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Pharmacological and biological activities of *Mirabilis jalapa* L.

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Abstract
Plants have been used for health care and medical purposes for several thousands of years. The number of higher plant species on earth is about 250000. It is estimated that 35000 to 70000 species have, at one time or another, been used in some cultures for medicinal purposes. One of these is *Mirabilis jalapa* L. which is traditionally used as Purgative and emetic, for treatment of many gastrointestinal disorders, including dysentery, diarrhea, muscle pain and abdominal colic. Besides this it also exhibits certain useful activities like Antiviral activity, Antimicrobial activity, Antimalarial activity, Anthelmintic activity, Antioxidant activity, Aytotoxic activity Anti-tubercular drugs induced hepatotoxicity, Antinociceptive activity, Antifungal activity, Anti-corrosion activity, Antispasmodic activity, Anti-inflammatory activity and many others. Pharmacologically active compounds include active alcoholic extract, ether compound-3,3'-Methylenebis (4- hydroxycoumarin) N-D-alpha-Phenylyglycinelaminaribiitol-3-(4-(dimethylamino) cinnamoyl) 4hydroxycoumarin. The purpose of my review is to find out the areas of scope and to give the detail of the work done on *Mirabilis Jalapa* L. for future research work.
Keywords: *Mirabilis jalapa* L., Phytochemical constituents, Pharmacology.

1. Introduction
Traditional herbal medicines have been improved the general health of most people. For thousands of years, medicinal plants have played a vital role throughout the world in treating, preventing and controlling a variety of diseases. The primary benefits of using plant-derived medicines are that they are relatively safer than synthetic alternatives. According to the World Health Organization (WHO) about 65–80% of the world's population in developing countries depending essentially on plants for their primary health care due to poverty and lack of access to modern medicine. *Mirabilis Jalapa* is one of these medicinal plants used for centuries for the treatment of various ailments; its leaves may be eaten cooked as well, but only as an emergency food. An edible crimson dye is obtained from the flowers to color jellies and cakes. It is popularly known as four o clock. It belongs to the family Nyctaginaceae. It is a large, herbaceous plant grown in gardens throughout India and Pakistan.

1.1 Synonyms
The synonyms of *Mirabilis jalapa* are; *M. dechotoma* Linn. (In Brazil), *M. dechotoma* Linn and *M. longiflora* Linn. (In tropical America), *M. lindheimeri* Linn. and *M. Odorata* Linn.

1.2 Taxonomic classification: Kingdom: Plantae; Sub kingdom: Tracheobionta; Division: Angiosperms; Class: Dicotyledons; Subclass: Caryophylidae; Order: Caryophyllales; Family: Nyctaginaceae; Genus: *Mirabilis;* Species *Mirabilis Jalapa.*

1.3 Morphology
Mirabilis jalapa usually grows 0.6-0.9m tall and just as wide. Leaves are pointed; flowers usually open from late afternoon onwards, hence the first of its common names. Flowers in group of three, flowers with five green bracelets; surround the perianth; usually yellow; crimson, white or variegated and opening in the evening. Perianth lobes are five, gamophyllus, stamens five with unequal filaments. Carpel one, unilocular, superior ovary with a single ovule, a nectariferous disc surrounds the ovary. Fruit achene surrounded by a leathery, ribbed, persistent perianth. The self-compatible, the perfect flowers, each have 5-6 stamens and a single-ovule ovary. Fruits are coriaceous obovoid and roots are prominent tuberous. The single-seeded fruits are spherical, wrinkled and black upon maturity, having started out greenish-yellow (Fig. 01).

1.4 Flower's colors
An outstanding aspect of *Mirabilis jalapa* is that it has flowers with various colors and can be found simultaneously on the same plant. Moreover an individual flower can be splashed with different colors. Flower patterns are referred to as flakes (stripes of varying length), sectors (whole sections of flower) and spots. A single flower can be pink or white, plain yellow, or have a combination of sectors, spots and flakes. Besides, it also has different combinations of

flowers and patterns can occur on different flowers of the same plant. Another fascinating point of this plant is a color-changing phenomenon. For instance, in the yellow variety, as the plant matures, it can display flowers that gradually change to a dark pink color. Similarly white flowers can change to light violet.

