

# *Mimosa pudica* L. (Laajvanti): An overview

Hafsa Ahmad, Sakshi Sehgal, Anurag Mishra, Rajiv Gupta

Department of Pharmacognosy, Faculty of Pharmacy, Babu Banarasi Das National Institute of Technology and Management, Faizabad Road, Lucknow, Uttar Pradesh, India

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## ABSTRACT

*Mimosa pudica* L. (Mimosaceae) also referred to as touch me not, live and die, shame plant and humble plant is a prostrate or semi-erect subshrub of tropical America and Australia, also found in India heavily armed with recurved thorns and having sensitive soft grey green leaflets that fold and droop at night or when touched and cooled. These unique bending movements have earned it a status of 'curiosity plant'. It appears to be a promising herbal candidate to undergo further exploration as evident from its pharmacological profile. It majorly possesses antibacterial, antivenom, antifertility, anticonvulsant, antidepressant, aphrodisiac, and various other pharmacological activities. The herb has been used traditionally for ages, in the treatment of urogenital disorders, piles, dysentery, sinus, and also applied on wounds. This work is an attempt to explore and compile the different pharmacognostic aspects of the action plant *M. pudica* reported till date.

**Key words:** Antidepressant, aphrodisiac, diuretic, *Mimosa pudica*, pulvini, symbionts

## INTRODUCTION

*Mimosa pudica* L. is a creeping annual or perennial herb. It has been identified as lajjalu in Ayurveda and has been found to have antiasthmatic, aphrodisiac, analgesic, and antidepressant properties. *M. pudica* is known to possess sedative, emetic, and tonic properties, and has been used traditionally in the treatment of various ailments including alopecia, diarrhea, dysentery, insomnia, tumor, and various urogenital infections. Phytochemical studies on *M. pudica* have revealed the presence of alkaloids, non-protein amino acid (mimosine), flavonoids C-glycosides, sterols, terpenoids, tannins, and fatty acids.<sup>[1]</sup> Two well-known movements are observed in *M. pudica* L. (ojigi-so in Japanese): one is the very rapid movement of the leaves when it is stimulated by touch, heating, etc., and the other is the very slow, periodical movement of the leaves called nyctinastic movement which is controlled by a biological clock.<sup>[2]</sup> The leaves of the sensitive plant *M. pudica* can adapt their closing response to electrical and mechanical stimulation so that they

reopen to repeated stimulation. The more intense the stimuli and the longer the intertribal interval, the longer it takes to adapt. Leaves adapted to the effects of mechanical stimulation can still respond by closing to electrical stimulation and *vice versa*.<sup>[3]</sup>

## BIOLOGICAL SOURCE

*Mimosa pudica* L. is a diffuse prickly undershrub belonging to family Mimosaceae [Figure 1].

### Parts used

Whole plant, leaves, and roots.

### Synonym

Laajvanti, Touch me not, and Chhui-mui

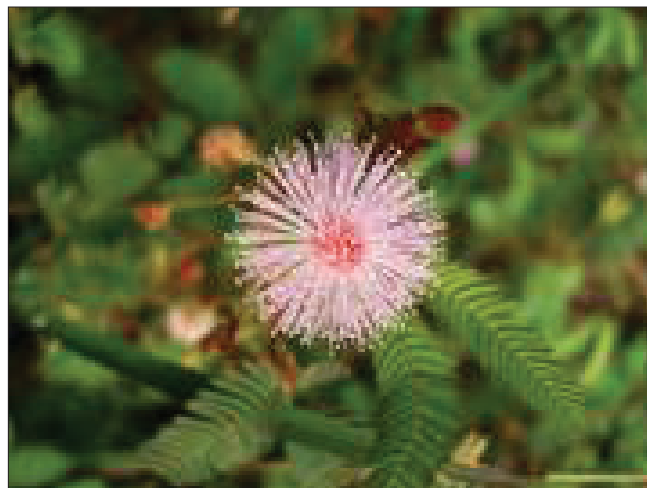


Figure 1: *Mimosa pudica* flower head

### Address for correspondence:

Prof. Rajiv Gupta, Department of Pharmacognosy, Faculty of Pharmacy, Babu Banarasi Das National Institute of Technology and Management, Lucknow, Uttar Pradesh, India.  
E-mail: rajiv961@rediffmail.com

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### Classical and common names

Ayurveda – Lajjalū, Namaskari, Samangaa, Samokchini, and Shamipatraa  
Siddha – Thottal Chinungi.<sup>[4]</sup>

### Vernacular names

Sanskrit – Lajja  
English – Sensitive plant  
Hindi – Laajvanti and Chhui-mui  
Bengali – Lajjabati  
Telugu – Attapatti and Peddanidrakanni  
Tamil – Tottaaladi and Thottalchnungi  
Kannada – Lajja, Nachika and Mudugu-davare  
Malayalam – Tintarmani

### Origin and geographical distribution

The plant is a native of tropical America and naturalized nearly all through the tropical and subtropical parts of India.

### Habitat

Commonly distributed in open-spaces, especially road side, cultivated land, and waste area.

### Propagation

By seeds and vegetative methods.

### Description

Semi-prostrate, prickly course herb, or subshrub up to 0.5-m tall.<sup>[5]</sup>

## MACROSCOPY

### Root

Cylindrical, tapering rependant, with secondary and tertiary branches, varying in length up to 2-cm thick, surface more or less rough or longitudinally wrinkled; grayish-brown to brown, cut surface of pieces pale yellow, fracture hard, woody, bark-fibrous; odor, distinct; taste, slightly astringent.

