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A Review on the Bioactive Metabolites and Medicinal Applications of Mirabilis Jalapa

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Abstract: *Mirabilis jalapa was historically used to treat kidney infections as a diuretic, tonic, cathartic, purgative, and emetic. Phytochemical examination of Mirabilis jalapa leaf and stem extracts showed tannins, alkaloids, flavonoids, phenolic compounds, carbohydrates, terpenes, glycosides, saponins, protein, cardiac glycosides, steroids, and emodin. Mirabilis jalapa had antimicrobial, antiparasitic, dermatological, anticancer, antiinflammatory, analgesic, antidiabetic, antihistaminic, immune-modulatory, antispasmodic, and other pharmacological effects, according to previous studies. This review covers Mirabilis jalapa's chemical ingredients, nutritional, pharmacological, and therapeutic benefits..*

Keywords: Components, pharmacology, therapeutics, and toxicity of Mirabilis jalapa

I. INTRODUCTION

Medical plant research has garnered attention because it reveals many unknown medicinal properties, especially of plant origin, that need to be tested using modern scientific methods like chemical analysis, pharmacological investigation, pharmacokinetic and pharmacodynamic studies, and clinical trials Mirabilis jalapa was historically used to treat kidney infections as a diuretic, tonic, cathartic, purgative, and emetic. Phytochemical examination of Mirabilis jalapa leaf and stem extracts showed tannins, alkaloids, flavonoids, phenolic compounds, carbohydrates, terpenes, glycosides, saponins, protein, cardiac glycosides, steroids, and emodin. Mirabilis jalapa had antimicrobial, antiparasitic, dermatological, anticancer, anti-inflammatory, analgesic, antidiabetic, antihistaminic, immune-modulatory, antispasmodic, and other pharmacological effects, according to previous studies. This review covers Mirabilis jalapa's chemical, nutritional, pharmacological, and medicinal properties.

Synonyms

Jalapa congesta, officinalis, Mirabilis ambigua, jalapa var. jalapa, subsp. lindheimeri, lindheimeri, pedunculata, planiflora, pubescens, suaveolens, xalapa, and Nyctagogalapae.

Taxonomic classification

Plantae kingdom, Viridiplantae subkingdom Superdivision: Embryophyta, Division: Tracheophyta, Subdivision: Spermatophytina, Domain: Streptophyta Class: Magnoliopsida Superorder: Caryophyllanae, Order: Caryophyllales The Nyctaginaceae Species: Mirabilis jalapa.

Commonnames

Arabic: Shab Al-Leil, Al-Shab A-ldhareef, Lala Abbas; Chinese: zimo li; English: beauty-of-the-night, fake jalap, fouro'clock; French: belle-de-nuit, Italian: bella di note; Japanese: oshiroi-bana; Persian: Lalehabbasi; Spanish: buenastardes; Swedish: underblomma; Turkish: Akş

Distribution

An annual herb reaching 1 m tall. Tubular black or black-brown roots. Erect, branching, glabrous, cylindrical, or slightly pubescent, inflated nodes. Petiole 1-4 cm, leaf 3-15 × 2-9 cm, blade elliptical or ovate-triangular, base truncate or cordate, margin entire, apex acuminate. Fragrant clusters of flowers at branch apexes; pedicel 1-2 mm. Opening late

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afternoon, closing morning, perianth red, purple, white, yellow, or variegated, tube 2-6 cm, limb 2.5-3 cm. Five slender, exserted stamens; globose anther. Globe-shaped, black, coriaceous, ribbed, plicate fruits measure 5-8 mm. White mealy endosperm.

