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AN UPDATED PHYTOPHARMACOLOGICAL REVIEW ON *HAMELIA PATENS* JACQ.

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ABSTRACT: *Hamelia patens* Jacq. (Rubiaceae) also known as firebush is an ornamental plant native to Florida and has been used traditionally in a number of conditions, including diabetes, pain, skin diseases, respiratory problems, dysentery, *etc*. This review aims to provide an overview of the plant profile, its phytoconstituents and pharmacological activities. Alkaloids of indole and oxindole class like rumberine, pteropodine, isopteropodine, mitrajavine, flavonoids like kaempferol-3-O-rutinoside, 7-0-a-L-rhamnopyranoside, 5, 7, 2', 5'tetrahydroxyflavanone 7-D-gluco-pyranoside, (-) epicatechin, 5, 7, 2', 5'-tetrahydroxyflavanone, narirutin and rosmarinic acid, carbohydrate, proteins and tannins have been identified and isolated from firebush. Different extracts of different parts of *Hamelia patens* have shown various pharmacological activities like antioxidant, antimicrobial, anthelmintic, antidepressant, acetylcholinesterase inhibitory, antilithiatic, hepatoprotective, wound healing, blood sugar lowering, cytotoxic and nanotechnological research has also been conducted. Further research is required for the identification and isolation of bioactive constituents, which might be used as potential drugs in the near future.

INTRODUCTION: Nature has been providing remedies for almost all diseases since times immemorial. The shift towards plants for the discovery of new entities is tremendously increasing as plants are a safer and cheaper alternative to synthetic drugs. With the emerging diseases, the focus towards natural resources for their cure is also increasing. *Hamelia patens* Jacq. commonly-known as firebush, scarlet bush, hummingbird bush, and by many other vernacular names, is an ornamental plant native to Florida. This plant has been investigated for a number of biological activities, and many bioactive constituents have been identified and isolated from different parts of the plant.

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This review summarizes the profile of the plant in terms of its activities and phytochemical constituents.

1.1. Plant Description: *Hamelia patens* Jacq. belonging to the Rubiaceae family is an ornamental plant native to tropical America and grows in a tropical or subtropical climate. It is an evergreen tree consisting of orange-red tubular flowers [1]. The genus Hamelia Jacq. consists of woody shrubs (Wealth of India) and is distributed from Florida and Mexico to Paraguay. There are two sections in this genus: section Hamelia and section Amphituba. The Hamelia section has red, orange, or yellow tubular flowers, and section Amphituba consists of yellow infundibular or trumpet-shaped flowers [2].

1.1.1. Synonyms: *Hamelia erecta* Jacq., *Hamelia coccinea*, *Hamelia pedicellata* Wernh, *Hamelia latifolia* Reichb. ex DC.

1.1.2. Species of Hamelia: *H. axillaris*, *H. barbata*, *H. calycosa*, *H. chrysantha*, *H. cuprea*, H. longipes, *H. macrantha*, *H. magnifolia*, *H.* ovate,

H. pepillosa, *H. patens*, *H. rostrata*, *H. rovirosae*, *H. sanguine*, *H. ventricosa*, H. xerocarpa, *H. xorullansis*, *H. grandiflora*, *H. magniloba*, *H. ovata*, *H. pedicellata*, *H. tubifora*, *H. viridifolia*, *H. brachystemon*, *H. brittoniana*, *H. axillaris* and *H. lutea* [3, 4].

1.1.3. Taxonomical Classification: [5]

Scientific name	**:**	*Hamelia patens*
Kingdom	**:**	Plantae
Subkingdom	**:**	Tracheobionta
Subdivision	**:**	Spermatophyta
Division	**:**	Magnoliophyta
Class	**:**	Magnoliopsida
Subclass	**:**	Asteridae
Order	**:**	Rubiales
Family	**:**	Rubiaceae
Genus	**:**	Hamelia Jacq.
Species	**:**	*Hamelia patens* Jacq.

Common Names: Firebush, scarlet bush, hummingbird bush, butterfly bush, firecracker bush, bálsamo, coloradillo, madura zapote, treshojitas, chichipín [6], polly red head [7] tsapuk [8], coral, trompetilla, jicarillo [92, 10, 11]. .