### Stem

Cylindrical, up to 2.5 cm in diameter; sparsely prickly, covered with long, weak bristles longitudinally grooved, external surface light brown, internal surface grey, bark fibrous; easily separable from wood.

### Leaf

Digitately compound with one or two pairs of sessile, hairy pinnae, alternate, petiolate, stipulate, linear lanceolate; leaflets 10–20 pairs, 0.6–1.2-cm long, 0.3–0.4-cm broad, sessile, obliquely narrow or linear oblong; obliquely rounded at base, acute, nearly glabrous; yellowish green.

### Flower

Pink, in globose head, peduncles prickly; calyx very small; corolla pink, lobes 4, ovate oblong; stamens 4, much exerted; ovary sessile; ovules numerous.

### Fruit

Lomentum, simple, dry, 1–1.6-cm long, 0.4–0.5-cm broad, with indehiscid segments and persistent sutures having —two to five seeds with yellowish spreading bristle at sutures, 0.3-cm long, glabrous, and straw colored.

### Seed

Compressed, oval-elliptic, brown to gray, 0–0.3-cm long, 2.5-mm broad, having a central ring on each surface.

## MICROSCOPY

### Root

Mature root shows cork 5–12 layered, tangentially elongated cells, a few outer layer crushed or exfoliated; secondary cortex consisting of 6–10 layered, tangentially elongated thin-walled cells; secondary phloem composed of sieve elements, fibers, crystal fibers, and phloem parenchyma traversed by phloem rays, phloem fibers, single or in groups, arranged in tangential bands; crystal fibers thick walled, 3–25 chambered, each with single or two to four prismatic crystals of calcium oxalate; phloem rays uni-to-multi-seriate, —two to three seriate more common; secondary xylem consists of usual elements traversed by xylem rays; vessels scattered throughout secondary xylem having bordered pits and reticulate thickenings; crystal fibers containing one or rarely two to four prismatic crystals of calcium-oxalate in each chambers; parenchyma, thick walled, scattered throughout secondary xylem; xylem rays uni-to-bi-seriate; rarely multi-seriate, wider toward secondary phloem and narrow toward center; starch grains, prismatic crystals of calcium oxalate and tannin present in secondary cortex, phloem and xylem rays, and parenchyma; starch grains both simple and compound having two to three components, rounded to oval measuring 6–20 μm and 16–28 μm in diameter, respectively.

### Stem

Mature stem shows four to eight layered, exfoliated cork of tangentially elongated cell filled with reddish brown contents; secondary cortex wide, consisting of large, moderately thick walled, tangentially elongated to oval, parenchymatous cells, filled with reddish brown contents, a few cells contain prismatic crystals of calcium oxalate, a number of lignified, fibers single or in groups, scattered throughout; secondary phloem consisting of usual elements, two to five transversely arranged strips of fibers occur alternating with narrow strips of sieve elements and parenchyma, crystal fibers elongated, thick-walled, containing single crystal of calcium oxalate in each chamber; phloem rays thick walled radially elongated; secondary xylem composed of usual elements traversed by xylem rays, vessels, drum shaped with spiral thickenings, tracheids pitted with pointed ends, fibers of two types, shorter wide lumen and longer with narrow lumen; xylem rays radially elongated, thick walled, 1–6 cells wide and 3–30 cells high; pith consisting of polygonal, parenchymatous cells with intracellular spaces.

### Leaf

Petiole shows single layered epidermis, covered with thin cuticle;

cortex four to seven layered of thin walled, parenchymatous cells; pericycle arranged in a ring; four central vascular bundles present with two smaller vascular bundles arranged laterally, one in each wing.

#### Midrib

Shows a single-layered epidermis, covered with thin cuticle, upper epidermis followed by a single-layered palisade, spongy parenchyma single-layered, pericycle same as in petiole; vascular bundle single.

#### Lamina

Shows epidermis on both surfaces, palisade single-layered; spongy parenchyma, three to five layers consisting of circular cells; rosette crystals and few veins present in spongy parenchyma.

#### Fruit

Shows single-layered epidermis with few nonglandular, branched, shaggy hair; mesocarp five to six layers of thin walled, parenchymatous cells; some amphicribal vascular bundles found scattered in this region; endocarp of thick-walled lignified cells followed by single-layered thin-walled, parenchymatous cells.

#### Seed

Shows single-layered radially elongated cells; followed by five- to six-layered angular cells filled with dark brown contents; endosperm consists of angular or elongated cells, a few containing prismatic crystals of calcium oxalate; cotyledons consist of thin-walled cells, a few cells containing rosette crystals of calcium oxalate; embryo straight with short and thick radical.

