Journal of Pharmaceutical Research International

32(19): 60-66, 2020; Article no.JPRI.59824
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Evaluation of Antioxidant and Cytotoxic Effect of Selenium Nanoparticles Synthesised Using *Capparis decidua*

P. S. Thana Lakshme[1], Preetha S[2*], M. Jeevitha[3] and S. Rajeshkumar[4]

[1]Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
[2]Department of Physiology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
[3]Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
[4]Department of Pharmacology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Authors' contributions

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

Article Information

DOI: 10.9734/JPRI/2020/v32i1930709
Editor(s):
(1) Dr. Sung-Kun Kim, Northeastern State University, USA.
Reviewers:
(1) Reza Tayebee, Hakim Sabzevari University, Iran.
(2) Babarinsa Kayode Michael, University of Ilorin, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59824

Original Research Article

Received 25 May 2020
Accepted 31 July 2020
Published 26 August 2020

ABSTRACT

Background: Among the nanoparticles, selenium nanoparticles (SeNP) are one of the most extensively studied as Selenium has zero oxidation state, non toxic and biologically inert material. This is the reason why Selenium is considered as a major nanoparticulate. In this study SeNPs were extracted from the fruit of *Capparis decidua* which is a xerophytic small herb.
Aim: The aim of the present study is to evaluate the cytotoxic effect and antioxidant capacity of selenium nanoparticles.
Materials and Methods: In this study SeNPs were extracted from the fruit of *Capparis decidua* which is a xerophytic small herb. The cytotoxic effect of SeNPs was evaluated using Brine Shrimp

**Corresponding author: E-mail: preethas.sdc@saveetha.com;*

assay and the antioxidant activity was determined using DPPH assay considering ascorbic acid as the standard.

Results: From the study of this assay the shrimps introduced into the well were almost alive in different concentrations and this indicates that there is no cytotoxicity in selenium nanoparticles. The percentage inhibition of Selenium nanoparticles in 10 µl was 15.4±0.1, 20 µl was 38.36±0.15, 30 µl was 45.3±0.1, 40 µl was 59.6±0.15 and 50 µl was 65.6 ± 0.1. It can be inferred that percentage inhibition increases with increase in concentration but it was less when compared to the percentage inhibition of the standard.

Conclusion: The selenium nanoparticles extracted from *Capparis decidua* do not have any cytotoxic effect on shrimps. The SeNPs possessed significant antioxidant activity in increasing concentrations compared to the standard used. Thus SeNPs are biologically useful and can be used as eco-friendly, cost effective and efficient biomedical agents and therapeutics.

Keywords: Selenium nanoparticles; Capparis decidua; cytotoxicity; antioxidant; non-toxic; brine shrimps; DPPH radical.

1. INTRODUCTION

Selenium (Se) plays a vital role in the antioxidant defense mechanism of the liver and thus protecting against oxidative stress [1]. Also Selenium prevents the accumulation of free radical species, and reduces the cellular damage which makes the researchers choose Selenium for study [2–4]. As it is familiar that Selenium is one of the essential trace elements with zero oxidation state which enhances bioavailability compared to other forms of Selenium [5,6]. But there also exists a limitation of dose which could be toxic when exceeded [7]. Yet another limitation would be that Selenium is a thermostable and biologically inert element and thus it is restricted to be food intake [8,9]. Selenium was designed as a nano-vehicle using polysaccharides, proteins, etc., as stabilisers [10,11]. Cytotoxic refers to a substance or process that results in cell damage or cell death. Even our own immune systems have cells that are considered to be cytotoxic, such as T cells which kill bacteria, viruses, and also cancer cells [12]. These cytotoxic drugs work by interrupting the cells in their growth cycle [13]. The term antioxidant itself infers that it inhibits oxidation. Oxidation being chain reactions, can produce free radicals that may damage the cells of organisms. Certain vitamins like beta carotene, Vitamin A and Vitamin E being a dietary supplement for antioxidant activities has no positive effect on mortality rate [14]. In case of Selenium, it is considered as a better antioxidant supplement though not a dietary intake but it was limited that selenium had no positive impact on cardiovascular disease [15]. The most interesting factor is that antioxidants being reducing agents, can act as pro oxidants but the relative importance of pro oxidants is still a matter of discussion [16]. *Capparis decidua,* commonly known as Karira which is used as folk medicine and herbalism grown in drought resistant areas [17]. From the prior studies, it was evident that *Capparis decidua* possesses sterols, fatty acids, flavones and alkaloids [18–20]. Thus the plant *Capparis decidua* was chosen to enable better results.

