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NASTIC MOVEMENTS DUE TO TURGOR PRESSURE IN PLANT

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ABSTRACT

Mimosa pudica commonly called Touch Me Not plant all over the world, Chui Mui plant in India and Makahiya plant in Philippines is an amazing herb with wonderful medicinal uses and health benefits. All parts of this plant have medicinal uses. In India, it is used in Ayurveda, Siddha and Unani forms of medicine for treating various diseases. *Mimosa pudica* belongs to the genus Mimosa and family Fabaceae. This plant is native to Central America and South America but it is found commonly all over India. This plant growing abundantly like weed in the farm and it is hard to remove this plant as it is covered in thorns. Touch me not plant produces beautiful pink flowers and small green leaves that closes or droops in the night or when touched. This plant can be found commonly in waste lands, cultivated lands and even along road sides in cities. Since it is a very popular plant, extensive studies have been done on the plant scientifically proving many of the traditional remedies it is used in. Phytochemical screening of touch me not plant leaf extract showed the presence of flavonoids, glycosides, terpenoids, alkaloids, coumarins, saponins, tannins, phenols and quinines. The root extract showed the presence of fatty acids, glycosides, essential oils, tannins, amino acids, alkaloids, phytosterol and flavonoids. Some of the important phytochemical compounds isolated from touch me not plant are mimosine, jasmonic acid, betulinic acid, stigmasterol, Beta-sitosterol, 2-hyrdoxymethyl-chroman-4-one, dimethyl ammonium salt and mimopudine.

KEYWORDS: Antidepressant, aphrodisiac, diuretic, Mimosa pudica, pulvini, symbionts.

INTRODUCTION

In biology, nastic movements are non-directional responses to stimuli (e.g. temperature, humidity, light irradiance), and are usually associated with plants. The movement can be due to changes in turgor (internal pressure within plant cells). Decrease in turgor pressure causes shrinkage, while increase in turgor pressure brings about swelling. Nastic movements differ from tropic movements in that the direction of tropic responses depends on the direction of the stimulus, whereas the direction of nastic movements is independent of the stimulus's position. The tropic movement is growth movement but nastic movement may or may not be growth movement. The rate or frequency of these responses increases as intensity of the stimulus increases. An example of such a response is the opening and closing of flowers (photonastic response), movement of euglena, chlamydomonas towards the source of light.[1] They are named with the suffix "-nasty" and have prefixes that depend on the stimuli

Epinasty: downward-bending from growth at the top, for example, the bending down of a heavy flower.
Hyponasty: upward bending of leaves from growth in the petiole (leaf stalk)
Photonasty: response to light
Nyctinasty: movements at night or in the dark
Chemonasty: response to chemicals or nutrients
Hydronasty: response to water
Thermonasty: response to temperature
Seismonasty: response to shock
Geonasty/gravinasty: response to gravity
Thigmonasty/seismonasty/haptonasty: response to contact

Turgor pressure is the force within the cell that pushes the plasma membrane against the cell wall. It is also called hydrostatic pressure, and is defined as the pressure in a fluid measured at a certain point within itself when at equilibrium. Generally, turgor pressure is caused by the osmotic flow of water and occurs in plants, fungi, and bacteria. The phenomenon is also observed in protists that have cell walls. This system is not seen in animal cells, as the absence of a cell wall would cause the cell to lyse when under too much pressure. The pressure exerted by the osmotic flow of water is called turgidity. It is caused by the osmotic flow of water through a selectively permeable membrane. Movement of water through a semipermeable membrane from a volume with a low solute concentration to one with a higher solute concentration is called osmotic flow. In plants, this entails the water moving from the low

concentration solute outside the cell into the cell's vacuole.[2]

Mimosa pudica (from Latin pudica 'shy, bashful, or shrinking'; also called sensitive plant, sleepy plant, action plant, [touch-me-not, or shameplant) is a creeping annual or perennial flowering plant of the pea/legume family Fabaceae. It is often grown for its curiosity value: the sensitive compound leaves fold inward and droop when touched or shaken and re-open a few minutes later. *Mimosa pudica* is not a carnivorous plant.

Taxonomy
Kingdom: Plantae
Clade: Tracheophytes
Clade: Angiosperms
Clade: Eudicots
Clade: Rosids
Order: Fabales
Family: Fabaceae
Subfamily: Caesalpinioideae
Clade: Mimosoid clade
Genus: Mimosa
Species: M. pudica
Binomial name: *Mimosa pudica*

Figure-1: Mimosa pudica leaf.