1.1.4. Description: The plant is a shrub or small tree with year-round flowering and grows to about 6-12 ft. height and spreads to about 5-8 ft. It can be propagated by seeds, cuttings, or air layers [12].

1.1.5. Distribution: Scarlet bush is found throughout tropical and sub-tropical America. It is widespread from Mexico to Paraguay. It is also indigenous to Bahamas and Caribbean [2].

1.2 Plant morphology: Leaves are simple, elliptic to ovate, light green or dark green varying to purplish or red depending upon cultivars with entire blade, wavy margin and short petiole (about 1 - 1/2 inches long); arranged in whorls of 3-5 leaves **Fig. 1** and about 3 - 8 inches long and 1 - 4 inches wide. The surface is glabrous with villous hairs on both upper and lower side[12] **Fig. 2**.

FIG. 1: TWIG OF *H. PATENS*

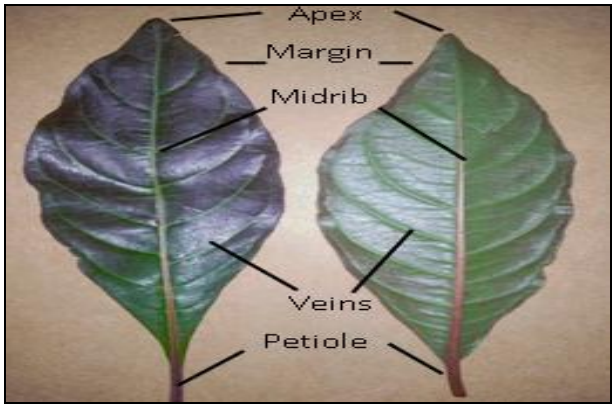

FIG. 2: LEAF OF *H. PATENS*

Flowers are arranged in cymes with forked terminal and axillary inflorescence with Long and stamens inserted within a fused corolla tube.

The color changes from yellow to orange when buds mature, ultimately becoming orange-red upon pollination [2, 12] **Fig. 3**.

FIG. 3: *H. PATENS* FLOWER

Stem are greenish-brown with 0.5 to 1.2 cm diameter and cylindrical shape [13] **Fig. 4**. Fruits are edible with oval to elliptic shape **Fig. 5A** and green in color changing to red while ripening and ultimately to purplish-black when mature **Fig. 5B** [12, 4].

FIG. 4: STEM OF *H. PATENS*

FIG. 5: (A) AND (B) FRUIT OF H.PATENS

1.3. Pollinators: Hummingbirds, bees, and butterflies [3].

1.4. Ethnobotany: *H. patens* has been used traditionally for a number of conditions like pain, rheumatism, inflammation, diabetes, wound healing, menstrual cramps, snakebite, scorpion bite, and fever, *etc.* [3, 10, 14, 15] **Table 1**.

TABLE 1: ETHNOMEDICINAL USES

S. no.	Region	Part	Administration		Ailment
1	Papantla, Veracruz, Mexico	Leaves	Fresh	Decoction	Blood circulation, Colitis, Diabetes, gastritis, Menstruation [11]
				Infusion	Anemia, Diabetes, gastritis, High pressure
				Burned	Breastfeeding
				Dry	Decoction
		Roots	Fresh	Decoction	Ulcers
				Squeezed	Skin problems, Fungus
				Bath	Wounds
			Dry	Decoction	Respiratory system
2	Tlanchiol, Hidalgo, Mexico	Aerial parts and leaves	Oral	Infusion	Diuretic, Gastritis, Stomach pain, Wounds [10]
				Macerated	Kidney problems
			Topical	Infusion	Gastritis, Wounds
3	Guatemala	Leaves	Infusion		Type 2 diabetes [6]
4	Belize	Whole plant	Tea		Menstrual cramps and High blood pressure [7]
			Tea bath		Sores and skin rashes
		Leaves	TopicalGrinded		Sores and skin rashes
5	Isthmus-Sierra (Oaxaca, Mexico)	Flower and Leaf	-		Dermatological diseases [16]
6	Pachalur hills of Dindigul district in Tamil Nadu, Southern India	Berries	"Varithelmunai" Syrup		Blood dysentery [17]
7	WexternPanama	Stem-Bark	Infusion		Snake bites and as a post-partum aid to relieve pain [18]
8	Achuar (Jivaro) of Amazonian Ecuador	Leaves	Decoction		Malaria [8]

