



CODEN [USA]: IAJPBB

ISSN : 2349-7750

**INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES**

SJIF Impact Factor: 7.187

<https://zenodo.org/records/11471758><https://www.iajps.com/volumes/volume11-june-2024/01-issue-06-june-24/>Available online at: <http://www.iajps.com>

Review Article

**A REVIEW OF THE THERAPEUTIC POTENTIAL OF
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Abstract:

Plants have been utilised for thousands of years to cure, prevent, and manage a wide range of ailments across the world. The primary advantage of adopting plant-derived medications is that they are generally safer than synthetic ones. There are more than 2,500,000 higher plant species worldwide. Throughout history, several of these plants have been utilised medicinally by diverse civilizations. One of those is *Mirabilis jalapa* Linn. *Mirabilis jalapa* L. (Nyctaginaceae) is a perennial bushy herb about 1 meter in height, propagated by seeds or root tubers and commonly known as "four o'clock" plant. It is a valuable medicinal herb that is widely used to treat a variety of illnesses. People from all around the world use it to treat stomach colic, aphrodisiac, boils, diarrhoea, inflammations, genitourinary problems, muscle discomfort, and other ailments. Several phytochemical substances identified from this plant's components include alkaloids, brassicasterol, carbohydrates, flavonoids, glycosides, phytosterols (beta-sitosterol and stigmaterol), oleanolic acid, trigonelline, and ursolic acid. This plant has been investigated for its anti-inflammatory, anti-microbial, anti-viral, anti-bacterial, anti-fungal, anti-oxidant and cytotoxic, anti-tumor, anti-nociceptive, anti-histamine and immune modulatory, anti-tubercular induced hepatotoxic effect, anti-parasitic, dermatological, hypoglycemic, and anti-hyperlipidemic properties. It also serves as a reductant in the creation of gold nanoparticles. This article gives a brief description regarding a biological description of *Mirabilis jalapa* include various botanical description, habitat, morphology, chemical constituents present in the plant, and pharmacological importance. The present study may enhance the knowledge regarding the use of *Mirabilis jalapa* for treating various diseases to involve the complex of use of plant.

Key words: *Mirabilis jalapa*, secondary metabolites, four O'clock plant, hypoglycemic activity, anti-parasitic activity.

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Please cite this article in press **K Ratna Jyothi et al, A Review Of The Therapeutic Potential Of Mirabilis Jalapa,,Indo Am. J. P. Sci, 2024; 11 (06).**

INTRODUCTION:

Medicinal plants were abundantly available in the tropics, but in recent years, many of these natural sources have been destroyed due to over exploitation and deforestation. Apart from their use in self-medication, these plants hold value for modern medicine in various ways. The fact that plant preparations have a relatively lower incidence of adverse reactions compared to synthetic drugs is encouraging both the general public and national health care institutions to consider plant medicines as alternatives. Throughout history, people have relied on medicinal plants for healing and treating diseases. Traditional use of these plants has been the foundation of medicine. Our ancestors used a wide

variety of plants for their treatment and healing purposes. Given the rising costs of modern drugs, medicinal plants offer a viable alternative [1,2].

Mirabilis jalapa (*M. jalapa*) is widely utilized as a medicinal plant in numerous traditional remedies across the globe to address diverse ailments. Belonging to the Nyctaginaceae family, *Mirabilis* is a genus primarily found in the Americas and commonly referred to as the four-o'clock flower. With around 50 species, *Mirabilis* is predominantly distributed in tropical and temperate regions worldwide. Notably, *Mirabilis himalaica* is the sole species indigenous to the Himalayas, making it the only member of the genus native to a region outside of the western hemisphere [3].



Figure 1: *Mirabilis jalapa*

Synonyms: Four O'Clock Flower, Marvel of Peru, Beauty of the Night, False Jalap, Jalap Root, Sweet Marvel of Peru, Marvel of the World. The taxonomical classification of *Mirabilis jalapa* was depicted in the below Table 1.

Table 1: Taxonomy of *Mirabilis jalapa* [3,4]

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Angiosperms
Class	Dicotyledons
Subclass	Caryophyllidae
Order	Caryophyllales
Family	Nyctaginaceae
Genus	<i>Mirabilis</i>
Species	<i>jalapa</i>

Biological source

Mirabilis jalapa plant was shown in the Figure 1. It is endemic to the arid tropical areas of North, Central, and South America, specifically Mexico, Guatemala, Chile, and Peru. This plant was introduced for decorative purposes and has now naturalised in tropical, subtropical, and temperate locations across the World.