The leaflets also close when stimulated in other ways, such as touching, warming, blowing, and shaking, which are all encapsulated within mechanical or electrical stimulation. These types of movements have been termed seismonastic movements. Mechanical stimulation like touch or contact, rapid winds, raindrops, etc. cause seismonastic movement in plants. Many plant parts, including the stigmas, stamens, and leaves, exhibit seismonastic movements. For example - The leaflets of the *Mimosa pudica* plant rapidly fold and droop in response to touch. This reflex may have evolved as a defense mechanism to disincentivize predators, or alternatively to shade the plant in order to reduce water loss due to evaporation.[3] The main structure mechanistically responsible for the drooping of the leaves is the pulvinus. The stimulus is transmitted as an action potential from a stimulated leaflet to the leaflet's swollen base (pulvinus), and from there to the pulvini of the other leaflets, which run along the length of the leaf's rachis. The action potential then passes into the petiole, and finally to the large pulvinus at the end of the petiole, where the leaf attaches to the stem. The pulvini cells gain and lose turgor due to water moving in and out of these cells, and multiple ion concentrations play a role in the manipulation of water movement. Seismonastic movement are the various type of responses and movements which are shown by plants on receiving stimulus. The stimulus may be electrical, chemical, pressure, touch, heat, etc. The plant shows some kind of change in their structure and move away from the source of stimulus. Seismonastic movements are the actions in which the plants pass away from the stimulus. For example, the plant *Mimosa pudica* shows a foldaway of the fliers when affected by touch. Such movements are not only shown towards the touch. Thus, the Seismonastic movements play a major role in the life of the plants.[4]

Mimosa pudica contains the toxic alkaloid mimosine [CAS: 500-44-7; IUPAC: (2S)-2-Amino-3-(3-hydroxy-4-oxopyridin-1-yl)propanoic acid], which has been found to also have antiproliferative and apoptotic effects. The extracts of *Mimosa pudica* immobilize the filariform larvae of Strongyloides stercoralis in less than one hour. Aqueous extracts of the roots of the plant have shown significant neutralizing effects in the lethality of the venom of the monocled cobra (*Naja kaouthia*). It appears to inhibit the myotoxicity and enzyme activity of cobra venom. The phytochemical analysis of the Lajvanti plant shows the presence of alkaloids, flavonoids, coumarins, saponins, tannins, cardiac glycosides, phenols, terpenoids, saponins, hexosamine, deoxyribonucleic acid, and nitric oxide.[5]

Mimosine or leucenol is a toxic non-protein amino acid chemically similar to tyrosine. It occurs in some Mimosa spp. (including *M. pudica*) and all members of the closely related genus Leucaena. Movements triggered by

touch, such as closing the traps of insectivorous plants, are called thigmonastic or seismonastic movements. The changing daily cycles of light and darkness produce “sleep” (nyctinastic) movements in leaves of many species. Thigmonasty is a rapid movement in which the plant parts move towards or away from the stimulus. Seismonasty is the response of a plant to a sudden disturbance or shock. It is a delayed response and involves the movement of the entire plant or specific plant tissues.[6]

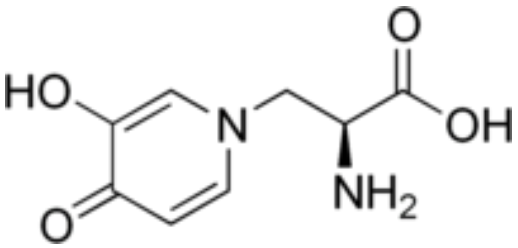

Figure-2: Mimosine.

This compound, also known as leucenol, was first isolated from the seeds of *Leucaena glauca* Benth., and was later investigated by Adams and coworkers.

