Journal of Complementary Medicine Research, ISSN: 2146-8397 Vol. 13, No. 5, 2022 (pp. 90-95)

RESEARCH ARTICLE WWW.JOCMR.COM

Green synthesis of selenium nanoparticles using clove and lemon grass and its antibacterial activity against E. faecalis

S Padmalochini [1],S Rajeshkumar [2*], T Lakshmi[3], M Tharani[4]

[1]*Department of Pharmacology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India*

[2,3,4]*Nanobiomedicine Lab, Department of Pharmacology, Saveetha Dental College and Hospitals, SIMATS, Saveetha University, Chennai , India*

ABSTRACT

Introduction: Nanotechnology is the branch of science and engineering which involves designing and using devices and systems by manipulating atoms and molecules at nanoscale. Nanotechnology has a wide application in the field of medicine and dentistry which resulted in the emergence of a new field known as Nanomedicine. In this study Clove and lemongrass are preferred for Green synthesis of Selenium because to check the anti- bacterial activity of the clove and lemongrass extracted selenium nanoparticle against enterococcus faecalis. Selenium has anti- cancer and anti- microbial properties, Gold which has DNA labeling, biosensor, drug delivery, cancer therapy and anti- microbial properties.

Aim:The aim of this study is to evaluate the antibacterial activity of selenium nanoparticles prepared using clove and lemongrass against e faecalis.

Materials and methods: Antibacterial activity of Selenium nanoparticles acts against the strain e faecalis. Mueller Hinton Agar was utilized for this activity to determine the zone of inhibition. Mueller hinton Agar were prepared and sterilized for 15 minutes at 121℃. Media poured into the sterilized plates and let it stable for solidification. The wells were cut using a 9mm sterile polystyrene tip and the test organisms were swabbed. The selenium nanoparticles with different concentrations (25µL, 50µL, 100µL) were loaded and in the fourth well standard antibiotic amoxyrite was loaded. The plates were incubated for 24 hours at 37℃. After the incubation time the zone of inhibition was measured.

Result: The results of the minimum inhibitory concentration values of the selenium nanoparticles is shown in table 1. In 100 µL concentration the MIC value decreased. The minimum bactericidal concentration of the selenium nanoparticles is shown in figure 4. In 100 µL concentration there is an increased MBC effect seen. The MIC of e faecalis is shown in Graph 1. The X axis represents the different concentrations of selenium nanoparticles (25µL, 50µL, 100µL) and standard antibiotic amoxyrite. The Y axis represents the absorbents. As the concentration of the nanoparticle increased the MIC also increased.

Discussion: In the present study MIC and MBC values have increased with respect to 100 µL concentration of the selenium nanoparticles. In a study conducted by Rangrazi et al have concluded with the same results that the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the selenium nanoparticles against gram-negative and gram-positive bacteria showed MIC values of 0.068, 0.137, and 0.274 mg ml−1. The results proved that the concentration of 0.274 mg ml−1 had a higher bactericidal effect than the other concentrations. As the concentration of selenium nanoparticles increased to 0.274 mg ml−1 the bacteria were completely killed.

Conclusion: Within the limits of the study it can be concluded that the green synthesized selenium nanoparticles using clove and lemongrass have remarkable antibacterial potentiality and can be added to dental materials to enhance their properties. Further animal studies are required for the evaluation of the efficacy of the nanoparticles.

Corresponding Author e-mail: rajeshkumars.sdc@saveetha.com

How to cite this article: Padmalochini S, Rajeshkumar S, Lakshmi T, Tharani M, Green synthesis of selenium nanoparticles using clove and lemon grass and its antibacterial activity against E. faecalis.. Journal of Complementary Medicine Research, Vol. 13, No. 5, 2022 (pp. 90-95)

INTRODUCTION

Nanotechnology is the branch of science and engineering which involves designing and using devices and systems by manipulating atoms and molecules at nanoscale. Nanotechnology has a wide application in the field of medicine and dentistry which resulted in the emergence of a new field known as Nanomedicine. It is very helpful in understanding the pathophysiology basis of disease, diagnosis and prevention of disease. Nanoparticles which are involved in Nanotechnology are nothing but the small particles that range between 1 to 100 nanometers in size.

