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A COMPREHENSIVE REVIEW ON ETHNOPHARMACOLOGY, PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITY OF AMAZING VELVET BEAN: *MUCUNA PRURIENS* (L.)

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ABSTRACT

Ayurveda is one of the oldest medical systems that treats and manages a variety of illnesses using plants and their extracts. *Mucuna pruriens* (L.) is a well known ayurvedic medicine for neurological, male fertility and libido belonging to fabaceae family. This plant contains a wide variety of phytochemical constituents that have been identified. *Mucuna pruriens* (L.) is widespread in tropical and subtropical regions of the world. Considering the many recent outcomes on this plant that are significant, a detailed explanation of the morphological, phytochemistry, traditional usage, pharmacological actions presented are given.

KEYWORDS: Mucuna pruriens, Phytochemistry, L-Dopa, Anti-Parkinson's activity.

INTRODUCTION

For thousands of years, natural ingredients have been used by humans as a source of medication. Only those traditional medications that principally employ medicinal plant preparations for therapy are considered herbal pharmaceuticals. The World Health Organization defines traditional medicine as the culmination of generations of indigenous medical systems' therapeutic experiences. Many plant parts, including the root, stem, bark, seed, and leaf, have been used for millennia to cure and prevent a wide range of illnesses and diseases. These parts have also proven to be an enormous resource for the discovery of new medications.[1]

Mucuna pruriens

M. pruriens, also referred to as velvet bean, is a tropical twining herb that is a member of the Fabaceae family. The plant is a shrub which climbs annually that may reach a maximum length of 15 meters in its tendrils. It is known that the *M. pruriens* bean produces the unique strong neurotransmitter L-dopa, a non-protein amino acid.[2] The valvet bean has been utilized in Ayurvedic medicine since ancient times to treat Parkinson's disease, a common age-related neurodegenerative disorder that is linked to the progressive degeneration of dopaminergic neurons in particular brain areas. Because of the high concentration of L-dopa in the seeds, more than four million individuals worldwide are impacted by it, either for nervous system problems or other reasons.[3] Scientists from various countries have found that mucuna is a highly nutritious crop that can be used as fodder and as an excellent addition to livestock diets. The demand for mucuna is increasing daily due to its potency as a medicine.[4]

Table 1: Vernacular Names.[5,6]

Sanskrit	Atmagupta, Kapikacchu
Hindi	Kiwach, Konch
English	Velvet bean, Cowhage, Cowitch, Itchy bean
Marathi	Khaajkuiri
Tamil	Poonaikkaali
Gujrati	Kavach, Kaucha
Bengali	Alkushi

Table 2: Taxonomy of *Mucuna pruriens.*

Kingdom	Plantae, Planta, Planter, Plants, Vegetal.
Sub Kingdom	Tracheobionta, Vascular Plants
Division	Magnoliophyta. (Angiospeens)
Class	Magnoliopsida (Dicote, Dicotyledon)
Sub class	Rosidae
Order	Fabales
Family	Leguminoseae
Sub Family	Fabaceae
Genus	Mucuna
Species	pruriens

Geographical Distribution

It is native to tropical and subtropical areas, particularly the West Indies, Africa, and India. It is widely distributed throughout the majority of the subcontinent and can be found in India's plains' bushes, hedges, and dry-deciduous low forests.[7] In India, 14 species of Mucuna are commonly found in the Andaman & Nicobar islands, Madhya Pradesh, Karnataka, Kerala,

Andhra Pradesh, Uttar Pradesh, the foothills of the Himalayas, and the plains of west Bengal.[8]

Cultivation

It is a kharif season crop grown in plains, where the seeds are sown as soon as the first shower occurs (June-July). Delays in sowing can have a negative impact on yield.[9] As a leguminous crop, less phosphorus and nitrogen are needed in the soil. It grows well in acidic soil (pH<5-8), humid areas with annual rainfall > 400 mm, and annual temperatures between 19 and 27ºC.[10] During the rainy season, the soil retains adequately moist, so the plant doesn't need any extra irrigation. The vines of the plant require outside assistance to climb and crawl as it grows and develops. The pods fully develop in December and are harvested after January. The pods are dried in the sun for four to five days before being threshed to remove seeds.[11]

