ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

Published by JK Welfare & Pharmascope Foundation Journal Home Page: www.ijrps.com

Enhanced Antibacterial activity of *Capparis decidua* fruit mediated Selenium Nanoparticle against *Enterococcus faecalis*

Anushya P[1], Preetha S*[1], Lavanya Prathap[2], Jeevitha M[3]

[1]Department of physiology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical sciences, Saveetha University, Chennai-77, Tamil Nadu, India
[2]Department of Anatomy, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical sciences, Saveetha University, Chennai-77, Tamil Nadu, India
[3]Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical sciences, Saveetha University, Chennai-77, Tamil Nadu, India

Article History:

Received on: 28 May 2020
Revised on: 25 Jun 2020
Accepted on: 04 Jul 2020

Keywords:

Capparis decidua,
Selenium nanoparticle,
Antibacterial activity,
Enterococcus faecalis

ABSTRACT

Nanotechnology has become one among the promising approaches for innovations which fulfil the human needs. Nanoparticles even have many applications in several fields like nanocomposites, medical imaging, nanobiocomposite filters, targeted drug delivery and hyperthermia of tumours. In which Selenium is an important micronutrient for living organisms. These nanoparticles are safe, eco friendly, inexpensive and nontoxic. *Enterococcus faecalis* is an emergent gram - positive opportunistic pathogen that is the causative agent of several nosocomial infections and surgical wound infections. Therefore, it is becoming increasingly necessary to find other alternative treatments than commonly utilized drugs. The purpose of this study is to assess the antibacterial activity of *Capparis decidua* fruit mediated selenium nanoparticles(cds-se Nps) against Enterococcus faecalis. In this experimental study Se Nps were prepared by the reaction of 30mM sodium selenite solution and extracts of Capparis decidua. Antibacterial activity of SeNPs was assessed by using a disc diffusion method against *Enterococcus faecalis.* The SeNPs were characterized by UV-visible spectrophotometers. In the present study, the zone of inhibition shows 32mm, 35 mm, 37mm and 30 mm at concentration of 50 microliter, 100 microliter, 150 microliter and antibody respectively. The *Capparis decidua* fruit mediated SeNp showed a good antibacterial activity against the pathogen *Enterococcus faecalis*

