

## Review

## Amazing bean “*Mucuna pruriens*”: A comprehensive review

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***Mucuna pruriens* commonly known as cow-age or cowitch or velvet bean or Alkushi, is a medicinal plant traditionally used in Indian medicine belongs to the family Leguminosae. *M. pruriens* seed is a natural source of the amino acid L-3,4-dihydroxy phenyl alanine (L-DOPA), the direct precursor to the neuro transmitter dopamine which is used widely in the treatment of Parkinson's disease (PD). Serotonin, oxitriptan, nicotine, N,N-DMT, and bufotenine are the other chemicals found in *M. pruriens* in addition to L-DOPA. According to Ancient Ayurvedic literature *Mucuna* is used as a potent aphrodisiac, geriatric tonic and vermifuge. It is also used for the treatment of menstruation disorders, constipation, edema, fever, tuberculosis, etc. In addition, *Mucuna* is also grown as food crop, ornamental plant, living mulch and green manure crop. The reviews summarize the botany, uses, phyto constituents and pharmacological activities of *M. pruriens*.**

**Key words:** *Mucuna pruriens*, uses, phytoconstituents, L-3,4-dihydroxy phenyl alanine (L-DOPA), phytochemistry, pharmacology.

### INTRODUCTION

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 (Kamboj, 2000). In India, herbal medicine has been used for treatments to cure various diseases (Biswas et al., 2004).

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. The earliest

recorded evidence of herbal drugs use in Indian, Chinese, Egyptian, Greek, Roman and Syrian texts dated back to about 5000 years. In India, the earliest mention of the use of medicinal plants was found in the Rig Veda, which is one of the oldest epic and written between 4500 and 1600 BC. Among the medicinal plants, one of the most important medicinal plant and very less exploited is *Mucuna pruriens* (L.) DC. Physicians in ancient India first used *Mucuna* seeds in the treatment of Parkinson's disease (PD) over 4500 years ago. This herb has one of the most fascinating chemical profiles on earth. It is the host of many interesting alkaloids which have profound actions on the human nervous system.

*M. pruriens* is a tropical legume and is commonly known as velvet bean or cowitch or cowhage or Alkushi. It is one of the most popular medicinal plants of India and is constituent of more than 200 indigenous drug formulations. It is widespread and is found in the plains of

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India (Sastry and Kavathekar, 1990; Agharkar, 1991; Singh et al., 1996). The demand for *Mucuna* in Indian as well as in international drug markets increased many fold only after the discovery of the presence of L-3,4-dihydroxy phenyl alanine (L-DOPA), an anti-Parkinson's disease drug in the *Mucuna* seeds (Farooqi, 1999).

## BOTANY

The genus *Mucuna* belongs to the family Leguminosae and consists of 100 species of climbing vines and shrubs. The name of the genus is derived from the word mucunã (Umberto, 2000). This genus is found all over the world in the woodlands of tropical areas especially in tropical Africa, India and the Caribbean. *M. pruriens* is a twinning annual that can reach 15 m in length. The plant is almost completely covered with fuzzy hairs when young, but it is almost free of hairs when it grows older (Sahaji, 2011). The leaves are trifoliate, alternate or spiraled, gray-silky beneath; petioles are long and silky, 6.3 to 11.3 cm. Leaflets are membranous, terminal leaflets are smaller, lateral very unequal sized. Flowers are dark purple, white or lavender in colour (6 to 30), pea-like but larger, with distinctive curved petals and occur in drooping racemes. Fruits, longitudinal pods are curved, 4 to 6 seeded and about 10 cm long (Agharkar, 1991) and are densely covered with persistent pale-brown or grey trichomes that cause irritating blisters if they come in contact with skin. The chemical compounds responsible for the itch is a protein, mucunain (Agharkar, 1991) and serotonin. Seeds are shiny black or brown, ovoid and 12 mm long (Sastry and Kavathekar, 1990; Agharkar, 1991; Verma et al., 1993).

## PHYTOCONSTITUENTS

*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. The leaves contain about 0.5% L-DOPA, 0.006% dimethyl tryptamine and 0.0025% 5-MeO-DMT (Erowid, 2002).