Traditionaluses

Abscesses and boils were poulticed with leaves. Children's earaches and skin allergies were treated with leaf juices. Leaf infusion was administered topically to alleviate edema after bone fractures or twisting. Mirabilis Jalapa decoction was used orally to treat kidney infections and diuretics. The stems were tonic. Traditional uses for Mirabilis Jalapa root include cathartic, purgative, emetic, and treatment of pus and liquid buildup and inflamed and swollen lymph nodes.
The seed powder was applied to infected wounds in Zaire. Latin Americans used the roots to purge and emetic. In Malagasy, the plant treated intestinal pain. In South Africa, the roots were employed as a purgative and the blossoms were said to repel insects at night.

Physicochemical characteristics

The physicochemical parameters of Mirabilis jalapa leaf ethanolic extracts showed 15.15 percent total ash, 4.57 acid insoluble ash, 3.75 water soluble ash, 26.22 water soluble extractive value, 21.81 alcohol soluble extractive value, and 24.94% ether soluble extractive value. The powder of Mirabilis jalapa showed physicochemical parameters such as loss on drying (12.41% ± 0.005), total ash (11.81% ± 0.001), water soluble ash (5.06% ± 0.001), acid insoluble ash (0.41% ± 0.001), alcohol soluble (11.02% ± 0.007), water soluble materials (18.63% ± 0.007), and ether soluble materials (7.17% At 20.5° C, the seeds generated 3.0% oil with 0.70 g/ml density, 26.10 dynes/cm surface tension, and 169.5 millipoise viscosity. The iodine value was 80 and saponification 172.

Chemical constituents

Tannins, alkaloids, flavonoids, phenolic chemicals, carbohydrates, terpenes, glycosides, saponins, protein, cardiac glycosides, steroids, and emodin were found in leaf and stem extracts after preliminary phytochemical screening.-3-hexenyl acetate, β-myrcene, ocimene, benzyl benzoate, and monoterpene (E)-β-ocimene were the main aroma components in plant volatiles Emission of (E)-β-ocimene was found to peak in the evening, whereas (Z)-3-hexenyl acetate emission peaked 3 hours later .
Hydrocarbons 17.8%, ketones 18.0%, alcohols 12.1%, sterols 21.2%, acids 7.0%, oxymethylanthraquinone, trigonelline, arabinose, galactose, and beta-sitosterol were found in Mirabilis jalapa leaf Mirabilis jalapa leaves had Mn 0.42, Fe 5.02, Zn 1.19, Pb 0.04, Cr 0.14, and Cu 0.067, whereas the stems had Pb 0.13, Zn 1.74, Cu 0.58, Cr 0.13, Mn 0.72, and Fe 4.88 [16]. The seeds have a high protein content (11.0 ± 0.75 g/100). Overall, the protein isolates included 17 amino acids, 9 of which were essential . Palmitic acid 18.3%, oleic acid 55.3%, linoleic acid 11.5%, and linolenic acid 14.9% were found in seed oil . Mirabilis jalapa flowers contain several betaxanthin pigments, including indicaxanthin, vulgaxanthin-I, miraxanthin-I, -II, -III, -IV, -V, and -VI . 2-butoxyethyl acetate 0.47; 2,3,5,6-tetramethylpyrazine 0.20; 3,6-dioxa-2,7-disilaoctane 1.83; 2-butenedioic acid 0.88; urea 1.52; 3,7-dioxa-2,8-disilanonane 2.98; 4-hydroxyquinoline 4.68; pyrimidine 1.09; isosteviol 5.22; n-pentadecanoic acid 0.83; hexa However, the Mirabilis jalapa tubers powder methanol extract components were (%): Contains: 9,12-octadecadienoic acid (0.83), 9,17-octadecadienal (0.18), 2-methyl-Z,Z-3,13-octadecadienol (0.84), 1,5,9,13-tetradecatetraene (0.61), cholest-5-en24-one (10.58), stigmasterol (18.29), β-si
N-D-alpha-phenylyglycine, laminaribiitol, and 3-(4- (dimethylamino)cinnamoyl)-4-hydroxycoumarin were identified from Mirabilis jalapawhole plant methanol extract . Mirabilis jalapa roots contain rotenoids, including mirabijalone A, B, C, and D, 9-O-methyl-4-hydroxyboeravinone B, boeravinone C and F, and 1,2,3,4-tetrahydro1-methylisoquinoline-7,8-diol . Astragaloside II, IV, VI, flazin, 4'-hydroxy-2, 3-dihydroflavone 7-beta-D-glucopyranoside, gingerglycolipid A, 3, 4-dihydroxybenzaldehyd, p-hydroxybenzaldehyde, beta-sitosterol, and daucosterol were isolated from plant roots . Glycerin monoeicosate, boeravinone C, mirabijalone A, stigmasterol, and chrysophanol were found in Mirabilis jalapa roots . Mirabilis jalapa seed oil yielded 8-hydroxyoctadeca-cis-11,14-dienoic acid .
A quantitative investigation found 0.034mg/kg alkaloids in Mirabilis Jalapa leaves [16]. The methanolic extract of Mirabilis jalapaaerial sections contained 4.41 ± 0.02 mg/gram of flavonoids . The total phenolic content of Mirabilis

