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THE TRADITIONAL USES AND PHARMACOLOGICAL ACTIVITIES OF *MUCUNA PRURIENS* (L)DC: A COMPREHENSIVE REVIEW

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ABSTRACT

Medicinal plants have served as a constant source of medicaments, which have a great efficacy and demand for the treatment of various diseases. One of the plants, that deserve attention is *Mucuna pruriens*. The present review was designed to evaluate the preliminary phytochemical screening and secondary metabolites. *Mucuna pruriens* (L.) DC belongs to the family Fabaceae and is commonly known as Velvet bean, Cow witch, Cow hage due to morphology, phytochemical constituents, traditional uses, medicinal values and some pharmacological activities. Different parts of the plant are used in Ayurvedic research since ancient period due to their excellent medicinal values and cure many diseases such as bone fractures, cough, dog-bite, madness, pain, pleuritis, ring worm, scorpion sting, snake-bite, sores and syphilis, and is anticholestrolemic, antiparkinson, antidiabetic, aphrodisiac, anti-inflammatory and antimicrobial, it is also used for the treatment of menstruation disorders, constipation, edema, fever, tuberculosis, etc. The seeds of *Mucuna pruriens* contain alkaloids, glycosides, reducing sugars, saponins, tannins, terpenoids, calcium, phosphorus and potassium, polyphenolic substances, protease inhibitor, phytic acid, and L-dopa is a major constituent present in whole herb. *M.pruriens* alkaloid P, Q, R, S, X (Alkaloid-misc), Myristic acid, Niacin (Inorganic), N,N¹ Dimethyltryptamine, N,N¹-Dimethyltryptamine-n-oxide, Nicotine, Oleic acid, Palmitic acid, Palmitoleic acid (Lipid), Phenylalanine, Phosphorus (Inorganic), Polysaccharide, Proline, Protein, Prurienidine, Prurieninine (Alkaloid-misc), etc are available. The most important of these bioactive compounds of plants are secondary metabolites. The present review is an attempt to provide reported details of information on this herb and its phytoconstituents and pharmacological activities. It is an attempt to provide a direction for further research.

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INTRODUCTION

Mucuna pruriens(L) DC :

Medicinal plants, since times immemorial, have been used in virtually all cultures as a source of medicine. The widespread use of herbal remedies and healthcare preparations, as those described in ancient texts such as Bible, the Vedas, and Bramhans jnana, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties[1]. Many secondary metabolites of plant are commercially important and find use in a number of pharmaceutical compounds. In recent times, focus on plant research has increased all over the world and a large body of evidence has collected to show immense potential plants used in various traditional medicinal systems. More than 13,000 plants have been studied during the last five year period. The isolated and purified compounds, in contrast, may lose their biological activity due to structural change or fail to behave in the same way as in the complex matrix that the original item of food represents[2].The drugs are derived from the whole plant or from different parts like leaves, stem, bark, root, flower, seed, etc. More than 30% of the entire plant species, at one time or other was used for medicinal purposes. Thus, the economic importance of medicinal plants is much more, so there is a need to study about the significance of *Mucuna pruriens* (L) DC.

Geographical distribution

Mucuna pruriens belongs to the species Fabaceae, commonly known as cowage plant. It is a popular Indian medicinal plant, which has long been used from ancient period. Ayurvedic system of medicine is typically found in tropical regions and used for various purposes in traditional medicine in several countries [3]. 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 and is grown right from lower Himalayan range to entire tropical plains of India.

The genus *Mucuna* consists of 100 species of climbing vines and shrubs. This is the second largest family of flowering plants and contains 600 genera and about 12000 species. The leaves are stipulate nearly always alternate and range from bipinnately or palmately compound to simple and leaflets are 2-3 mm long (**Figure-A**). The petiole base is commonly enlarged into a pulvinus that commonly functions in orientation of the leaves. The flowers are usually bisexual actinomorphic to zygomorphic, slightly to strongly perigynous and commonly in racemes, spikes or heads. The perianth commonly one or many stamens distinct of variously united sometimes. The pistil is simple often stipulate comprising a single style and stigma and a superior ovary with one locule containing two or many marginal ovules. The fruit is usually a legume sometimes aloments, follicle, indehiscent pod, achene, drupe or berry, ripening stage, a 4 to 13 cm long and 1 to 2 cm wide unwinged leguminous fruit develops. The seeds are Ovoid or transversely oblong slightly laterally compressed with polish dark, brown or black or occasionally mottled testa. Thickness of seed about – 0.5 mm. Hilum is prominent white to pale yellow.