#### Powder

Reddish brown, shows reticulate, pitted vessels, prismatic and rosette crystals of calcium oxalate, fibers, crystal fibers, yellow or brown parenchymatous cells, palisade cells, nonglandular, branched, shaggy hair, single and compound starch grains, measuring 6–25 mm in diameter with two to three components [Figure 2].<sup>[6]</sup>

### BENDING MOVEMENTS OF THE CURIOSITY PLANT *MIMOSA PUDICA*-

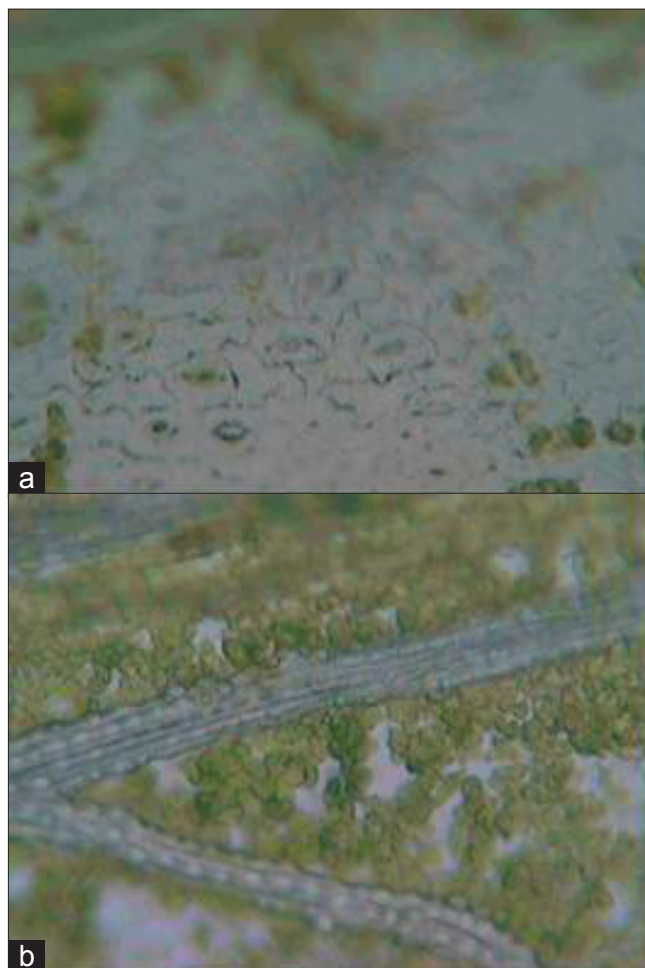
Plant leaf movements can be mediated by specialized motor organs, the pulvini or can be epinastic (i.e. based on different growth velocities of the adaxial and abaxial halves of the leaf).

Both processes are associated with diurnally regulated increase in the rates of membrane water transport, which in many cases, has been shown to be facilitated by aquaporins. Rhythmic leaf movements are known from many plant species but more recently a promising model plant to study pulvinus-mediated leaf movements is *M. pudica*. The contribution of both plasma membrane and tonoplast localized aquaporins to the seismonastic leaf movements in *M. pudica* has been analyzed.<sup>[7]</sup> The bending movement of the pulvinus of *M. pudica* is caused by a rapid change in volume of the abaxial motor cell, in response to

various environmental stimuli. The bending of the pulvinus is retarded by treatments with actin-affecting reagents and calcium channel inhibitors. The actin filaments in the motor cells are fragmented in response to electrical stimulation. Hence the study demonstrated that depolymerization of the actin cytoskeleton in pulvinus motor cells in response to electrical signals results in increased levels of calcium.<sup>[8]</sup>

The seismonastic movement of *M. pudica* is triggered by a sudden loss of turgor pressure. On comparing the cell cytoskeleton by immunofluorescence analysis before and after movement and evaluation of the effects of actin and microtubule targeted drugs by injecting them into the cut pulvinus, it is seen that fragmentation of actin filaments and microtubule occurs during bending, although the actin cytoskeleton and not the microtubules are involved in the regulation of the movement.

TEM reveals that actin cables become loose after bending. On injecting phosphatase inhibitors into several pulvinus to examine the effects of such inhibitors, it is seen that changes in actin isoforms, fragmentation of actin filaments and the bending movements are all inhibited after injecting a tyrosine phosphatase inhibitor.<sup>[9]</sup> Special red cells are found on the adaxial surface of



**Figure 2:** (a) Stomata on *M. pudica* leaf. (b) Water transport system in *M. pudica* (800 × 800)

the tertiary pulvini of *M. pudica*. Using anatomical (light, scanning and transmission electron microscopy) and electrophysiological techniques it has been demonstrated that these red cells are the real mechanoreceptor cells. They can generate receptor potential following mechanical stimuli and they are in connection with excitable motor cells (through plasmodesmata). These red cells are derived from stomatal subsidiary cells and not the guard cells [Figure 3].<sup>[10]</sup>

### *Mimosa pudica* symbionts

Bacteria isolated from *Mimosa* nodules in Taiwan, Papua New Guinea, Mexico, and Puerto Rico were identified as belonging to either the alpha- or beta-proteobacteria. The beta-proteobacteria *Burkholderia* and *Cupriavidus* strains formed effective symbiosis with the common invasive species *Mimosa diplotricha*, *M. pigra*, and *M. pudica*, but the alpha-proteobacterial *Rhizobium etli* and *R. tropici* strains produced a range of symbiotic phenotypes from no nodulation through ineffective to effective nodulation, depending on *Mimosa* species.

