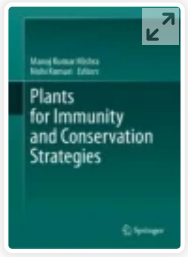

Plants for Immunity and Conservation Strategies pp 169–205

An Insight of Phytochemicals of Shatavari (*Asparagus racemosus*)

Vibha Pandey, Manju Shri, Sonali Dubey, Syed Saema & Shivani Tiwari

Chapter | First Online: 26 July 2023

Abstract

Asparagus racemosus is known to be a very important species due to its vital application in various diseases. Shatavari is the popular name of

pharmacological activities of extracts of *A. racemosus* that include antioxidant, anti-cancerous, anti-diarrheal, immunomodulatory, anti-ulcer, and anti-diabetic activities. Steroidal saponins (shatavarinI–X) are the main active components of shatavari root extract with pharmacological activity. In the same category, shatavarinIV has been classified as glycosides of sarsasapogenin. Along with shatavarin, there are a few other active components that have been identified and characterized, such as quercetin, rutin, and immunoside. Not only the roots, flowers, fruits, as well as leaves also possess many of these pharmacologically active compounds such as shataverins, diosgenin, and quercetin-3 glucuronide. In this chapter, we will try to collect the state of the art of phytochemicals discovered from shatavari with their biological application that will be beneficial for utilization in the development of specialty/functional foods.

Keywords

Phytochemicals **Steroidal saponins**

Shatavari **Secondary metabolites**

Abbreviations

ABTS$^{\bullet+}$: 3-ethyl benzothiazolin-6-sulfonic acid radical cation (blue chromophore)

CAE: Catechin equivalents

CHE: Cholesterol equivalent

DPPH: 2,2-diphenylpicrylhydrazyl

DW: Dry weight

LC: Liquid chromatography

MS: Mass spectroscopy

NMR: Nuclear magnetic resonance

PDA: Photodiode array

QRE: Quercetin equivalent

QTOF: Quadrupole time of flight

RUE: Rutin equivalent

TLC: Thin-layer chromatographic

TOF: Time of flight

References

Agarwal S, Prakash R, Dixit A, Srivastava A (2018) Chemical analysis and their therapeutic activity of ethanolic extract of *Asparagus racemosus* (Shatawari) root by GC-MS analysis. J Ultra Chem 14(6):163–165

Ahmad S, Pandey AR, Singh SP, Singh S,

medicinal plant: review on its cultivation, morphology and medicinal significance. PharmaTutor 6(12):46–54

Ashraf GJ, Das P, Dua TK, Paul P, Nandi G, Sahu R (2021) High-performance thin-layer chromatography-based approach for bioassay and ATR-FTIR spectroscopy for the evaluation of antioxidant compounds from *Asparagus racemosus* Willd. Aerial parts. Biomed Chromatogr 35(12):e5230

Behera SK (2018) Phytochemical screening and antioxidant properties of methanolic extract of root of *Asparagus racemosus* Linn. Int J Food Prop 21(1):2681–2688

Bhutani KK, Paul AT, Fayad W, Linder S (2010) Apoptosis inducing activity of steroidal constituents from *solanum xanthocarpum* and *Asparagus racemosus*. Phytomedicine 17(10):789–793

Chikhale RV, Sinha SK, Patil RB, Prasad SK, Shakya A, Gurav N, Prasad R, Dhaswadikar SR, Wanjari M, Gurav SS (2021) *In-silico* investigation of phytochemicals from *Asparagus racemosus* as plausible antiviral agent in COVID-19. J Biomol Struct Dyn 39(14):5033–5047

Deshmukh BD, Namdeo AG, Singh S, Fulzele DP, Mahadik KR (2020) Effect of gamma-irradiation processing on microbial decontamination, bioactive shatavarin IV constituent and shelf life of shatavari (*Asparagus racemosus*) marketed formulations. Radiat Phys Chem 174:108896

Dhanusha G, Sujith S, Nisha AR, Aathira KK, Haima JS (2021) Cytotoxic and antiproliferative potential of methanolic extracts of *Asparagus racemosus* in MDAMB231 cells. Pharm Innov J 10(2):355–358

Dinan L, Savchenko T, Whiting P (2001) Phytoecdysteroids in the genus *asparagus* (Asparagaceae). Phytochemistry 56(6):569–576

