Green Synthesis and Antioxidant Activity of Silver Nanoparticles Synthesized Using *Ficus benghalensis*

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Authors’ contributions

This work was carried out in collaboration among all authors. Author AKS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft manuscript. Authors MJ and SR managed the analyses of the study. Author SJ managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i62B35177

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/78087

Received 25 October 2021
Accepted 28 December 2021
Published 29 December 2021

ABSTRACT

**Background:** Nanoparticles are materials with overall dimensions in the nanoscale, ie, under 100 nm. Silver nanoparticles (AgNPs) have shown excellent bactericidal properties against a wide range of microorganisms. *Ficus benghalensis* is a very large tree and had been considered as effective, economical and safe treatments for curing various diseases.

**Aim:** The present study is aimed to evaluate the antioxidant activity of AgNPs synthesized using *F. benghalensis*.

**Materials and Methods:** Bio-mediated synthesis of metal oxide nanoparticles using *F. benghalensis* is a promising alternative to traditional chemical synthesis. The antioxidant activity of
AgNPs was synthesized using DPPH radical scavenging assay. 1 gm of F. benghalensis mixed with 100 mL of distilled water and boiled in 60-70 degree celsius in the heating mantle for 10-15 minutes. Add filtered using Whatman no. 1 filter paper. 20 milli molar (0.574g) of silver was dissolved in 60mL of distilled water. 40 mL of filtered F. benghalensis extract is mixed with 60 mL of silver nanoparticles.

**Results:** The activity of F. benghalensis extract was compared with standard ascorbic acid by measuring absorption intensity in the spectrophotometer at the wavelength of 517 nm. While increasing the concentration (10 µL, 20 µL, 30 µL, 40 µL, 50 µL) of F. benghalensis extracts, the percentage of inhibition of DPPH also increased.

**Conclusion:** In this study, a simple, biological and low-cost approach was done for the preparation of silver nanoparticles using F. benghalensis. Thus the synthesized F. benghalensis mediated silver nanoparticles can be subjected to the various other biological activities such as antioxidant, antibacterial, antifungal and cytotoxic evaluation to know the efficiency of these nanoparticles.

Keywords: Antioxidant; Ficus benghalensis; green synthesis; innovative technology; silver nanoparticles.

