Indian J. Applied & Pure Bio. Vol. 38(2), 453-460 (2023). **ISSN: 0970-2091**
A web of Science Journal

Pharmacological evaluation of *Polygonatum verticillatum* (L.) All. of Indian Ayurvedic medicinal plant

[1]Sahil Saini; [1]Harish Kumar; [2]Sonali Bihana; [3,#]Anil Kumar Sharma; [4]Seema Ramniwas and [3]Ajay Kumar Gupta*

[1]M.M. College of Pharmacy, [3]Department of Biotechnology,
[2]Gaur Brahman Ayurvedic College, Rohtak-124001 (India)
Maharishi Markandeshwar (Deemed To be University), Mullana, Ambala-133203 (India)
[4]University Centre for Research and Development, University Institute of Biotechnology
Chandigarh University, Gharuan, Mohali-140413 (India)
* Corresponding Author: akgupta.in@gmail.com or
# anibiotech18@gmail.com

Abstract

Polygonatum verticillatum (L.) All is a useful medicinal plant found in the himalayan region at elevations ranging from 2400 to 2800 metres. The species' rhizome is used in the preparation of Chyavanprash and many other ayurvedic formulations. Saponins, phytohormones, flavonoids, alkaloids, flavonoids, serine, diosgenin, lysine, santonin, lysine, sitosterol, calarene, aspartic acid, piperitone, docasane, calarene, and other active constituents have been discovered in this species. It also has antimalarial, urease inhibitor, anti-inflammatory, lipoxygenase inhibitor, antipyretic, anticonvulsant, tracheorelaxant, anticonvulsant, diuretic, tracheorelaxant, antinociceptive, antidiarrheal, antifungal, and insecticidal properties. Because of its broad therapeutic effects, especially those of its rhizome, the plant has gained attention in traditional medicinal systems. Because of the huge and uncontrollable collection of wild material, it now falls into the category of threatened plants. So various efforts are made to conserve this plant such as ex situ and in situ conservation. This paper provides a brief overview of this plant's botanical, traditional, bioactive components, pharmacological, and conservation-related aspects.

Key words : *Polygonatum verticillatum,* Bioactive components, Antioxidant, Antiinflammatory, Anticancer, Ayurvedic medicines, Medicinal plant.

***P**olygonatum is a* member of family of almost 57 species in the Liliaceae family. *Polygonatum* is widely spread in East Asia, particularly in Japan and China, where 40 species are discovered[20]. Afghanistan, Hindustan, Korea, Nepal, Bhutan, Russia, Pakistan and

temperate climate zones in Europe and north America are also home to them. *P. verticillatum* (L.) All., *P. cirrhifolium*, Royle, *P. geminiflorum* Decne and *P. multiflorum* Thunb. were discovered in the Flora of Pakistan. These species are found throughout the country, such as Swat, Hazara, Kurram Agency and Chitral[45]. Polygonatum is notable for its medicinal properties, but the majority of its participants are used in ayurvedic medicine since ancient times in various parts of the world. All parts of the plant have medical uses, but the most important are the rhizome because they contain many powerful and effective medicinal properties such as adaptogenic, anti-oxidant, cardioprotective, emollient, hypotensive, energizer, antidiabetic, tonics, antibacterial antifungal properties[25] and also used to treat pulmonary problems such as dry coughs and TB[18]. *P. verticillatum*, is a temperate Himalayan perennial rhizomatous herb and a well-known medicinal plant. It is most commonly found at elevations between 2400 and 2800 m[17]. It is a very useful medicinal plant, particularly the rhizome, which is used in syrup form to ease pain, chills, phthisis and burning sensation[44] in conjunction with many other herbs because it promotes urine discharge[6]. The herb is widely used as an galactagogue, aphrodisiac, emollient, appetiser, and tonic for weakness[2]. This plant's rhizome is an essential component of Ashtavarga, an Herbal tonic and aphrodisiac[8]. The plant even has antifungal activity and is used as a skin tonic in cosmetics. Its medicinal rhizomes (Meda and Mahameda) are obtained and traded in the wild. This is one of the causes that why *P. verticillatum* is quickly becoming extinct. As a result, the preservation of this plant is essential[7].