Morphological characters

Leaves- *M. pruriens* is an annual herbaceous legume with long, thin branches that twines and climbs. When the plant is young, it has fuzzy hairs all over it, but as it gets older, the hairs almost completely fall out of it.[12] The petioles are long and silky, ranging 6.3 to 11.3 centimeters; the leaves are trifoliate, alternate or spiraled, and gray-silky beneath. Stipules, which can resemble leaves, thorns, or be very inconspicuous, are always present.[13] The margins of leaves are entire or sometimes serrated. The leaflets are membrane-bound, with smaller terminal and lateral leaflets that differ greatly in size.[14]

Flowers- Flowers are usually bisexual, actinomorphic to zygomorphic, slightly to severely perigynous, and range in color from white to dark purple. They also hang in long clusters or pendulous racemes, spikes, or heads.[6] One or more stamens, which are usually independent or sometimes irregularly connected, are present in the perianth. Pistils are typically relatively simple, consisting of a superior ovary with a single locule containing two or more marginal ovules, a single style, and a stigma.[15]

Pods- The pods are half an inch in width and 2 to 3 inches in length. They resemble letters with blunt tips, minor covering at both ends, and a slight longitudinal ridge running through them. These are turgid, explosively dehiscing pods. The pod is densely covered with many brief, hard or stiff, and feeble hairs that are not quickly separated. The initial color of the

hairs is a light yellowish brown or a somewhat rusty brown; however they ultimately become grey steel. Pods contain four to six seeds, or more, separated by partitions or septa.[3,16]

Seeds-The mucuna bean seeds have an oval or reniform shape, measuring 15-20 mm in length, 7-15 mm in width, and 4 to 6.5 cm in thickness. It has a thick seed coat, shiny, firm, & speckled sporadically. The embryonic seed consists of two big cotyledons that fill the seed.[17] The hilum, the base of the funiculus (the placenta's attachment to plant seeds), is covered in a thick layer of arillus, a fleshy seed shell.[18]

Leaves **Flowers** **Pods** **Seeds**

Fig. 1: Morphology of different part of Mucuna *pruriens*.

TRADITIONAL USES[6,20,21,22]

Roots- Aphrodisiac, diuretic, emmenagogue, anthelmintic, febrifuge, stimulant, purgative, bitter, thermogenic, emolient, tonic and Parkinson's disease. They are useful in treating vitiated vata and pitta diseases, ulcers, helminthiasis, fever, delirium, elephantiasis, dropsy, dysmenorrhea, amenorrhea, nephropathy, constipation, and dysmenorrhea, according to Ayurveda.

Leaves- The leaves are good for general weakness, helminthiasis, ulcers, and inflammation. They are tonic, anthelmintic, and aphrodisiac as well.

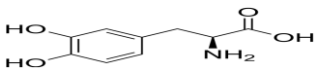
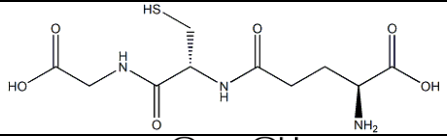
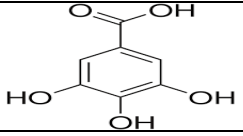
Seeds- It has a long history of usage in Indian Ayurvedic medicine, where it is prescribed for a variety of conditions including gout, delirium, dysmenorrhea, worms, dysentery, diarrhea, snakebite, sexual debility, cough, TB, impotence, rheumatic disorders, and muscular discomfort. It is used as a diuretic, emmenagogue, uterine stimulant, aphrodisiac, and blood purifier in India. For decades, people in Central America have ground and roasted mucuna beans to make a coffee substitute; this practice is known as nescafé. As a vegetable, the bean is cooked. The seed has been used internally in Brazil to treat worms, intestinal gas, edema, impotence, and Parkinson's disease. It is regarded as a nerve tonic, aphrodisiac, and diuretic. Ulcers are treated with it externally. Seeds are laxative, anthelmintic, aphrodisiac,