## TRADITIONAL USES

All parts of *Mucuna* possess valuable medicinal properties (Caius, 1989). It is used against a wide range of disorders, such as urinary tract, neurological and

menstruation disorders, constipation, edema, fever, tuberculosis, ulcers, PD (Katzenschlager et al., 2004) and helminthiasis like elephantiasis (Oudhia, 2002). Traditionally, the powdered seeds of *M. pruriens* was found to increase the general mating behavior and thereby sexual activity in rats (Amin et al., 1996).

Roots, according to the Ayurveda, are bitter, thermogenic, anthelmintic, diuretic, emollient, stimulant, aphrodisiac, purgative, febrifuge, and tonic. It is considered useful to relieve constipation, nephropathy, dysmenorrhoea, amenorrhoea, elephantiasis, dropsy, neuropathy, ulcers, helminthiasis, fever and delirium (Warrier et al., 1996).

Leaves are popular potherbs and are used as a fodder crop. Leaves are useful in ulcers, inflammation, cephalagia and general debility. Dried leaves of *M. pruriens* are sometimes smoked. The pods are covered with coarse hairs, trichomes which cause itching, blisters and dermatitis. Pods are also used as vegetable. Pod hairs are used as anthelmintic. Hairs mixed with honey are used as vermifuge. An ointment prepared with hairs act as a local stimulant and mild vesicant (Sastry and Kavathekar, 1990).

The plant and its extracts are used in tribal communities as a toxin antagonist for various snakebites. Seed is a source of minerals (Singh et al., 1995). 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 consumed (Oudhia, 2002) and formulations of the seed powder have shown promise in the management and treatment of PD (Chamakura, 1994).

## OTHER USES

Beside medicinal properties, in many parts of the world, *M. pruriens* is used as an important forage, fallow and green manure crop. Since the plant is a legume, it fixes nitrogen and fertilizes soil. *M. pruriens* is a wide spread fodder plant in the tropics. The whole plant is fed to animals as silage, dried hay or dried seeds. *M. pruriens* silage contains 11 to 23% crude protein, 35 to 40% crude fiber and the dried beans contain 20 to 35% crude protein. It is also used as a biological control for problematic *Imperata cylindrica* grass in Benin and Vietnam (Kavitha and Vadivel, 2008).

The genus is also used as living mulch for tropical areas and it increases phosphorus availability after application of rock phosphate (Vanlauwe et al., 2000). *M. pruriens* was used in Native American milpa agriculture. *Mucuna* is also used as a food crop, e.g. in Eastern Nigeria, although the L-DOPA content makes it less desirable. The plant is to be processed before it can be eaten, that is, the leaves must be soaked to leach out the L-DOPA. The seeds are also cracked open and soaked

before eaten. If consumed in large quantities as food, unprocessed *M. pruriens* is toxic to non-ruminant mammals, including humans (Oudhia, 2002; Diallo and Berhe, 2003).

## CULTIVATION

*Mucuna* is grown as kharif crop in India. Seeds are sown at rate of 50 kg/ha with plant spacing of 60 × 60 cm. Although, no named cultivar of *Mucuna* is available, locally available seeds possess good viability and higher germination (Oudhia, 2001). Plant needs support for growth. Increase in yield upto 25% and reduction in pest infestation is obtained by providing support. Normally, flowering begins in 45 to 50 days after sowing (Oudhia and Tripathi, 2001).

Thomas and Palaniappan (1998a, b) found that application of 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased the growth, yield components and seed yield of velvet bean. Kumwenda and Gilbert (1998) stated that *M. pruriens* had the highest biomass production averaging 7.3 t ha<sup>-1</sup> with P<sub>2</sub>O<sub>5</sub> application. The nutrient omission trial in *Mucuna* showed that when N and P were absent in the complete fertilizer treatment, biomass production decreased significantly on an average by 69% (N) and 33% (P) (Houngnandan et al., 2001). Philip et al. (2001) found that dry matter production under 30 and 45 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> application was at par in *M. bracteata*. Better growth of the plant, increased number of leaves and longer duration of leaves due to delayed senescence were observed when *M. pruriens* plants were provided with both organic (cocopeat at 5 t/ha and farm yard manure at 12.5 t/ha) and inorganic forms (NPK 40:30:30 kg/ha) of nutrition (Kavitha and Vadivel, 2006a).

