

Chapter 10

Natural antibacterial potential of *Grewia rhamnifolia* Roth (Malvaceae): insights from phytochemical analysis

Sumitra Jethy* and Sanjeet Kumar

Ambika Prasad Research Foundation, Odisha, India

*Email-Id: sumitrajethy19@gmail.com

ABSTRACT

Antibiotic resistance has become a major global problem, leading researchers to explore medicinal plants as natural antibacterial agents. This experiment focused on the fruits of *Grewia rhamnifolia*, a wild plant belonging to the Malvaceae family known for its therapeutic properties. Fruit extracts were prepared using the Soxhlet extraction method with contrasting solvents and tested for their chemical composition and antibacterial activity. The hydroethanolic extract showed the presence of several important compounds such as tannins, phenolics, alkaloids, and reducing sugars, suggesting it was the most effective solvent for extracting active ingredients. The antibacterial test against *Escherichia coli* showed that the extract could stop bacterial growth at a concentration of 100 mg/mL. These results indicate that *G. rhamnifolia* fruits contain useful natural compounds with potential antibacterial properties. This study supports the traditional use of this plant and highlights its possible role in developing new plant-based medicines.

Keywords: Ethnomedicine, antibiotic resistance, plant-based therapeutics

INTRODUCTION

Today, the search for natural antibacterial agents has gained considerable global attention due to the crisis of increasing antibiotic resistance (Angelini, 2024). However, traditional knowledge systems known as modern-day ethnobotany and ethnomedicine have long recognized the therapeutic potential of plants, providing a solid foundation for a new era of drug discovery (McClatchey *et al.*, 2009). Worldwide, numerous indigenous communities have historically relied on medicinal plants to treat infectious diseases, guided by generations of experiential knowledge from traditional

healers and folk medicine practitioners. These plant-based remedies constitute a diverse group of bioactive compounds like flavonoids, phenolics, alkaloids, tannins and many more that add to their antibacterial potency (AlSheikh *et al.*, 2020). This brings us to the pretext that wild and underexplored plants having medicinal uses can be used for developing safer and sustainable natural antibacterial agents. *Grewia rhamnifolia* (Figure 1) is one such wild climbing shrub found in seasonally dry tropical biomes native to India and Sri Lanka (POWO, 2025).



Figure 1: A twig of *Grewia rhamnifolia*

The leaves of this species are ovate-lanceolate with serrulate or crenulate margins, an acuminate apex, and a rounded or obtuse base. They are typically 3-nerved, occasionally exhibiting two additional smaller lateral nerves, with 3-5 secondary veins, and are nearly glabrous. The flowers are large, white to yellowish in colour, and borne in terminal or leaf-opposed umbels containing few blossoms. Floral buds are ovoid, distinctly ribbed, and covered with dense tomentose and hirsute hairs. The gonophore is short, and the style is stout with a four-lobed stigma. The drupe is depressed-globose, hairy, and yellow tomentose, containing several seeds; the fruiting pedicels are stout

and firm, which adds to its distinguishable characteristics (Saxena and Brahmam, 1994). A notable fact that aligns with its morphology is that typical members of the family Malvaceae, belonging to the genus *Grewia*, exhibit a diverse range of medicinal properties (Table 1), which makes them an integral part of folk medicine in their native habitats (Suguna and Umesha, 2022). The present study suggests that *G. rhamnifolia* (Figure 2) may possess comparable pharmacological potential similar to this trend.

Table 1: Traditional therapeutic applications of some selected species of genus *Grewia*

Species	Plant part used	Therapeutic applications	Source(s)
<i>Grewia asiatica</i>	Leaves	Applied on skin for anti-toxic and connective effects.	Morton, (1987)
	Roots and bark	Used for stiffness, astringent and stomachic properties; treats blood, heart, and respiratory problems.	
	Bark	Used as a demulcent, febrifuge, and to relieve bowel looseness.	Waliullah <i>et al.</i> , (2011)
	Unripe fruit	Mentioned in Ayurveda for curing Vata, Pitta, and Kapha imbalances; used for wounds, fever, ulcers, menstrual disorders, and diabetes.	Morton, (1987)
	Fruit	Reduces inflammation, soothes throat infections, and is used to expel dead fetuses.	Gupta <i>et al.</i> , (2006)
<i>Grewia abutilifolia</i>	Whole plant	Treats malaria, smallpox, cough, bladder and intestinal disorders, eczema, dysentery, typhoid fever, rheumatism, infertility, and abscesses.	Rafe <i>et al.</i> , (2018)

<i>Grewia gamblei</i>	Leaves, root and bark	Juice consumed with other herbs for snakebite treatment.	Dey and De, (2011)
<i>Grewia disperma</i>	Roots	Used to control bleeding, treat bronchitis, cough, and cold.	Ullah <i>et al.</i> , (2012)
	Bark	Applied for boils.	
	Fruits	Used as a cardiotonic.	
<i>Grewia tenax</i>	Roots	Treats jaundice, asthma, and pulmonary infections.	Aadesariya <i>et al.</i> , (2017)
	Leaves	Used for trachoma (eye infection).	
	Leaves and fruits	Decoction and juice are taken to increase haemoglobin in anaemic patients.	
<i>Grewia tiliaefolia</i>	Leaves and bark	Decoction used to treat snakebite.	Dharmasoth and Rao, (2019)
	Root powder	Used for sprains, ulcers, burning sensations, and skin diseases.	

