ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

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

Green synthesis of Selenium nanoparticles using *Capparis decidua* and its anti-inflammatory activity

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Article History:

Received on: 28 May 2020
Revised on: 20 Jun 2020
Accepted on: 01 Jul 2020

Keywords:

Anti-inflammatory activity,
Capparis decidua,
Green synthesis,
Selenium nanoparticles.

ABSTRACT

This in vitro study focuses on the green synthesis of selenium nanoparticles using *Capparis decidua* and its anti-inflammatory activity. Nanotechnology is the speciality associated with Material science and biology, rather than a particular field. It involves the formulation of particles at nanoscale known as Nanoparticles, where they have control over bulk macroscopic properties of the same material. Selenium, being a 'Drug nanocarrier', possesses strong antibacterial, antioxidant and anti-cancer as well as anti-inflammatory properties. As the medicinal plant *Capparis decidua* possesses a lot of phytochemicals, this study combined it to synthesise selenium nanoparticles, and anti-inflammatory properties were analysed. Synthesis of Selenium nanoparticles using *Capparis decidua* extract, collection of NPs using centrifugation, analysis of anti-inflammatory using UV spectroscopy and inhibition of Bovine serum albumin denaturation assay were performed. Biosynthesised selenium nanoparticles using *Capparis decidua* exhibit effective anti-inflammatory properties and act as an alternative candidate for steroidal and non-steroidal anti-inflammatory drugs. On account of performing the Green synthesis of selenium nanoparticles along with the combination of *Capparis decidua,* it is evident that *Capparis decidua* possesses effective anti-inflammatory with increasing concentrations up to 5muL. In future, we can encounter further efficacy by raising the concentrations by adding new formulations other than *Capparis decidua.*

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ISSN: 0975-7538

DOI: https://doi.org/10.26452/ijrps.v11i4.3298

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INTRODUCTION

In current years, Novel nanotechnologies have seized a lot of attention in research areas as they hold enormous applications in multidisciplinary fields (Cui, 2018). Nanotechnology is the speciality associated with Material science and biology, rather than a specific field. It involves the formulation of particles at nanoscale known as Nanoparticles, where they have control over bulk macroscopic properties of the same material (Fulekar, 2010). Many studies have proved the pharmaceutical and nutraceutical values of nanoparticles, in

which they interact at cellular as well as molecular levels with a high degree of specificity, sensitivity and signalling capability (El-Ghazaly, 2017). These nanoparticles have been utilised in several fields like genomics and proteomics, food industry, cosmetic industry etc.. due to their marvellous ligand binding potential and deep penetrating power (Agarwal *et al.*, 2019). Selenium, being an indispensable dietary trace element, has been recently introduced in biomedicine as a 'Drug nanocarrier'. A lot of research has reported that Selenium possesses strong antioxidant, antibacterial and anti-cancer properties (Song, 2020). Selenium plays a crucial part in boosting immunity, protecting tissues against oxidative stress, Reproduction, growth, development and modulation (Murdock, 2008). Between Selenium's bioactivity and toxicity, there exists a thin margin only. Selenium shows immense biological activity, bioavailability and less toxicity if synthesised biologically rather than physicochemical methods (Wadhwani, 2017).

Capparis decidua is a deciduous bushy shrub, primarily seen in the arid regions of India, Asia, Africa and Saudi Arabia. *Capparis decidua* is named in versatile languages as Karil (Bengal), Senkam (Tamil), Mumudata (Telugu), Karir (Kannada), Karimulli (Malayalam), Kerdo (Gujarati) etc.. (Chopra *et al.*, 1958). It is commonly called 'Caperberry'. This unique arid plant species is resistant to Drought, salinity, soil erosion and tolerates frost to some extent also (Anjum, 2018). Following the arrival/ advent of humanity, This plant has been exploited in Folk medicine (Ayurveda, Unani) and Herbalism and possess enormous medicinal values such as Antibacterial, Anti-diabetic, Anti-fungal, Antirheumatic, Anti-tumour, Antidote Properties (Ayat *et al.*, 2016). This plant has numerous nutraceutical values and is enriched with proteins, carbohydrates, vitamins, fibre, potassium, calcium and used as fodder for livestock (Ozcan, 2005; Romeo, 2007). *Capparis decidua* contains several alkaloids, Terpenoid, Glycosides and fatty acids (Zhang and Ma, 2018; Reynolds, 2020). The powdered coal of stem of *Capparis decidua* helps in the healing of the bone fracture, while the paste form of its root is applied for scorpion bite. Apart from the aspects mentioned above, *Capparis decidua* is an eco- friendly and cost-effective biofuel (Nour and El-imam, 2013).