The largest significant effect was for *M. pudica*, in which LMG19424 formed 57% of the nodules in the presence of 0.5 mM potassium nitrate. In the host, ammonium also had a similar, but lesser, effect. Comparable results were also found using an N-containing soil mixture, and environmental N levels are therefore suggested as a factor in the competitive success of the bacterial symbionts *in vivo*.<sup>[11]</sup> The ability of *Burkholderia phymatum* STM815 to effectively nodulate *Mimosa* species, and to fix nitrogen ex planta, was compared with that of the known *Mimosa* symbionts *Cupriavidus taiwanensis* LMG19424. Both strains were equally effective symbionts of *M. pudica*, but nodules formed by STM 815 had greater nitrogenase activity. STM 815 was shown to have a broader host range across the genus *Mimosa* than LMG 19424 nodulating 30 out of 31 species, 21 of these effectively. LMG 19424 effectively nodulated only nine species.<sup>[12]</sup>

### Phytochemistry

Several studies have shown several biochemical substances involved in the contractility of the leaves.<sup>[13]</sup> Fresh tissues give nor-epinephrine, D-pinitol (3-mono-methyl ether of inositol), and b-sitosterol. Leaves contain alkaloids.<sup>[4]</sup> An alkaloid mimosine has been isolated from the plant.<sup>[13]</sup> The preliminary phytochemical screening of the *M. pudica* leaf extract showed the presence of bioactive components such as terpenoids, flavonoids, glycosides, alkaloids, quinines, phenols, tannins, saponins, and coumarins [Table 1].<sup>[14,23]</sup>

Roots of the plant are indicative of the presence flavonoids, phytosterol, alkaloids, amino acids, tannins, glycoside, and fatty acids. Chromatographic procedures revealed that petroleum ether fraction majorly contains flavonoids, phytosterol, alkaloids, and amino acids. Acetone fraction has confirmed the presence of flavonoids. The chloroform fraction showed the presence of alkaloids. The essential oils and fatty acids were majorly contained in the benzene extract [Table 2].<sup>[138]</sup>



**Figure 3:** *Mimosa pudica* leaves (a) open and (b) closed

The yield of the plant material in various solvents obtained by successive extraction was found out [Table 3].

Crocetin dimethyl ester and tannin have been isolated from the plant. The mucilage from seed is composed of D-xylose and D-glucuronic acid 4-O-(3,5-dihydroxybenzoic acid)-b-D-glucuronide.<sup>[15]</sup> The constituents were separated and purified by column chromatography with macroporous adsorption resin Diaion HP-20, Sephadex LH-20, Tyopearl HW-40, MCI Gel CHP-20, RP-18, and normal phase silica gel. Their structures were identified on the basis of physical and spectral data. Four compounds were isolated and identified as:

7,8,3',4'-tetrahydroxyl-6-C-[alpha-L-rhamnopyranosyl-(1→2)]-b-D-glucopyranosyl flavone (I); 5,7,4'-trihydroxyl-8-C-[alpha-L-rhamnopyranosyl-(1→2)]-b-D-glucopyranosyl flavones (II); 5,7,3',4'-tetrahydroxyl-6-C-[alpha-L-rhamnopyranosyl-(1→2)]-b-D-glucopyranosyl flavone (III); catcher (IV).

Compound I is a new compound and compounds II–IV were isolated from this plant for the first time.<sup>[16]</sup> Cellular and chloroplast lipids of leaves of *M. pudica* have been analyzed. Qualitatively the total lipid composition of this plant is similar to that reported for the photosynthetic tissues of other plants.



**Table 1: Phytochemical screening of *Mimosa pudica* leaf extracts**

Test	n-Hexane	Chloroform	Ethyl acetate	Methanol
Alkaloids	–	+	+	+
Glycosides	–	+	+	+
Terpenoids	–	–	–	–
Carbohydrates	+	+	+	+
Proteins	–	–	–	–
Steroids	+	+	–	+
Flavonoids	–	+	+	+
Phenols	–	–	–	+
Tannins	–	–	–	–
Quinones	–	–	–	–
Saponins	+	+	–	–
Resin	–	–	–	–

**Table 2: Detection of constituents in roots of *M. pudica* by chromatographic scheme**

Solvent system used	Detection reagent	Observation	Inference	P	B	C	A	M	E
Ethyl acetate:methanol: water (75.5:13.5:10)	KOH	Red. (Vis) yellow	Anthraquinone anthrone	–	–	–	–	–	–
	Vanillin sulphuric acid	Red/ yellow/brown/blue- green	Bitter principle	–	–	–	–	–	–
	Dragendorff's reagent	Orange red (vis)	Alkaloid	+	–	+	–	–	–
	NP/PEG and UV	Yellow/green/orange	Flavonoid	+	–	–	+	–	+
Toluene:ethylacetate (93:7)	VS reagent	Blue (vis)	Saponin	–	–	–	–	–	–
	VS reagent	Red/ yellow/brown/blue- green	Essential oil	+	+	–	–	–	–
	HCl/acetic acid	Blue-brown	Valeopriate	–	–	–	–	–	–
	NH <sub>3</sub> /KOH	Light blue brown	Coumarin	–	–	–	–	–	–

P = Petroleum ether, B = Benzene, C = Chloroform, A = Acetone, M = Methanol, E = Ethanol

**Table 3: Successive solvent extraction of *Mimosa pudica* Linn. leaves**

Solvent	Color and consistency	Extractive value (% w/w)
n-Hexane	Yellowish brown waxy	5.366
Chloroform	Brownish waxy	7.75
Ethyl acetate	Dark brown waxy	10.25
Methanol	Reddish brown waxy	17.90

