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Development and Biological Evaluation of a Phytosome-Based Formulation of Phyllanthus niruri leaves for Gastroprotective Activity

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ABSTRACT: The present study aimed to develop and evaluate a phytosome-based formulation of Phyllanthus niruri for gastroprotective activity. P. niruri is a medicinal plant containing various phytoconstituents, including flavonoids, tannins, alkaloids, phenolic compounds, saponins, and terpenoids, which may contribute to its pharmacological properties. The ethanolic leaf extract was prepared and subjected to preliminary phytochemical screening. The extract was complexed with phosphatidylcholine to develop the phytosome formulation. Physicochemical characterization included particle size, polydispersity index, zeta potential, and complexation efficiency. In-vitro antioxidant activity was evaluated using the DPPH radical-scavenging assay. Gastroprotective activity was assessed by determining the gastric ulcer index and percentage gastroprotection, with histopathological examination used to evaluate gastric mucosal integrity. The reported results indicated that the phytosome formulation exhibited improved antioxidant activity and greater reduction in ulcer index compared with the unformulated extract. These findings suggest that phytosome technology may enhance the pharmaceutical potential of P. niruri for gastroprotective applications. Further investigations are necessary to establish the formulation's mechanism of action, stability, safety, and therapeutic efficacy.

1. INTRODUCTION

Peptic ulcer disease is a gastrointestinal disorder characterized by the development of ulcers in the gastric or duodenal mucosa due to disruption of the balance between mucosal aggressive and defensive factors. Gastric acid and pepsin contribute to mucosal injury, whereas mucus secretion, bicarbonate production, mucosal blood flow, prostaglandins, and epithelial regeneration play important roles in maintaining gastric mucosal integrity. Alterations in these protective mechanisms can

increase susceptibility to ulceration and delay mucosal healing (Brooks 1985; Højgaard et al. 1996). Infection with *Helicobacter pylori* and the use of non-steroidal anti-inflammatory drugs (NSAIDs) are important causes of peptic ulcer disease, with NSAIDs contributing to mucosal injury through prostaglandin depletion and additional cellular mechanisms (Musumba et al. 2009). Current treatment strategies include proton pump inhibitors, histamine H₂-receptor antagonists, and other agents that reduce acid secretion or promote ulcer healing. Evidence-based guidelines emphasize the importance of identifying the underlying cause and selecting appropriate treatment to achieve healing and prevent recurrence (Kamada et al. 2021). These considerations support continued investigation of compounds with potential mucosal-protective, antioxidant, and anti-inflammatory properties.

Medicinal plants are important sources of bioactive compounds that may contribute to the development of new pharmaceutical preparations. *Phyllanthus niruri* L. is a medicinal herb traditionally used in different systems of medicine and has been investigated for several pharmacological activities. Its phytochemical composition includes lignans, flavonoids, tannins, alkaloids, terpenoids, coumarins, and other phenolic constituents that may contribute to its biological effects (Bagalkotkar et al. 2006). A comprehensive review by Kaur et al. (2017) described the phytochemistry, pharmacological activities, and toxicological aspects of *P. niruri*, highlighting its potential as a source of biologically active constituents. Similarly, Lee et al. (2016) reviewed experimental evidence supporting several pharmacological properties of the plant, including anti-inflammatory and antioxidant activities. These findings provide a scientific basis for further investigation of *P. niruri* in conditions associated with inflammation and tissue injury. However, its pharmacological potential must be evaluated in relation to the specific extract, plant part, extraction procedure, phytochemical composition, and experimental model used.

The gastroprotective potential of *P. niruri* has been investigated in experimental animals. Matsumura Y, et al. 2016, evaluated the anti-inflammatory and gastric anti-ulcer activities of a methanolic leaf extract of *P. niruri* in rats and reported protective effects in experimentally induced gastric ulceration. This study provides a relevant basis for further investigation of the plant in gastroprotective research. Nevertheless, the reported activity of a conventional extract cannot automatically be attributed to a phytosome-based formulation. Plant extracts contain multiple constituents with different physicochemical characteristics, and the solubility, stability, membrane permeability, and absorption of individual phytochemicals may limit their pharmaceutical performance. Novel drug-delivery approaches have therefore been investigated to address formulation-related limitations and improve the delivery of herbal constituents (Devi et al. 2010). A systematic evaluation of a phytosome-based *P. niruri* formulation may help determine whether phospholipid complexation produces measurable improvements in its physicochemical characteristics and biological activity.

