



Review Article

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

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Received: 08 February 2016
Accepted: 24 February 2016

ABSTRACT

Mucuna pruriens (L.) DC belongs to the family Fabaceae is commonly known as Velvet bean, Cowitch, Cowhage in English and Kawaanchin Hindi. *M. pruriens* has been of keen interest in phytochemical and Ayurvedic research due to its excellent medicinal values. *M. pruriens* had been evaluated and concluded as a potential medicinal herb in terms of anti cholestrolemic, antiparkinson, antidiabetic, aphrodisiac, anti-inflammatory and antimicrobial. The plant exhibits wide array of phytoconstituents like alkaloids, flavonoids, tannins and phenolic compounds which are responsible for varied potent physiological and pharmacological activities. Approximately 15 species have been reported from India. This review is in a narrative format and consists of publications relevant to *M. pruriens* available in public domain along with their morphology, phytochemical constituents, traditional uses, medicinal values and some pharmacological activities.

Keywords: *Mucuna pruriens*, Taxonomy and nomenclature, Therapeutic uses, Phytochemistry, Pharmacology

Introduction

Need of herbal medicines

Hunger and disease are the two extremely vital phenomena which threaten the very survival of mankind in mother earth. To cure himself off the diseases, mankind has tried various methods and strategies. Due to the easy access to the number of plants growing around the dwelling place, the initial empirical attempts were made with plants and plant products. To date, the herbal medicine is still the mainstay of about 75 to 80% of the world population, mainly in the developing countries, for primary health care because of better compatibility with the human body and

lesser side effects. According to WHO (1991), traditional medicine is the synthesis of therapeutic experience of the generations of indigenous systems of medicine. Herbal drugs constitute only those traditional medicines, which primarily use medicinal plant preparations for therapy.^{17,19} In India, herbal medicine has been used for treatments to cure various diseases.^{18,19}

Mucuna pruriens

M. pruriens (Figure 1) is a tropical twining herb commonly known as Velvet bean belongs to the family Fabeaceae.¹ The plant is famous for the extreme itchiness it produces on contact,

particularly with the young foliage and the seed pods due to the presence of protein, mucunain and serotonin [5- hydroxytryptamine (5-HT)].^{2,3,20} The beans of the *M. pruriens* are known to produce the unusual non protein amino acid L-dopa, a potent neurotransmitter.⁴



Figure 1: Leaves and flower of *Mucuna pruriens*.¹

In Ayurveda *M. pruriens* has been well documented for its therapeutic potentials as well as keen interest in phytochemical and Ayurvedic research due to its excellent medicinal values.¹ From the ancient times Cowhage has been used in Ayurvedic medicine for the treatment of Parkinson's disease associated with progressive degeneration of dopaminergic neurons in specific areas in the brain which is a common age-related neurodegenerative disorder. It affects more than four million people worldwide or for nervous system disorders as of the high concentration of L-dopa in the seeds. Dopamine does not cross the blood-brain barrier and therefore cannot be used directly as a treatment. But the researches discover that it is also used in many other diseases such as for treating arthritis, anxiety, cancer, cough, diarrhoea, dysentery,

diabetes, dysmenorrhea, delirium, gonorrhoea, gout, impotence, muscular pain, parasitic infections, rheumatic disorders, as analgesic and antipyretic, to induce vomiting, to treat snakebite and scorpion stings, sexual debility, sterility, tuberculosis and its direct application on skin can help to stimulate surface blood flow in conditions that involve paralysis.^{5,6}

Distribution

In India, it is one of the most popular medicinal plants.⁷ Cultivated in Uttar Pradesh, Madhya Pradesh, Andaman and Nicobar Islands etc. It is widespread over most of the subcontinent and found in forms of bushes, hedges, in dry-deciduous low forests types throughout the plains of India. It grows naturally grown right from lower Himalayan range to entire tropical plains of India^{7,8} and also cover the tropical regions, specially Africa, West Indies, tropical America, the Pacific Islands and the United State.^{9,10}