Mimosa pudica demonstrates both antioxidant and antibacterial properties. This plant has also been demonstrated to be non-toxic in brine shrimp lethality tests, which suggests that *M. pudica* has low levels of toxicity. Chemical analysis has shown that *Mimosa pudica* contains various compounds, including "alkaloids, flavonoid C-glycosides, sterols, terenoids, tannins, saponin and fatty acids". The roots of the plant have been shown to contain up to 10% tannin. A substance similar to adrenaline has been found within the plant's leaves. *Mimosa pudica*'s seeds produce mucilage made up of D-glucuronic acid and D-xylose. Additionally, extracts of *M. pudica* have been shown to contain crocetin-dimethylester, tubulin, and green-yellow fatty oils. A new class of phytohormone turgorines, which are derivatives of gallic acid 4-O-(β-D-glucopyranosyl-6'-sulfate), have been discovered within the plant.[7]

Leaves of *Mimosa pudica* exhibit movements when touched. When touched, this sensitive leaf reacts to stimulus as there is higher pressure at that point. This causes the leaves to close. It is due to the turgor pressure difference between the upper and lower halves of the base of the petiole (pulvinus). 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. Shame plant (*Mimosa pudica*) Flower, Leaf, Care, Uses – Picture. The Sensitive plant is aptly named for its distinctive response of curling up when touched, whereby its fernlike leaves fold inward. *Mimosa pudica* is easy to grow--seeds sprout in a week. Sensitive plant closes it leaves at night and opens them again in the morning. The leaves also fold up if the plant is shaken or exposed to heat. In fact, high temperatures (75-85°F/24-29°C) may trigger the leaves to close. The leaves of the 'touch-me-not' fold up and droop each evening before reopening at dawn. They also do this more rapidly if they are touched or shaken. It is likely the responses evolved separately. Many plants close up at night, usually to protect pollen or reduce water loss while the leaves aren't photosynthesising. Touch Me Not plants are very good medicine for treating Constipation, Piles, Fistula related problems. Touch Me Not balances the hormones in the body and relieves heavy bleeding during menstruation. Touch Me Not plant is useful to get rid of itchy skin. (A) Mimosa hamata is a shrub that grows in the Thar Desert of Rajasthan. It grows to approx. 3 m maximum height, and the plant in this photograph is approx. 2 m.

The nitrogen-fixing properties of *Mimosa pudica* contribute to a high nitrogen content within the plant's leaves. The leaves of *M. pudica* also contain a wide range of carbon to mineral content, as well as a large variation in 13C values. The correlation between these two numbers suggests that significant ecological adaptation has occurred among the varieties of *M. pudica* in Brazil.[8]

The roots contain sac-like structures that release organic and organosulfur compounds including SO_2, methylsulfinic acid, pyruvic acid, lactic acid, ethanesulfinic acid, propane sulfinic acid, 2-mercaptoaniline, S-propyl propane 1-thiosulfinate, and thioformaldehyde, an elusive and highly unstable compound never before reported to be emitted by a plant. Thigmonastic movement is shown by some plants and fungi in response to touch. Thigmonastic movement is nastic movement and non - directional. The leaves of Albizia (related genus to Mimosa) exhibit thigmonastic movement. In Thigmonastic movement is, the leaves of plants get closed when stimuli touch. In thigmonasty, an example is the shutting of a venus fly trap. The drooping of leaflets of *Mimosa pudica* when touched is also a thigmonastic movement.