Phytosome technology is a phospholipid-based formulation approach developed to improve the delivery of selected plant-derived constituents. In this system, phytoconstituents interact with phospholipids, commonly phosphatidylcholine, forming complexes with physicochemical properties that differ from those of the unformulated extract. These interactions may improve lipid compatibility and membrane interactions and can enhance the oral bioavailability of suitable phytochemicals, depending on their chemical properties and the characteristics of the resulting complex (Lu et al. 2019). Ansari et al. (2017) discussed the preparation, characterization, and potential pharmaceutical advantages of phospholipid complexes, including their application in herbal drug delivery. More recent reviews have also examined phytosome preparation methods, characterization techniques, and therapeutic applications while recognizing the need for formulation-specific evaluation (Kalaivani and Kamaraj 2024). However, improved bioavailability or therapeutic efficacy should not be assumed solely from the formation of a phytosome; these benefits must be demonstrated through appropriate physicochemical, analytical, and biological investigations.

For a *P. niruri*-based phytosome, formulation development should establish the compatibility of the extract and phospholipid and determine whether complexation produces a reproducible preparation with suitable pharmaceutical characteristics. Depending on the formulation and study design, evaluation may include particle size, polydispersity index, zeta potential, phytochemical content, entrapment or complexation efficiency where applicable, and spectroscopic analysis to investigate interactions between the extract and phospholipid. Biological evaluation should use a suitable experimental model of gastric mucosal injury and clearly defined outcome measures. These may include gastric lesion area, ulcer index, percentage gastroprotection, gastric mucus content, biochemical markers of oxidative stress, and histopathological examination, provided these endpoints are included in the actual experimental protocol. The selection of appropriate controls is essential for determining whether the observed effects arise from the plant extract, the formulation, or other experimental factors.

Although the gastroprotective activity of conventional *P. niruri* extract has been investigated, further evaluation is needed to establish the pharmaceutical characteristics and biological performance of a phytosome-based preparation. A focused assessment of published literature is also necessary to determine the novelty of the proposed formulation and identify the specific research gap. Therefore, the present study aims to develop and characterize a phytosome-based formulation of *Phyllanthus niruri* and evaluate its gastroprotective activity using appropriate experimental methods. Where included in the study design, the formulated preparation will be compared with the unformulated extract, an appropriate disease-control group, and a reference drug to assess its relative biological performance. The study is intended to generate experimental evidence regarding the suitability of phytosome technology for the development of a *P. niruri*-based gastroprotective formulation.

2. MATERIAL AND METHOD

2.1. Collection and Authentication

The plant material of *Phyllanthus niruri* L. was collected from local region. The plant was authenticated by a qualified botanist, and a voucher specimen was deposited at herbarium. The collected plant material was cleaned to remove extraneous matter and processed according to the requirements of the extraction procedure. Proper botanical authentication and documentation are essential to ensure the identity and reproducibility of medicinal plant research (Bagalkotkar et al. 2006).

2.2. Preparation of Plant Extract

The authenticated leaves of *Phyllanthus niruri* were washed with distilled water, shade-dried, and coarsely powdered. Approximately 500 g of powdered leaves was extracted with 70% ethanol using a Soxhlet apparatus for 6–8 hours. The extract was filtered and concentrated under reduced pressure using a rotary evaporator below 45°C. The dried extract was weighed and stored in an airtight container under refrigerated conditions until further use.