Chloroplast lipids show some resemblance to those of algae. The cerebroside fraction of both leaves and chloroplasts contains a polyunsaturated fatty acid (20:4 $\omega$ 3) and a long chain sphingosine base whose  $R_f$  value coincides with that from ox brain cerebroside and not that of phytosphingosine from spinach<sup>[17]</sup> Jasmonic acid was identified from *M. pudica* L. plants by mass spectrometry, high performance liquid chromatography, and thin layer chromatography. Effects of authentic jasmonic acid on pulvinule movement and transpiration of the pinnae were compared with those of abscisic acid. Jasmonic acid and abscisic acid each at  $10^{-5}$  M inhibited both auxin- and light-induced opening of the pulvinules. A closure-inducing activity of jasmonic acid at  $10^{-4}$  M was greater than that of abscisic acid at  $10^{-4}$  M. Pinnae transpiration was reduced by  $10^{-5}$  M abscisic acid but not by  $10^{-4}$  M jasmonic acid.<sup>[18]</sup>

The secretory cells accumulate material that gives a positive test for carbohydrates and a negative test for proteins.<sup>[19]</sup> Interestingly

certain compounds with enzyme inhibitory activity have also been isolated from *M. pudica* recently [Figure 4].

## EVALUATION AND ANALYSIS

### Identity, purity, and strength

Foreign matter – not more than 2%

Total ash – not more than 10%

Acid-insoluble ash – not more than 5%

Alcohol-soluble extractive – not less than 9%

Water-soluble extractive – not less than 9%.

### Thin layer chromatographic studies

TLC of alcoholic extracts of drug on Silica Gel G plates using *n*-butanol:acetic acid:water (4:1:5). Under UV (366 nm) four fluorescent zones appear at  $R_f$  0.35, 0.62, 0.69 (all blue) and 0.81 (bluish pink). On exposure to iodine vapor two spots appear at  $R_f$  0.35 and 0.94 (both yellow). On spraying with the Dragendorff reagent followed by 5% methanolic sulfuric acid reagent one spot appears at  $R_f$  0.35 (orange).<sup>[6]</sup>

### Reverse phase HPTLC

A sensitive, simple, and reliable reversed-phase HPTLC method has been established for quantification of mimosine in *M. pudica* L. whole plant powder. The plant powder was first extracted with methanol. The residue was then extracted with water and the aqueous extract was used for quantification. Chromatography was

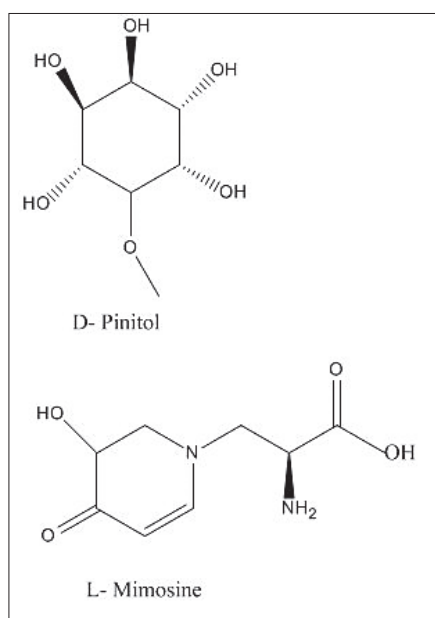
performed on silica gel RP-18 F254s plates with ethyl acetate–glacial acetic acid–water, 6 + 1 + 1.7 (v/v), as the mobile phase. Quantification was achieved by densitometric scanning at  $\lambda_{\max} = 282$  nm in the reflectance–absorbance mode. The response to mimosine was a linear function of concentration over the range 30–100 mg/mL in the extract. The amount of mimosine in *M. pudica* was found to be 20 mg g<sup>-1</sup> whole plant powder. The method was validated for linearity, precision, accuracy, and robustness.<sup>[20]</sup>

### NMR imaging

The water distribution in the pulvinus of *Mimosa* can be visualized by an NMR imaging technique. After stimulation of a *Mimosa* plant, water in the lower half of the main pulvinus disappeared, the water previously contained in this area seems to be transferred to the upper half of the main pulvinus. Movement of the water in conjunction with *Mimosa* movement was visualized sequentially by a noninvasive NMR imaging procedure.<sup>[21]</sup>

### Bioassay

Wherever a movement factor is suspected, its aqueous extract is



**Figure 4:** Structure of chemical constituents

prepared and tests are performed on it as such or after separation into components, making use of the rapid reactivity of *M. pudica*. In the bioassay in the climate chamber, a pinna of *M. pudica* is placed in a solution of the supposed active principles and is observed. The movement factors are drawn up and cause each pair of the pinnules to fold up neatly one behind the other. The reaction behavior induced by the chemonastic stimulus of a *Mimosa* crude extract can be demonstrated as a function of its concentration in a number of tests. Despite individual variation which can always be observed in the bioassay, a clear decrease in the reaction time with declining concentrations can be seen.<sup>[22]</sup>

### Fluorescence analysis

The powdered leaf samples as well as leaf extracts were subjected to fluorescence analysis on long and short wavelengths in day light [Tables 4 and 5].<sup>[23]</sup>

## MAJOR PHARMACOLOGICAL ACTIVITIES

### Wound healing activity

The roots of *M. pudica* were studied for wound healing activity by incorporating the methanolic and the total aqueous extracts in simple ointment base B.P. in concentration of 0.5% (w/w), 1% (w/w), and 2% (w/w). Wound healing activity was studied in three types of model in rats viz. excision, incision, and estimation of biochemical parameters. Treatment of wound with ointment containing 2% (w/w) the methanolic and 2% (w/w) the total aqueous extract exhibited significant ( $P < 0.001$ ) wound healing activity. The methanolic extract exhibited good wound healing activity probably due to phenols constituents.<sup>[24]</sup>

