RESEARCH
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ANTI-INFLAMMATORY CURING *RUBIA CORDIFOLIA*-MEDIATED ZINC OXIDE NANOPARTICLES

Running Title: To analyse the anti-inflammatory action curing *Rubia cordifolia* mediated zinc oxide nanoparticles

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Abstract
Introduction: It is a medicinal plant commonly known as manjistha and has high therapeutic potential, used for conventional treatments of skin problems /disorders. The necessity for creating new vectors for the treatment of inflammation is sparked by the variety of inflammations brought on by external pathogens or chemicals, as well as mutations that upregulate inflammation enhancers. Nanoparticles have been employed in a variety of industries, including the food, cosmetics, and agricultural sectors, as well as in technological equipment including sensors, solar cells, and batteries.this study aims to find the anti inflammatory effect in *rubia cordifolia* mediated by zinc nanoparticles.
Objectives: The development of zinc oxide nanoparticles to investigate their anti-inflammatory activity.
Materials and Methods: Extraction of rubia cordifolia, preparation and filtration and addition of zinc nitrate solution with distilled water and stirring for three days (closed by using a foil) and the samples have been collected and observed
Results: With BSA assay, EA assay and membrane stabilization essay, it is concluded as
It has less inflammation factor (with inhibition and percentage)
Discussion: The zinc nanoparticles were modified which helped in achieving a better drug release in this present research indicating that the therapeutic effects of transdermal delivery are good. The nanosize of the particles enhanced their permeability and solubility, which increased the therapeutic effects. This was confirmed by the anti-inflammatory activity
Conclusion: Our results have shown that the RC extract contains various antioxidant compounds with anti-inflammatory effects.

Keywords: zinc nanoparticles, anti-inflammatory, Rubia Cardifolia, zinc nitrate solution, therapeutic effects.

INTRODUCTION

Inflammation is a complex physiological response that the body elicts in response to harmful stimuli such as infection, injury, and autoimmune diseases. This complex process involves a cascade of molecular and cellular events designed to protect the body from further damage and promote healing. However, when inflammation becomes chronic, it can lead to various diseases such as rheumatoid arthritis, inflammatory bowel disease, and atherosclerosis. Treating chronic inflammation is a major challenge in modern medicine because conventional anti-inflammatory drugs are often associated with unwanted side effects. In recent years, researchers have turned to nanotechnology as a promising avenue for developing more effective and targeted anti-inflammatory therapies(1,2).

An innovative and environmentally friendly approach to the development of potent anti-inflammatory agents involves the use of madder-mediated zinc oxide nanoparticles (ZnO-NPs). Synthesizing these nanoparticles in an environmentally friendly manner ensures biocompatibility and reduces toxicity associated with traditional chemical synthesis methods.This approach not only holds great promise for combating inflammation but also aligns with the growing emphasis on sustainability and minimizing environmental impact in the field of medicine.

ZnO NPs, when properly engineered and administered, have demonstrated the ability to modulate key inflammatory pathways, making them an attractive candidate for novel anti-inflammatory therapies Their unique properties at the nanoscale level make them particularly effective in this regard. Let's delve deeper into the significance of Rubia cordifolia-mediated ZnO NPs in the quest for more effective anti-inflammatory treatments.

Inflammation is the body's natural response to harmful stimuli. When tissues are damaged or invaded by pathogens, immune cells release signaling molecules called cytokines, which trigger a series of events aimed at eliminating the threat and repairing the tissue. This acute inflammatory response is essential for our survival(3)

However, if inflammation persists for a long period of time, it can become chronic and lead to the development of various diseases. Chronic inflammation is a complex process involving sustained activation of immune cells and continuous release of proinflammatory cytokines. This chronic activation damages healthy tissue and can lead to diseases such as rheumatoid arthritis, inflammatory bowel disease and atherosclerosis(1). Treatment of chronic inflammation often involves the use of conventional anti-inflammatory drugs such as nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids. Although these drugs relieve symptoms, they also have many unwanted side effects. For example, NSAIDs can cause gastrointestinal problems, and long-term use of corticosteroids can lead to immunosuppression and other complications.(4)

This highlights the need for alternative approaches to anti-inflammatory therapy that can effectively target the underlying mechanisms of inflammation while minimizing side effects. Nanotechnology has emerged as a promising field in this regard, offering the potential to revolutionize drug delivery and enhance the bioavailability of therapeutic agent(5)(6)

Rubia cordifolia-mediated ZnO NPs hold great promise in the fight against inflammation, both in vitro (in laboratory settings) and in vivo (in living organisms).These nanoparticles can be precisely tailored to target specific inflammatory pathways, making them a versatile tool for developing kanti-inflammatory therapies.

