Antioxidant And Anti-Inflammatory Activity Of Zinc Oxide Nanoparticles Synthesized Using Banana Stem

Srivatchava.S[1], Dr.M.Jeevitha[2*], Dr.S.Rajeshkumar[3]

[1]Undergraduate, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences,
Saveetha University, Chennai-600077, Tamil Nadu,India. Mail ID- 151901028..sdc@saveetha.com
[2*]Senior Lecturer, Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077, Tamil Nadu,India.
Mail ID- jeevitham.sdc@saveetha.com
[3]Nanomedicine lab, Department of Pharmacology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077, Tamil Nadu,India.
Mail ID- rajeshkumars.sdc@saveetha.com

***Corresponding Author:** M.Jeevitha
*Senior Lecturer, Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077,Tamil Nadu,India.
Mail ID- jeevitham.sdc@saveetha.com

Abstract
Introduction: Banana belongs to the family Musaceae and is considered to be the largest herbaceous flowering plant. The fruit, stem, and leaves of this plant are used for various purposes. The banana stem is edible and rich in fibre which has the goodness of potassium and vitamin B6. Zinc oxide nanoparticles are least toxic and possess antibacterial, anticancer, anti inflammatory properties.
Aim: The aim of the study is to determine the antioxidant and anti-inflammatory activity of Zinc Oxide nanoparticles synthesized using Banana stem.
Materials and methods: 1g of banana stem powder was measured and 100 ml of distilled water was measured using a measuring cylinder. They were mixed in the beaker together with the help of a stirrer. The extract was boiled at 70°C for 10 to 15 minutes and filtered using whatman filter paper. The zinc oxide solution is mixed with the prepared aqueous extract. Then the solution was tested for anti-inflammatory activity and antioxidant activity by DPPH assay.
Results and Discussion: The present study shows that the antioxidant activity and anti inflammatory activity of banana stem mediated zinc oxide nanoparticles was seen to be increased as the concentration increased in a dose-dependent manner, hence it can act as a good antioxidant and anti inflammatory agent.
Conclusion: Banana stem mediated zinc oxide nanoparticles were found to exhibit potent anti inflammatory activity and antioxidant activity and the results of the study show that these zinc oxide nanoparticles are promising sources of potent antioxidants and anti inflammatory drugs that may aid for therapy.

Keywords: Anti oxidant; Anti inflammatory; zinc oxide; banana stem

Running title: Antioxidant and anti-inflammatory activity of Zinc Oxide nanoparticles from Banana stem

Introduction

Banana belongs to the family Musaceae and is considered to be the largest herbaceous flowering plant. The fruit, stem, and leaves of this plant are used for various purposes. The banana stem is edible and rich in fibre which has the goodness of potassium and vitamin B6. Zinc oxide nanoparticles are least toxic and possess antibacterial, anticancer, anti inflammatory and UV blocking properties. The banana plant (*Musa paradisiaca*) is a popular fruit crop which is widely available in the tropics. Almost all parts of the banana plant, such as leaves, young plant, fruit and stems, can be used as food and for various medicinal purposes (1) . A drug which reduces inflammation (redness, swelling, and pain) in the body. Antioxidants act as scavengers of free radicals in the body cells and reduce the risk produced by oxidation.

Zinc oxide nanoparticles are one of the important metal oxide nanoparticles which are employed in different fields for their chemical and physical properties. ZnO nanoparticles were firstly used in rubber industries as they increase the quality and toughness of polymers. Strong UV absorption properties of ZnO make them useful in preparing cosmetics and sunscreen (2). Recently, zinc oxide nanoparticles grabbed attention for their purpose in cancer therapy i.e induction of selective cancerous cell killing. The potential risks and various toxic effects associated with zinc oxide nanoparticles are very comparatively low (3). Sol-gel method is used for the synthesis of the zinc oxide nanoparticles as it is advantageous in terms of eco-friendliness, time consumption, cost effectiveness and easy application (4). Zinc oxide nanoparticles purity is assumed to be very high. In other notes, it doesn't show any resistance against antibiotics but toxicity and pollution is not common (5).

