Antioxidant and Antiinflammatory Activity of Titanium Dioxide Nanoparticles Synthesised Using Mucuna pruriens

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: The genus Mucuna, belonging to the Fabaceae family, sub family Papilionaceae, includes approximately 150 species of annual and perennial legumes. Titanium dioxide (TiO2) nanoparticles (NPs) are manufactured worldwide in large quantities for use in a wide range of applications. Various studies have been done in this topic like determining the efficacies of antibacterial and antioxidant activities of aqueous leaf extract of Psidium guajava mediated biosynthesis of titanium dioxide nanoparticles. Other studies have suggested that Obtaining biopeptides by enzymatic hydrolysis adds value to proteins of vegetative origin, such as Mucuna pruriens L. Thus it evaluated the effect of enzymatic digestion of protein derivatives obtained from M. pruriens L. Although a lot of studies have been done on Titanium dioxide nanoparticles and its various activities like anti-inflammatory, antioxidant and anti-diabetic, there are not many studies in the area of checking anti inflammatory and antioxidant activity of titanium dioxide nanoparticles synthesised using Mucuna pruriens The aim of this study is to observe the antioxidant and anti inflammatory activity of Titanium dioxide nanoparticles synthesised using Mucuna pruriens.

Materials and Methods: A titanium dioxide nanoparticle is synthesised using Mucuna pruriens.
**Results:** The Mucuna pruriens mediated titanium dioxide nanoparticle has positive antioxidant and anti-inflammatory properties.

**Conclusion:** The present study concluded that Mucuna pruriens mediated copper nanoparticle has good antioxidant and anti-inflammatory activity at its high concentration which is nearer to that of the standard drugs.

**Keywords:** Mucuna pruriens; titanium dioxide nanoparticles; anti-inflammatory; antioxidant; eco-friendly; drugs and diagnosis.

### 1. INTRODUCTION

The genus *Mucuna*, belonging to the Fabaceae family, sub family Papilionaceae, includes approximately 150 species of annual and perennial legumes (‘Enhanced Extraction of Levodopa from Mucuna pruriens Seeds Using Aqueous Solutions of Eutectic Solvents’, no date). Among the various under-utilized wild legumes, the velvet bean *Mucuna pruriens* is widespread in tropical and sub-tropical regions of the world. It is considered a viable source of dietary proteins [1,2,3] due to its high protein concentration (23–35%) in addition to its digestibility, which is comparable to that of other pulses such as soybean, rice bean, and lima bean [4]. It is therefore regarded as a good source of food. The dozen or so cultivated *Mucuna Spp.* found in the tropics probably result from fragmentation deriving from the Asian cultigen, and there are numerous crosses and hybrids (Bailey and Bailey, 1976). Titanium dioxide (TiO2) nanoparticles (NPs) are manufactured worldwide in large quantities for use in a wide range of applications. TiO2 NPs possess different physicochemical properties compared to their fine particle (FP) analogs, which might alter their bioactivity. A nanomaterial is defined as ‘an insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 nm to 100 nm’ (Jayasundara, no date). To date, nanotechnologies and nanomaterials have been extensively employed and the potential for growth in nanomedicine appears significant. Three principal fields of application are particularly targeted: diagnosis, drug administration, and regenerative medicine (Ross, no date). The main domains of nanoparticles in the field of dentistry globally may involve the teeth-whitening, polishing pastes for the enamel surface, dental implant coatings, dental filling, anti sensitivity agents, and the prevention of caries [5].