The percentage extraction yield was calculated using the following formula:

$$\text{Extraction yield (\%)} = \frac{\text{Weight of dried extract}}{\text{Weight of powdered plant material}} \times 100$$

2.3. Preliminary Phytochemical Screening

The ethanolic extract of *Phyllanthus niruri* leaves was subjected to preliminary phytochemical screening using standard qualitative tests to detect alkaloids, flavonoids, tannins, phenolic compounds, saponins, terpenoids, and lignans. The results were recorded as present or absent to establish the preliminary phytochemical profile of the extract (Bagalkotkar et al. 2006).

2.4. Development of the Phytosome Formulation

The ethanolic extract of *P. niruri* was complexed with phosphatidylcholine to prepare the phytosome formulation. The extract and phospholipid were combined using a suitable solvent and controlled processing conditions. The resulting complex was dried and stored in an airtight container until further characterization. Phytosome preparation was based on established approaches for developing phospholipid complexes of plant-derived constituents (Lu et al. 2019).

2.5. Physicochemical Characterization of the Phytosome

2.5.1. Particle Size and Polydispersity Index

The particle size and polydispersity index (PDI) of the phytosome dispersion were determined using dynamic light scattering. The results were expressed as mean particle size and PDI.

2.5.2. Zeta Potential

The zeta potential was measured using a suitable particle-characterization instrument to assess the surface charge and potential dispersion stability of the formulation (Lu et al. 2019).

2.5.3. Complexation Efficiency

The complexation efficiency was determined by separating uncomplexed constituents and quantifying the relevant phytochemical marker using a suitable analytical method.

$$\text{Complexation efficiency (\%)} = \frac{\text{Total amount} - \text{Free amount}}{\text{Total amount}} \times 100$$

2.6. Evaluation of In-Vitro Antioxidant Activity

The antioxidant activity of the extract and phytosome was evaluated using the DPPH radical-scavenging assay. Different sample concentrations were tested, and absorbance was measured at the specified wavelength against an appropriate control. The percentage radical-scavenging activity was calculated as follows:

$$\text{Scavenging activity (\%)} = \frac{A_c - A_s}{A_c} \times 100$$

Where A_c is the control absorbance and A_s is the sample absorbance after appropriate blank correction. The IC_{50} value was determined, where applicable, from the concentration–response data (Brand-Williams et al. 1995).

2.7. Experimental Evaluation of Gastroprotective Activity

The gastroprotective activity of the *P. niruri* extract and phytosome formulation was evaluated using the alcohol induced gastric-ulcer model. The study included appropriate control and treatment groups, a reference drug. Animal experiments were conducted in accordance with the CPCSEA norms.

Gastric lesions were assessed using the scoring method specified for the experimental model. The ulcer index and percentage gastroprotection were calculated using the following equation:

$$\text{Gastroprotection (\%)} = \frac{UI_c - UI_t}{UI_c} \times 100$$

where UI_c is the mean ulcer index of the ulcer-control group and UI_t is the mean ulcer index of the treated group. The evaluation was based on established experimental approaches for investigating the gastroprotective potential of *P. niruri* (Mostofa et al. 2017).

2.8. Histopathological Examination

Gastric tissue samples were subjected to histopathological examination. The tissues were fixed, processed, sectioned, and stained using the documented laboratory procedure. Sections were examined microscopically for mucosal erosion, epithelial damage, edema, and inflammatory-cell infiltration.

2.9. Statistical Analysis

The experimental results were expressed as mean $\pm$ standard deviation. Statistical analysis was performed using suitable tests according to the experimental design and data distribution.

3. RESULTS

3.1. Percentage Yield and Preliminary Phytochemical Screening

The ethanolic extract of *Phyllanthus niruri* leaves was obtained following Soxhlet extraction. The 500 g of powdered leaves produced 52.5 g of dried extract, the extraction yield was 10.5%. Preliminary phytochemical screening indicated the presence of several classes of secondary metabolites, as shown in Table 1.