**Table 4: Fluorescence analysis of extracts of *Mimosa pudica* L. leaves**

Extracts	Day light	UV light	
		Short (254 nm)	Long (365 nm)
n-Hexane	Green	Green	Yellow fluorescence
Chloroform	Dark green	Red	Brown
Ethyl acetate	Pale green	Blue fluorescence	Dark orange
Methanol	Reddish brown	Blue fluorescence	Black

**Table 5: Fluorescence analysis of drug powder of *Mimosa pudica* Linn. leaves**

Treatment	Day light	UV Light	
		Short (254 nm)	Long (365 nm)
Powder	Pale green	Dark green	Pale green
Powder + water	Brown	Green	Green
Powder + 1 N HCl	Greenish brown	Pale brown	Brown
Powder + 1 N HNO <sub>3</sub>	Pale green	Green	Pale brown
Powder + 1 N H <sub>2</sub> SO <sub>4</sub>	Reddish brown	Blue fluorescence	Green fluorescence
Powder + 1 N NaOH	Greenish brown	Dark green	Pale green
Powder + Alc. NaOH	Pale green	Brown	Green
Powder + 1 N KOH	Yellow	Green	Dark brown
Powder + Alc. KOH	Red	Red	Green fluorescence
Powder + ammonia	Pale green	Green	Brown

### Regeneration of sciatic nerve

An extract administered in a dose of 1.6 mg/100 g parenterally every 4th day up to 120 days in rats having experimental injury of sciatic nerve, exhibited 30–40% higher results in the process of regeneration of sciatic nerve as compared to the hydrocortisone group.<sup>[4]</sup>

### Antidepressant action

In Mexico, aqueous extracts from dried leaves of *M. pudica* are employed to alleviate depression. In this study, behavioral actions of aqueous extracts of *M. pudica* at various concentrations were tested. Rats having received saline (0.9%; 0.30 mL; I.P.), clomipramine, desipramine, or several dosage of aqueous extracts from *M. pudica* ( $m_1 = 2.0$  mg/kg;  $m_2 = 4.0$  mg/kg;  $m_3 = 6.0$  mg/kg;  $m_4 = 8.0$  mg/kg) during a 30-day period were submitted to the forced swimming test and to the test for differential reinforcement of low rates of response at 72 s (DRL-72 s). Any possible anxiolytic action resulting from several doses ( $m_1 = 2.0$  mg/kg;  $m_2 = 4.0$  mg/kg;  $m_3 = 6.0$  mg/kg;  $m_4 = 8.0$  mg/kg) of extracts of *M. pudica* were compared with those caused by diazepam (1.3 mg/kg, I.P.) in the elevated plus-maze test.

Results showed that clomipramine (1.25 mg/kg, I.P.), desipramine (2.14 mg/kg, I.P.), and *M. pudica* (6.0 mg/kg and 8.0 mg/kg, I.P.) reduced immobility in the forced swimming test and increased the rate of reinforces received in the DRL-72 s test; these data suggest that *M. pudica* produces antidepressant effects in the rat. Diazepam increased the open-arms exploration time in the elevated plus-maze test, but *M. pudica* did not show any comparable action at any tested dose. *M. pudica* therefore produced an anti-depressant like profile similar to two tricyclic anti-depressants.<sup>[25]</sup>

### Anticonvulsant action

The decoction of *M. pudica* leaves given intraperitoneally at a dose of 1000–4000 mg/kg protected mice against pentylenetetrazole and strychnine-induced seizures. *M. pudica* had no effect against picrotoxin-induced seizures. It also antagonized N-methyl-D-aspartate-induced turning behavior. These properties could explain its use in African traditional medicine.<sup>[26]</sup>

### Hyperglycemic effect

Ethanol extracts of *M. pudica* leaves given by oral route to mice at a dose of 250 mg/kg showed a significant hyperglycemic effect.<sup>[27]</sup>

### Diuretic effect

Decoction of leaves of *M. pudica* in doses of 200, 500, 1000, and 2000 mg/kg in rats and dogs exhibited diuretic activity (considering urinary output  $\text{Na}^+ - \text{K}^+ - \text{Cl}^-$  excretion). The activity in rats at 250 mg/kg dose was found to be 82% of standard diuretic (hydrochlorothiazide 2.5 mg/kg) treated group of rats. There was significant reduction (above 50%) of  $\text{Na}^+$  and  $\text{Cl}^-$  excretion without affecting  $\text{K}^+$  excretion. The drug can be combined as a moderate diuretic with any modern synthetic diuretic causing  $\text{K}^+$  loss.

### Effect on uterine bleeding

Aqueous extracts of root powder in pilot studies on patients with dysfunction uterine bleeding gave promising results.<sup>[4]</sup>

### Antifertility activity

*Mimosa pudica* is one of the folk medicinal plants commonly used as antifertility agent in some places in India. Air-dried roots of *M. pudica* were extracted using methanol. The dried methanol extract of the root was administered orally to Swiss albino mice for 21 consecutive days. Estrous cycle, reproductive hormones (LH, FSH, prolactin, estradiol, and progesterone) and number of litters produced were studied in both control and extract administered groups by using standard methods. Phytochemical studies of the methanolic root extract were carried out using qualitative and TLC methods. The root extract of *M. pudica* has antifertility effect as it prolongs the estrous cycle and disturbs the secretion of gonadotropin hormone in albino mice. The decrease in FSH levels in the proestrous and estrous stages in the extract administered group compared with those of control animals indicates the disturbance of estrous cycle and ovulation through suppression of FSH.<sup>[28]</sup>