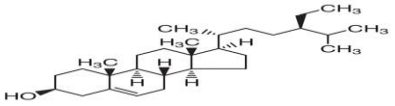
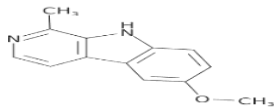
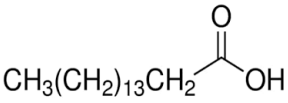
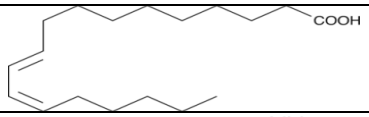
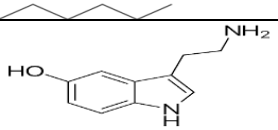
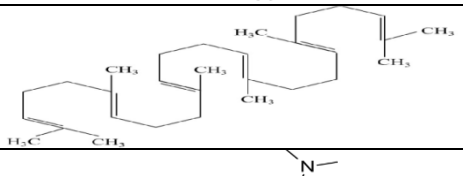
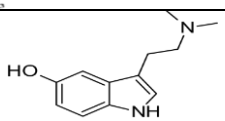
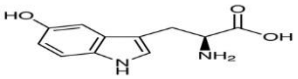
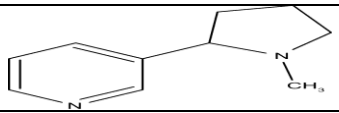
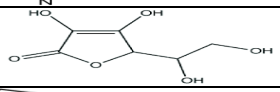
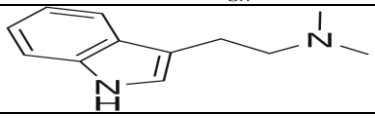
alexipharmic, and tonic properties. They help with gonorrhea, consumption, sterility, vata vitiated conditions, and overall weakness. Both the flowers and the hairs are vermifuge. Mucuna seed powder is used to treat Parkinson's disease in the Ayurvedic system.

PHYTOCHEMISTRY

The unusual nonprotein amino acid 3-(3, 4-dihydroxyphenyl)-l-alanine (L-DOPA) is reportedly produced by velvet bean seeds.[23] Beta-sitosterol, gallic acid, and glutathione are also present. Mucunine, mucunadine, prurienine, and prurieninine are some of its unidentified bases. Other bases that were separated from the seeds, roots, leaves, and pods include indole-3-alkylamines-N, N-dimethyltryptamine. The leaves also yielded 6-methoxyharman. Only pods contain serotonin.[19] Oleic, linoleic, stearic, and palmitic acids make up the oils found in the seeds.[24] An examination using gas chromatography-mass spectrometry revealed that the plant extract contained phytochemicals such as octadecanoic acid (6.21%), n-hexadecanoic acid (48.21%), squalene (7.87%), oleic acid (7.62%), and ascorbic acid (3.80%).[25] Two tetrahydroquinoline alkaloids, 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, are additionally found in the seed.[26] Serotonin (5-hydorxy tryptamine, 5-HT), 5-hydorxy tryptophane (5-HTP), nicotine, N, N-dimethyl tryptamine (DMT), bufotenine, and 5-imethoxy-N, N-dimethyl tryptamine (5-MeODMT) 5-imethoxy-N,N-dimethyl tryptamine-noxide (5-MeO-DMT-n-oxide) are also present. Mature plant seeds have a concentration of 3.1-6.1% L-DOPA along with trace levels of nicotine, serotonin, betacarboline, 5-MeO-DMT-n-oxide, and bufotenine. The leaves contains around 0.0025% 5-MeO-DMT, 0.006% DMT, 0.003% DMT n-oxide, and 0.5% LDOPA.[22,27,28] Table 3 lists the structures of the active ingredients.

Table 3: Structure of chemical components of *Mucuna pruriens*.[26,29,30]

Chemical compound	Structure
L-dopa(L-3,4-dihydroxyphenylalanine)	
Glutathione (γ-l-glutamyl-l-cysteinylglycine)	
Gallic acid (3,4,5-trihydroxybenzoic acid)	

Beta-sitosterol	
6-methoxyharman	
Palmitic acid (hexadecanoic acid)	
Stearic acid (octadecanoic acid)	
Linoleic acids	
Serotonin (5-hydroxytryptamine)	
Squalene	
Bufotenine	
5-hydorxy tryptophane	
Nicotine	
Ascorbic acid	
indole-3-alkylamines-N, N-dimethyltryptamine	