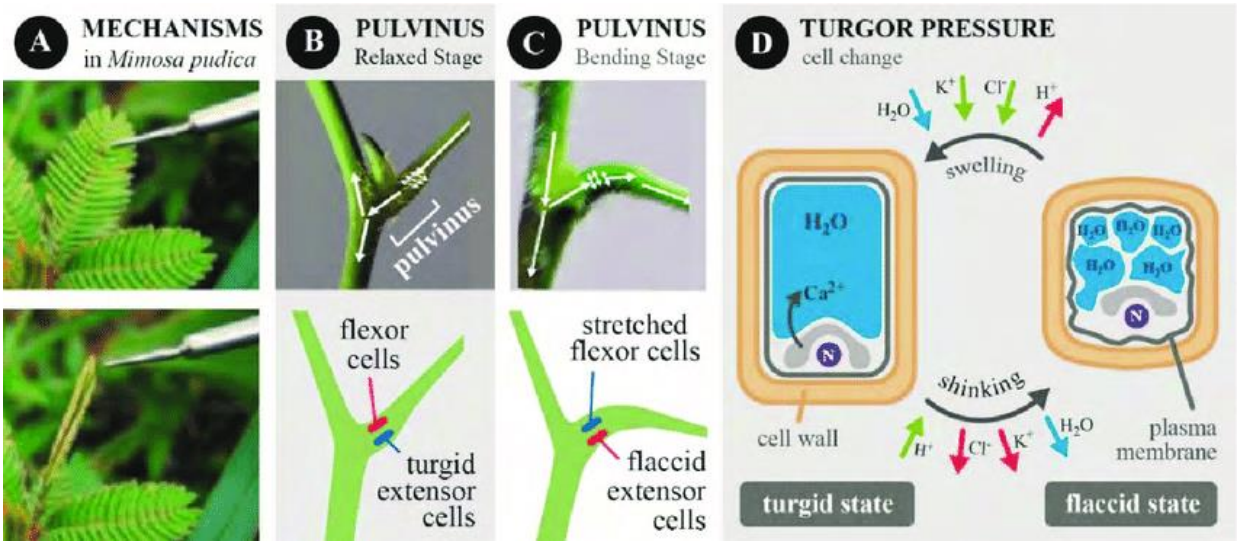

Figure-3: Turgor mechanism.

It is because the response of this plant is not influenced by the direction of stimulus, which is a characteristic of thigmotrophic movements.[9] While the mechanism of thigmonastic movement in *Mimosa pudica* is not clear at the present time, there are a few hypotheses to describe it. The osmotic hypothesis states that the thigmonastic movement of *Mimosa pudica* is powered by a sudden loss of turgor pressure in the motor cells of the pulvinus. Thigmotropism is when a plant will respond to touch from an external source. The plant will move toward or away from the contact stimulus. When the plant moves toward the stimulus, it is called positive thigmotropism. An example of positive thigmotropism is when a tendril on a climbing plants coils around a fence. An example of thigmotropism is the coiling of tendrils or twiners upon contact to objects for support. In nastic movement, the movement response of the plant to contact is called thigmonasty. An example of thigmonastic movement is the shutting of a venus fly trap. Another form of nastic movement is the nyctinasty. The key difference between thigmotropism and thigmonasty is that thigmotropism is a directional response of a plant organ to touch or physically contact a solid object. Meanwhile, thigmonasty is a form of non-directional movement by a plant in response to touch or vibration. Movements triggered by touch, such as closing the traps of insectivorous plants, are called thigmonastic or seismonastic movements. The changing daily cycles of light and darkness produce "sleep" (nyctinastic) movements in leaves of many species.[10]

CONCLUSION

Leaves of *Mimosa pudica* exhibit movements when touched. When touched, this sensitive leaf reacts to stimulus as there is higher pressure at that point. This causes the leaves to close. It is due to the turgor pressure difference between the upper and lower halves of the base of the petiole (pulvinus). Thus, the entire leaf droops down when touched. Leaves of *Mimosa pudica* are sensitive. When touched the stimulus reaches the base of the leaf and the water in the vacuoles of the cells of the leaf loses water to the adjacent cell. All the water escapes the leaf which then becomes flaccid. This causes the leaves to close. This is due to the passing of impulse which causes the change of turgor pressure. Owing to this stimulus, the turgor of the lower half of the pulvinus is lost and the leaf droops down. Mimosa plants use their ability to shrink as a defense from herbivores. Animals may be afraid of a fast-moving plant and would rather eat a less active one. Also, the sudden movement dislodges harmful insects. They will reopen after a few minutes. The main structure responsible for the drooping of the leaves is the pulvinus. The stimulus is transmitted as an action potential from a stimulated leaflet to the leaflet's swollen base, and from there to the pulvini of the other leaflets, which run along the length of the leaf's rachis. The action potential then passes into the petiole, and finally to the large pulvinus at the end of the petiole, where the leaf attaches to the stem. *Mimosa pudica* is a tropical creeping plant. It belongs to the sub-family Mimosaceae. They are commonly known as sleeping plants, shy plants, shame plants, touch me not, sensitive plants, action plants, etc. The reflex mechanism may have evolved as a defense mechanism to escape from predators or to reduce water loss due to evaporation.

