

PHCOG REV.: Plant Review

Mucuna pruriens Linn. - A Comprehensive Review

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ABSTRACT

Mucuna pruriens Linn. is a popular Indian medicinal plant, which has long been used, in traditional Ayurvedic Indian medicine for diseases including parkinsonism. This plant is pharmacologically studied for various activities like antidiabetic, aphrodisiac, antineoplastic, antiepileptic, antimicrobial activities etc., A wide range of phytochemical constituents has been isolated from this plant. A comprehensive account of the morphology, phytochemical constituents, traditional uses, pharmacological activities and analytical methods reported, are included in view of the many recent findings of importance on this plant.

Key words: *Mucuna pruriens*, Antiparkinsonian, Phytochemistry, Aphrodisiac, L-Dopa, Review.

INTRODUCTION

The term herb refers to a plant used for medicinal purpose. Medicinal Herbs and plant extracts are now generally considered as effective medicines to be respected, appreciated and they play a major role in modern pharmacy. In 1985, the World Health organization estimated that about 80% of the world's population relies on herbs for their primary health care needs. There has been an explosion of scientific information concerning plants, crude plant extracts, and various substances from plants as medical agents during last 20-30 years. Although herbal medicine has existed since the dawn of time, our knowledge of how plants actually affect human physiology remains largely unexplored. Numbers of plants are claiming various medicinal uses and many researches are going on in this view. One such plant, which claims various medicinal properties is *Mucuna pruriens* Linn., one of the popular and important medicinal plants of India. It is a constituent of more than 200 indigenous drug formulations. The plant is an important cover crop (or green manure crop) in many parts of the world, especially among subsistence farmers (1). The plant is commonly called as Common Cowitch, Velvet bean and Cowhage, belonging to the family of Leguminosae and is indigenous to tropical countries like of India and West Indies. All parts of *Mucuna pruriens* possess valuable medicinal properties (2) and there is a heavy demand of *Mucuna* in Indian and International drug markets. This plant is widely used in Ayurveda, which is the ancient traditional medicinal system in India. In this review a comprehensive account of the morphology, phytochemical constituents, traditional uses, pharmacological activities, and analytical methods are included in view of the many recent findings of importance on this plant.

Taxonomy of *Mucuna pruriens* Linn.

Kingdom: Plantae, Planta, Planter, Plants, Vegetal.

Sub Kingdom: Tracheobionta, Vascular Plants.

Division: Magnoliophyta. (Angiospeens)

Class: Magnoliopsida (Dicote, Dicotyledon)

Sub class: Rosidae.

Order: Fabales

Family: Leguminosae

Sub Family: Fabaceae

Genus: *Mucuna*

Species: *pruriens*

Synonyms (3)

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 (3)

Nescafé *Mucuna* , Fava-coceira, Cabeça-de-frade, Cowage, Cowhage, Cow-itch, Velvet Bean, Bengalbean, Mauritius bean, Itchy bean, Krame, Picapica, Chiporro, Buffalobean.

Vernacular names (4)

Hindi- Kiwach, Daunch, Goncha, Bengali- Alkushi, bichchoti, Marathi- Kavacha, Kuhili, Kanchkuri, Gujarathi- Kivanch, Kavatch, Kannada- Nasukunni, Malayalam- Naicornna, Oriya- Kaincho.

Growth & Distribution

Mucuna pruriens (L) Dc. is an annual climbing legume that grows 3-18 m in height. It is indigenous to tropical regions, especially Africa, India, and the West Indies. It is wide spread over most of the subcontinent and is found in bushes, hedges, and dry-deciduous, low forests throughout the plains of India (5). In India 14 species of *Mucuna* are found in the foothills of the Himalayas, the plains of west Bengal, Madhya Pradesh, Karnataka, Kerala, Andhra Pradesh, Uttar Pradesh, the Andaman & Nicobar islands and Srilanka (6).

