REVIEW ARTICLE

Phytochemistry and pharmacological activity of *Mucuna pruriens*: A review

Mukesh Kumar Yadav[1], Prabhat Upadhyay[2], Suresh Purohit[2], B. L. Pandey[2], Harish Shah[3]

[1]Department of Kayachikitsa, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, [2]Department of Pharmacology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, [3]Department of Pharmacy, Institute of Medical Sciences, Meerut, Uttar Pradesh, India

Abstract

The plant *Mucuna pruriens* (Fabaceae) is an established herbal drug, widely known as "velvet bean," a vigorous annual climbing legume originally from Southern China and Eastern India, where it was at one time widely cultivated as a green vegetable crop. It has been shown that its seeds are potentially of substantial medicinal importance. The ancient Indian medical system, Ayurveda, traditionally used *M. pruriens*, even to treat such things as Parkinson's disease. *M. pruriens* has been shown to have antiparkinson and neuroprotective effects, which may be related to its antioxidant activity and used for the management of male infertility, nervous disorders, and also as an aphrodisiac.

Key words: Aphrodisiac, green vegetable crop, Parkinson's disease

INTRODUCTION

The genus *Mucuna*, belonging to the Fabaceae family, subfamily Papilionaceae, includes approximately 150 species of annual and perennial legumes. Among the various underutilized wild legumes, the velvet bean *Mucuna pruriens* is widespread in tropical and subtropical regions of the world. It is considered a viable source of dietary proteins[1-3] due to its high protein concentration (23-35%) in addition to its digestibility, as compared to other pulses such as soybean, rice bean, and lima bean.[4] The most important of these bioactive compounds of plants are alkaloids, flavonoids, tannins, and phenolic compounds.[5] The chemical constituents may be used for the various purposes such as activity against pathogenic bacteria.[6] In many parts of the world, *M. pruriens* is used as an important forage, fallow, and green manure crop. Since the plant is in the legume family (peas and beans), it, with the help of nitrogen-fixing bacteria, takes nitrogen gas from the air and combines it with other chemical compounds producing fertilizer and improving the soil. *M. pruriens* is a widespread fodder plant in the tropics. To that end, the whole plant is fed to animals as silage, dried hay, or dried seeds. *M. pruriens* silage contains 11-23% crude protein, 35-40% crude fiber, and the dried beans 20-35% crude protein. *M. pruriens* is used to cure from impotence,[7] diabetes mellitus,[8] and cancer[9] whereas the seeds have multi-diversified functions such as several free radical-mediated diseases management, rheumatoid arthritis, diabetes, atherosclerosis, nervous disorders, analgesic, antipyretic activity, and in the management of Parkinsonism.[10] The hairs lining the seed pods contain 5-hydroxytryptamine (serotonin) which causes severe itching (pruritus). The hairs on the outside of the pods of *M. pruriens* are a common ingredient in itching powder [Tables 1 and 2].[11]

PLANT DESCRIPTION

The plant is an annual, climbing shrub with long vines that can reach over 15 m in length. When the plant is young, it is almost completely covered with fuzzy hairs, but when older, it is almost completely free of hairs. The leaves are tripinnate, ovate, reverse ovate, rhombus-shaped, or widely ovate. The

Address for correspondence:
Prabhat Upadhyay, Department of Pharmacology, Institute of Medical Sciences, Banaras Hindu University, Varanasi - 221 005, Uttar Pradesh, India.
E-mail: upadhyayprabhat.89@gmail.com

Received: 13-02-2017
Revised: 17-03-2017
Accepted: 03-04-2017

sides of the leaves are often heavily grooved, and the tips are pointy. In the young plant, both sides of the leaves have hairs [Figure 1].