Distribution in world :

They can be found in Afghanistan, Turkey, Pakistan, Europe, Tibet and North Central Asia, among other places. They can be found in Himachal Pradesh, Chhattisgarh, and Jammu and Kashmir in India. Species have been reported from Binsar, Bhuna, Niti, Rudra Nath, Tungnath, Dunagiri, Valley of Flowers and Dayara[13,31,47].

Botanical description :

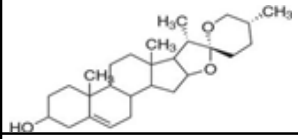
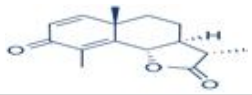
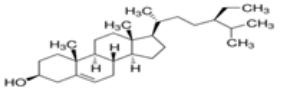
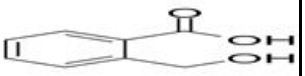
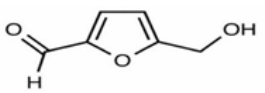
Polygonatum verticillatum, called Meda in Indian Traditional system of medicines, is a rhizomatous perennial herb. It is one of the most valuable contents of Astavarga (group of 8 medicinal plants) mentioned in Ayurveda. Its rhizomes are tuber-like, brief, and 0.7–1.5 centimeter thick in most cases. Stems are usually upright, 2–4 feet (30–60 cm) feet in length, angled and flanged, glabrous, and occasionally mottled. Leaf in whorls of 4-8, occasionally substitute near the stem's base, sometimes opposite near the tip, ellipse to closely lanceolate or sequential, 4-8, 14-12 inches, or 34 inches in the case of lanceolate, tips generally acute, occasionally and yet acuminate, margins entire, occasionally mildly rolled, glaucous lower surface. Whorled inflorescence racemes, 2 to 3 flowered, 1–2 cm peduncle, the bract seems to be 1 mm in length or non-existent, as well as the pedicel is non-existent. 2.5–4.5 mm, transsexual, perianth 8–9 micrometres and 1/3 inch, white as well as pale yellow, eco-friendly, obtained in the centre, teeth inside, hairy tip[11].

Chemical constituents :

The plants possess many phytochemical constituents isolated from its various parts, such as the compound diosgenin isolated from

the plant's rhizome[48]. Galactose, glucose, sucrose, and fructose are also found in the rhizome[42]. The study discovered that plant aerial parts comprise saponins, phenols, flavonoids, alkaloids, tannins, phenols, and other compounds[24]. Serine, Lysine, diosgenin, threonine, aspartic corrosive, sitosterol, sucrose, and glucose were also found in the plant's rhizome[41]Diosgenin and santonin, two naturally occurring chemicals compounds were also extracted from Meda rhizomes[37]. To test the biological activities of this plant's rhizome, bioactivity guided isolation was used to isolate 2 distinct compounds, 5-hydroxymethyl-2-furaldehyde and diosgenin[20]. In another study, the plant's rhizome contained significant amounts of phenolic and flavonoid compounds[1]. The plant's aerial parts contain a high concentration of phenolic and alkaloid content[20]. A lectin has already been isolated phytochemically from the root system of Meda. The lectin was obtained in a purified form (120 mg/kg) with a high proportion of asparaginic acid (28%)[4]. The phytochemicals in the plant's aerial parts and rhizome were studied. Both parts contain tannins, alkaloids, phenols, saponin, flavonoids, glycosides sterols, and, but the rhizome also contained terpenoids and anthraquinones[22]. Two new compounds, 2,3, dihydroxy propyl and propyl pentadecanoate were isolated from the plant's rhizome using various modern techniques like electron ionisation, high resolution, mass spectrometry, 1D and 2D NMR[30].

Table-1. Description of Chemical Constituents of *Polygonatum verticillatum* L.