MORPHOLOGY (3)

It is an annual herbaceous twining, climbing legume with long, thin branches and opposite, trifoliolate, lanceolate leaves 15 to 30 cm length. Leaflets broadly ovate, elliptic or rhomboid ovate, unequal at base. Its flowers are white to dark purple and hang in long clusters or pendulous racemes,

grow in racemes in 2 or 3. The fruit of the plant is pod, which is thick and leathery. It is covered with reddish-orange coloured long stiff hairs that are readily dislodged and responsible for itching in workers involved in collection of the plant. The species name "*pruriens*" (from Latin, "itching sensation") refers to the results from contact with the seedpod hairs. Pods curved, 5-10 cm x 1.5-1.8 cm, longitudinally ribbed, turgid, densely clothed with persistent pale brown or gray, irritant bristles. Seeds, known as *Mucuna* beans are black, 4-6 in a pod, ovoid (6-12 mm long) with funicular hilum (5,7,8).

MICROSCOPY (9)

Seed

The seed is characterized by the presence of a single layered palisade with irregularly thickened cell wall and light line passing through the upper part, single layer of parallel arranged bone shaped columnar cells, presence of substantial number of irregularly shaped stone cells just below the palisade layer in the hilum region around vascular sac and abundance of large, round to oval starch grains measuring 17 to 25 μ in parenchyma cells of cotyledons (10).

TS of seed show testa with palisade-like cells with thickened anticlinal walls in epidermis. Hypodermis comprises of 'T' shaped cells, which is followed by parenchyma with tangentially elongated cells. Cotyledons comprise of epidermis, and parenchymatous cells containing oil globules and oval starch grains (11).

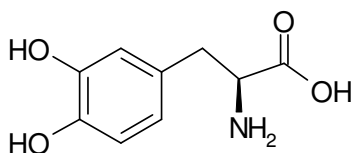
Root (9)

At wounded or injured region of the root almost all the cortical cells contain rectangular crystals. A characteristic feature is the presence of interxylary phloem, which alternates with the fibre groups.

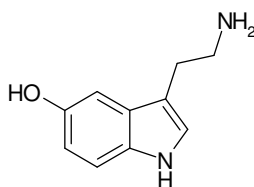
PHYTOCHEMISTRY

The plant is reported to have L-Dopa as a major constituent mainly in seeds (12 - 14). Alkaloidal constituents (15, 16) viz., mucunadine, mucunine, prurienidine, prurienine (17) are reported from seeds. Numbers of amino acids are reported from this plant (18, 19). Epoxy fatty acids viz., cis-12, 13-epoxyoctadec-trans-9-cis-acid, cis-12, 13-epoxyoctadec-trans-9-enoic acid are reported (20). Lecithin is reported to be present in seed (21).

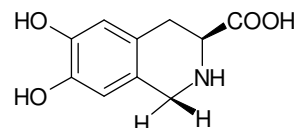
According to Dr. Duke's phytochemical and ethnobotanical databases *Mucuna pruriens* contains many diverse phytochemicals like 1-methyl-3-carboxy-6, 7-dihydroxy-1,2,3,4-tetrahydroisoquinoline, 5-hydroxy tryptamine, 5-methoxy-n,n-dimethyltryptamine-n-oxide, 5-oxyindole-3-alkylamine, 6-methoxyharman, alanine, arachidic acid, arginine, aspartic acid, behenic acid, β -carboline, β -sitosterol, bufotenine, choline, cystine, leucine, linoleic acid, myristic acid, n,n-dimethyltryptamine, n,n-dimethyltryptamine-n-oxide, nicotine, oleic acid, palmitic acid, palmitoleic acid, phenylalanine, phosphorus, proline, protein, saponins, serine, stearic acid, threonine, tryptamine, tyrodine, valine and vernolic acid (22). Recently three new lipid derivatives were reported from n-hexane extract of seeds of *Mucuna pruriens*, namely (Z)-Triactont-5,7,9-triene; (Z)-Docos-2,4,6-trien-1,8-diol and (Z)-Docos-5-en-1-oic acid (23). This plant is a source of minerals (24). Misra and Wagner reported isolation of four 1,2,3,4 tetra hydroisoquinoline alkaloids (25) from the seed.