The stems of the leaflets are 2-3 mm long, and additional adjacent leaves present are about 5 mm long. The flower heads take the form of axially arrayed panicles. They are 15-32 cm long and have two to three or many flowers. The accompanying leaves are about 12.5 mm long, the flower stand axes are from 2.5 to 5 mm. The bell is 7.5-9 mm long and silky. The sepals are longer or of the same length as the shuttles. The crown is purplish or white. The flag is 1.5 mm long. The wings are 2.5-3.8 cm long. In the fruit ripening stage, a 4-13 cm long, 1-2 cm wide, unwinged, leguminous fruit develops. The husk is very hairy and carries up to seven seeds. The seeds are flattened uniform ellipsoid, 1-1.9 cm long, 0.8-1.3 cm wide, and 4-6.5 cm thick.

Table 1: Scientific classification

Kingdom	**Plantae**
Division	Magnoliophyta
Class	Magnoliopsida
Order	Fabales
Family	Fabaceae
Subfamily	Faboideae
Tribe	Phaseoleae
Genus	Mucuna
Species	*M. pruriens*

M. pruriens: Mucuna pruriens

Table 2: Common names

Sanskrit	**Atmagupta, Kapikacchu**
Hindi	Kiwanch or Konch
Marathi	Khaajkuiri
Bengali	Alkushi
Tamil	Poonaikkaali
English	Velvet bean, Cowitch, Cowhage
German	Juckbohne, Itch bean
Portuguese	Mad Bean
Malayalam	Naykaranam
Thai language	MahMui

Figure 1: Mucuna pruriens

PHYTOCHEMISTRY

Seeds of velvet beans are known to produce the unusual nonprotein amino acid 3-(3,4- dihydroxyphenyl)-l-alanine (L-DOPA). It also contains glutathione, gallic acid, and beta-sitosterol. It has unidentified bases such as mucunine, mucunadine, prurienine, and prurieninine. Other bases isolated from the pods, seeds, leaves, and roots include indole-3-alkylamines-N, N-dimethyltryptamine. Leaves also gave 6-methoxyharman. Serotonin is present only in pods.[12] The seeds also contain oils including palmitic, stearic, oleic, and linoleic acids.[13] Gas chromatography-mass spectrometry analysis showed the presence of phytochemicals such as n-hexadecanoic acid (48.21%), squalene (7.87%), oleic acid (7.62%), ascorbic acid (3.80%), and octadecanoic acid (6.21%) were present in the extract.[10]

The seed also contains two tetrahydroquinoline alkaloids namely: 3-methoxy-1,1-dimethyl-6,7-dihydroxy-1,2,3.4-tetrahydroquinoline and 3-methoxy-1, 1-dimethyl-7,8-dihydroxy-1,2,3.4-tetrahydroquinoline [Table 3].[14]

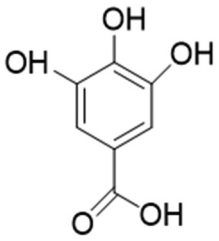
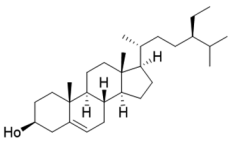
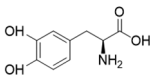
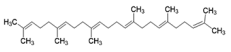
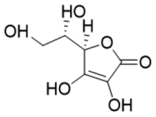
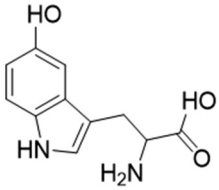
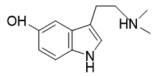
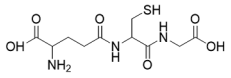
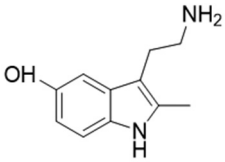
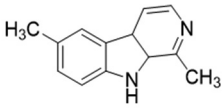
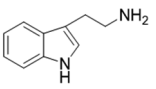
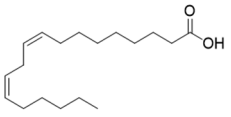
Pharmacological Activity [Table 4]

Table 4 show the biological properties of *M. pruriens* in different extracts.