KEYWORDS:
Clove, lemongrass, selenium nanoparticles, anti- bacterial activity, MIC, MBC

ARTICLE HISTORY:
Received June 16, 2022
Accepted Oct 10, 2022
Published Dec 11, 2022

DOI:
10.5455/jcmr.2022.13.05.17

These undetectable particles can exhibit a wide physical and chemical properties to their larger material counterparts. Nanoparticles are used in the areas of biomedicine, drug delivery systems, genetics, pharmaceuticals, chemical industries, optics, mechanics, etc. The most commonly involved metal nanoparticles are selenium which has anti-cancer and anti- microbial property, Gold which has DNA labeling, biosensor, drug delivery, cancer therapy and anti-microbial property, Palladium which is a biocatalyst, Copper which has anti- microbial property, Iron which has a anti-cancer, molecular imaging and cancer therapy activities, Zinc oxide which is used in cosmetics and coatings, Silver which has anti- cancer, anti- microbial and anti- viral properties and platinum has an anti- cancer property (Urnukhsaikhan et al. 2021) (Swain 2016).

Green synthesis of metallic nanoparticles has gained much attraction among researchers in recent years because it has several benefits. It is cost effective, good stability, less time consuming, release of non toxic by-products, eco friendly and most importantly they are very good for large scale synthesis (Malhotra and Alghuthaymi 2022). There are several plant species involved in green synthesis of nanoparticles. For example Silver nanoparticles can be synthesized from Geranium indicum, Cyperus sp etc. Gold nanoparticles from Aloe vera, Garcinia mangostana etc. Likewise Selenium can be synthesized from Hawthorn, Dried raisin, Lemon plant, Bougainvillea spectabilis, Ginger fruit, Ashwagandha (Withania somnifera) (Alagesan and Venugopal 2019), Fenugreek (Trigonella foenum- graecum), Avaram (Cassia auriculata), Arauna (Terminalia arjuna), Java tea, Lavender leucas (Leucas lavandulifolia), Aloe vera, Garlic (Allium sativum), Walnut (Juglans regia), Horseshoe geranium (Pelargonium Zonale), Asteriscus graveolens, catharanthus roseus, Orange peel, Clausena dentata, mountain persimmon, Emblica officinalis, Ficus benghalensis, Drumstick (Moringa oleifera) Guava (Psidium guajava) and Cacao bean shell (Theobroma cacao L.) (Pyrzynska and Sentkowska 2021). Selenium nanoparticles can also be synthesized from clove and cinnamon extract and lemongrass (cymbopogon). In this study Clove and lemongrass are preferred for Green synthesis of Selenium because to check the anti- bacterial activity of the clove and lemongrass extracted selenium nanoparticle against enterococcus faecalis.

Enterococcus faecalis is a normal commensal of the human oral cavity, GIT and vagina because it finds it as a good environment for its growth since these areas are with rich nutrients and low oxygen levels and intricate ecology. Due to their E faecalis is a gram negative aerobic bacteria. E faecalis are a source of many nosocomial infections. They are now third most common among the nosocomial pathogens. They are known to cause urinary tract infections, bacteremia, intra- abdominal infections and endocarditis. In a previous study the author stated that the selenium nanoparticle mediated antibacterial activity over e faecalis had a good effect and was able to combat biofilm formation. Therefore, it has a significant role in dentistry particularly in root canal disinfection (Miglani and Tani-Ishii 2021). Some of the nanoparticles which are having antibacterial potential against e faecalis are listed. Silver nanoparticles have an antimicrobial activity against biofilm forming e faecalis on root dentin (Halkai et al. 2018). Fe2o3 has an antibacterial activity against e faecalis when combined with antibiotics (Shahbazi, Morshedzadeh, and Zaeifi 2019). Chitosan - propolis nanoparticle CPN 250 and CPN 100 had antibacterial activity and can be used as an intracanal medicaments in patients wherein the root canal treatment have failed (Parolia et al. 2020). The aim of this study is to evaluate the antibacterial activity of selenium nanoparticles prepared using clove and lemongrass against e faecalis.

MATERIALS AND METHODS

Preparation of extract

Cloves and lemongrass were obtained from an organic store, chennai. The leaves of the lemongrass were washed thoroughly under the tap water. For seven days, the leaves were dried in the shade at room temperature. The leaves of the lemongrass and dry cloves were separately grounded using a mixer grinder into fine powder. 1 gm of powdered leaves of lemongrass and cloves was added to 100 mL of distilled water and heated at a temperature of 60- 70℃ using a heating mantle. Finally, using whatman no. 1 filter paper, the mixture was filtered and extract was stored for further use (Figure 1).