*Corresponding Author

Name: Preetha S
Phone: +91- 8610042363
Email: drpreeth.homeo@gmail.com

ISSN: 0975-7538

DOI: https://doi.org/10.26452/ijrps.v12i1.3905

Production and Hosted by

IJRPS | www.ijrps.com

INTRODUCTION

In the twenty-first century, nanotechnology has become one among the promising approaches for innovations which fulfill the human needs (Ramamurthy *et al.*, 2013). Nanoparticles have many applications in several fields like nanocomposites, medical imaging, nanobiocomposite filters, targeted drug delivery and hyperthermia of tumours (Yazdi *et al.*, 2012; Wang *et al.*, 2016). In the synthesis of nanoparticles, the main goal is to form the nanoparticles with minimum particle size and maximum stability (Eskandari-Nojehdehi *et al.*, 2016; McClements and McClements, 2016). The origin of the "selenium" name came from the Selene which suggests moon goddesses in Greek culture (El-Deeba *et al.*, 2018). It was first discovered in 1817 within the sort of precipitate which is red in color (Kumar and Prasad, 2019). Selenium has received considerable attention in recent years due to its role as an important micronutrient for living organisms and due to its physical properties like anisotropy of thermal conductivity, superconductivity, catalytic activities to hydration and oxidation reactions. But other nanoparticles are high thermoelectric, piezoelectric and nonlinear optical responses (Berger and Usa, 1997). Biologically made selenium nanoparticles are more stable due to the natural coating of organic materials over the surface, which don't allow nanoparticles to be aggregated within the period of time (Park *et al.*, 2011). There are some limitations within the use of chiral selenium nanoparticles as a drug delivery system and lack of targeting abilities may necessarily cause drug toxicity and unwanted side effects (Chen *et al.*, 2015). Se Nps show a very lower risk compared to selenium. It has been used as an antioxidant and as a dietary supplement (Dhanjal and Cameotra, 2010; Rajendran, 2013). Due to its antioxidant activity, it scavenge free radicals both Invitro and invivo. It also protects the DNA from oxidative injury (Battin *et al.*, 2011). It controls hormone metabolism, the body's defence mechanism and various cancer metastases (Benstoem *et al.*, 2015; Zhou *et al.*, 2016). It helps in the formation of selenoproteins, which are vital antioxidants like thioredoxin reductase, peroxidase and deiodinase (Rotruck *et al.*, 1973). Selenium at nanosize acts as a possible chemopreventive agent with reduced toxicity (Zhang *et al.*, 2001; Wang *et al.*, 2007). It also performs antifungal activity, so it is used in the treatment of dry scalp (Shoeibi and Mashreghi, 2017). These nanoparticles are safe, eco friendly, inexpensive and nontoxic (Wadhwani *et al.*, 2016). *Capparis decidua* is usually referred to as Karira and belongs to capparidaceae (Kaul, 1963). It's one among the important multipurpose tree species of desert, arid regions of the Indian subcontinent (Patil and Naikwade, 2018). It's spicy fruits are used for preparing vegetables, curry and fine pickles. These fruits are found to be the richest source of beta -carotene and vitamin -c (Chaturvedi *et al.*, 2001; Duhan *et al.*, 1992). It also has various medicinal properties like antidiabetic, antifungal, anthelmintic, analgesic, antirheumatic, antinociceptive, antigiardial, hepatoprotective, antioxidant, antibacterial, antiatherosclerotic, hypolipidemic, anti-tumor, anti-inflammatory, and anticonvulsant activities (Dhar *et al.*, 1972; Nazar *et al.*, 2020). These fruits are claimed to alleviate ailments like toothache, cough, asthma, intermittent fever, rheumatism, inflammation, swellings, jaundice and infection of joints (Ahmad *et al.*, 1992; Joseph and Jini, 2011). Skin diseases and topical injuries require unique consideration as they create human and creature powerless to bacterial, contagious and viral defilement's, during this way making them future helpless against other quite optional entanglements (Tiwari *et al.*, 2012). The most common pathogens are Enterococci, Streptococcus spp., Fusobacterium, Escherichia coli, Candida (Henry and John, 2001). It is important to discover new synthetic substances with antimicrobial properties to be utilized against these microorganisms to decrease their destructiveness property (Vignesh and Geetha, 2019). These bacterial pathogens can be suppressed or destroyed by antibacterial agents. *Enterococcus faecalis* is an emergent gram - positive opportunistic pathogen that is the causative agent of several nosocomial infections and surgical wound infections (Arias and Murray, 2008; Mohamed and Huang, 2007). It can survive for extended periods on environmental surfaces which include medical equipment, bed rails and door knobs (Arias and Murray, 2012; Jia *et al.*, 2014). It causes bacteremia, endocarditis, meningitis, periodontitis and urinary tract infection. Ampicillin is the preferred antibiotic used to treat this infection (Watson, 2017). Medicinal plants are effective within the treatment of infectious diseases and its benefit in reducing side effects. The aim of this study was to work out the antibacterial activity of *Capparis decidua* fruit mediated selenium nanoparticle against *Enterococcus faecalis*.

MATERIALS AND METHODS

Collection and Preparation of plant extract

Fresh fruits of *Capparis decidua* were obtained, identified and authenticated by Botanist and it was double washed with running water and then dried under shade. The dried fruit were thoroughly ground to a fine powder using blender. The obtained powder of *Capparis decidua* is stored in an airtight container. One gram of *Capparis decidua* powder is diluted with 40 ml of distilled water and boiled for 20 mins. The extract is filtered using whatman filter paper and allowed to stand undisturbed for 20 mins. 20 ml of filtered extract is obtained and used for green synthesis. (Figure 1 and Figure 2)

Synthesis of Selenium nanoparticles

In this procedure, 40 ml of prepared filtered extract was added to dropout 30 mM Sodium selenite solution, alongside 60ml of metal solution is added.

Table 1: Zone of Inhibition of *Capparis decidua* - Se Nps extract

Concentration (microliter)	Zone of Inhibition (mm)
50	32±1
100	35±1
150	36±1
Antibiotic	30.3±0.57

