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Phytochemical and pharmacological studies of *Ipomoea stans*

Estudios fitoquímicos y farmacológicos de *Ipomoea stans*

Vania Aymara Martínez-Hernández [a]

Abstract:

Ipomoea stans, commonly known as "tumbavaqueros", is a plant from the Convolvulaceae family, used in Mexican traditional medicine to treat nervous system disorders such as epilepsy, insomnia, anxiety, and nervousness, as well as digestive and muscular issues. This narrative review compiles detailed data information regarding its pharmacological activities, including anticonvulsant, neuroprotective, antispasmodic, and antioxidant properties as reported in previous studies. Additionally, it highlights its potential as a source of bioactive compounds, though further research is needed to validate its safety, efficacy, and traditional applications. The aim of this work is to provide an updated review of the literature on the phytochemical profile and pharmacological properties of *Ipomoea stans*.

Keywords:

Ipomoea stans, Convolvulaceae, Medicinal plants

Resumen:

Ipomoea stans, conocida comúnmente como "tumbavaqueros", es una planta de la familia Convolvulaceae con uso en la medicina tradicional mexicana para tratar trastornos del sistema nervioso, como epilepsia, insomnio, ansiedad y nerviosismo, así como problemas digestivos y musculares. En esta revisión narrativa, se recopila información de bases de datos detallada sobre su actividad farmacológica anticonvulsivante, neuroprotectora, antiespasmódica, antioxidante basado en estudios previos. Además de que se destaca su potencial como fuente de compuestos bioactivos, aunque se requieren más estudios para validar su seguridad, eficacia y uso tradicional. El objetivo de este trabajo es hacer una revisión actual de la literatura sobre los compuestos fitoquímicos y la actividad farmacológica de *Ipomoea stans*.

***Palabras Clave**:*

Ipomoea stans, Convolvulaceae, Plantas medicinales.

INTRODUCTION

Medicinal plants are a therapeutic resource in traditional medicine; they have been used empirically (either as part of the diet, or in infusions or extracts) to treat and alleviate the symptoms of certain diseases.[1] These resources are highly valuable as they combine traditional knowledge with scientific research for the treatment of different ailments in primary healthcare.[2]

The *Ipomoea* genus, belonging to the Convolvulaceae family, is distributed from Central America to the southern part of the American continent, with approximately 500 to 600 species reported. These species have several uses due to their antimicrobial, analgesic, and other biological activities.[3] Of the 2,663 genera of vascular plants registered in Mexico, *Ipomoea* ranks tenth in number of species used by communities in Oaxaca, Chiapas, Jalisco, Guerrero, Veracruz, and Hidalgo.[4]

In our country, a significant number of *Ipomoea* species are used for ornamental purposes, such as *Ipomoea murucoides*; nutritional and agricultural purposes, such as *Ipomoea batatas* and *Ipomoea tricolor*; and medicinal purposes, such as *Ipomoea stans (I. stans)*, which are used to treat seizures.[5]

The phytochemicals of this genus include active compounds such as nortropene, ergoline, and indolizidine alkaloids (Fig. 1-3), phenolic compounds, coumarins, norisoprenoids, diterpenes, flavonoids, anthocyanosides, glycolipids, and triterpenes.[9] In recent years, there has been a renewed popular interest in the use of plants of the genus *Ipomoea* for the treatment of diseases (Table 1).[10-31]

[a] Universidad Autónoma del Estado de Hidalgo, https://orcid.org/0009-0001-6416-9134, Email: ma383502@uaeh.edu.mx

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Table 1. *Traditional uses of the genus Ipomoea*[1,10-31]

Genus	Traditional uses	Ref.
I. aquatica	Treatment for diabetes, purgative, diuretic, fever and emetic.	10-12
I. batatas	The leaves have been used as an aphrodisiac, astringent, bactericide, and fungicide. Sweet potato is used in the treatment of asthma, burns, insect bites, fever, and diarrhea. It has also been consumed to treat anemia, hypertension and diabetes.	13-18
I. carnea	Used in the treatment of hypertension, anxiolytic, sedative and anticonvulsant.	19-21
I. digitata	The root is used as a tonic, aphrodisiac and for constipation.	22
I. indica	Used as a purgative and healing of broken bones.	23
I. pes-caprae	Used as a purgative, anthelmintic and dysentery.	24,25
I. purpurea	Used as a diuretic, to stop bleeding, as a purgative, and to treat syphilis.	26
I. stans	Used as a purgative, in epileptic attacks and to soothe the nerves.	27,28
I. stolonifera	Used as a diuretic, to treat postpartum pain, stomach problems, inflammation, swelling, and wounds.	29-31