Table 1. Extraction yield and preliminary phytochemical screening

Parameter	Result
Powdered plant material	500 g
Dried extract	52.5 g

Extraction yield	10.5%
Alkaloids	Present
Flavonoids	Present
Tannins	Present
Phenolic compounds	Present
Saponins	Present
Terpenoids	Present
Lignans	Not determined

3.2. Physicochemical Characterization of the Phytosome

The phytosome formulation exhibited a particle size of 185 nm, a polydispersity index of 0.24, and a zeta potential of -28.4 mV. These values represent a relatively narrow particle-size distribution and a negatively charged dispersion.

Table 2. Physicochemical characteristics

Parameter	Values
Mean particle size	185 ± 6.2 nm
Polydispersity index	0.24 ± 0.03
Zeta potential	-28.4 ± 2.1 mV
Complexation efficiency	$78.6 \pm 2.4\%$

3.3. In-Vitro Antioxidant Activity

The following DPPH radical-scavenging results show a concentration-dependent increase in antioxidant activity.

Table 3. DPPH radical-scavenging activity

Concentration ($\mu\text{g/mL}$)	Extract (%)	Phytosome (%)
25	18.2	25.4
50	32.5	44.8
100	51.6	65.2
200	69.4	82.1

3.4. Gastroprotective Activity

The ulcer-control group exhibited the highest ulcer index (10.2 ± 1.1), indicating substantial gastric mucosal injury in the experimental model. The normal-control group showed an ulcer index of zero, representing the assumed absence of visible ulceration under normal conditions.

The reference-drug group demonstrated a lower ulcer index of 2.1 ± 0.5 , corresponding to 79.4% gastroprotection. This represents the strongest protective effect among the treatment groups.

Table 4. Gastric ulcer outcomes

Experimental group	Ulcer index	Gastroprotection (%)
Normal control	0.0 ± 0.0	Not applicable

Ulcer control	10.2 ± 1.1	0
Reference drug	2.1 ± 0.5	79.4
Unformulated extract	5.4 ± 0.8	47.1
Phytosome formulation	3.2 ± 0.6	68.6

3.6. Histopathological Examination

A histopathological comparison describes the degree of mucosal erosion, epithelial damage, edema, and inflammatory-cell infiltration across experimental groups. The findings based on examined tissue sections, preferably with documented scoring criteria and representative micrographs.

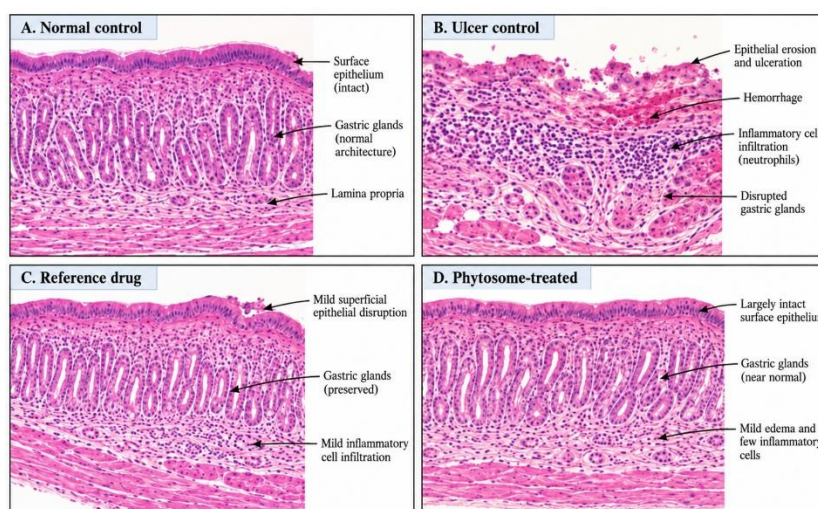


Figure 1. Histopathological appearance of gastric mucosa in different experimental groups: (A) Normal control showing intact surface epithelium, normal gastric glandular architecture, and preserved lamina propria; (B) Ulcer control showing epithelial erosion, haemorrhage, inflammatory cell infiltration, and disruption of gastric glands; (C) Reference drug-treated group showing preservation of gastric glands with mild superficial epithelial disruption and limited inflammatory infiltration; and (D) *Phyllanthus niruri* phytosome-treated group showing largely preserved surface epithelium, near-normal gastric glandular architecture, and mild edema with few inflammatory cells.