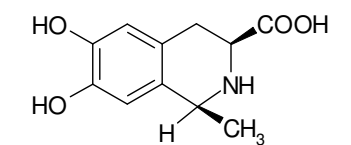
L-Dopa



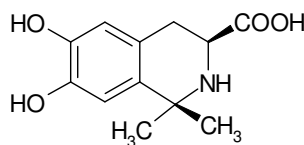
5-hydroxy tryptamine



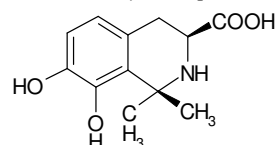
(-)-3-Carboxy-6,7-dihydroxy-1,2,3,4-tetrahydroisoquinoline



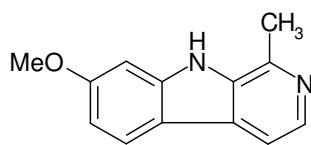
(-)-3-Carboxy-1-methyl-6,7-dihydroxy-1,2,3,4-tetrahydroisoquinoline



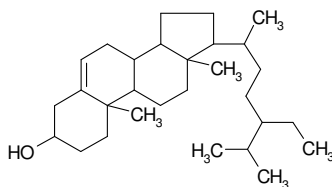
(-)-3-Carboxy-1,1-dimethyl-6,7-dihydroxy-1,2,3,4-tetrahydroisoquinoline



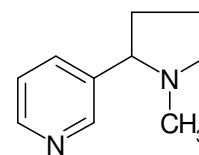
(-)-3-Carboxy-1,1-dimethyl-7,8-dihydroxy-1,2,3,4-tetrahydroisoquinoline



6-methoxy harman



β -Sitosterol



Nicotine

TRADITIONAL USES (26, 27)

Plant parts used- Seed, leaf and root.

Mucuna pruriens finds traditional use in number of diseases and its various parts are used for various purposes.

Roots

Root is bitter, thermogenic, emolient, stimulant, purgative, aphrodisiac, diuretic, emmenagogue, anthelmintic, febrifuge and tonic. They are useful in vitiated conditions of vata and pitta in Ayurveda. The Ayurvedic usage of roots still extend for constipation, nephropathy, strangury, dysmenorrhoea, amenorrhoea, elephantiasis, dropsy, neuropathy, consumption, ulcers, fever and delirium.

Leaves

Aphrodisiac, anthelmintic, tonic, and are useful in ulcers, inflammation, helminthiasis, cephalalgia and general debility.

Seeds

It has a long history of use in Indian Ayurvedic medicine, where it is used for worms, dysentery, diarrhea, snakebite, sexual debility, cough, tuberculosis, impotence, rheumatic disorders, muscular pain, gonorrhoea, sterility, gout, delirium, dysmenorrhoea, diabetes, and cancer. In India, it is considered an aphrodisiac, emmenagogue, uterine stimulant, nerve tonic, diuretic, and blood purifier. In Central America, *Mucuna* beans have been roasted and ground to make a coffee substitute for decades and is widely known as nescafé for this reason. The bean is cooked as a vegetable. In Brazil, the seed has been used internally for Parkinson's disease, edema, impotence, intestinal gas, and worms. It is considered a diuretic, nerve tonic, and aphrodisiac. Externally it is applied to ulcers. Seeds are astringent, laxative, anthelmintic, aphrodisiac, alexipharmic and tonic. They are useful in gonorrhoea, consumption, sterility, vitiated conditions of vata and general debility. The hairs and flowers are vermifuge. In Ayurvedic system, powder of *Mucuna* seeds is used for treating Parkinson's disease.

BIOLOGICAL ACTIVITIES

Anti-Parkinson's activity

Traditionally, *M. pruriens* has been used as a nerve tonic for nervous system disorders. Because of the high concentration of L-dopa in the seeds, it has been studied for its possible use in Parkinson's disease. Numerous *in vivo* studies also have been conducted in rats and humans (28, 29). Hussain *et al* proved that *Mucuna pruriens* is more effective than L-DOPA in parkinson's disease in animal model (30). Even L-Dopa free fraction of seed showed significant antiparkinsonism activity (31, 32). These studies state that at equivalent doses *Mucuna* powder resembles L-DOPA with respect to modulation of dopaminergic pathways, while the presence of other constituents in contribute to improved antiparkinsonian activity and greater tolerability in animals.