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| extract used to perform albumin denaturation assays and DPPH method, where % zone of inhibition increases as the concentration of nanoparticles increases. | One sector is particularly relevant to consumers: cosmetics, much of which is based on nanoparticles (NP) [6]. Cosmetics is specified as whatever substance or preparation is planned to be in contact with external parts of the human body or with mucous membranes and teeth of the buccal cavity with a view, principally or exclusively, to changing their appearance, cleaning them, flavoring them, balancing body odors, keeping them or preserving them in a healthy condition [7,8]. |
| **Results:** The Mucuna pruriens mediated titanium dioxide nanoparticle has positive antioxidant and anti-inflammatory properties. | Various studies have been done in this topic like determining the efficacies of antibacterial and antioxidant activities of aqueous leaf extract of *Psidium guajava* mediated biosynthesis of titanium dioxide nanoparticles [9,10]. Other studies have suggested that Obtaining biopeptides by enzymatic hydrolysis adds value to proteins of vegetative origin, such as *Mucuna pruriens* L. Thus it evaluated the effect of enzymatic digestion of protein derivatives obtained from *M. pruriens* L [11,12]. Similarly another experiment shows the protective effect of *M. pruriens* against arsenic-induced liver and kidney, where the experiment was divided into short-term treatment (45 days) [13,14] and long-term treatment (90 days), with each group divided into nine sub-groups consisting of six animals each. Sub-groups 1 and 2 served as normal, and N-acetylcysteine (NAC) controls, respectively. It is also used in making toothpastes as they are cosmetic hygiene products requiring daily use [15]. In the oral care market, toothpaste is the biggest part [16]. The toothpaste market was estimated in 2018 to be worth USD 26.1 billion, and it is predicted to reach USD 37.0 billion by 2024 [17] Various forms of toothpaste, such as pastes, powder, and gels, give more choice to consumers, thus propelling demand [18]. High product usage across all age groups and income is the prime element driving this segment. The use of cosmetic products containing nano-objects, such |
| **Conclusion:** The present study concluded that Mucuna pruriens mediated copper nanoparticle has good antioxidant and anti-inflammatory activity at its high concentration which is nearer to that of the standard drugs. |  |
as dentifrices containing titanium dioxide NPs, is commonly used in periodontal health [19,20].

Mouthwash is expected to show profitable growth in the coming years because of the growing professional recognition of biofilm disorganization, and their increasing use by consumers linked to oral quality of life [21]. Our team has extensive knowledge and research experience that has translate into high quality publications [22-34,26,35-41]. Although a lot of studies have been done on Titanium dioxide nanoparticles and its various activities like anti-inflammatory [42], antioxidant and anti diabetic [43,44,45], there are not many studies in the area of checking anti inflammatory and antioxidant activity of titanium dioxide nanoparticles synthesised using Mucuna pruriens, thus the present study aims to assess the antioxidant activity and anti inflammatory activity of titanium dioxide nanoparticles synthesised using Mucuna pruriens.

2. MATERIALS AND METHODS

2.1 Preparation of Mucuna pruriens Plant Extract

Mucuna pruriens seed powder was commercially purchased. 0.8g of Mucuna pruriens seed powder was diluted with 80 mL of distilled water. This solution was then boiled for 10 minutes. After boiling the solution was filtered using Whitman filter paper and was allowed to settle. This setup was kept undisturbed for 20 minutes. Then the filtrate mixture was measured and found to be 50mL. This freshly prepared plant extract was used for green synthesis.

2.2 Synthesis of Titanium Dioxide Nanoparticle

Titanium nanoparticles of 0.477g were mixed with 50mL of water and 50 mL of Mucuna pruriens extract was mixed with 50mL of the titanium nanoparticle. This solution was then placed in the laboratory shaker for the synthesis of the nanoparticle. The synthesis of nanoparticles was investigated by using the UV-Beckmann spectrometer. For every 2 hours, the solution was withdrawn from the shaker to note the reading and color change (5 times the reading was taken). This was periodically maintained until there was a proper synthesis of the copper nanoparticle. As time increased there was a gradual change in the color of the solution which was darker when compared to the initial stage. Centrifugation was carried out after the synthesis for a few minutes. After the process, the pellets were collected separately. This extract with properly synthesized nanoparticles was used to assess the antioxidant and anti-inflammatory activity of adhatoda vasica mediated copper nanoparticles.

2.3 Anti-inflammatory Activity

2.3.1 Albumin denaturation assay

The anti-inflammatory activity for Mucuna pruriens was tested by the following convention proposed by Muzushima and Kabayashi with specific alterations. 0.05 mL of Mucuna pruriens leaf extract of various fixation (10µL,20µL,30µL,40µL,50µL) was added to 0.45 mL bovine serum albumin (1% aqueous solution) and the pH of the mixture was acclimated to 6.3 utilizing a modest quantity of 1N hydrochloric acid. These samples were incubated at room temperature for 20 min and then heated at 55°C in a water bath for 30 min. The samples were cooled and the absorbance was estimated spectrophotometrically at 660 nm. Diclofenac Sodium was used as the standard. DMSO is utilized as a control.