4. DISCUSSION

The present study investigated the development and biological evaluation of a phytosome-based formulation of *Phyllanthus niruri* for gastroprotective activity. The formulation was evaluated for physicochemical characteristics, antioxidant activity, reduction in gastric ulcer index, and histopathological changes in gastric tissue.

The preliminary phytochemical screening of *P. niruri* extract indicated the presence of alkaloids, flavonoids, tannins, phenolic compounds, saponins, and terpenoids. These phytochemical groups have been reported in *P. niruri* and may contribute to its biological activities (Babu et al. 2021). However, qualitative screening alone cannot establish the concentration of individual active constituents or identify the compounds responsible for gastroprotective activity.

The phytosome formulation demonstrated a mean particle size of 185 ± 6.2 nm, a polydispersity index of 0.24 ± 0.03 , a zeta potential of -28.4 ± 2.1 mV, and a complexation efficiency of $78.6 \pm 2.4\%$. The particle size and polydispersity index suggest a relatively uniform particle-size distribution. The measured zeta potential provides information about the surface charge of the formulation, while complexation efficiency indicates the extent of association between the plant extract and phospholipid. Nevertheless, these parameters should be interpreted together with appropriate analytical evidence confirming phytosome formation and formulation stability. Phospholipid-based delivery systems have been investigated for improving the delivery of plant-derived bioactive compounds (Lu et al. 2019).

The antioxidant activity was evaluated using the DPPH radical-scavenging assay. At a concentration of 100 µg/mL, the extract exhibited 51.6% radical-scavenging activity, whereas the phytosome formulation exhibited 65.2%. The higher activity observed with the phytosome formulation may be associated with improved dispersion or availability of extract constituents in the assay medium. However, this interpretation requires confirmation, and appropriate formulation blanks and controls are necessary to exclude interference from the formulation components. The DPPH method is widely used to evaluate the radical-scavenging capacity of compounds and extracts (Brand-Williams et al. 1995).

The gastroprotective activity was assessed by determining the gastric ulcer index. The ulcer control group exhibited an ulcer index of 10.2 ± 1.1 , whereas the unformulated extract and phytosome-treated groups showed values of 5.4 ± 0.8 and 3.2 ± 0.6 , respectively. The corresponding gastroprotective activities were 47.1% for the unformulated extract and 68.6% for the phytosome formulation. These findings indicate a greater reduction in the ulcer index with the phytosome formulation than with the unformulated extract. The observed difference supports further investigation of the formulation as a potential approach for improving the gastroprotective activity of *P. niruri*. Previous studies have also reported gastroprotective effects against experimentally induced gastric mucosal injury using other compounds and formulations (Halabi et al. 2014; Li and Li 2026).

Histopathological examination provides additional information about gastric mucosal integrity and tissue injury. Preservation of the gastric epithelium, maintenance of glandular architecture, and reduced inflammatory infiltration would support the biochemical and ulcer-index findings. Conversely, epithelial erosion, hemorrhage, edema, and inflammatory-cell infiltration are features associated with gastric mucosal injury. Prostaglandin-mediated gastric cytoprotection and changes in gastric mucosal morphology have been investigated in experimental models (Robert et al. 1992). The histopathological findings in the present study should be interpreted using the actual tissue sections obtained from each experimental group.

The gastroprotective effects of *P. niruri* may involve several mechanisms, including antioxidant activity, maintenance of the gastric mucosal barrier, and modulation of inflammatory responses. Oxidative stress and inflammation are relevant to experimentally induced gastric injury, and gastroprotective effects have been reported for other compounds in models of ethanol-, indomethacin-, and stress-induced ulcers (Li et al. 2014). However, the involvement of these mechanisms in the present formulation can only be established through appropriate biochemical and molecular investigations.