In previous studies, involving the antioxidant capacity of SeNPs it establishes low cytotoxicity and enhanced antioxidant capacity. This study by Chitosan also speaks on the ability of considered nanoparticles to penetrate cells or tissue effectively [21]. The present study is the extension of prior studies undertaken with *Capparis decidua* as it had been acknowledged that this plant is a potent source of various bio chemicals and therapeutics. Similarly, with consideration of selenium it possesses a better antioxidant activity. Thus determining the antioxidant and cytotoxic effect of Selenium nanoparticles with the extract of *Capparis decidua* would enhance the pharmacological development of drugs in future. The study on the combination of both antioxidant and cytotoxic effects of Selenium nanoparticles as a subject is the uniqueness of our study. Our recent research portfolio slides numerous articles in reputed journals [22–30]. Based on this experience we planned to pursue the cytotoxicity and antioxidant property of Selenium nanoparticles. Thus the aim of the study is to evaluate antioxidant and cytotoxic effects of selenium nanoparticles using *Capparis decidua.*

2. MATERIALS AND METHODS

The current study has been approved by the Scientific review board, Saveetha Dental College, Chennai.

2.1 Preparation of Plant Extract

The well dried *Capparis decidua* fruits were collected and made into a powder using mortar and pestle. 1 grams of C. *decidua* powder was dissolved in distilled water and boiled for 10 mins at a controlled temperature of 60 degree in a hot mantle. The solution was filtered.

2.2 Preparation of Nanoparticle Solution

0.01 milligram of Sodium selenite was dissolved in 8 ml of distilled water. 40 ml of plant extract was added with 60 ml of prepared metal solution and were made into 100 ml solution. This solution was kept in a shaker and readings were taken. These selenium nanoparticles can also be synthesized from an isolated bacterial colony [31]. Selenium dioxide nanoparticles were successfully prepared from *Equisetum arvense* obtained from the north-east of Iran [32].

2.3 UV Characterization

Synthesised nanoparticle solution is characterised using UV spectroscopy in the range of 250-650 nm. These results were recorded for graphical analysis.

2.4 Preparation of Nanoparticle Powder

Selenium nanoparticle solution was centrifuged using refrigerated centrifuge at 8000 rpm for 3 minutes and pellet was collected and washed with distilled water twice. The purified pellet was collected and dried for 2-3 days in a hot air oven. Finally, the nanoparticle powder was collected and stored in an airtight Eppendorf tube.

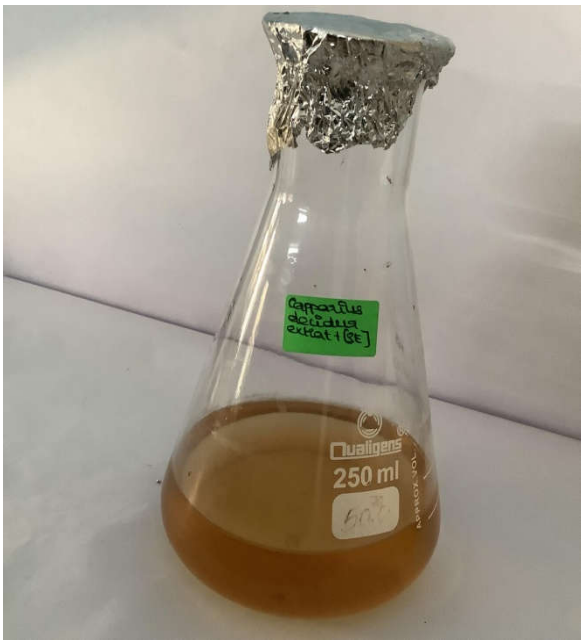

Fig. 1. Shows the preparation of selenium nanoparticle

2.5 Determination of Cytotoxic Effect

The cytotoxic effect was determined by carrying out brine shrimp assay method. Distilled water was taken in different concentrations such as 10 microliter, 20 microliter and till 50 microliter. The shrimps were introduced into each well in the count of exactly 10 involving the control. Then the extract was added according to the concentration of distilled water in each well excluding the control. This setup was undisturbed and then observed after 24 hours. Now the alive shrimps were counted.