2. Phytoconstituents: Biosynthesis and production of monoterpenoid indole and oxindole alkaloids was studied by elicitation using jasmonic acid as elicitor [19]. Tryptophan, glutamine, glutamic acid, sucrose, chlorogenic acid, p-coumaric acid and strictosidine along with monoterpenoid oxindole alkaloids palmirine and pteropodine were found to be prominent in plants treated with jasmonic acid

and loganic acid, aspartic acid, acetic acid, and glucose were high in control plants which was in accordance to analysis from Methanol/Water fractions. Increased level of 1-deoxy-D-xylulose-5-phosphate synthase, strictosidine synthase, and STR activity was followed by increased levels of isopteropodine, pteropodine, rumberine, speciophylline, palmirine, and hameline in treated plants. Tryptophan was also confirmed to be a precursor of MIA and MOA *via* the shikimate pathway.

TABLE 2: PHYTOCONSTITUENTS PRESENT

S. no.	Phytoconstituent		Extract
1	Indole Alkaloid	Aricine	Acetone leaves extract [20]
			Micro propagated plantlets [21]
		Oxindole aricine	Acetone leaves extract [20]
		Mitrajavine	Dichloromethane leaves extract [22]
		Tetrahydroalstonine	Micro propagated plantlets [21]
2	Oxindole Alkaloid	Palmirine	Ethanolic aerial parts extract [23]
			Dichloromethane leaves extract [22]
			Micro propagated plantlets [21]
		Rumberine	Ethanolic aerial parts extract [23]
			Dichloromethane leaf extract [22]
			Micro propagated plantlets [21]
		Isopteropodine	Dichloromethane leaf extract [24, 22]
			Micro propagated plantlets [21]
		(-)-Hameline	Micro propagated plantlets [21]
		Pteropodine	Micro propagated plantlets [21]
		Uncarine-F	Micro propagated plantlets [21]
		Speciophylline	Micro propagated plantlets [21]
3	Phenylethylamine	Ephedrine	Methanolic leaf extract [25]
4	Flavanone glycoside	5, 7, 2′, 5′tetrahydroxyflavanone-7-rutinoside	Methanolic aerial parts extract [26]
5	Flavan-3-ol	Catechin	Hexane leaves extract [20]
			Methanolic leaves extract [27]
			70% ethanolic leaves extract [28]
6	Esterof caffeic acid	Chlorogenic acid	Methanolic leaves extract [27]
			Ethanolic plant extract [29]
7	Flavonoid	(-)-Epicatechin	Methanolic extract of leaves [27]
			Ethyl acetate extract [22]
8	Polyphenol	Caffeic acid	Ethanolic plant extract [29]
9	Flavonoid	Quercetin	Ethanolic plant extract [29]
10	Flavonoid	Kaempferol-3-O rutinoside	Ethyl acetate extract [22]
11	Flavonoid	β-carotene	Hexane extract of aerial parts [9]
12	Cyclic polyol	Quinic acid	70% leethanolic extract of leaves [28]
13	Phenylpropanoids	Hydroxycinnamic acid	70% ethanolic extract of leaves [28]
14	Alkyl caffeate ester	Caffeoylquinic acid	70% ethanolic extract of leaves [28]
15	Proanthocyanidin	Procyanidin β-2	70% ethanolic extract of leaves [28]
16	Flavonol glycoside	(+)-Catechin 3-O-glucoside	70% ethanolic extract of leaves [28]
17	Dihydrochalcones flavanoid	3-hydroxyphloretin-2'-O-glucoside	70% ethanolic extract of leaves [28]
18	Flavonoid	Narirutin, Rosmarinic acid	Methanolic extract of aerial parts [26]
19	Terpene	(6E, 10E, 14E, 18E)-2, 6, 10, 14, 18, 23-hexamethyl-2, 6, 10, 14, 18, 22 tetracosahexaene	Hexane extract of leaves [30]
20	Triterpenoid	Rotundic acid,	Acetone extract of leaves [20]
		2E-3, 7, 11, 15, 19-pentamethyl-2-eicosaen-1-ol,	Hexane extract of leaves [30]
		ß-sitosterol, stigmasterol,	
21	Pentacyclic triterpenoid	24-methylenecycloartan-3ß-ol, ursolic acid	Acetone extract of leaves [20]
22	3-β-hydroxy steroid	24-methylcycloart-25-en-3ßol	Acetone extract of leaves [20]
23	Triterpenoid	Stigma-4-ene-3, 6-dione	Aerial parts [31]
24	Saturated and Unsaturated aliphatic hydrocarbons	2,3-dihydro-3,5-dihydroxy-6-methyl4H-pyran 1, 3-propanediol, 2-ethyl-2-(hydroxymethyl), mome inositol and squalene	Methanolic extract of leaves [32]