As this species remains scientifically understudied, the present study was undertaken to qualitatively assess its phytochemical composition and evaluate the antibacterial activity of its fruit extracts, which can provide a base for its further exploration.

METHODOLOGY

Fruits of *Grewia rhamnifolia* were collected from Chandaka, Khordha, Odisha, India and were taxonomically identified by the authors. The collected samples were properly tagged and placed in cotton bags to prevent contamination during transport (Figure 3). The solvent extraction methods employed for isolating bioactive constituents from medicinal plants largely depend on the type of solvent used and the application of heat. The finely ground fruit samples of *G. rhamnifolia* were enclosed in a porous cellulose thimble and placed in the extraction chamber of the Soxhlet apparatus. The

n-hexane and hydro-ethanol solvents, upon heating in the round-bottom flask, vaporised and ascended into the thimble chamber, where they condensed and gradually filtered through the plant matrix, dissolving the desired phytoconstituents, respectively.



Figure 2: Fruit of *Grewia rhamnifolia*

When the solvent volume reached the siphon arm, it was automatically siphoned back into the boiling flask, and this cyclic operation was repeated several times to ensure exhaustive extraction (Jena *et al.*, 2025).



Figure 3: Collected fruit sample of *G. rhamnifolia*

The antibacterial potential of the extracts was subsequently evaluated against *Escherichia coli* (MTCC 45). The minimum inhibitory concentration (MIC) was determined by the broth microdilution method following standard protocols with minor modifications (Jena *et al.*, 2025) to assess the concentration-dependent antibacterial efficacy of the extracts.

RESULTS AND DISCUSSION

The qualitative analysis of *Grewia rhamnifolia* fruit extracts showed a clear influence of solvent polarity on the type and abundance of secondary metabolites extracted (Table 2). The non-polar solvent system (n-hexane) mainly extracted fat-soluble compounds and simple sugars, showing the presence of only reducing sugars. This indicated that n-hexane was not efficient in recovering a wide range of phytoconstituents due to its low polarity. In contrast, the hydroethanolic solvent system, with its higher polarity, extracted a broader spectrum of bioactive compounds, including tannins, phenolics, alkaloids, and reducing sugars. This suggested that mixed polar solvents like aqueous-ethanol combinations are more suitable for

isolating different phytochemicals, which are typically polar or semi-polar in nature.

Table 2: Solvent-dependent secondary metabolite screening of fruits of *G. rhamnifolia*

Solvent system	Relative polarity	Nature of extracted compounds	Detected bioactive compound	Inference
n-Hexane	Non-polar	Fat-soluble, non-polar compounds	Reducing sugars	Inefficient for extracting a diverse array of metabolites.
Hydroethanolic	Polar	Polar and semi-polar compounds	Tannins, Phenolic compounds, Reducing sugars and Alkaloids	Effective solvent for extracting secondary metabolites.

The antibacterial efficacy of the hydroethanolic extract of *G. rhamnifolia* fruits was assessed by determining its minimum inhibitory concentration (MIC) against *Escherichia coli* (Table 3).

Table 3: Estimation of Minimum Inhibitory Concentration (MIC)

Hydroethanolic extract	Concentration (mg/mL)				MIC (mg/mL)
	100	50	25	12.5	
<i>Grewia rhamnifolia</i> (fruits)	NG	G	G	G	100
Nutrient broth	NG	NG	NG	NG	-
Microbial broth	G	G	G	G	-
Antibiotics	NG	NG	NG	NG	-

(NG: No growth of bacteria; G: Growth)

The results showcased that bacterial growth was inhibited only at the concentration of 100 mg/mL, while growth was consistent at all the other lower tested concentrations, indicating the MIC value to be 100 mg/mL. The absence of bacterial growth in the antibiotic control validated the assay conditions, while nutrient and microbial broths served as appropriate negative and positive controls, respectively. In one of the folkloric medicinal plant studies conducted by Senthil *et al.*, (2015), the fruit juice of *G. rhamnifolia* was documented to be taken orally for treating stomachache and for alleviating digestive problems. The observed antibacterial potential through this experimental set-up can be attributed towards dual directions in that context. One, as a collateral to the antibacterial activity of *G. rhamnifolia* fruit extract to be effective against *E. coli* and the other towards the presence of phytochemicals such as tannins and phenolic compounds, which are known to disrupt bacterial cell membranes and interfere with enzymatic activity (Takó *et al.*, 2020), giving a valid reason for its antibacterial potency.