Taxonomy

Domain	:	<i>Eukaryota</i>
Kingdom	:	<i>Plantae</i>
Subkingdom	:	<i>Viridaplantae</i>
Phylum	:	<i>Magnoliophyta</i>
Subphylum	:	<i>Spermatophytina</i>
Infraphylum	:	<i>Angiospermae</i>
Class	:	<i>Magnoliopsida</i>
Subclass	:	<i>Rosidae</i>
Superorder	:	<i>Fabanae</i>
Order	:	<i>Fabales</i>
Family	:	<i>Fabaceae</i>
Subfamily	:	<i>Faboideae</i>
Tribe	:	<i>Phaseoleae</i>
Genus	:	<i>Mucuna</i>

Common names

Cowitch, Cowhage, Velvet Bean, Buffalo bean, mucuna, nescafe, podemico, fava-coceira, cabeça-de-frade,, bengal bean, mauritius bean, itchy bean, krame, picapica, chiporro, Bengal velvet bean, Florida velvet bean, Mauritius velvet bean, Yokohama velvet bean, lacuna bean, Lyon bean. Alkusa, Alkushi, Kivanch, *Khaja-Kuhali*, Kawaanch, Kavach, Nasugunni Khavalyavali, Majram, Nayikuruma, Shoriyanam Kuhili, Kawanchi, Gugli, Kavanch, Punaikkali, Poonakkate, Dulagondi, Pilliadagu.

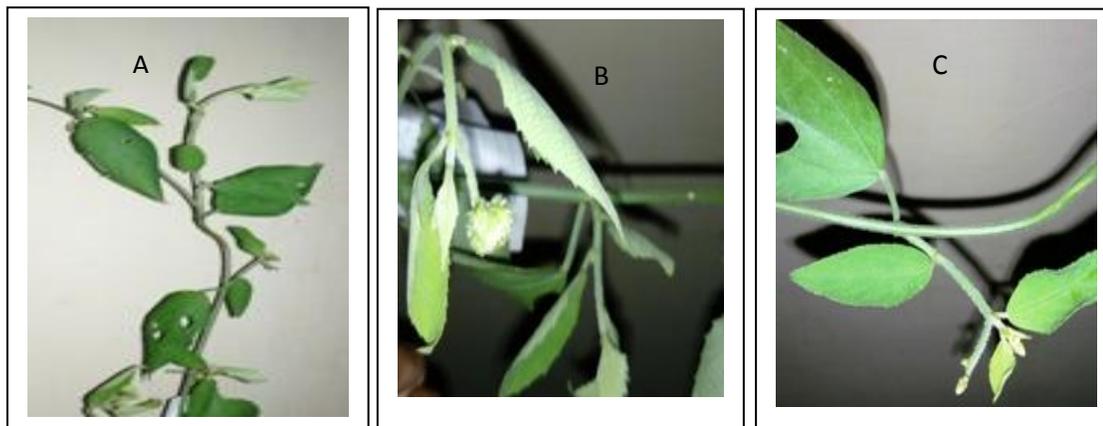


Fig:1-A: *Mucuna pruriens* (L) DC plant; Fig-B and C: Inflorescence of *Mucuna pruriens* (L) DC.

Traditional Medicinal Therapeutic uses of *M. pruriens*

All parts of *M. pruriens* possess valuable medicinal properties in traditional system of medicine in India and West Africa for example, *M. Pruriens* seeds, flowers and leaves (Figure-B and C) are used against snake bites [4] and also used as a uterine stimulant and aphrodisiac. In Honduras, Central America, Africa and Guinea, this plant leaves are also used as food.