Gautam M, Saha S, Bani S, Kaul A, Mishra S, Patil D, Satti NK, Suri KA, Gairola S, Suresh K, Jadhav S, Qazi GN, Patwardhan B (2009) Immunomodulatory activity of *Asparagus racemosus* on systemic Th1/Th2 immunity: implications for immunoadjuvant potential. J Ethnopharmacol 121(2):241–247

Gohel RA, Solanki BH, Gurav NI, Patel GH, Patel BH (2015) Isolation and characterization of Shatavarin IV from root of *Asparagus racemosus* willd. Int J Pharm Pharm Sci 7(6):362–365

Gomase VS, Sherkhane AS (2010) Isolation, structure elucidation and biotransformation studies on secondary metabolites from *Asparagus racemosus*. Int J Microbiol Res 2(1):7–9

Gravel IV, Skibina AA, Kuz'menko AN, Demina NB, Krasnyuk II, Zavadskiy SP, Pirogov AV (2017) Study of chemical composition of *Asparagus racemosus* roots. Mosc Univ Chem Bull 72(4):192–195

Hasan M, Panda BP (2020) Chemometric analysis of selective polyphenolic groups in *Asparagus racemosus* (Shatavar) root extracts by traditional and supercritical fluid (CO_2) based extractions. Sep Sci Technol 55(7):1339–1355

Hayes PY, Jahidin AH, Lehmann R, Penman K, Kitching W, De Voss JJ (2006a) Asparinins, asparosides, curillins, curillosides and shavatarins: structural clarification with the isolation of shatavarin V, a new steroidal saponin from the root of *Asparagus racemosus*. Tetrahedron Lett 47(49):8683–8687

Hayes PY, Jahidin AH, Lehmann R, Penman K, Kitching W, De Voss JJ (2006b) Structural revision of shatavarins I and IV, the major components from the roots of *Asparagus racemosus*. Tetrahedron Lett 47(39):6965–6969

Hayes PY, Jahidin AH, Lehmann R, Penman K, Kitching W, De Voss JJ (2008) Steroidal saponins from the roots of *Asparagus racemosus*.

Jadhav DM (2018) Phytochemical investigation and antimicrobial activity of *Asparagus racemosus* Willd root against some pyogenic bacteria. Pharma Innov J. 7(3):115–118

Jadhav AN, Bhutani KK (2006) Steroidal saponins from the roots of *Asparagus adscendens* Roxb and *Asparagus racemosus* Willd. Indian J Chem 45B(6):1515–1524

Jaiswal Y, Liang Z, Ho A, Chen H, Zhao Z (2014) A comparative tissue-specific metabolite analysis and determination of protodioscin content in *asparagus* species used in traditional Chinese medicine and Ayurveda by use of laser microdissection, UHPLC-QTOF/MS and LC-MS/MS. Phytochem Anal 25(6):514–528

Janani SR, Singaravadivel K (2014) Screening of phytochemical and GC-MS analysis of some bioactive constituents of *Asparagus racemosus*. Int J Pharm Tech Res 6(2):428–432

Jayashree GV, Kumar KH, Krupashree K, Rachitha P, Khanum F (2015a) LC–ESI–MS/MS analysis of *Asparagus racemosus* Willd. Roots and its protective effects against t-BHP induced oxidative stress in rats. Ind Crop Prod 78:102–109

Jayashree GV, Rachitha P, Krupashree K, Kumar KH, Khanum F (2015b) Antioxidant and DNA damage protective effects of *Asparagus racemosus* in human colon and Mice muscle cells. Pharm J 7(3):182–190

Jayashree GV, Rachitha P, Krupashree K, Kumar KH, Khanum F (2015c) Chemical composition of *Asparagus racemosus* root by GC–MS analysis. Sci Technol Arts Res J 4(4):124–126

Kafle A, Kalauni SK, Manandhar MD (2012) Phytochemical studies and in vitro activity of *Asparagus racemosus*. JNPA J Nepal Pharm Assoc 26(1):48–53

Kishor K, Sahni YP, Sharma RK, Shrman K, Singh RP, Dinodia N, Singh P (2019) Characterization of Shatavarin-IV in root extracts *of Asparagus racemosus* by UHPLC. J Pharmacogn Phytochem 8(5):272–275