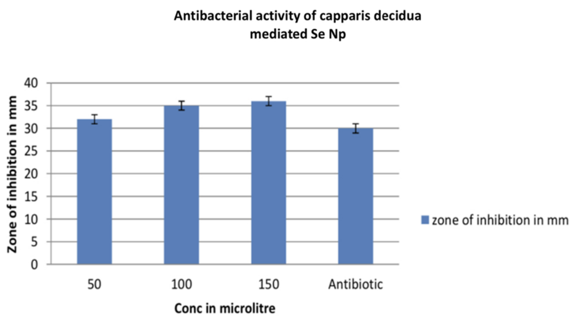

Figure 1: Antibacterialactivity of *Capparis decidua* mediated Se Np

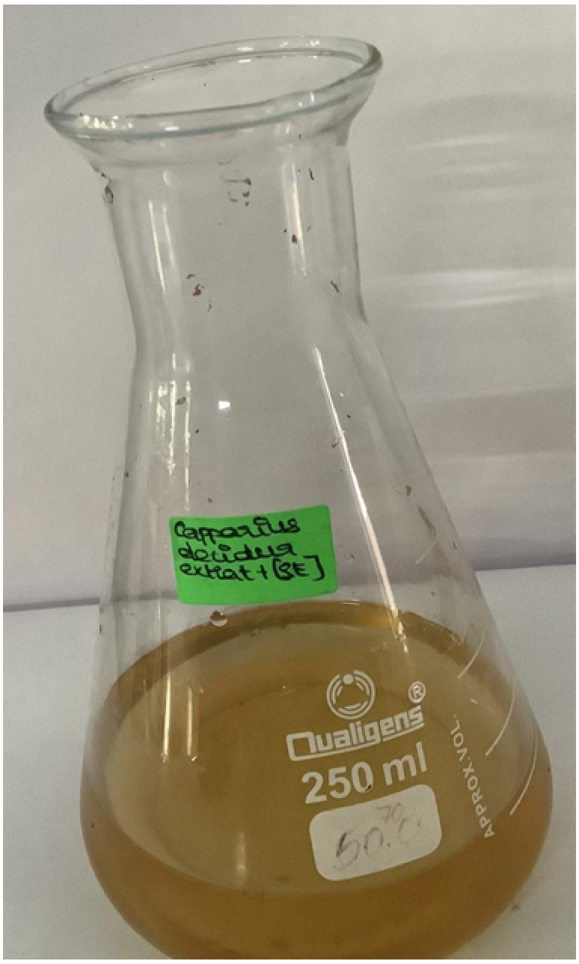

Figure 2: Se Np preparation

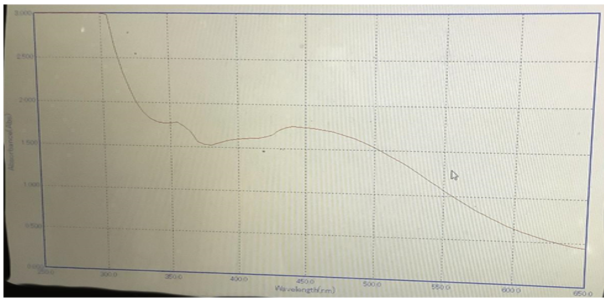

Figure 3: Ultraviolet- visible spectroscopy

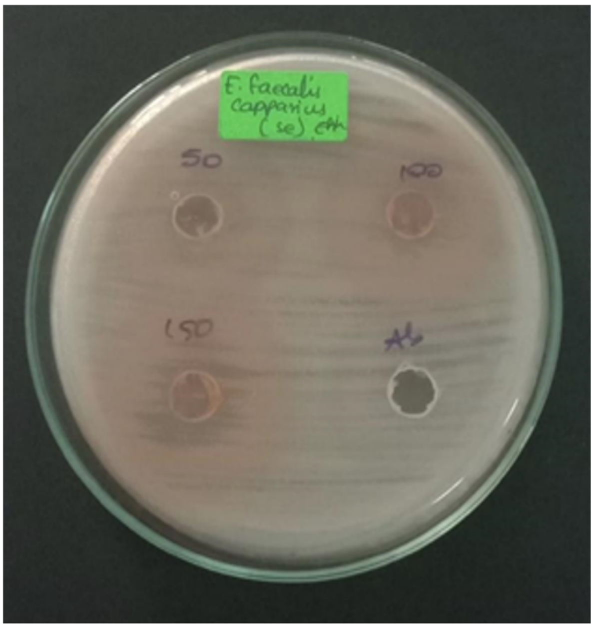

Figure 4: Zone of Inhibition against *Enterococcus faecalis*

This extract is permitted to stand in the magnetic stirrer for duration of 1 hour and kept in the shaker for intermixing of the particles to obtain green synthesis. The color change of the solution was visually observed and photographed. (Figure 1)

Characterisation of Selenium nanoparticles

The synthesized nanoparticles solution is preliminarily characterised by using ultraviolet visible spectroscopy. It is scanned in double - beam UV - visible Spectroscopy from 250 nm to 650 nm wavelength. The results were recorded for the graphical analysis. (Figure 3)

Antibacterial activity

The antibacterial activity of Selenium nanoparticles was determined using the agar well diffusion assay method. The stock culture of *Enterococcus faecalis* were prepared and maintained in saturated dextrose agar slants at 4 degree Centigrade and positive control drugs were also given parallely. The plates were examined for the evidence of a zone of inhibition, which appears as a clear area around the well. The diameter of such zones were measured using a ruler. The Zone of inhibition was recorded on the plate.