Botanical classification¹¹

Family: Fabaceae

Genus: *Mucuna*

Species: *pruriens*

Taxonomy and nomenclature¹¹

Latin name: *Mucuna pruriens*

Synonyms: *Carpopogon pruriens*, *Dolichos pruriens*, *Mucuna aterrima*, *M. atropurpurea*, *M. cochinchinensis*, *M. cyanosperma*, *M. deeringiana*, *M. esquirolii*, *M. prurita*, *M. utilis*, *Stizolobium aterrimum*, *S. deeringianum*, *S. pruriens*, *S. pruritum*, *S. niveum*, *Negretia pruriens*

Common names: Cowitch, Cowhage, Velvet Bean, Cow-itch, Buffalo bean velvet bean, mucuna, nescafe, podemico, fava-coceira, cabeca-de-frade, cowage, cowhage, cow-itch, bengal bean, mauritius bean, itchy bean, krame, picapica, chiporro, buffalo bean, Bengal velvet bean, Florida velvet bean, Mauritius velvet bean, Yokohama velvet bean, cowage, cowitch, lacuna bean, Lyon bean.^{12,13}

Other names¹⁴

Bengali- Alkusa, Alkushi
 English- Cowhage, Couritch plant
 Gujarati- Kivanch
 Hindi- Kawaanch, Kavach
 Kannad- Nasugunni
 Konkani- Khavalyavali, Majram
 Malayalam- Nayikuruma, Shoriyanam
 Marathi- Kuhili
 Punjabi- Kawanchi, Gugli, Kavanch
 Tamil- Punaikkali, Poonakkate
 Telgu- Dulagondi, Pilliadagu

Table 1: *Mucuna* species reported in India.²⁴

S.No	Indian <i>Mucuna</i> species
1.	<i>Mucuna atropurpurea</i> , DC.
2.	<i>Mucunabracteata</i> , DC.
3.	<i>Mucunacapitata</i> , Wight & Arn.
4.	<i>Mucuna cochinchinensis</i> (Lour.) Cheval
5.	<i>Mucunadeeringiana</i> , (Bort) Merrill
6.	<i>Mucunagigantea</i> , DC.
7.	<i>Mucunahirusta</i> , Wight & Arn
8.	<i>Mucunamonosperma</i> , DC.
9.	<i>Mucunanigricans</i> , DC.
10.	<i>Mucunapruriens</i> (Linn.) DC.
11.	<i>Mucunaprurita</i> , Hook
12.	<i>Mucunaurens</i>
13.	<i>Mucunautilus</i> , Wall
14.	<i>Mucunamacrocarpa</i> Wall.

Therapeutic uses of *M. pruriens*

- *M. pruriens* cure night dreams, impotency and promote fertility, for sexual debility, seminal weakness and spermatorrhea, as an aphrodisiac to increase seminal fluid and manly vigour, emmenagogue, antivenin, nervine, for abortion, diarrhea, diabetes, gonorrhoea, muscular pain, persistent coughs, pulmonary tuberculosis, rheumatic disorders, scorpion stings and snakebite, worm infestation, sterility and general debility.¹⁵
- According to Ayurveda, seeds are astringent, laxative, astringent, laxative, anthelmintic, aphrodisiac, alexipharmic and tonic. Seeds are found to have antidepressant properties in cases of depressive neurosis when consumed²¹and

formulations of the seed powder have shown promise in the management and treatment of PD.²²

- Seeds possess anabolic, androgenic, analgesic, anti-inflammatory, antispasmodic, antivenom, aphrodisiac, febrifuge, cholesterol lowering, hypoglycemic, immune modulator, antilithiatic, antibacterial, antiparasitic, cough suppressant, blood purifier, carminative, hypotensive, and uterine stimulant properties.^{24,28}