1. **INTRODUCTION**

Nanoparticles show novel properties which depend on their size, shape and morphology which enable them to interact with plants, animals and microbes [1]. Silver nanoparticles (AgNPs) have been proven to have bactericidal properties against a wide range of bacteria [2]. They are prepared from different perspectives, often to study their morphology or physical characteristics [3]. Biosynthesis of AgNPs involves bacteria, fungi, yeast, and plant extracts [4,5]. Recently, a number of parts of plants such as flowers, leaves and fruits, besides enzymes, have been used for the synthesis of gold and silver nanoparticles [6]. The size, morphology and stability of nanoparticles depend on the method of preparation, nature of solvent, concentration, strength of reducing agent and temperature [7]. Antioxidant compounds in food play an important role as a health protecting factor [8]. Scientific evidence suggests that antioxidants reduce the risk for chronic diseases including cancer and heart disease [9]. The potentially important derivatives of oxygen, endorsed as ROS (Reactive Oxygen Species) such as O₂, H₂O₂ and OH radicals are generated within the human body, if there is ROS overproduction the equilibrium is hindered favoring the ROS gain that leads to oxidative stress [10]. The ROS readily attack and induce oxidative damage to various biomolecules like proteins, lipids, lipoproteins and DNA [11,12]. This oxidative damage can eventually lead to diabetes mellitus, cancer, atherosclerosis, arthritis, and neurodegenerative diseases. Recently additional interest has been shown in the field of free radical biology, to avoid the causes of chronic diseases [13]. Epidemiological studies have shown that the intake of antioxidants such as Vitamin- C (ascorbic acid) can reduce the risk of coronary heart disease and cancer [14]. The use of synthetic antioxidants such as butylated hydroxytoluene, butylated hydroxyanisole, tert–butylhydroquinone and propyl gallate has been negatively perceived by consumers because of its safety and health effects [15]. Hence, there is an increased interest and demand in search of natural antioxidants from plant sources. It is well known that many botanical products possess natural antioxidants with high antioxidant activity and investigations on these were initiated based on their uses in traditional herbal medicines [16]. The genus Ficus includes 750 species in most tropical and subtropical forests throughout the world. The genus is remarkable for its large variation in the habits of its species. Ficus benghalensis is a very large tree distributed throughout India [17]. It is commonly known as ‘Indian Banyan tree’ and is considered the holy tree of India. Recent studies reveal that the herbal preparations of different parts of F. benghalensis had been considered as most effective and safe treatments for curing various types of diseases in the Indian traditional system and used as medicine. The hanging roots of F. benghalensis have been reported as antidiarrheal agents [18]. The fruit extract of F. benghalensis has been documented for its antitumor and antibacterial activities [19]. The plant is used in folk medicine for respiratory disorders and certain skin diseases [20]. The bark of F. benghalensis has been traditionally used to cure diabetes mellitus and is also used as oral administration of bark extract showed lowering of blood glucose level and enhancement of serum insulin levels in normoglycemic as well as diabetic rats. Blood
sugar lowering and serum insulin raising action was also found in a dimethoxy derivative of leucocyanidin 3-O-beta-galactosyl cellobioside and a dimethoxy ether of leucopelargonidin-3-O-alpha-L-rhamnoside isolated from the bark of F. benghalensis [21]. Bengalenoside, a glucoside isolated from F. benghalensis, also showed hypoglycemic activity in normal and alloxan diabetic rabbits. The antioxidant effect of aqueous extract of the bark of F. benghalensis has been evaluated in hypercholesterolemic rabbits [22]. Our team has extensive knowledge and research experience that has translated into high-quality publications [12,23–34,35-41]. The aim of the present study is to evaluate the antioxidant activity of silver nanoparticles synthesized using F. benghalensis.

2. MATERIALS AND METHODS

2.1 Preparation of the Extract

A sample of 1 gm of F. benghalensis was mixed with 100 mL of distilled water and boiled in 60-70 degrees Celsius in the heating mantle for 10-15 minutes. Add filtered using Whatman number 1 filter paper. 20 millimolar (0.574 g) of silver was dissolved in 60 mL of distilled water. 40 mL of filtered F. benghalensis extract was mixed with 60 mL of silver nanoparticles.

2.2 Synthesis of Silver Nanoparticles (AgNPs)

Synthesis of AgNPs is done by a green synthesis method, in which the 1 mL of aqueous filtrate of the prepared extract was taken into 100 mL of Erlenmeyer flask. Then the extract was mixed into silver nitrate (AgNO3) to make the final volume concentration of 1 mm solution. The reaction mixture was exposed to sunlight irradiation conditions until the colour change arose as shown in Fig. 1. The reaction mixture of seed extracts and AgNPs was subjected to centrifugation at 8,000xg for 15 min; the resulting pellet was washed three times with deionized water and filtered.

2.3 UV Spectrometric Analysis of Synthesized Nanoparticles

The endpoint of the reaction was evaluated by UV–vis spectroscopy. The biologically reduced brown colour solution mixture was scanned by Shimadzu, Lambda UV mini-1240 instrument operated at a resolution of 1 nm. The UV–visible analysis was performed in the absorption wavelength of 200–700 nm periodically for 1 hr in order to observe rapid reduction AgNPs by the action of faeces Bengalis extracts. The distilled water was used as a blank.

