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Chemical characterization and therapeutics of *Dalbergia latifolia* Roxb: A review

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Abstract

Dalbergia latifolia Roxb. is recognized as a medicinally important tree of Indian forest flora providing diverse source of phytochemicals having huge potential in Ayurveda and other materia medica. *D. latifolia* is rich in alkaloids, carbohydrates, glycosides, flavonoids, alkaloids, phenolic compounds and tannin. Biomolecules such as dalbergin, latifolin, (R)-dalbergione, dalbinol, dalbin, latinone and dalcridain were reported profoundly from *D. latifolia* wood. It is a rich source of triterpenoids, benzofuran, neoflavonoids and rotenoids. Extracts from *D. latifolia* heartwood, leaves, seeds, bark and roots exhibited antimicrobial, antioxidant, anthelmintic, anticancer, antimutagenic, anti-termite, anti-obesity, cerebroprotective etc. activities. Current article provides an inclusive account on phytochemical diversity and the range of pharmacological activities of *D. latifolia*.

Keywords: biomolecules, *Dalbergia latifolia*, medicinal plant, phytochemistry, therapeutics

Introduction

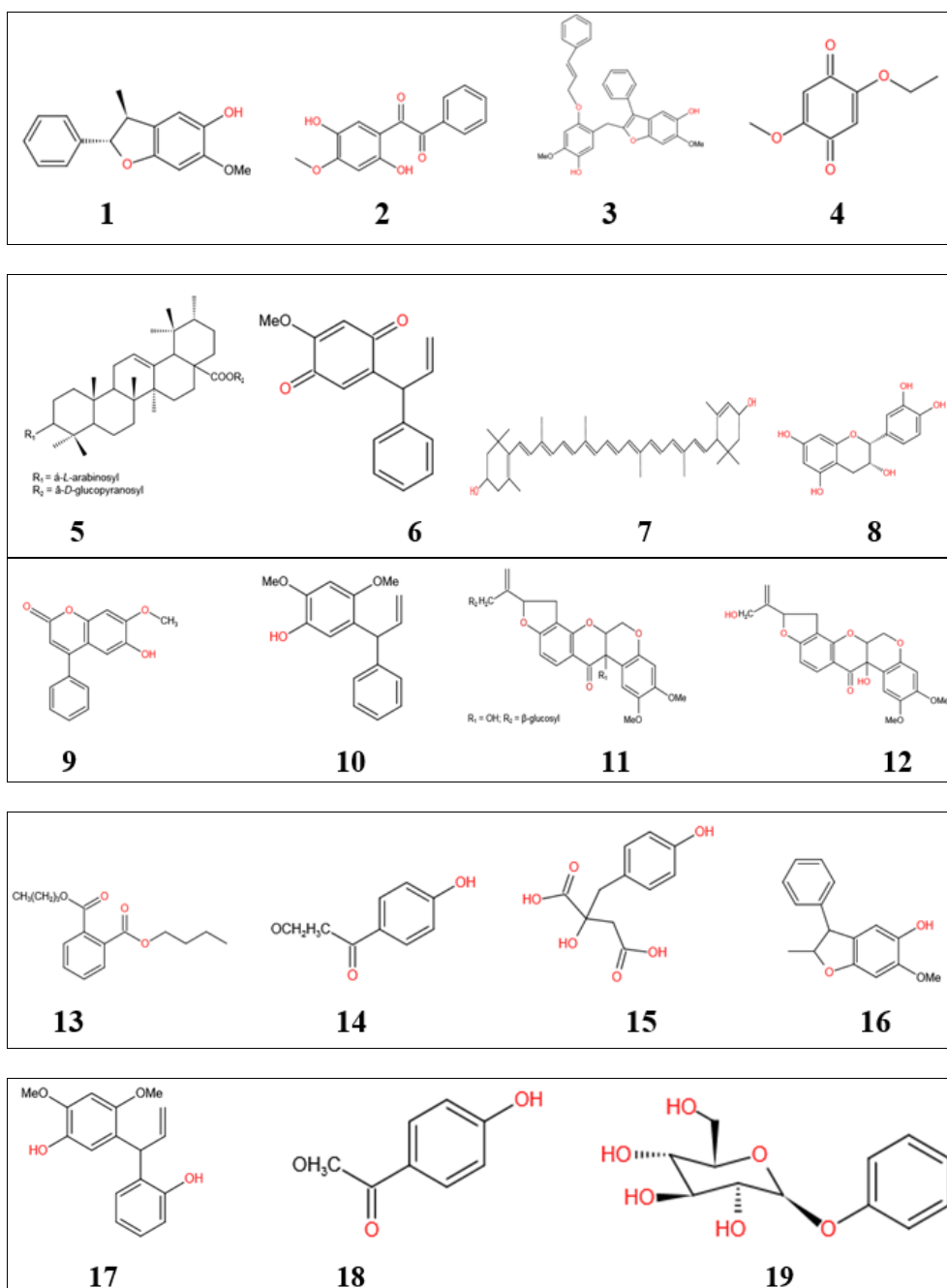
Worldwide genus *Dalbergia* is represented by 300 species of which 25 species including *Dalbergia latifolia* were reported in India [1]. *Dalbergia latifolia* Roxb. belongs to subfamily Papilionoideae of family Fabaceae. It is commonly known as Bombay Blackwood or Indian rosewood [2, 3]. *D. latifolia* has a reputation of an important timber tree species and mostly wood is used for decorative, furniture and cabinet work purposes. In India, it is widely distributed and stretches from Western Ghat areas of Tamil Nadu and Kerala [4]. Oil extracted from firing heart wood of *D. latifolia* is used as remedy for skin diseases [5]. Whole plant and bark is used to treat body pain, leprosy, dyspepsia, diarrhoea and obesity; additionally, plant is adapted as bitter tonic, anthelmintic and stomachic [6, 7]. Present comprehensive review provides insights about phytoconstituents diversity and pharmacological activities of *D. latifolia*.