Table 2: Worldwide ethnobotanical uses.⁶

Country	Use
Brazil	Anthelmintic, aphrodisiac, diuretic, food, hydropsy, intestinal worms, nerve tonic, poison
Germany	Carminative, cholesterol, hypotensive, hypoglycemic, muscle pain, rheumatism, rubefacient, worms
India	Abortion, alterative, anthelmintic, antivenin, aphrodisiac, cancer, catarrh, cholera, cough, debility, delerium, diabetes, diarrhea, diuretic, dropsy, dysentery, dysmenorrhoea, emmenagogue, fertility, gout, impotency, irritant, lithiasis, nerve tonic, nervine, night dreams, scorpion sting, snakebite, spermatorrhea, sterility, tuberculosis, uterine stimulant, worms
Nigeria	Snakebite
Pakistan	Aphrodisiac, diabetes
Elsewhere	Anasarca, anodyne, anthelmintic, antidotal, aphrodisiac, asthma, burns, cancer, cholera, cough, cuts, diarrhea, diuretic, dogbite, dropsy, emmenagogue, insanity, intestinal parasites, mumps, nervine, paralysis, pleuritis, resolvent, ringworm, rubefacient, snakebite, sores, syphilis, tumors, vermifuge, wind-burns, worms

Benefits of M. pruriens⁵¹

Improved sleep (promotes deep sleep), reduced body fat & decreased cellulite, decreased wrinkles, improved skin texture & appearance, increased bone density and reversal of osteoporosis, increased lean muscle mass, improved mood and sense of well-being, enhanced libido & sexual performance, increased energy levels, improved cholesterol profile & regeneration of organs (heart, kidney, liver, lungs, dramatically strengthen immune system).

Side effects of M. pruriens⁵²

- Increased serum levels of L-Dopa from consumption of Mucuna bean leads to high concentration of dopamine in peripheral tissues.
- It induces antiphysiological effects such as nausea, vomiting, anorexia, paranoid delusions, hallucinations, delirium and unmasking dementia.
- The most common side effects found in the body is a sensation of abdominal bloating and nausea.
- Other side effects observed during cowhage preparations include headache, pounding heartbeat, and symptoms of psychosis including confusion, agitation, hallucinations, and delusions.
- The hair of the cowhage bean pod is a strong irritant and can cause severe itching, burning, and swelling if it is taken by mouth or applied to the skin.
- Less common side effects include vomiting, abnormal body movements, and insomnia.

Contraindications⁶

- The seed is a known teratogen and has uterine stimulant activity and should not be used during Pregnancy.
- Velvet bean is contraindicated in combination with M.A.O. inhibitors.

- Velvet bean has androgenic activity, increasing testosterone levels. Persons with excessive
- Androgen syndromes should avoid using Velvet bean.
- Velvet bean inhibits prolactin. If you have a medical condition resulting in inadequate levels of Prolactin in the body, do not use Velvet bean unless under the direction of your healthcare Practitioner.
- The seed contains high quantities of L-dopa. Levodopa is the pharmaceutical medication used for Parkinson's disease. Those with Parkinson's should only use Velvet bean under the supervision of a qualified healthcare practitioner.

Drug interactions⁶

- May potentiate androgenic medications.
- May potentiate hypoglycemic medications.
- May potentiate levodopa.

Phytochemistry

Major chemical constituents

1-Methyl-3-carboxy-6,7 -dihydroxy-1-,2, 3,-4Tetrahydroisoquinolone, 5-oxyindole-3-alkylamine, Alanine (Amino acid), Alkylamine, 5-oxyindole-3 Alkylamine, indole-3 Amino acid analysis (Proteid), Arachidic acid, Arginine (Amino acid), Aspartic acid, Behenic acid, Beta carboline, Calcium, Carbohydrates, Carboline, beta, Cis-12,13-epoxyoctadec-trans-9-cis-acid, Cis-12,13-epoxyoctadec-trans-9-enoic acid, Chymotrypsin Inhibitor, Cystine (Amino acid), DOPA- L (Proteid), Fat, Fatty acids, unsaturated, Flavone, 4'-5-6-trihydroxy-3'-7-8-trimethoxy4'-O-beta-d-xylopyranosyl(1-2)-O-alpha-1-rhamnopyranoside) (Flavone), Galactose, D (Carbohydrate), Gallic acid, Glycine, Glutamic acid, Glutathione, Histidine (Amino acid), Iron (Inorganic), Indole-3-alkylamine, Isoleucine, Lecithin (Carbohydrate), Leucine (Amino acid), Leucine, iso, Linoleic