Nanoparticles can modify their physical, chemical and biological characteristics on account of their large surface to volume ratio. 'Green chemistry' plays a vital role in fabricating bioengineered nanoparticles, to attain peculiar composition and function (Darroudi *et al.*, 2010; Sorescu, 2016). The green protocol also eliminates the chances of producing unwanted/ hazardous by-products rather than the conventional physical and chemical methodologies (Gurunathan, 2015; Lee *et al.*, 2014) .

Inflammation is part of the body's immune response to remove harmful stimuli and begin the healing process. Chronic inflammation can eventually cause several diseases and conditions, including cancer and rheumatoid arthritis (Byford, 1871). From this study, we are attempting to analyse the combined anti-inflammatory activity of bio-synthesised selenium nanoparticles prepared from *Capparis decidua.*

MATERIALS AND METHODS

Collection and preparation of plant

Fresh fruits of Capparis decidua were obtained, identified and authenticated by Botanist and it is double washed with running water and then dried under shade. The dried fruits were thoroughly ground to a fine powder using a 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.

Preparation of Selenium nanoparticle extract

0.01mg of sodium selenite is weighed and mixed with distilled water of 8 ml and mixed with the filtered extract Figure 1. The nanoparticles mixed with the plant extract are permitted to stand in a magnetic stirrer for 1 hour and kept in a shaker for intermixing of the particles to obtain green synthesis. UV spectrometers periodically monitored the reduction of sodium selenite to selenium nanoparticles. The colour change was visually noted and photographed.

Characterisation of Selenium nanoparticles

The synthesised selenium nanoparticles solution is primarily characterised using Ultraviolet (UV)- Visible spectroscopy Figure 2; 3 ml of the solution is taken in the coveted and scanned in double-beam UV- visible spectrophotometer from 300-650 nm wavelength. The results were recorded for the graphical analysis.

Preparation of Nanoparticle powder

Using Lark refrigerated centrifuge, The selenium nanoparticles solution is centrifuged at 8000 rpm for 10 min, and the pellet is collected and washed with distilled water twice. The final purified pellet is collected and dried at 100- 150 degree Celsius for

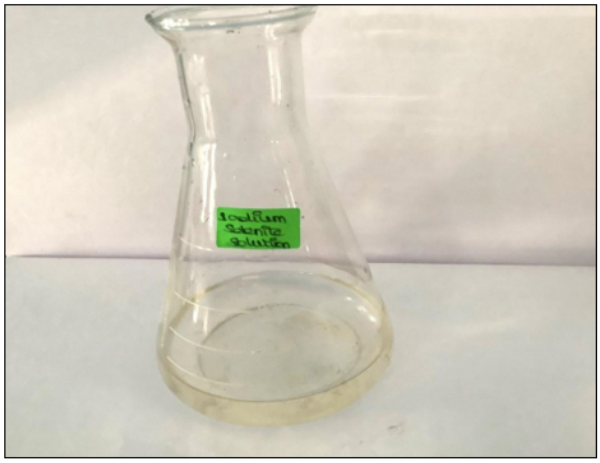

Figure 1: Sodium selenite solution

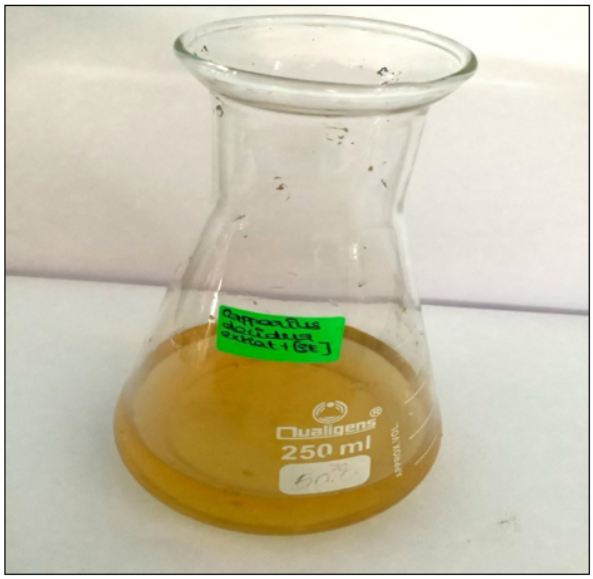

Figure 2: Biosynthesis Nanoparticle solution

2/24 h, and finally, the nanoparticles powder is collected and stored in airtight Eppendorf tube.

Evaluation of anti-inflammatory activity by Albumin denaturation assay

2 mL of 1% Bovine serum albumin (BSA) was mixed with 400 μL of methanolic crude extract in different concentrations (500-100 μg/mL), and the pH of the reaction mixture was adjusted to 6.8 using 1N HCl. The reaction mixture was incubated at room temperature for 20 min and then heated to 55 °C for 20 min in a water bath. The mixture was cooled to room temperature, and the absorbance value was recorded at 660 nm. A BSA mixture with 30% methanol solution was used as a control. Diclofenac sodium in different concentrations was used as a standard. The experiment was performed in triplicate.