1.5 Habitat

This weedy species can be found scattered throughout the world disturbed sites include, waste ground, old home sites. It is also cultivated in Anthropogenic (man-made or disturbed habitats), meadows and fields. It is the most commonly grown ornamental species of *Mirabilis*, and is available in a range of colors. *Mirabilis jalapa* is a herbaceous plant with numerous branches, perennial plant that exist in southern and warm western regions, and an annual in cooler northern regions, of its native tropical South America. It has been naturalized in many parts of the world, including Israel [1].

1.6 Pollen Morphology

The shape of the pollen grains of *Mirabilis Jalapa* is Spheroidal, oblate spheroidal, with a diameter ranging from 125-140 µm and thickness of 10-15 µm. Exine ornamentation is Spinulose; spinules 0.5-1 µm high, randomly distributed, Aperture type Pantoporare with numbers ranging from 18-20 the diameter of aperture varies between 6.3-10 mm while the membrane of the aperture is Margin ornate, membrane provided with spinulose and granules (Fig 02). Pollen dimorphism is frequently found in this species (white-pink, mixed and mixed radiated); occasional giant, dimorphic anomalous, deformed and joint grains have been observed. All these anomalous pollen grains except giant pollen grains are sterile [2].

Flowers

Leaves

Roots

Seeds

Figure 1: Morphology of different parts of *Mirabilis jalapa*.

Figure 2: Salient pollen morphological characters. A: broad view, B: closer view.

1.7 Vernacular names

Andhra Pradesh: *Chandrakantha;* **Assamese:** Godhuli gopal; **Bengali:** Sandhyamaloti; **Brazil:** Marvel; **China:** Xizao

hua; **France:** Belle de nuit; **Hebrew:** Lilanit Rav-Gonit; **Indonesia:** Bunga pukul empat; **Japan:** Oshiroi-bana**; Karnataka:** Sanje mallige; **Kerala:** Naalumani ; poovu; **Maharashtra:** Gulabakshi; **Maithili:** Sanjhaa phool ; **Netherlands:** Nachtschone; **Oriya:** Rangani; **Pakistan:** Gul adnan , gul-e-abbas; **Persian:** Laleh abbasi; **Sri Lanka:** Hendirikka; **Tamil Nadu:** Andhi mandhaarai; **Turkish:** Akşam sefası.

2. Active constituents

Chemical analysis of different parts of *M. jalapa* manipulated the presences of alkaloids, flavonoids, phenols, steroids, triterpenes, glycosides, tannins, saponins and lignins. The detailed study of these compound compounds from TLC visualized alanine, arabinose, campesterol (fig. 3), daucosterol and dopamine, d-glucan, hexacon-1-ol, indicaxanthin, isobetanin, 6-methoxyboeravinone, C-methylabronisoflavones, miraxanthins, n-dotriacontane, n nonacosane, n-pentacosane, n-triacontane. Flowers mostly contain anthocyanins and flavonoids. A number of active compounds were extracted from different organs of *M. jalapa*, including anti-fungal phenolic compounds, ribosome-in activating protein (RIP) which is associated with anti-viral activity, anti-microbial peptides and rotenoids that are potent inhibitors of HIV-1 reverse transcriptase [3]. The alcoholic extract of *M. jalapa* is a possible source of active compounds against pathogenic enteric organisms [4]. About twenty different chemical constituents have been identified from the methanolic extract of the whole plant of *Mirabilis Jalapa* by Gas chromatogram Mass spectrometry (GC-MS) analysis. The presence of various bioactive compounds justifies the use of whole plant for various ailments by traditional practitioners. GC-MS analysis of *Mirabilis jalapa* revealed the existence of the ether compound-3, 3'-Methylenebis(4- hydroxycoumarin)(fig. 3)(17.07), N-D-alpha-Phenylyglycine (38.76), laminaribiitol (7.753), 3-(4-(dimethylamino) cinnamoyl) 4-hydroxycoumarin (16.89), unknown (5.284), unknown (10.26) [5]. Four new rotenoids named mirabijalone A–D1 (1–4) (fig. 3), boeravinone C (6) and F (7), together with 9-O-methyl-4-hydroxyboeravinone B (5) (fig. 3) and 1, 2, 3, 4-tetrahydro-1-methylisoquinoline-7, 8-diol (8), were extracted from the roots of *Mirabilis jalapa*. Their structures were determined on the basis of their HR-EI-MS, UV, IR, 1H- and 13C-NMR (DEPT), and 2D NMR (HMQC, HMBC, NOESY) data [6].