Synthesis of Selenium Nanoparticles

Sodium selenite (Na_2SeO_3), 30mM dissolved in 50mL of distilled water. To that, 50mL of clove and lemongrass extract was slowly added. Then, the reaction mixture was kept on a magnetic stirrer at 650- 700 rpm for 48- 72 hours (Figure 3).

Antibacterial activity

Antibacterial activity of Selenium nanoparticles acts against the strain e faecalis. Mueller Hinton Agar was utilized for this activity to determine the zone of inhibition. Mueller hinton Agar were prepared and sterilized for 15 minutes at 121℃. Media poured into the sterilized plates and let it stable for solidification. The wells were cut using a 9mm sterile polystyrene tip and the test organisms were swabbed. The selenium nanoparticles with different concentrations (25µL, 50µL, 100µL) were loaded and in the fourth well standard antibiotic amoxyrite was loaded. The plates were incubated for 24 hours at 37℃. After the incubation time the zone of inhibition was measured.

RESULTS

The results of the minimum inhibitory concentration values of the selenium nanoparticles is shown in table 1. In 100 µL concentration the MIC value decreased. The minimum bactericidal concentration of the selenium nanoparticles is shown in figure 4. In 100 µL concentration there is an increased MBC effect seen. The MIC of e faecalis is shown in Graph 1. The X axis represents the different concentrations of selenium

nanoparticles (25µL, 50µL, 100µL) and standard antibiotic amoxyrite. The Y axis represents the absorbents. As the concentration of the nanoparticle increased the MIC also increased.

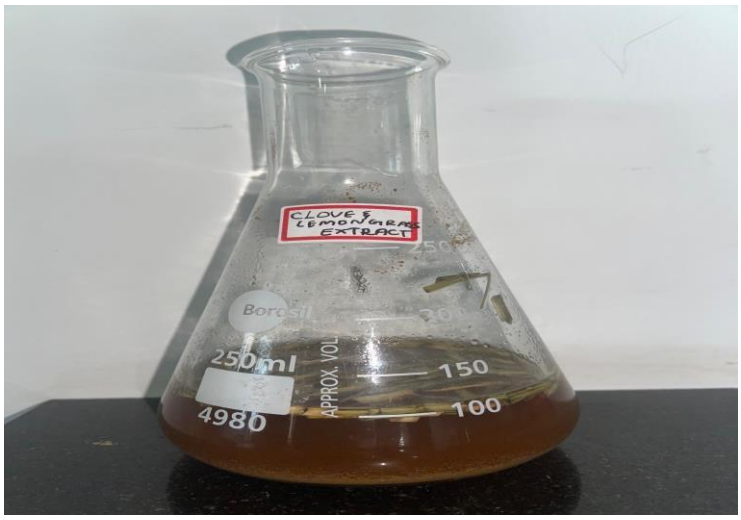

Figure 1: representing the preparation of clove and lemongrass extract.

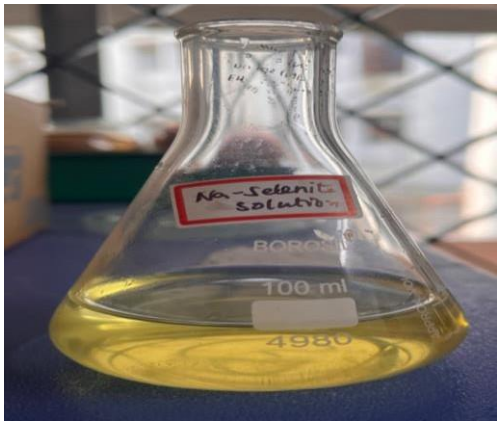

Figure 2: representing the preparation of the nanoparticles.