Chemical constituent	Structure	Pharmacological activity	Reference
1. Diosgenin		Anti-obesity, anti-diabetic, anti-cancer, anti-inflammatory	9,33,34
2. Santonin		Anti-helminthic	12,3
3. β- Sitosterol		Anti-cancer, immunomo-dulatory, anti-mutagenic, angiogenic, analgesic, hypocho-lesterolemic, chemoprotective, anti-inflammatory.	26,19,5,28,32,46,29
4. 2-hydroxy-benzoic acid		Anti- microbial	10
5. 5 hydroxy-methyl 2 furaldehyde		Anti-pyretic, anti-convulsant	20

Nutritional values :

P. verticillatum contains different nutrition like protein, carbohydrates, fibre, energy value, ash, moisture, fat. The nutritional composition of the plant's bulb and rhizome was investigated. The mineral description of a plant extract demonstrated that it contained both micro as well as macronutrients such as Phosphorus, Magnesium, Potassium, Calcium, Iron, Sodium, Manganese[43]. The mineral characteristic of *P. verticillatum* aerial parts was also studied in various plant extracts. According to the findings, the plants contain a large amount of the both macronutrients (Ca, Na, K) and micronutrients (Mn, Ni, Cu, Cr, Fe, Pb, Zn, Ni)[38].

Pharmacological activities :

Antiinflammatory activity :

Meda rhizome was evaluated for anti-inflammatory activity in rats with carrageenan-induced paw oedema. The results revealed that the plant rhizome significantly reduced oedema and had anti-inflammatory activity at test doses of 50, 100, and 200 mg/kg. The protection at 200 mg/kg is 65.22 percent, which is comparable to aspirin[36]. In this study, the aerial parts of plant were examined in wistar rats for the same activity. Carrageenan was used to induce hind paw oedema. The plant's methanolic extracts demonstrated significant anti-inflammatory activity as well as a reduction in paw oedema in rats at test doses of 50, 100, or 200 mg/kg, with the concentration of 200 mg/kg yielding the best results (65.22 percent)[24].

Antioxidant activity :

The rhizome extract illustrated significant antioxidant activity in the DPPH assay, with the highest antioxidant activity observed in ethyl etanoate, and then n-butanol[23] reviewed the radical - scavenging activities of *P. vericillatum* aerial parts with 1,1-diphenyl-2-picrylhydrazyl (DPPH), finding that the crude extract (IC_{50}: 122 µg/mL) had the highest activity, followed by 1-butanol (IC_{50} : 167 µg/mL) and ethyl ethanoate extract (IC_{50} : 137 µg/mL) fractions[24]. Another study looked at the antioxidant properties of two compounds isolated from Meda rhizomes: diosgenin and santonin. The DPPH as well as reducing power assays were used for this purpose. In the DPPH assay, both compounds demonstrated strong antioxidant activity. Similarly, the IC_{50} values in reducing power assays are santonin (46.40 µg/mL) and diosgenin (62.10 µg/mL) respectively[40].

Antimalarial activity :

Different extracts of Meda aerial parts were tested for antimalarial activity against *Plasmodium falciparum*. The n-hexane fraction was the most efficacious followed by chloroform fraction but when especially in comparison to other pathogenic microbes, the crude extract was less effective (IC_{50} : 21.67 g/mL). The rhizome of *P. verticillatum* has been evaluated for antimalarial activity against *Plasmodium falciparum*. The crude extract and its non-polar fractions were discovered to have significant antimalarial activity[1].

Antinociceptive activity :

The antinociceptive activity of *P.*

verticillatum rhizome crude methanolic extract was studied in various pain models in rodents at different concentrations of drug extract. In various pain models, such as, formalin test, the visceral pain model and hot plate test, the plant demonstrated significant antinociceptive activity[24]. Plant extracts' effects on various pain models were investigated. All of the plants demonstrated significant antinociceptive activity. According to the author, a plant may comprise some biologically active compounds that may interact with effect of blockade or even the release of intrinsic stimulants that seem to be responsible for the stimulation of pain nerve cells[20].

Leishmanicidal activity :

The crude extract as well as different solvent extracts of *P. verticillatum* were tested for their *in vitro* anti-leishmanicidal action against *Leishmania*. The results showed that neither the crude extract nor its solvent fraction had shown any greater efficacy against *Leishmania major*[39].