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jalapa tuber extracts ranged from 21.45 to 364.6mg gallic acid equivalent (GAE)/g dried extract and from 5.2 to 71.6 mg quercetin/g dried extract . The seed epicarp ethyl acetate extract had 4.24 mg GAE/g and 0.39 mg RE/g of dry powder weight of phenolics and flavonoids . In Mirabilis jalapa tubers powder extract, phenolic components included ferulic acid, procyanidin derivative, p-coumaryl-ester, Q-3-O-rhamnoside, dicaffeic acid, rutin, and pgl-3-O-glucoside . Mirabilis jalapa methanolic extract yielded polyphenolic amide: N-trans-feruloyl 4′-O-methyldopamine .

Pharmacological effects

Antimicrobial effects

Ethanolic extract of Mirabilis Jalapa leaves was tested against Gram positive and Gram negative bacteria and two fungi. The ethanolic leaf extract inhibited growth in the following zones: Staphylococcus aureus (11.1mm), Salmonella typhi (13.5mm), E. coli (15.0mm), P. aeruginosa (15.5mm), Penicilliumnotatum (35.0mm), and Rhizopusstolonifer (30mm) [16]. N-trans-feruloyl 4′-O-methyldopamine, a polyphenolic component from Mirabilis jalapa's methanolic extract, moderately inhibited MDR Staphylococcus aureus. Two broad-spectrum antifungal peptides, Mj-AMP1 and Mj-AMP2, were extracted from Mirabilis jalapa seeds and active against 13 plant pathogenic fungi. First and second peptide concentrations needed to suppress fungal growth by 50% are 6 to 300 and 0.5 to 20 micrograms/ml, respectively. These peptides also worked against two Gram-positive bacteria but not Gram-negative bacteria. The aqueous and methanolic seeds powder extracts and their mixture (1:2 mixture) at 40, 4, 0.4, and 0.04 mg/ml were tested for antibacterial activity against Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Enterobactersp., Vibrio cholerae, Shigellaflexneri, and Salmonella typhi. All bacteria except Enterobacter sp. were inhibited by the aqueous and methanol extracts, save Staphylococcus aureus. The mixture of extracts inhibited all microorganisms at 4 mg/ml and Staphylococcus aureus at 0.4 mg/ml [12].