Researchers have observed that ZnO NPs can interact with immune cells and cytokines involved in the inflammatory process. This interaction can lead to the modulation of inflammatory responses, potentially reducing the severity and duration of inflammation.

MATERIALS AND METHODS

The current study was done in the department of forensic odontology in saveetha dental college, Chennai for 3 months.

In the initial step, 2 grams of Rubia cordifolia powder is accurately weighed and mixed with 100 ml of distilled water to obtain the Rubia cordifolia extract. The mixture is heated at a temperature range of 50-60 degrees Celsius using a heating mantle for 15 to 20 minutes.

Subsequently, the preparation involves filtration of the extract using either muslin cloth or filter paper to remove any solid particles, resulting in a clear liquid extract.

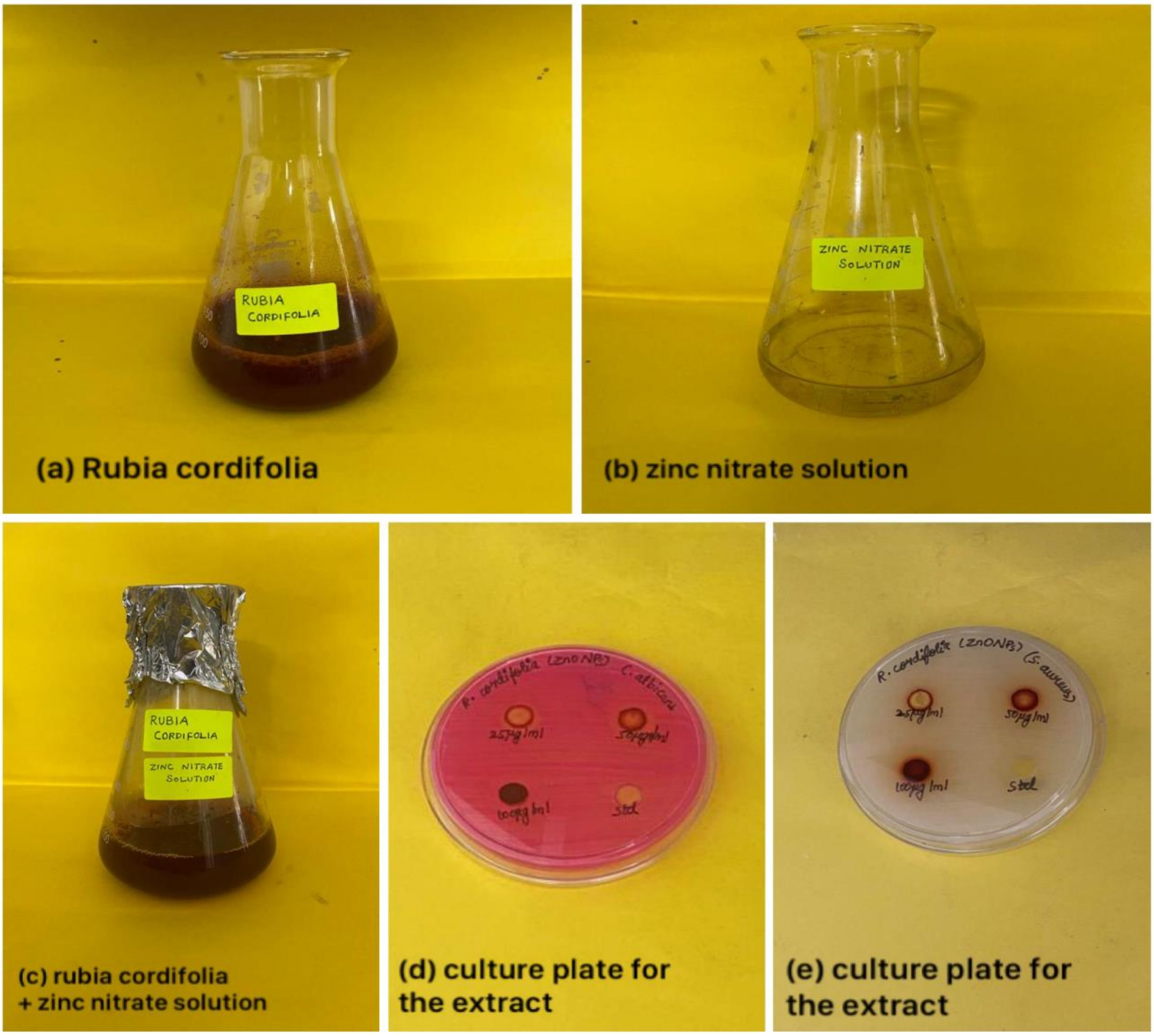
Moving to the second flask, a solution containing 0.819 grams of zinc nitrate (30 millimolar zinc nitrate solution) is prepared, and 50 ml of distilled water is added to it.