*M. pudica* root powder (150 mg/kg body weight) when administered intragastrically, altered the estrous cycle pattern in female *Rattus norvegicus*. Nucleated and cornified cells were absent in all rats. The smear was characterized by leucocytes only, as in diestrus, which persisted for 2 weeks. There was a significant reduction in the number of ova in rats with the root powder compared with the control rats, and a significant increase in the number of degenerated ova.<sup>[29]</sup>

### Spasmogenetic potential

Ethanol extracts (50%) of the whole plant exhibited spasmogenetic activity in isolated guinea pig ileum.<sup>[4]</sup>

### Antihepatotoxic and antioxidant potential

Reactive oxygen species (ROS) are believed to be responsible for pathogenesis of various diseases affecting tissues and the main organ, the liver. Hence, in this study, the extent of lipid peroxidation (LPO) and ROS elimination and its defense mechanisms by the enzymic and nonenzymic antioxidants in liver and serum was investigated. Hepatotoxicity was manifested by significantly decreased ( $P < 0.05$ ) levels in the activities of the enzymic antioxidants such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase, and the non-enzymic antioxidants such as glutathione and vitamin-C in rats with induced hepatic damage by ethanol. Simultaneous administration of the leaf extract *M. pudica* along with the toxin ethanol in rats showed a considerable protection against the toxin-induced oxidative stress and liver damage as evidence by a significant increase ( $P < 0.05$ ) in antioxidant activities. The study reveals that the co-administration of the *M. pudica* aqueous extract significantly lowered the level of lipid peroxidation in alcohol-fed mice.<sup>[30]</sup>

### Antivenom activity

The aqueous root extract of *M. pudica* dose dependently inhibited

the hyaluronidase and protease activities of Indian snakes (*Naja naja*, *Vipera russelii*, and *Echis carinatus*) venom.

Aqueous and alcoholic extracts of dried roots of *M. pudica* were tested for their inhibitory activity on lethality, myotoxicity, and toxic enzymes of *Naja kaouthia* venom. The aqueous extract, particularly the normal water extract, displayed a significant inhibitory effect on the lethality, myotoxicity, and tested enzyme activities of venom compared with alcoholic extracts. The present findings suggest that an aqueous extract of *M. pudica* root possesses compound(s), which inhibit the activity of cobra venom.<sup>[31]</sup>

### Antimicrobial properties

Antimicrobial activity of the successive extracts of *M. pudica* whole plant in petroleum ether, chloroform, ethyl acetate, methanol, and water was studied against various Gram positive and Gram negative bacterial strains using the zone of inhibition. Both the agar well diffusion method and agar disc diffusion method were used to evaluate the antibacterial efficacy of the said plant extracts. The microorganisms used in the test were: *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus albus*, *Proteus vulgaris*, *Salmonella typhi*, *Salmonella paratyphi A*, *Salmonella paratyphi B*, *Shigella flexneri*, *Klebsiella pneumonia*, and *Pseudomonas aeruginosa*. The minimum inhibitory concentration (MIC) of the methanolic extract of said plant was determined by the agar well diffusion method. The reference antibiotics chloramphenicol and ampicillin were also tested against the said microorganisms used in the assay and the results were compared with that of the plant extracts. The results of the study revealed that the *M. pudica* whole plant extract possesses good antimicrobial activity between the range of 7–18 mm against the pathogens used for screening.<sup>[32]</sup>

### Antifungal activity

The methanolic extract and aqueous extract of 100, 200, and 500 mg were tested against different fungal pathogens, *Aspergillus fumigatus* for their antifungal activity. It was demonstrated by a well diffusion assay.<sup>[14]</sup>

### Antiviral properties

Four of the seven tested medicinal plants exhibited antimicrobial activity against *Vibrio cholerae*. These seven plants are: *Ficus capensis*, *Mitragyna stipulosa*, *Entada Africana*, *Piliostigma reticulatum*, *Terminalia avicennoides*, *M. pudica*, and *Lannea acid*. *M. pudica* showed antimicrobial activity. Potential of these herbs in the control of cholera needs to be determined.<sup>[33]</sup>

### Aphrodisiac property

This study was aimed to investigate the effect of the ethanolic extract of roots of *M. pudica* Linn. (Mimosae) on libido of sexually normal Swiss albino male mice. The suspension of the extract was administered orally at the dose of 100, 250, and 500 mg/kg, to different groups of male mice ( $n = 6$ ) once a day for 7 days. The female albino mice involved in mating were made receptive by hormonal treatment. The general libido and potency were determined and compared with the standard

reference drug sildenafil citrate. A change in hormonal parameter like testosterone was evaluated. Oral administration of the extract significantly increased the libido and hormonal levels of testosterone. The most appreciable effect of the extract was observed at the dose of 500 mg/kg. The results indicated that the ethanolic extract of roots of *M. pudica* Linn. (Mimosae) produced a significant and sustained increase in the aphrodisiac activity of normal male mice, without any adverse effects.<sup>[34]</sup>

## USES

### Classical/traditional uses

Charak and Sushruta prescribed a decoction, with Samangaa as an important ingredient in hemothermia, piles, diarrhea, and persistent dysentery. Included in an ointment, the herb was applied over piles, ulcers, and wounds.