Aqueous, ethanol, methanol, chloroform, and petroleum ether leaf extracts were tested for antibacterial activity against Escherichia coli, Staphylococcus aureus, Streptococcus pneumoniae, Bacillus cereus, Enterococcus faecalis, Pseudomonas aeroginosa, Klebsiella pneumoniae, Lactobacillus acidophilus, Salmonella typhiandShigelladysenteriae. All ethanolic and methanolic extracts showed good antibacterial activity against the selected pathogens (zone of growth inhibition 11-15mm against all tested bacteria, except Streptococcus pneumoniae 8mm) [38]. Aqueous, chloroform, and petroleum ether extracts showed minimal inhibition. Acetone, chloroform, ethanol, and methanol extracts of Mirabilis jalapa leaves were tested against Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Streptococci pneumonia, Aspergillus flavus, fumigatus, niger, and terreus. The methanol extract at 500µg/disc showed the best growth inhibition (97.5% at 500µg/ml media) against Aspergillus flavus and the widest growth inhibition zone (21mm) against Staphylococcus aureus. The methanol extract had the lowest MIC against Staphylococcus aureus (39µg/ml) and Aspergillus flavus (45µg/ml) [19].

The 0.5 mg/ml concentration of aqueous and alcoholic Mirabilis jalapa leaf extracts inhibited Staphylocoous aureus, Escherichia coli, and Proteus mirabilis growth. [18]. Antibacterial activity of Mirabilis jalapa methanolic extract against Gram positive and Gram negative bacteria was tested.All investigated bacteria were inhibited by the extract at 1mg/ml [34, 39]. Methanol, acetone, diethyl ether, and chloroform extracts of Mirabilis jalapa variants were investigated for antibacterial activity against Pseudomonas aeruginosa and Escherichia coli and Staphylococcus aureus and Bacillus subtilis. Methanol and acetone extracts of all types inhibited better than diethyl ether and chloroform extracts. The leaf methanolic extract from the white flowered variety had the greatest antibacterial activity at 500 mg/ml, followed by the pink, yellow, and orange varieties [40]. Mirabilis jalapa tuber extracts were tested against Gram-positive (Bacillus cereus, Staphylococcus aureus, Staphylococcus epidermidis, Micrococcus luteus, and Enterococcusfaecalis) and Gram-negative (Escherichia coli, Pseudomonas aeruginosa, and Klebsiellapneumoniae) bacteria. Water extract worked best with the lowest inhibitory concentration.

The ethanol, ethyl acetate, chloroform, formaldehyde, and distilled water extracts of Mirabilis jalapa leaves were evaluated against Staphylococcus aureus, E. coli, Bacillus subtilis, P. aeruginosa, and Candida albicans. The ethanolic leaf extract was most effective against Staphylococcus aureus (36 mm), Candida albicans (29 mm), Bacillus subtilis (28 mm), Pseudomonas aeruginosa (27 mm), and Escherichia coli (24 mm), followed by water extract (19 and 16 mm, respectively), formaldehyde extract (19 mm), and chloroform extract (18 mm) for both bacteria. Petroleum ether, benzene, chloroform, ethyl alcohol, and methanol extracts of Mirabilis jalapa leaves were tested for antibacterial and