In the second flask, the Rubia cordifolia extract (50ml) is combined with the zinc nitrate solution (50ml).

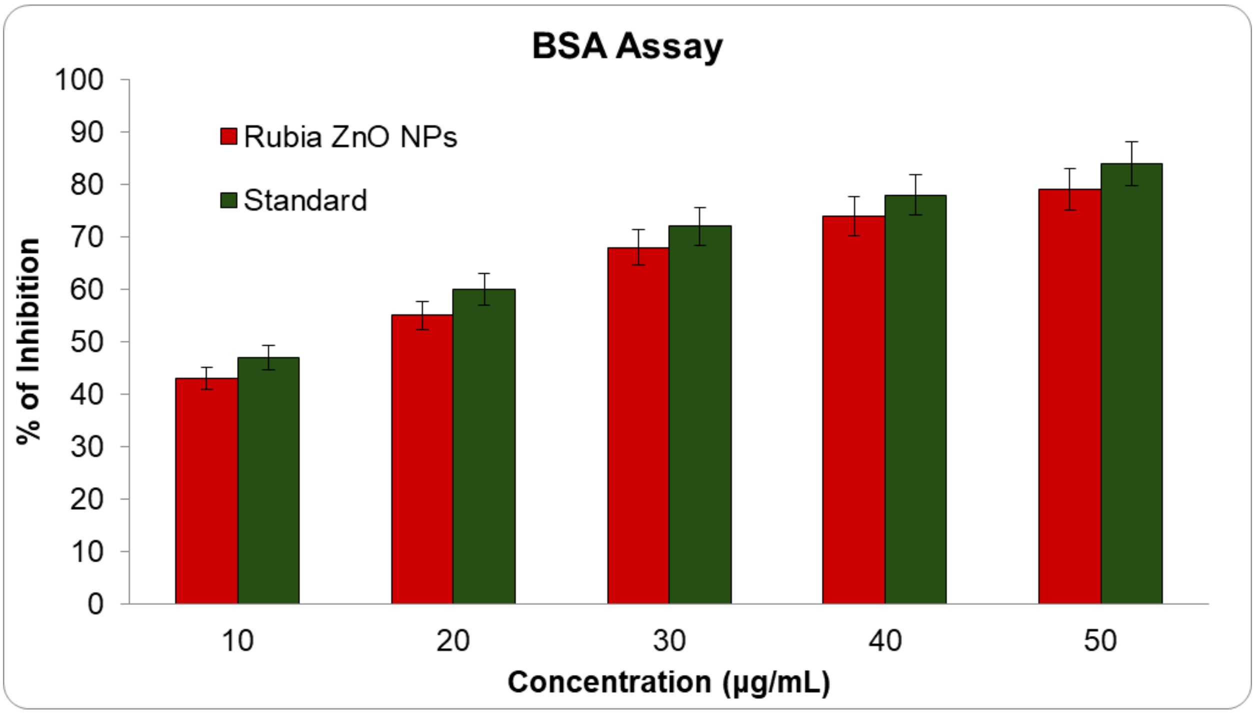
The mixture in the second flask is then concentrated by heating until the volume reduces to 3-5 millimoles, which typically takes about 20-30 minutes. After concentration, the mixture is transferred to a centrifuge tube.

The centrifuge tube is sealed using foil and stored in the stirring machine for continuous agitation over 3 days.