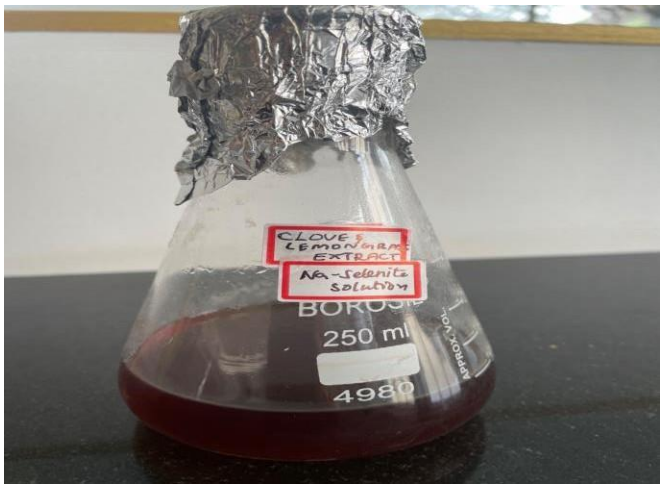

Figure 3: representing the synthesis of Selenium Nanoparticles.

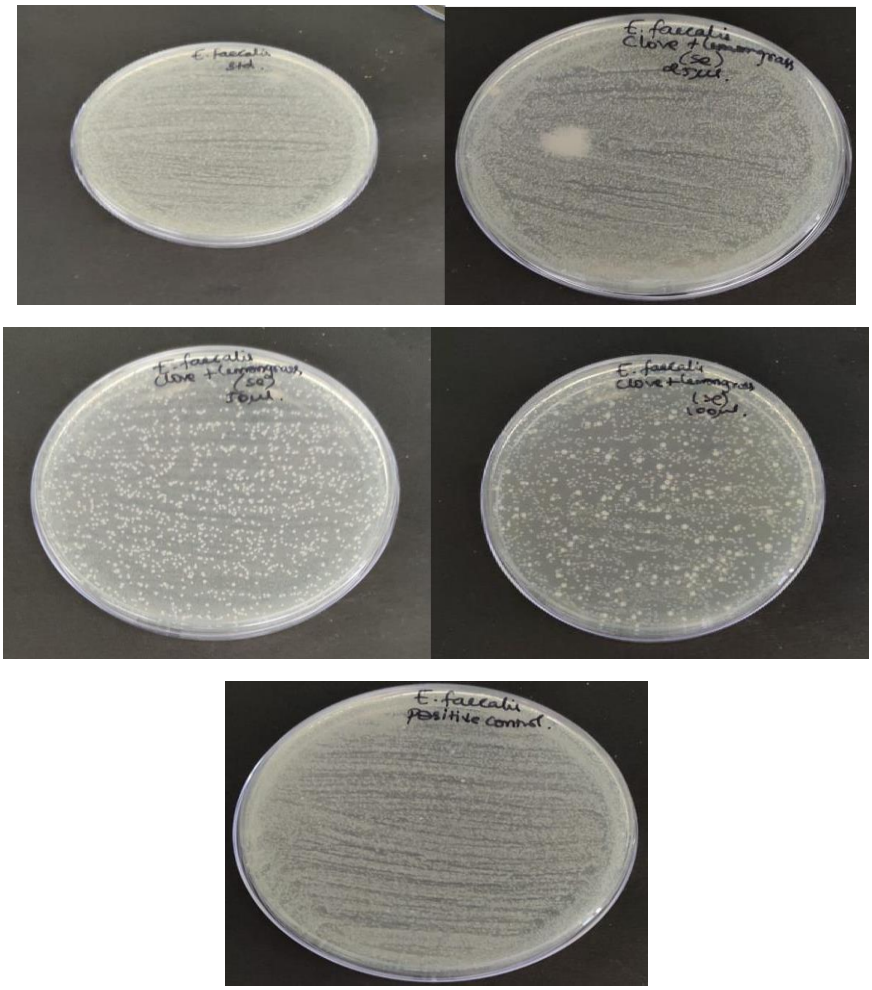

Figure 4: Representing Minimum bactericidal concentration for Selenium nanoparticles.

