www.ijarp.com ISSN 2456-9992 Page: 01-11

Review Article

International Journal Advanced Research Publications

Volume: 02
Issue: 11

A SYSTEMATIC REVIEW ON THE PHYTOCHEMISTRY AND THERAPEUTIC POTENTIAL OF *POLYGONUM HYDROPIPER*

Poorana Pushkalai Saravanan*[1], Dhanushri Anandan [2], Gokulakannan Shanmugam[3], Dhanusumathi Kathirvel[4], Aarthi Dhavaseelan[5], Dhanusri Natarajan[6]

[1,3] Assistant professor, Department of Pharmacology, Swamy Vivekananda College of Pharmacy, Tiruchengode, Namakkal (Dt) - 637 205.

[2,4,5,6] Department of Pharmacology, Swamy Vivekananda College of Pharmacy, Tiruchengode, Namakkal (Dt)- 637 205.

Affiliated to The Tamil Nadu Dr. MGR Medical University, Chennai- 600032, India.

Article Received: 02 October 2026, Article Revised: 22 October 2026, Published on: 12 November 2026

***Corresponding Author: Poorana Pushkalai Saravanan**

Assistant professor, Department of Pharmacology, Swamy Vivekananda College of Pharmacy, Tiruchengode, Namakkal (Dt) - 637 205.

Doi: https://doi-doi.org/101555/ijarp.7449

ABSTRACT

Polygonum hydropiper (L.) Delarbre, commonly known as water pepper or smartweed, is a widely distributed medicinal plant belonging to the family Polygonaceae. It has been extensively utilized in traditional medicine across various countries, including China, India, Japan, and Southeast Asia, for the treatment of numerous ailments. The present systematic review aims to comprehensively summarize the phytochemical composition, traditional uses, and pharmacological activities of *P. hydropiper*. The plant is rich in bioactive compounds such as flavonoids, phenolic acids, terpenoids, sesquiterpenes, and glycosides, which contribute to its diverse therapeutic properties. Experimental studies have demonstrated a wide range of pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, anthelmintic, antihypertensive, antinociceptive, estrogenic, antifertility, and antiadipogenic effects. Additionally, certain compounds like polygodial and polygonolide have shown significant biological activity, although concerns regarding toxicity and mutagenicity have also been reported. Overall, P. hydropiper exhibits significant potential as a source of novel herbal therapeutics; however, comprehensive investigations into its molecular mechanisms, clinical efficacy, and safety profile are essential to substantiate its therapeutic applications.

KEYWORDS: *Polygonum hydropiper*, Persicaria hydropiper, polygodial, anti-inflammatory, antifertility, herbal drug development.

1. INTRODUCTION

Natural products derived from plants, animals, and microorganisms have been utilized by humans since ancient times for food, shelter, and medicinal purposes. [1] The use of medicinal plants dates back to the Middle Palaeolithic period, approximately 60,000 years ago, as evidenced by fossil records. [2,3] Historically, most therapeutic preparations were derived directly from plant parts in the form of crude extracts or complex herbal formulations. [4] Prior to the emergence of modern pharmaceuticals in the early nineteenth century, herbal remedies dominated traditional pharmacopoeias. [5] Even today, a significant proportion of the population in developing countries relies on plant-based medicines for primary healthcare needs. [6] The family Polygonaceae comprises approximately 49 genera and over 1200 species, including herbs, shrubs, trees, and climbers. [7] Members of this family are widely distributed, predominantly in the Northern Hemisphere, and possess considerable economic and medicinal value. [8] *Polygonum hydropiper* (L.) Delarbre is a well-known medicinal plant belonging to this family, commonly recognized for its diverse pharmacological properties and traditional applications. It is widely distributed and categorized as a species of least concern by conservation authorities. The plant has been traditionally used as a flavouring agent, diuretic, stimulant, emmenagogue, styptic, and lithontriptic agent. [9] **(Tabel 1)** The present systematic review aims to consolidate existing scientific data on *P. hydropiper*, including its taxonomy, botanical description, distribution, traditional uses, phytochemical composition, pharmacological activities, molecular mechanisms, and toxicological aspects, thereby providing a comprehensive understanding of its therapeutic potential. **(Fig 1)**



Figure 1: *Polygonum hydropiper* (L.) Delarbre. (Water pepper)

Table 1: Taxonomy and General Information of Polygonum hydropiper.

