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

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**ABSTRACT**

Nanotechnology has become one among the promising approaches for innovations which fulfill 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*.

**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 scavenges 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, anti-inflammatory, anticoagulant, anti-inflammatory, hepatoprotective, antioxidants, 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. (Figures 1 and 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. This
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: Antibacterial activity of Capparis decidua mediated Se Np

Figure 2: Se Np preparation

Figure 3: Ultraviolet- visible spectroscopy

Figure 4: Zone of Inhibition against Enterococcus faecalis

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 parallelly. 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 Figures 1 and 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, anti-fungal, analgesic, anti-nociceptive, antirheumatic, hypolipidemic, anti-tumor, antiatherosclerotic, anti-giardial, 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.

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Conflict of Interest

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

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