CONCLUSION

Nowadays, the modern science of drug discovery is rapidly running toward the development of easily accessible, more effective and powerful drug compositions. This not only helps modern healthcare but also gives rise to more complex problems like antibiotic resistance. Natural antibacterial agents in that aspect can prove a good alternative. *Grewia rhamnifolia*, a potential natural antibacterial agent, was assessed for its phytochemical profile, which revealed the presence of tannins, phenolic compounds, reducing sugars and alkaloids. This was validated through studying its antibacterial activity by determining its minimum inhibitory concentration (MIC) against *E. coli*, which was found to be 100 mg/mL. These findings encourage further isolation and characterisation of bioactive compounds of this species for a better understanding of their mechanisms of action and to explore their potential in developing alternative antibacterial formulations.

REFERENCES

- Aadesariya MK, Gauni BM, Duggirala SM, Ram VR and Vyas SJ. (2017). Antibacterial activity of *Abutilon pannosum* and *Grewia tenax* leaves

- extracts. World Journal of Pharmaceutical Research. 6(16): 1259-1274.
- AlSheikh HMA, Sultan I, Kumar V, Rather IA, Al-Sheikh H, Jan AT and Haq QMR. (2020). Plant-Based phytochemicals as possible alternative to antibiotics in combating bacterial drug resistance. Antibiotics. 9(8): 480. doi: 10.3390/antibiotics9080480.
- Angelini P. (2024). Plant-derived antimicrobials and their crucial role in combating antimicrobial resistance. Antibiotics. 13(8): 746. doi: 10.3390/antibiotics13080746.
- Dey A and De JN. (2011). Traditional use of plants against snakebite in Indian subcontinent: a review of the recent literature. African Journal of Traditional, Complementary and Alternative Medicines. 9(1): 153-174.
- Dharmasoth RD and Rao BG. (2019). Phytochemical and pharmacological review of *Grewia tiliacifolia* (VAHL). International Journal of Pharmaceutics. 10(9): 39-42.
- Gupta MK, Sharma PK, Ansari SH and Lagarkha R. (2006). Pharmacognostical evaluation of *Grewia asiatica* fruits. International Journal of Plant Sciences. 1(2): 249-251.
- Jena N, Vimala, Singh B, Patra A, Sharma BP, Hossain E and Kumar S. (2025). Methods for ethnobotanical data collection, phytochemistry, antioxidant, anthelmintic, and antimicrobial activities for pharmacological evaluation of medicinal plants. Journal of Biodiversity and Conservation. 9(2): 87-107.
- McClatchey WC, Mahady GB, Bennett BC, Shiels L and Savo V. (2009). Ethnobotany as a pharmacological research tool and recent developments in CNS-active natural products from ethnobotanical sources. Pharmacology and Therapeutics. 123(2): 239-254.
- Morton JF. (1987). Fruits of Warm Climates. Julia F Morton, Miami, USA.
- Plants of the World Online (POWO). (2025). *Grewia rhamnifolia* Roth. Royal Botanic Gardens Kew, United Kingdom.

- Rafe MR, Salam R, Hossain MM and Masud MM. (2018). Phytochemical Screening and acetylcholinesterase and butyrylcholinesterase inhibitory and thrombolytic activities of *Grewia abutilifolia* Vent. and Juss. Leaf. Dhaka University Journal of Pharmaceutical Sciences. 17(1): 81-86.
- Saxena HO and Brahmam M. (1994). The Flora of Orissa, Volume 1. Regional Research Laboratory, Bhubaneswar, Odisha & Orissa Forest Development Corporation Ltd., Bhubaneswar, Odisha, India.
- Suguna M and Umesha S. (2022). Phytochemical composition, pharmacological properties, and therapeutic activities of genus: *Grewia*. Journal of Pharmacognosy and Phytochemistry. 11(4): 263-272.
- Takó M, Kerekes EB, Zambrano C, Kotogán A, Papp T, Krisch J and Vágvölgyi C. (2020). Plant phenolics and phenolic-enriched extracts as antimicrobial agents against food-contaminating microorganisms. Antioxidants. 9(2): 165. doi: 10.3390/antiox9020165.
- Ullah W, Uddin G and Siddiqui BS. (2012). Ethnic uses, pharmacological and phytochemical profile of genus *Grewia*. Journal of Asian Natural Products Research. 14(2): 186-195.
- Waliullah GU, Rauf A, Siddiqui BS, Rehman T, Azam S and Qaisar M. (2011). Chemical constituents and biological screening of *Grewia optiva* Drummond ex Burret whole plant. American-Eurasian Journal of Agricultural and Environmental Sciences. 11(4): 542-546.