PHARMACOLOGICAL ACTIVITY

Every part of the mucuna plant has therapeutic qualities. L-dopa (about 5%) is known to be the main phenolic component found in mucuna seeds. Mucuna is currently a topic of extensive research since L-dopa is a medication used as a first-line treatment for Parkinson's disease. According to several research, when L-dopa extracted from *M. pruriens* given to Parkinson's patients offers many advantages over synthetic L-dopa because long-term use of synthetic L-dopa can result in a number of negative effects. Over the past few decades, mucuna has been investigated for a number of pharmacological properties. Pharmacological

research indicates that Mucuna is a prominent ingredient in formulations of polyherbal extracts used to treat many medical conditions. A few recent instances are covered in the below.[31,32]

Table 4: Pharmacological activity of Mucuna pruriens and its compounds.

Pharmacological Activity	Plant Part	Extract	Material/Compound	Reference
Anti-venom	seeds	water	Proteins(gpMuc)	34,35,36
Antioxidant	seeds, leaves, whole plant	methanol	Phenol, tannins	37,38,39
Antidiabetic	seeds	Ethanol:water (1:1)	cyclitols, oligosaccharides	40,41,42
Neuroprotective	Seeds, whole plant	Ethanol:water (1:1)	L-dopa, amino acids, alkaloids	26,47,48,49
Antimicrobial	leaves	methanol	Tannins, alkaloids, L-dopa	51,52,53

Antivenom activity

M. pruriens is one of the plants that anti-snake venom properties have been demonstrated. In fact, traditional medicine uses the seeds of this plant to prevent the toxic effects of snake bites, which are primarily caused by strong toxins like phospholipase A2 (PLA2), neurotoxins, cardiotoxins, and proteases. In a study examining the effects of echis carinatus venom (EV), the processes underlying the protective properties of *M. pruriens* seed aqueous extract (MPE) were thoroughly examined.[34] Mice were used in vivo tests, and the results indicated that protection against the poison became apparent 24 hours (short term) and 1 month (long term) after MPE injection. Using an immunological mechanism, MPE shields mice from the harmful effects of EV. An immune-stimulating component found in MPE is a multiform glycoprotein, which binds to specific venom proteins and causes an antibody to be produced.[35,36]

Antioxidant Activity

In vivo models of lipid peroxidation using antioxidant activity revealed that an oral dose of 60 mg/100 mg body weight of the *M. pruriens* seed extract was shown to significantly reduce lipid peroxidation caused by immobilization stress and alloxan for duration of 30 days. Since it doesn't cause any peroxidation, the extract by itself has no harmful effects at this dosage.

In vitro investigation that *M. pruriens* exhibits dose-dependent defense against the creation of superoxide, hydroxyl radicals, and lipid peroxidation brought on by FeSO4. They provide protection by either directly chelating free iron or by eliminating free radicals.[37]

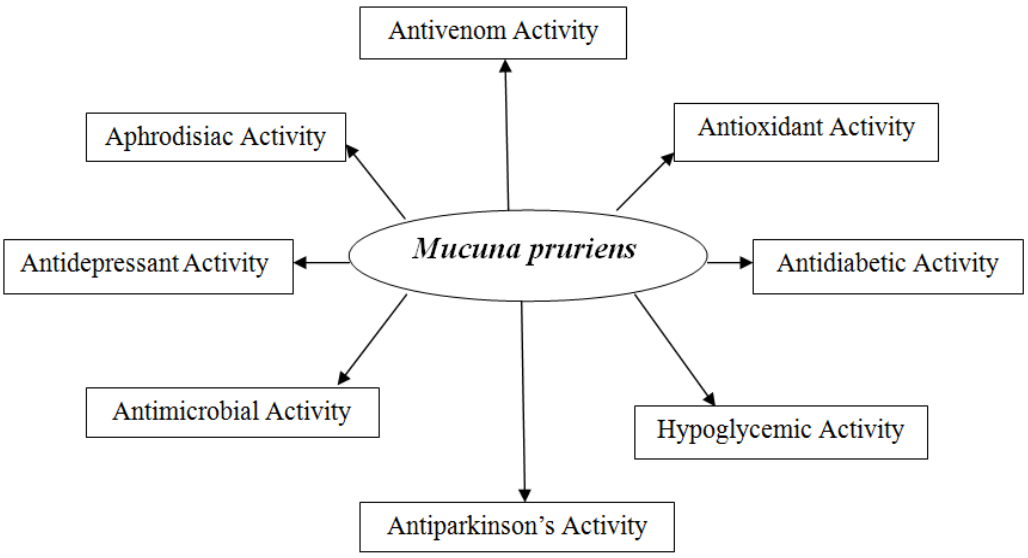
According to in vitro tests show entire plant of *M. pruriens*, containing significant levels of phenolic compounds, showed strong antioxidant and free radical scavenging properties. These plant extracts were a significant source of naturally occurring antioxidants that may be useful in slowing the development of different oxidative stresses.[38]