Kumeta Y, Maruyama T, Wakana D, Kamakura H, Goda Y (2013) Chemical analysis reveals the botanical origin of shatavari products and confirms the absence of alkaloid asparagamine a in *Asparagus racemosus*. J Nat Med 67(1):168–173

Leema HP, Prakash O (2019) Chemical composition and *in vitro* antioxidant potential of pili and Safed shatavar (*Asparagus racemosus*). Pharma Innov J 8(10):153–158

Madan VK (1972) Polyfructosans of *Asparagus racemosus*. Z Pflanzenphysiol 68(3):272–280

Mandal D, Banerjee S, Mondal NB, Chakravarty AK, Sahu NP (2006) Steroidal saponins from the fruits

Mishra JN, Verma NK (2017) *Asparagus racemosus*: chemical constituents and pharmacological activities—a review. Eur J Biomed Pharm Sci 4:207–213

Mishra A, Mishra VK, Dwivedi D, Dwivedi KN (2015) A FT-IR spectroscopic study of phytoconstituents of *Asparagus racemosus* Willd. Root tuber. World J Pharm Res 4(8):2754–2763

Mitra SK, Prakash NS, Sundaram R (2012) Shatavarins (containing Shatavarin IV) with anticancer activity from the roots of *Asparagus racemosus*. Indian J Pharmacol 44(6):732–736

Onlom C, Nuengchamnong N, Phrompittayarat W, Putalun W, Waranuch N, Ingkaninan K (2017a) Quantification of saponins in *Asparagus racemosus* by HPLC-Q-TOF-MS/MS. Nat Prod Commun 12(1):7–10

Onlom C, Phrompittayarat W, Putalun W,

(2017c) Preparative and rapid purification of saponins from *Asparagus racemosus* root by high performance centrifugal partition chromatography. Nat Prod Commun 12(2):241–244

Pahwa P, Singh T, Goel RK (2022) Anticonvulsant effect of *Asparagus racemosus* Willd. In a mouse model of catamenial epilepsy. Neurochem Res 47(2):422–433

Pasha S, Khanam S, Afsar Z (2016) Isolation and characterization of chemical constituents of *Asparagus racemosus* as markers. Int J Res Dev Pharm Life Sci 5(4):2255–2263

Patil D, Gautam M, Jadhav SS, Patwardhan B (2009) HPLCESI- MS/MS based determination of steroidal saponins in complex matrices. Paper presented at: International Seminar on Herbal Drug Research: Present and Future Prospects; December 4–5, 2009; Ooty, Tamil Nadu, India

Patil D, Gautam M, Gairola S, Jadhav S, Patwardhan B (2014b) HPLC/tandem mass spectrometric studies on steroidal saponins: an example of quantitative determination of Shatavarin IV from dietary supplements containing *Asparagus racemosus*. J AOAC Int 97(6):1497–1502

Pise M, Rudra J, Bundale S, Begde D, Upadhyay A (2011) Shatavarin production from *in vitro* cultures of *Asparagus racemosus* wild. J Med Plant Res 5(4):507–513

Pise M, Rudra J, Bundale S, Begde D, Nashikkar N, Upadhyay A (2012) *Asparagus racemosus* cell cultures: a source for enhanced production of shatavarins and sarsapogenin. In Vitro Cell Dev Biol Plant 48(1):85–91

Qazi S, Raza K (2021) Phytochemicals from Ayurvedic plants as potential medicaments for ovarian cancer: an *in-silico* analysis. J Mol Model 27(4):114

Ratdiya V, Aher A (2020) *Asparagus racemosus*: a review on pharmacognostic characters, phytochemistry and pharmacological activities. Curr Trends Pharm Pham Chem 2(3):18–23

Sabde S, Bodiwala HS, Karmase A, Deshpande PJ, Kaur A, Ahmed N, Chauthe SK, Brahmbhatt KG, Phadke RU, Mitra D, Bhutani KK, Singh IP (2011) Anti-HIV activity of Indian medicinal plants. J Nat Med 65(3–4):662–669

Samal J (2016) Medicinal plants and related developments in India: a deep into 5-years plan of India. Indian J Health Sci Biomed Res (KLEU) 9(1):14