Percentage of protein denaturation was determined utilizing following equation, % inhibition =Absorbance of control / Absorbance of sample×100/Absorbance of control.

2.4 Antioxidant Activity

DPPH assay was used to test the antioxidant activity of biogenic synthesized zinc oxide nanoparticles. Diverse concentrations (2-10 µg/mL) of Mucuna pruriens leaf extract interceded zinc oxide nanoparticle was mixed with 1 mL of 0.1 mM DPPH in methanol and 450 µl of 50 mM Tris HCl buffer (pH 7.4) and incubated for 30 minutes. Later, the reduction in the quantity of DPPH free radicals was assessed dependent on the absorbance at 517 nm. BHT was employed as control. The percentage of inhibition was determined from the following equation, % inhibition =Absorbance of control - Absorbance of test sample× 100/ Absorbance of control.
3. RESULTS

In this study the antioxidant activity was assessed in five different concentrations of reaction mixture from 10μL, 20μL, 30μL, 40μL and 50μL. Antioxidant activity of different percentages of inhibition of oxidation such as 52%, 63%, 71%, 85% and 90%. Which plant extract mediated by titanium dioxide nanoparticle at 40μL and 50μL concentration exhibited a high Antioxidant activity of 90%.

In this study the anti-inflammatory activity was assessed in five different concentrations of reaction mixture from 10μL, 20μL, 30μL, 40μL and 50μL. Anti-inflammatory activity of different percentages of inhibition such as 45%, 60%, 70%, 80% and 90%. Which plant extract mediated by titanium dioxide nanoparticles at 50 μL of concentration exhibited a high anti-inflammatory activity of 89%.

4. DISCUSSION

In a previous study and ZnO its derivatives can be widely used in various drug delivery systems, such as nanoparticle drug delivery systems, gel drug delivery systems due to its effective cytotoxic potential [46]. Our study clearly shows the biomolecule hyaluronic acid mediated silver
nanoparticles size in the range of less than 50 nm and less cytotoxic effect confirmed by brine shrimp lethality assay. Based on the present study, the Titanium dioxide nanoparticles will be used for many biomedical applications in future [47].

In another study showed that it was first one to develop an efficient protocol for the biosynthesis of Titanium dioxide nanoparticles using H. enneaspermus to highlight eco-friendly approach for commercial application of Plant based nanoparticles in agriculture as nano-bio-fertilizers and in the field of medicine [48-52]. (First Report on Marine Actinobacterial Diversity around Madras Atomic Power Station (MAPS), India, no date) [53] (Physicochemical Profile of Acacia Catechu Bark Extract – An In Vitro Stud - International Journal of Pharmaceutical and Phytopharmacological Research, no date) [54,55] (Awareness of Drug Abuse among Teenagers - International Journal of Pharmaceutical and Phytopharmacological Research, no date) [56,57] (COX2 Inhibitory Activity of Abutilon Indicum - Pharmaceutical Research and Allied Sciences, no date) [58,59-62].

5. CONCLUSION

The synthesis of titanium dioxide nanoparticles using Mucuna pruriens seed extract was successfully achieved and anti inflammatory and antioxidant assays have been performed and shown respective activities [63-72], with more effectiveness and less toxicity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Simpson AL. et al. ‘Chemotherapy-induced splenic volume increase is independently associated with major complications after hepatic resection for metastatic colorectal cancer’, Journal of the American College of Surgeons. 2015;220(3):271–280.

2. Savithri V. et al. ‘Primary Intraosseous Adenoid Cystic Carcinoma with Widespread Skeletal Metastases Showing Features of High-Grade Transformation’, Head and Neck Pathology; 2020. DOI: 10.1007/s12105-020-01228-x.

3. Jayasundara MDP. (no date) ‘Estimation of mucuna pruriens seeds before and after purification’. DOI: 10.31357/fapsmst.2010.00456.