3. Physicichemical characteristics of *Mirabilis Jalapa*

Chemical analysis of *Mirabilis jalapa* seeds manifested that they contain 98.73% Total carbohydrates, Protein 0.8 %, Lipids 0.23%, Ash 0.24% and Amylose 8.60%. Thermal analysis of *Mirabilis jalapa* showed typical starch behavior during mass loss (TG/DTG) and gelatinisation (DSC), with gelatinization temperature and enthalpy around 80 °C and 5.62 J g1, respectively. The tiny (around 1mm), diameter of starch from *M. jalapa* could be appropriate for use in the cosmetic and pharmaceutical industry credit to their high adsorption capacity. It is also suitable in the food industry for encasing flavors, essences and other substances [7].

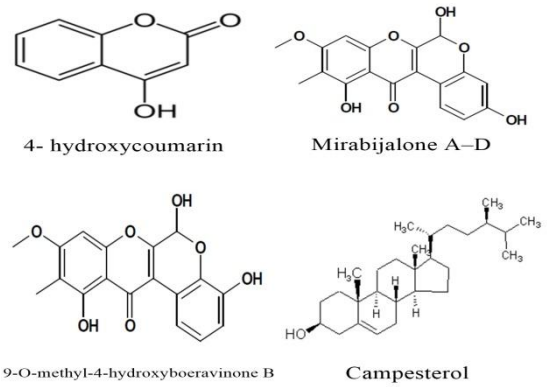

Figure 3: Chemical structure of some active constituents of *Mirabilis jalapa*.

4. Medicinal uses

Mirabilis jalapa L. Is a useful medicinal plant and has a great importance in the field of ethnobotany. Leaves of *Mirabilis jalapa* have Purgative and emetic properties [8]. Decoction of leaves is used against genitourinary system disorders while poultice of subterranean parts is used to treat injuries [9]. The indigenous people of Mexico use *Mirabilis jalapa* for treatment of many gastrointestinal disorders, including dysentery, diarrhea, muscle pain and abdominal colic. The extract of *Mirabilis jalapa* exhibits an inhibitory effect on digestive gut and smooth muscle contractility whereas it stimulates the contraction of rabbit aortic muscle in a concentration-dependent manner [10]. Decoction is use of Constipation [11]. The leaves are crushed and mixed with salt and use in Sprain and bruise [12]. It is also used for treating amenorrhea and dysmenorrhea in women [13]. Leaves of *Mirabilis jalapa* are applied on external wounds until recovery [14]. Juice of leaves is mixed with water and use for treatment of jaundice [15]. Paste of leaves has emollient property [16] and is useful in Skin eruption, while leaves juice is taken orally in Hepatitis [17]. Root extract has Hypolipidemic and

hypoglycemic activity [18]. Stem with leaves are used for depigmentation [19]. Roots are used to arouse aphrodisiac activity [20]. Leaves are fried in clarified butter and are fastened on the abscess. Leaf juice is used as eye drop to soothe eye inflammation. Boiled Leaves are eaten to reduce body pains. Tuber is administered in minute quantities to cure piles [21].