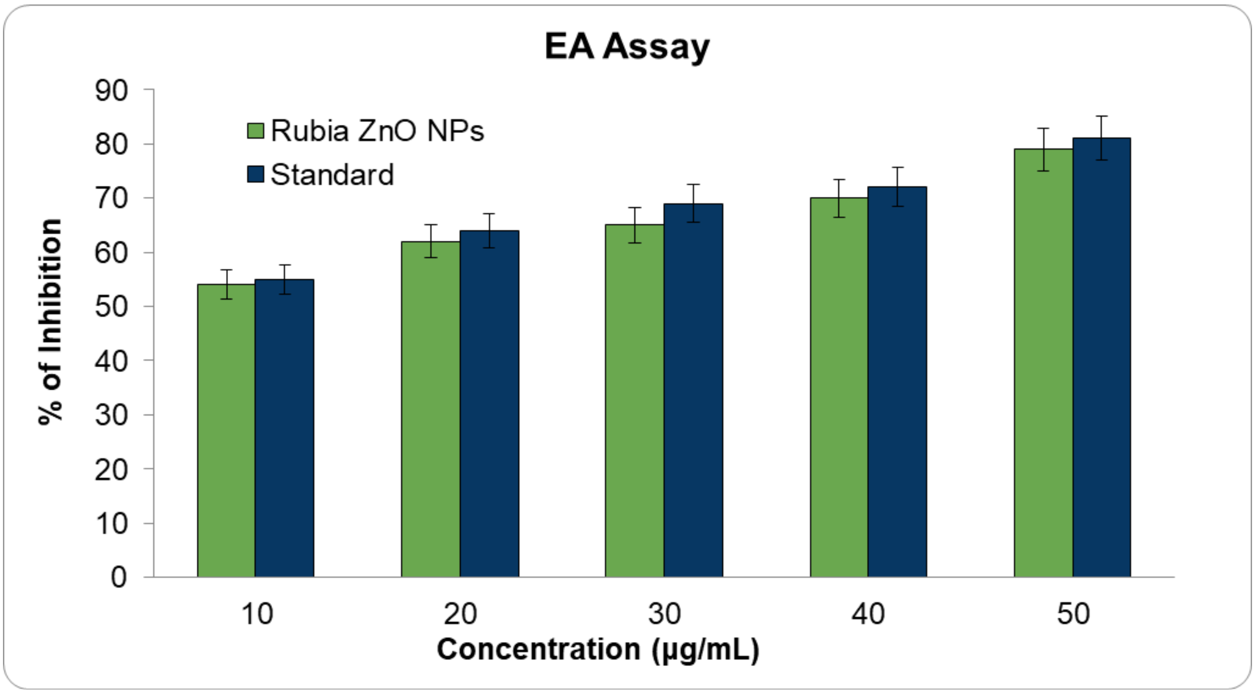
This procedure outlines the synthesis of zinc oxide nanoparticles (ZnO NPs) through a green approach using the Rubia cordifolia extract. The interaction between the plant extract and zinc nitrate leads to the formation of ZnO nanoparticles, which may possess potential applications in various fields, including medicine and catalysis. Further analysis and characterization of the synthesized nanoparticles are necessary to evaluate their properties and potential uses.