TABLE 3: STARCH, PROTEIN, LIPID AND PHENOL CONTENT OF VARIOUS PARTS

Part	Content	Quantity (mg/g)
Leaves	Starch	37.5 ± 0.41 mg/g
	Soluble sugars	48.2 ± 0.64 mg/g
	Proteins	87.8 ± 0.79 mg/g
	Lipid contents	28.5 ± 0.77 mg/g
	Phenol contents	104.6 ± 1.12 mg/g
Stem	Starch	28.6 ± 1.12 mg/g
	Soluble sugars	44.5 ± 0.89 mg/g
	proteins	34.5 ± 1.14 mg/g
	Lipid contents	2.6 ± 0.41 mg/g
	Phenol contents	50.7 ± 1.41 mg/g
Bark	Starch	30.4 ± 1.51 mg/g
	soluble sugars	52.6 ± 1.14 mg/g
	Proteins	94.2 ± 1.41 mg/g
	Lipid contents	5.7 ± 1.12 mg/g
	Phenol contents	47.2 ± 0.89 mg/g

Quantitative Estimation: Starch, protein, lipid, and phenol content of various parts of *H. patens* were quantitatively evaluated. The results are summarized in **Table 3** [33].

3. Biological Activity:

Total Phenols: Quantitative estimation of total phenolic content (T.P.C.) of different extracts of the plant has been done by several researchers, as given in **Table 4**.

Total Flavonoids: The total flavonoid content of Petroleum ether, Chloroform, and Methanol was 8.47 ± 0.67, 15.09 ± 1.21, and 43.42 ± 1.41 mg rutin equivalents per gram of dried extract, respectively when determined using Aluminium chloride colorimetric method [34].

TABLE 4: TOTAL PHENOLIC CONTENT

S. no.	Extract		Total phenolic content (mg gallic acid equivalent per gm)
1	Stem	Petroleum ether	19.083 ± 1.12 [34]
		Chloroform	30.58 ± 1.28
		Methanolic	99.25 ± 1.39
2		Crude methanolic	141.58 +/- 11.99 [35]
		Hexane	33.96 +/- 1.13
		Ethyl acetate	375.18 +/- 13.09
		Butanol	132.08 +/- 3.62
3	Bark	Aqueous	413.8 [36]
		Acetone	303.6
		Methanolic	310.8
4	Stem + Bark	Aqueous (25 + 25 g)	354.3 [36]
		Aqueous (15 + 35 g)	437.5
		Aqueous (35 + 15 g)	296.2

Antioxidant Activity: Various extracts of *Hamelia patens* has been evaluated for antioxidant activity using different assays, and the results obtained are summarized in **Table 5**.