Saran PL, Singh S, Solanki VH, Kalariya KA, Meena RP, Patel RB (2019) Impact of shade-net intensities on root yield and quality of *Asparagus racemosus*: a viable option as an intercrop. Ind Crop Prod 141:111740

mass spectrometry (GC–MS) profiling of aqueous dried tuberous roots of *Asparagus racemosus* Willd: the queen of herbs. J Pharmacogn Phytochem. 9(3):466–476

Satti NK, Suri KA, Dutta P, Suri OP, Amina M, Qazi GN, Rauf A (2006) Evaluation of *Asparagus racemosus* on the basis of immunomodulating sarsasapogenin glycosides by HPTLC. J Liq Chromatogr Relat Technol 29(2):219–227

Saxena VK, Chourasia S (2001) A new isoflavone from the roots of *Asparagus racemosus*. Fitoterapia 72(3):307–309

Sekine T, Fukasawa N, Kashiwagi Y, Ruangrungsi N, Murakoshi I (1994) Structure of asparagamine a, a novel polycyclic alkaloid from *Asparagus racemosus*. Chem Parm Bull 42(6):1360–1362

Sekine T, Ikegami F, Fukasawa N, Kashiwagi Y, Aizawa T, Fujii Y, Ruangrungsi N, Murakoshi I

Asparagus racemosus. Phytochemistry 44(4):763–764

Selvaraj K, Sivakumar G, Veeraraghavan VP, Dandannavar VS, Veeraraghavan GR, Rengasamy G (2019) *Asparagus racemosus*—a review. Syst Rev Phar 10(1):87–89

Selvarajan S, Devi VG, John AS, Jeyakannan J, Balakrishnan D, Raaman N (2014) Pharmacognostical identification of *Asparagus racemosus* Willd. (root) with the help of HPTLC method. World. J Pharm Res 3(6):486–498

Shah MA, Abdullah SM, Khan MA, Nasar G, Saba I (2014) Antibacterial activity of chemical constituents isolated from *Asparagus racemosus*. Bangladesh J Pharmacol 9(1):1–3

Shalini K, Ilango K (2021) Preliminary phytochemical studies, GC-MS analysis and *in vitro* antioxidant activity of selected medicinal plants

chemical markers in a polyherbal formulation. J Pharm Pharmacogn Res 10(2):253–269

Shameem I, Majeedi SF (2020) A review on potential properties and therapeutic application of *Asparagus racemosus* wild. World J Pharm Res. 9(7):2532–2540

Sharma A, Sharma DN (2017) A comprehensive review of the pharmacological actions of *Asparagus racemosus*. Am J Pharm Tech Res 7(1):1–19

Sharma U, Saini R, Kumar N, Singh B (2009) Steroidal saponins from *Asparagus racemosus*. Chem Pharm Bull 57(8):890–893

Sharma P, Chauhan PS, Dutt P, Amina M, Suri KA, Gupta BD, Suri OP, Dhar KL, Sharma D, Gupta V, Satti NK (2011) A unique immuno-stimulant steroidal sapogenin acid from the roots of *Asparagus racemosus*. Steroids 76(4):358–364

saponin and diphenylpentendiol from the roots of

Asparagus racemosus. Nat Prod Commun 7(8):995–998

Sharma U, Kumar N, Singh B, Munshi RK, Bhalerao S (2013) Immunomodulatory active steroidal saponins from *Asparagus racemosus*. Med Chem Res 22(2):573–579

Shastry RA, Madagundi SD, Habbu PV, Patil BS, Joshi SD, Kulkarni VH (2015) Phytochemical investigation and antiepileptic activity of *Asparagus racemosus* (wild) root extracts in rodents. RGUHS J Pharm Sci 5(3):97–103

Shrestha R, Shakya A, Shrestha KK (2015) Phytochemical screening and antimicrobial activity of *Asparagus racemosus* Willd. And *asparagus Curillus* Buch. -ham. Ex Roxb. J Nat Hist Mus 29:91–102

Siddiqui NA, Ali M, Ahmad A, Khan TH, Ahmad A (2013) New ursane glycoside from the roots of

racemosus elicits protective immune responses against HBsAg. Immunol Lett. 135(1–2):129–135

Singh AK, Singh SK, Singh PP, Srivastava AK, Pandey KD, Kumar A, Yadav H (2018a) Biotechnological aspects of plants metabolites in the treatment of ulcer: a new prospective. Biotechnol Rep (Amst) 18:e00256