1. Mimosa Pudica Wound Healing Activity: Traditionally the leaf extract made by grinding the leaves with little water and extracting the juice is used for treating wounds. This remedy has been proven scientifically now! For the study, both the methanolic and water extract was used in 3 different concentrations (0.5 %, 1 % and 2 %) in a basic ointment base. The ointment containing 2 % of both methanolic and water extract showed significant wound healing activity.
2. Mimosa Pudica Anti Venom Activity: An interesting study was done on the anti venomous activity of mimosa pudica and that too cobra venom! The study which was done on the water extract of the mimosa pudica dried root (made by boiling the dried root in

water) proved that it is very good at inhibiting the activity of the snake venom. But this remedy has to be done under the observation of an experienced healer or herbalist.

3. Anti Depressant, Anti Anxiety and Memory Enhancing Properties: Traditionally, touch me not plant has been used for treating depression in certain countries. Along with treating depression, it also reduces anxiety and also improves memory, for it the the whole plant extract is used. A study on mice proved all these traditional uses to be true, you can read the study here.
4. Mimosa Pudica For Piles: Mimosa Pudica is very good for treating bleeding piles and has been used as a remedy for it for many many years. For the remedy, crush the leaves into a fine paste and apply as a poultice, it will greatly ease the burning and bleeding. This is due to it's amazing wound healing and anti inflammatory properties.
5. Mimosa Pudica For Ulcers: Another very important study on mimosa pudica was its effect on ulcers. The leaf extract reduced the volume of gastric acid secretion, total acidity and ulcer index compared to control. The study done on rats with artificially induced ulcers proved that 100 mg of ethanolic extract very effectively reduced the ulcers.
6. Mimosa Pudica For Diarrhea: Mimosa pudica is very good for treating diarrhoea and has been used for it for years. For treating diarrhoea, the leaf extract is used. A study done on albino rats by inducing them to diarrhea using castor oil and treating them with ethanolic extract of the leaves proved to be very effective in controlling the diarrhea.
7. Mimosa Pudica Anti Inflammatory Properties: Another study proved its anti inflammatory properties. The study done on rats with artificially induced paw odema proved its anti inflammatory properties. The results were very effective and significant. In village sides, we boil the leaves of mimosa pudica and use the warm liquid as a compress, happy to know that it has been proven scientifically.
8. Mimosa Pudica Anti Diabetic Activity: Mimosa pudica's anti diabetic activity has been proven through research too. The research was done using the ethanolic extract but usually the leaf powder or the root powder is taken daily for bringing down the blood sugar levels. But I would kindly suggest consulting an ayurvedic physician for the correct dosage if you are planning on taking it to reduce blood sugar levels.
9. Liver Protecting & Anthelmintic Activity of Mimosa Pudica: Another important medicinal use is protection of liver against toxins . When rats were given toxic ethanol along with mimosa pudica extract, it proved to be very effective in protecting the liver from toxicity. Mimosa pudica also has anthelmintic properties (expels worms) so when we consume the extract, it expels worms very effectively.
10. Anti Microbial, Anti Fungal & Anti Viral Properties Of Mimosa Pudica: Mimosa pudica has been proven for its anti microbial, anti fungal and anti viral properties. The research was done using different concentrations of the mimosa pudica ethanol extract on various fungus and bacteria and it proved to be very effective in controlling them.
11. Anti Mumps Activity: Another interesting but not much known medicinal use of touch me not plant is the anti mumps activity. Touch me not plant completely prevented mumps and this due to it's wonderful anti viral property. You can read the study that supports this claim here.
12. Anti Convulsant Properties: Touch me not plant leaf extract also has anti convulsant properties and it is used in traditional African medicine for it. In a study done on mice, the leaf extract given at a dose of 1000 to 4000 mg per kg protected them from induced convulsants.
13. Hypolipidemic Properties: Touch me not plant lowers lipid levels and this due to the presence of flavonoids, alkaloids and glycosides in it. In a study touch me not plant leaf extract at a dose of 200 mg per kg proved to be very very effective in reducing lipids. Research is going on to extract the compound responsible for the hypolipidemic activity.
14. Uterine Prolapse: Touch me not plant is used for treating uterine prolapse in Ayurveda. For treating it, 15 to 20 ml of the plant decoction is given 3 times a day. Along with it, the root paste is also applied externally as a poultice. This is a 40 day treatment that is best done under medical supervision.
15. Aphrodisiac Properties: Touch me not plant root has been used traditionally as an aphrodisiac and this use also has been proven through research. A study done on mice proved that 500 mg of ethanol extract of touch me not plant proved to be very effective and there was no side effect like stomach ulcer consuming it at all.

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