Overall, the findings indicate that phytosome formulation may improve the gastroprotective potential of *P. niruri* compared with the unformulated extract. Further studies involving phytochemical standardization, formulation stability, dose-response evaluation, mechanistic investigations, and safety assessment would strengthen the evidence supporting its potential application.

5. CONCLUSION

The phytosome-based formulation of *Phyllanthus niruri* demonstrated improved gastroprotective activity compared with the unformulated extract, along with enhanced in-vitro antioxidant activity. These findings suggest that phytosome technology may be a promising approach for improving the therapeutic potential of *P. niruri* in gastric ulcer management. Further studies are required to establish its mechanism of action, safety, and efficacy.

REFERENCES

- [1] Ansari SH, Islam F, Sameem M. Phospholipid complex technique for superior bioavailability of phytoconstituents. *Applied Pharmaceutical Science*. 2017;7(5):234–244.
- [2] Babu AR, Sunny A, John DB, Sharma S. Anti-diabetic activity by invitro inhibition of α -amylase enzyme and phytochemical screening of *Phyllanthus niruri*. *Current Trends in Biotechnology and Pharmacy*. 2021;15(5):511–518.
- [3] Bagalkotkar G, Sagineedu SR, Saad MS, Stanslas J. Phytochemicals from *Phyllanthus niruri* Linn. and their pharmacological properties: a review. *Journal of Pharmacy and Pharmacology*. 2006;58(12):1559–1570.
- [4] Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. *LWT—Food Science and Technology*. 1995;28(1):25–30.
- [5] Brooks FP. The pathophysiology of peptic ulcer disease. *Digestive Diseases and Sciences*. 1985;30(11 Suppl):15S–29S.
- [6] Devi VK, Jain N, Valli KS. Importance of novel drug delivery systems in herbal medicines. *Pharmacognosy Reviews*. 2010;4(7):27–31.

