SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980

ANTI-INFLAMMATORY ACTIVITY OF SOLANUM XANTHOCARPUM INDUCED WITH SILVER NANOPARTICLES- AN IN VITRO STUDY

Swathi UB
Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India, Mail Id :swathiudayabhanu95@gmail.com

Sindhu Ramesh
Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India, Mail Id :sindhuramesh@saveetha.com

S.Rajesh Kumar
Department of Pharmacology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India
Mail id: ssrajeshkumar@hotmail.com

Abstract

Introduction

Inflammation is the primary response of the body against an infection or an injury and it is very essential when it comes to our immunity. It is important to understand about the anti-inflammatory drugs that are available in the market due to the growing prominence of pain and pain-related conditions. This study deals with the anti-inflammatory activity of silver nanoparticles which are synthesized using Solanum Xanthocarpum fruit extract.

Materials and Methods

25 grams of dried fruit powder of Solanum Xanthocarpum was mixed with 250 ml of water..25 ml of plant filtrate was added into 225 ml of aqueous solution of 1mM silver nitrate for reduction of silver nitrate into Ag+ ions and kept at room temperature for 24 hours in a rotating shaker at 28 degree C.After preparation of the silver nanoparticles using Solanum Xanthocarpum fruit extract the anti-inflammatory activity was assessed.

Results

This research provokes the inflammatory action of silver nanoparticles produced from the plant extracts. It is shown that Solanum Xanthocarpum induced with Silver nanoparticles has a significant inhibitory activity.

Conclusion

The silver nanoparticles synthesized using the fruit extract Solanum Xanthocarpum showed excellent anti-inflammatory activity.

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980
Keywords: Anti-inflammatory Activity; Silver nanoparticles; Solanum xanthocarpum;Fruit extract;Plant extract.

Introduction

Inflammation is a set of interactions that occur between soluble factors and cells and can arise in any tissue in response to autoimmune, traumatic, infectious, toxic, post-ischemic injuries.(Kirtikar & Basu, 1935; Kolattukudy & Niu, 2012; Nathan, 2002) Inflammation can be treated with non-steroidal and steroidal anti-inflammatory drugs (NSAIDs).(Cannon, 2006) NSAIDs are the most widely used classes of medications.All NSAIDs can cause serious side-effects, including stomach ulcers, gastrointestinal bleeding, kidney failure, heart attacks and strokes.Traditional medicinal plants can be used for the treatment of inflammation.(Calixto, Otuki, & Santos, 2003)

Solanum xanthocarpum (Solanaceae) is a prickly diffuse bright green perennial herb and is commonly known as Yellow Berried Nightshade (Kaṇṭakāri),it is woody at the base, with height of 2-3 m and is found throughout India.(Pardhi, Jain, Ganeshpurkar, & Rai, 2010)

It is a commonly used drug in Ayurveda.Solanum. Xanthocarpum is bitter,it is acrid, thermogenic, anthelmintic, anti-inflammatory, digestive, carminative, appetizer, stomachic, febrifuge, expectorant, laxative, stimulant, diuretic, rejuvenating, emmenagogue,aphrodisiac.(Roshy, Ilanchezhian, & Patgiri, 2012) Alkaloids, sterols, saponins, flavonoids and their glycosides ,carbohydrates, fatty acids ,amino acids are present in the plant.(Singh & Singh, 2010)

Various activities are reported in solanum xanthocarpum plant include hepatoprotective,(Govindan, Viswanathan, Vijayasekaran, & Alagappan, 1999; Gupta, Sharma, Sharma, Dobhal, & Gupta, 2012; Hussain, Gupta, Sweety, Eswaran, et al., 2012; Hussain, Gupta, Sweety, Khan, et al., 2012; Kar, Maharana, Pattnaik, & Dash, 2006; Poongothai, Ponmurugan, Ahmed, Kumar, & Sheriff, 2011) anti-asthmatic,(Lugun, Bhoi, Kujur, Kumar, & Surin, 2018) antidiabetic,(N. Kumar, Prakash, & Kumar, 2010; Sultana, Khanam, & Devi, 2011) antioxidant, immunomodulatory, wound healing, diuretic, antispermatogenic, antifertility, antipyretic, anticancer, anti-allergic,anthelmintic,antimicrobial.(Gavimath et al., 2012; Patel, Patel, Saralai, & Gandhi, 2012; Purohit, 1992; Salar, 2009) Extract of dried fruits of S. xanthocarpum and its combination with extract of dried fruits of Cassia fistula are reported to possess anti-inflammatory activity.(Anwikar & Bhitre, 2010)