Parts used: Seeds, leaves, flowers and roots.

Distribution and habitat

Mirabilis jalapa is native to the Americas and is widely distributed in tropical and subtropical regions. It is cultivated and naturalized in various parts of the world. The plant thrives in a variety of habitats, including: gardens and landscapes, roadsides and disturbed areas, waste places, tropical and subtropical regions.

Macroscopical characters

Macroscopical characters of *Mirabilis jalapa* were illustrated in the Figure 2 and 3.

Plant height: *Mirabilis jalapa* is a perennial herb that can reach a height of about 0.6 to 1.5 meters.

Leaves: The leaves are simple, ovate to heart-shaped, and arranged alternately on the stems. They have a smooth texture and can vary in size.

Flowers: The plant produces trumpet-shaped blooms with diameters ranging from 2.5 to 5 cm. The blossoms are usually fragrant and come in a range of hues, including as red, pink, yellow, and white. Interestingly, different-coloured blooms can occasionally be seen on the same plant.

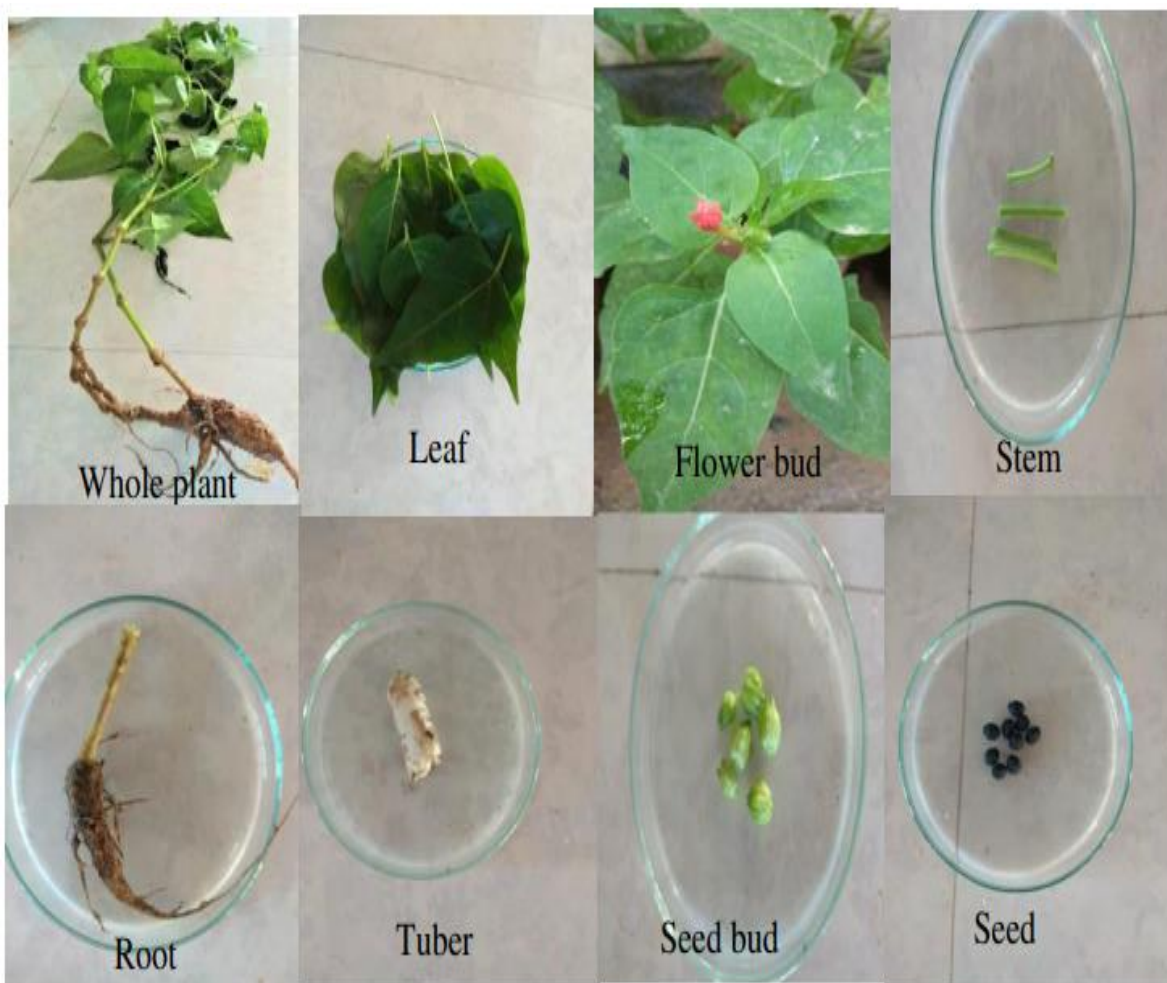


Figure 2: Morphology of *Mirabilis jalapa*

Fruits: *Mirabilis jalapa* forms capsules as fruits, containing seeds. The capsules are about 1 to 1.5 centimetres in diameter.

Roots: The roots are tuberous and fleshy, and they have traditionally been utilised for medicinal purposes. They are often picked for their purgative effects.

Geographical distribution

Mirabilis jalapa Linn. (Family: Nyctaginaceae) was formally documented in 1753, despite the fact that it has long been used as a decorative plant across the world's tropics. This plant is native to the tropics of South America, Latin America, France, and India. In India, grows primarily in West Bengal and the Western Himalayas [3].

Fragrance: The flowers emit a pleasant, sweet fragrance, especially in the late afternoon and evening.

Ecological requirements: *Mirabilis jalapa* likes well-drained soil and is relatively adaptable to diverse soil types. It thrives in circumstances ranging from full sun to light shade.