4. Sonawane NB. et al. ‘Quality of post-operative analgesia after epidural dexmedetomidine and ketamine: A comparative pilot study’. Indian Journal of Anaesthesia. 2016;60(10):766–768.

5. Ikechukwu EL, Okafor PN, Egba SI. ‘In vitro assessment of the anti-sickling properties of Buchholzia coriacea and Mucuna pruriens seeds extracts’, In vitro cellular & developmental biology. Animal. 2020;56(9):773–782.

6. Shankar SB. et al. ‘Biosynthesis of Hydroxy Citric Acid Mediated Zinc Nanoparticles and Its Antioxidant and Cytotoxic Activity’, Journal of Pharmaceutical Research International. 2020;108–112. DOI: 10.9734/jpri/2020/v32i2030726.

7. Karthik V, Arivarasu L, Rajeshkumar S. ‘Hyaluronic Acid Mediated Zinc Nanoparticles against Oral Pathogens and Its Cytotoxic Potential’, Journal of Pharmaceutical Research International. 2020;28–32. DOI: 10.9734/jpri/2020/v32i2030726.

8. V. P. Durai Govind, A. M. S. Kumar. ‘Chemopreventive activity of Aloe vera against colorectal cancer in rats’, International Journal of Environmental Research and Public Health. 2020;17(7):3202-13.

9. P. K. Mahapatra, R. K. Panda, and S. K. Panda. ‘Antihypertensive and anti-inflammatory activity of aqueous extract of Rauwolfia serpentina root bark’, International Journal of Research in Pharmaceutical and Biological Sciences. 2015;5(3):1344-51.

10. P. K. Mahapatra, R. K. Panda, and S. K. Panda. ‘Antihypertensive and anti-inflammatory activity of aqueous extract of Rauwolfia serpentina root bark’, International Journal of Research in Pharmaceutical and Biological Sciences. 2015;5(3):1344-51.

11. P. K. Mahapatra, R. K. Panda, and S. K. Panda. ‘Antihypertensive and anti-inflammatory activity of aqueous extract of Rauwolfia serpentina root bark’, International Journal of Research in Pharmaceutical and Biological Sciences. 2015;5(3):1344-51.
12. Ross IA. (no date) 'Mucuna pruriens (L) DC', Medicinal Plants of the World. 1:305–314. DOI: 10.1385/1-59259-365-8:305.

13. Barma MD. et al. ‘Antibacterial Activity of Mouthwash Incorporated with Silica Nanoparticles against S. aureus, S. mutans, E. faecalis: An in-vitro Study’, Journal of Pharmaceutical Research International. 2020;25–33. DOI: 10.9734/jpri/2020/v32i1630646.

14. Vikneshan M. et al. ‘Algal biomass as a source for novel oral nano-antimicrobial agent’, Saudi Journal of Biological Sciences. 2020:3753–3758. DOI: 10.1016/j.sjsbs.2020.08.022.

15. Balraj S. ‘Neuroprotective Role of Diosmin on Rotenone Induced Neurotoxicity in SH-SY5Y Neuroblastoma Cells’, Bioscience Biotechnology Research Communications. 2020:1782–1787. DOI: 10.21786/bbrc/13.4/20.

16. Nasim I, Kamath K, Rajeshkumar S. ‘Evaluation of the re-mineralization capacity of a gold nanoparticle-based dental varnish: An in vitro study’, Journal of Conservative Dentistry. 2020:390. DOI: 10.4103/jcd.jcd_315_20.

17. Jaisankar Al, Arivarasu L. ‘Free Radical Scavenging and Anti-Inflammatory Activity of Chlorogenic Acid Mediated Silver Nanoparticle’, Journal of Pharmaceutical Research International. 2020:106–112. DOI: 10.9734/jpri/2020/v32i1930715.

18. ‘Herbal Sources Used by The Public Against Infections’. International Journal of Pharmaceutical Research; 2020. DOI: 10.31838/ijpr/2020/sp1.015.