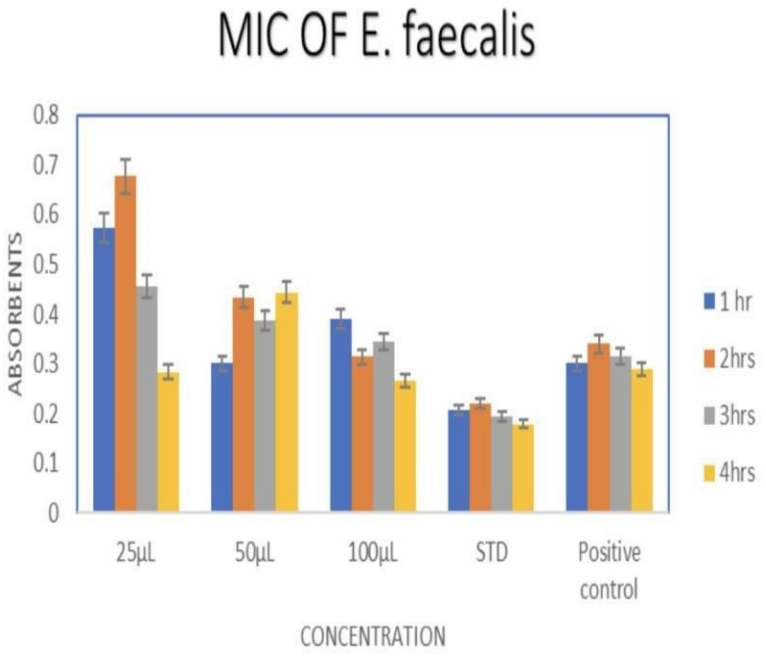

Fig 5 : Minimum inhibitory concentration and time kill assay of green synthesized selenium nanoparticles

The above graph 1 depicts the MIC of E.faecalis. The X axis represents the different concentrations of selenium nanoparticles (25µL, 50µL, 100µL) and standard antibiotic amoxyrite. The Y axis represents the absorbance. Amoxyrite was used as standard. The minimum inhibitory dose for E.faecalis was found to 50 µL concentration. At 50 µL concentration, the growth inhibition was initiated at 2 hours which signifies the sensitive nature of the pathogen to the green synthesized selenium nanoparticles.

DISCUSSION

Antibiotic resistance by the bacteria is one of the main issues. At present, infections and associated diseases became quite common despite the intense effort made by the medical fraternity. Many researchers made study on the development of nanostructured inorganic compounds with anti- bacterial activity. The use of selenium nanoparticles is a replacement to conventional products as they have significant anti- bacterial activity (Hernández-Díaz et al. 2021, Rajeshkumar et al., 2016, Sowmya et al., 2018).

Clove and lemongrass are growing interest among the researchers to use as antibacterial agents. They have the power to kill even the MRSA. So, they can be a good alternative for the routinely followed protocols. In a study the author stated that the minimum biofilm inhibitory concentration (MBIC) and minimum biofilm eradication concentration (MBEC) values of clove oil against planktonic cells ranged from 2.0 % to 3.0 % and 2.4 % to 5.0 %. The data show that combined clove and lemongrass essential oils efficiently kills S. aureus and is therefore an alternative way for staphylococcus aureus eradication (Amalia et al. 2019).

Selenium nanoparticles have a great anti- bacterial activity compared to the other nanoparticles. It can be combined with other available treatment protocols or biosynthesized from herbal products. Selenium nanoparticles combined with photodynamic therapy against enterococcus faecalis biofilm could be an alternative disinfectant and for root canal treatment (Shahmoradi et al. 2021, Jayapriya et al., 2022). Many researchers suggest that the nanoparticles mediated treatment protocol would be beneficial in the field of dentistry. Since selenium has potent anti- bacterial activity it can be used in the formulation of root canal disinfectant, oral gel, mouth wash, toothpaste and even in suture materials (Miglani and Tani-Ishii 2021,Agarwal et al., 2018; Iyer et al. 2021).

In the present study MIC and MBC values have increased with respect to 100 µL concentration of the selenium nanoparticles. In a study conducted by Rangrazi et al have concluded with the same results that the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the selenium nanoparticles against gram-negative and gram-positive bacteria showed MIC values of 0.068, 0.137, and 0.274 mg ml−1. The results proved that the concentration of 0.274 mg ml−1 had a higher bactericidal effect than the other concentrations. As the concentration of selenium nanoparticles increased to 0.274 mg ml−1 the bacteria were completely killed (Rangrazi et al. 2020) (Priyadharshini et al. 2021).

In a similar study conducted by Beladi et al, concluded that selenium nanoparticles have more antibacterial activity compared to the use of selenium. In their study to determine MIC and MBC, disc diffusion and serial broth method were used and the results turned out to be the antibacterial activity of the selenium and selenium nano-particles demonstrated to be effective on 32% and 56% of the strains studied.