Antibacterial activity :

The agar well diffusion test was used to analyse crude and distinct solvent extracts of plant rhizome against a variety of Gram-positive bacteria, including *Staphylococcus aureus*, and Gram-negative including *Pseudomonas aeruginosa* as well. With the exception of *P. aeruginosa*, the plant extract demonstrated strong antimicrobial activity against such bacteria, particularly gramme-negative bacteria. *S. aureus* was more sensitive to this plant in Gram-positive bacteria. In different extracts, the plant's aerial parts were also evaluated for antimicrobial activities against the same gram-positive as well as gram-negative microbes. The results showed that the plant extract would be only effective against *B. subtilis* in gram-positive bacteria, while it is ineffective against *Pseudomonas aeruginosa* in Gram-negative bacteria, such as rhizome, in Gram-positive bacteria[14].

Tracheorelaxant activity :

The tracheorelaxant activity of Meda rhizome was investigated in isolated guinea-pig upper airway tissues. The results revealed that Meda rhizome completely inhibited high Potassium and carbachol induced contractions at doses ranging from 0.01–10 mg/mL, which is equivalent to verapamil, that also causes tissue relaxation[16].

Diuretic activity :

The diuretic activity of *P. verticillatum* rhizome was evaluated in male Albino rats at different doses. The plant demonstrated mild diuretic activity at low doses but no activity at a high-dose, according to the study's findings. In male Wistar rats, the aerial parts of the plant were also tested for diuretic activity. In comparison with the standard drug hydrochlorothiazide, the plant demonstrated moderate diuretic activity but was deemed weak in both low- and high-test doses[20].

Hypoglycemic activity :

It was observed that the plant is used to treat diabetes based on the traditional medicine system. The plant was tested for anti-diabetic activity in dexamethasone-induced

insulin resistant HepG2 cells to verify this. The finding showed that plant had minimal anti-diabetic activity[27].

Bronchodilator activity :

The bronchodilator action of *P. verticillatum* aerial parts was tested in rabbit isolated tracheal tissues. While tested against K+ (80 mmol/L) and carbachol the methanolic extract of plant parts demonstrated significant bronchodilator activity, causing contractions. It did, however, exhibit Ca2+ channel blocker activity[15].

Lipoxygenase activity :

A UV absorbance-based enzyme assay was used to test the plant for inhibitory activity of soybean lipoxygenase. In comparison to the standard drug, baicalaim, the plant has high activity against lipoxygenase. Various solvents extracts have been used to test the lipoxygenase activity of the plant's aerial parts, including the rhizome. The plant exhibited significant lipoxygenase activity in all extracts, and while ethyl acetate extracts have been the most effective inhibitors of the enzyme, next to this aqueous fraction and crude extract also demonstrated inhibitory activity[35].

Status of P. verticillatum (L.) All. :

The native habitat of the plant is decreasing in many regions of the world due to overexploitation, uncontrolled harvesting, overgrazing, and a lack of awareness. This is the reason for the extinction of the species. Second, because the plant is also used in herbal products and has good market value in many parts of the world, locals harvest the plant before it matures, leading to a lower mature seed production and a large number of seeds destroyed. Furthermore, because the plant's rhizome has a high medicinal value, the entire plant is forcibly removed from the soil, which also kills the plant. As a result, there is a need for both in-situ and propagation and ex-situ conservation in order to preserve this important medicinal plant.

The practice of Ayurveda is as old as our civilization. From the ancient times, Indians practiced the Ayurvedic medicine therapy. *P. verticillatum* is one of the miracle plants which is used in multiple diseases. As the population increases continuously, there is a rapid decline in the forests due to deforestation. *P. Verticillatum* is a rare but extremely valuable medicinal plant native to the temperate Himalayas. So, there is an urgent need to conserve this precious plant by breeding, horticulture, *in situ and ex situ* conservation methods.

Conflict of Interest :

Authors declare no conflict of interest.

Authors acknowledge the help and support by Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, India.

References :

1. Ahmad M., H. Khan, M. Saeed, M.A. Khan, I. Khan, and N. Muhammad, *et al*. (2012). *Med Chem Res; 21:* 1278-82.
2. Alam G., (2004). Editor. Database on medicinal plants. Calcutta: CUTS Centre for International Trade, Economics and Environment; p. 33.