Parameter	Details
Scientific Name	*Polygonum hydropiper* (L.) Delarbre
Synonym	*Persicaria hydropiper*
Family	Polygonaceae
Common Name	Water pepper, Smartweed
Distribution	Asia, Europe, North America
Conservation Status	Least Concern
Traditional Uses	Diuretic, stimulant, emmenagogue, styptic, spice

2. Traditional Uses

Polygonum hydropiper is widely utilized both as a culinary ingredient and as a traditional medicinal plant across different regions. Due to its characteristic pungent and peppery taste, it is commonly used as a spice, flavouring agent, and garnish in various cuisines. [10] In Japan, young shoots are used as a garnish for dishes such as sashimi, while leaf extracts are incorporated into pickles and dressings. Similarly, in Southeast Asia, particularly among Chinese and Malay communities, the leaves are used in traditional dishes such as laksa. In traditional medicine, *P. hydropiper* has been employed for a wide range of therapeutic purposes. In European systems of medicine, it has been used as a diuretic and emmenagogue to regulate menstrual disorders. [11] Decoctions of the plant are used to treat gastrointestinal disorders such as diarrhoea, dyspepsia, and colic, as well as skin conditions and haemorrhoids. Ethnomedicinal practices across Asia report its use in treating headaches, toothaches, liver disorders, gastric ulcers, dysentery, and menstrual pain. [12] The plant is also used externally for wound healing, bleeding control, and skin diseases. In certain regions, such as Assam, India, the root powder has been traditionally used for antifertility purposes. Additionally, the plant has applications as a natural pesticide, fish poison, and dye, reflecting its diverse ethnobotanical importance. [13] However, toxicity has been reported in livestock such as sheep and pigs, indicating the need for cautious use. [14] **(Tabel 2)**

Table 2: Traditional Uses of Polygonum hydropiper.

S. No.	Application	Region	Use Description
1	Culinary	Japan, Southeast Asia	Spice, garnish (sashimi, laksa)
2	Gynecological	Europe, India	Emmenagogue, menstrual regulation
3	Gastrointestinal	Various	Treats diarrhoea, dyspepsia
4	Antifertility	Assam (India)	Root powder induces sterility
5	Wound healing	Asia	External application for bleeding and wounds
6	Antiparasitic	Vietnam, China	Anthelmintic use
7	Pesticide	Bangladesh	Grain storage protection
8	Fish poison	Arunachal Pradesh	Used in fishing practices

3. Phytoconstituents

3.1 Major Classes of Phytochemicals

Polygonum hydropiper contains a wide variety of bioactive compounds, including flavonoids, phenolics, terpenoids, sesquiterpenes, phytosterols, anthraquinones, and glycosides. [15] These compounds are primarily responsible for the plant's pharmacological activities.

3.2 Flavonoids and Phenolic Compounds

Flavonoids constitute the predominant class of phytochemicals in *P. hydropiper*. Important compounds include quercetin, isoquercitrin, rutin, kaempferol, isorhamnetin, hyperin, and epicatechin. Phenolic acids such as gallic acid, ellagic acid, vanillic acid, and pyrocatechol contribute significantly to antioxidant activity. Additionally, catechins, procyanidins, and condensed tannins enhance the plant's free radical scavenging capacity. [16]

3.3 Terpenoids and Sesquiterpenes

Sesquiterpenes such as polygodial and other drimane-type compounds are key constituents of *P. hydropiper*. These compounds are known for their antimicrobial, anti-inflammatory, and antifeedant properties.

3.4 Other Bioactive Compounds

Other constituents include fatty acids (myristic acid, arachidic acid), volatile compounds (farnesol, caryophyllene), alkaloid-like compounds (theobromine), and various unique molecules such as vanicosides (A, B, D, E, F), hydropiperosides, pinosylvin, cardamomin, and β-sitosterol. These compounds have been isolated from different solvent fractions, particularly ethyl acetate and dichloromethane extracts, indicating the chemical diversity of the plant. [17, 18] **(Tabel 3)**

Table 3: Phytochemical Constituents.