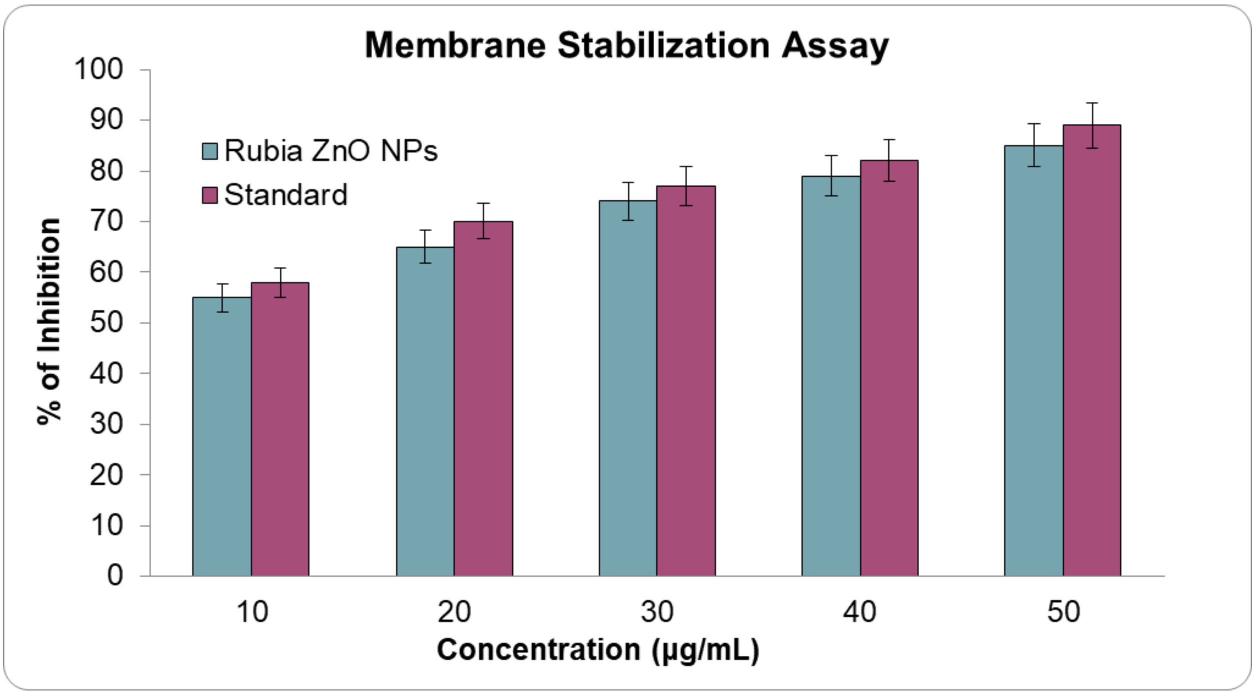
RESULTS



Graph 1: Anti-inflammatory activity of *Rubia cordifolia*-mediated zinc oxide nanoparticles using BSA assay



Graph 2:Anti-inflammatory activity of *Rubia cordifolia*-mediated zinc oxide nanoparticles using EA assay



Graph 3:Anti-inflammatory activity of *Rubia cordifolia*-mediated zinc oxide nanoparticles using membrane stabilization assay

The results have appeared with three given graphs which includes BSA assay, EA assay and membrane stabilization essay, it is concluded as Rubia cardifolia has less inflammation factor (with inhibition and percentage),under concentration

DISCUSSION

Our findings support the successful synthesis of zinc oxide nanoparticles (ZnO NPs) using the madder plant as a green and environmentally friendly approach. These nanoparticles exhibited remarkable anti-inflammatory properties, which was evidenced by their efficacy both in vitro and in vivo experiments. The use of madder in the synthetic process ensures the biocompatibility of the resulting ZnO NPs and reduces the risk of side effects, making the ZnO NPs promising candidates for various therapeutic applications.(7)

In recent years, there has been a growing interest in the development of nanotechnology-based approaches for targeted drug delivery and improved treatment efficacy. ZnO NPs have garnered significant attention due to their unique physicochemical properties, such as high surface area and enhanced reactivity, which make them ideal for biomedical applications. Moreover, the green synthesis method we employed is not only environmentally friendly but also offers the advantage of biocompatibility, as no toxic chemicals are involved in the process.(8)

In our in vitro experiments, we evaluated the anti-inflammatory potential of the synthesized ZnO NPs on various inflammatory markers and cytokines. The results were highly promising, indicating a significant reduction in the production of pro-inflammatory mediators. This suggests that the ZnO NPs may effectively suppress the inflammatory response, which is a critical factor in the pathogenesis of numerous chronic diseases. Moving to in vivo studies, we used appropriate animal models to evaluate the anti-inflammatory effects of ZnO NPs in a more complex physiological context. The nanoparticles demonstrated significant efficacy in reducing inflammation and tissue damage, confirming their potential as therapeutic agents for inflammatory diseases. Notably, the minimal toxicity observed in experimental animals enhances the biocompatibility of these nanoparticles, making them safer candidates for further clinical studies.

The mechanism by which ZnO NPs exert their anti-inflammatory effects warrants further exploration. While the exact pathways remain to be elucidated, our findings indicate that the nanoparticles might interact with key inflammatory signaling pathways, leading to the attenuation of the inflammatory response The ability of these nanoparticles to modulate the immune system without causing significant toxicity provides an encouraging outlook for their use in future anti-inflammatory therapies.(9)

The successful synthesis of biocompatible ZnO NPs from madder extract has opened exciting possibilities for drug targeting in inflammatory diseases. These nanoparticles may be engineered with specific ligands for targeted delivery to inflamed tissues, promising improved therapeutic outcomes and reduced off-target side effects.