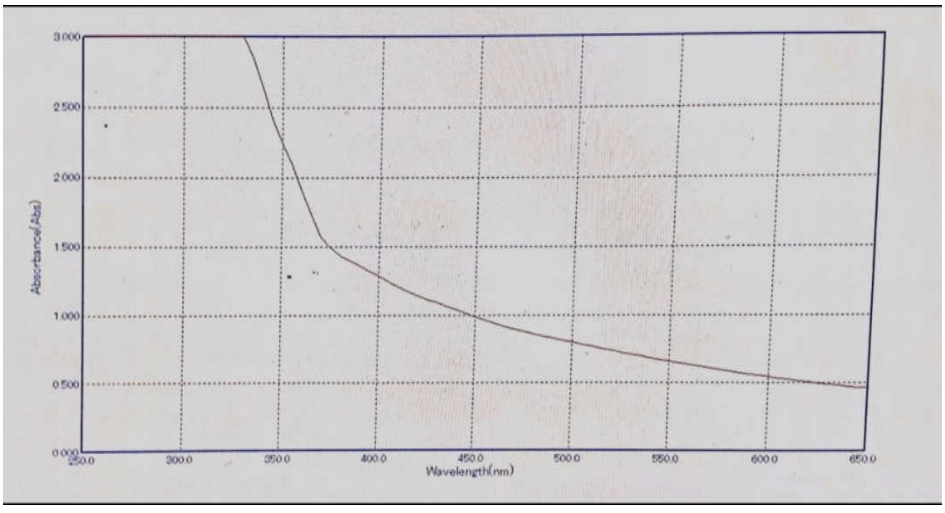

Fig. 2. Shows UV spectroscopy of synthesised nanoparticle solution

2.6 Determination of Antioxidant Activity

Antioxidant activity of Se nanoparticle was determined on the basis of radical scavenging mechanism in DPPH assay (2, 2-diphenyl-1-picryl-hydrazyl-hydrate) which is a free radical method based on electron transfer. The value of RSC% (Radical Scavenging Capacity) was calculated using the following formula:

Radical scavenging activity, RSC% = A0-A1/A0 multiplied by 100

where A0 is the absorbance of the control and A1 is the absorbance of the mixed solution of the antioxidant and free radical agent. This assay was carried out based on the work of Xu B J et. al., 2007 [33]. 0.2 mL of nanoparticle powder was mixed vigorously with 3.8 mL of DPPH radical ethanol solution with DPPH concentration as 0.1mmol/L, and then maintained at room temperature in the dark for 30 minutes. The absorbance was measured at 517 nm with a UV spectrophotometer.

Fig. 3. Shows the DPPH assay

3. RESULTS AND DISCUSSION

The cytotoxic activity of Selenium nanoparticles shows that all the introduced shrimps were alive in the control whereas in the well of 10 µl, 9 shrimps were alive, in 20 µl nanoparticle well 9 shrimps were alive, in the well of 30 µl and 40 µl nanoparticles also 9 shrimps were alive. However, in the well with a concentration of 50 µl of nanoparticles only 8 shrimps were alive after 24 hours. It is presented in a bar graph.

Thus it is evident that there is no significant cytotoxicity in Selenium nanoparticles. For the evaluation of antioxidant capacity, the percentage inhibition of 10 µl was 15.4±0.1, 20 µl was 38.36±0.15, 30 µl was 45.3±0.1, 40 µl was 59.6±0.15 and 50 µl was 65.6± 0.1 which were presented in the form of a graph in comparison with the percentage inhibition of the standard (Ascorbic acid) used.

This can be concluded that with increase in concentration, the percentage inhibition of Selenium nanoparticles is increased but it remains less than the percentage inhibition of standard ascorbic acid. Hence Selenium nanoparticles possess better antioxidant capacity but it is less effective when compared to the antioxidant property of the standard used.

The synonymous study carried by R. S. Das et.al., performed the similar DPPH assay on SeNPs with ascorbic acid as standard and established the same result which adds evidence to our study and exists as a supporting study [34]. Another supporting study by Mughal Quayam et.al., also performed DPPH assay for antioxidant determination also total phenolic content was estimated ensuring the significant antioxidant capacity in C.*decidua* and thus adds an evidence to our present study [35]. Yet another similar study by Tapiero H et.al., establishes that selenium compounds like selenite induce cytotoxicity causing apoptosis but Selenium has no cytotoxic effect which is synonymous with our study and thus adds evidence to the present study [1]. The study by Mojdeh Safari et.al., involving SeNPs, cytotoxicity was determined by MTT assay which showed low toxicity toward investigated cell lines for 24 hrs which contradicts our findings and thus remains as an opposite finding to our study [36].