Previously our team had a rich experience in working on various research projects across multiple disciplines; (Azeem & Sureshbabu, 2018; Felicita, 2017; Felicita, Chandrasekar, & Shanthasundari, 2012; A. R. Jain, 2017; Krishnan & Lakshmi, 2013; M. S. Kumar, Vamsi, Sripriya, & Sehgal, 2006; Mp, 2017; Patturaja, 2016; Rao & Kumar, 2018; Sekar, Lakshmanan,

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980
Mani, & Biruntha, 2019; Sivamurthy & Sundari, 2016).The aim of this study was to evaluate anti-inflammatory activity of solanum xanthocarpum when induced with silver nanoparticles.

Materials and Methods

Collection of Plant Materials

Fruit of Solanum xanthocarpum was collected from Tamilnadu, India. The collected plant materials were brought to the laboratory for plant extraction and for synthesis of silver nanoparticles.

Processing of Plant Materials

The fruit was separated from the plant, washed thoroughly then cut into small pieces for quick drying. Cleaned fruits were shade dried for a duration of 10-15 days. The dried plant materials were then crushed into fine powder with an electric grinder. Finally the fine powder was stored in an airtight container at room temperature.

Preparation of Solanum Xanthocarpum Aqueous Fruit Extract

25 grams of dried Solanum xanthocarpum fruit powder was mixed with 250 ml of water. The solution was stirred for proper mixing. Then the solution was placed in a rotating shaker (100rpm) at room temperature for 48 hours (2 days). After incubation, the extract was filtered in Whatman No: 1 filter paper. Finally the filtrate was allowed to air dry at room temperature and dried powder was stored at 4 degree C until use.

Synthesis of Silver Nanoparticles from Fruit Extract

25 ml of plant filtrate was added into 225 ml of aqueous solution of 1mM silver nitrate (AgNO) for reduction of silver nitrate into Ag+ ions and kept at room temperature for 24 hours in a rotating shaker at 28 degree C and the solution was kept in the dark to avoid biological changes. There was reduction of silver ions to metallic silver during silver nanoparticles production.Silver nanoparticles were determined by the change in colour of the reaction mixture.

Synthesis of Nanoparticles Powder

Lark refrigerated centrifuge was used for centrifugation of the nanoparticles. The solution of silver nanoparticles is centrifuged at 8000rpm for 10 minutes and the pellet is collected and washed with distilled water twice. The final purified pellet is collected and dried at 60 degree Celsius for 2-4 hours. Solanum xanthocarpum induced silver nanoparticles powder was collected and stored in an airtight eppendorf tube.

Inhibition of Albumin Denaturation Assay

Bovine serum albumin (BSA) was used as a reagent .BSA makes up approximately 60% of all proteins in animal serum. It is commonly used in cell culture. BSA undergoes denaturation on heating and starts expressing antigens associated with type 3 hypersensitivity reactions which

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980

are related to diseases such as rheumatoid arthritis, glomerulonephritis, serum sickness, and systemic lupus erythematosus.2 ml of 1% bovine albumin fraction was mixed with 400 µL of plant crude extract in different concentrations (500–100 µg/mL), pH of the reaction mixture was suggested to 6.8 using 1N HCL. The reaction mixture was incubated at room temperature for 20 min and then heated at 55○C for 20 min in a water bath.

The mixture was cooled to room temperature after which absorbent values was recorded at 660 nm. Different concentrations of diclofenac sodium were used as standard.
% Inhibition :
percentage of inhibition =Control OD -Sample OD/Control OD ×100

Statistical Analysis
The results of the test were described as means ± the standard deviation and analyzed using the UV-Vis Spectroscopy.