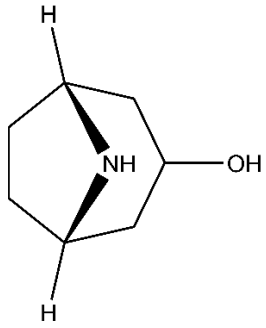

Figure 1. Nortropene.[6]

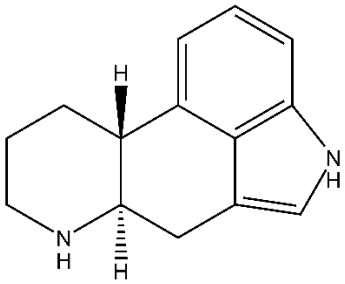

Figure 2. Ergoline.[7]

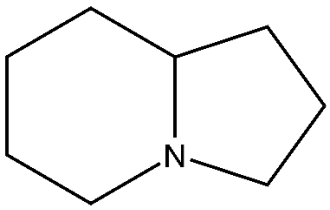

Figure 3. Indolizidine [8]

IPOMOEA STANS

Ipomoea stans Cav. (Fig. 4) is a plant popularly known as "tumbavaqueros", "espantalobos", "espantavaqueros", "campanita", "Santa María del campo", and "pegajosa". It is found in the states of Hidalgo, San Luis Potosí, Guanajuato, Querétaro, Coahuila, Estado de México, Veracruz, Jalisco, Michoacán, Oaxaca, Zacatecas, Puebla, Chiapas and Guerrero.[27] It is a plant endemic to Mexico and commonly found in tropical and warm temperate regions. Its habitat is primary vegetation, ruderal vegetation. It is distributed across bioclimatic zones such as grasslands and xerophilous scrublands.[28]

FIGURE 4. IPOMOEA STANS (OWN WORK)

The morphology of *I. stans* is a perennial herbaceous plant that blooms from May to October depending on the region.[32] It is upright, branched, and robust. Its stem is covered in trichomes. The leaves are alternate and oblong. The flowers have a calyx with five sepals and a purple corolla. Its fruits and seeds are dry

and enclosed in ovoid capsules (Fig. 5). Finally, its root is characterized by having possessing a well-developed underground stem.[33,34]

Fig. 5 *Ipomoea stans* herbarium specimen (own work*).*[33,34]

ISOLATED COMPOUNDS FROM IPOMOEA STANS

Scientific interest in these plants has increased due to the characterization of their chemical properties and the identification of new active ingredients in the formulation of new medications.[35]

The seeds of plants of the genus *Ipomoea* contain numerous ergot alkaloids, including ergoline and its derivatives ergine and ergometrine, used as dopaminergic agonists, among other applications.

In 1992, Enriquez et al. isolated a mixture of glycosidic acids from *I. stans*. Basic hydrolysis allowed the isolation of a single compound whose structure was determined using two-dimensional nuclear magnetic resonance (NMR) methods. Subsequent HPLC separation of the original mixture allowed the identification of a compound that, through 2D NMR, was shown to contain 2-methylbutanoic acid molecules linked to C-4 of the terminal quinovose and C-2 of the rhamnose, 3-hydroxy-2-methylbutanoic acid linked to C-6 of glucose, and palmitic acid forming a lactone at C-3 of rhamnose. A more detailed inspection revealed that this compound was in fact a mixture of diastereomers involving different enantiomers ((2R,3R) and (2S,3S)) of 3-hydroxy-2-methylbutanoic acid attached to a chiral tetrasaccharide core.[37]

Reynolds et al. in 1995 isolated and identified three new tetrasaccharide glycosides, which differ from the previously identified one in the type of short-chain fatty acids linked by esters to the tetrasaccharide nucleus, from an oligosaccharide fraction of *I. stans*.[38]

In 2004, León et al. isolated five new tetrasaccharide glycosides, known as stansins (1-5), from the roots of *I. stans* and elucidated their structures using spectroscopic and chemical methods.[39]