CONCLUSION

Within the limits of the study it can be concluded that the green synthesized selenium nanoparticles using clove and lemongrass have remarkable antibacterial potentiality and can be added to dental materials to enhance their properties. Further animal studies are required for the evaluation of the efficacy of the nanoparticles.

Ethical approval-NA

Funding details - Funded by Saveetha Dental College, Chennai, India

Conflict of interest-NA

Informed Consent- None declared

Authorship contribution

PS compiled the manuscript RKS conducted the study TL designed the study MT Performed Proof reading of the Manuscript

REFERENCES

1. Alagesan, Venkatesan, and Sujatha Venugopal. 2019. “Green Synthesis of Selenium Nanoparticle Using Leaves Extract of Withania Somnifera and Its Biological Applications and Photocatalytic Activities.” BioNanoScience. https://doi.org/10.1007/s12668-018-0566-8.
2. Amalia, Bunda, Retno Yunilawati, Windri Handayani, Agustina Arianita C., and Cuk Imawan. 2019. “Antimicrobial Effect of Concord Paper Containing with Lemongrass Oil against Escherichia Coli and Staphylococcus Aureus.” Proceedings of the 2nd International Conference of Essential Oils. https://doi.org/10.5220/0009956200540059.
3. Halkai, Kiranrahul, Jayashreea Mudda, Vasundhara Shivanna, Vandana Rathod, and Rahul Halkai. 2018. “Antibacterial Efficacy of Biosynthesized Silver Nanoparticles against Enterococcus Faecalis Biofilm: An in Vitro Study.” Contemporary Clinical Dentistry. https://doi.org/10.4103/ccd.ccd_828_17.
4. Hernández-Díaz, José A., Jorge Jo Garza-García, Janet M. León-Morales, Adalberto Zamudio-Ojeda, Jenny Arratia-Quijada, Gilberto Velázquez-Juárez, Julio C. López-Velázquez, and Soledad García-Morales. 2021. “Antibacterial Activity of Biosynthesized Selenium Nanoparticles Using Extracts of against Potentially Clinical Bacterial Strains.” Molecules 26 (19). https://doi.org/10.3390/molecules26195929.
5. Iyer, Prabhav Kumar, M. Jeevitha, S. Rajeshkumar, and Selvaraj Jeyaraman. 2021. “Preparation and Antimicrobial Activity of Zinc Oxide Nanoparticles (Abies Webbiana) Based Mouthwash.” Journal of Pharmaceutical Research International.

https://doi.org/10.9734/jpri/2021/v33i62b35167.