Mucuna pruriens leaves are used in bone fractures, cough, dog-bite, madness, pain, pleuritis, ring worm, scorpion sting, snake-bite, sores and syphilis. They are used as an aphrodisiac, nerve tonic and in leucorrhoea, spermatorrhoea and applied to ulcers. The roots are said to be useful to cure cholera, elephantiasis, diuretic and purgative. *Mucuna pruriens* is well known for producing itching. This property is attributed to the presence of 5-hydroxytryptamine (5-HT) in the hair on the pods. The plant has been studied for various activities like anti-diabetic, aphrodisiac, antineoplastic, antiepileptic, antimicrobial activities, learning and memory enhancement, antivenom, antihelmintic, and antiinflammatory activities, The seeds have been reported to be antidiabetic, antifungal, antioxidant activity, hypotensive, hypocholesterolemic, hypothermic and antiparkinsonian activities, Abortion, alterative, anthelmintic, aphrodisiac, cancer, catarrh, immunomodulator, cough, debility, delirium, dropsy, dysentery, dysmenorrhoea, emmenagogue, fertility, gout, impotency, irritant, lithiasis, nervine, night dreams, sterility, tuberculosis, uterine stimulant, worms.

In *Mucuna pruriens* the Phytochemical screening has revealed the presence of alkaloids, reducing sugar, anthraquinones, flavonoids, saponins, tannins, cardiac glycosides, phenols and steroids [5]. According to the Ayurveda *M.pruriens* roots are bitter, thermogenic, emollient, stimulant, purgative, aphrodisiac, diuretic, emmenagogue, anthelmintic, febrifuge, diuretic and tonic [6]. It is considered useful to relieve constipation, nephropathy, dysmenorrhoea, amenorrhoea, elephantiasis, dropsy, neuropathy, ulcers, helminthiasis, fever and delirium. The *M.pruriens* seeds contains alkaloids, glycosides, reducing sugars, saponins, tannins, terpenoids, calcium, phosphorus and potassium, polyphenolic substances, protease inhibitor, phytic acid and L-dopa. The *Mucuna pruriens* seeds, pods and leaves are described as vermifuge. The seeds are used for human food and animal feed in Nigeria and one of the best sources of protein content. The seeds are astringent, laxative, anthelmintic, aphrodisiac and tonic. *M. pruriens* Seeds possess the activity of different aliments of 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 [6]. *Mucuna pruriens* Leaves are useful in ulcers, inflammation, cephalagia and general debility. Dried leaves of *M. pruriens* are sometimes smoked, an ointment prepared with hairs act as a local stimulant and mild vesicant [7].

PHYTOCHEMICAL SCREENING

LEVODOPA

The seeds of *M. pruriens* have L-dopa for the first time in 1937 as a major constituent and mainly in seeds. 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 isolation of L-DOPA (1.5% on dry weight basis) from *M. pruriens* seeds is carried using different extraction procedures. The fully matured *M. pruriens* seeds ranges 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 [7]. The unusual non protein amino acid and a direct precursor to the neurotransmitter dopamine, is 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. The leaves contain about 0.5% L-DOPA, 0.006% dimethyl tryptamine and 0.0025% 5-MeO-DMT.

Levo-dopa has also been investigated as a dietary supplement to manage hypertension, renal failure, and liver cirrhosis [8]. Protective effects of L-Dopa on small bowel injury, ulcer, gastrointestinal diseases, diabetes, etc. Beside L-Dopa, nicotine, physostigmine, serotonin, bufotenine, choline, N-N-dimethyl tryptamine and some indole compounds are the other phytochemicals present in other parts such as roots, stems, leaves of *M. pruriens* [4]. In addition to L-DOPA, pharmacologically active compounds methylated and non-methylated tetra hydroisoquinoline are also present in *Mucuna spp* [9]. L-DOPA, if ingested in large amounts, is potentially toxic. L-DOPA extraction and its quantification is important as ingestion of excessive amounts can lead to severe psychosis, nausea, emesis, arrhythmia, hypertension and dyskinesias.