Antivenom Activity

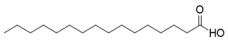
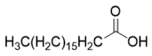
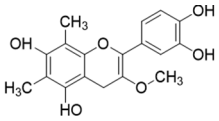
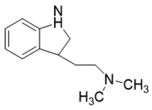
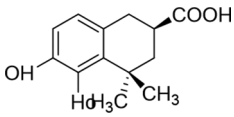
M. pruriens is one of the plants that have been shown to be active against snake venom and, indeed, its seeds are used in traditional medicine to prevent the toxic effects of snake bites, which are mainly triggered by potent toxins such as neurotoxins, cardiotoxins, cytotoxins, phospholipase A2 (PLA2), and proteases. The mechanisms of the protective effects exerted by *M. pruriens* seed aqueous extract (MPE) were investigated in detail in a study involving the effects of echis carinatus venom (EV).[15] *In vivo* experiments on mice showed that protection against the poison is evident at 24 h (short term) and 1 month (long term) after injection of MPE.[16] MPE protects mice against the toxic effects of EV through an immune mechanism. MPE contains an immunogenic component, a multiform glycoprotein, which stimulates the production of antibodies that cross-react with (bind to) certain venom proteins.[17]

Table 3: Chemical compounds present in *Mucuna pruriens*

Chemical compounds	Structure
Gallic acid (3,4,5-trihydroxybenzoic acid)	
β-sitosterol	
L-DOPA (L-3,4-dihydroxyphenylalanine)	
Squalene	
Ascorbic acid	
5-hydroxytryptophan	
Bufotenine	
Glutathione	
5-hydroxytryptamine	
6-methoxyharman	
Tryptamine	
Linoleic acid	

(*Contd*...)

Table 3: (*Continued*)

Chemical compounds	Structure
Palmitic acid (n-hexanoic acid)	
Stearic acid (octadecanoic acid)	
3-methoxy-1,1-dimethyl-6,7-dihydroxy-1,2,3,4-tetrahydroquinoline	
Indole-3-alkylamines-N, N-dimethyltryptamine	
3-methoxy-1, 1-dimethyl-7,8-dihydroxy-1,2,3.4-tetrahydroquinoline	

Antidiabetic Activity

The presence of these cyclitols is of interest due to the insulin-mimetic effect of d-chiro-inositol, which constitutes a novel signaling system for the control of glucose metabolism.[18,19] *M. pruriens* seeds are used at a dose of 500 mg/kg to reduce plasma glucose level.[20] These and other data demonstrated that the amount of seeds necessary to obtain a significant antidiabetic effect contain a total of approximately 7 mg of d-chiro-inositol. The antidiabetic properties of *M. pruriens* seed ethanol/water 1:1 extract are most likely due to d-chiro-inositol and its galacto derivatives. The seed extract of *M. pruriens* at doses of 100 and 200 mg/kg body weight reduced oral glucose load from ~127 to 75 mg % after 2 h of oral administration. In another experiment, there was reduction of blood glucose from ~250 to 90 mg % in streptozotocin diabetic rats after 21 days. The investigation suggested that the antidiabetic activity may be due to its dietary fiber content.[21]

Antioxidant Activity

The hydrogen-donating ability of the methanol extract of *M. pruriens* (MEMP) was measured in the presence of 1,1-diphenyl-2-picryl-hydrazyl radical. Ethyl acetate and MEMP plant, which contains large amounts of phenolic compounds, exhibits high antioxidant and free radical scavenging activities.[22] Reactive oxygen species (ROS) react readily with free radicals to become radicals themselves. Antioxidants provide protection to living organisms from damage caused by uncontrolled production of ROS and concomitant lipid peroxidation, protein damage and DNA strand breakage. The alcohol extract showed significant antioxidant activity which was comparable with standard ascorbate and total phenol content.[23]

Table 4: Biological properties of *Mucuna pruriens* in different extracts

Pharmacological activities	Plant part	Extract	Compound
Antivenom	Plant seed	Water	Proteins (gpMuc)[15]
Antidiabetic	Plant seed	Ethanol/water (1:1)	Cyclitols, oligosaccharides[21]
Antioxidant	Whole plant	Methanol	Phenols, tannins[22]
Neuroprotective	Plant seed, whole plant	Ethanol/water (1:1)	L-DOPA, amino acids, alkaloids
		n-propanol	Isoquinolines, alkaloids[25]
Antimicrobial	Plant leave	Methanol	Tannins, alkaloids, L-DOPA[27]