5. Biological activities of *Mirabilis jalapa*

5.1 Antimicrobial activity

The research indicated clearly that red flowered *Mirabilis jalapa* plant has strong antibacterial potential and is active against a wide range of microorganisms. *Mirabilis jalapa* is the least active plant against bacteria, none of the four aqueous ethanolic extracts of this plant showed antibacterial activity [22]. The potentials of *Mirabilis Jalapa* alcoholic extract are a possible source of active compounds against pathogenic enteric organisms. Further isolation of active components in their purest form is made possible that may serve as suitable candidates in the design of antibacterial drugs that are of plant origin [23]. It is noticed that neither aqueous, non methanolic extracts of *Mirabilis Jalapa* were able to inhibit any of the tested bacterial strains [24]. The antibacterial activity of various extracts of *Mirabilis Jalapa* stem has been studied. Methanolic stem extract of *Mirabilis Jalapa* showed potent antibacterial activity against Gram positive bacteria while dichloromethane stem extract showed potent anti-bacterial activity against Gram negative bacteria, which was less than that of the standard drug [25]. However the therapeutic potency of *Mirabilis jalapa* for use in folklore medicine is due to the presence of some of the secondary metabolites like alkaloids, saponins, tannins, and flavonoids which have known antimicrobial activity [26]. The anti-microbial activity of methanolic extract of *Mirabilis jalapa* is worthy of further investigation as a natural wide spectrum antibacterial agent [27]. Antibacterial activities of the ethanolic extract of the red color flower of *Mirabilis Jalapa* have been examined in vitro against *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Bacillus subtilis*, *Vibrio cholera*, *Serratia marcescence* and *Pseudomonas aeruginosa*. The ethanolic extract of the flower showed highest inhibition against *Bacillus subtilis* (47%) followed by *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Vibrio cholerae* and *Serratia marcescence* [28]. Moreover the qualitative phytochemical screening of ethanolic extract confirmed the presence of high content of tannins along with moderate amounts of alkaloids, carbohydrates, saponin and terpenes. The existence of high amount of tannins in the extract of this plant indicated the potential antibacterial [29] and antiviral [30] properties of the plant. Investigation showed that neither water nor methanolic flower extracts of *Mirabilis Jalapa* were potent to inhibit any of the tested bacterial strains. Similar results were noted in the study of Nair et al [31] with *Mirabilis jalapa* stem and leaf extracts. Most of the bioactive compounds responsible for bactericidal activity might be present in ethanolic extract. Whereas the bacterial insensitivity to aqueous extract might be due to the antimicrobial peptides and other bioactive compounds which might not be soluble in water. Finally, it is known to be infected by a bacterial blight, due to *Xanthomonas campestris* [32].

5.2 Antiviral activity

Various antiviral compounds derived Plant is active against animal, plant, and human viruses [33]. Zipf concluded that such compounds are grouped together as furocoumarins, terpenoids, alkaloids, linens, and other specific proteins. One of the plant-derived antiviral proteins, a group called ribosome-inactivating proteins (RIPs), which are widely distributed in higher plants [34].

The antiviral activity of *Mirabilis Jalapa* has been observed by different scientists. Root extracts of *M. Jalapa* was sprayed on test plants 24 hours before the virus or viroid inoculation which inhibited the infection by almost 100%, as corroborated by infectivity assays and the nucleic acid spot hybridization test [35]. Noronha et al noted that *Mirabilis jalapa* extracts reduced the multiplication of *Tobacco mosaic* virus (TMV) by 50% when added to the inoculum [36]. *Mirabilis jalapa* is well known to have an anti-viral protein whose mode of action is a ribosome- inactivation [37, 38]. Because of its antiviral activity, it is not surprising that it hosts very few pathogens. The only known host of *Phytophthora mirabilis* is *M. jalapa*. *Phytophthora mirabilis* infects only leaves and other aboveground plant parts [39] *M. jalapa* is known to be host to two viruses: *Parietaria mottle* virus [40] and *Mirabilis mosaic* virus (family Caulimoviridae) [41].

5.3 Antifungal activity

Plant extracts of different parts of many higher plants have been reported to exhibit antifungal properties under laboratory study [42, 43]. The organic extract of the cell mass form manipulated plant cell culture of *Mirabilis jalapa*.L resulted in the isolation of the three new phenolic compounds. Two of the phenolic compounds were found to show antifungal activity against *Candida albicans* [44]. The Methanol extracts of *Mirabilis Jalapa*. L were tested for their antifungal activities against *Aspergillus Niger*, *Candida albicans* and *Daedalea*. Results showed that *M. Jalapa* has the potential inhibitory effect against *Aspergillus Niger and Daedalea flavida* while have no effect on *Candida albicans* [45].