Clinical Research

HP-200, which is a first liquid levodopa contains *Mucuna pruriens* endocarp, has been shown to be effective in the treatment of Parkinson's disease. The long-term effect of *Mucuna pruriens* endocarp in HP-200 on monoaminergic neurotransmitters and its metabolite in various regions of the rat brain was studied by Manyam *et al*. HP-200 at oral administration of *Mucuna pruriens* endocarp in the form of

HP-200 had a significant effect on dopamine content in the cortex with no significant effect on levodopa, norepinephrine or dopamine, serotonin, and their metabolites- HVA, DOPAC and 5-HIAA in the nigrostriatal tract. The failure of *Mucuna pruriens* endocarp to significantly affect dopamine metabolism in the striatonigral tract along with its ability to improve Parkinsonian symptoms in the 6-hydroxydopamine animal model and humans may suggest that its antiparkinson effect may be due to components other than levodopa or that it has an levodopa enhancing effect (33). In a clinical trial, Eight Parkinson's disease patients with a short duration L-dopa response and on period dyskinesias completed a randomised, controlled, double blind crossover trial. *Mucuna* preparation led to a considerably faster onset of effect, reflected in shorter latencies to peak L-dopa plasma concentrations. Peak L-dopa plasma concentrations were 110 % higher and the area under the plasma concentration v time curve (area under curve) was 165.3% larger. No significant differences in dyskinesias or tolerability occurred (34).

Hypoglycaemic and Hypocholesterolemic activity

M.C. Pant *et al* reported that *Mucuna pruriens* possesses hypoglycemic and hypocholesterolemic effects in the normal rats (35). The sugar level was lowered by 39% and the cholesterol level was lowered by 61% with the rats fed with *Mucuna pruriens*.

Anti-tumour effect

Antineoplastic activity of *M. pruriens* was evaluated by several studies. Gupta *et al* reported the antineoplastic efficacy in their search for anticancer plants (36). The effect of methanolic extract of *Mucuna pruriens* seeds on tumour growth and host's survival time in Ehrlich ascitic carcinoma bearing Swiss albino mice was reported by Yerra Rajeshwar *et al* (37). *Mucuna pruriens* at a dose of 125 and 250 mg/kg body weight showed decrease in tumour volume, packed cell volume, viable cell count and increase in the mean survival time in treated animals compared to control. Haematological studies resulted in restoration of Hb content to near normal levels, significant decrease in RBC count and increase in WBC counts in extract treated animals when compared to control. *M. pruriens* decreased the levels of lipid peroxidation and increased the levels of glutathione, superoxide dismutase and catalase.

Antioxidant activity

Tripathi *et al* (38) established the antioxidant activity on *in vivo* models of lipid peroxidation. When Alcoholic extract of the seeds of *M. pruriens* was administered orally at a dose of 60mg/100mg body weight up to 30 days showed significant inhibition in lipid peroxidation induced by alloxan and immobilized stress. The extract by itself has no toxic effect on this dose, as it does not induce any peroxidation. In their *in vitro* study they have proven that *M. pruriens* possesses dose dependent protection against superoxide generation, hydroxyl radical production and FeSO₄-induced lipid peroxidation. The protective action is through their removal of free radicals or by direct chelation of free iron (38). According to Tripathi *et al* the alcohol extract of the seeds of *M. pruriens* has an anti-lipidperoxidation property, which is mediated through the removal of superoxides and

hydroxyl radicals. This was established by the study of *in vitro* antioxidant activity in rat liver homogenate to investigate the chemical interaction of various phytochemicals with different species of free radicals. There was no change on the rate of aerial oxidation of GSH content but it significantly inhibited FeSO₄ induced lipid peroxidation. It also inhibited the specific chemical reactions induced by superoxides and hydroxyl radicals. An *in vivo* study on albino rats for 30 days showed no toxic effect up to a dose of 600-mg/kg body weight, on oral administration. There was no change in the level of TBA-reactive substances, reduced glutathione content and SOD activity in the liver. The activity of SGOT, SGPT and alkaline phosphatase was also unchanged (39).

Yerra Rajeshwar *et al* reported inhibition of ascorbate/FeSO₄ induced peroxidation by methanolic extract of *M. pruriens* which was monitored by the change in optical density of the prepared concentrations (10 - 320 µg/ml). The inhibition of increased with increase in concentration of the extract (40).

Neuroprotective effect

M. pruriens cotyledon powder showed significant increase in the brain mitochondrial complex I activity (*in vitro*) on the nigrostriated tract of 6-OHDA lesioned rats. The endogenous levodopa, dopamine, norepinephrine and serotonin content in the substantia nigra were restored significantly. The possible mechanism, as reported, for the neurorestorative activity was shown due to increased complex I activity and also the presence of NADH and Co-enzyme Q in the *M. pruriens* cotyledon powder (41).