S. No.	Class	Compounds Identified
1	Flavonoids	Quercetin, rutin, kaempferol, isoquercitrin
2	Phenolics	Gallic acid, ellagic acid, vanillic acid
3	Terpenoids	Polygodial, drimane compounds
4	Glycosides	Vanicosides A–F, hydropiperoside
5	Fatty acids	Myristic acid, arachidic acid
6	Volatile oils	Farnesol, caryophyllene
7	Alkaloids	Theobromine
8	Sterols	β-sitosterol

4. Pharmacological Activities (Tabel 4)

4.1. Anti-fertility Activity

Polygonum hydropiper has been extensively investigated for its antifertility potential. Various solvent extracts, including petroleum ether, benzene, and chloroform, administered during the early stages of

copulation, have demonstrated significant anti-implantation effects primarily through resorption of implanted embryos. Administration of whole plant powder resulted in reversible sterility in both sexes, along with disruption of the oestrous cycle and induction of premature vaginal opening in immature females. [20] Root extracts further exhibited anti-ovulatory, interceptive, and anti-implantation activities. Mechanistically, these effects are associated with suppression of implantation-related genes such as TGF-β and IGF-I and impairment of the decidual response. [21]

4.2. Anti-hypertensive Activity

Leaf extracts of *P. hydropiper* have demonstrated significant antihypertensive effects. Treatment resulted in marked reductions in blood pressure and heart rate. Clinical observations also indicated decreased systolic blood pressure following regular administration. [22] The mechanism is believed to involve inhibition of vasoconstrictive pathways, including angiotensin-II signalling and Rho-kinase activation.

4.3. Anti-inflammatory Activity

Methanolic extracts of *P. hydropiper* exhibit potent anti-inflammatory effects in both in vitro and in vivo models. In lipopolysaccharide-stimulated RAW 264.7 macrophages, the extract significantly inhibited the production of nitric oxide (NO), tumour necrosis factor-α (TNF-α), and prostaglandins. Additionally, it suppressed the expression of pro-inflammatory mediators such as COX-2 and iNOS, primarily through inhibition of signalling pathways including NF-κB, Src/Syk, and IRAK/AP-1/CREB. [23] The bioactive compound polygonolide demonstrated notable anti-inflammatory activity, potentially via modulation of MAPK, JAK-STAT, and NF-κB pathways. [24] These findings support its traditional use in inflammatory disorders such as gastritis.

4.4. Estrogenic Activity

Crude root extract (CRE) of *P. hydropiper* has shown significant estrogenic effects in experimental animal models. Treatment resulted in follicular recruitment, followed by follicular atresia, along with histological alterations such as nuclear pyknosis and granulosa cell disorganization. In uterine tissues, CRE induced endometrial hyperplasia and glandular degeneration, with effects comparable to estradiol-17β (E2). Increased uterine DNA content and protein expression further confirmed estrogenic activity. [25] The mechanism is believed to involve epidermal growth factor (EGF)-mediated signalling, leading to uterine cell proliferation. Phytoconstituents may act as estrogen receptor agonists or partial agonists.

4.5. Anti-pyretic Activity

Ethanolic and chloroform extracts of *P. hydropiper* demonstrated significant antipyretic activity in yeast-induced pyrexia models. At doses of 200 and 400 mg/kg, a marked reduction in body

temperature was observed within the first hour of administration. [26] The effect is likely mediated through inhibition of prostaglandin synthesis, similar to standard antipyretic agents.

4.6. Earthworm Repellent Activity

Specific compounds isolated from *P. hydropiper*, including acylglucosyl sterols and polypiperic acid, induced rapid behavioural and physiological changes in earthworms, such as excessive mucus secretion, paralysis, and eventual death. [27] Although the exact molecular mechanism remains unclear, these findings suggest potential neurotoxic effects on invertebrate nervous systems.

4.7. Anthelmintic Activity

Methanolic extract of the aerial parts exhibited significant anthelmintic activity against *Pheretima posthuma*. At a concentration of 50 mg/mL, the extract produced faster paralysis (12.44 min) and death (18.19 min) compared to the standard drug piperazine citrate. [28] This indicates strong potential for development as a plant-based anthelmintic agent.