RESULTS AND DISCUSSION

In this research, the antibacterial activity of *Capparis decidua* mediated selenium nanoparticles (cds-se-NPs) which were evaluated against the pathogen *Enterococcus faecalis* using agar well diffusion method. In our study, Zone of inhibition ranged from 30-37mm (Table 1 and Figure 1, Figure 4). These results show synthesized Selenium nanoparticles have significant antibacterial activity. In recent studies, (Shoeibi and Mashreghi, 2017) have evaluated antibacterial activity of Se nanoparticles against pathogen Enterococcus faecalis. In their results, synthesized selenium nanoparticles range between 29-195nm. In enterococcus faecalis, the formation of Red Cell Suspension indicates that this bacterium is in a position to bio reduce toxic and colourless selenite to non -toxic and red metallic se-NPs (Watson, 2017; Rangrazi *et al.*, 2020) have performed antibacterial activity of the chitosan based selenium nanoparticles (cts-Se-NPs) against gram positive and gram negative. In their results, *Enterococcus faecalis* shows Minimum inhibitory concentration values of 0.068, 0.137 and 0.274 mg /ml. Therefore, increased concentration of cts-se-NPs, destroy the entire pathogens after 1,12and 6hrs. (Fardsadegh and Jafarizadeh-Malmiri, 2019) have determined Antimicrobial activity using extract of burn plant leaf mediated green synthesis of selenium nanoparticles against spoilage fungi and pathogenic bacteria strains. In their results, extract of burn plant leaf mediated selenium nanoparticles shows high antibacterial activity against Escherichia coli and Staphylococcus aureus. In previous literature, they have investigated antibacterial activity of selenium nanoparticles synthesised using various extract like burn plant, Chitosan, Emblica officinalis (Gunti *et al.*, 2019), aqueous extract of cow urine (Menon *et al.*, 2020). In our study, *Capparis decidua* was used to synthesise nanoparticle which has numerous medicinal properties like antidiabetic, anthelmintic, antibacterial, antifungal, analgesic, anti-nociceptive, antirheumatic, hypolipidemic, anti-tumor, antiatherosclerotic, antigiardial, antioxidant, anti-inflammatory, hepatoprotective and anticonvulsant activities (Nazar *et al.*, 2020). Once we compare our study with previous study, our *Capparis decidua* fruit mediated selenium nanoparticles also shows effective antibacterial activity against pathogen *Enterococcus faecalis* at higher concentration. Through this study, it was found that *Capparis decidua* mediated Se Nps is effective against the *Enterococcus faecalis* pathogens. Many of the synthetic drugs present cause various side effects. Therefore, the drugs which are developed through plant based compounds have no adverse effects. Hence, cds -se -NPs have got very good antibacterial activity.

CONCLUSIONS

This study showed increase in zone of inhibition with increase in concentration of selenium nanoparticles and it is an eco friendly approach using *Capparis decidua* extract compared to other synthesis methods. Selenium nanoparticles are thus found to possess antibacterial activity against *Enterococcus faecalis.*

ACKNOWLEDGEMENTS

This research was done under the supervision of the department of Saveetha Dental college and hospitals. We sincerely show gratitude to the corresponding guides who provide insight and expertise that greatly assisted the research.

Conflict of Interest

The author declares that there was no conflict of interest in the present study.

Funding Support

The authors declare that they have no funding support for this study.

REFERENCES

Ahmad, V. U., Ismail, N., Arif, S., ur Rehman Amber, A. 1992. Two New N-Acetylated Spermidine Alkaloids from Capparis decidua. *Journal of Natural Products*, 55(10):1509–1512.

Arias, C. A., Murray, B. E. 2008. Emergence and management of drug-resistant enterococcal infections. *Expert Review of Anti-infective Therapy*, 6(5):637–655.