TABLE 5: IC_{50} VALUES OF DIFFERENT EXTRACTS IN DIFFERENT ANTIOXIDANT ASSAYS

S. no.	Assay	Extract		Result (IC_{50})
		Part	Solvent	
1	DPPH	Leaf	Ethanolic (70%)	116 µg/mL [37]
			HEX	- [30]
			DCM–EtOAc	158.2 ± 9.6 [30]
			MeOH–EtOAc	IC_{50} 18.6 mg/mL [30]
			MeOH–Aq.	93.9 ± 12.1 [30]
		Stem	Petroleum ether	250.58 [34]
			Chloroform	46.03 [34]
			Methanol	83.44 [34]
			Methanolic crude	77.87 ± 5.67 µg/mL [35]
			Hexane	236.64 ± 26.32 µg/mL [35]
			Ethyl acetate	45.87 ± 2.24 µg/mL [35]
			Butanol	50.97 ± 0.85 µg/mL [35]
2	Nitric oxide scavenging assay	Stem	Petroleum ether	219.97 [34]
			Chloroform	61.33 [34]
			Methanol	94.57 [34]
3	Hydrogen peroxide scavenging assay	Stem	Petroleum ether	172.54 [34]
			Chloroform	66.09 [34]
			Methanol	93.51 [34]
		Bark	Aqueous	76.11 ± 0.01 [36]
			Acetone	93.07 ± 0.06 [36]
			Methanolic	91.09 ± 0.12 [36]
		Stem + Bark	Aqueous (25 + 25 g)	81.09 ± 0.12 [36]
			Aqueous (35 + 15 g)	82.13 ± 0.20 [36]
			Aqueous (15 + 35 g)	73.88 ± 0.01 [36]
4	Metal chelating activity	Stem	Petroleum ether	294.12 [34]
			Chloroform	126.90 [34]
			Methanol	112.36 [34]

Along with 22 Mexican species, free radical scavenging and antioxidant activities of hexane, acetone, and methanol extracts of the aerial parts of *H. patens* were studied. The β-carotene bleaching method and DPPH radical scavenging assay were used. Methanolic extract was found to have greater antioxidant activity than acetone least activity was observed in the hexane extract of *Hamelia patens*. *H. patens* showed similar activity as BHA (Butylated Hydroxyl Anisole) and higher activity than natural anti-oxidant like α-tocopherol [9].

Anti-inflammatory Activity: Hexane, chloroform, and methanolic extracts of the plant have been evaluated for topical anti-inflammatory activity using croton oil ear edema mice model and chloroform extract was found to have the highest activity with ID 255 µg/cm^2 which was comparable to indomethacin (ID_{50} = 93 µg/cm^2) [38]. In carrageenan-induced paw edema in rats (oral) and TPA (12- tetradecanoylphorbol-13-acetate) induced ear edema in mice (topical), HEX extract at 500 and 200 mg/kg b. wt significantly decreased the inflammation. The highest myeloperoxidase activity inhibition was shown by MeOH–EtOAc (83.5%) [30].

Antimicrobial Activity: Camporese *et al.,* evaluated the antibacterial activity of hexane, chloroform, and methanol leaf extracts of *H. patens* against *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Enterococcus faecalis* amongst which only hexane extract was found to effective against *E. coli* [39]. Okoye *et al.,* also studied the antimicrobial activity of the plant leaf extracts (Ethanol, Methanol, Petroleum ether, and aqueous extract) against *E. coli*, Proteus mirabilis, *Pseudomonas aeruginosa*, *Salmonella typhiand, S. aureus* and antifungal activity against *C. albicans* and *A. niger*.

The minimum inhibitory concentration was between 12.5 mg/ml to 100 mg/ml. Ethanolic extract showed the highest antimicrobial effect [40]. Anti-bacterial activity of Ethanolic (70%) leaf extract prepared using Maceration, Soxhlet and Percolation against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *S. paratyphi* was compared by Paz *et al.*, and the activity was not found to differ significantly in extracts prepared by three methods, and all the extracts showed antimicrobial activity [28]. Antibacterial and antifungal activity of aqueous, acetone, methanolic and ethanolic extracts of bark, stem, and stem + bark extracts against *Staphylococcus aureus, Bacillus subtilis*, *Pseudomonas flurescens*, *Escherichia coli* and *Aspergillus niger*, *Penicillium chrysogenum*, *Alternaria alternata* was done by Singh *et al.*, using agar well diffusion and serial dilution methods extracts tested were Aqueous, Acetone, Methanolic and Ethanolic extracts of Bark, Stem, and Stem + Bark. Acetone extracts were found to have the highest activity [36]. A bubacker *et al.*, studied the antifungal potential of leaf, flower and fruit aqueous extracts for *Aspergillus fumigatus*, *Candida albicans, Fusarium oxysporum,* and *Rhizoctonia solani*. Leaf and fruit extract were effective [41]. At 10% Aq. leaf extract inhibited *A. fumigates*, *C. albicans*, *F. oxysporum* and *R. solani* completely; Flower extract inhibited *F. oxysporum* and *R. solani* by 100% while fruit extract inhibited all the fungal strains. Silver nanoparticles synthesized from aqueous leaf extract of *H. patens* were tested for antibacterial activity against Salmonella ebony *Bacillus subtilis*, *Klebsiella pneumonia,* and *Pseudomonas aeruginosa* by Reddy *et al.,* Maximum activity of the nanoparticles was observed against *Pseudomonas aeruginosa* followed by Salmonella ebony [42].