During 16th century, Lajjalu was a popular herb for treating piles and diseases of female genital tract. Samangaadi churna is available over the counter, prescribed internally in bleeding piles.<sup>[4]</sup>

### Therapeutic uses

Raktapita, atisara, yoniroga, sophra, daha, svasa, vрана, and kustha.<sup>[6]</sup> The plant is sheetala (Sheetaveerya), tikta, kashaya; subdues deranged kapha and pitta beneficial in hemorrhagic diseases, diarrhea, and gynecological disorders.<sup>[15]</sup>

### Leaves

The leaves together with leaves from other medicinal plants are used in treating hemorrhoids and urinary infections.<sup>[5]</sup> The juice is used in sinus, sores, piles, and fistula, paste is applied to glandular swellings, and hydrocele.

### Roots

Decoction is efficacious in gravel and other urinary complaints.<sup>[15]</sup> Treats dysentery, fever, syphilis, leprosy, stomach worms, venereal diseases, insect bite, insomnia, nervousness, and piles.<sup>[5]</sup>

### Some endemic uses of *Mimosa*

- As Chhuimui, leaves used for increasing the sexual potency in men in Kurukshetra District (Haryana), India.
- As Laajvanti; its leaves and roots are used for gravel and other kidney diseases, also for piles and fistula in the Sagar District, Madhya Pradesh, India. The roots are also used in an oral snakebite remedy.
- As Lazaoni, root decoction is gargled for gum trouble and toothache by Rahba in West Bengal.
- As Punyo-sisa; leaves are used in pillows to induce sleep in children and the elderly in Ecuador.<sup>[35]</sup>
- In Orissa (Kandhamal district) as Lajakulilata: The warmed root paste is plastered with the help of a cloth on boils to get relief. The paste of root fried in castor oil is applied on deep cut wounds to stop bleeding and for healing. The warmed leaf paste is applied around furuncle, abscess, and boils to burst and release of pus. The leaf paste is applied on the burst boils and itches for quick healing. The paste of



root fried in ghee is applied on caries teeth for relief from toothache. The leaf paste is applied on forehead to get relief from headache and migraine. The leaf paste with honey is prescribed twice a day in empty stomach for 3–4 days for stomach ache and intestinal worms.<sup>[36]</sup>

### **Mimosa mucilage as a sustained release excipient**

This study was conducted to investigate the sustained release properties of *M. pudica* seed mucilage. Matrix tablets of diclofenac sodium containing different proportions of mucilage and dibasic calcium phosphate as diluent were formulated by the wet granulation method. The tablets had uniform physical appearance, average weight, drug content, and adequate hardness. The results of *in vitro* release conducted using an USP type II dissolution rate apparatus, in a dissolution media comprising of 900 mL of 0.1 N HCl for 2 h followed by phosphate buffer (pH 6.8) for 24 h at 37 °C and 50 rpm, revealed that as proportion of mucilage in the matrix was increased there was corresponding decrease in the release of drug.

Further, the matrix tablets were found to release the drug following Higuchi square root kinetics, with the mechanism of release being diffusion for tablets containing higher proportion of mucilage and a combination of matrix erosion and diffusion for tablets containing smaller proportion of mucilage. The swelling and erosion studies revealed that, as the proportion of mucilage in tablets was increased, there was a corresponding increase in percent swelling and a decrease in percent erosion of tablets. The SEM photomicrographs showed gelling structures in tablets containing higher percentage of mucilage, while both pores and gelling structures were present on the surface of tablets containing smaller proportion of mucilage and commercial formulation. On comparative evaluation, the dissolution profile from formulation containing mucilage to drug in the proportion of 1:40 was found to be similar to the commercial sustained release formulation of diclofenac.<sup>[37]</sup>

### **Toxicity**

The brine shrimp lethality assay (BSL) has been used routinely in the primary screening of the crude extracts as well as the isolated compounds to assess the toxicity toward brine shrimps, which could also provide an indication of possible cytotoxic properties of the test materials. It has been established that the cytotoxic compounds usually show good activity in the BSL assay, and this assay can be recommended as a guide for the detection of antitumor and pesticidal compounds because of its simplicity and cost effectiveness. The extracts of *M. pudica* did not show any significant toxicity toward brine shrimps in the BSL assay. Owing to a high degree of lipophilicity, the *n*-hexane extract could not be tested. Whereas the LD<sub>50</sub> value of the DCM and MeOH extracts of *M. pudica* was 1.0 mg/mL. The LD<sub>50</sub> value of the positive control, podophyllotoxin, was  $2.8 \times 10^{-3}$  mg/mL.<sup>[1]</sup>

### **Formulations**

Samangaadi Churna, Kutajavaleha, Pusyanug Churna, Bhret Gangadhara Churna.

### **Dose**

10–20 g of drug for decoction.<sup>[6]</sup>

## **CONCLUSIONS**

The plant prominently features in the texts of ‘Ayurveda’, i.e. the traditional Indian system of medicine, which prompted the authors to compile the published data and to critically analyze it, and is an honest, though rather the preliminary attempt for the preparation of the plant monograph. The review presented a brief profile of *M. pudica*, a plant associated with fond memories of almost every Indian childhood (chhui-mui). The literature claims that there is vast potential in this herb in view of therapeutics and furthermore, commercialization of this herb would be in line with the WHO guidelines (developing country needs to give more emphasis on exploration of their natural resources like medicinal plants) is highly desirable for the benefits of humanity. It is suggestive of greater benefits as it is economically viable, easily available and a reservoir of significant medicinal properties.<sup>[39]</sup>

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