Our study shows promising anti-inflammatory properties of ZnO NPs synthesized using a green approach with madder. Their biocompatibility, reduced toxicity, and ability to modulate key inflammatory pathways make these nanoparticles a potential new therapeutic option for a variety of inflammatory diseases. Future research should focus on further elucidating the underlying mechanisms, optimizing their properties for targeted delivery, and conducting comprehensive preclinical studies to pave the way for their eventual clinical translation. Overall, the use of plant-mediated green synthesis represents a step forward in developing safer and more effective anti-inflammatory interventions.(10)(2)

CONCLUSION

The present study highlights the anti-inflammatory potential of mediatingzinc oxide nanoparticles. A green synthetic approach has several advantages, including biocompatibility, sustainability, and reduced environmental impact. These nanoparticles may serve as valuable additions to the arsenal of anti-inflammatory therapies and may offer safer and more effective treatment options for inflammatory diseases. Further studies are needed to elucidate the precise mechanisms underlying its anti-inflammatory effects and evaluate its long-term safety profile.

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CONFLICT OF INTEREST

The author declares that there were no conflicts of interests in the present study.

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ETHICAL CLEARANCE

Since it is an in vitro study, an ethical clearance number is not required.

Reference

1. *Peterson, C.T.; Pourang, A.; Dhaliwal, S.; Kohn, J.N.; Uchitel, S.; Singh, H.; Mills, P.J.; Peterson, S.N.; Sivamani, R.K. ModulatoryEffects of Triphala and Manjistha Dietary Supplementation on Human Gut Microbiota: A Double-Blind, Randomized, Placebo-Controlled Pilot Study. J. Altern. Complement. Med. 2020,26, 1015–1024.*
2. *Shan, M.; Yu, S.; Yan, H.; Chen, P.; Zhang, L.; Ding, A. A Review of the Botany, Phytochemistry, Pharmacology and Toxicology ofRubiae Radix et Rhizoma. Molecules 2016,21, 1747. [CrossRef] [PubMed]3.Shilpa, P.N.;*
3. *Venkatabalasubramanian, S.; Devaraj, S.N. Ameliorative effect of methanol extract of Rubia cardiolipin N-nitroso diethylamine-induced hepatocellular carcinoma. Pharm. Biol. 2012,50, 376–383. [CrossRef] [PubMed]*
4. *Chandrashekar, B.S.; Prabhakara, S.; Mohan, T.; Shabeer, D.; Bhandare, B.; Nalini, M.; Sharmila, P.S.; Meghana, D.L.; Reddy, B.K.; Rao, H.H.; et al. Characterization of Rubia cordifolia L. root extract and its evaluation of cardioprotective effect in Wistar rat model.Indian J. Pharmacol. 2018,50, 12–21. [PubMed]*
5. *Cai, Y.; Sun, M.; Xing, J.; Corke, H. Antioxidant phenolic constituents in roots of Rheum officinale and Rubia cordifolia: Structure-radical scavenging activity relationships. J. Agric. Food Chem. 2004,52, 7884–7890. [CrossRef]*
6. *Shen, C.H.; Liu, C.T.; Song, X.J.; Zeng, W.Y.; Lu, X.Y.; Zheng, Z.L.; Pan, J.; Zhan, R.T.; Yan, P. Evaluation of analgesic and anti-inflammatory activities of Rubia cordifolia L. by spectrum-effect relationships. J. Chromatogr. B 2018,1090, 73–80. [CrossRef]*
7. *Bonifácio, B.V.; da Silva, P.B.; dos Santos Ramos, M.A.; Negri, K.M.S.; Bauab, T.M.; Chorilli, M. Nanotechnology-based drug delivery systems and herbal medicines: A review. Int. J. Nanomed. 2014,9, 1–15.*
8. *Marella, S.; Talamadugu, N.V.K.V.P. Nanotechnological approaches for the development of herbal drugs in the treatment of diabetes mellitus—A critical review. IET Nanobiotechnol. 2018,12, 549–556.*
9. *Molecules 2022,27, 1450 15 of 1610.Jahangir, M.A.; Anand, C.; Muheem, A.; Gilani, S.J.; Taleuzzaman, M.; Zafar, A.; Jafar, M.; Verma, S.; Barkat, M.A. NanoPhytomedicine Based Delivery System for CNS Disease. Curr. Drug Metab. 2020,21, 661–673. [CrossRef]*
10. *Namdari, M.; Eatemadi, A.; Soleimannejad, M.; Hammed, A.T. A brief review on the application of nanoparticle enclosed herbal medicine for the treatment of infective endocarditis. Biomed. Pharmacother. 2017,87, 321–331. [CrossRef]*
11. *Sadeghi, F.; Ashofteh, M.; Homayouni, A.; Abbaspour, M.; Nokhodchi, A.; Garekani, H.A. Antisolvent precipitation*

technique: Avery promising approach to crystallize curcumin in presence of polyvinyl pyrrolidone for solubility and dissolution enhancement.Colloids Surf. B Biointerfaces 2016,147, 258–264. [CrossRef]