Various studies indicate its toxicity like hepatotoxicity, toxicity of lungs , neurotoxicity, and immunotoxicity. Zinc oxide nanoparticles play a positive beneficiary role in the treatment and diagnosis of various diseases but toxicity is dose dependent and should be evaluated for each preparation (6). Zinc is a trace metal found in the human body and the impact of zinc on the health of individuals is becoming as equal as iron and other important elements (7). The influence of pH, cationic valency, and ionic strength strongly determines the stability and behavior of zinc oxide nanoparticles which are used in various therapies (8). ZnO nanostructures are very advantageous in the application of catalytic reaction processes as they possess large surface area and high catalytic activity. The nanoparticles show different physical and chemical properties with respect to the morphology of nanostructures (9). Zinc oxide nanoparticles exhibit very effective antimicrobial action against gram positive and gram negative bacteria and various fungi. Zinc oxide nanoparticles exhibit selective toxicity towards normal and tumour cells, which is determined by reactive oxygen formation. Despite the potential anticancer activity of Zinc oxide nanoparticles, it has been scientifically shown in some studies that these nanoparticles can be cytotoxic and genotoxic for different lines and types of human cells such as neuronal, epithelial cells and much more (10).

The aim of the study is to determine the antioxidant and anti-inflammatory activity of Zinc Oxide nanoparticles synthesized using Banana stem.

Materials and Methods

Extract preparation:

1gm of Banana stem was added in 100 ml of distilled water and boiled for 10-15 minutes at 70 degrees celsius. After boiling, the plant extract was filtered by Whatman No 1 filter paper. 90 ml of 1 millimolar zinc oxide is prepared in 250 ml of a conical flask, 40 ml of filtered plant extract was mixed to it and kept in a magnetic stirrer for nanoparticles synthesis (Figure 1). The synthesized nanoparticles were first analyzed using UV visible spectroscopy. Before the final step, the nanoparticles solution was centrifuged at 8000 rpm to prepare nanoparticle pellet powder, it was dried in a hot air oven at 80 degrees celsius (Figure 2). The dried powder was sent for characterization. Finally, the leftover solution was taken to calculate antioxidant and anti-inflammatory activity.

Figure 1: Figure showing the preparation of banana stem mediated zinc oxide nanoparticles extract.

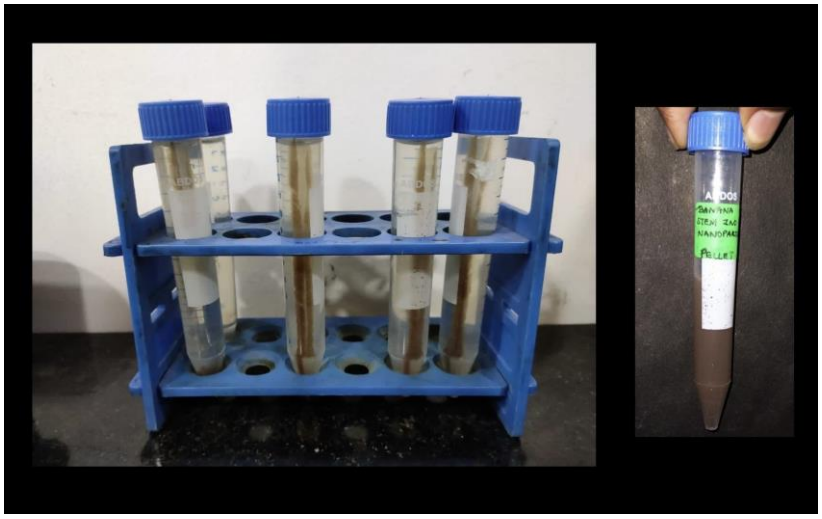


Figure 2: Figure showing the banana stem mediated zinc oxide nanoparticles solution being centrifuged and collected as pellets.

Antioxidant activity
DPPH method:
DPPH assay was used to test the antioxidant activity of banana stem mediated zinc oxide nanoparticles. Diverse concentrations (2-10 µg/ml) of Banana stem extract mediated zinc oxide nanoparticle were mixed with 1 ml of 0.1 mM DPPH in methanol and 450 µl of 50 mM Tris HCl buffer (pH 7.4) and incubated for 30 minutes (Figure 3). Later, the reduction in the quantity of DPPH free radicals was assessed dependent on the absorbance at 517 nm. Vitamin C was employed as control.