Antidiabetic Activity

Numerous researches have confirmed *Mucuna pruriens* Linn.'s antidiabetic efficacy. This *M. pruriens* property was observed in wistar rats that were given a single 120 mg/kg intravenous injection of alloxan monohydrate to induce diabetes. The rats with diabetes were then given varying amounts of the extract. The outcomes were contrasted with diabetic rats that were not receiving any medical attention. The crude ethanolic extract of *M. pruriens* seeds was administered at doses of 5, 10, 20, 30, 40, 50, and 100 mg/kg to rats with diabetes caused by alloxan (plasma glucose > 450 mg/dL). After 8 hours of treatment, the diabetic rats' blood glucose levels decreased by 18.6%, 24.9%, 30.8%, 41.4%, 49.7%, 53.1%, and 55.4%, respectively, while glibenclamide dosage: 5 mg/kg daily led to a 59.7% decrease. The extract was administered continuously, and the blood glucose level significantly decreased in response to the dose ($P<0.001$). It proved that the antidiabetic properties of *M. pruriens* seeds are present in both the methanolic and ethanolic fractions of the extract.[42]

Using both chromatography and NMR methods, it was demonstrated that two galacto-derivatives of D-chiro-inositol found in M. pruriens seed exhibit antiglycaemic properties.[45]

SUMMARY OF ALL PHARMACOLOGICAL ACTIVITY OF *MUCUNA PRURIENS*



Hypoglycemic activity

The hypoglycemic effects of the aqueous extract of *M. pruriens* seeds were investigated in rats treated with streptozotocin (STZ) and in rats with normal glucose loads. Two hours after the seeds were orally administered, the blood glucose levels of normal and STZ diabetic rats were significantly reduced by the aqueous extract of *M. pruriens* seeds (100 and 200 mg/kg body weight). In STZ diabetic rats, the extract significantly decreased blood glucose levels after 21 days of daily oral dosing. Thus, it was amply proven that *M. pruriens* may be a source of hypoglycemic compounds.[46]

Anti-Parkinson's activity

Traditionally, *M. pruriens* has been utilized as a nerve tonic for nervous system illnesses. The high level of L-dopa in the seeds has led to research on their potential application in Parkinson's disease. It was proved that *Mucuna pruriens* is more effective than L-DOPA in parkinson's disease in animal mode.[47] As per "Bhasava Rajyam," powdered *M. pruriens* seed containing 4–6% levodopa was administered to cure Parkinson's disease.[48] On the basis of its parkinsonian effect, clinical trials had been conducted. The eight patients received weekly treatments of 15 and 30 gm of *M. Pruriens* seed powder formulation for three weeks. A single 200/50 mg combination dose of L-DOPA and carbamazepine was administered as the standard. The longer duration of action of seed powder indicated that it could be beneficial for people with Parkinson's disease that suffer severe side effects from synthetic medications.[49]

Antimicrobial Activity

Utilizing its antibacterial qualities, *Mucuna pruriens* has been used to extract plant metabolites that combat plant-pathogenic fungus and bacteria.[50] The presence of phenols and tannins in crude MEMP leaves is likely the reason for their modest effectiveness against certain bacteria.[51] The entire plant's methanolic extract exhibited antibacterial qualities against both gram-positive and gram-negative organisms. Salmonella typhi, Bacillus subtilis, Shigella dysenteriae, and Escherichia coli are the principal microorganisms that this extract is effective against. Zone of inhibition (ZI) was used to determine the antibacterial potency; Escherichia coli showed a larger ZI (2.8 cm) than Bacillus subtilis (2.1 cm).[52,53]