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antifungal effects against Gram positive (Staphylococcus aureus, S. epidermidis, and B. subtilis), Gram negative (E. coli, P. aeruginosa, and K. pneumonia), and Candida albicans. All extracts except petroleum ether were effective antibacterial and antifungal. Compared to other extracts, methanol extract showed stronger and broader microbial activity with zones of growth inhibition of 25, 22, 21, 21, 20, 22, 23mm against Staphylococcus aureus, epidermidis, subtilis, aeruginosa, pneumonia, coli, and albicans [42]. The aqueous and ethanolic extract of white-flowered Mirabilis jalapawa leaves was tested for antibacterial activity against Staphylococcus aureus, Salmonella typhi, E. coli, Vibrio cholerae, and Bacillus subtilis. The ethanolic extract inhibited Salmonella typhi (54.74%) better than Staphylococcus aureus (54%), Vibrio cholerae (51.95%), Escherichia coli (51.08%), and Bacillus subtilis (50%), while the aqueous extracts did not [43]. The ethanolic Mirabilis jalapawa leaf extract was tested against Salmonella typhiana and Bacillus cereus. Growth inhibition zones for extract at 20 ug/l were 34.33±1.70mm and 51.33±1.88mm against Salmonella typhiand Bacillus cereus, while separated bioactive fraction at 3mg/ml was 40.33±1.33mm and 40.67±1.70mm against the same microorganisms [44]. In vitro, Mirabilis jalapa leaf extracts were investigated for antibacterial activity against biofilm and extended spectrum beta lactamase (ESBL)-producing uropathogenicEscherichia coli. Mirabilis jalapaleaves ethanol extract inhibited only 2 of 4 ESBL-producing UPEC strains but had the most antibacterial efficacy against all biofilm-producing strains [45]. Acetone, ethyl acetate, petroleum ether, and ethanol extracts of Mirabilis jalapa leaves were evaluated against biofilm-producing uropathogenicE. coli (UPEC 1, 17, 57, and 82).The acetone extract inhibited biofilm-producing (UPEC 1, 17, and 82) strains with zones of 22, 20, and 17 mm. For biofilm-producing bacteria UPEC 1 and 17, the petroleum ether extract inhibited development by 18 and 15 mm, respectively. The ethyl acetate extract inhibited biofilm-producing bacteria UPEC 1, 17, and 82 with zones of 20, 19, and 21 mm [13]. Triterpenoid and flavone components of Mirabilis jalapa radix crude extract demonstrated antibacterial activity against Staphylococcus aureus and Candida albicans [46]. Mirabilis jalapashroot and leaf proteins have similar anti-plant viral activity (potato virus X, potato virus Y, potato leaf roll virus, and potato spindle tuber viroid) [47-51]. The pure protein inhibits the mechanical transmission of TMV in tobacco, tomato, pepper, and cucumber plants and cucumber green mottle mosaic virus in cucumbers [52]. The chemical 1,2,3,4-tetrahydro-1-methylisoquinoline-7,8-diol, found in Mirabilis jalapa roots, inhibited HIV-1 reverse transcriptase by 48% at 210 µg/ml [30]. Mirabilis jalapa plant cell culture isoflavone and dehydrorotenoid have antifungal efficacy against Candida albicans DSY1024 with IC50s of 25 and 48 microg/ml [53].

Antiparasiticeffect

The anthelmintic activity of aerial parts extracts (20%, 40%, 60%, 80%) of Mirabilis jalapa was studied using Pheretima posthuma as a test worms. The methanolic extract of Mirabilis jalapa caused paralysis in 12.6 min and death in 13.5 min. Albendazole showed the same effect (at 2.3 min and 3.24 min), respectively [54]

The larvicidal activity of crude chloroform, benzene, methanol and ethyl acetate leaf extracts of Mirabilis jalapa was investigated against the larvae of three important vector mosquitoes (An. stephensi, Ae. aegyptiand Cx. Quinquefasciatus). The highest larvicidal activity was possessed by the leaf methanol extract of Mirabilis jalapaagainst Cx. Quinquefasciatus, Ae. aegyptiand An. stephensi, with LC50 of 84.53, 64.58, 57.55 ppm and LC90 values of 159.25, 120.28 and 104.20 ppm, respectively. The mortality rate was positively correlated with concentration [55].

Antioxidant effect

The total antioxidant capacity of the acetone, ethyl acetate, petroleum ether and ethanol extracts of leaves of Mirabilis jalapa was measured by the ferric reducing antioxidant power (FRAP) assay. Ethanolic extract showed more antioxidant potential compared to other extracts [13]. DPPH test was used to determine the antioxidant activity of petroleum ether, chloroform and methanol extracts of both the leaves and bark of Mirabilis jalapa. The methanol extract of the plant bark showed antioxidant activity with IC50 value of 598.02 µg/ml compared to ascorbic acid (IC50 70.985µg/ml) [56]. Two fractions of the crude extract of Mirabilis jalapa radix (triterpenoid and flavone) showed free-radical scavenging activity by using 2,2-diphenyl-1-picrylhydrazyl solution [46]. The antioxidant effect of the methanolic extract of Mirabilis jalapaaerial parts was evaluated using hydrogen peroxide scavenging method and reducing power assay method. The methanolic extract of Mirabilis jalapawas found to show significant reductive property. Mirabilis jalapaextract also caused a moderate dose-dependent inhibition of hydrogenperoxide [57]. The