Table 1. Represents the percentage inhibition of selenium nanoparticles and the standard ascorbic acid for corresponding concentration in DPPH assay

Concentration (µl)	% inhibition of DPPH (Selenium nanoparticle)	% inhibition of DPPH (Std)
10 µl	15.4 ± 0.1	24.69 ± 0.59
20 µl	38.36 ±0.15	51.34 ± 1.46
30 µl	45.3 ±0.1	65.54 ± 1.05
40 µl	59.6 ±0.15	78.42 ± 0.73
50 µl	65.6 ± 0.1	91.53 ± 1.51

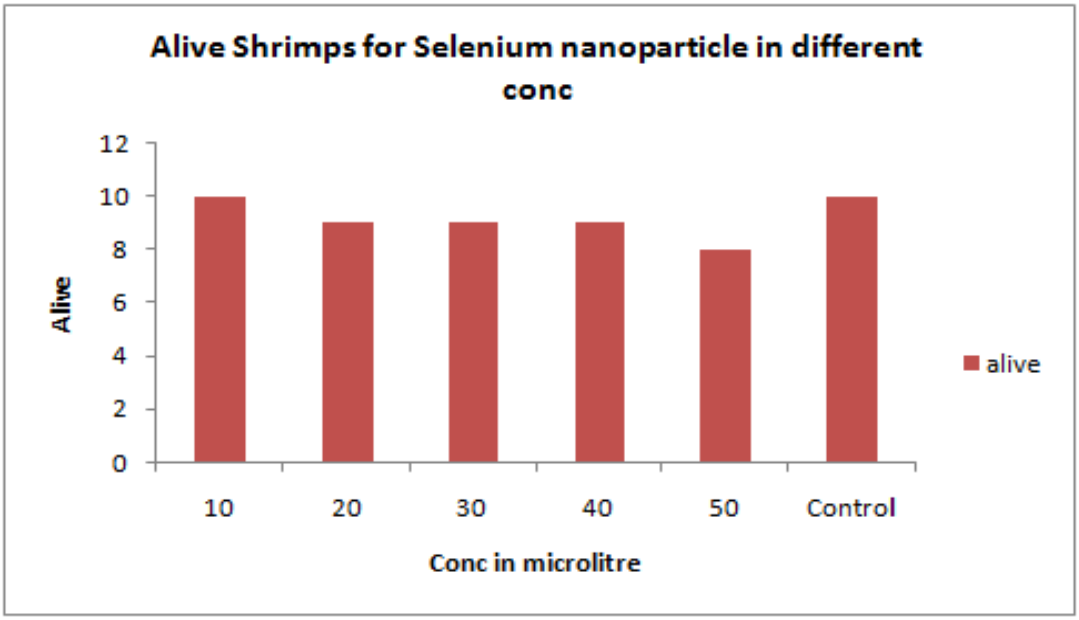

Fig. 4. Shows the count of alive shrimps after 24 hours in Brine shrimp assay

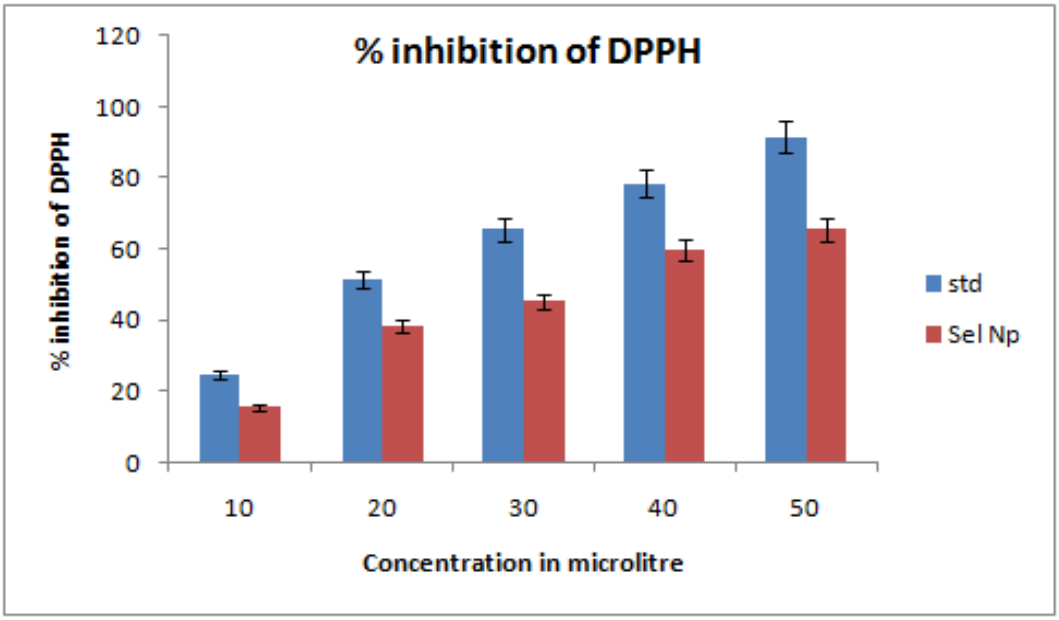

Fig. 5. Shows the percentage inhibition of selenium nanoparticles and the standard used with respect to concentration. This graph represents that with increase in concentration, the percentage inhibition of Selenium nanoparticles is increased but it remains less than the percentage inhibition of standard ascorbic acid

4. CONCLUSION

From the above study it is evident that SeNPs biosynthesised from *Capparis decidua* is a potent source of antioxidant activity with nil cytotoxic effects which can emerge as a better treatment for various diseases.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENT

We sincerely thank Saveetha Dental College for their constant support to carry out and finish this work on time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tapiero H, Townsend DM, Tew KD. The antioxidant role of selenium and seleno-compounds. Biomedicine & Pharmacotherapy. 2003;57:134–144.
2. Liu W, Li X, Wong Y-S, et al. Selenium Nanoparticles as a carrier Of 5-Fluorouracil to achieve anticancer synergism. ACS Nano. 2012;6:6578–6591.
3. McKenzie RC. Selenium, ultraviolet radiation and the skin. Clinical and Experimental Dermatology. 2000;25:631–636.
4. Qin S, Huang B, Ma J, et al. effects of selenium-chitosan on blood selenium concentration, antioxidation status, and cellular and humoral immunity in mice. Biological Trace Element Research. 2015;165:145–152.
5. Wang H, Zhang J, Yu H. 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. 2007;42:1524–1533.
6. Torres SK, Campos VL, León CG, et al. Biosynthesis of selenium nanoparticles by Pantoea agglomerans and their antioxidant activity. Journal of Nanoparticle Research; 14. Epub ahead of print; 2012.
DOI: 10.1007/s11051-012-1236-3
7. Wang W, Mai K, Zhang W, et al. Dietary selenium requirement and its toxicity in juvenile abalone Haliotis discus hannai Ino. Aquaculture. 2012;330-333:42–46.