acid, Linolenic acid (Lipid), Lysine (Amino acid), Mannose, D (Carbohydrate), Methionine (Amino acid), Mucunadine, Mucunain, Mucunine, Mucuna polysaccharide (Carbohydrate), Mucunapuriens alkaloid P, Mucunapuriens alkaloid Q Mucunapuriens alkaloid R Mucunapuriens alkaloid S, Mucunapuriens alkaloid X (Alkaloid-misc), Myristic acid, Niacin (Inorganic), N,N-Dimethyltryptamine, N,N-Dimethyltryptamine-n-oxide, Nicotine, Oleic acid, Palmitic acid, Palmitoleic acid (Lipid), Phenylalanine (Amino acid), Phosphorus (Inorganic), Polysaccharide (Carbohydrate), Proline (Amino acid), Protein (Protein), Prurienidine, Prurieninine (Alkaloid-misc), Quinoline, iso: 1-2-3-4-tetrahydro (Isoquinoline Alkaloid), Riboflavin (Inorganic), Saponins (Saponin), Serine (Amino acid), Serotonin, Sitosterol, (beta Sterol), Stearic acid, Stizolamine (Alkaloid), Thiamin (Inorganic), Threonine (Amino acid), Trypsin, Tryptamine, Tyrosine (Amino acid), Valine, Vernolic acid (Lipid).^{15,16} *M. pruriens* seeds contain high concentrations of L-DOPA, an unusual non protein amino acid and a direct precursor to the neuro transmitter dopamine, an important brain chemical involved in mood, sexuality and movement. Besides, it also contains some other amino acids, glutathione, lecithin, gallic acid and beta sitosterol. The mature seeds of the plant contain about 3.1 to 6.1% L-DOPA, with trace amounts of 5-hydroxy tryptamine (serotonin), nicotine, dimethyl tryptamine (DMT), bufotenine, 5-MeO-DMT and beta-carboline.^{19,23} Extract of the whole herb is reported to have L-dopa as a major constituent and mainly in seeds.²⁴⁻²⁶ Four alkaloids in *M. pruriens* seeds were recently reported. They are L- 3- carboxy- 1, 2, 3, 4- tetrahydroisoquinoline, (-)- 1- methyl- 3carboxy- 6, 7- dihydroxy- 1, 2, 3, 4- tetrahydroisoquinoline, dimethyl- 3carboxy- 6, 7- dihydroxy- 1, 2, 3, 4- tetrahydroisoquinoline and (-)- 1- 3- carboxy- 1, 1- dimethyl- 7, 8- dihydroxy- 1, 2, 3, 4- tetra hydroisoquinoline.^{24,27}

L-DOPA¹⁹

The presence of L-DOPA, a precursor of dopamine in the seeds of *M. pruriens* made the plant valuable in the treatment of PD. *M.*

pruriens is used in Ayurvedic medicine to treat diseases of the central nervous system and geriatric disorders. L-DOPA is present at about 1% by fresh weight in leaves and roots of *M. pruriens*. There was no significant difference in the content of L-DOPA when *M. pruriens* was grown under shade or open conditions. The variation of L-DOPA contents in different parts of *Mucuna* species, namely, fully matured seeds 3.6 to 4.2%, pod-pericarp 0.14 to 0.22%, leaves 0.17 to 0.35%, stems 0.19 to 0.31% and roots 0.12 to 0.16% and the highest amount of L-DOPA was found in half mature seeds. The content of L-DOPA in the seeds of different accessions ranged from 7.62 to 8.37%. The isolation of L-DOPA (1.5% on dry weight basis) from *Mucuna* seeds is carried using different extraction procedures. A high performance liquid chromatographic assay for the extraction and quantitative determination of L-DOPA in *M. pruriens* var *utilis* seeds is reported. Scientists reported that high performance liquid chromatography (HPLC) analysis revealed L-DOPA concentrations ranged from 3.9 to 6.2% in *Mucuna* seeds.