5.4 Antioxidant activity

The anti-oxidant activity of *Mirabilis Jalapa* is confirmed through several studies. The plant extract possesses

modest antioxidant properties [46]. In-vitro Antioxidant Potential of Methanolic Extracts of *Mirabilis jalapa* revealed the immense potential of the methanolic extract of the aerial parts and root for the anti-oxidant activity and elucidating their tentative mechanisms of action. Zachariah, et al finds out that the methanolic extract of *Mirabilis Jalapa* has potential anti-oxidant activity [47]. The total flavanoid content of the extract was discovered to be an active compound responsible for anti-oxidant activity and could serve as a free radical inhibitor or scavengers. It is confirmed through further experiments that extracts of *Mirabilis jalapa* have moderate to potent antioxidant activity [48]. Further study is necessary for isolation and characterization of the active antioxidants, which can be used to treat various oxidative stress-related diseases.

5.5 Antispasmodic activity

Antispasmodic activity is the activity of a drug to contract smooth muscles. The Methanolic extract of *Mirabilis jalapa* .L exhibits inhibitory effects on gut smooth muscle contractility as well as at the same time stimulated the contraction of rabbit aortic muscle in a concentration –dependent manner [49]. Methanolic extract of *Mirabilis Jalapa* flowers contains several compounds showing spasmolytic activity such as some routioides (boeravinone F, at least), sitosterol-d-glucoside and ursolic acid. However, additional studies are requiring explaining the mode of action of *Mirabilis jalapa* extract [50].

5.6 Anti-inflammatory activity

Anti-inflammatory or anti-inflammatory refers to the property of a substance or treatment that reduces inflammation or swelling. The alcoholic, aqueous, pet ether extracts from the leaves of *Mirabilis Jalapa*. L was studied for obtaining the anti-inflammatory activity by carrageenan- induced paw edema, formalin-induced paw edema, cotton pellets induced granuloma models in Wistar albino rats, which confirmed the anti-inflammatory activity of the extract of *Mirabilis Jalapa* [51, 52].

5.7 Antinociceptive activity

The Antinociceptive activity of a drug reduces sensitivity to painful stimuli. Literature has revealed the Antinociceptive effect of *Mirabilis jalapa* extracts from leaves and stems in models of pains in mice, it was concluded from studies that *Mirabilis jalapa* presents antinociceptive activity in mice, which supports its folkloric use as an analgesic [53]. The leafy ethyl acetate (Eta) of *Mirabilis Jalapa* produces anti nociceptive in clinically related models of pain without the induction of tolerance, namely postoperative, chronic inflammation and neuropathic pain model. Moreover, this effect in the chronic inflammation model seems to be an intermediate agent in the activation of the cholinergic system, through pain inhibition. So, *Mirabilis jalapa* can be used successfully in various ethno pharmacological preparations to treat different painful diseases [54].

5.8 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 [55].

5.9 Anti-diabetic activity studies

Long term hyperglycemia leads to the development of complications associated with diabetes. Diabetic complications are now a day a global health problem without any effective therapeutic approach. The ethanol extract of the roots of *Mirabilis Jalapa* has anti diabetic activity. Oral administration of ethanolic extract of root of the *Mirabilis jalapa* L. (10mg/kg and 20mg/kg).

Streptozotocin induced diabetic rats for 12ds and mice for 28 days. It showed significantly reduced serum, glucose, triglycerides, urea, creatinine, total cholesterol, LDL-cholesterol and the activity of gluconeogenic enzyme glucose-6-phosphate, but increased serum insulin, HDL-cholesterol, protein, liver and skeletal muscle [56-58]. Ji-Yin Zhou *et al* declared that *Mirabilis Jalapa* L. root can be used to treat type 2 diabetes with hyperlipidemia. Root of *Mirabilis jalapa* L. may be developed as an oral hypoglycemic agent or functional food for diabetic patients with hyperlipidemia and for persons with high risk of diabetes [59].