PHARMACOLOGICAL ACTIVITY OF *IPOMOEA STANS*

Antioxidant activity

Romero-López et al. in 2022 conducted research on the root of *I. stans*, with the aim of exploring its alternative use in the food industry in the form of an infusion and its prosimate chemical composition was analyzed using standardized methods, showed that the root has 10.82% moisture, 3.75% ash, 0.20% protein, 66.09% crude fiber, 0.54% ether extract and 10.00% reducing sugars. In addition, an infusion in water was prepared at an artisanal level, to which the content of reducing sugars was quantified, showing 7%. In the evaluation of the antioxidant capacity by the ABTS method, the result was 87.62% inhibition and 41.33 µmol equivalents of Trolox/g contained in the root and in the prepared infusion a 92.44% inhibition was observed with 41.33 µmol Trolox equivalents/mL, likewise, in its sensory evaluation it was accepted by the panel of consumer judges.[40]

Activity in the Central Nervous System

In 1996 Contreras et al. investigated the anticonvulsant activity of the infusion and lyophilized powder of *I. stans*, where male Balb/c mice were given a standard infusion of the plant in place of water (IS). They were also given total lyophilized powder (IS-T) and two mixtures of compounds (IS-A and IS-B) from the plant. Their PTZ and electrical shock (ECS) seizure thresholds were tested. Data from animals that died following a high-dose IS regimen suggested mesenteric infarction. Similar results appeared after treatments with IS-T and IS-A. IS-B in particular protected mice against seizures produced by a low dose of PTZ and delayed the onset of seizures produced by ECS. IS and IS-T were also administered to male Wistar rats, where the results showed that they increased the threshold for amygdala discharges produced by cortical electrical stimulation. It was concluded that IS possesses some valproic acid-like anticonvulsant properties attributable to fraction B. Fraction A appeared to possess weaker anticonvulsant activity and some toxic properties.[41]

In a 1996 study by Navarro-Ruiz et al., they analyzed the anticonvulsant activity of aqueous (AQ), ethanolic (E-OH) and chloroformic (CHL) extracts of *I. stans* root in adult male Wistar rats after *ad libitum* ingestion of the aqueous extract for 7 days, or a single oral dose of 100 mg/kg of E-OH or CHL extract. The experimental epilepsy models used were the maximal electroshock seizure induction test (MES) and subcutaneously injected metrazol (METsc). The maximum protection exhibited with MES was 80%, 36%, and 57%; and in the case of METsc, 15%, 41%, and 50% when AQ, E-OH, or CHL extract was administered, respectively.[42]

Herrera-Ruiz et al. in 2007 investigated the activity of *I. stans* root ethyl acetate extract (IS-EAE) on the central nervous system (CNS). The administration of IS-EAE significantly reduced spontaneous motor activity and increased GABA release in the cerebral cortex of mice. These results suggest that IS-EAE

possesses anxiolytic and anticonvulsant properties, and could have a potential sedative effect, probably through a GABAergic system.[43]

Neuroprotective activity

In 2014, a study by León-Rivera et al. isolated stanisines from the roots of *I. stans* and evaluated them as neuroprotectors in rats. Pretreatment with stansine 6 inhibited kainic acid-induced seizures in rats, reduced the degeneration pattern in the CA3 region, decreased astrocytic reactivity, and reduced the expression of IL-1β and TNF-α induced by kainic acid. The results suggest that stansine 6 has neuroprotective activities.[44]

Antispasmodic activity

In a study conducted by Perusquía et al. in 1995, they investigated the effects of aqueous extracts of various plants, including the roots of *I. stans*, on the isolated thoracic aorta of male Wistar rats precontracted by noradrenaline (NA). In all cases, the aqueous extracts significantly and concentration-dependently inhibited, the maximum contractile response induced by NA in the aorta. Thus, the results validate the use of *I. stans* as an antispasmodic agent in Mexican folk medicine.[45]

Insecticidal activity

In 2019, Reyes-Silva evaluated the insecticidal activity of *I. stans* on corn weevils (*Sitophilus zeamais*) with ethanolic extracts at different concentrations. The weevils that were subjected to the ethanolic extracts showed greater mortality than the synthetic insecticide, with the flower and stem parts showing greater insecticidal activity. The results contributed to corroborate the traditional use of *I. stans* in the community.[46]

CONCLUSIONS

Plants of the genus *Ipomoea* have long been used in folk medicine to treat a wide range of pathological conditions. In recent years, scientific interest in *Ipomoea* species has increased considerably. Substantial advances in the chemical and pharmacological understanding of this genus have supported this trend. Pharmacological studies have confirmed some traditional uses. However, although there are various specialized works, there remains a broad field of research on species of this genus, for the identification of more bioactive compounds and evaluation of their efficacy and pharmacological effects.

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