Cultural uses: In some cultures, *Mirabilis jalapa* is used for medicinal purposes, believed to have diuretic and purgative properties.

Chemical constituents

The early phytochemical analysis of the leaf and stem extracts indicated the presence of tannins, alkaloids, flavonoids, phenolic compounds, carbohydrates, terpenes, glycosides, saponins, protein, cardiac glycosides, steroids and emodin. (Z)-3-hexenyl acetate, β -myrcene, (Z)-ocimene, benzyl benzoate, monoterpene (E)- β -ocimene were the major fragrance component in the plant volatiles [5].

The *Mirabilis jalapa* leaves extract contained hydrocarbons 17.8%, ketones 18.0%, alcohols 12.1%, sterols 21.2% and acids 7.0%, oxymethylantraquinone, trigonelline, arabinose, galactose and beta-sitosterol. The amount of essential elements in *Mirabilis jalapa* leaves (mg/kg) were: Mn 0.42, Fe 5.02, Zn 1.19, Pb 0.04, Cr 0.14 and Cu 0.067 and in the stems were: Pb 0.13, Zn 1.74, Cu 0.58, Cr 0.13, Mn 0.72 and Fe 4.88 [6-8].



Figure 3: Morphology of *M. jalapa*

The seeds showed high protein content (11.0 ± 0.75 g/100 seed), amino acid analyses of the total protein isolates reported that it contains 17 amino acids of which 9 were essential. The analysis of fatty acids constituents of the seed oil showed that they included palmitic acid 18.3%, oleic acid 55.3%, linoleic acid 11.5% and linolenic acid 14.9% [9].

Many betaxanthin pigments (indicaxanthin, vulgaxanthin-I, miraxanthin-I, II, III, IV, V and VI) were identified in the flowers of *Mirabilis jalapa*. The compounds isolated from the dichloromethane extract of *Mirabilis jalapa* tubers powder were (%): 2-butoxyethyl acetate 0.47; 2,3,5,6-tetramethyl pyrazine 0.20; 3,6-dioxo-2,7-disilaoctane 1.83; 2-butenedioic acid 0.88; urea 1.52; 3,7-dioxo-2,8-disilanonane 2.98; 4-hydroxyquinoline 4.68; pyrimidine 1.09; isosteviol 5.22; n-pentadecanoic acid 0.83; hexadecanoic acid 10.98; octadecan-1-ol 0.83; linoleic acid 10.47; oleic acid 24.74; cyclopentasiloxane 0.90; cholestan-16-one 1.08; lukianol 1.29; pregn-5-en-20-one 1.15; dihydrostigmasterol 3.15 and benzene 1.23% [10].