Results
Visual Observation
The fruit extract of Solanum Xanthocarpum incorporated with silver nanoparticles was visually observed [Figure 1]. It turned into a brown color extract which was indicated
with the formation of silver nanoparticles.

Color Change
The synthesized Ag nanoparticles were confirmed by naked observation. Production of Ag nanoparticles takes place by the reduction of silver ions during exposure to the plant followed by color change. Within 2 hours the silver ions get reduced and it exhibits colorless to dark reddish brown colour.This color change is due to the Surface Plasmon Resonance (SPR) phenomenon.

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980

Figure 1:Colour change observed before and after addition of silver nanoparticles

UV-VIS Spectra Analysis

There was an increase in the intensity of the silver nanoparticles solution. Wavelength between 400-450nm the formation of silver nanoparticles reach the peak maximum.(Figure 2)The specific characteristic peak for silver nanoparticles was due to the SPR.The UV-Visible spectrum shows the formation of silver nanoparticles of aqueous fruit extract as the peak maxima in 440 nm.This is characteristic to silver nanoparticles and the broadening of peak indicated that the particles were polydispersed.

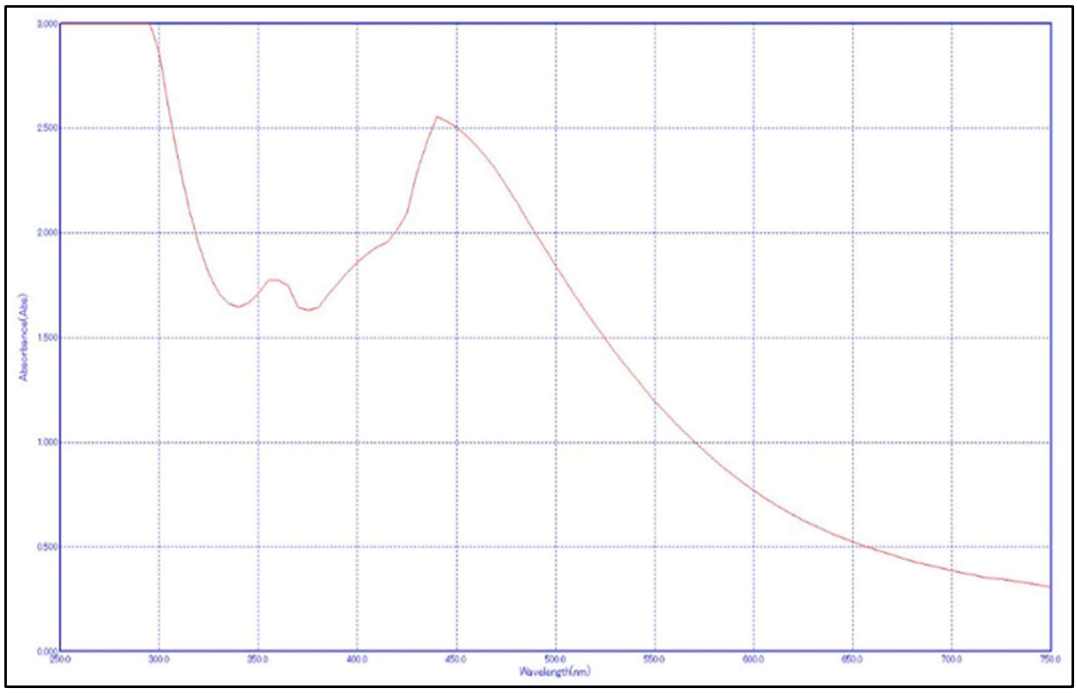

Figure 2: UV-vis spectrograph of Ag nanoparticle synthesized from Solanum

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7094980

xanthocarpum aqueous fruit extract

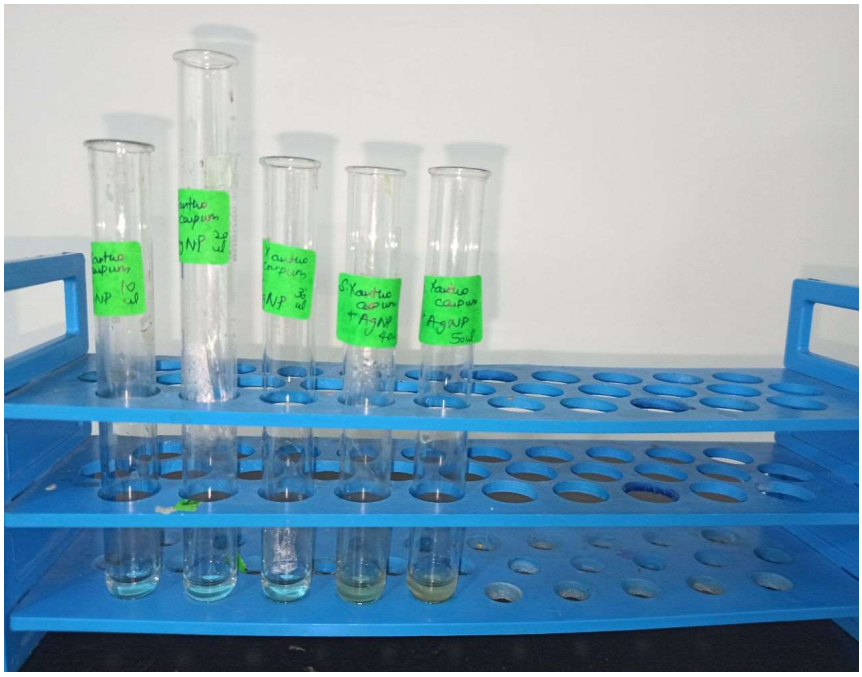

Figure 3: Color change observed in test tubes

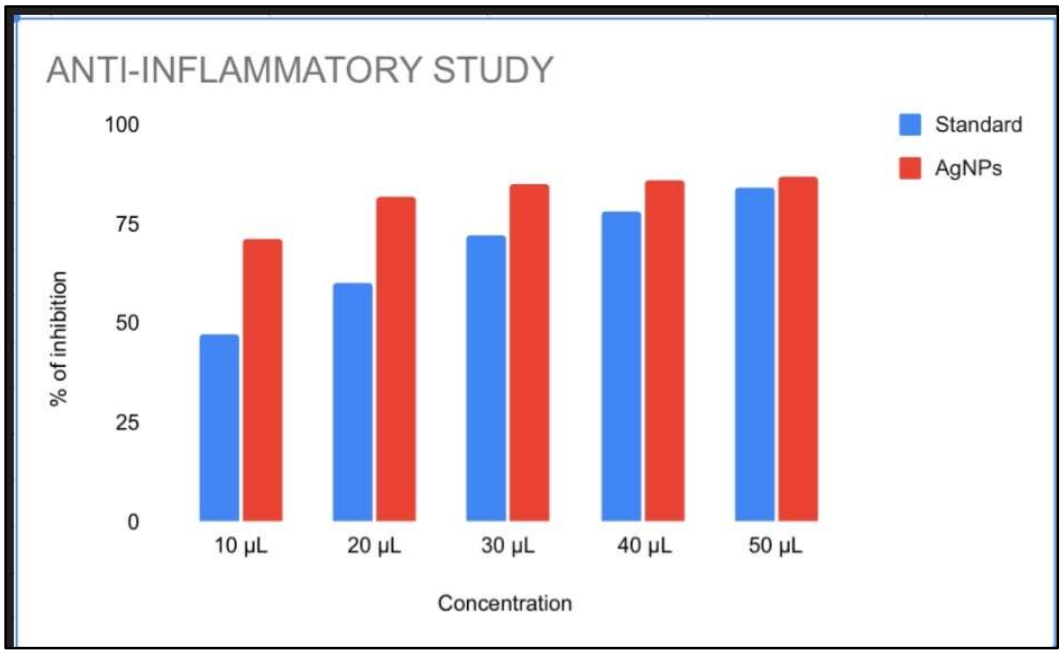

Figure 4 :Graphical representation of Results

Discussion

Protein denaturation can cause an inflammatory response to the cells. (Perumal, Inapagolla, Kannan, & Kannan, 2008) BSA was used as a reagent for the assay. 60% of total protein content in animal serum is constituted from BSA alone, and is commonly used in cell culture,