2.4 Antioxidant Activity

Antioxidant activity is the ability of bioactive constituents to prevent, inhibit, and protect against oxidation of numerous substrates such as DNA and lipid components in living organisms and food products. Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method was followed for evaluating the antioxidant activity of synthesized nanoparticles. DPPH is a stable free radical in methanol that accepts an electron or hydrogen radical and transforms into a stable diamagnetic molecule. It is commonly employed as a test subject for antioxidative activities. Five distinct extract concentrations were combined with various DPPH concentrations. By comparing the absorbance to a blank containing only DPPH and solvent, the radical scavenging activity was measured. % inhibition was calculated using the below equation:

\[
\% \text{ inhibition} = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100
\]

3. RESULTS AND DISCUSSION

The synthesis of biological nanoparticles represents an alternative for the physical and chemical methods of nanoparticle formation. The majority of researchers focused on the green synthesis of nanoparticles for the formation of metal and oxide nanoparticles. The use of plants for the synthesis of nanoparticles is a rapid, low-cost, eco-friendly option and is safe for human use.

3.1 Visual Identification

In this study, the silver nanoparticles were synthesized using F. benghalensis extract. At various intervals of incubation time, colour changes in the reaction mixture were noticed. The silver ions are reduced to silver nanoparticles, which are detected by a change in colour (Fig. 2). The colour changed from yellow to reddish brown, indicating that silver nanoparticles had synthesized. With increasing incubation time, the brown colour intensity increased. After 24 hours, a dark brown colour appeared, followed by no colour change, indicating that the synthesis of silver...
nanoparticles was complete. With respect to this current study, studies with similar results were also found. The development of intense yellowish-brown colour owing to the surface plasmon resonance confirmed the synthesis of the silver nanoparticles [42]. After 80 mins there was a significant increase in the brown colour which confirms the growth of the silver nanoparticles [43]. Colour changes of the reaction mixture 240 min after the bioreduction process, which was recorded by UV-vis spectrophotometer at 400-700 nm. In particular, absorbance in the range of 500-550 nm has been used as an indicator to confirm the reduction of Ag+ to metallic Ag [44]. In a previous study, silver nanoparticles synthesized using tulsi leaf extract, the colour change was observed from yellow to black-brown [45].

3.2 UV-Vis Absorption Spectrophotometer Activity

The UV-vis spectroscopy showed the excitation of the surface plasmon resonance band peak positioned at the wavelength from 250 nm to 650 nm and was observed at various time intervals. The spectrum clearly demonstrates that the absorbance steadily increases as the incubation time is increased. The UV-vis spectroscopic analysis of silver nanoparticles synthesized from the F. benghalensis showed absorbance peak at 450 nm (Fig. 3). Similarly, a study showed that UV absorption spectra of the silver nanoparticles from methanolic stem extract of Gymnema sylvestre was reported to be 443 nm [46].

3.3 Antioxidant Activity of Silver Nanoparticles using F. benghalensis

Antioxidants are an integral part of plants as secondary metabolites which play an important role as free radical scavengers and by converting highly reactive free radicals into less reactive species [47]. Different studies verify the significant role of antioxidants in the reduction of oxidative stress, which provoke us to determine the antioxidant potential of various extracts of F. benghalensis [47,48]. The antioxidant capability of samples cannot be assessed by a single assay [48]. Therefore, DPPH free radical scavenging, total reduction power and TAC assays were performed to verify the antioxidant potential. DPPH is the stable free radical and antioxidant potential of crude extract was determined on the basis of scavenging of free radical i.e. DPPH. The principle of the assay is based on the conversion of the purple color of the free radical to the yellow color molecule by accepting a hydrogen electron from donor antioxidants present in samples. In the current study, high percentage free radical scavenging activity was shown by F. benghalensis. The activity of F. benghalensis extract was compared with standard ascorbic acid by measuring absorption intensity in the spectrophotometer at the wavelength of 517 nm. While increasing the concentration (10 µL, 20 µL, 30 µL, 40 µL, 50 µL) of F. benghalensis extracts, the percentage of inhibition of DPPH also increased. However, the inhibition percentage is directly proportional to the concentration of extract as shown in Fig. 4. Previous research works have reported on the various activities exhibited by the nanoparticles synthesized from natural sources such as antibacterial, antioxidant and cytotoxic activity [49-51]. In a study, silver nanoparticles were synthesized from aqueous leaf extract of Cestrum nocturnum and its antioxidant and antibacterial activities were tested against bacteria and the results confirmed that the silver nanoparticles have more antioxidant activity as compared to vitamin C [52]. In other study, Antioxidant and antibacterial activity of silver nanoparticles is due to the presence of bioactive molecules on the surface [53].