3. Anonymous (2016). CTI Reviews. Chemistry of natural products, a unified approach. Cram 101, Textbook Reviews, Heim / Rafbekur.
4. Antoniuk V.O. (1978). *Ukr Biokhim Zh 65:* 41-48.
5. Awad A.B., A.C. Downie, and C.S. Fink (2000). *Int J Mol Med.* May;5(5): 541-545. doi: 10.3892/ijmm.5.5.541. PMID: 10762659.
6. Ballabh B., O.P. Chaurasia, Z. Ahmed, and S.B. Singh (2008). *J. Ethnopharmacol; 118:* 331-339.
7. Bisht S., N.S. Bisht, and S. Bhandari (2012). *Physiol Mol Biol Plants; 18:* 89-93.
8. Chaumont J.P. (1979). *Acta Bot Gallica; 126 :* 537-42.
9. Chen Y., Y.M. Tang, S.L. Yu, Y.W. Han, J.P. Kou, B.L. Liu, and B.Y. Yu. (2015). *Chin J Nat Med. Aug; 13*(8): 578-587. doi: 10.1016/S1875-5364(15)30053-4. PMID: 26253490.
10. Cho J.Y., J.H. Moon, K.Y. Seong, and K.H. Park (1998). *Biosci Biotechnol Biochem. Nov; 62*(11): 2273-6. doi: 10.1271/bbb.62.2273. PMID: 9972252.
11. Collett H. (1971). A handbook of flowering plants of Simla and the neighbourhood. Dehradun: Bishen Singh Mahendra Pal Singh; p. 524.
12. Evans, W. (2009) Trease and Evans Pharmacognosy, 16th (Edn.), WB Saunders Elsevier, Edinburgh, UK.
13. Gaur, R.D. (1999). Flora of district Garhwal, North West Himalaya: with ethnobotanical notes. Srinagar: TransMedia; Ed.
14. Ghaffar, R., H. Khan, M. Saeed, N. Muhammad, S.A. Khan, S. Hassan (2012) *Pak J Pharm Sci.; 25:* 463-467.
15. Gilani A.H., H. Khan, M. Saeed, M.H. Mehmood, N. Rehman, and N. Muhammad, *et al*. (2013). *Phytother Res.; 27:* 1288-1292.
16. Haq, I., H. Khan, M. Saeed, M.H. Mehmood, N.U. Rehman and N. Muhammad, *et al*. (2013). *BMC Complement Altern Med* ; doi: 10.1186/1472-6882-13-197.
17. Healing herbs of himalaya- a pictorial & herbaria guide. (2008) Department of AYUSH, Ministry of Health and Family Welfare, Government of India; , p. 110058.
18. Jiang S. (1977). [Dictionary of Chinese herbal medicine]. Shanghai: Shanghai People's Publishing Press, p. 2041-4.
19. Ju Y.H., L.M. Clausen, K.F. Allred, A.L. Almada, and W.G. Helferich (2004) *J. Nutr.* May; *134* (5): 1145-51. doi: 10.1093/jn/134.5.1145. PMID: 15113961.
20. Khan H., M. Saeed, A.H. Gilani, M.A. Khan, I. Khan, and N. Ashraf (2011). *Phytother Res, 25:* 1024-1030.
21. Khan H., M. Saeed, A.H. Gilani, N. Muhammad, I. Haq, and N. Ashraf, *et al.* (2013). *Phytother Res, 27:* 468-471.
22. Khan H., M. Saeed, N. Muhammad, R. Gaffar, F. Gul and N. Raziq (2013). *Toxicol Ind Health, 31:* 758-763.
23. Khan, H., M. Saeed, N. Muhammad, F. Khan, M. Ibrar, and S. Hassan, *et al*. (2012) *Pak J. Pharm Sci., 25:* 871-875.
24. Khan, H., M. Saeed, N. Muhammad, and S. Perviz (2013). *Toxicol Ind Health,* doi: 10.1177/0748233713512362.
25. Krishnaraju A.V., T.V.N. Rao, D. Sundararaju, M. Vanisree, HS Tsay, and G.V. Subbaraju (2006) *Int J App Sci Eng; 4:* 115-125.
26. Loizou S., I. Lekakis, G.P. Chrousos, and P. Moutsatsou (2010). *Mol Nutr Food Res.* Apr, *54*(4): 551-8. doi: 10.1002/mnfr.200900012. PMID: 19937850.