Percentage inhibition was calculated using the following formula:

% inhibition = Absorbance of control – Absorbance of the test $_{x\ 100}$

The absorbance of the control

RESULTS AND DISCUSSION

UV - Spectroscopy

The UV- visible analysis of sodium selenite nanoparticles was analysed in the absorbency range of 300-650 nm Figure 5. The peak was found to be maximum at 300 nm. reduction of aqueous metal ions with the *Capparis decidua* extract indicates the formation and synthesis of the selenium nanoparticles.

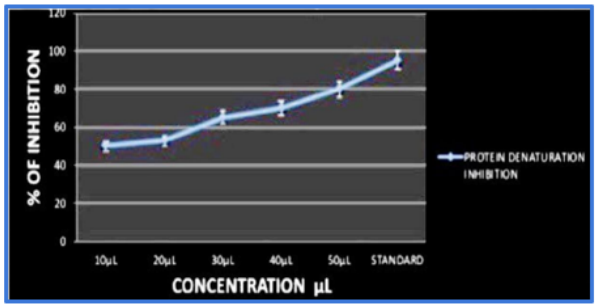

Figure 3: Graphical representation depicting enhancedanti-inflammatory activity of selenium nanoparticles along with Capparis decidua.

Selenium nanoparticle synthesised from *Capparis decidua* was taken in different concentrations of 10 μL, 20 μL, 30 μL, 40 μL and 50 μL Figures 3 and 4. For the concentrations as mentioned above, the following percentage of the zone of inhibition was observed as 50%, 53%, 65%, 70% and 80%. Maximised zone of inhibition, i.e., 80% was noted in the concentration of 50 muL. This depicts that effective anti-inflammatory activity of bio fabricated selenium nanoparticles increased with higher concentrations. Diclofenac, a standard synthetic anti-inflammatory drug, exhibits 95% anti-inflammatory activity. This indicates the effectiveness of the extract is close to the standard taken, and its efficacy can be increased with increasing concentration.

Concentration µL	10µL	20µL	30µL	40µL	50µL	STANDARD
PROTEIN DENATURATION INHIBITION	50	53	65	70	80	95

Figure 4: Tabulation of percentage of anti-inflammatoryactivity for the corresponding concentration of selenium nanoparticleextract

From the advent of humanity, several medicinal plants have been exploited for research purposes of investigating their properties which can be applied

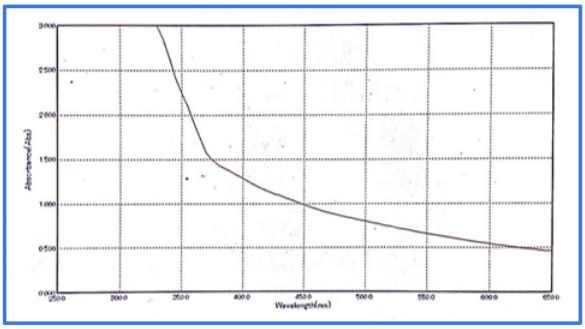

Figure 5: Ultraviolet visible spectroscopy

in industrial and medical fields. A lot of artificial drugs like NSAIDs which are used against inflammation are effective, but they have many side effects like gastrointestinal and renal damage (Pilotto, 2010). In a study done by El-Ghazaly et al., regarding the anti-inflammatory effect of selenium nanoparticles on the inflammation induced on irradiated rats, Nano-Se were administered orally in a dose of 2.55 mg/kg. It has been found that Nano-Se lessened the elevating inflammation in both irradiated and non-irradiated rats (El-Ghazaly, 2017). Melatonin-SeNPs treatment decreased pathological abnormalities of the liver, proinflammatory cytokines and splenocyte proliferation. The combination of silymarin and selenium nanoparticle at Low concentration is an excellent candidate possessing anti-inflammatory as well as antioxidant properties (Khurana, 2019) . To lessen the side effects and toxicity, biologically prepared herbs act as an excellent alternative. Medicinal plants have a wide range of phytochemicals like secondary metabolites which are potent and safe to use. This study has proved the anti-inflammatory property of selenium nanoparticles synthesised using *Capparis decidua,* which as per previous reviews.

CONCLUSION

In this study, Using *Capparis decidua*, selenium nanoparticles have been synthesised. This bio-engineered nanoparticle has proved to exhibit significant anti-inflammatory properties with higher concentrations. It is non-toxic, without any side effects as that of steroidal and non -steroidal anti-inflammatory drugs. Future studies will be carried out to identify other properties present in selenium nanoparticles synthesised using *Capparis decidua*.

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.

Source of Funding

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

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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