The inhibition percentage was determined from the equation below,

% inhibition= Absorbance of control- Absorbance of test sample × 100
Absorbance of control

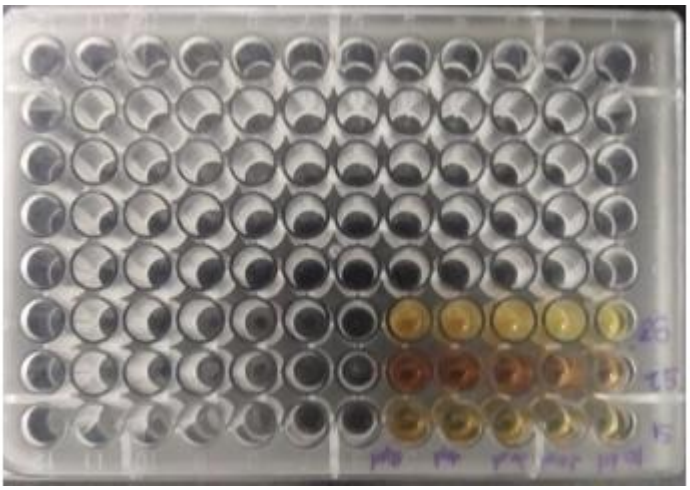
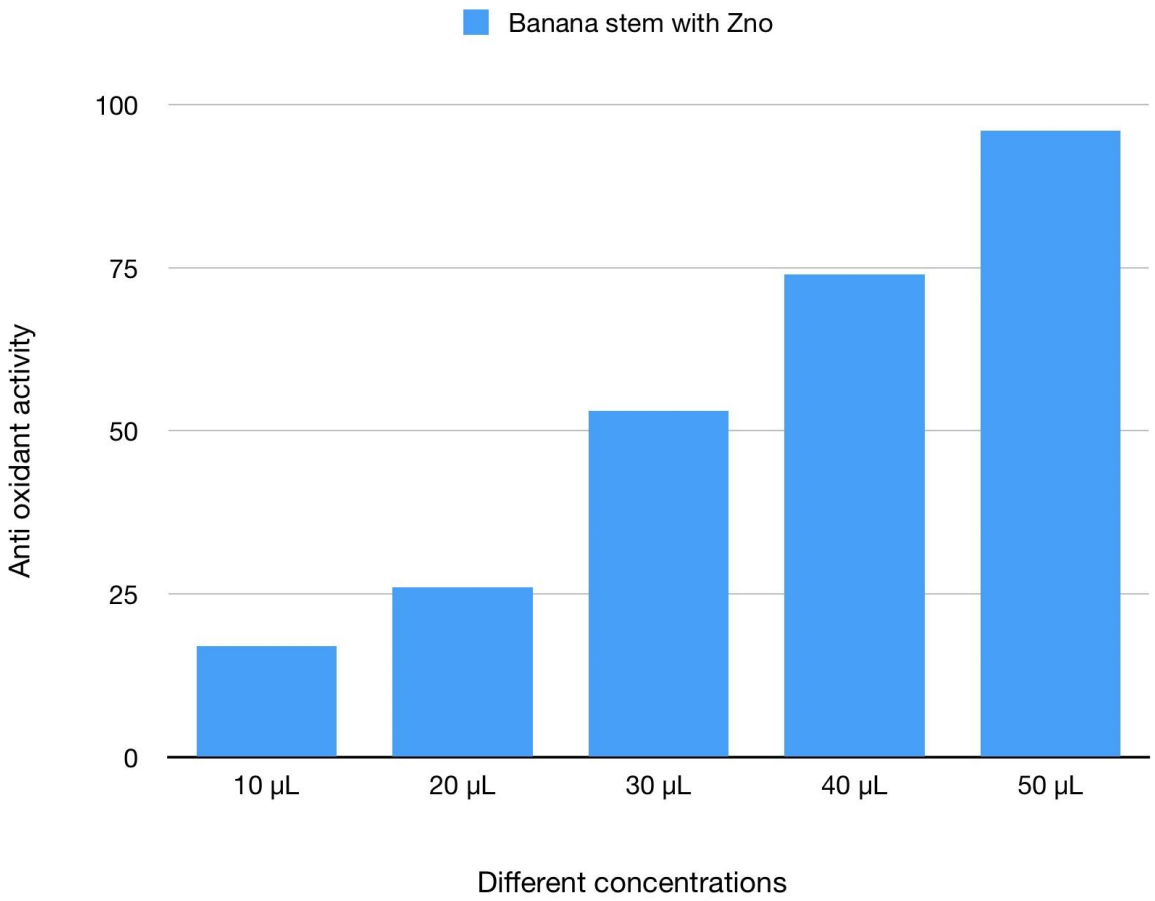


Figure 3: DPPH assay comparison ELISA plate wells with different concentrations of Banana stem mediated zinc oxide nanoparticles for evaluation of its antioxidant activity.