DOI: 10.5281/zenodo.7094980

particularly when protein supplementation is necessary and the other components of serum are unwanted.(Elisha, Dzoyem, McGaw, Botha, & Eloff, 2016) BSA undergoes denaturation when exposed to heat, and expresses antigens associated with Type III hypersensitivity reaction, which are related to diseases such as glomerulonephritis, rheumatoid arthritis.(Elisha et al., 2016)

Our institution is passionate about high quality evidence based research and has excelled in various fields.(R. K. Jain, Kumar, & Manjula, 2014; Johnson et al., 2019; Keerthana & Thenmozhi, 2016; Lakshmi, Krishnan, Rajendran, & Madhusudhanan, 2015; Neelakantan, Subbarao, Subbarao, De-Deus, & Zehnder, 2011)

This research provokes the inflammatory action of silver nanoparticles produced from the plant extracts.It is shown that Solanum Xanthocarpum induced with Silver nanoparticles has a significant inhibitory activity.

Conclusion

This research provokes the inflammatory action of silver nanoparticles produced from the plant extract. The silver nanoparticles synthesized using the fruit extract Solanum Xanthocarpum showed excellent anti-inflammatory activity.Further research is required in knowing the benefits of these plants and also the mechanism behind their action. This study thus provides a strong base for understanding the anti-inflammatory activity of silver nanoparticles synthesized from solanum Xanthocarpum fruit extract.

Acknowledgement

With Sincere gratitude, we acknowledge the staff members of the department of Conservative Dentistry and
Endodontics and Saveetha Dental College for their extended support towards the completion of the research.

Conflicts of Interest

There are no conflicts of interest.

References

- Anwikar, S., & Bhitre, M. (2010). Study of the synergistic anti-inflammatory activity of Solanum xanthocarpum Schrad and Wendl and Cassia fistula Linn. *International Journal of Ayurveda Research*, *1*(3), 167–171.
- Azeem, R. A., & Sureshbabu, N. M. (2018). Clinical performance of direct versus indirect composite restorations in posterior teeth: A systematic review. *Journal of Conservative Dentistry: JCD*, *21*(1), 2.
- Calixto, J. B., Otuki, M. F., & Santos, A. R. S. (2003). Anti-inflammatory compounds of plant origin. Part I. Action on arachidonic acid pathway, nitric oxide and nuclear

factor kappa B (NF-kappaB). *Planta Medica*, *69*(11), 973–983.

- Cannon, J. G. (2006). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 11th Edition Edited by Laurence Brunton, John Lazo, and Keith Parker. McGraw Hill, New York. 2005. xxiii 2021 pp. 21 × 26 cm. ISBN 0-07-142280-3. $149.95. *Journal of Medicinal Chemistry*, Vol. 49, pp. 1222–1222. https://doi.org/10.1021/jm058286b
- Elisha, I. L., Dzoyem, J.-P., McGaw, L. J., Botha, F. S., & Eloff, J. N. (2016). The anti-arthritic, anti-inflammatory, antioxidant activity and relationships with total phenolics and total flavonoids of nine South African plants used traditionally to treat arthritis. *BMC Complementary and Alternative Medicine*, Vol. 16. https://doi.org/10.1186/s12906-016-1301-z
- Felicita, A. S. (2017). Quantification of intrusive/retraction force and moment generated during en-masse retraction of maxillary anterior teeth using mini-implants: A conceptual approach. *Dental Press Journal of Orthodontics*, *22*(5), 47–55.
- Felicita, A. S., Chandrasekar, S., & Shanthasundari, K. K. (2012). Determination of craniofacial relation among the subethnic Indian population: a modified approach - (Sagittal relation). *Indian Journal of Dental Research: Official Publication of Indian Society for Dental Research*, *23*(3), 305–312.
- Gavimath, C. C., Kulkarni, S. M., Raorane, C. J., Kalsekar, D. P., Gavade, B. G., Ravishankar, B. E., & Hooli, R. S. (2012). Antibacterial potentials of Solanum indicum, Solanum xanthocarpum and Physalis minima. *Int J Pharma Appl*, *3*, 414–418.
- Govindan, S., Viswanathan, S., Vijayasekaran, V., & Alagappan, R. (1999). A pilot study on the clinical efficacy of Solanum xanthocarpum and Solanum trilobatum in bronchial asthma. *Journal of Ethnopharmacology*, *66*(2), 205–210.
- Gupta, R., Sharma, A. K., Sharma, M. C., Dobhal, M. P., & Gupta, R. S. (2012). Evaluation of antidiabetic and antioxidant potential of lupeol in experimental hyperglycaemia. *Natural Product Research*, Vol. 26, pp. 1125–1129. https://doi.org/10.1080/14786419.2011.560845
- Hussain, T., Gupta, R. K., Sweety, K., Eswaran, B., Vijayakumar, M., & Rao, C. V. (2012). Nephroprotective activity of Solanum xanthocarpum fruit extract against gentamicin–induced nephrotoxicity and renal dysfunction in experimental rodents. *Asian Pacific Journal of Tropical Medicine*, *5*(9), 686–691.
- Hussain, T., Gupta, R. K., Sweety, K., Khan, M. S., Hussain, M. S., Arif, … Rao, C. V. (2012). Evaluation of antihepatotoxic potential of Solanum xanthocarpum fruit extract against antitubercular drugs induced hepatopathy in experimental rodents. *Asian Pacific Journal of Tropical Biomedicine*, *2*(6), 454–460.
- Jain, A. R. (2017). Prevalence of Partial Edentulousness and treatment needs in Rural Population of South India. *World Journal of Dentistry*, *8*(3), 213–217.
- Jain, R. K., Kumar, S. P., & Manjula, W. S. (2014). Comparison of intrusion effects on maxillary incisors among mini implant anchorage, j-hook headgear and utility arch.