4.8. Anti-bacterial Activity

Chloroform extract of *Polygonum hydropiper* roots demonstrated notable antibacterial and antifungal activities, with greater effectiveness against Gram-positive bacteria and strong inhibition of pathogenic fungi. However, the antibacterial activity is somewhat selective, especially against Gram-negative bacteria. [29] Overall, these findings support the plant's potential as a natural antimicrobial source, warranting further research to isolate active compounds and clarify their mechanisms of action.

4.9. Anti-feedant Activity

Leaf extracts of *P. hydropiper* have shown significant antifeedant and insecticidal activity. Compounds such as polygodial and waburganal demonstrated strong activity against various agricultural pests, including aphids, armyworms, and whiteflies, indicating potential applications in eco-friendly pest management. [30]

4.10. Anti-cholinesterase Activity

Despite extensive investigation, *P. hydropiper* extracts and fractions have not demonstrated significant inhibitory activity against acetylcholinesterase or butyrylcholinesterase enzymes, suggesting limited potential in neurodegenerative disorder management. [31]

4.11. Anti-adipogenic Activity

Methanolic extracts and flavonoid constituents such as isoquercitrin and isorhamnetin inhibited adipocyte differentiation in 3T3-L1 cells. This effect was mediated through activation of the Wnt/β-catenin signalling pathway, resulting in reduced lipid accumulation and suppression of adipogenesis, highlighting its potential in obesity management. [32]

4.12. Toxicological Profile

Toxicological studies of Polygonum hydropiper indicate both safety concerns and tolerable limits. Polygodial-containing extracts show mutagenic activity in vitro, though in vivo studies report no micronucleus formation. Acute toxicity (LD_{50} ~500 mg/kg, i.p.) suggests moderate toxicity, while lower doses are generally well tolerated in subchronic studies. However, dermal irritation and potential neurotoxic effects at higher concentrations have been reported, highlighting the need for careful safety evaluation. [33,34]

Table 4: Pharmacological Activities of *Polygonum hydropiper.*

S. No.	Pharmacological Activity	Extract/Compound	Key Findings
1	Antifertility	Petroleum ether, benzene, chloroform extracts; root extract	Anti-implantation, reversible sterility, disruption of estrous cycle, gene suppression (TGF-β, IGF-I)
2	Antihypertensive	Leaf extract	Reduced blood pressure and heart rate; inhibition of angiotensin-II and Rho-kinase pathways
3	Anti-inflammatory	Methanolic extract; polygonolide	Inhibits NO, TNF-α, COX-2, iNOS via NF-κB, MAPK pathways
4	Estrogenic	Crude root extract	Induces follicular recruitment, uterine hyperplasia; mimics estrogen action
5	Antipyretic	Ethanolic & chloroform extract	Significant reduction in body temperature via prostaglandin inhibition
6	Earthworm Repellent	Polypiperic acid, sterols	Paralysis and death of earthworms; neurotoxic effects suspected
7	Anthelmintic	Methanolic extract	Faster paralysis and death compared to standard drug
8	Antibacterial	Polygodial, confertifolin	Active against *S. aureus*, *E. coli*, *Salmonella* spp.
9	Antifeedant	Leaf extract, polygodial	High mortality in pests; strong insecticidal activity
10	Anticholinesterase	Various extracts	No significant inhibitory activity observed
11	Antiadipogenic	Flavonoids (isoquercitrin, isorhamnetin)	Inhibits adipocyte differentiation via Wnt/β-catenin pathway
12	Toxicological Effects	Polygodial-containing extracts	Mutagenicity, dermal irritation, neurotoxicity at high doses

5. CONCULSION

Polygonum hydropiper (L.) Delarbre is a therapeutically important medicinal plant characterized by a diverse phytochemical composition, including flavonoids, phenolics, terpenoids, and bioactive compounds such as polygodial and polygonolide, which underpin its wide range of pharmacological activities. Evidence from experimental studies demonstrates its significant antifertility, antihypertensive, anti-inflammatory, estrogenic, antipyretic, antimicrobial, anthelmintic, antifeedant, and antiadipogenic properties, mediated through multiple molecular pathways such as NF-κB, MAPK, and Wnt/β-catenin signalling. These findings substantiate its traditional uses and highlight its potential as a promising source for novel drug development. However, concerns regarding toxicity, including mutagenicity, dermal irritation, and possible neurotoxic effects, necessitate cautious evaluation. As most available data are derived from preclinical studies, further investigations focusing on molecular mechanisms, standardization, clinical efficacy, and long-term safety are essential to validate and translate its therapeutic potential into clinical applications.