Anti-inflammatory activity
Albumin Denaturation Assay:
The anti-inflammatory activity for Banana stem mediated zinc oxide nanoparticles was tested by the following convention proposed by Muzushima and Kabayashi with specific alterations 0.05 mL of the extract of various fixation (10µL,20µL,30µL,40µL,50µL) was added to 0.45 mL bovine serum albumin (1% aqueous solution) and the pH of the mixture was acclimated to 6.3 utilizing a modest quantity of 1N hydrochloric acid. The sample solutions were incubated at room temperature for 20 min and then heated at 55 °C for 30 min in a water bath. The samples were cooled and the absorbance was estimated spectrophotometrically at 660 nm. Diclofenac Sodium was used as the standard. DMSO is utilized as a control.

The protein denaturation percentage was determined from the equation below,
% inhibition= Absorbance of control- Absorbance of sample×100
Absorbance of control

Results and Discussion



Graph 1: The graph represents a comparison of antioxidant activity of banana stem mediated zinc oxide nanoparticles at different concentrations. From the above graph it has been observed that the antioxidant activity of banana stem mediated zinc oxide nanoparticles was seen to be increased as the concentration increased in a dose-dependent manner.

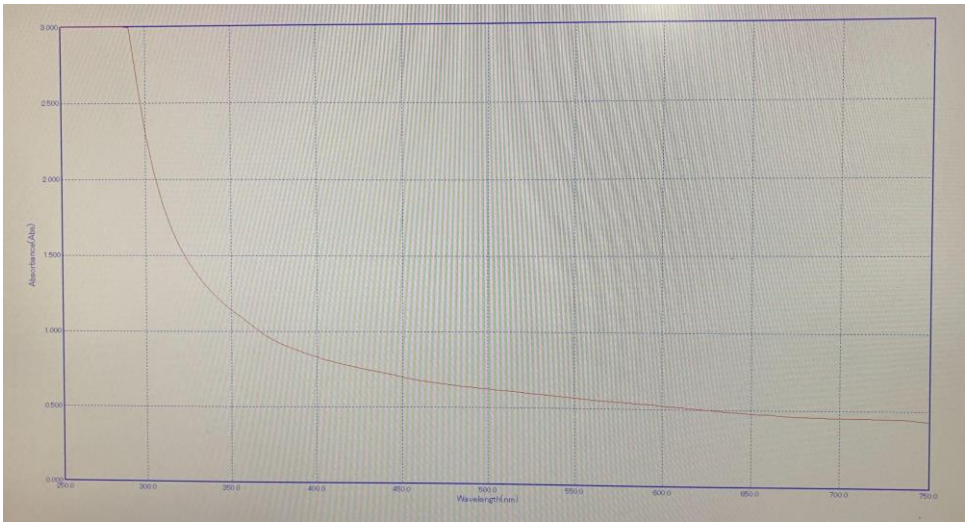
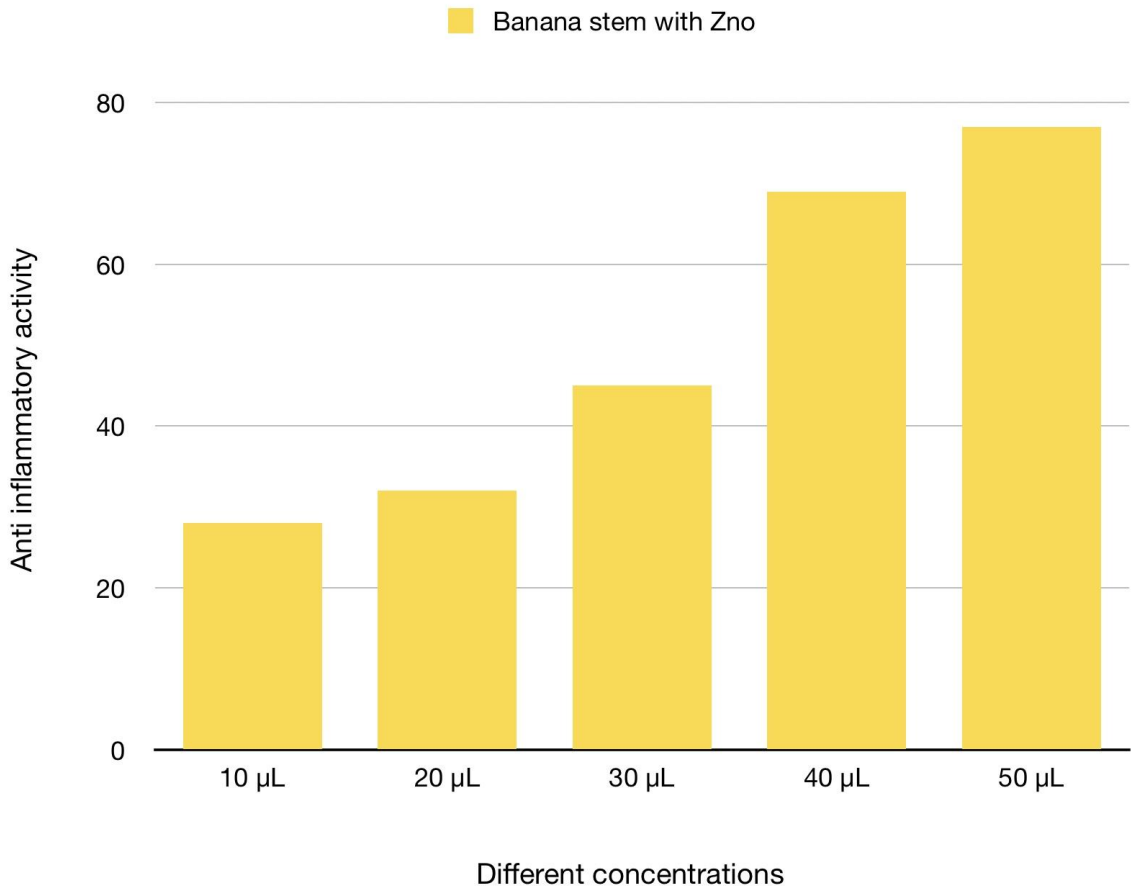