Anticancer Activity: Studies conducted to evaluate its cytotoxic activity with the cells used, and results obtained are summarized in **Table 6**.

Antinociceptive Activity: In thermal-induced nociception (hot plate) and the chemical-induced nociceptive tests (acetic acid and formalin), the effect of ethanolic extract of leaves was evaluated **Table 7** [47]. Rao *et al.,* [48] also studied the analgesic activity of ethanolic extract of *H. patens* leaves using hot plate test and formalin-induced paw licking test in rats and observed that extract (50-200 mg/kg b. wt.) increased reaction time of animals in a dose-dependent manner.

Blood Sugar Lowering Activity: HEX, DCM–EtOAc, MeOH–EtOAc, and MeOH–Aq. extracts were evaluated for in vitro α-glucosidase inhibition. The highest inhibition was exhibited by HEX extract with IC_{50} value was 26.07 mg/ mL [30]. The ability of crude and fractional methanolic extracts

to reduce blood glucose levels in streptozotocin-induced hyperglycemia was evaluated.

All the extracts normalized the glucose level after 10 administrations. Epicatechin and chlorogenic acid out of the five compounds identified in the extracts demonstrated Anti-hyperglycemic activity [27] and may be considered responsible for the activity. Alloxan induced diabetes in rats has also been used to investigate the anti-diabetic activity of petroleum ether and ethanolic extracts of *H. patens* (100 and 400 mg/kg). Both the extracts reduced blood glucose level, total cholesterol, and total triglycerides significantly in a dose-dependent manner, which was comparable to that of Standard drug glibenclamide (10 mg/kg, body wt.).

TABLE 6: CYTOTOXIC ACTIVITY IN DIFFERENT CANCER CELLS

S. no.	Extract	Cancer Cells	Result
1	Root bark extract	Cervix adenocarcinoma (Hela)	IC_{50} = 13 µg/mL [43]
2	Alkaloid fraction(HPAE)	MCF-7	IC_{50} 8.42 ± 1.1C_{50} µg/ml [44]
		H-460	IC_{50} 90.40 ± 18.48 µg/ml
		SF-268	IC_{50} 91.47 ± 19.74 µg/ml
3	Crude leaf and flower extracts	Liver carcinoma	Crude leaf and flower extracts, both ME and ZSM-5 encapsulated could be used as ancillary therapy for liver carcinoma [45]
		Breast carcinoma	For breast carcinoma, crude extracts were found to be more effective. Chloroform leaf fraction showed antiproliferative potency in both the cell lines. Microemulsion form of the methanolic fraction was more potent than plain, and ZSM-5 encapsulated form
4	Plant extracts	HeLa cells	No significant cytotoxic activity was found [46]
5	Methanolic, hexane, ethyl acetate and butanol extracts	Vero cells	No significant activity [35]

TABLE 7: ANTINOCICEPTIVE ACTIVITY OF ETHANOLIC EXTRACT

Test	Extract	Anti-nociceptive activity
Thermal induced nociception	100 mg/kg	17%
	200 mg/kg	25%
Formalin induced nociception	100 mg/kg	30%
	200 mg/kg	39%
Acetic acid induced nociception	100 mg/kg	57%
	200 mg/kg	65%

Hypoglycemic effects of aerial parts of *H. patens* ethanol (50%) and water extracts were demonstrated in STZ nicotinamide induced diabetes in rats. Water extract produced hypoglycemic effect after 120 min while ethanol (50%) extract produced effect after 60 min, which was similar to glibenclamide, which also showed hypoglycemic effects after 60 min [29].