- [7] Halabi MF, Shakir RM, Bardi DA, et al. Gastroprotective activity of ethyl-4-[(3,5-di-tert-butyl-2-hydroxybenzylidene)amino]benzoate against ethanol-induced gastric mucosal ulcer in rats. PLoS ONE. 2014;9(5):e95908.
- [8] Højgaard L, Mertz Nielsen A, Rune SJ. Peptic ulcer pathophysiology: acid, bicarbonate, and mucosal function. Scandinavian Journal of Gastroenterology Supplement. 1996;216:10–15.
- [9] Kalaivani P, Kamaraj R. Phytosome technology: a novel breakthrough for the health challenges. Cureus. 2024;16(8):e68180.
- [10] Kamada T, Satoh K, Itoh T, et al. Evidence-based clinical practice guidelines for peptic ulcer disease 2020. Journal of Gastroenterology. 2021;56(4):303–322.
- [11] Kaur N, Kaur B, Sirhindi G. Phytochemistry and pharmacology of *Phyllanthus niruri* L.: a review. Phytotherapy Research. 2017;31(7):980–1004.
- [12] Lee NY, Khoo WK, Adnan MA, Mahalingam TP, Fernandez AR, Jeevaratnam K. The pharmacological potential of *Phyllanthus niruri*. Journal of Pharmacy and Pharmacology. 2016;68(8):953–969.
- [13] Li G, Li M. Psoralidin shows gastroprotective activity against ethanol-induced acute gastric mucosal injury in rats via inhibiting oxidative stress and inflammation. Journal of Pharmacological Sciences and Research. 2026.
- [14] Li YC, Liang HC, Chen HM, et al. Gastroprotective effect and mechanism of patchouli alcohol against ethanol, indomethacin and stress-induced ulcer in rats. Chemico-Biological Interactions. 2014;222:27–36.
- [15] Matsumura Y, et al. The Protective Potential of *Phyllanthus niruri* and Corilagin on Gastric Lesions Induced in Rodents by Different Harmful Agents. 2016
- [16] Mostofa R, Ahmed S, Begum MM, et al. Evaluation of anti-inflammatory and gastric anti-ulcer activity of *Phyllanthus niruri* L. (Euphorbiaceae) leaves in experimental rats. BMC Complementary and Alternative Medicine. 2017;17:267.
- [17] Musumba C, Pritchard DM, Pirmohamed M. Review article: cellular and molecular mechanisms of NSAID-induced peptic ulcers. Alimentary Pharmacology & Therapeutics. 2009;30(6):517–531.
- [18] Robert A, Leung FW, Guth PH. Morphological and functional gastric cytoprotection by prostaglandin in rats receiving absolute ethanol orally. Gut. 1992;33(4):444–451.
- [19] Kumar, Y. G., Dharmamoorthy, G., Devhare, L. D., Gunjal, S. D., & Deshpande, M. (2023). Toxicity Profile Study of Antihypertensive Drug Prazosin in Pregnant Wistar Rats. Journal of Advanced Zoology, 44, 64
- [20] Devhare, L. D.(2023) Extraction phytochemical screening and comparative pharmacological evaluation of some indigenous plants for antiulcer activity.Shodhganga.1-244
- [21] Konda V V S Krishna, Virendra Kumar Maurya, S. R. Fulmali, Praful N Giradkar, Lalchand D. Devhare (2023). A Textbook of Social and Preventive Pharmacy. Pritam Publication.1-201
- [22] Konda V V S Krishna, Amruta R. Patil, Anupama A. Kapadnis, Vinod M. Thakare, Lalchand D. Devhare. (2023). Textbook of Pharmacotherapeutics. Pritam Publication.1-166
- [23] Savita Shrikant Deokar Vedanshu R. Malviya, Biresh Kumar Sarkar, Lalchand D Devhare, Mangla Nand Singh.(2023). A Textbook of Novel Drug Delivery System. IIP Publication.1-230.
- [24] Chand, G., Devhare, L. D., & Hooda, T. (2024). Diverse Properties of *Tinospora Cordifolia* (Giloy, Heart Leaved Moonseed) world wild use for immunotherapies;boosting the body's defence and immune support . Emerging Paradigms for Antibiotic-Resistant Infections: Beyond the Pill. Springer Nature. 471-486
- [25] Upreti, P., Devhare, L. D., Abdulmageed, L. H., Kumar, Y. G., Kumar, R., & Dharmamoorthy, G. (2024). Combatting Antibiotic Resistance: Leveraging Fecal Microbial transplantation for gut health. Emerging Paradigms for Antibiotic-Resistant Infections: Beyond the Pill. 211-232.
- [26] Salpe, H. G., Devhare, L. D., Ghugare, A. P., & Singh, N. (2016). Formulation and evaluation of hpmc coated diltiazem hcl tablet and its comparison with other marketed preparation. Research chronicle in health sciences, 3(1), 11-17.
- [27] Devhare, L., Hiradeve, S., & Bobade, T. (2017). Method Development & Validation For Determination Of Water Content. LAP LAMBERT Academic Publishing.
- [28] Devhare, L. D., Ghugare, A. P., Hatwar, B. P., Goupale, D. C., & Devhare, L. D. (2015). Method development for determination of water content from various materials by spectrophotometry and it's validation. International journal of drug delivery, 7(4), 233-240.
- [29] Tonde, T. U., Kasliwal, R. H., & Devhare, L. D. (2016). Quantitative estimation of bacoside a in polyherbal memory enhancer syrup for memory boosting activity using hptlc method. Research chronicle in health sciences, 2(6), 315-320.