8. Zhang J, Wang H, Yan X, et al. Comparison of short-term toxicity between Nano-Se and selenite in mice. Life Sciences. 2005;76:1099–1109.
9. Chen H, Shin D-W, Nam J-G, et al. Selenium nanowires and nanotubes synthesized via a facile template-free solution method. Materials Research Bulletin. 2010;45:699–704.
10. Kaur G, Iqbal M, Bakshi MS. Biomineralization of fine selenium crystalline rods and amorphous spheres. The Journal of Physical Chemistry C. 2009;113:13670–13676.
11. Zhang Y, Wang J, Zhang L. Creation of highly stable selenium nanoparticles capped with hyperbranched polysaccharide in water. Langmuir. 2010;26:17617–17623.
12. Andersen MH, Schrama D, Thor Straten P, et al. Cytotoxic T cells. J Invest Dermatol. 2006;126:32–41.
13. Jingwen B, Yaochen L, Guojun Z. Cell cycle regulation and anticancer drug discovery. Cancer Biology & Medicine. 2017;14:348.
14. Abner EL, Schmitt FA, Mendiondo MS, et al. Vitamin E and all-cause mortality: A meta-analysis. Current Aging Sciencee. 2011;4:158–170.
15. Shekelle PG, Morton SC, Jungvig LK, et al. Effect of supplemental vitamin E for the prevention and treatment of cardiovascular disease. Journal of General Internal Medicine. 2004;19:380–389.
16. Duarte TL, Lunec J. Review part of the series: From dietary antioxidants to regulators in cellular signalling and gene expression review: When is an antioxidant not an antioxidant? A review of novel actions and reactions of vitamin C. Free Radical Research. 2005;39:671–686.
17. Sharma P. Diversity, indigenous uses, threat categorization and conservation prioritization of medicinal plants: A case study from Himachal Pradesh, India. Journal of Biodiversity & Endangered Species; 02. Epub ahead of print; 2014.
DOI: 10.4172/2332-2543.1000134
18. Rathee P, Rathee D, Rathee D, et al. In-vitro cytotoxic activity of β-Sitosterol triacontenate isolated from *Capparis decidua* (Forsk.) Edgew. Asian Pacific Journal of Tropical Medicine. 2012;5:225–230.
19. Dalvi SN, Funde PE, Pokharkar RD, et al. Effect of concentration of KOH, H2O, temp in in-situ transestrification reaction of Sesbania sesban, *capparis decidua*s seed. Renewable Energy and Power Quality. 2009;1:28–31.
20. Dar AI, Masar G, Jadhaw V, et al. Isolation and structural elucidation of the novel flavone glycoside from *Feronia limonia* L. Journal of Pharmacy Research. 2013;7: 697–704.