Neuroprotective Activity

Reports suggested that the seed powders of *Mucuna pruriens* are more beneficial to Parkinson's patients than the synthetic drug, when it is used for long term.[24] An n-propanol extract of *M. pruriens* seeds yields the highest response in neuroprotective testing involving the growth and survival of DA neurons in culture. Interestingly, n-propanol extracts, which contain a negligible amount of L-DOPA, have shown significant neuroprotective activity, suggesting that a whole extract of *M. pruriens* seeds could be superior to pure L-DOPA with regard to the treatment of Parkinsonism. The dopamine content in brain tissue is reduced when the conversion of tyrosine to L-DOPA is blocked. L-DOPA, the precursor of dopamine, can cross the blood-brain barrier and undergo conversion to dopamine, restoring neurotransmission.[25]

Antimicrobial Activity

Antimicrobials of plant origin have enormous therapeutic potential. Phytochemical compounds are reportedly responsible for the antimicrobial properties of certain plants.[26] Crude MEMP leaves have been shown to have mild activity against some bacteria, probably due to the presence of phenols and tannins.[27] This extract is mainly effective against *Escherichia coli, Salmonella typhi, Bacillus subtilis,* and *Shigella dysenteriae.* The antimicrobial potency was evaluation by zone of inhibition (ZI) where *E. coli* showed higher ZI (2.8 cm) than *B. subtilis* ZI (2.1 cm).[6]

CONCLUSION

M. pruriens seeds contain high concentrations of levodopa, a direct precursor of the neurotransmitter dopamine. It has long been used in traditional Ayurvedic Indian Medicine for diseases including Parkinson's disease. *M. pruriens* plant has many activities which need to elaborate for future cure in Ayurvedic tradition.

REFERENCES

1. Duke JA. Handbook of Legumes of World Economic Importance. New York, NY, USA: Plenum Press; 1981.
2. Kala KB, Mohan VR. Effect of microwave treatment on the antinutritional factors of the two accessions of velvet bean *Mucuna pruriens* (L.) DC. Var. Utilis (Wall. Ex. Wight) bak. Ex burck. Int Food Res J 2012;19:961-9.
3. Pugalenthi M, Vadivel V, Siddhuraju P. Alternative food/feed perspectives of an underutilized legume *Mucuna pruriens* var. utilis - A review. Plant Foods Hum Nutr 2005;60:201-18.
4. Gurumoorthi P, Pugalenthi M, Janardhanan K. Nutritional potential of five accessions of a South Indian tribal pulse *Mucuna pruriens* var. Utilis: II. Investigation on total free phenolics, tannins, trypsin and chymotripsin inhibitors, phytohaemagglutinins, and *in vitro* protein digestibility. Trop Subtrop Agroecosys 2003;1:153-8.
5. Duke AT. Handbook of Medicinal Herbs. 3rd ed. London: CRS Press; 1995. p. 220.
6. Kumar A, Rajput G, Dhatwalia VK, Srivastav G. Phytocontent screening of *Mucuna* seeds and exploit in opposition to pathogenic microbes. J Biol Environ Sci 2009;3:71-6.
7. Buckles D. Velvet bean: A new plant with a history. Econ Bot 1995;40:13-25.
8. Bhaskar A, Vidhya VG, Ramya M. Hypoglycemic effect of *Mucuna pruriens* seed extract on normal and streptozotocin-diabetic rats. Fitoterapia 2008;79:539-43.
9. Sathiyanarayanan L, Arulmozhi S. *Mucuna pruriens* Linn. A comprehensive review. Pharmaconosy Rev 2007;1:157-62.
10. Bhaskar A, Nithya V, Vidhya VG. Phytochemical evaluation by GC-MS and antihyperglycemic activity of *Mucuna pruriens* on streptozotocin induced diabetes in rats. J Chem Pharm Res 2011;3:689-96.
11. Joglekar GV, Bhide MB, Balwani JH. An experimental method for screening antipruritic agents. Br J Dermatol 1963;75:117-9.
12. Khare CP. Encyclopedia of Indian Medicinal Plants. Berlin, Heidelberg: Springer Verlag; 2004.
13. Mishra L, Wagner H. Lipid derivatives from *Mucuna pruriens* seeds. Indian J Chem 2006;45:801-4.
14. Misra L, Wagner H. Alkaloidal constituents of *Mucuna pruriens* seeds. Phytochemistry 2004;65:2565-7.
15. Guerranti R, Aguiyi JC, Neri S, Leoncini R, Pagani R, Marinello E. Proteins from *Mucuna pruriens* and enzymes from *Echis carinatus* venom: characterization and cross-reactions. J Biol Chem 2002;277:17072-8.
16. Guerranti R, Ogueli IG, Bertocci E, Muzzi C,