In *Mucuna pruriens* seeds four alkaloids are reported. They are L-3-carboxy-1,2,3,4-tetrahydroisoquinoline, (-)-1-methyl-3-carboxy-6,7-dihydroxy-1,2,3,4 tetrahydroisoquinoline, dimethyl-3-carboxy-6, 7-dihydroxy-1,2,3,4- tetrahydroisoquinoline and (-)-1-3-carboxy-1, 1- dimethyl-7, 8- dihydroxy-1, 2, 3, 4- tetra hydroisoquinoline. Dukes Phytochemical and ethno botanical database describes diversified chemical constituents in *Mucuna* seeds like, 5- hydroxytryptamine, 5-methoxy- N, N- dimethyltryptamine- N-oxide, 5-oxyindole-3-alkylamine, 6- methoxyharman, arahidic acid, arginine, ash, aspartic acid, behenic acid, betacarboline, betasitosterol, bufotenine, choline, cis-12,13 epoxyoctadec- trans-9- cis- acid, cis-12, 13- epoxyoctadec- trans-9- enoic acid, gallic acid, glutamic acid, glutathione, indole-3-alkylamine, linoleic acid, mucunadine, mucunain, mucynine, myristic acid, N, N-dimethyltryptamine, N, N-dimethyltryptamine, -N-oxide, niacin, nicotine, oleic acid, palmitic acid, prurienine, riboflavin, saponins, serotonin, stearic acid, thiamine, vernolic acid. Seeds of *M. pruriens* are known to produce the unusual nonprotein amino acid 3-(3,4-dihydroxyphenyl)-1-alanine (L-Dopa). It also contains glutathione, Gallic acid and betasitosterol [10].

1-Methyl-3-carboxy-6,7 -dihydroxy-1-,2, 3-,4-Tetrahydroisoquinolone, 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, DOPA- L, Fat, Fatty acids, unsaturated, Flavone, 4'-5-6-trihydroxy-3'-7-8-trimethoxy-4'-O-beta-D-xylopyranosyl(1-2)-O-alpha-1-rhamnopyranoside (Flavone), Galactose, Gallic acid, Glycine, Glutamic acid, Glutathione, Histidine, Iron (Inorganic), Indole-3-alkylamine, Isoleucine, Lecithin, Leucine, Linoleic acid, Linolenic acid (Lipid), Lysine, Mannose, Methionine, Mucunadine, Mucunain, Mucunine, Mucuna polysaccharide, *M. pruriens* alkaloid P, Q, R, S, X (Alkaloid-misc), Myristic acid, Niacin (Inorganic), N,N-Dimethyltryptamine, N,N-Dimethyltryptamine-n-oxide, Nicotine, Oleic acid, Palmitic acid, Palmitoleic acid, Phenylalanine, Phosphorus (Inorganic), Polysaccharide, Proline, Protein, Prurienidine, Prurienine (Alkaloid-misc), Quinoline, iso: 1-2-3-4-tetrahydro (Isoquinoline Alkaloid), Riboflavin, Saponins, Serine, Serotonin, Sitosterol, (beta Sterol), Stearic acid, Stizolamine (Alkaloid), Thiamine, Threonine, Trypsin, Tryptamine, Tyrosine, Valine and Vernolic acid.

In *Mucuna pruriens* leaves the data base reveals the presence of L-dopa, 6-methoxyharman, genistein, hydroxygenistein in minimal concentration. Recently three new lipid derivatives were also reported, triactont-5, 7, 9- triene, docos-2, 4, 6- triene-1, 8-diol and docos-5-en-1- oic acid. *M. pruriens* leaves also gave 6- methoxyharman [11]. Serotonin is present only in pods. The seeds also contain oils including palmitic stearic, oleic and linoleic acids. GC-MS analysis showed the presence of photochemicals like nhexadecanoic acid (48.21%), squalene (7.87%), Oleic acid (7.62%), ascorbic acid (3.80%) and Octadecanoic acid (6.21%) [12]. *M. pruriens* leaves also contains serotonin (5- hydroxy tryptamine, 5-HT), 5-hydroxy tryptophan (5-HTP), nicotine, N, N-dimethyl tryptamine (DMT), bufotenine, and 5-imethoxy- N,N-dimethyl tryptamine (5-MeO-DMT) 5- imethoxy-N,N- dimethyl tryptamine-n-oxide (5- MeO-DMT-n-oxide) [13].

PHARMACOLOGY USES OF *MUCUNA PRURIENS*

The pharmacological evidence reports that *Mucuna pruriens* is one of the major constituents in polyherbal extract formulations for treating different ailments. Few recent evidences are discussed below.

Antibacterial activity

Antibacterial activity of methanolic extract of *Mucuna pruriens* was evaluated and well documented the broad spectrum activity against Gram positive *Bacillus cereus*, *Staphylococcus* and Gram negative *Proteus vulgaris* [3, 14]. The methanolic extract showed high antibacterial activity against *Erwinia carotovora*, *Pseudomonas syringae*, *P. marginalis*, *P. acuginosa*, *Xanthomonas campestris* [15].