Fig. 1. Synthesis process of silver nanoparticles
Fig. 2. Reduction of silver ions to silver nanoparticles visually identified by colour changed at various periods of incubation time

Fig. 3. UV-Vis Spectroscopic analyses of silver nanoparticles synthesized from *F. benghalensis* recorded as function of time
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Fig. 4. *F. benghalensis* showed increased DPPH inhibition with increase in concentration of extract. Inhibition was measured after 48 hours of incubation. X-axis shows concentrations in microlitre, Y-axis shows percentage of inhibition.

4. CONCLUSION

In this study, a simple, biological and low-cost approach was done for the preparation of silver nanoparticles using *F. benghalensis*. Thus the synthesized *F. benghalensis* mediated silver nanoparticles which was shown to have potent antioxidant property can be subjected to the various other biological activities such as antibacterial, antifungal and cytotoxic evaluation to know the efficiency of these nanoparticles. So that they can be developed as a substitute for conventional formulations in the treatment of oral diseases and help in the betterment of life.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable

ETHICAL APPROVAL

It is not applicable

REFERENCES

1. Shathviha PC, Ezhilarasan D, Rajeshkumar S, Selvaraj J. β-sitosterol Mediated Silver Nanoparticles Induce Cytotoxicity in Human Colon Cancer HT-29 Cells. Avicenna Journal of Medical Biotechnology; 2020. Available: http://dx.doi.org/10.18502/ajmb.v13i1.4577

2. Nasim I, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, India. Cytotoxicity and antimicrobial analysis of silver and graphene oxide bio nanoparticles. Vol. 16, Bioinformation. 2020; 831–6. Available: http://dx.doi.org/10.6026/97320630016831

3. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. Vol. 89, Journal of Periodontology. 2018; 1241–8. Available: http://dx.doi.org/10.1002/jper.17-0445

4. Singh J, Dutta T, Kim K-H, Rawat M, Samddar P, Kumar P. “Green” synthesis of metals and their oxide nanoparticles: applications for environmental remediation. J Nanobiotechnology. 2018;16(1):84.

