

Research Article**Therapeutic Potential of *Oxalis corniculata* Against Urinary Tract Infections (UTIs): A Pharmacological and In-Silico Perspective (Review Article)****Nayak Ruchi, Sahoo N. K.**

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Abstract

Urinary tract infections (UTIs) are among the most prevalent bacterial infections worldwide, significantly affecting public health and quality of life. The increasing incidence of antibiotic resistance among uropathogens has necessitated the exploration of alternative therapeutic strategies. Medicinal plants have gained attention due to their rich phytochemical composition and multi-target biological activities. *Oxalis corniculata* L., a widely distributed medicinal herb, has been traditionally used to treat infections, inflammation, and urinary disorders. This review summarizes the pharmacological properties, phytochemical profile, and in-silico studies related to *Oxalis corniculata* in the context of UTI management. The plant is rich in flavonoids, phenolics, tannins, and alkaloids, which exhibit antimicrobial, antioxidant, and anti-inflammatory activities. In-vitro studies demonstrate significant inhibitory effects against common UTI pathogens such as *Escherichia coli* and *Klebsiella pneumoniae*. In-silico docking studies further reveal strong interactions of its phytoconstituents with bacterial target proteins, suggesting

possible mechanisms of action. The review highlights the therapeutic potential of *Oxalis corniculata* as a natural alternative for UTI treatment and emphasizes the need for further clinical and mechanistic studies.

Keywords

Oxalis corniculata, Urinary Tract Infection, Phytochemicals, Antibacterial Activity, Molecular Docking, Herbal Medicine

1. Introduction

Urinary tract infections (UTIs) represent a significant public health concern, affecting individuals across all age groups, particularly women. These infections are primarily caused by bacterial pathogens such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus mirabilis*. Conventional antibiotic therapy remains the standard treatment; however, the rapid emergence of multidrug-resistant strains has limited its effectiveness.

Medicinal plants have gained attention as alternative therapeutic agents due to their safety, affordability, and minimal side effects. Among these, *Oxalis corniculata* L. has been widely used in traditional

medicine systems for the treatment of infections, inflammation, and urinary disorders. The plant is rich in bioactive phytochemicals that exhibit antimicrobial, antioxidant, and anti-inflammatory activities.

This study aims to evaluate the pharmacological potential and in-silico interactions of *Oxalis corniculata* phytoconstituents against UTI-causing pathogens.

2. Literature Review

Traditional medicinal systems have long recognized *Oxalis corniculata* for its therapeutic properties. It has been used to treat dysentery, fever, skin diseases, and urinary problems. Previous studies have reported its antimicrobial, anti-inflammatory, and antioxidant activities.

The literature review highlights previously published research on *Oxalis corniculata* and its relevance in treating urinary tract infections (UTIs).

Traditional Uses

In traditional medicinal systems such as Ayurveda and folk medicine, *Oxalis corniculata* has been widely used for its healing properties. It has been traditionally prescribed for:

- Gastrointestinal disorders like dysentery
- Fever and inflammatory conditions
- Skin infections and wounds
- Urinary problems including painful urination and infections

These traditional claims suggest that the plant possesses biologically active compounds capable of treating infections and inflammation.

Reported Pharmacological Activities

Modern scientific studies have validated many of these traditional uses. Research indicates that *Oxalis corniculata* exhibits:

- **Antimicrobial activity** – effective against various bacteria and pathogens
- **Anti-inflammatory activity** – reduces swelling and irritation
- **Antioxidant activity** – neutralizes free radicals and protects cells from damage

These properties are particularly important in UTIs, where infection and inflammation occur simultaneously.

Phytochemical Basis

Phytochemical investigations have revealed that the plant contains several bioactive compounds, including:

- **Flavonoids** – known for antimicrobial and antioxidant effects
- **Phenolic compounds** – contribute to antibacterial and anti-inflammatory action
- **Tannins** – help in protein precipitation and microbial inhibition
- **Alkaloids** – possess strong biological and antimicrobial activities

These compounds work either individually or synergistically to inhibit bacterial growth.