Biomass yield of *Mucuna* varies directly with length of growing season and soil fertility conditions. High biomass accumulation (10 t ha<sup>-1</sup>) was observed in areas of longer growing season. Varietal characteristics were also observed to influence the rate of dry matter production (IITA, 1997). Becker and Johnson (1998) reported that soil phosphorus is an important factor in *Mucuna* biomass accumulation, as legumes require phosphorus for growth and nitrogen fixation. The integrated nutrient combination involving organic manures (cocopeat at 5 t/ha and farmyard manure at 12.5 t/ha) and inorganic fertilizers (NPK 40:30:30 kg/ha) and harvesting at dry pod stage showed a greater degree of positive influence on dry matter production (Kavitha and Vadivel, 2008).

According to Kay (1979) seed yield in *Mucuna* ranged from 700 to 1100 kg ha<sup>-1</sup> in India, 1700 to 2200 kg ha<sup>-1</sup> in USA and 600 kg ha<sup>-1</sup> in Australia. Humphreys and Riveros (1986) reported that staking is generally recommended for improving quantity and quality of *Mucuna* seed production. The globular or reniform seeds are usually coloured black, white, creamy yellow or may be mottled and are about 4 to 8 seeds per pod. Hundred

seed weight varied from 25 to 110 g (Buckles, 1995). Chadha (1995) reported that seed yield varied between irrigated and rainfed crop. In a rainfed crop without staking seed yield of 1500 to 1750 kg ha<sup>-1</sup> and with staking, yield of 3000 to 3750 kg ha<sup>-1</sup> were obtained. Yield upto 5000 kg/ha have been recorded from well managed irrigated crop provided with stakes (Singh et al., 1995; Farooqi et al., 1999). Kavitha and Vadivel (2006b) reported that the integrated nutrient combination involving organic form of manures (cocopeat at 5 t/ha and farmyard manure at 12.5 t/ha) and inorganic fertilizers (NPK 40:30:30 kg/ha) resulted in high seed yield.

## L-DOPA

Dymock and Warden (1980) reported that 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 (Mahajani et al., 1996). Climatic factors are observed to have no direct effect on L-DOPA content in *M. pruriens* while plants supported by stakes have higher L-DOPA content (Pieris and Janz, 1980). Fujii et al. (1992) stated that L-DOPA is present at about 1% by fresh weight in leaves and roots of *M. pruriens*. Sunitha (1996) reported that there was no significant difference in the content of L-DOPA when *M. pruriens* was grown under shade or open conditions. Prakash and Tiwari (1999) investigated 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. Vadivel and Janardhanan (2000) reported that the content of L-DOPA in the seeds of different accessions ranged from 7.62 to 8.37%. Ramaswamy (1957) reported on the isolation of L-DOPA (1.5% on dry weight basis) from *Mucuna* seeds. Siddhuraju and Becker (2001) developed a high performance liquid chromatographic assay for the extraction and quantitative determination of L-DOPA in *M. pruriens* var *utilis* seeds. Yang et al. (2001) reported that high performance liquid chromatography (HPLC) analysis revealed L-DOPA concentrations ranged from 3.9 to 6.2% in *Mucuna* seeds.