5. Paramasivam A, Priyadharsini JV, Raghunandhakumar S, Elumalai P. A
novel COVID-19 and its effects on cardiovascular disease. Hypertension Research. 2020;43:729–30. Available:http://dx.doi.org/10.1038/s41440-020-0461-x
6. Rajeshkumar S, Sandhiya D. Biomedical Applications of Zinc Oxide Nanoparticles Synthesized Using Eco-friendly Method. Nanoparticles and their Biomedical Applications. 2020;65–93. Available:http://dx.doi.org/10.1007/978-981-15-0391-7_3
7. Ganta SSL, Jeevitha M, Preetha S, Rajeshkumar S. Anti-Inflammatory Activity of Dried Ginger Mediated Iron Nanoparticles. Journal of Pharmaceutical Research International. 2020;14–9. Available:http://dx.doi.org/10.9734/jpri/2020/v32i2830866
8. Shunmugam R, Balusamy SR, Kumar V, Menon S, Lakshmi T, Perumalsamy H. Biosynthesis of gold nanoparticles using marine microbe (Vibrio alginolyticus) and its anticancer and antioxidant analysis. Journal of King Saud University - Science. 2021;33:101260. Available:http://dx.doi.org/10.1016/j.jksus.2020.101260
9. Nasim I, Kamath K, Rajeshkumar S. Evaluation of the re-mineralization capacity of a gold nanoparticle-based dental varnish: An in vitro study. Vol. 23, Journal of Conservative Dentistry. 2020:390. Available:http://dx.doi.org/10.4103/jcd.jcd_315_20
10. Rajeshkumar S, Sherif MH, Malarkodi C, Ponnakajamideen M, Arasu MV, Al-Dhabi NA, et al. Cytotoxicity behaviour of response surface model optimized gold nanoparticles by utilizing fucoidan extracted from padina tetrastromatica. Journal of Molecular Structure. 2021;1228:129440. Available:http://dx.doi.org/10.1016/j.molstruc.2020.129440
11. Oskam G. Metal oxide nanoparticles: synthesis, characterization and application. Journal of Sol-Gel Science and Technology. 2006;37:161–4. Available:http://dx.doi.org/10.1007/s10971-005-6621-2
12. Del Fabbro M, Karanxha L, Panda S, Buochi C, Nadathur Doraismwamy J, Sankari M, et al. Autologous platelet concentrates for treating periodontal infrabony defects. Cochrane Database Syst Rev. 2018;11:CD011423.
13. Paramasivam A, Priyadharsini JV. MitomiRs: new emerging microRNAs in mitochondrial dysfunction and cardiovascular disease. Hypertension Research. 2020;43:851–3. Available:http://dx.doi.org/10.1038/s41440-020-0423-3
14. Jayaseelan VP, Arumugam P. Dissecting the theranostic potential of exosomes in autoimmune disorders. Cellular & Molecular Immunology. 2019;16:935–6. Available:http://dx.doi.org/10.1038/s41440-2019-0310-5
15. Vellappally S, Al Kheraif AA, Divakar DD, Basavarajappa S, Anil S, Fouad H. Tooth implant prostheses using ultra low power and low cost crystalline carbon bio-tooth sensor with hybridized data acquisition algorithm . Vol. 148, Computer Communications. 2019;176–84. Available:http://dx.doi.org/10.1016/j.comcom.2019.09.020
16. Varghese SS, Ramesh A, Veeraiyen DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students . Vol. 83, Journal of Dental Education. 2019:445–50. Available:http://dx.doi.org/10.21815/jde.019.054
17. Vellappally S, Al-Kheraif AA, Anil S, Basavarajappa S, Hassanain AS. Maintaining patient oral health by using a xeno-genetic spiking neural network. Journal of Ambient Intelligence and Humanized Computing; 2018. Available:http://dx.doi.org/10.1007/s12652-018-1166-8
18. Sarode SC, Gondivkar S, Sarode GS, Gadbail A, Yuwanati M. Hybrid oral potentially malignant disorder: A neglected fact in oral submucous fibrosis. Oral Oncology. 2021;105390. Available:http://dx.doi.org/10.1016/j.oraloncology.2021.105390
19. Kavarthapu A, Gurumoorthy K. Linking chronic periodontitis and oral cancer: A review. Oral Oncology. 2021;105375. Available:http://dx.doi.org/10.1016/j.oraloncology.2021.105375
20. Venkatesan J, Singh SK, Anil S, Kim S-K, Shim MS. Preparation, Characterization and Biomedical Applications of Biosynthesized Silver Nanoparticles with Chitosan-Fucoidan Coating. Molecules. 2018;23(6).
21. Venkatesan J, Rekha PD, Anil S, Bhatnagar I, Sudha PN, Dechsakulwatana C, et al. Hydroxyapatite from Cuttlefish Bone: Isolation, Characterizations, and Applications. Biotechnology and Bioprocess Engineering. 2018;135:383–93. Available: http://dx.doi.org/10.1007/s12257-018-0169-9

22. Vellappally S, Al Kheraif AA, Anil S, Wahba AA. IoT medical tooth mounted sensor for monitoring teeth and food level using bacterial optimization along with adaptive deep learning neural network. Measurement. 2019;672–7. Available: http://dx.doi.org/10.1016/j.measurement.2018.11.078

23. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. J Periodontol. 2018;89(10):1241–8.

24. Paramasivam A, Priyadharsini JV, Raghunandhakumar S, Elumalai P. A novel COVID-19 and its effects on cardiovascular disease. Hypertens Res. 2020;43(7):729–30.

25. SG, TG, KV, Faleh AA, Sukumaran A, PNS. Development of 3D scaffolds using nanochitosan/silk-fibroin/hyaluronic acid biomaterials for tissue engineering applications. Int J Biol Macromol. 2018;120(Pt A):876–85.