Journal of Clinical and Diagnostic Research: JCDR, *8*(7), ZC21–ZC24.

- Johnson, J., Lakshmanan, G., Biruntha, M., Vidhyavathi, R. M., Kalimuthu, K., & Sekar, D. (2019). Computational identification of MiRNA-7110 from pulmonary arterial hypertension (PAH) ESTs: a new microRNA that links diabetes and PAH. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *43*(4), 360–362.
- Kar, D. M., Maharana, L., Pattnaik, S., & Dash, G. K. (2006). Studies on hypoglycaemic activity of Solanum xanthocarpum Schrad. & Wendl. fruit extract in rats. *Journal of Ethnopharmacology*, *108*(2), 251–256.
- Keerthana, B., & Thenmozhi, M. S. (2016). Occurrence of foramen of huschke and its clinical significance. *Journal of Advanced Pharmaceutical Technology & Research*, *9*(11), 1835.
- Kirtikar, K., & Basu, B. D. (1935). Indian medicinal plants. *Indian Medicinal Plants.* Retrieved from https://www.cabdirect.org/cabdirect/abstract/20057004287
- Kolattukudy, P. E., & Niu, J. (2012). Inflammation, endoplasmic reticulum stress, autophagy, and the monocyte chemoattractant protein-1/CCR2 pathway. *Circulation Research*, *110*(1), 174–189.
- Krishnan, V., & Lakshmi, T. (2013). Bioglass: A novel biocompatible innovation. *Journal of Advanced Pharmaceutical Technology & Research*, *4*(2), 78–83.
- Kumar, M. S., Vamsi, G., Sripriya, R., & Sehgal, P. K. (2006). Expression of matrix metalloproteinases (MMP-8 and -9) in chronic periodontitis patients with and without diabetes mellitus. *Journal of Periodontology*, *77*(11), 1803–1808.
- Kumar, N., Prakash, D., & Kumar, P. (2010). *Wound healing activity of Solanum xanthocarpum Schrad. & Wendl. fruits*. Retrieved from http://nopr.niscair.res.in/handle/123456789/10815
- Lakshmi, T., Krishnan, V., Rajendran, R., & Madhusudhanan, N. (2015). Azadirachta indica: A herbal panacea in dentistry - An update. *Pharmacognosy Reviews*, *9*(17), 41–44.
- Lugun, O., Bhoi, S., Kujur, P., Kumar, D. V., & Surin, W. R. (2018). Evaluation of Antithrombotic Activities of Solanum xanthocarpum and Tinospora cordifolia. *Pharmacognosy Research*, *10*(1), 98–103.
- Mp, S. K. (2017). THE EMERGING ROLE OF BOTULINUM TOXIN IN THE TREATMENT OF OROFACIAL DISORDERS: LITERATURE UPDATE. *Asian Journal of Pharmaceutical and Clinical Research*, 21–29.
- Nathan, C. (2002). Points of control in inflammation. *Nature*, *420*(6917), 846–852.
- Neelakantan, P., Subbarao, C., Subbarao, C. V., De-Deus, G., & Zehnder, M. (2011). The impact of root dentine conditioning on sealing ability and push-out bond strength of an epoxy resin root canal sealer. *International Endodontic Journal*, *44*(6), 491–498.
- Pardhi, P., Jain, A. P., Ganeshpurkar, A., & Rai, G. (2010). Anti-microbial, Anti-oxidant and Anthelmintic Activity of Crude Extract of Solanum xanthocarpum. *Pharmacognosy Journal*, *2*(11), 400–404.