Arias, C. A., Murray, B. E. 2012. The rise of the Enterococcus: beyond vancomycin resistance. *Nature Reviews Microbiology*, 10(4):266–278.

Battin, E. E., Zimmerman, M. T., Ramoutar, R. R., Quarles, C. E., Brumaghim, J. L. 2011. Preventing metal-mediated oxidative DNA damage with selenium compounds. *Metallomics*, 3(5):503–503.

Benstoem, C., Goetzenich, A., Kraemer, S., Borosch, S., Manzanares, W., Hardy, G., Stoppe, C. 2015. Selenium and Its Supplementation in Cardiovascular Disease—What do We Know? *Nutrients*, 7(5):3094–3118.

Berger, L. I. ., Usa 1997. *Semiconductor Materials*, volume 13. CRC Press, Boca Raton, FL.

Chaturvedi, Y., Y, Nagar, R., R 2001. Levels of beta carotene and effects of processing on selected fruits and vegetables of the arid zone of India? *Plant Foods hum Nutr*, 56(2):127–132.

Chen, Q., Yu, Q., Liu, Y., Bhavsar, D., Yang, L., Ren, X., Sun, D., Zheng, W., Liu, J., Chen, L. 2015. Multifunctional selenium nanoparticles: Chiral selectivity of delivering MDR-siRNA for reversal of multidrug resistance and real-time biofluorescence imaging. *Nanomedicine: Nanotechnology, Biology and Medicine*, 11(7):1773–1784.

Dhanjal, S., Cameotra, S. 2010. Aerobic biogenesis of selenium nanospheres by Bacillus cereus isolated from coalmine soil. *Microbial Cell Factories*, 9(1):52–52.

Dhar, D. N., Tewari, R. P., Tripathi, R. D., Ahuja, A. P. 1972. Chemical examination of Capparis decidua. *Proceedings of the national academy of sciences India section a-physical sciences*, 42:24–27.

Duhan, A., Chauhan, B. M., Punia, D. 1992. Nutritional value of some non-conventional plant foods of India. *Plant Foods for Human Nutrition*, 42(3):193–200.

El-Deeba, B., Al-Talhib, A., Mostafac, N. 2018. Rawan Abou-assyd, Biological Synthesis and Structural Characterization of Selenium Nanoparticles and Assessment of their Antimicrobial Propertie. *American Scientific Research Journal for Engineering*, 45(1):135–170.

Eskandari-Nojehdehi, M., Jafarizadeh-Malmiri, H., Rahbar-Shahrouzi, J. 2016. Optimization of processing parameters in green synthesis of gold nanoparticles using microwave and edible mushroom (Agaricus bisporus) extract and evaluation of their antibacterial activity. *Nanotechnology Reviews*, 5(6):537–537.

Fardsadegh, B., Jafarizadeh-Malmiri, H. 2019. Aloe vera leaf extract mediated green synthesis of selenium nanoparticles and assessment of their In vitro antimicrobial activity against spoilage fungi and pathogenic bacteria strains.

Gunti, L., Dass, R. S., Kalagatur, N. K. 2019. Phytofabrication of Selenium Nanoparticles From Emblica officinalis Fruit Extract and Exploring Its Biopotential Applications: Antioxidant, Antimicrobial, and Biocompatibility.

Henry, B., John, B. 2001. Clinical Diagnosis and Management by Laboratory Methods, Saunders Company. *J Agric FoodChem*.

Jia, W., Li, G., Wang, W. 2014. Prevalence and Antimicrobial Resistance of Enterococcus Species: A Hospital-Based Study in China. *International Journal of Environmental Research and Public Health*, 11(3):3424–3442.

Joseph, B., Jini, D. 2011. A Medicinal Potency of Capparis decidua–A Harsh Terrain Plant. *Research Journal of Phytochemistry*, 5(1):1–13.

Kaul, R. N. 1963. Need for afforestation in the arid zones of India. *La-Yaaran*, 13:30–34.

Kumar, A., Prasad, K. S. 2019. Biogenic selenium nanoparticles for their therapeutic application. *Asian Journal of Pharmaceutical and Clinical Research*, 13:4–9.

McClements, J., McClements, D. J. 2016. Standardization of Nanoparticle Characterization: Methods for Testing Properties, Stability, and Functionality of Edible Nanoparticles. *Critical Reviews in Food Science and Nutrition*, 56(8):1334–1362.

Menon, S., Agarwal, H., Rajeshkumar, S., Rosy, P. J., Shanmugam, V. K. 2020. Investigating the Antimicrobial Activities of the Biosynthesized Selenium Nanoparticles and Its Statistical Analysis.