Learning and memory enhancement

In the study by Poornachandra *et al*, *Mucuna pruriens* showed significant activity on learning skills and memory enhancement in Wistar male rats. Results on memory retrieval, assessed on 17th day suggested an increase of 15% and 35 % memory retrieval in animals that received extract only in memory retrieval session and animals that received extract during both in training and memory retrieval sessions respectively (42).

Antidiabetic activity

The antidiabetic efficacy of *Mucuna pruriens* Linn. has been established by many researchers (43, 44). Grover *et al* reported this property in their search for antidiabetic plants in alloxan induced diabetic rats (45). Rathi *et al* (46) evaluated the alcoholic extract of *M. pruriens* (100, 200 and 400 mg/kg/day) in alloxan induced rats and streptozotocin (STZ) mice. The maximum antihyperglycaemic effect occurred at week 6 at a dose of 200 mg/kg/day. In chronic alloxanized rats, a decrease of 40.71%, 45.63%, 50.33% and 51.01% in plasma glucose levels at 1, 2, 3 and 4 months was observed. In chronic STZ diabetic mice no significant effect was observed. The alteration in hepatic and skeletal muscle glycogen content and hepatic glucokinase, hexokinase, glucose-6-phosphate and phosphofructokinase levels in diabetic mice were not restored. Grover *et al* (47) studied the effect of extract on glucose concentration and renal damage in streptozotocin-induced diabetic mice. Plasma glucose concentrations in STZ-diabetic mice were reduced by 9.07%, prevented polyuria and the rise in UAE levels from day 0 to 40

in comparison to diabetic controls whereas *Mucuna pruriens* failed to modify renal hypertrophy. Rathi *et al* also studied the protective effect of *Mucuna pruriens* in the prevention of murine alloxan diabetic cataract. Lyophilized aqueous extract of *M. pruriens* (200 mg/kg p.o.) decreased (40.17%) the incidence rate of cataract in treated groups (48). Donati *et al* demonstrated the presence of D-chiro-inositol and its two galacto-derivatives in *Mucuna pruriens* seeds and explained their antihyperglycaemic effect (49).

Aphrodisiac activity

The traditional aphrodisiac property of this plant is scientifically analysed and proved by several experiments using seeds of *M. pruriens*. According to the studies of Amin *et al* (50), *M. pruriens* stimulates sexual function in normal male rats which was observed by increase in mounting frequency, intromission frequency and ejaculation latency where as, Rajendran *et al* (51) proved the decrease in sexual function in female rats.

Antivenom activity

The anti-venom activity is studied extensively and established by Guerranti *et al*. The antivenom property of water extract of seeds was assessed *in vivo* in mice and tested for its immunological properties. Two proteins of *Echis carinatus* venom with apparent molecular masses of 25 and 16 kDa were detected. The results demonstrated that the observed antivenin activity has an immune mechanism. Antibodies of mice treated with non-lethal doses of venom reacted against some proteins of *M. pruriens* extract (52).

The effect of a lethal *Echis carinatus* venom on serum enzyme levels and blood plasma coagulation parameters in rats pretreated with *Mucuna pruriens* seed aqueous extract was investigated by Aguiyi *et al* (53). They observed an increased enzymes lactate dehydrogenase (LDH), glutamic pyruvic transaminase (SGPT), creatinine kinase (CK) and changed coagulation parameters D-Dimer and Quick levels due to the venom effect were inhibited. However, the extract MP101UJ appeared to significantly inhibit the lethal venom induced myotoxic, cytotoxic and coagulation activities in experimental animals. An increase in procoagulant activity was found with the extract of MP101UJ in prothrombin activation by EV *in vitro* by clotting and chromogenic assay (54).

Immunization against cobra venom using *Mucuna pruriens* derived serum immunoglobulins was carried out in a mouse model. The neutralizing ability of circulating antibodies was assessed by challenging the immunized mice with a minimum lethal dose of purified venom after 4, 24, 72 and 168 h. The single injection of the antibody preparation produced a high and sustained immune response with high survival rates of treated animals. Guerranti *et al* (55) demonstrated that the MPE immunogen generating the antibody that cross-reacts with the venom proteins is a multiform glycoprotein (gpMuc) whose immunogenic properties mainly reside in its glycan-chains and stated that gpMuc contains both N- and O-glycans. Mild alkaline treatment but not PNGase F led to loss of reactivity, indicating that O-glycans are probably involved in the antigenicity of gpMuc.