Therapeutic uses

Mirabilis jalapa is a commonly used traditional medicine in many regions of the world for the treatment of a variety of ailments, including viral inhibition and anti-tumor activities. Traditional medicine claims that the plant's leaves may be used to alleviate inflammation. Parts of the plant can be used in herbal medicine as a diuretic, purgative, and vulnerary (wound healing) agent. The root is thought to have aphrodisiac, diuretic, and purgative qualities. It is also used to treat dropsies. The leaves help to alleviate inflammation. Abscesses are treated using a decoction made by crushing and boiling them. Leaf juice might be used to cure wounds [11].

Pharmacological importance

Anti-bacterial activity:

The cup plate method and disc diffusion method were utilized to evaluate the anti-bacterial activity. Streptomycin served as the standard drug. Analysis of phytochemicals revealed that *Mirabilis jalapa* contains a variety of alkaloids, terpenes, carbohydrates, proteins, and amino acids in differing concentrations in its leaves. The ethanolic extract from *Mirabilis jalapa* leaves exhibited significant efficacy against both gram-positive and gram-negative bacteria. The positive results were confirmed by measuring the zone of inhibition using the two aforementioned methods. The objective of this study is to identify plants with anti-bacterial properties that are non-toxic [12].

Anti-oxidant effect:

The ferric reducing antioxidant power (FRAP) assay was utilized to measure the total antioxidant capacity of the acetone, ethyl acetate, petroleum ether, and ethanol extracts of *Mirabilis jalapa* leaves. Among these extracts, the ethanolic extract exhibited a higher antioxidant potential than the others. In order to determine the antioxidant activity of the petroleum ether, chloroform, and methanol extracts from both the leaves and bark of *Mirabilis jalapa*, the DPPH test was employed. The methanol extract from the plant bark demonstrated antioxidant activity with an IC_{50} value of 598.02 $\mu\text{g/ml}$, surpassing that of ascorbic acid (IC_{50} 70.985 $\mu\text{g/ml}$) [13,14].

Anti-inflammatory effect:

The total alcoholic extract (300 mg/kg) and petroleum ether fractions (200 mg/kg) of leaves of *Mirabilis jalapa* were screened for their anti-inflammatory activity using carrageenan-induced rat paw oedema and cotton pellet-induced granuloma models. The total alcoholic extract and petroleum ether fraction possessed significant anti-inflammatory activity ($P < 0.05$) in the cotton pellet granuloma model, they inhibited the increase in the number of fibroblasts and synthesis of collagen and mucopolysaccharides during granuloma tissue formation. The anti-inflammatory activity of the aqueous leaf extract of *Mirabilis jalapa* was evaluated using carrageenan and formalin-induced paw oedema models in rats [15,16].

Anti-diabetic activity:

Nowadays, the diabetic complication is a major global health problem without any effective therapeutic approach. The ethanol extract of the root of the *M. jalapa* has anti-diabetic activity. Another study showed that the serum glucose, triglycerides, urea, creatinine, total cholesterol, LDL- and the activity of gluconeogenic enzyme glucose-6-phosphate levels are significantly decreased by the root extract of *M. jalapa* Linn. But the level of serum insulin, HDL-cholesterol, protein, liver, and skeletal muscle are significantly increased. Many scientists declared that the root of *M. jalapa* Linn. can be used in the treatment of type II diabetes [17].

Anti-viral activity:

The anti-viral activity of the leaves was tested against the HSV-I and VSV by simplified plaque reduction assay and scientifically the preliminary result exhibits to a certain extent the pharmacological activities. A group of anti-viral proteins called ribosome-inactivating proteins is widely distributed in *M.*

jalapa L. The extract of leaf suspension cultured and its function with 90% saturated ammonium sulphate solution showed anti-plant viral activity comparable to that of roots and leaves of the original plant. *M. jalapa* extracts alleviated the multiplication of the Tobacco Mosaic Virus (TMV) by 50% when added to the inoculums. *M. jalapa* is known to be host to two viruses: *Parietaria mottle* virus and *Mirabilis mosaica* virus [17,18].