Physiology

Antiparkinson's activity

Parkinsonism is treated by the administration of powdered seed of *M. pruriens* containing 4 to 6% of levodopa.^{19,29} For the dose, *M. pruriens* showed twice the anti-Parkinsonian activity of synthetic L-DOPA.^{19,30} Clinical study revealed the contribution of L-DOPA in the recovery of PD followed by Ayurveda medication.^{19, 31} 30 g *Mucuna* seed powder preparation has considerable faster action in treating PD patients than conventional standard drugs, namely, Levodopa or Carbidopa and suggested that natural source of L-DOPA might possess advantages over conventional drugs in long term management of PD.^{19,31} *M. pruriens* cotyledon powder significantly increased the brain mitochondrial complex-I activity but did not affect the total monoamine oxidase activity (in vitro) as having Nicotine adenine dinucleotide (NADH) and coenzyme Q-10 in the cotyledon powder which are shown to have a therapeutic benefit in Parkinson's disease. Unlike synthetic

levodopa treatment, *M. pruriens* cotyledon powder treatment significantly restored the endogenous levodopa, dopamine, norepinephrine and serotonin content in the substantianigra.^{1,19,24,33}

Aphrodisiac activity

M. pruriens seed powder rejuvenates the harmonic balance of male reproductive hormones in infertile men and reactivates the enzymatic activity of metabolic pathways and energy metabolism.³⁴ On treatment with *M. pruriens* significantly improves psychological stress and seminal plasma lipid peroxide levels along with improved sperm count and motility and also restored the levels of SOD (Super Oxide dismutase), catalase, GSH (Glutathione) and ascorbic acid in seminal plasma of infertile men which was found to be low before the treatment.³⁵ Dose and time-dependent effects of ethanolic extract of *M. pruriens* Linn. Seed produced a significant and sustained increase in the sexual activity of normal male rats at a particular dose (200 mg/kg) by enhancing the various sexual activity like mounting frequency, intromission frequency and ejaculation latency.³⁶ Effect of *M. pruriens* on semen profile and biochemical parameters showed significantly inhibited lipid peroxidation, elevated spermatogenesis, and improved sperm motility. Treatment also recovered the levels of total lipids, triglycerides, cholesterol, phospholipids, and vitamin A, C, and E and corrected fructose in seminal plasma of infertile men.³⁷ *M. pruriens* improves male fertility by its action on the hypothalamus–pituitary–gonadal axis. After the treatment with *M. pruriens* significant improvement were observed in T, LH, dopamine, adrenaline, and nor-adrenaline levels in infertile men and reduced levels of FSH and PRL. The sperm count and motility were significantly recovered in infertile men after treatment not only reactivates the anti-oxidant defense mechanism, but also helps in the management of stress and improves semen quality.^{38,40} *M. pruriens* and its Major Constituent L-DOPA Recover spermatogenic loss by combating ROS, loss of mitochondrial membrane potential and apoptosis.^{1,19,24,39}

Hypoglycemic activity

The hypoglycemic activity of *M. pruriens* ethanolic extract in alloxan induced rats and streptozotocin induced mice produced the maximum activity at 6th week in 200mg/kg/day dose 38. A comparative study of the hypoglycemic effect of aqueous extract of the seeds of *M. pruriens* between normal, glucose load conditions and streptozotocin induced diabetic rats were analyzed. The results showed that in normal rats, the aqueous extract of the seeds of *M. pruriens* (100 and 200 mg/kg body weight) significantly ($p < 0.001$) reduced the blood glucose levels after an oral glucose load from 127.5 ± 3.2 to 75.6 ± 4.8 mg % 2 h after oral administration of MPE seed extract. It also significantly lowered the blood glucose in streptozotocin-induced diabetic rats from 240.5 ± 7.2 to 90.6 ± 5.6 mg% after 21 days of treatment ($p < 0.001$).⁴¹ Thus, antidiabetic activity of *M. pruriens* seeds was present in the methanolic and ethanolic fractions of the extract.⁴²

Antivenom activity

The protective effects of *M. pruriens* seed extract (MPE) against histopathological changes induced by intravenous injection of *Najas putatrix* (Malayan cobra) venom in rats pretreated with the MPE seed extract was examined. Examination by light microscope revealed that the venom induced histopathological changes in heart and blood vessels in liver, but no effect on brain, lung, kidney and spleen. The induced changes were prevented by pretreatment of the rats with MPE. Finally it is suggested that MPE pretreatment protects rat heart and liver blood vessels against cobra venom induced damages. MPE pretreatment was given to rats and the animals were challenged with various snake venoms. The effectiveness of MPE to neutralize the lethality of snake venoms was investigated by *in vitro* neutralization and concluded as MPE effectively protect the animal models against lethality of *Najas putatrix* venom and moderate protection against *Calloselasma rhodostoma* venom.^{24, 43}