Antimicrobial activity

Yerra Rajeshwar *et al* (40) reported the antimicrobial activity of the methanolic extract of *M. pruriens* by disc diffusion method against gram positive and gram-negative bacteria. Extract showed a broad spectrum of activity against all bacterial strains tested.

Anti-protozoal effect

Ekanem *et al* proved that the crude methanolic extract of leaves of *Mucuna pruriens* has potential for effective control of *I. multifiliis* infection in Goldfish. There was a 90% reduction in numbers of *I. multifiliis* on fish after treatment in baths of plant extract at 200 mg/litre and parasite-induced fish mortality was reduced significantly. *In vitro* tests led to a 100 % mortality of *I. multifiliis* in 150 mg/litre of *M. pruriens* extract (56).

Analgesic and Anti-inflammatory activities

Hishikar *et al* has reported the anti-inflammatory activity of seeds of *M. pruriens* (57). Analgesic and antipyretic effects of *Mucuna pruriens* was reported by Lauk *et al* (58).

Pharmacological Activities of Isolated compounds

The alkaloidal constituent prurieninine from *Mucuna pruriens* is reported to slow down the heart, dilate the blood vessels, decrease blood pressure, and increase the peristaltic action of intestine of frogs (3). According to Saksena *et al* the total alkaloids increase spermatozoa population, weight of testis, seminal vesicles and prostrate of rats (59). Total alkaloids of seed showed weak neuro-muscular blocking effect on frog rectus abdominus (60).

Toxicity studies

The acetone extract of the root was toxic to the insects, being 1.93 times as toxic as the extract of *Jatropha curcas* Linn. seeds. The hairs on fresh/dry pods can cause intense itching on contact. It may also cause blister/dermatitis due to mucanin. The use of unprocessed, raw VB in diets for both humans and chickens is often accompanied by toxic symptoms. In human, symptoms of neurotoxicity and behavioral changes as well as severe vomiting have been reported by Infante *et al* (61) and Miller *et al* (62).

ANALYTICAL METHODS

Parikh *et al* (63) reported HPLC method for the estimation of L-DOPA, the major phytochemical in *Mucuna pruriens* using Lichrosphere 100 RP-18 (5µm, 125 X 4 mm id) column at the flow rate of 1ml/min. Paper chromatography and potentiometric methods also available for L-DOPA estimation (64). Tomiato-Yokotani *et al* analysed L-DOPA by HPLC and LC-ESI/MS in a study (65).

CONCLUSION

The study of herbal medicine spans the breadth of pharmacology, the study of the history, source, physical, and chemical properties, mechanisms of action, absorption, distribution, biotransformation, excretion and therapeutic uses of "Drugs". In many respects, the pharmacological investigation of herbal medicine is just beginning. From this review, no doubt that the pharmacologically potent plant *Mucuna pruriens* is investigated for many activities. Still there is paucity for the mechanism and bioactive principles that are responsible for the activities except L-DOPA and some alkaloids. The important aspect in using herbal extracts

and their formulation is the quality assurance of the herbal preparations for their safety and efficacy. Although there is a tremendous development in the formulations of herbal products, still the quality control aspects for the crude and prepared forms of many herbal medicines are at infancy. This is due to the complex nature of the constituents of plants. The level of same constituent in the herbal medicine may vary extremely depending on geographic origin, climatic condition, soil, harvest season, processing techniques and other factors. Generally only limited components are determined by chromatographic methods in the quality testing of herbal preparations. Various chromatographic techniques such as TLC, GC, HPLC, HPTLC, and PC-SFC-DAD are used for herbal analysis. The literature survey revealed that there are less scientific analytical methods for the *Mucuna pruriens* extracts and their constituents except some methods like HPLC, method for the estimation of L-dopa. Due to the diversity of phytochemical constituents it is difficult to predict the exact mechanism in past days but the recent tremendous development in modern analytical methods can be useful for the separation, characterization and quality control aspects. There is lack of recent advanced methods like HPTLC, Flash chromatography etc. Further researches in view of fulfilling the need of quality control aspects, standardization for the various constituents and extracts are needed.

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