Hepatoprotective Activity: Methanolic crude, hexane, ethyl acetate, and butanol extracts of *H. patens* were evaluated for hepatoprotective activity. Aspartate Aminotransferase (AST) activity on HepG2 cells damaged with CCl_4 was done, and best activity was shown by Butanol extract (43.74 ± 4.03) [35].

Antidepressant: Chloroform and methanolic extracts were investigated for antidepressant activity in mice. Chloroform extract (100 and 200 mg/kg/day, p.o.) showed better activity in forced swim test and tail suspension test by decreasing immobility time. No significant change in locomotor activity was shown by the extracts in open field tests [49].

Acetylcholinesterase Inhibitory: Docking after GC-MS analysis of a methanolic extract of *H. patens* leaves was done.

Acetylcholinesterase inhibitory activity of the extract was studied both *in-vitro* and *in-vivo* on the brain of Danio rerio (zebrafish), which was found to be significant [50].

Toxicity Studies: The LD_{50} of 500-500 mg/kg b. wt. of *H. patens* leaves ethanol extract was found to be 2964 mg/kg b. wt. i.p. and >5000 mg/kg b. wt.

p.o (peroral) acute and subacute toxicity studies respectively [47]. Some other pharmacological activities evaluated by researchers are summarized in **Table 8**.

TABLE 8: OTHER PHARMACOLOGICAL ACTIVITIES

S. no.	Activity	Extract	Result
1	Anti-diarrheal activity *In-vitro* (Inhibitory effect on the smooth muscles) and *In-vivo* in mice and rats	Methanol extract	Most potent activity at 100 mg/kg [51]
2	Anti-leishmanial activity against *Leishmania mexicana*	Methanol leaf extract was partitioned between Hexane, Dichloromethane and Ethyl acetate Four alkaloids from DCM extract	Highest activity shown by Dichloromethane and Ethyl acetate extract and Palmirine [22]
3	Antiurolithiatic activity	Roots decoction	Potent anti-urolithiatic activity [52]
4	Antilithiatic activity (ethylene glycol (EG) used to alter the ionic level of urine)	Ethanolic leaf extract	The levels of calcium, phosphate, uric acid and oxalate ions level scaled down and level of magnesium was increased [53]
5	Anthelmintic activity	Ethanolic leaf, stem and root extracts	Immobilization of *Pheretima posthuman* [54]
6	Indicator for acid-base titrations activity	Methanolic flower extract	Good activity in strong acid against strong base, strong acid against a weak base, weak acid against strong base and weak acid against weak base titrations [55]
7	Docking studies for finding out a new compound like Nutlin (MDM-p53 inhibitor)	Methanolic extract	Five compounds (isopteropodine, rumberine, palmirine, maruquine and alkaloid A) hypothesized to have the potency to inhibit MDM2 protein [56]
8	Stabilizing and reducing agent	Plant extract	Reducing and stabilizing agent for formulation of Ag-Au nanoparticles at a concentration of 2% w/v and proved to be a fast reducing agent [57]
9	Antipyretic activity (Brewer's yeast induced hyperpyrexia)	Ethanolic leaf extract	The reduction in temperature from 38.2 ± 0.4 to 36.0 ± 0.3 after 120 min of the administration of 200 mg/kg [48]
10	Antiviral activity (VHS- 1and VHS-2 cells)	Plant extracts	No significant anti-herpetic activity [46]
11	Wound healing activity Double incision wound healing model	Ethanolic extract of aerial parts	Breaking strength of wounds increased [58]
12	Myometrium relaxant activity KCl-induced contraction in rat myometrium	Five different samples collected from Mexico	Positive responses probably because of presence of oxindole alkaloids [23]

CONCLUSION: *Hamelia patens* are rich in bioactive constituents which might be responsible for its various pharmacological activities. Various extracts of leaves, flowers, stems and roots of the plant as well as the major constituents isolated have shown potent activities.

Further, research is needed to identify and isolate bioactive ingredients that would be beneficial in various diseases and may reduce dependence on synthetic drugs.

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CONFLICTS OF INTEREST: Nil

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