Antidepressant Activity

M. pruriens' antidepressant efficacy in acute and chronic depression models was investigated. In a psycho-pharmacological study, *M. pruriens* was treated for 14 days in the forced swim

test (FST), tail suspension test (TST) in mice, and olfactory bulbectomy in rats. With dose of Mucuna (10-20 mg/kg i.p.) greatly increased the anti-depressant action of fluoxetine and bupropion in mice FST and TST correspondingly. At the same dosage level, rats showed reversal of reserpine-induced hypothermia while mice showed potentiation of 5-hydroxytryptophan-induced head twitches. Additionally, long-term mucuna therapy reduced the behavioral abnormalities in open-field observations of olfactory bulbectomized rats (OBX).[54,55] In TST and FST, Methanolic extract of *Mucuna pruriens* seeds (MEMP) showed a substantial reduction in the time of immobility, indicating antidepressant action.[56]

The hydroalcoholic extract of *M. pruriens* seeds (MPE) at 100 and 200 mg/kg, p.o., was found to have an antidepressant effect in mice using the Tail Suspension Test (TST), Forced Swimming Test (FST), and Chronic Unpredictable Mild Stress (CUMS) tests. After administering haloperidol (0.1 mg/kg, i.p.) and bromocriptine (2 mg/kg, i.p.) on the seventh day of MPE therapy, the dopaminergic interaction of the same dosages of MPE in the FST and TST was examined. Actophotometer was also used to assess the impact of MPE on locomotor activity. The immobility time in the FST and TST was significantly reduced by MPE. Furthermore, in the FST and TST, haloperidol significantly reduced the antidepressant effect of MPE, while bromocriptine increased it. Significant increases in the intake of sucrose by stressed mice after 21 days of MPE therapy demonstrated protection in CUMS. After 1 hour and 7 days of MPE treatment, mice's locomotor activity was not affected appreciably. According to this study's findings, MPE's hydroalcoholic extract has antidepressant properties that may be mediated by interactions with the dopaminergic system.[57]

Aphrodisiac activity

The second most probable effect of this Mucuna is aphrodisiac. After giving the *Mucuna pruriens*, ethanolic extract to either sex rodent, the mounting frequency, intromission frequency, and ejaculation latency were all significantly increased, and the mounting latency, intromission latency, post-ejaculatory interval, and inter-intromission interval were all significantly decreased. The erection, quick flips, extended flips, and general reflex were significantly improved after the potency test. The ethanolic extracts of *M. pruriens* seed at a specific dose (200 mg/kg) significantly and persistently boosted the sexual behavior of healthy male rats as compared to the control.[58]

Male reproductive hormones in infertile men are restored by *M. pruriens* seed powder to their natural harmonic balance and restores the enzymatic function of energy metabolism and

metabolic processes.[59] In addition to improving sperm count and motility, treatment with *M. pruriens* elevates seminal plasma lipid peroxide levels and greatly decreases psychological stress. Moreover, it increases previously low levels of ascorbic acid, GSH (glutathione), catalase, SOD (super oxide dismutase), and seminal plasma in infertile males.[60]

CONCLUSION

M. pruriens is an amazing herb that grows in waste areas and garbage. Its entire plant has a wide spectrum of pharmacological activity and significant medicinal properties. It has a high concentration of necessary fatty acids, carbohydrates, crude protein, and some essential amino acids. Additionally, it has a variety of anti-nutritional components, including verbascose, stachyose, raffinose, oligosaccharides, and several cyclitols having anti-diabetic properties. High amounts of levodopa, a direct precursor of the neurotransmitter dopamine, are found in *M. pruriens* seeds. It has been used for many years to treat illnesses, including as Parkinson's disease, in traditional Indian Ayurvedic medicine. This review indicates that this plant and its extracts may have therapeutic potential for a number of illnesses, but further research is required to fully understand the mechanisms behind *M. pruriens* pharmacological actions.

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