6. Malhotra, Satinder Pal Kaur, and Mousa A. Alghuthaymi. 2022. "Biomolecule-Assisted Biogenic Synthesis of Metallic Nanoparticles." Agri-Waste and Microbes for Production of Sustainable Nanomaterials. https://doi.org/10.1016/b978-0-12-823575-1.00011-1.
7. Miglani, Sanjay, and Nobuyuki Tani-Ishii. 2021. "Biosynthesized Selenium Nanoparticles: Characterization, Antimicrobial, and Antibiofilm Activity against." PeerJ 9 (June): e11653.
8. Parolia, Abhishek, Haresh Kumar, Srinivasan Ramamurthy, Fabian Davamani, and Allan Pau. 2020. "Effectiveness of Chitosan-Propolis Nanoparticle against Enterococcus Faecalis Biofilms in the Root Canal." BMC Oral Health 20 (1): 339.
9. Priyadharshini, S., M. Jeevitha, S. Rajeshkumar, and Selvaraj Jayaraman. 2021. "Abies Webbiana Mediated Zinc Oxide Nanoparticles and Its Anti-Inflammatory Activity." Journal of Pharmaceutical Research International. https://doi.org/10.9734/jpri/2021/v33i62b35174.
10. Pyrzynska, Krystyna, and Aleksandra Sentkowska. 2021. "Biosynthesis of Selenium Nanoparticles Using Plant Extracts." Journal of Nanostructure in Chemistry. https://doi.org/10.1007/s40097-021-00435-4.
11. Rangrazi, Abdolrasoul, Hossein Bagheri, Kiarash Ghazvini, Alireza Boruziniat, and Majid Darroudi. 2020. "Synthesis and Antibacterial Activity of Colloidal Selenium Nanoparticles in Chitosan Solution: A New Antibacterial Agent." Materials Research Express. https://doi.org/10.1088/2053-1591/ab6a56.
12. Shahbazi, Erfan, Firouzeh Morshedzadeh, and Davood Zaeifi. 2019. "Bacteriostatic Potency of FeO Against in Synergy with Antibiotics by DDST Method." Avicenna Journal of Medical Biotechnology 11 (2): 176–79.
13. Shahmoradi, Samane, Aref Shariati, Nazanin Zargar, Zahra Yadegari, Mohammad Asnaashari, Seyed Mohammad Amini, and Davood Darban-Sarokhalil. 2021. "Antimicrobial Effects of Selenium Nanoparticles in Combination with Photodynamic Therapy against Enterococcus Faecalis Biofilm." Photodiagnosis and Photodynamic Therapy 35 (September): 102398.
14. Swain, Asim Kumar. 2016. "Review on Green Synthesis of Silver Nanoparticles by Physical, Chemical and Biological Methods." International Journal of Scientific & Engineering Research. https://doi.org/10.14299/ijser.2016.10.008.
15. S Rajeshkumar (2016) Green synthesis of different sized antimicrobial silver nanoparticles using different parts of plants – A Review International Journal of ChemTech Research 9 (4) 197-208 (Scopus)
16. Jayapriya Johnson, Rajeshkumar Shanmugam and Thangavelu Lakshmi A review on plant-mediated selenium nanoparticles and its applications J Popul Ther Clin Pharmacol Vol 28(2):e29–e40; DOI https://doi.org/10.47750/jptcp.2022.870
17. Dharman, S., G, M., Shanmugasundaram, K., S,Rajeshkumar. A Systematic Review and Meta-Analysis on the Efficacy of Curcumin/Turmeric for the Prevention and Amelioration of Radiotherapy/Radiochemotherapy Induced Oral Mucositis in Head and Neck Cancer Patients. Asian Pacific Journal of Cancer Prevention, 2021; 22(6): 1671-1684. doi: 10.31557/APJCP.2021.22.6.1671.
18. Mohamed ThameemulAnsari.K.A, Rajeshkumar, A.K.Anjali Anti-Inflammatory Activity of Silver Nanoparticles Synthesised Using Indian Herbs -AReview Annals of the Romanian Society for Cell Biology: - 5904-5914.
19. H. Agarwal, S. Menon, S.V. Kumar, S.Rajeshkumar, Mechanistic study on antibacterial action of zinc oxide nanoparticles synthesized using green route, Chemico-Biological Interactions 286 (2018): 60-70., doi: 10.1016/j.cbi.2018.03.008.
20. Soumya Menon, Shrudhi Devi KS, Santhiya R, Rajeshkumar S, Venkat Kumar S, Selenium nanoparticles: A potent chemotherapeutic agent and an elucidation of its mechanism, Colloids and Surfaces B: Biointerfaces (2018) 1;170:280-92.
21. Urnukhsaikhan, Enerelt, Bum-Erdene Bold, Aminaa Gunbileg, Nominchimeg Sukhbaatar, and Tsogbadrakh Mishig-Ochir. 2021. "Antibacterial Activity and Characteristics of Silver Nanoparticles Biosynthesized from Carduus Crispus." Scientific Reports 11 (1): 21047.
22. "Website." n.d. DOI https://doi.org/10.47750/jptcp.2022.874.
23. ———. n.d. Jembulingam Sabarathinam, Madhulaxmi, Rajeshkumar. Development Of Anti Inflammatory and Antimicrobial Silver Nanoparticles Coated Suture Materials. Int J Dentistry Oral Sci. 2021;08(03):2006-2013. doi: http://dx.doi.org/10.19070/2377-8075-21000395.
24. ———. n.d. Rajeshkumar, M. Vanaja, Arunachalam Kalirajan, "Degradation of Toxic Dye Using Phytomediated Copper Nanoparticles and Its Free-Radical Scavenging Potential and Antimicrobial Activity against Environmental Pathogens", Bioinorganic Chemistry and Applications, vol. 2021, ArticleID 1222908, 10 pages, 2021. https://doi.org/10.1155/2021/1222908.