Activity Against UTI Pathogens

Several studies have demonstrated that extracts of *Oxalis corniculata* are effective against Gram-negative bacteria such as:

- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Proteus mirabilis*

These bacteria are the most common causes of UTIs. The plant extracts have shown the ability to inhibit their growth, suggesting its potential as a natural antibacterial agent.

Research Gap

Although previous studies confirm its antibacterial and therapeutic properties, there are still important gaps:

- Limited understanding of **exact mechanism of action**
- Lack of detailed **molecular interaction studies**
- Insufficient **in-silico and drug-target analysis**
- Few **clinical studies for validation**

Need for Present Study

Therefore, there is a need for integrated research combining:

- Pharmacological (in-vitro) studies
- Computational (in-silico docking) approaches

Such combined studies help in understanding how the plant compounds interact with bacterial targets at the

3.4 In-Silico Molecular Docking

molecular level, which is essential for drug development.

3. Materials and Methods

3.1 Plant Material Collection and Extraction

Fresh leaves of *Oxalis corniculata* were collected, washed, shade-dried, and powdered. The powdered material was subjected to solvent extraction using ethanol and methanol via Soxhlet extraction.

3.2 Phytochemical Screening

Qualitative phytochemical tests were performed to detect the presence of:

- Alkaloids
- Flavonoids
- Tannins
- Phenolics
- Glycosides

3.3 Antibacterial Activity (In-vitro)

Antibacterial activity was evaluated using:

- Agar well diffusion method
- Minimum Inhibitory Concentration (MIC)

Test organisms included:

- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Proteus mirabilis*

In-silico molecular docking is a computational technique used to predict the interaction between bioactive

compounds (ligands) and target proteins (receptors). In this study, selected phytoconstituents of *Oxalis corniculata* were evaluated for their ability to bind with key bacterial enzymes involved in the survival and pathogenicity of urinary tract infection (UTI) pathogens.

Target Proteins

Two important bacterial targets were selected:

- **DNA Gyrase:**

DNA gyrase is an essential enzyme responsible for DNA replication and supercoiling in bacteria. Inhibition of this enzyme disrupts DNA synthesis, ultimately leading to bacterial cell death. It is a well-established target for antibacterial drugs.

- **Urease:**

Urease is an enzyme that catalyzes the hydrolysis of urea into ammonia and carbon dioxide. This reaction increases the pH of urine, promoting bacterial survival and contributing to the formation of infection-induced kidney stones (struvite stones). Inhibiting urease can reduce bacterial colonization and associated complications.

Docking Procedure

Molecular docking studies were carried out using **AutoDock**, a widely used computational tool for predicting ligand–protein interactions.

The procedure involved the following steps:

1. **Protein Preparation:**

The 3D structures of DNA gyrase and urease were obtained from protein

databases (such as PDB) and prepared by removing water molecules and adding hydrogen atoms.

2. **Ligand Preparation:**

Selected phytochemicals (e.g., flavonoids, phenolic compounds) were drawn or retrieved and energy-minimized to obtain stable conformations.

3. **Docking Simulation:**

The ligands were docked into the active site of the target proteins using AutoDock. The software evaluates multiple binding conformations.

4. **Binding Energy Calculation:**

Binding affinity was calculated in terms of **binding energy (kcal/mol)**. Lower (more negative) values indicate stronger and more stable interactions.

5. **Interaction Analysis:**

The docked complexes were analyzed for:

- Hydrogen bonding
- Hydrophobic interactions
- Van der Waals forces

4. Results

4.1 Phytochemical Screening

The qualitative phytochemical analysis of *Oxalis corniculata* extract confirmed the presence of multiple classes of secondary metabolites. The extract tested positive for flavonoids, alkaloids, tannins, phenolic compounds, and glycosides. The detection of these bioactive constituents suggests that the plant possesses a diverse chemical profile, which may be responsible for its observed biological activities. Such compounds are well known for their

therapeutic potential, particularly in antimicrobial and anti-inflammatory applications.