- [30] Ghugare, A. P., Devhare, L., & Hatwar, B. P. (2016). Development and validation of analytical methods for the simultaneous estimation of Nimorazole and Ofloxacin in tablet dosage form. *International Journal of Drug Delivery*, 8, 96-98
- [31] Makhani, A. A., & Devhare, L. (2017). Development and validation of vierordt's spectrophotometric method for simultaneous estimation of Drotaverine and Nimesulide combination. *Research chronicle in health sciences*, 3(2), 22-28
- [32] Kumar YG, Devibala PK, Shrivastav S, Babu JD, Chauhan J, Devhare LD, Thakur A, Kazi SM. Enhancing Risperidone Delivery through Optimized Niosomal Formulation Using Central Composite Design. *Int J Drug Deliv Technol*. 2026;16(10s): 741-748; DOI: 10.25258/ijddt.16.10s.87
- [33] Lalchand D Devhare, Sachin Hiradeve, Vaibhav Uplanchiwar, Vinod Thakare, Namrata S Mane, Pravinkumar B Suruse, Kurtika Channe. Development and In-Vitro Categorization of Cilnidipine-loaded Transdermal Patches: Design, Evaluation, and Performance Assessment. *Journal of Pharmaceutical Innovation*. 2026; 21:406. <https://doi.org/10.1007/s12247-026-10583-1>.
- [34] Lalchand Devhare, Anitha K N et al. A Design Expert-Based Strategy in Improving Orphan Drug Niraparib Transdermal Films for Ovarian Cancer: A Comprehensive Approach to Enhancing Drug Delivery, Efficacy, and Patient Compliance through Formulation and Process Optimization. *Journal of Applied Bioanalysis*. 2025; 11(5):179-190. <http://doi.org/10.53555/jab.v11i5.535>.
- [35] Devhare LD, N AK, Masoodali KS, A A, Ubgade SA, Bhelkar KB, Dana T, Formulation, Optimization, And In-Vitro Assessment of a Montelukast Sodium-Loaded Proniosomal Gel for Sustained Drug Delivery in Asthma Management. *Int J Drug Deliv Technol*. 2025;15(4): 18141825, DOI: 10.25258/ijddt.15.4.34
- [36] Devhare, L. D., & Gokhale, N. (2022). Antioxidant and Antiulcer property of different solvent extracts of *Cassia tora* Linn. *Research journal of pharmacy and technology*, 15(3), 1109-1113.
- [37] Devhare, L. D., & Gokhale, N. (2023). A brief review on: phytochemical and antiulcer properties of plants (fabaceae family) used by tribal people of gadchiroli maharashtra. *International journal of pharmaceutical sciences and research*, 14(4), 1572-1593.
- [38] Devhare, L. D., & Gokhale, N. (2023). In silico anti-ulcerative activity evaluation of some bioactive compound from *Cassia tora* and *Butea monosperma* through molecular docking approach. *International journal of pharmaceutical sciences and research*, 14(2), 1000-08.
- [39] Suruse, P. B., Jadhav, B. A., Barde, L. G., Devhare, L. D., Singh, S., Minj, K. H., & Suman, A. (2023). Exploring the potential of *Aerva Lanata* extract in a herbal ointment for fungal infection treatment. *Journal of Survey in Fisheries Sciences*, 10(1), 1922-1932.
- [40] Bodhankar, S. S., Devhare, L. D., Meshram, A. S., Moharkar, D. W., & Badwaik, C. B. (2023). Formulation and in vitro evaluation of dental gel containing ethanglic extract of *Mimosa pudica*. *European Chemical Bulletin*, 12(5), 1293-1299.
- [41] Singh, S., Minj, K. H., Devhare, L. D., Uppalwar, S. V., Anand, S., Suman, A., & Devhare, D. L. (2023). An update on morphology, mechanism, lethality, and management of dhatura poisoning. *Eur. Chem. Bull*, 12(5), 3418-3426.
- [42] Devhare, L. D., Bodhankar, S. S., Warambhe, P., Uppalwar, S. V., Devhare, D. L., Uchibagle, S., & Shende, S. (2023). Important role of food and nutritional security during Covid-19: A survey. *Eur. Chem. Bull*, 12(5), 1363-1374.
- [43] Gnana, R. P. M., Devhare, L. D., Dharmamoorthy, G., Khairnar, M. V., & Prasadha, R. (2023). Synthesis, Characterisation, Molecular Docking Studies and Biological Evaluation of Novel Benzothiazole Derivatives as EGFR Inhibitors for Anti-breast Cancer Agents. *International Journal of Pharmaceutical Quality Assurance*, 14(3), 475-480.