Mohamed, J. A., Huang, D. B. 2007. Biofilm formation by enterococci. *Journal of Medical Microbiology*, 56(12):1581–1588.

Nazar, S., Hussain, M. A., Khan, A., Muhammad, G., Tahir, M. N. 2020. Capparis decidua Edgew (Forssk.): A comprehensive review of its traditional uses, phytochemistry, pharmacology and nutrapharmaceutical potential. *Arabian Journal of Chemistry*, 13(1):1901–1916.

Park, Y., Hong, Y. N., Weyers, A., Kim, Y. S., Linhardt, R. J. 2011. Polysaccharides and phytochemicals: a natural reservoir for the green synthesis of gold and silver nanoparticles. *IET Nanobiotechnology*, 5(3):69–69.

Patil, S. B., Naikwade, N. S. 2018. Capparis decidua edgew-a wild medicinal plant. *International Journal of Current Research and Review*, 2(3):16–25.

Rajendran, D. 2013. Application of nano minerals in animal production system. *Research Journal of Biotechnology*, 8(3):1–3.

Ramamurthy, C., Sampath, K. S., Arunkumar, P., Kumar, M. S., Sujatha, V., Premkumar, K., Thirunavukkarasu, C. 2013. Green synthesis and characterization of selenium nanoparticles and its augmented cytotoxicity with doxorubicin on cancer cells. *Bioprocess and Biosystems Engineering*, 36(8):1131–1139.

Rangrazi, A., Bagheri, H., Ghazvini, K., Boruziniat, A., Darroudi, M. 2020. Synthesis and antibacterial activity of colloidal selenium nanoparticles in chitosan solution: a new antibacterial agent. *Materials Research Express*, 6(12):1250h3–1250h3.

Rotruck, J. T., Pope, A. L., Ganther, H. E., Swanson, A. B., Hafeman, D. G., Hoekstra, W. G. 1973. Selenium: Biochemical Role as a Component of Glutathione Peroxidase. *Science*, 179(4073):588–590.

Shoeibi, S., Mashreghi, M. 2017. Biosynthesis of selenium nanoparticles using Enterococcus faecalis and evaluation of their antibacterial activities. *Journal of Trace Elements in Medicine and Biology*, 39:135–139.

Tiwari, R., Kumar, A., Singh, S. K., Gangwar, N. K. 2012. Skin and wound infections of animals: an overview. *Livestock Technology*, 2(3):16–18.

Vignesh, S., Geetha, R. V. 2019. Comparison on evaluation of antimicrobial activity of cumin, neem, and clove oil on oral pathogens. *Drug Invention Today*, (11):974–977.

Wadhwani, S. A., Shedbalkar, U. U., Singh, R., Chopade, B. A. 2016. Biogenic selenium nanoparticles: current status and future prospects. *Applied Microbiology and Biotechnology*, 100(6):2555–2566.

Wang, H., Zhang, J., Yu, H. 2007. Elemental selenium at nano size possesses lower toxicity without compromising the fundamental effect on selenoenzymes: Comparison with selenomethionine in mice. *Free Radical Biology and Medicine*, 42(10):1524–1533.

Wang, X., Zhang, Y., Ma, Y., Chen, D., Yang, H., Li, M. 2016. Selenium - containing mesoporous bioactive glass particles: Physicochemical and drug delivery properties. *Ceramics International*, 42(2):3609–3617.

Watson, S. 2017. Enterococcus faecalis, Health line. [Accessed On September 26, 2017]. *healthline*.

Yazdi, M., Mahdavi, M., Kheradmand, E., Shahverdi, A. 2012. The Preventive Oral Supplementation of a Selenium Nanoparticle-enriched Probiotic Increases the Immune Response and Lifespan of 4T1 Breast Cancer Bearing Mice. *Arzneimittelforschung*, 62(11):525–531.

Zhang, J. S., Gao, X. Y., Zhang, L. D., Bao, Y. P. 2001. Biological effects of a nano red elemental selenium. *BioFactors*, 15(1):27–38.

Zhou, Y., Xu, M., Liu, Y., Bai, Y., Deng, Y., Liu, J., Chen, L. 2016. Green synthesis of Se/Ru alloy nanoparticles using gallic acid and evaluation of theiranti-invasive effects in HeLa cells. *Colloids and Surfaces B: Biointerfaces*, 144:118–124.