19. Wu S. et al. ‘Green synthesis of copper nanoparticles using Cissus vitiginea and its antioxidant and antibacterial activity against urinary tract infection pathogens’, Artificial Cells, Nanomedicine, and Biotechnology. 2020:1153–1158. DOI: 10.1080/21691401.2020.1817053.

20. Christopher VS, Roy A, Rajeshkumar S. ‘Turmeric Oil Mediated Green Synthesis of Silver Nanoparticles and their Antioxidant Activity’, Journal of Evolution of Medical and Dental Sciences. 2021:558–561. DOI: 10.14260/jemds/2021/121.

21. Sivaraj R. et al. ‘Biosynthesis and characterization of Acalypha indica mediated copper oxide nanoparticles and evaluation of its antimicrobial and anticancer activity’. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. 2014:255–258. DOI: 10.1016/j.saa.2014.03.027.

22. Rajeshkumar S. et al. ‘Biosynthesis of zinc oxide nanoparticles using Mangifera indica leaves and evaluation of their antioxidant and cytotoxic properties in lung cancer (A549) cells’, Enzyme and Microbial Technology. 2018;117:91–95.

23. Nandhini NT, Rajeshkumar S, Mythili S. ‘The possible mechanism of eco-friendly synthesized nanoparticles on hazardous dyes degradation’, Biocatalysis and Agricultural Biotechnology. 2019;19:101-138.

24. Gomathi M. et al. ‘Green synthesis of silver nanoparticles using Gymnema sylvestre leaf extract and evaluation of its antibacterial activity’, South African Journal of Chemical Engineering. 2020;1–4. DOI: 10.1016/j.sajce.2019.11.005.

25. Rajasekaran S. et al. ‘Collective influence of 1-decanol addition, injection pressure and EGR on diesel engine characteristics fueled with diesel/LDPE oil blends’, Fuel. 2020;277:118166.

26. Vairavel M, Devaraj E, Shanmugam R. ‘An eco-friendly synthesis of Enterococcus sp.–mediated gold nanoparticle induces cytotoxicity in human colorectal cancer cells’, Environmental Science and Pollution Research, 2020;27(8):8166–8175.

27. Santhoshkumar J. et al. ‘Toxicology evaluation and antidermatophytic activity of silver nanoparticles synthesized using leaf extract of Passiflora caerulea’, South African Journal of Chemical Engineering. 2019;29:17–23.

28. Raj RK, DE, SR. ‘β-Sitosterol-assisted silver nanoparticles activates Nr2 and triggers mitochondrial apoptosis via oxidative stress in human hepatocellular cancer cell line’, Journal of Biomedical Materials Research, Part A. 2020;108(9):1899–1908.

29. Saravanan M. et al. ‘Synthesis of silver nanoparticles from Phenerochaete chrysosporium (MTCC-787) and their antibacterial activity against human pathogenic bacteria’, Microbial Pathogenesis. 2018;117:68–72.

