the zinc nanoparticles can provide a deeper understanding of their potential therapeutic applications. Scale-up and Commercialization: Once the synthesis and characterization processes are optimized, efforts can be made to scale up the production of zinc nanoparticles from *Cymodocea serrulata*.

CONFLICT OF INTEREST

There is no conflict of interest

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AUTHOR CONTRIBUTION

All authors are equally contributed.

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