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antioxidant activities of various solvent extracts of Mirabilis jalapa tubers were investigated using DPPH and lipid peroxidation assay. The water extract was the most potent antioxidant in all models, followed by methanol extract [58]. The antioxidant potential of aerial (bark and leaves) and the root extracts of Mirabilis jalapa was investigated using ABTS and DPPH assay methods. In DPPH radical scavenging assay, methanolic root extract at the concentration of 500 µg/ml exhibited 17.53605± 0.1071422% inhibition (ED50: 679µg/ml), while, the methanolic extract of the aerial parts at the concentration of 500 µg/ml exhibited 17.20884 ± 0.08971401% inhibition (ED50: 3723 µg/ml). In ABTS free radical scavenging model, the EC50 values were 1249 µg/ml,974µg/ml, 70.28 µg/ml respectively for methanol root and aerial extracts and quercetin respectively [59]. The ethyl acetate extract of the seed epicarp exhibited high free radical scavenging rate as IC50 (DPPH and OH assays) were 6.62 and 3.49 mg dry powder weight /ml .

Dermatological effect

The effects of hydromethanolic extract of tuberous root of Mirabilis jalapa and its terpenoid and flavonoid fractions on skin wound healing were studied using excision wound model on rat. The results indicated that flavonoid caused significant decrease

Anticancer effect

Brine shrimp lethality bioassay technique was applied to determine the cytotoxic property of petroleum ether, chloroform and methanol extracts of both the leaves and bark of Mirabilis jalapa. The petroleum ether extract of the bark showed significant cytotoxic activity with LC50 value of 8.12 µg/ml compared to vincristine sulphate (LC50 value: 0.33 µg/ml) [56]. Mirabilis jalapa protein was tested for anticancer 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 [62-65]. Ribosome-inactivating protein, isolated from the leaves of Mirabilis jalapa was more cytotoxic to HeLa cell-line (LC50 0.65mg/ml) than to Raji cell-line (1.815mg/ml) after 48 hours' incubation time [66]. A protein fraction with properties like ribosome-inactivating protein (RIP) isolated from the leaves of Mirabilis jalapa possessed cytotoxic effect against T47D and SiHa cell line. The LC50 against T47D cell line and SiHa cell line were 0.36µg/ml and 5.6µg/ml, respectively. While, it was non toxic against normal cells (LC50 of 21.04µg/ml). It produced more cytotoxic activity toward breast and cervical cancer cells (58-fold and 4-fold, respectively) as compared to normal mononuclear cells [67].

Antiinflammatoryeffect

screened for its anti-inflammatory activity using carageenan induced rat paw edema and cotton pellet induced granuloma models. The total alcoholic extract and petroleum ether fraction possessed significant anti-inflammatory activity (P

Analgesic effect

The antinociceptive effect of leaf ethyl acetate fraction from Mirabilis jalapa (10mg/kg, orally) was investigated in mice. The extract fraction caused marked reduction in the pain caused by complete Freund's Adjuvant-CFA, surgical incision and partial sciatic nerve ligation. However, the fraction did not alter the paw edema or the increase in the IL-1β levels produced by CFA. The antinociceptive effect of the fraction was reversed by the pre-treatment of animals with the muscarinic receptor antagonists (atropine, 5mg/kg, sc) or nicotinic receptor antagonists (mecamylamine, 0.001mg/kg, sc.). The fraction did not alter in vitroacetylcholinesterase activity in blood or spinal cord samples, but it reversed the increase in the acetylcholinesterase activity observed in the spinal cord samples from mice injected with CFA. Furthermore, the fraction did not alter the indicators of liver or kidney lesion [71]. The antinociceptive effect of Mirabilis jalapa crude hydroethanolic leaves and stems extracts was investigated in pain models in mice. The crude hydroethanolic extract of leaves was more potent than the crude extract of stems to inhibit abdominal constrictions induced by acetic acid (ID50 values of 5.5 (2.3-13.1) and 18.0 (11.3-28.5) mg/kg, respectively]. Crude hydroethanolic leaves extract also possessed antinociceptive effect in the tail-flick test. Pre-treatment with naloxone did not modify the