4.2 Antibacterial Activity

The antibacterial potential of the plant extract was evaluated against selected uropathogenic microorganisms. The results indicated that the extract exhibited considerable inhibitory effects on all tested bacterial strains. Among them, the highest level of inhibition was observed against *Escherichia coli*, which is the primary causative agent of urinary tract infections. This was followed by notable activity against *Klebsiella pneumoniae*. The observed antibacterial effect may be attributed to the synergistic action of the phytochemicals present in the extract, which can interfere with bacterial cell functions and growth.

4.3 In-Silico Docking Results

Molecular docking studies demonstrated that key phytoconstituents, particularly flavonoids and phenolic compounds, showed strong interaction with selected bacterial target proteins. The compounds exhibited favorable binding energies, indicating stable ligand–protein complexes. These interactions suggest that the phytochemicals may inhibit essential bacterial enzymes, thereby disrupting metabolic processes and reducing bacterial survival. The in-silico findings provide supportive evidence for the antibacterial activity observed in experimental studies and highlight the potential of these

compounds as promising therapeutic agents.

5. Discussion

The presence of diverse phytochemicals in *Oxalis corniculata* contributes to its broad-spectrum antibacterial activity. Flavonoids and phenolic compounds are known to disrupt bacterial cell membranes and inhibit essential enzymes.

The in-vitro findings confirm the plant's effectiveness against common UTI pathogens, supporting its traditional use. The in-silico docking results further validate these findings by demonstrating strong interactions between phytoconstituents and bacterial target proteins.

Additionally, the antioxidant and anti-inflammatory properties of the plant help reduce oxidative stress and inflammation associated with UTIs. Its diuretic effect may aid in flushing out pathogens from the urinary tract.

Overall, the combined pharmacological and computational approach provides a comprehensive understanding of its therapeutic potential.

6. Conclusion

Oxalis corniculata exhibits significant potential as a natural therapeutic agent against urinary tract infections. Its rich phytochemical composition, strong antibacterial activity, and favorable molecular interactions with bacterial

targets make it a promising candidate for drug development.

However, further studies including toxicity evaluation, standardization, and clinical trials are necessary to validate its safety and efficacy in humans.

Although further experimental and clinical validation is required, the plant represents a valuable candidate for developing safe and effective herbal therapeutics for UTIs.

References

1. Gupta VK et al. Medicinal plants as antimicrobial agents. Journal of Ethnopharmacology.
- [2] Nirmal SA, Pal SC, Otimenyin SO, Aye T, Elachouri M, Kundu SK, et al. Contribution of herbal products in global market. Pharma Rev 2013 Nov:95–104.
- [3] Nisar B, Sultan A, Rubab SL. Comparison of medicinally important natural products versus synthetic drugs-a short commentary. Nat. Prod. Chem. Res. 2018;6(2):308.
- [4] Zahra W, Rai SN, Birla H, Singh SS, Rathore AS, Dilnashin H, et al. Economic importance of medicinal plants in Asian countries. In Bioeconomy for sustainable development. Singapore: Springer; 2020. p. 359–77.
- [5] Azmir J, Zaidul IS, Rahman MM, Sharif KM, Mohamed A, Sahena F, et al. Techniques for extraction of bioactive compounds from plant materials: a review. Journal of Food Engineering 2013;117(4):426–36.
- [6] Nazir A, Malik K, Qamar H, Basit MH, Liaqat A, Shahid M, Khan MI, Fatima A, Irshad A, Sadia H. 9. A review: use of plant extracts and their phytochemical constituents to control antibiotic resistance in *S. aureus*. Pure and Applied Biology (PAB) 2020;9(1):720–7.
- [7] Ifesan BO, Fashakin JF, Ebosele F, Oyerinde AS. Antioxidant and antimicrobial properties of selected plant leaves. European Journal of Medicinal Plants 2013;3(3):465–73.
- [8] Uddin MS, Lee SW. Mpb 3.1: a useful medicinal plants database of Bangladesh. Journal of Advancement in Medical and Life Sciences 2020;8. 02.
- [9] Farjana A, Zerin N, Kabir MS. Antimicrobial activity of medicinal plant leaf extracts against pathogenic bacteria. Asian Pacific Journal of Tropical Disease 2014;4:S920–3.
- [10] Ishma T, Syeed Uddin HM, Acharjee M. Estimation of microbial propagation and in-vitro antibacterial traits of the commonly available plant extract through extraction methods and MIC. EC Microbiology 2019;16(1). 01-10.
- [11] Suhag MH, Hossain MU, Ahmed S, Kayes MN. Qualitative evaluation of antibacterial and DNA binding activity of four local ethnomedicinal plants available in Barishal, Bangladesh. Asian Journal of Medical and Biological Research 2020;6(3):475–81.
- [12] Sharmin M, Nur IT, Acharjee M, Munshi SK, Noor R. Microbiological profiling and the demonstration of in vitro anti-bacterial traits of the major oral herbal medicines used in Dhaka Metropolis. SpringerPlus 2014;3(1):1–8.
- [13] Sharmin M, Banya PD, Paul L, Chowdhury FF, Afrin S, Acharjee M,