Figure 4: Figure showing the UV visible absorption spectrum of the banana stem mediated zinc oxide nanoparticles. An intense surface plasminogen resonance between 300 nm is the UV spectrum clearly reveals the formation of zinc oxide nanoparticles.



Graph 2: The graph represents a comparison of anti-inflammatory activity of banana stem mediated zinc oxide nanoparticles at different concentrations. From the above graph it has been observed that the anti-inflammatory activity of banana stem mediated zinc oxide nanoparticles was seen to be increased as the concentration increased in a dose-dependent manner.

The antioxidant activity was determined in five different concentrations of solutions from 10 µL, 20 µL, 30 µL, 40 µL and 50 µL. Antioxidant activity of different percentage of inhibition is noted as shown in Graph 1.

In this study the anti-inflammatory activity was assessed in five different concentrations of reaction mixture from 10 µL, 20 µL, 30 µL, 40 µL and 50 µL. Anti-inflammatory activity of different percentages of inhibition is observed as shown in Graph 2 .

In the study by Nagajyothi et al., . Zinc oxide nanoparticles exhibited very modest antioxidant activity at 45.47% DPPH at 1mg/mL showing scavenging activity and high anti-inflammatory activity in dose dependent manner by suppression of mRNA and protein expressions (11). In the previous study by Basnet et al., the credible mechanisms and the action of phytochemicals of the plant extracts which show involvement in the formation of Zinc oxide nanoparticles act as potent photocatalysts and inhibitors of microbial agents (12). In other study by Nagajyothi et al., the synthesized zinc oxide nanoparticles revealed mild antibacterial action against Gram-positive and Gram-negative bacteria and outstanding free radical scavenging action and the synthesized nanoparticles expressed no toxic effects (13). In the study by Murali et al., it was inferred that the significant antioxidant results revealed by zinc oxide nanoparticles affirm that these can be used as a substitute to current chemical compounds (14). In a study done by Gharpure et al., zinc oxide nanoparticles are chosen over other metal oxide nanoparticles as they are biocompatible in nature and exhibit excellent antibacterial actions (15). In the study by Ishak et al., due to the complex compositions, biomolecules contents and constituents present

in plant extracts such as alkaloids, flavonoids make them a potent antimicrobial, antioxidant and anti-inflammatory agent (16).