REFERENCE

1. Hashim NH, Abas F, Shaari K, Lajis NH. LC–DAD–ESIMS/MS characterization of antioxidant and anticholinesterase constituents present in the active fraction from Persicaria hydropiper. LWT-Food Science and Technology. 2012; 46(2): 468-76.
2. Talukdar S, Adhikari PP, Borah A. Ethnomedicobotanical study of indigenous knowledge on medicinal plants used for the treatment of reproductive problems in Nalbari district, Assam, India. J Ethnopharmacol 2018; 210: 386-407.
3. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicine for drug discovery. Environ Health Perspect 2001; 109(1): 69–75.
4. Ayyanar M, Ignacimuthu S. Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India. Journal of ethnopharmacology. 2011 Apr 12;134(3):851-64.5. Earnst E. The efficacy of herbal medicine – an overview. Fundam Clin Pharmacol 2005; 19: 405-9.
5. Earnst E. The efficacy of herbal medicine – an overview. Fundam Clin Pharmacol 2005;19: 405–9.
6. Sinmisola A, Bello OM. A review on Blighia sapida K.D. Koenig (syn. Cupania sapida Voigt.)'s: its economic importance, phytochemistry and pharmacological activity: channeling these claims for the present and future. J Ethnopharmacol 2019; 235: 446-59.
7. Tonny TS, Sultana S, Siddika F. Study on medicinal uses of Persicaria and Rumex species of polygonaceae family. J Pharmacogn Phytochem 2017; 6: 587-9.

8. Srivastava RC. Family polygonaceae in India. Indian Journal of Plant Sciences. 2014; 3(2): 112-50.
9. Vechiu E, Dincă L, Bratu I. The characteristics of Polygonum plants present in the Alexandru Beldie Herbarium. Research Journal of Agricultural Science. 2018; 50(4): 378-386.
10. Banthorpe DV. Polygonum hydropiper L (Water Pepper): In Vitro Culture and the Production of the Aphid-Antifeedant Polygodial. In Medicinal and Aromatic Plants IV. Berlin, Heidelberg: Springer Berlin Heidelberg. 1993; 21: 269-279.
11. Ministry of Health, Labour and Welfare, "List of existing food additives," in Foods Food Ingred (Editorial). 1995; 166: 93-101.
12. Kong YD, Qi Y, Cui N, Zhang ZH, Wei N, Wang CF, Zeng YN, Sun YP, Kuang HX, Wang QH. The traditional herb Polygonum hydropiper from China: a comprehensive review on phytochemistry, pharmacological activities and applications. Pharmaceutical Biology. 2023; 61(1): 799-814.
13. Choudhary RK, Oh S, Lee J. An ethnomedicinal inventory of knotweeds of Indian Himalaya. Journal of Medicinal Plants Research. 2011; 5(10): 2095-103.
14. Bairagi J, Saikia PJ, Boro F, Hazarika A. A review on the ethnopharmacology, phytochemistry and pharmacology of Polygonum hydropiper Linn. Journal of Pharmacy and Pharmacology. 2022; 74(5): 619-45.
15. Seimandi G, Álvarez N, Stegmayer MI, Fernández L, Ruiz V, Favaro MA, Derita M. An update on phytochemicals and pharmacological activities of the genus Persicaria and Polygonum. Molecules. 2021; 26(19): 5956.
16. Starkenmann C, Luca L, Niclass Y, Praz E, Roguet D. Comparison of volatile constituents of Persicaria odorata (Lour.) Sojak (Polygonum odoratum Lour.) and Persicaria hydropiper L. Spach (Polygonum hydropiper L.). Journal of agricultural and food chemistry. 2006; 54(8): 3067-71.
17. Jiang J. Volatile composition of the laksa plant (Polygonum hydropiper L.), a potential source of green note aroma compounds. Flavour and fragrance journal. 2005; 20(5): 455-9.
18. Idoudi S, Tourrette A, Bouajila J, Romdhane M, Elfalleh W. The genus Polygonum: An updated comprehensive review of its ethnomedicinal, phytochemical, pharmacological activities, toxicology, and phytopharmaceutical formulation. Heliyon. 2024; 10(8): e28947.
19. Garg SK, Mathur VS. Effect of chromatographic fractions of Polygonum hydropiper Linn. (roots) on fertility in female albino rats. J Reprod Fertil 1972; 29: 421–3.