26. Paramasivam A, Vijayashree Priyadharsini J. MitomiRs: new emerging microRNAs in mitochondrial dysfunction and cardiovascular disease. Hypertens Res. 2020;43(8):851–3.

27. Jayaseelan VP, Arumugam P. Dissecting the theranostic potential of exosomes in autoimmune disorders. Cell Mol Immunol. 2019;16(12):935–6.

28. Vellappally S, Al Kheraif AA, Divakar DD, Basavarajappa S, Anil S, Fouad H. Tooth implant prosthetic using ultra low power and low cost crystalline carbon bio-tooth sensor with hybridized data acquisition algorithm. Comput Commun. 2019;148:176–84.

29. Vellappally S, Al Kheraif AA, Anil S, Assery MK, Kumar KA, Divakar DD. Analyzing Relationship between Patient and Doctor in Public Dental Health using Particle Memetic Multivariable Logistic Regression Analysis Approach (MLRA2). J Med Syst. 2018;42(10):183.

30. Varghese SS, Ramesh A, Veeraiyan DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students. J Dent Educ. 2019 Apr;83(4):445–50.

31. Venkatesan J, Singh SK, Anil S, Kim S-K, Shim MS. Preparation, Characterization and Biological Applications of Biosynthesized Silver Nanoparticles with Chitosan-Fucoidan Coating. Molecules. 2018;23(6). Available: http://dx.doi.org/10.3390/molecules23061429

32. Alsubait SA, Al Ajlan R, Mitwalli H, Aburaisi N, Mahmood A, Muthurangan M, et al. Cytotoxicity of Different Concentrations of Three Root Canal Sealers on Human Mesenchymal Stem Cells. Biomolecules. 2018;8(3). Available: http://dx.doi.org/10.3390/biom8030068

33. Venkatesan J, Rekha PD, Anil S, Bhatnagar I, Sudha PN, Dechsakulwatana C, et al. Hydroxyapatite from Cuttlefish Bone: Isolation, Characterizations, and Applications. Biotechnol Bioprocess Eng. 2018;23(4):383–93.

34. Vellappally S, Al Kheraif AA, Anil S, Wahba AA. IoT medical tooth mounted sensor for monitoring teeth and food level using bacterial optimization along with adaptive deep learning neural network. Measurement. 2019;135:672–7.

35. PradeepKumar AR, Shemes H, Nivedhithe MS, Hashir MMJ, Arockiam S, Uma Maheswari TN, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis. J Endod. 2021;47(8):1198–214.

36. Ramani RH, Tilakaratne P, Sukumaran WM, Ramasubramanian G, Krishnan RP. Critical appraisal of different triggering pathways for the pathobiology of pemphigus vulgaris-A review. Oral Dis; 2021. Available: http://dx.doi.org/10.1111/odi.13937

37. Ezhilarasad S, Lakshmi T, Subha M, Deepak Nallasamy V, Raghunandhakumar S. The ambiguous role of sirtuins in head
and neck squamous cell carcinoma. Oral Dis; 2021.
Available: http://dx.doi.org/10.1111/odi.13798

38. Sarode SC, Gondivkar S, Sarode GS, Gad bail A, Yuwanati M. Hybrid oral potentially malignant disorder: A neglected fact in oral submucous fibrosis. Oral Oncol. 2021 Jun 16;105390.

39. Kavarthapu A, Gurmooorthy K. Linking chronic periodontitis and oral cancer: A review. Oral Oncol. 2021;105375.

40. Vellappally S, Abdullah Al-Kherai A, Anil S, Basavarajappa S, Hassanein AS. Maintaining patient oral health by using a xeno-genetic spiking neural network. J Ambient Intell Humaniz Comput; 2018. Available: https://doi.org/10.1007/s12652-018-1166-8

41. Aldhuwayhi S, Mallineni SK, Sakhamuri S, Thakare AA, Mallineni S, Sajja R, et al. Covid-19 Knowledge and Perceptions Among Dental Specialists: A Cross-Sectional Online Questionnaire Survey. Risk Manag Healthc Policy. 2021;14:2851–61.