The present study shows that the antioxidant activity and anti inflammatory activity of banana stem mediated zinc oxide nanoparticles was seen to be increased as the concentration increased in a dose-dependent manner, hence it can act as a good antioxidant and anti inflammatory agent. Further studies should be done to confirm the safety and efficacy of banana stem mediated zinc oxide nanoparticles in pharmaceuticals.

Conclusion

Banana stem mediated zinc oxide nanoparticles were found to exhibit potent anti inflammatory activity and antioxidant activity and the results of the study show that these zinc oxide nanoparticles are promising sources of potent antioxidants and anti inflammatory drugs that may aid for therapy.

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Conflicts of Interest

The authors declare that there are no conflicts of interest in the present study.

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References

1. BL O, Panneer Selvam S, Ramadoss R, et al. (May 07, 2024) Fabrication of Periodontal Membrane From Nelumbo nucifera: A Novel Approach for Dental Applications. Cureus 16(5): e59848. doi:10.7759/cureus.59848
2. S K, Panneer Selvam S, Shanmugam R, et al. (May 03, 2024) Exploring the Antimicrobial Potential and Cytotoxic Effects of Different Brassica oleracea Varieties. Cureus 16(5): e59613. doi:10.7759/cureus.59613
3. Soni J, Panneer Selvam S, Shanmugam R, et al. (March 18, 2024) Quantification of the Bioactivity of Ethanolic Extract From Phoenix dactylifera. Cureus 16(3): e56391. doi:10.7759/cureus.56391
4. Panneer Selvam S, Ramadoss R, Shanmugam R, et al. (February 18, 2024) Assessment of Female Hormonal Influence on COVID-19 Vaccine Response: A Prospective Cohort Study. Cureus 16(2): e54417. doi:10.7759/cureus.54417
5. Panneer Selvam, S., Ramani, P., R, R., Sundar, S., & T A, L. (2022). COVID-19 Vaccines and the Efficacy of Currently Available Vaccines Against COVID-19 Variants. Cureus, 14(5), e24927. https://doi.org/10.7759/cureus.24927
6. Panneer Selvam, S., Ramani, P., Ramadoss, R., Trivandrum Anandapadmanabhan, L., & Sundar, S. (2022). Incessant Role of Fibroblast in Malignant Transformation of Gnathic Fibro-Osseous Lesions? - Should We Rework on Treatment Strategies. Asian Pacific journal of cancer prevention : APJCP, 23(7), 2177–2178. https://doi.org/10.31557/APJCP.2022.23.7.2177
7. Ravikumar R, Ramani P, Sukumaran G, Ramasubramanian A, Selvam SP. Quantification of Apoptotic Bodies and Correlation of TNF-α & IL-2 Levels with Severity of Pemphigus Vulgaris. Journal of Advanced Oral Research. 2024;0(0). doi:10.1177/23202068241248259
9. Suresh N, Kaarthikeyan G (April 28, 2024) Green Synthesis and the Evaluation of Osteogenic Potential of Novel Europium-Doped-Monetite Calcium Phosphate by Cissus quadrangularis. Cureus 16(4): e59202. doi:10.7759/cureus.59202.
10. Korukonda H, Suresh N, K S (December 25, 2023) Fabrication and Characterization of an Innovative Silver- and Gadolinium-Doped Bioglass for Bone Regeneration. Cureus 15(12): e51086. doi:10.7759/cureus.51086
11. Suresh N, Gurumurthy K, K S. Exploring Synergies of Lotus Seed Extract-Hyaluronic Acid Gel for Enhanced Local Drug Delivery. BSCM [Internet]. 2024 Apr. 8 [cited 2024 Aug. 24];63(2):108-13.
12. Murali M, Mahendra C, Nagabhushan, Rajashekar N, Sudarshana MS, Raveesha KA, Amruthesh KN. Antibacterial and antioxidant properties of biosynthesized zinc oxide nanoparticles from Ceropegia candelabrum L. - An endemic species. Spectrochim Acta A Mol Biomol Spectrosc. 2017 May 15;179:104-109.

13. Gharpure S, Ankamwar B. Synthesis and Antimicrobial Properties of Zinc Oxide Nanoparticles. J Nanosci Nanotechnol. 2020 Oct 1;20(10):5977-5996.
14. N A I Md Ishak et al ,Green synthesis of metal and metal oxide nanoparticles via plant extracts: an overview,2019 Mater. Res.