Anti-Parkinson's activity

The Parkinsonism was treated by the administration of powdered seed of *M. pruriens* containing 4 to 6% of levodopa [16]. In a clinical study, the contribution of L-DOPA in the recovery of PD followed by Ayurveda medication. Katzenschlager *et al.*, [17] revealed that 30g *Mucuna* seed powder preparation has considerable faster action in treating PD patients than conventional standard drugs namely, Levo-dopa or Carbi-dopa and suggested that natural source of L-DOPA might possess advantages over conventional drugs in long term management of PD.

Mucuna 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 substantia nigra [6, 7, 18].

Clinical study confirmed the efficacy of the *M. pruriens* seeds in the management of Parkinson's disease by virtue of their L-DOPA content. *M. pruriens* has been shown to increase testosterone levels. Seeds of *M. pruriens* contain high levels (1–6%) of L-Dopa (L-3,4-dihydroxyphenylalanine [7]; a precursor of dopamine used in the treatment of Parkinson's disease. The effects of *M. pruriens* were studied in the 6-hydroxydopamine (6-OHDA) lesioned rat model of Parkinson's Disease. The Lieu *et al.*, [19] have also studied *Mucuna pruriens* by the MPTP treated monkey Parkinson's Disease model. They compared levo-dopa (LD) kinetic-dynamic profile of a dose of LD/aromatic amino acid decarboxylase peripheral inhibitors versus a nominally equivalent dose of a commercial *Mucuna pruriens* (*Mucuna*) seeds extract in 2 patients with Parkinson disease chronically taking LD standard combined with self-prescribed *Mucuna* [20].

Antitumour effect

The antitumour effect of methanolic extract of *Mucuna pruriens* seed against Erlich Acites Carcinoma (EAC) bearing Swiss albino mice were studied [3]. 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, respectively and hence, *M. pruriens* can probably influence immune response in mice [18]. The reports showed that acute systematic toxicity was reduced by methanolic extract of *Mucuna pruriens* seeds on albino mice and rabbits [21].

Antioxidant effect

The antioxidant activity on in vivo models of lipid peroxidation concluded that the seed ethanolic extract of *Mucuna pruriens* has an anti lipidperoxidation property which is mediated through the removal of super oxides and hydroxyl radicals. 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. The antioxidant effect on methanolic extract of *Mucuna pruriens* seed against Erlich Acites Carcinoma (EAC) bearing Swiss albino mice were studied by the following parameters; 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. Divya *et al.*, [22] results suggest that the methanolic extract of *Mucuna pruriens* seeds exhibit significant antioxidant effects in EAC bearing mice [3].

In vitro assays indicated that a whole plant of ethyl acetate and methanolic extract of *Mucuna pruriens*, containing large amounts of phenolic compounds, exhibited high antioxidant and free radical scavenging activities. These plant extracts served as a significant source of natural antioxidant, which might be helpful in preventing the progress of various oxidative stresses [23]. Due to the high concentration of phenolic compounds, it is expected that *Mucuna pruriens* seeds have high antioxidant capacity. The various parts of this plant contain total phenols which might have antioxidant activity. The similar findings were observed for this plant where free radical scavenging activity was evaluated via nitric oxide scavenging method. The alcohol extract showed significant antioxidant activity which was comparable with standard ascorbate and total phenol content. The methanol extract of *Mucuna pruriens* seeds showed significant invitro antioxidant activity while it has also been indicated that the methanol extract of *Mucuna pruriens* can be a potential source of natural anti-oxidant [24].

Anti venom effect

Using various structural and biochemical tools coupled with *in vivo* assays, A purified protein from *M. pruriens* which was named as MP-4. The MP-4 does not afford direct protection against snake venom because it is actually a poor inhibitor of serine proteases. Further experiments showed that antibodies generated against MP-4 cross react with the whole venom and provide protection to mice against *Echis carinatus* snake venom. This study shows that the MP-4 contributes significantly to the snake venom neutralization activity of *M. pruriens* seeds through an indirect antibody-mediated [25]. The protective effects of *M. pruriens* seed extract (MPE) against histopathological changes induced by intravenous injection of *Naja sputatrix* (Malayan cobra) venom in rats pre-treated with the MPE seed extract was examined [26]. The MPE pre-treatment was given to rats and the animals were challenged with various snake venom.