42. Madhumitha B, Santhakumar P, Jeevitha M, Rajeshkumar S. Green Synthesis of Selenium Nanoparticle using Capparis decidua fruit extract and its Characterization using Transmission Electron Microscopy And UV-Visible Spectroscopy. Research Journal of Pharmacy and Technology. 2021;2129–32. Available: http://dx.doi.org/10.52711/0974-360x.2021.00377

43. K J, Janani K, Preetha S, Jeevitha, Rajeshkumar S. Green synthesis of Selenium nanoparticles using Capparis decidua and its anti-inflammatory activity. International Journal of Research in Pharmaceutical Sciences. 2020;11:6211–5. Available: http://dx.doi.org/10.26452/ijrps.v1i4.3298

44. Menon S, Agarwal H, Venkat Kumar S, Rajeshkumar S. Biometric synthesis of selenium nanoparticles and its biomedical applications. Green Synthesis, Characterization and Applications of Nanoparticles. 2019;165–97. Available: http://dx.doi.org/10.1016/b978-0-08-102579-6.00008-3

45. Subha V, Ravindran RSE, Preethi R, Cyrill J, Kirubanandan S, Renganathan S. Silver Nanoparticles - Green Synthesis with Aq. Extract of Stems Ipomoea Pes-Caprae, Characterization, Antimicrobial and Anti-Cancer Potential. International Journal of Medical Nano Research. 2018;5. Available: http://dx.doi.org/10.23937/2378-3664.1410024

46. Renganathan S, Subha V, Sathyya R, Ernest Ravindran RS. Silver nanoparticles from methanolic stem extract of Gymnema sylvestre and its characterisation studies. Vol. 7, International Journal of Nano and Biomaterials. 2017;1. Available: http://dx.doi.org/10.1504/ijnbm.2017.10010333

47. Renganathan S, Fatma S, Kalainila P. Green synthesis of copper nanoparticle from passiflora foetida leaf extract and its antibacterial activity. Vol. 10, Asian Journal of Pharmaceutical and Clinical Research. 2017;79. Available: http://dx.doi.org/10.22159/ajpcr.2017.v10i4.15744

48. Hemalatha DH, Saraswath S. Green synthesis of copper oxide nanoparticles using aloe vera extract. Vol. 3, Nanoscale Reports. 2020. Available: http://dx.doi.org/10.26524nr.3.21

49. Barma MD. Synthesis of Triphala Incorporated Zinc Oxide Nanoparticles and Assessment of its Antimicrobial Activity Against Oral Pathogens : An In-Vitro Study. Bioscience Biotechnology Research Communications. 2020;13:1–8. Available: http://dx.doi.org/10.21786/bbrc/137/14

50. Mohapatra S, Leelavathi L, MA, Adeep KR, SR. Assessment of Antimicrobial Efficacy of Zinc Oxide Nanoparticles Synthesized Using Clove and Cinnamon Formulation against Oral Pathogens- An In Vitro Study. Journal of Evolution of Medical and Dental Sciences. 2020;9:2034–9. Available: http://dx.doi.org/10.14260/jemds/2020/443

51. Narayanan PM, Wilson WS, Abraham AT, Sevanan M. Synthesis, Characterization, and Antimicrobial Activity of Zinc Oxide Nanoparticles Against Human Pathogens. Bio Nano Science. 2012;2:329–35. Available: http://dx.doi.org/10.1007/s12668-012-0061-6

52. Keshari AK, Srivastava R, Singh P, Yadav VB, Nath G. Antioxidant and antibacterial activity of silver nanoparticles synthesized by Cestrum nocturnum. Journal of Ayurveda and Integrative Medicine. 2020;11:37–44.
53. Bhuvaneswari R, Xavier RJ, Arumugam M. Facile synthesis of multifunctional silver nanoparticles using mangrove plant L. for its antibacterial, antioxidant and cytotoxic effects. J Parasit Dis. 2017;41(1):180–7.

Peer-review history:
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