Singh AK, Srivastava A, Kumar V, Singh K (2018b) Phytochemicals, medicinal and food applications of Shatavari (*Asparagus racemosus*): an updated review. Nat Prod J 8(1):32–44

Singh L, Kumar A, Choudhary A, Singh G (2018c) *Asparagus racemosus*: the plant with immense medicinal potential. J Pharmacogn Phytochem 7(3):2199–2203

Sivakumar T, Gajalakshmi D (2014) Phytochemical screening and GC-MS analysis of root extract from *Asparagus racemosus* L. Int J Pharm Sci Res

Smita SS, Trivedi M, Tripathi D, Pandey-Rai S, Pandey R (2021) Neuromodulatory potential of *Asparagus racemosus* and its bioactive molecule Shatavarin IV by enhancing synaptic acetylcholine level and nAChR activity. Neurosci Lett 764:136294

Sofowora A, Ogunbodede E, Onayade A (2013) The role and place of medicinal plants in the strategies for disease prevention. Afr J Tradit Complement Altern Med 10(5):210–229

Sparg S, Light ME, Van Staden J (2004) Biological activities and distribution of plant saponins. J Ethnopharmacol 94(2–3):219–243

Suja S, Sivakala S (2021) Phytochemical, purification and spectral analysis of compounds from root tuber extract of *Asparagus racemosus* (Willd). Mater Today Proc 41(3):618–621

Tantapakul C, Chaiyosang B, Promgool T, Somteds A, Suthiphasilp V, Kanokmedhakul K, Laphookhieo

Characterization and *in vitro* immunomodulatory screening of fructo-oligosaccharides of *Asparagus racemosus* Willd. Int J Biol Macromol 50(1):77–81

Thakur AV, Ambwani TK, Ahmad AH, Rawat DS, Ambwani S (2018) Determination of the phytochemical ingredients and antioxidative potential of hydromethanolic extract of *Asparagus racemosus* Willd. Int J Herbal Med 6(1):39–43

Thakur S, Kaurav H, Chaudhary G (2021) Shatavari (*Asparagus Racemosus*)-the best female reproductive tonic. Int J Res Rev 8(5):73–84

Tuszynska M (2010) Pharmacological and therapeutic application of *Asparagus racemosus* willd. Herba Pol 56(2):92–103

Verma A, Dwivedi S, Singh N (2013) Spectral analysis of steroidal saponin isolated and purified from leaves extract of *Asparagus racemosus* (family–Asparagaceae). Am J Adv Drug Del

Verma A, Dwivedi S, Singh N (2014) Isolation, purification and spectral analysis of pure compound obtained from leaves extract of *Asparagus racemosus*. World J Pharm Res 3(1):1395–1402

Wiboonpun N, Phuwapraisirisan P, Tip-pyang S (2004) Identification of antioxidant compound from *Asparagus racemosus*. Phytother Res 18:771–773

Yu Q, Fan L (2021) Improving the bioactive ingredients and functions of asparagus from efficient to emerging processing technologies: a review. Food Chem 358:129903

Author information

Vibha Pandey and Manju Shri contributed equally with all other contributors.

Authors and Affiliations

CSIR-National Botanical Research Institute, Lucknow, India

India

Manju Shri

Department of Environmental Science, Integral University, Lucknow, India

Syed Saema

Azad Institute of Pharmacy and Research, Lucknow, India

Shivani Tiwari

Editor information

Editors and Affiliations

Faculty of Engineering and Technology, Department of Biotechnology, Rama University, Kanpur, India

Manoj Kumar Mishra

Department of Botany, Mahila Mahavidyalaya, Banaras Hindu University, Varanasi, India

Nishi Kumari

Rights and permissions

Copyright information

racemosus). In: Mishra, M.K., Kumari, N. (eds) Plants for Immunity and Conservation Strategies. Springer, Singapore. https://doi.org/10.1007/978-981-99-2824-8_11

DOI	Published	Publisher Name
https://doi.org/10.1007/978-981-99-2824-8_11	26 July 2023	Springer, Singapore

Print ISBN	Online ISBN	eBook Packages
978-981-99-2823-1	978-981-99-2824-8	Biomedical and Life Sciences Biomedical and Life Sciences (R0)