27. Ma J.Z., L.X. Yang, X.L. Shen, J.H. Qin, L.L. Deng, and S. Ahmed, *et al.* (2014). *Nat Prod Bioprospect ; 4:* 197-206.
28. Manayi A., S. Saeidnia, S.N. Ostad, A. Hadjiakhoondi, M.R. Ardekani, M. Vazirian, Y. Akhtar, and M. Khanavi (2013). *L. Z Naturforsch C J Biosci.* Sep-Oct; *68*(9-10): 367-75. PMID: 24459770.
29. Moon E.J., Y.M. Lee, O.H. Lee, M.J. Lee S.K. Lee, M.H. Chung, Y.I. Park, C.K. Sung, J.S. Choi, and K.W. Kim (1999) *Angiogenesis. 3*(2): 117-23. doi: 10.1023/a:1009058232389. PMID: 14517429.
30. Muhammad N., H. Khan, M. Saeed, M.A. Khan, I. Haq, and R. Ghaffar (2013). *Med Chem Res 22:* 2088-92.
31. Naithani B.D. (1984) Flora of Chamoli. Vol. 2, Botanical survey of India-flora of India series 3. Howrah: Government of India; p. 654.
32. Ovesná Z., A. Vachálková, and K. Horváthová (2004) *Neoplasma. 51*(6): 407-414. PMID: 15640948.
33. Raju J. and R. Mehta (2009) *Nutr Cancer. 61*(1): 27-35. doi: 10.1080/01635580802357352. PMID: 19116873.
34. Rao, C. V., and J. Raju, (2012). Diosgenin, a Steroid Saponin Constituent of Yams and Fenugreek: Emerging Evidence for Applications in Medicine. In (Ed.), Bioactive Compounds in Phytomedicine.
35. Raziq N., Khan H., Saeed M., Muhammad N., Gaffar R., and F. Gul (2013). *Toxicol Ind Health 31:* 758-763.
36. Rehman N.U., H. Khan, M. Saeed, M.H. Mehmood, N. Muhammad, and I. Haq, *et al*. (2013). *BMC Complement Altern Med* doi: 10.1186/1472-6882-13-197.
37. Saeed M., H. Khan, A. Rauf, M.A. Khan, and N. Muhammad (2015) *Nat Prod Res 29:* 2160-3.
38. Saeed M., H. Khan, M.A. Khan, F. Khan, S.A. Khan, and N. Muhammad (2010). *Pak J Bot 42:* 3995-4002.
39. Saeed M., H. Khan, M.A. Khan, S.U. Simjee, N. Muhammad, and S.A. Khan (2010) *Afr J Biotechnol 9:* 1241-4.
40. Saeed M., N. Muhammad, and S. Perviz (2013) *Toxicol Ind Health* doi: 10.1177/0748233713512362.
41. Sagar P.K. (2014). *Int J. Pharm Sci Res 5:* 4023-39.
42. Shanker V., S. Prakash, and M.R. Uniyal (1970) *Nat Appl Sci Bull 22:* 139.
43. Sharma B.D., L. Singh, and M.J. Kaur (2014). *Int J Agric Food Sci Technol 5:* 75-80.
44. Singh A.P. (2006). *Ethnobotanical Leaflets 10:* 104-8.
45. Stewart R.R. (1972). [An annotated catalogue to the vascular plants of West Pakistan and Kashmir]. Karachi : Fakhri Printing Press; p. 56.
46. Sugano M., H. Morioka, and I. Ikeda (1977). *J Nutr.* Nov;*107*(11):2011-2019. doi: 10.1093/jn/107.11.2011. PMID: 908959.
47. Vashistha R.K. (2006). Ecophysiology and agro-technology of two important Himalayan herbs: Angelica glauca Edgew. and Angelica archangelica Linn. [dissertation]. Srinagar: H.N.B. Garhwal University.
48. Yesilada E. (1987). *Gazi Univ Eczacilik Fak Derg 4:* 11-7.