Many of the researchers found its effects against *Naja* species has shown that it has potential use in the prophylactic treatment of snakebites. Aqueous extracts of *M. pruriens* seeds were tested for their activity on various pharmacological effects like lethality, phospholipase activity, edema forming activity, fibrinolytic activity and haemorrhagic activity of cobra and krait venoms [27]. About 0.16 and 0.19 mg of *M. pruriens* seed extracts were able to completely neutralize the lethal activity of 2 LD₅₀ of cobra and krait venom respectively, thus suggesting that aqueous extracts of *M. pruriens* seeds possess compounds, which inhibit the activity of cobra and krait venoms. According to Fung and Tan [28] rats pretreated with *M. pruriens* seed extract showed protective effect against the lethal and cardiovascular depressant effects of *Naja sputatrix* venoms by neutralization of the venom toxins. The effectiveness of MPE to neutralize the mortalities of snake venoms was investigated by in vitro neutralization and concluded as MPE effectively protect the animal models against lethality of *Naja sputatrix* venom and moderate protection against *Calloselasma rhodostoma* venom [6].

Mucuna pruriens aqueous extract was given intra-peritoneal for three weeks. After 3 weeks, *Calloselasma rhodostoma* venom was administered intra-venous and studied various pharmacology parameters like blood pressure, heart rate, respiratory rate and muscle twitch tension in rats. Seed part showed strong antivenom activity which might be due to presence of higher amount of phytochemicals [29].

Antidiabetic effect

All parts of *M. pruriens* possess valuable medicinal properties. Roots, leaves and seeds of the plant are commonly used in the treatment of impotence, diabetes mellitus^[30]. The previous investigation reports have suggested that the antidiabetic activity may be due to its dietary fiber content [29] many reports have been established relating to antidiabetic property of *M. pruriens*. The hypoglycaemic 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. The hypoglycemic effect of the aqueous extract of the seeds of *M. pruriens* was investigated in normal, glucose load conditions and streptozotocin (STZ)-induced diabetic rats. In normal and STZ diabetic rats, the aqueous extract of the seeds of *M. pruriens* (100 and 200 mg/kg body weight) significantly reduced the blood glucose levels 2h after oral administration of seed extract. The cholesterol, urea and creatinine is responsible for increase the blood glucose level. They observed that both cholesterol and creatinine levels were decreased in streptozotocin diabetic rats in similar experiment. They explained that this hypocholesteric activity is due to presence of squalene content. This study evaluated the biochemical properties of a local lime concentrate preparation and an ethanolic extract of seeds of *Mucuna pruriens* on Alloxan-induced diabetic rats by a single intraperitoneal injection of 150 mg/kg leads decreases the diabetic activity [31]. Thus, antidiabetic activity of *M. pruriens* seeds was present in the methanolic and ethanolic fractions of the extract [32].

Aphrodisiac effect

The second most potential is aphrodisiac effect proved for this *Mucuna pruriens*. The *M. pruriens* ethanolic extract administered in either sex rats significantly increased the mounting frequency, intromission frequency and ejaculation latency, and decreased the mounting latency, intromission latency, post-ejaculatory interval and interintromission interval. The potency test significantly increased erections, quick flips, long flips and total reflex. *M. pruriens* and its Major Constituent L-DOPA Recover spermatogenic loss by combating ROS, loss of mitochondrial membrane potential and apoptosis^[18]. The oral administration of 5g of *Mucuna* seed powder once in a day for men with decreased sperm count and motility ameliorated psychological stress and seminal plasma lipid peroxide levels along with improved sperm count and motility. The study also concluded that *M. pruriens* not only reactivates the anti oxidant defense mechanism, but also helps in the management of stress and improves semen quality. The results on sperm count found highly significant. It also showed good improvement in other seminal parameter like Volume of semen, pH of semen, motility of sperms etc. It showed mild significant result in Non progressive sperm (NP) and not significant in Slow linear progress of sperm (SLP). It also significantly increased the sexual desire, penile rigidity, erection and duration of ejaculation with orgasm^[33]. *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]. The 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* 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. 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. *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 Testosterone, Leutenizing Hormone, dopamine, adrenaline, and nor-adrenaline levels in infertile men and reduced levels of Follicle Stimulating Hormone and Prolactin. 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^[35, 36].