5.10 Antimalarial activity

Plant extracts of different plants are used for the treatment of malaria. The preliminary Antimalarial activity investigation of Forty-six different species collected in the Mosetene ethnia, dwelling in the Andean Piedmont of Bolivia, one of them was *Mirabilis jalapa* was conducted. They reported *Mirabilis jalapa,* being inactive against malaria [60].

5.11 Anti-tubercular drugs induced hepatotoxicity

Studies were carried on the anti-tubercular activity of *Mirabilis jalapa*. It was deduced that *Mirabilis Jalapa* Linn leaves show a protective effect on hepatotoxicity induced by anti- tubercular drugs [61].

5.12 Cytotoxic activity

The leaf extract of *Mirabilis Jalapa* L contains RIP (ribosome inactivating protein) which has cytotoxic activity on

Hela and Raji cell line with different level [62].

5.13 Anti-corrosion activity

Inhibitors protect metals from corrosion by adsorbing onto the surface by forming a thin adsorption layer. The efficiency of an inhibitor is largely dependent on the extent of adsorption of the inhibitor molecules on the metal surface. The nature of corrosion inhibitor has been deduced in terms of the adsorption characteristics of the inhibitor. *Mirabilis jalapa* flowers acted as an efficient corrosion inhibitor for mild steel in 1ml HCl. The inhibition efficiency of the extract of *Mirabilis jalapa* was maximum at 5% v/v concentration of the stock and at 49.89 °c [63].

5.14 Biofilm

Biofilms present significant therapeutic barriers for many antibiotics and the discovery of agents which could prevent their formation or adherence would be of great use. Plant extracts of *Mirabilis Jalapa* demonstrated limited bacteriostatic activity. It is inferred from different ethno botanical usage for inhibition of growth and biofilms in Mithicilin-resistant *Staphylococcus aureus* that *Mirabilis Jalapa* shows no considerable biofilm inhibition activity [64].

5.15 Endophytic Mycoflora

Endophytic Mycoflora of *Mirabilis Jalapa* was studied and isolated. Experiments showed the existence of about 17 endophytic fungal belonging to 10 genera. Their colonization frequency was investigated which was found to be 17%. The fungal composition included 70.2% of Hyphomycetes, 17.5% of Coelomycetes, 11.6% of Ascomycetes and 11.6% of sterile mycelia [65].

5.16 Poisonousness

Poisonous plants have always been part of our daily life and some of them are so common that we do not even suspect their toxic nature. Although, tubers are eaten in pickled form, but intake of tubers as such is Poisonous causing severe irritation in the mouth, chocking and paralysis of the respiratory system [66].

5.17 Gold nano particles

Extract of different parts of various plant species has been found to be environmentally friendly and cost effective for the production of nano particles on a large scale. Flowers of *Mirabilis Jalapa* can be the cheapest source as registrant for the preparation of gold nano particles in just 1-2 hours. The presence of pink colorant (anthocyanin) is an obvious choice for the preparation of gold nanoparticles [67].

5.18 Phytoremediation

Phytoremediation of soils contaminated by organic chemicals is a challenging problem in environmental science and engineering. *Mirabilis Jalapa* L is a widely spread species that can be effectively applied to phytoremediation of ≤10, 000 mg/kg petroleum contaminated soil. On the basis of identifying remediation plants from ornamentals, we come to an end through investigation that the remediation capability of *Mirabilis Jalapa* L. to treat petroleum contaminated soil efficiency of removing total petroleum hydrocarbons (TPHs) by *M. jalapa* over the 127-day culture period was high, up to 41.61–63.20%, when the removal rate of natural attenuation was only 19.75–37.92% [68].

6. Conclusion

I concluded from my review that *Mirabilis Jalapa* Linn traditionally widely used medicinal plant. It is widely available weed cultivated for medicinal and ornamental purposes. It shows a wide range of biological activities that helps to utilize the medicinal benefits of this plant. However, here remains an immense scope for further exploration of this plat and needs the attention of scientists to exploit the full potential activities of this plant.

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