DOI: 10.5281/zenodo.7094980

- Patel, P., Patel, M., Saralai, M., & Gandhi, T. (2012). Antiurolithiatic Effects of Solanum xanthocarpum Fruit Extract on Ethylene-Glycol-Induced Nephrolithiasis in Rats. *Journal of Young Pharmacists: JYP*, *4*(3), 164–170.
- Patturaja, K. P. (2016). Awareness of Basic Dental Procedure among General Population. *Research Journal of Pharmacy and Technology; Raipur*, *9*(9), 1349–1351.
- Perumal, O. P., Inapagolla, R., Kannan, S., & Kannan, R. M. (2008). The effect of surface functionality on cellular trafficking of dendrimers. *Biomaterials*, Vol. 29, pp. 3469–3476. https://doi.org/10.1016/j.biomaterials.2008.04.038
- Poongothai, K., Ponmurugan, P., Ahmed, K. S. Z., Kumar, B. S., & Sheriff, S. A. (2011). Antihyperglycemic and antioxidant effects of Solanum xanthocarpum leaves (field grown & in vitro raised) extracts on alloxan induced diabetic rats. *Asian Pacific Journal of Tropical Medicine*, *4*(10), 778–785.
- Purohit, A. (1992). Contraceptive efficacy of solanum xanthocarpum berry in male rats. *Ancient Science of Life*, *12*(1-2), 264–266.
- Rao, T. D., & Kumar, M. P. S. (2018). Analgesic efficacy of paracetamol vs ketorolac after dental extractions. *Journal of Advanced Pharmaceutical Technology & Research*, *11*(8), 3375.
- Roshy, J. C., Ilanchezhian, R., & Patgiri, B. J. (2012). Therapeutic potentials of kantakari (Solanum xanthocarpum Schrad. & Wendl.). *Ayurpharm Int J Ayur Alli Sci*, *1*(2), 46–53.
- Salar, R. K. (2009). Evaluation of antimicrobial potential of different extracts of Solanum xanthocarpum Schrad. and Wendl. *African Journal of Microbiology Research*. Retrieved from https://academicjournals.org/journal/AJMR/article-abstract/1CA4BE812246
- Sekar, D., Lakshmanan, G., Mani, P., & Biruntha, M. (2019). Methylation-dependent circulating microRNA 510 in preeclampsia patients. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *42*(10), 1647–1648.
- Singh, O. M., & Singh, T. P. (2010). Phytochemistry of Solanum xanthocarpum: an amazing traditional healer. *Journal of Scientific and Industrial Research*. Retrieved from http://nopr.niscair.res.in/handle/123456789/10295
- Sivamurthy, G., & Sundari, S. (2016). Stress distribution patterns at mini-implant site during retraction and intrusion—a three-dimensional finite element study. *Progress in Orthodontics*, *17*(1), 1–11.
- Sultana, R., Khanam, S., & Devi, K. (2011). Immunomodulatory effect of methanol extract of Solanum xanthocarpum fruits. *International Journal of Life Science and Pharma Research*, *2*(2), 93–97.