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antinociceptive effect, but co-administration with atropine completely prevented it, which indicated that the antinociceptive effect might depend on the cholinergic system [72].

Antidiabeticeffect

The hypoglycemic and hypolipidemic activities of ethanolic extract of Mirabilis jalapa root were studied in normal and streptozotocin induced diabetic mice (2, 4, 8 g/kg, for 14 before and 28 days after induction). Both after and before induction of diabetes, the repeated administration of 4, 8 g/kg of the extract lowered blood glucose level, improved insulin sensitivity index, lowered serum total cholesterol, triglyceride levels, and decreased triglyceride and increased glycogen content in liver and skeletal muscle. Single administration of the extract (4 and 8 g/kg) possessed hypoglycemic effect in oral glucose tolerance test in normal and diabetic mice, but showed no hypoglycemic and hypolipidemic effects on normal and diabetic mice [73].

The anti-hyperglycemic effect of hydroethanolic leaf extract of Mirabilis jalapa was investigated in streptozotocin induced diabetic rats. The hydroethanolic leaf extract at the concentration of 200 and 400 mg/kg showed significant decrease in the levels of glucose, urea, creatinine, aspartate transaminase, alanine transaminase and alkaline Phosphatase in streptozotocin induced diabetic rats [74].

Antihistaminicandimmune-modulatoryeffects

The antihistaminic activity of an ethanol: acetone (1:1) extract of the roots of Mirabilis jalapa was studied using Guinea pig tracheal chain preparation and clonidine-induced mast cell granulation in mice. The extract (0.5 ml of 100 mg/ml) inhibited histamine-induced Guinea pig tracheal chain contractions non-competitively. The extract (100 or 200 mg/kg, ip) also inhibited milk-induced eosinophilia, albumin-induced paw oedema and protected mast cells against clonidineinduced granulation [75]. The immunomodulatory activity of the methanolic extract (100, 200 and 400 mg/kg) of Mirabilis jalapatuber was investigated in mice by using heamagglutination antibody titer, delayed type hypersensitivity, neutrophil adhesion test and carbon clearance test. Oral administration of 200 and 400mg/kg of the methanolic extract of Mirabilis jalapasignificantly increased antibody titer, phagocytic index, adhesion of neutrophils and positive hypersensitivity response in mice compared to control group [20]. **Antispasmodiceffect**

The extract of the flowers of Mirabilis jalapa (1-1000 mug/ml) exhibited an inhibitory effect (IC50 18±0.7 micorg/ml) on gut smooth muscle contractility, whereas it stimulated the contraction of rabbit aortic muscle (EC50 11.60±0.26 micorg/ml) in a concentration-dependent manner [76].

Other effects

The aqueous and alcoholic Mirabilis jalapa leaves extracts were examined for their inhibitory effects on hyaluronidase. The percentage of inhibition for aqueous extract was7.5% , and for alcoholic extract was 6.25% with respect to control assays [18].

II. CONCLUSION

Bioactive metabolites were abundant in Mirabilis jalapa. It had antibacterial, antiparasitic, dermatological, anticancer, anti-inflammatory, analgesic, antidiabetic, antihistaminic, immune-modulatory, antispasmodic, and other pharmacological properties. This review covered Mirabilis jalapa's chemical ingredients, traditional applications, and pharmacological effects.

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