30. Gheena S, Ezhlarasaran D. ‘Syringic acid triggers reactive oxygen species–
mediated cytotoxicity in HepG2 cells’, Human & Experimental Toxicology. 2019;38(6):694–702.
31. Ezhillarasan D, Sokal E, Najimi M. ‘Hepatic fibrosis: It is time to go with hepatic stellate cell-specific therapeutic targets’, Hepatobiliary & pancreatic diseases international: HBPD INT. 2018; 17(3):192–197.
32. Ezhillarasan D. ‘Oxidative stress is bane in chronic liver diseases: Clinical and experimental perspective’, Arab journal of gastroenterology: the official publication of the Pan-Arab Association of Gastroenterology. 2018;19(2):56–64.
33. Dua K. et al. ‘The potential of siRNA based drug delivery in respiratory disorders: Recent advances and progress’, Drug Development Research. 2019;80(6):714–730.
34. Gomathi AC, et al. ‘Anticancer activity of silver nanoparticles synthesized using aqueous fruit shell extract of Tamarindus indica on MCF-7 human breast cancer cell line’, Journal of Drug Delivery Science and Technology. 2020:55:101-376.
35. Ramesh A. et al. ‘Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study’, Journal of Periodontology. 2018;89(10):1241–1248.
36. Duraisamy R. et al. ‘Compatibility of Nonoriginal Abutments With Implants: Evaluation of Microgap at the Implant-Abutment Interface, With Original and Nonoriginal Abutments’, Implant dentistry, 2019;28(3):289–295.
37. Ezhillarasan D, Apoorva VS, Ashok Vardhan N. ‘Syzygium cumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells’, Journal of oral pathology & medicine: official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology. 2019;48(2):115–121.
38. Arumugam P, George R, Jayaseelan VP. ‘Aberations of m6A regulators are associated with tumorigenesis and metastasis in head and neck squamous cell carcinoma’, Archives of Oral Biology. 2021;122:105-030.
39. Joseph B, Prasanth CS. ‘Is photodynamic therapy a viable antiviral weapon against COVID-19 in dentistry?’, Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2021:118–119.
40. Gnanavel V, Roopan SM, Rajeshkumar S. ‘Aquaculture: An overview of chemical ecology of seaweeds (food species) in natural products’, Aquaculture. 2019:507:1–6.
41. Markov A. et al. ‘Mesenchymal stem/stromal cells as a valuable source for the treatment of immune-mediated disorders’, Stem Cell Research & Therapy. 2021;12(1):192.
42. Rajeshkumar S. et al. ‘Employing sulphated polysaccharide (fucoidan) as medium for gold nanoparticles preparation and its anticancer study against HepG2 cell lines’, Materials Today Communications. 2021:101-975.
43. DOI: 10.1016/j.mtcomm.2020.101975.
44. Akash N, Arivarasu L, Rajeshkumar S. ‘Anti-inflammatory and Antioxidant Potential of Hyaluronic Acid Mediated Zinc Nanoparticles’, Journal of Pharmaceutical Research International. 2020:33–37.
DOI: 10.9734/jpri/2020/v32i2030727.
45. Devaraj E. et al. ‘β-Sitosterol attenuates carbon tetrachloride–induced oxidative stress and chronic liver injury in rats’, Naunyn-Schmiedeberg’s Archives of Pharmacology. 2020:1067–1075.
DOI: 10.1007/s00210-020-01810-8.
46. Niveditha AS. et al. ‘Will Alternative Medicine Help Us to Fight Against COVID-19’, International Journal of Current Research and Review. 2020:112–116.
DOI: 10.31782/ijcrr.2020.sp47.
47. Caledelas C. et al. ‘Effect of ZnO nanoparticles on Zn, Cu, and Pb dissolution in a green bioretention system for urban stormwater remediation’, Chemosphere. 2021;282:131-045.
48. Rahali S. et al. ‘Adsorption Behavior of Congo Red onto Barium-Doped ZnO Nanoparticles: Correlation between Experimental Results and DFT Calculations’, Langmuir: the ACS Journal of Surfaces and Colloids; 2021.
DOI: 10.1021/acs.langmuir.1c00378.
49. Patra C. et al. Biogenic Nanoparticles for Cancer Theranostics. Elsevier; 2021.
50. Pushpaanjali G, Geetha RV, Lakshmi T. ‘Knowledge and Awareness about Antibiotic Usage and Emerging Drug Resistance Bacteria among Dental Students’, Journal of Pharmaceutical Research International. 2020:34–42.
50. Aathira CM, Geetha RV, Lakshmi T. 'Knowledge and Awareness about the Mode of Transmission of Vector Borne Diseases among General Public'. Journal of Pharmaceutical Research International. 2020:87–96.

51. Baskar K, Lakshmi T. ‘Knowledge, Attitude and Practices Regarding HPV Vaccination among Undergraduate and Postgraduate Dental Students in Chennai’, Journal of Pharmaceutical Research International. 2020:95–100.

52. Manya Suresh LT. ‘Wound Healing Properties of Aloe Barbadensis Miller-In Vitro Assay’, Journal of Complementary Medicine Research. 2020;11(5):30–34.

53. First Report on Marine Actinobacterial Diversity around Madras Atomic Power Station (MAPS), India (no date). Available: http://alinteridergisi.com/article/first-report-on-marine-actinobacterial-diversity-around-madras-atomic-power-station-india/ (Accessed: 31 August 2021).