Rahman T, Noor R. Study of microbial proliferation and the in vitro antibacterial traits of commonly available flowers in Dhaka Metropolis. *Asian Pacific Journal of Tropical Disease* 2015;5(2):91–7.

[14] Hossaini F, Das NC, Hossaini F, Acharjee M, Munshi SK. Antimicrobial traits of different medicinal plants locally available in Bangladesh. *Biomedical and Biotechnology Research Journal (BBRJ)* 2021;5(1):1.

[15] Farjana T, Rahman MM, Eva KA, Zerin N, Kabir MS. Evaluation of antioxidant and antibacterial activities of different Bangladeshi spices (turmeric, garlic and ginger). *European Journal of Biomedical and Pharmaceutical Sciences* 2016;3(7):43–9.

[16] Aunjum A, Biswas R, Nurunnabi TR, Rahman SM, Billah M, Islam M, Islam KM. Antioxidant and antibacterial activity of three herbs belonging to *Zingiber* genus of Bangladesh. *Advances in Traditional Medicine* 2020;20(3):343–50.

[17] Hossain MS, Das KK, Acharjee M. In-vitro antibacterial properties of ethanol and methanol extracts of betel leaves collected from different areas of Bangladesh. *Bangladesh Journal of Microbiology* 2017;34(2): 125–7.

[18] Rahman M, Wadud M, Islam T, Hussain M, Bristy EM, Tuhin A. Evaluation of antibacterial activity of *Piper* betel leaves and *Nigella sativa* seeds against multidrug resistant food and water borne pathogenic Bacteria: an in vitro study model. *Microbiology Research Journal International* 2017;22(4). 1-1.

[19] Millat MS, Islam S, Hussain MS, Moghal MM, Islam T. Antibacterial

profiling of *Launaea sarmentosa* (Willd.) and *Bruguiera cylindrica* (L.): two distinct ethno medicinal plants of Bangladesh. *Eur Exp Biol* 2017;7(6).

[20] Hasan N, Shirin F, Khan MA, Mamun MA, Belal MH, Hasan MM, Islam A, Tasnin N, Karim MR, Asaduzzaman M, Islam MD. Hypoglycemic, hypolipidemic and antibacterial activity of *Ficus racemosa* fruit extract. *J Pharmaceut Res Int* 2017;16(1):1–9.

[21] Hossain MS, Jindal H, Maisha S, Samudi Raju C, Devi Sekaran S, Nissapatorn V, et al. Antibacterial effects of 18 medicinal plants used by the Khyang tribe in Bangladesh. *Pharmaceutical Biology* 2018;56(1): 201–8.

[22] Ahmed SR, Roy R, Romi IJ, Hasan M, Bhuiyan MK, Khan MM. Phyto chemical screening, antioxidant and antibacterial activity of some medicinal plants grown in Sylhet region. *IOSR J. Pharm. Biol. Sci.* 2019;14:26–37.

[23] Matin MM, Bhattacharjee SC, Hoque MS, Ahamed F. Antibacterial activity of some medicinal plants against carbapenem-resistant *Acinetobacter baumannii* isolated from patients. *European Journal of Pharmaceutical and Medical Research* 2019;6(7):111–6.