Effect on Fertility

Mucuna pruriens improves male fertility by its action on the hypothalamus-pituitary-gonadal axis. *M. pruriens* significantly improved serum testosterone, luteinizing hormone, dopamine, adrenaline, and noradrenaline levels in infertile men and reduce the levels of follicle stimulating hormone (FSH) and prolactin hormone (PRL). Sperm count and motility were significantly recovered in infertile men^[36]. The quality of seminal changes due to psychological stress was assessed after treating the case with *M. pruriens* seed powder at 5g/ day orally. For carrying out morphological and biochemical analysis, semen samples were collected twice, first before starting the treatment and second after 3 months of treatment. The results demonstrated the decreased sperm count and motility in subjects who were under psychological stress. Moreover, serum cortisol and seminal plasma lipid peroxide levels were also found elevated along with decreased seminal plasma glutathione (GSH) and ascorbic acid contents, reduced superoxide dismutase (SOD) and catalase activity. Treatment with *M. pruriens* significantly ameliorated psychological stress and seminal plasma lipid peroxide levels along with improved sperm count and motility. Treatment also restored the levels of SOD, catalase, GSH and ascorbic acid in seminal plasma of infertile men. *M. pruriens* not only reactivates the antioxidant defense system of infertile men but also helps in the management of stress and improves semen quality. The effects of *M. pruriens* on the gonads of male Guinea pigs were investigated and found to be the potential male antifertility agent even at a lower dosage of 70mg/kg. The methanolic extracts of *M. pruriens* significantly increased the relative weight of the testis, serum and testicular testosterone level, testicular cholesterol level, protein level in the testis and epididymis, and epididymal alkaline phosphatase activity^[37].

Anti-depressant activity

The anti depressant activity by *M. pruriens* in acute and chronic model of depression was studied. Psycho-pharmacological investigation involved treatment (14 days) of *M. pruriens* in forced swim test (FST), tail suspension test (TST) in mice and olfactory bulbectomy in rats, respectively. With dose of Mucuna (10-20 mg/kg i.p.) 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 ^[18].

Antiprotozoal effect

Methanolic extract of leaves of *Mucuna pruriens* has the potency to eradicate *Lichthyophthirius multifiliis* infection (90%) in gold fish after treatment in baths of plant extracts at 200 mg/ liter and parasite induced fish mortality was reduced significantly ^[38].

Antitumour activity

The antitumour effect of methanolic extract of *Mucuna pruriens* seed against Erlich Acites Carcinoma (EAC) bearing Swiss albino mice were studied ^[3]. 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. respectively and hence, *M. pruriens* can probably influence immune response in mice ^[18].

Antiproliferative activity

The antiproliferative potential of aqueous leaf extract of *Mucuna pruriens* was evaluated on 7, 12 dimethylbenzanthracene (DMBA)-induced-breast cancer in female albino rats ^[5]. Both the Ethyl acetate and Methanol extract of MP seed had antiproliferative effect in Huh-7 cells. Later, cytotoxicity assay on THLE-2 cells revealed that the ME extract expressed less toxicity on normal human hepatocytes using MTT reagent ^[39]. The Antiproliferative action of isolated M1 (6,7-dimethoxy-1,2,3,4-tetrahydroisoquinoline-3-carboxylic acid) from *M. pruriens* seeds using human hepatic carcinoma cell line (Huh-7 cells). Initially, docking studies was performed to find out the binding affinities of M1 to caspase-3 and 8 enzymes. M1 possessed antiproliferative activity on Huh-7 cells (EC 50=13.97 μ M) and inhibited the action of caspase-8 enzyme, signified process of apoptosis. M1 was active against Huh-7 cells that may be useful for future hepatic cancer treatment ^[40].

Anti cancer activity

The study was made in comparison between the anticancer potential of different extracts of *M. Pruriens* seeds in vitro against sertoli (GC) prostate cancer and ZR-75 breast cancer cell lines was investigated. In the term of half maximum inhibitory concentration (IC50), or cytotoxicity, cell viability count, and growth inhibition of both cell lines at different concentration of each extracts. The MEMP (IC50-14.74 μ g) and PEMP (IC50-15.50 μ g) was found more cytotoxic than AEMP (IC50-16.64 μ g) against GC cells, but MEMP (IC50-15.06 μ g) and AEMP (IC50-15.35 μ g) was more cytotoxic than PEMP (IC50- 16.63 μ g) against ZR-75 cells. (Sanjeev Soni *et al.*, ^[41] the reports that acute systematic toxicity and tropical of methanolic extract of *M. pruriens* seeds on albino mice and rabbits respectively ^[21].