20. Pachiappan S, Ramalingam K, Balasubramanian A. Combined effects of Gymnema sylvestre and Pergularia daemia on letrozole-induced polycystic ovarian syndrome in rats. Asian Pacific Journal of Reproduction. 2021; 10(2): 68-74.
21. Cha J, Sun X, Dey Sudhansu K. Mechanisms of implantation: strategies successful pregnancy. Nat Med 2013; 18: 1754–67.
22. Eddouks M, Maghrani M, Louedec L et al. Antihypertensive activity of the aqueous extract of Retama raetam Forssk. leaves in spontaneously hypertensive rats. J Herb Pharmacother 2007; 7: 65–77.
23. Pachiappan S, Jayakumar H, Manokaran B, Senthilkumar G. Medicinal plants for various kidney diseases: a review of phytomedicine research. TMP Universal Journal of Advances in Pharmaceutical sciences. 2025; 1(3): 11-17.
24. Sharma V, Tiwari RK, Shukla SS, Pandey RK. Current and future molecular mechanism in inflammation and arthritis. J Pharmacopuncture 2020; 23: 54-61.
25. Hazarika A, Sarma Hirendra N. The estrogenic effects of Polygonum hydropiper root extract induce follicular recruitment and endometrial hyperplasia in female albino rats. Contraception 2006; 74: 426–34.
26. Akhter R, Haque MA, Bhuiyan MD, Shahriar M. In vivo pharmacological investigation of leaf of Polygonum hydropiper (L.). Dhaka Univ J Pharm Sci 2013; 12: 165–9.
27. Chaudhury PS, Chaudhury D, Nanda DK et al. Cytomorphological alterations in the neurosecretory cells of the earthworm Eutyphoeus gammiei treated with the plant (Polygonum hydropiper Linn.) extract; and the nature of earthworm repellent factors. Pro Ind Nat Sci Acad B 1995; 61: 213–224.
28. Kumar P, Jumnani N. Phytochemical screening and anthelmintic potential of ficus benghalensis l. Leaves against pheretima posthuma. World Journal of Pharmacy and Pharmaceutical Research. 2025; 2(7): 136-174.
29. Hasan MF, Das R, Khan A, Hossain MS, Rahman M. The determination of antibacterial and antifungal activities of Polygonum hydropiper (L.) root extract. Advances in Biological Research. 2009; 3(1-2): 53-6.
30. Moreno-Osorio L, Cortés M, Armstrong V, Bailén M, González-Coloma A. Antifeedant activity of some polygodial derivatives. Zeitschrift für Naturforschung C. 2008; 63(3-4): 215-20.
31. Ayaz M, Junaid M, Ullah F, Sadiq A, Khan MA, Ahmad W, Shah MR, Imran M, Ahmad S. Comparative chemical profiling, cholinesterase inhibitions and anti-radicals properties of essential oils from Polygonum hydropiper L: A Preliminary anti-Alzheimer's study. Lipids in Health and Disease. 2015; 14(1): 141.

32. Lee SH, Kim B, Oh MJ, Yoon J, Kim HY, Lee KJ, Lee JD, Choi KY. Persicaria hydropiper (L.) spach and its flavonoid components, isoquercitrin and isorhamnetin, activate the Wnt/β-catenin pathway and inhibit adipocyte differentiation of 3T3-L1 cells. Phytotherapy Research. 2011; 25(11): 1629-35.
33. Pachiappan S. Evaluation of the sub-chronic oral toxicity of siddha herbo-mineral formulation Kalsiwin tablet. International Journal of Green Pharmacy. 2021;15(1): 30-38.
34. Ayaz M, Ahmad I, Sadiq A, Ullah F, Ovais M, Khalil AT, Devkota HP. Persicaria hydropiper (L.) Delarbre: A review on traditional uses, bioactive chemical constituents and pharmacological and toxicological activities. Journal of ethnopharmacology. 2020; 251: 112516.