Aguiyi JC, Cianti R, *et al.* Proteomic analysis of the pathophysiological process involved in the antisnake venom effect of *Mucuna pruriens* extract. Proteomics 2008;8:402-12.
17. Guerranti R, Aguiyi JC, Ogueli IG, Onorati G, Neri S, Rosati F, *et al.* Protection of *Mucuna pruriens* seeds against *Echis carinatus* venom is exerted through a multiform glycoprotein whose oligosaccharide chains are functional in this role. Biochem Biophys Res Commun 2004;323:484-90.
18. Larner J, Allan G, Kessler C, Reamer P, Gunn R, Huang LC. Phosphoinositol glycan derived mediators and insulin resistance. Prospects for diagnosis and therapy. J Basic Clin Physiol Pharmacol 1998;9:127-37.
19. Ortmeyer HK, Larner J, Hansen BC. Effects of D-chiroinositol added to a meal on plasma glucose and insulin in hyperinsulinemic rhesus monkeys. Obes Res 1995;3 Suppl 4:605S-8.
20. Suresh S, Prithiviraj E, Lakshmi NV, Ganesh MK, Ganesh L, Prakash S. Effect of *Mucuna pruriens* (Linn.) on mitochondrial dysfunction and DNA damage in epididymal sperm of streptozotocin induced diabetic rat. J Ethnopharmacol 2013;145:32-41.
21. Vadivel V, Janardhanan K. Nutritional and anti-nutritional composition of velvet bean: an under-utilized food legume in South India. Int J Food Sci Nutr 2000;51:279-87.
22. Kumar DS, Muthukottai A, Smith AA, Manavalan R. *In vitro* antioxidant activity of various extracts of whole plant of *Mucuna pruriens* (Linn). Int J Pharmtech Res 2010;2:2063-70.
23. Kumar DS, Muthu AK. Free radical scavenging activity of various extracts of whole plant of *Mucuna pruriens* (Linn): An *in-vitro* evaluation. J Pharm Res 2010;3:718-21.
24. Katzenschlager R, Evans A, Manson A, Patsalos PN, Ratnaraj N, Watt H, *et al*. *Mucuna pruriens* in Parkinson's disease: A double blind clinical and pharmacological study. J Neurol Neurosurg Psychiatry 2004;75:1672-7.
25. Liu W, Ma H, DaSilva NA, Rose KN, Johnson SL, Zhang L, *et al.* Development of a neuroprotective potential algorithm for medicinal plants. Neurochem Int 2016;100:164-77.
26. Mandal P, Sinha Babu SP, Mandal NC. Antimicrobial activity of saponins from *Acacia auriculiformis*. Fitoterapia 2005;76:462-5.
27. Ogundare AO, Olorunfemi OB. Antimicrobial efficacy of the leale of *Dioclea reflexa*, *Mucana pruriens*, *Ficus asperifolia* and *Tragia spathulata*. Res J Microbiol 2007;2:392-6.

Source of Support: Nil. **Conflict of Interest:** None declared.