Analgesic and antiinflammatory activity

Mucuna pruriens was evaluated for its antiinflammatory, analgesic and antipyretic activity and found to produce significant effects ^[42].

Antimicrobial activity

Mucuna pruriens is also used for antimicrobial properties for extracting plant metabolites against plant pathogenic bacteria and fungi ^[15]. The methanolic extract of *M. pruriens* of whole plant had antimicrobial properties against gram +ve and gram -ve organism. This extract is mainly effective against *Escherichia coli*, *Salmonella typhi*, *Bacillus subtilis* and *Shigella dysenteriae* ^[43].

Anti fungal activity

High anti fungal activity against *Curvularia lunata*, *Fusarium oxysporum*, *Pencillium expansum*, *Rhizoctonia solani*, *Tiarosporella phaseolina*, *Ustilago pomaydis* was shown by *M. pruriens* extracts. *M. pruriens* extracts possess the various degrees of significant inhibitory effect against the tested organisms ^[15].

Alternative Food/Feed Perspectives and cultivation

Mucuna pruriens (velvet bean) are important feed resources, as they are high in protein, total ash and phosphorus ^[44]. The proximate nutritional composition, total protein content and in vitro protein digestibility of *M. pruriens* seeds is analogous to other edible legumes. Physical and biochemical methods used to process *M. pruriens* beans include soaking, cooking, dehulling followed by drying and milling into flours.

Recently, the velvet beans are exploited as a protein source in the diets of fish, poultry, pig, and cattle after subjected to appropriate processing methods. Although the velvet beans contain high levels of protein and carbohydrate, their utilization is limited due to the presence of a number of antinutritional/antiphysiological compounds, phenolics, tannins, L-Dopa, lectins, protease inhibitors, etc. *M. pruriens* is rich in protein (23–35 %) and has a nutritional quality comparable to that of other pulses like soy bean, rice bean and lima bean. Mucuna bean remains a minor food crop. It is poorly adopted in agricultural systems due to the presence of anti-nutritional and toxic compounds. The major toxicant in Mucuna bean is a non-protein amino acid, 3, 4-dihydroxy-L-phenylalanine (L-Dopa) ^[45].

Mucuna pruriens has been reported to be disease resistant, though it is vulnerable to several pests and diseases. *M. pruriens* suppresses weeds through physically smothering and through a certain degree of allelopath. Among the antinutrients, polyphenols, phytic acid and antitrypsin have been reported in *M. pruriens* beans ^[46]. It is cultivated as a green manure or cover crop and accumulates nutrients in various environments. From an agronomic point, it is known to produce seed yield of 2000 kg/ha perform well under dry farming and low soil fertility conditions, shows resistance against wide range of diseases, exhibits allelopathic properties and is effective in lowering nematode population. Its positive impacts as green manure cover crop are documented in earlier studies ^[47].

Genetic mapping markers

M. pruriens toxic properties of the drug and resultant side effects such as nausea, anorexia and vomiting in human beings and intestinal ailments in livestock, render the plants, particularly seeds inedible. In *M. pruriens* except for a few studies involving molecular markers ^[48] and a lone published linkage map based on amplified fragment length polymorphism (AFLP) markers. To elucidate the genetic control of agronomic traits, an intraspecific genetic linkage map of Indian *M. pruriens* has been developed based on amplified fragment length polymorphism (AFLP) markers using 200 F2 progenies derived from a cross between wild and cultivated genotypes. Mahesh et al., ^[49] to improve *M. pruriens* utilization, several investigations have attempted to eliminate anti-nutritional factors by simple processing techniques ^[50].

CONCLUSION

The *M. pruriens*, the fascinating herb, grown in rubbish and waste places, all parts of the plant have important medicinal properties and wide range of pharmacological preparations and activity. Due to its importance it should be focused on this particular plant and more research has to be done. In view of the widespread uses, more clinical trials are also necessary to investigate other importance of this plant and it is less known about anti inflammatory activity. To explore it, is a study to know in detail about all the activities of the plant.

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Conflict of interests

The authors have no conflict of interest to declare

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