## In vitro production

To accommodate the huge demand for L-DOPA, *in vitro* production of the drug using cell cultures, is now practiced extensively. The presence of L-DOPA in callus and cell suspension cultures of *M. pruriens* has been reported (Brain, 1979; Obata-Sasamata and Komamine, 1983). Huizing et al. (1985) demonstrated the presence

of L-DOPA in the cell suspension cultures of *M. pruriens* by means of thin layer chromatography (TLC) and HPLC. Wichers et al. (1985) reported that addition of 2,4-D to the cell suspension culture medium of *M. pruriens* suppressed L-DOPA production. Huizing (1986) reported that the synthesis of L-DOPA was upto 90% from *M. pruriens* cultures. Wichers et al. (1993) detected the presence of dopamine in the cell suspension cultures of *M. pruriens*. Chattopadhyay et al. (1994) reported that discernibly higher production of L-DOPA, from *M. pruriens* f. *pruriens* cell cultures was obtained in comparison to single stage culture. Huang et al. (1995) concluded that the high yields of L-DOPA was associated with the precise control of pH, adequate Indole-3-Acetic Acid (IAA) concentration and a yellowish or brown cell colour which reflected melanin production in cell line culture of *Stizolobium hassjoo*. Huang and Chen (1998) reported that efficient production of L-DOPA is possible in *Stizolobium hassjoo* cell culture in a two stage configuration. Murashige and Skoog (MS) medium with 2 mg/L 2,4-D was found to be the best medium for inducing callus in various explants, namely, stem bits, leaf bits and root bits and L-DOPA accumulation was more in cell suspension culture in liquid MS medium with 4% sucrose + 1 mg/L IAA + 1 mg/L BA (Kavitha and Vadivel, 2005).

## PHARMACOLOGY

### Anti-Parkinson's activity

The clinical syndrome of Parkinsonism was identified in ancient India even before the period of Christ and was treated methodically. According to "Bhasava rajyam" the Parkinsonism was treated by the administration of powdered seed of *M. pruriens* containing 4 to 6% of levodopa (Ovallath and Deepa, 2013).

Hussian and Manyam (1997) indicated that for the dose, *M. pruriens* showed twice the anti-Parkinsonian activity of synthetic L-DOPA. In a clinical study, Nagashayana et al. (2000) revealed the contribution of L-DOPA in the recovery of PD followed by Ayurveda medication. Katzenschlager et al. (2004) revealed that 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.

### Antiglycaemic effect

Using a combination of chromatographic and NMR techniques, the presence of D-chiro-inositol and its two galacto-derivatives having antiglycaemic effect was demonstrated in *M. pruriens* seeds (Donati et al., 2005).

### Hypoglycemic activity

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 2 h after oral administration of seed extract. It also significantly lowered the blood glucose in STZ diabetic rats after 21 days of daily oral administration of the extract. Thus, it was clearly depicted that *M. pruriens* could be a source of hypoglycemic compounds (Bhaskar et al., 2008).

### Antioxidant activity

*In vitro* assays indicated that a whole plant of ethyl acetate and methanolic extract of *M. 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 (Satheesh et al., 2010; Kumar and Muthu, 2010).

### Antivenom activity

Research on its effects against *Naja* species (Tan et al., 2009) has shown 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. About 0.16 and 0.19 mg of *M. pruriens* seed extracts were able to completely neutralize the lethal activity of 2LD<sub>50</sub> 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 (Meenatchisundaram and Michael, 2010). According to Fung and Tan (2012), 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.

### Aphrodisiac activity

Shukla and Mahdi (2010) demonstrated that oral administration of 5 g of *Mucuna* seed powder once in a day for men with decreased sperm count and motility ameliorated psychological stress and seminal plasma liquid 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.

### Antimicrobial activity

*M. pruriens* is also used for antimicrobial properties for extracting plant metabolites against plant pathogenic bacteria and fungi. The methanolic extract showed high antibacterial activity against *Erwinia carotovora*, *Pseudomonas syringae*, *Pseudomonas marginalis*, *Pseudomonas acroginosa*, *Xanthomonas campestris* and high anti fungal activity against *Curvularia lunata*, *Fusarium oxysporum*, *Penicillium expansum*, *Rhizoctonia solani*, *Tiarosporella phaseolina*, *Ustilago pomaydis* (Rayavarapu and Kaladhar, 2011).

### CONCLUSION

*M. pruriens*, the fascinating herb is abided with manifold uses. All parts of the plant are being used in pharmacological preparation. Hence, due importance should be focused on this particular plant and more research has to be carried out to exploit the total potential of the crop in the field of pharmacology.

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