Antioxidant activity

The antioxidant activity on *in vivo* models of lipid peroxidation concluded that the seed ethanolic extract of *M. pruriens* has an antilipid peroxidation property which is mediated through the removal of super oxides and hydroxyl radicals.⁴⁴ Experiment on *in vitro* lipid peroxidation of *M. pruriens* seeds revealed the inhibition of ascorbate/FeSO₄ induced peroxidation by methanolic extract of *M. pruriens* which was monitored by the changes in optical density of the prepared concentrations (10-320 µg/ml). The inhibition increased with increase in concentration of the extract.^{24,45}

Antimicrobial activity

This research involves the study of antibacterial activity of root and seed of *M. pruriens*. The hexane, petroleum ether, benzene and aqueous extracts of root and seed were tested against *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Escherichia coli* using disc diffusion method. The methanolic extract showed high antibacterial activity against *Erwiniacarotovora*, *Pseudomonas syringae*, *Pseudomonas marginalis*, *Pseudomonas aeruginosa*, *Xanthomonascampestris* and high anti fungal activity against *Curvularia lunata*, *Fusarium oxysporum*, *Pencillium expansum*, *Rhizoctoniasolani*, *Tiarosporellaphaseolina*, *Ustilagopomaydis*.^{19,47} The results show that the extracts possess the various degrees of significant inhibitory effect against the tested organisms.^{1,46}

Anti-depressant activity

This involves the study of anti-depressant-like effects of *M. pruriens* acute and chronic model of depression. Psycho-pharmacological investigation involved treatment (14 days) of mucuna in forced swim test (FST), tail suspension test (TST) in mice and olfactory bulbectomy in rats, respectively. The investigations results show the initial anti-depressant-like effect of Mucuna (10-20 mg/kg i.p.) or the mucuna (10 mg/kg) significantly enhanced the anti-depressant action of fluoxetine and bupropion in mice FST and TST

respectively. Potentiation of 5-Hydroxytryptophan induced head twitches response (in mice) and reversal of reserpine induced hypothermia (rats) were observed at same dose level. Further, the behaviour anomalies exhibited by olfactory bulbectomised rats (OBX) were attenuated by chronic mucuna treatment as observed in open field.^{1,48}

Anti-inflammatory activity

This study involves evaluating the effect of the methanolic extract of *M. pruriens* seed in mice with respect to delayed hypersensitivity reaction (DTR), primary and secondary antibody response and *in vivo* inflammatory leucocyte mobilization. The extract caused elevation of secondary SRBCs-specific antibody titre with antibody response being significantly ($p < 0.05$) increased at 250 and 500 mg/kg when compared with control. The results shows that the extract at 250 and 500 mg/kg produced significant ($p < 0.05$) inhibition of DTR in mice by 33.33% and 28.89%, respectively and hence, can probably influenced immune response in mice.^{1,49}

Antitumour activity

Methanolic extract of *M. pruriens* seed against Erlich Acites Carcinoma (EAC) bearing Swiss albino mice was administered at 125 and 250 mg/kg body weight once daily for 14 days, starting after 24 h of tumor inoculation. Decrease in tumor volume, packed cell volume and viable cell count were observed in extract treated animals when compared to EAC treated animals. Treatment with extract at a dose of 125 and 250 mg/kg increased the mean survival time to 29.5 ± 0.55 and 34 ± 0.2 days respectively. The extract also decreased the bodyweight of the EAC tumor bearing mice. There was as significant decrease in WBC count and increase in RBC counts in extract treated animals when compared to EAC treated animals. The study was also extended to estimate the liver biochemical parameters such as LPO, GSH and antioxidant enzymes like SOD, catalase etc. Treatment with extract decreased the levels of lipid peroxidation and increased the levels of glutathione, superoxide dismutase and catalase. The results suggest that the methanolic extract of *M.*

pruriens seeds exhibits significant antitumor and antioxidant effects in EAC bearing mice.^{24,50}

Funding: No funding sources

Conflict of interest: None declared

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