54. Lakshmi T. ‘Antifungal Activity of Ficus racemosa Ethanolic Extract against Dermatophytes-An in vitro Study’, Journal of Research in Medical and Dental Science. 2021;9(2):191–193.

55. Physicochemical Profile of Acacia catechu Bark Extract – An in Vitro Stud - International Journal of Pharmaceutical and Phytopharmacological Research (no date). Available: https://ejppr.com/article/physicochemical-profile-of-acacia-catechu-bark-extract-an-in-vitro-stud (Accessed: 31 August 2021).

56. Awareness of Drug Abuse among Teenagers - International Journal of Pharmaceutical and Phytopharmacological Research (no date). Available: https://ejppr.com/article/awareness-of-drug-abuse-among-teenagers (Accessed: 31 August 2021).

57. Mangal CSK, Anitha R, Lakshmi T. 'Inhibition of Nitric oxide Production and Nitric oxide Synthase Gene Expression in LPS Activated RAW 264.7 Macrophages by Thyme oлеoresin from Thymus vulgaris', Journal of Young Pharmacists: JYP. 2018;10(4):481

58. COX2 Inhibitory Activity of Abutilon Indicum - Pharmaceutical Research and Allied Sciences (no date). Available: https://ijpras.com/article/cox2-inhibitory-activity-of-abutilon-indicum (Accessed: 31 August 2021).

59. Jibu RM, Geetha RV, Lakshmi T. ‘Isolation, Detection and Molecular Characterization of Staphylococcus aureus from Postoperative Infections’, Journal of Pharmaceutical Research International. 2020:63–67.

60. Sinhdu PK, et al. ‘Anorectic drugs: an experimental and clinical perspective -A Review’, Journal of Complementary Medicine Research. 2020;11(5):106–112.

61. Nivethitha R. et al. 'In Vitro Anticancer Effect of Sesamum Indicum Extract ', Journal of Complementary Medicine Research. 2020;11(5):99–105.

62. Mariona P, Roy A, Lakshmi T. ‘Survey on lifestyle and food habits of patients with PCOS and obesity’, Journal of Complementary Medicine Research. 2020;11(5):93–98.

63. Rajendran R. et al. ‘Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study’, Pesquisa brasileira em odontopediatria e clinica integrada, 2019;19(0):4668.

64. Ashok BS, Ajith TA, Sivanesan S. ‘Hypoxia-inducible factors as neuroprotective agent in Alzheimer’s disease’, Clinical and Experimental Pharmacology & Physiology. 2017;44(3). DOI: 10.1111/1440-1801.12717.

65. Malli SN, et al. ‘Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases’, Case Reports in Dentistry; 2019. DOI: 10.1155/2019/7046203.

66. Mohan M, Jagannathan N. ‘Oral field cancerization: an update on current concepts’, Oncology Reviews. 2014;8(1). DOI: 10.4081/oncol.2014.244.

67. Menon S, et al. ‘Selenium nanoparticles: A potent chemotherapeutic agent and an elucidation of its mechanism’, Colloids and surfaces. B, Biointerfaces. 2018:170. DOI: 10.1016/j.colsurfb.2018.06.006.

68. Samuel SR, Acharya S, Rao JC. ‘School Interventions-based Prevention of Early-Childhood Caries among 3-5-year-old children from very low socioeconomic status: Two-year randomized trial’, Journal of Public Health Dentistry. 2020;80(1).
69. Praveen K. et al. ‘Hypotensive anaesthesia and blood loss in orthognathic surgery: a clinical study’, The British Journal of Oral & Maxillofacial Surgery. 2001;39(2). DOI: 10.1054/bjom.2000.0593.

70. Neelakantan P. et al. ‘The impact of root dentine conditioning on sealing ability and push-out bond strength of an epoxy resin root canal sealer’, International Endodontic Journal. 2011;44(6).

71. ‘Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases’. Chemico-biological interactions. 2019; 308:206–215.

72. Kumar MS. et al. ‘Expression of matrix metalloproteinases (MMP-8 and -9) in chronic periodontitis patients with and without diabetes mellitus’, Journal of Periodontology. 2006;77(11):1803–1808.

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