Anti-asthmatic activity:

It is reported that ethanol and acetone root extract have anti-asthmatic activity using a guinea pig tracheal chain preparation and clonidine-induced mast cell granulation in mice [19].

Anti-nociceptive activity:

The antinociceptive activity of a drug reduces sensitivity to painful stimuli. The literature revealed that *M. jalapa* possesses antinociceptive activity in mice, which supports its folkloric use as an analgesic. So, *M. jalapa* can be used successfully in various ethnopharmacological preparations to treat painful disease [20].

Dermatological effect:

The wound healing activity of the ethanolic extract of the leaves of *Mirabilis jalapa* (1000mg/kg bw) was investigated using excision wound model, incision wound model and dead space wound models in experimentally induced diabetic rats. *Mirabilis jalapa* extract showed significant wound contraction from 9th to 18th day, significantly increase in wound breaking strength, significantly increase in dry tissue weight, and increased hydroxyproline content compared to normal control and diabetic control animals [21].

Anti-spasmodic effect:

The extract of the flowers of *Mirabilis jalapa* (1-1000 mug/ml) exhibited an inhibitory effect (IC_{50} 18±0.7 micorg/ml) on gut smooth muscle contractility, whereas it stimulated the contraction of rabbit aortic muscle (EC_{50} 11.60±0.26 micorg/ml) in a concentration-dependent manner [22].

Anti-cancer effect:

Mirabilis jalapa protein was tested for anti-cancer effect against different cell lines. It showed cytotoxicity against T47D and SiHa cell lines while it was relatively less cytotoxic to mononuclear cell. It showed more specific cytotoxic activity against cancer cell line such as MACF-7, A549, HCT 116,

than the normal cell line (Vero). Furthermore, it possessed strong apoptotic effects [23].

Anti-fungal activity:

The anti-fungal activities of *M. jalapa* were tested using the agar diffusion method against *Aspergillus niger*, *Fusarium solani*, *Fusarium oxysporum*, and *Fusarium granulation*. Two of the phenolic compounds isolated from *M. jalapa* L. showed anti-fungal activity against *Candida albicans*. The methanol extracts of *Mirabilis jalapa* has the potential inhibitory effect against *Aspergillus niger* and *Daedalea flavida* while do not affect *C. albicans* [24].

Anthelmintic activity:

The activity of drugs that expel parasitic worms (helminths) and other internal parasites from the body by either stunning or killing them and without causing significant damage to the host is called anthelmintic activity. The aerial parts of *Mirabilis jalapa* showed anthelmintic activity. The anthelmintic activity was determined for the methanolic extract of a real part of *Mirabilis jalapa*, which displayed significant anthelmintic properties at higher concentration. The extract revealed anthelmintic activity in a dose dependent manner which is effective against parasitic infections of human [25].

Anti-tubercular activity:

Mirabilis jalapa's anti-tubercular activity was investigated using anti-tubercular medications that caused hepatotoxicity. *Mirabilis jalapa* Linn leaves have been shown to protect against hepatotoxicity caused by anti-tubercular medicines [26].

CONCLUSION:

In conclusion, the comprehensive review of *Mirabilis jalapa's* phytochemical and pharmacological studies reveals that, a rich repository of bioactive compounds with significant potential for medicinal applications. The extensive phytochemical diversity, including alkaloids, terpenoids, flavonoids, carbohydrates, underscores the pharmacological significance. *Mirabilis jalapa* exhibits a promising pharmacological activity, such as anti-inflammatory, anti-oxidant, anti-cancer properties. These findings suggest its potential as a source for developing therapeutic agents to address various health challenges. The anti-oxidant properties identified in the phytochemical screening further contribute to the plant's appeal for oxidative stress related disorders. While traditional uses of *Mirabilis jalapa* provide

cultural and historical context, standardisation of identification protocols is imperative for ensuring consistent and reliable results. The identification of specific bioactive compounds is responsible for the observed pharmacological activities remains an essential avenue for further research. Overall, *Mirabilis jalapa* emerges as a valuable candidate for further exploration in drug discovery and development. Continued research efforts, exploring synergistic interactions among phytochemicals, will be crucial for unlocking the full therapeutic potential of this plant.

Competing interest statement

All authors declare that there is no conflict of interests regarding publication of this paper.

Ethical approval

Not required.

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