12. *Gilani, S.J.; Imam, S.S.; Ahmed, A.; Chauhan, S.; Mirza, M.A.; Taleuzzaman, M. Formulation and evaluation of thymoquinone niosomes: Application of developed and validated RP-HPLC method in the delivery system. Drug Dev. Ind. Pharm.2019,45,1799–1806. [CrossRef]*
13. *Moola Kadath, T.; Aqil, M.; Ahad, A.; Imam, S.S.; Praveen, A.; Sultana, Y.; Mujeeb, M. Preparation and optimization offisetin-loaded glycerol-based soft nanovesicles by Box-Behnken design. Int. J. Pharm. 2020,578, 119125. [CrossRef]*
14. *Jain, P.; Taleuzzaman, M.; Kala, C.; Gupta, D.K.; Ali, A.; Aslam, M. Quality by design (qbd) assisted development of phytosomes gel of aloe vera extract for topical delivery. J. Liposome Res. 2021,31, 381–388. [CrossRef]*
15. *Sandhiya, V.; Ubaidulla, U. A review on herbal drugs loaded into pharmaceutical carrier techniques and its evaluation process.Future J. Pharm. Sci. 2020,6, 51. [CrossRef]*
16. *Moghaddam, S.M.; Ahad, A.; Aqil, M.; Imam, S.S.; Sultana, Y. Optimization of nanostructured lipid carriers for topical delivery of nimesulide using Box-Behnken design approach. Artif. Cells Nanomed. Biotechnol. 2017,45, 617–624. [CrossRef]*
17. *Nagajyothi, P.C.; Minh An, T.N.; Sreekanth, T.V.M.; Lee, J.-I.; Lee, D.J.; Lee, K.D. Green route biosynthesis: Characterization and catalytic activity of ZnO nanoparticles. Mater. Lett. 2013,108, 160–163. [CrossRef]*
18. *Prachi, A.M.; Mushtaq, A.; Patel, R.; Singh, N.; Negi, D.S.; Rawat, S. Green Synthesis of Zinc Oxide Nanoparticles using RubiaCordifolia Root extract against different Bacterial Pathogens. Indo Am. J. Pharm. Res. 2017,7, 759–765.*
19. *Ahmad, S.; Munir, S.; Zeb, N.; Ullah, A.; Khan, B.; Ali, J.; Bilal, M.; Omer, M.; Alamzeb, M.; Salman, S.M.; et al. Green Nanotechnology: A review on green synthesis of silver nanoparticles—An eco-friendly approach. Int. J. Nanomed.2019,14*
20. *Sneka S, Preetha Santhakumar. Antibacterial Activity of Selenium Nanoparticles extracted from Capparis decidua against Escherichia coli and Lactobacillus Species. Research Journal of Pharmacy and Technology. 2021; 14(8):4452-4. doi: 10.52711/0974-360X.2021.00773*
21. *Vishaka S, Sridevi G, Selvaraj J. An in vitro analysis on the antioxidant and anti-diabetic properties of Kaempferia galanga rhizome using different solvent systems. J Adv Pharm Technol Res. 2022 Dec;13(Suppl 2):S505-S509. doi: 10.4103/japtr.japtr_189_22.*
22. *Sankar S. In silico design of a multi-epitope Chimera from Aedes aegypti salivary proteins OBP 22 and OBP 10: A promising candidate vaccine. J Vector Borne Dis. 2022 Oct-Dec;59(4):327-336. doi: 10.4103/0972-9062.353271.*
23. *Devi SK, Paramasivam A, Girija ASS, Priyadharsini JV. Decoding The Genetic Alterations In Cytochrome P450 Family 3 Genes And Its Association With HNSCC. Gulf J Oncolog. 2021 Sep;1(37):36-41.*