21. Zhai X, Zhang C, Zhao G, et al. Antioxidant capacities of the selenium nanoparticles stabilized by chitosan. Journal of Nanobiotechnology; 15. Epub ahead of print; 2017.
DOI: 10.1186/s12951-016-0243-4
22. Subramaniam N, Muthukrishnan A. Oral mucositis and microbial colonization in oral cancer patients undergoing radiotherapy and chemotherapy: A prospective analysis in a tertiary care dental hospital. J Investig Clin Dent. 2019;10:e12454.
23. Vadivel JK, Govindarajan M, Somasundaram E, et al. Mast cell expression in oral lichen planus: A systematic review. J Investig Clin Dent. 2019;10:e12457.
24. Patil SR, Maragathavalli G, Ramesh DNSV, et al. Assessment of maximum bite force in oral submucous fibrosis patients: A preliminary study. Pesqui Bras Odontopediatria Clin Integr. 2020;20:482.
25. Patil SR, Maragathavalli G, Araki K, et al. Three-rooted mandibular first molars in a Saudi Arabian population: A CBCT study. Pesqui Bras Odontopediatria Clin Integr. 2018;18:e4133.
26. Patil SR, Yadav N, Al-Zoubi IA, et al. Comparative study of the efficacy of newer antioxitands lycopene and oxitard in the treatment of oral submucous fibrosis. Pesqui Bras Odontopediatria Clin Integr. 2018;18:1–7.
27. Dave PH, Preetha. Pathogenesis and novel drug for treatment of asthma-a review. Research Journal of Pharmacy and Technology. 2016;9:1519.
28. Fathima F, Preetha P. Evaluation of thyroid function test in obese patients. Asian Journal of Pharmaceutical and Clinical Research. 2016;9:353.
29. Preetha S, Packyanathan J. Comparison of the effect of Yoga, Zumba and Aerobics in controlling blood pressure in the Indian population. Journal of Family Medicine and Primary Care. 2020;9:547.
30. Shruthi M, Preetha S. Effect of simple tongue exercises in habitual snorers. Research Journal of Pharmacy and Technology. 2018;11:3614.
31. Mollania N, Tayebee R, Narenji-Sani F. An environmentally benign method for the biosynthesis of stable selenium nanoparticles. Research on Chemical Intermediates. 2016;42:4253–4271.
32. Tayebee R, Pejhan A, Ramshini H, et al. Equisetum arvense as an abundant source of silica nanoparticles. SiO2 /H3 PW12 O40 nanohybrid material as an efficient and environmental benign catalyst in the synthesis of 2-amino-4H-chromenes under solvent-free conditions. Applied Organometallic Chemistry. 2018;32:e3924.
33. Xu BJ, Chang SKC. A comparative study on phenolic profiles and antioxidant activities of legumes as affected by extraction solvents. Journal of Food Science. 2007; 72:S159–S166.
34. Gunti L, Dass RS, Kalagatur NK. Phytofabrication of selenium nanoparticles from *Emblica officinalis* fruit extract and exploring its biopotential applications: Antioxidant, antimicrobial and biocompatibility. Frontiers in Microbiology; 10. Epub ahead of print; 2019.
DOI: 10.3389/fmicb.2019.00931.
35. Zia-Ul-Haq M, Ćavar S, Qayum M, et al. Compositional studies: Antioxidant and antidiabetic activities of *Capparis decidua* (Forsk.) edgew. International Journal of Molecular Sciences. 2011;12:8846–8861.
36. Boroumand S, Safari M, Shaabani E, et al. Selenium nanoparticles: Synthesis, characterization and study of their cytotoxicity, antioxidant and antibacterial activity. Materials Research Express. 2019;6:0850d8.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/59824