Phytochemical diversity

Preliminary phytochemical analysis of *Dalbergia latifolia* leaves methanolic extract confirms presence of alkaloids, glycosides, phenol, resins and tannin [8]. In another report resins, terpenoids, carbohydrates, tannin and steroids were also reported from methanol extract of leaves [9]. Ethanol extract of *D. latifolia* root identified carbohydrates, glycosides, flavonoids, alkaloids, phenolic compounds and tannin [10, 11]. From methanolic extract of leaves flavonoid, terpenoids, sterols, glycosides, phenol and tannins were identified [12]. Successive extract of *D. latifolia* bark reported presence of steroids, phenolic compounds, tannins, flavonoids and triterpenes [13]. Aqueous and alcoholic extract of bark tested positive for carbohydrate, glycoside, protein and flavonoid [14, 1]. Hydro-alcoholic extract of bark confirmed flavonoids, steroids, triterpenes, phenolic compounds and tannins [15]. Latifolin was successfully extracted from *D. latifolia* heartwood using light petroleum [16]. *O*-dimethyl Latifolin was derived from light petroleum extract of *D. latifolia* heartwood [2]. Compound (R)-dalbergione was extracted from heartwood [17]. Latifolin, (R)-dalbergione, 2,4,6-trimethoxyacetophenone, β -sitosterol and dalbergin was successfully isolated from *D. latifolia* [18]. β -sitosterol and lupeol were reported from bark and softwood of *D. latifolia* [19]. Dalbinol, a new rotenoid, was isolated from seeds of *D. latifolia* [20]. Further, Dalbin was isolated from ethanol extract of seeds and chemical analysis revealed it as new rotenoid glycoside [21]. A phenanthrene-1,4-quinone named as Latinone was successfully isolated from *D. latifolia* heartwood [22]. From *D. latifolia* heartwood Dalcridain was extracted which confirmed as the first binary neoflavonoid [23]. Ethanolic extract of *D. latifolia* bark found rich in phenolics compared to flavonoids [1].

Phytoconstituents like latifolin, dalbergiphenol and 4-methoxydalbergione were identified from *D. latifolia* heartwood [24]. Ether soluble fraction of heartwood yielded latifolin and neoflavonoid [25]. Along with known phthalic acid butyl isobutyl ester, dibutyl phthalate, methyl-4-hydroxybenzoate, ethyl-4-hydroxybenzoate, p-hydroxybenzaldehyde, eucomic acid, 2-ethoxy-5-methoxy-1,4-benzoquinone and phenyl β -D-glucopyranoside compounds, a novel diaryl 1, 2-diketone compound named as 1-(2,5-dihydroxy-4-methoxyphenyl)-2-phenylethane-1,2-dione was also isolated from hydro-alcoholic extract of *D. latifolia* heartwood [26]. Seven triterpenoids identified as, 3-O- α -L-arabinopyranosyl-28-O- β -D-glucopyranosyl pomolic acid, β -sitostenone, β -sitosterol, stigmasterol, β -amyrin acetate, β -amyrin-3-palmitate and 3-acetoxy-oleanoic acid was successfully isolated from hydro-ethanolic extract of heartwood [27]. Three benzofuran compound such as, newly identified 2-[5-hydroxy-4-methoxy-2-(3-p-phenyl-trans-allyloxy)benzyl]-5-hydroxy-6-methoxy-3-phenyl benzofuran along with (+)-obtusafuran and isoparvifuran were derived from hydro-ethanolic extract of heartwood [28]. Ten

neoflavonoids were recovered from hydro-ethanolic extract of *D. latifolia* heartwood [29]. GC-MS analysis of *D. latifolia* heartwood identified eight compounds viz, Phenol, 4-methyl-2-[5-(2-thienyl)pyrazol-3-yl]-, 13-Docosenamamide, (Z)-, Naphtho[2,3-b]furan-4,9-dione, 2-isopropyl-, 1-Thioflavone, 7-methoxy-, 1,7,7-Trimethyl-3-phenethylidenebicyclo[2.2.1]heptan-2-one, Phenol, 4,4'-methylenebis[2,6-dimethyl-, 1,1'-Biphenyl, 4,2',3',4'-tetramethoxy-5'-methyl-6-methylaminomethyl-, (4-Methylsulfanylphenyl) carbamic acid, 2,6-dimethoxyphenyl ester [30]. β -eudesmol, catechol, elemicin, formononetin, 2,6-dimethoxy-4-allylphenol and 7-hydroxy-3-(4-methoxyphenyl)-2H-chromen-2-one were the major components isolated from *D. latifolia* wood using GC-MS, Py-GC/MS and TD-GC/MS methods [31]. HPTLC analysis of methanolic extract of bark identified β -sitosterol [32]. Fractions 1 and 2 derived from *D. latifolia* wood showed highest content of total phenolics while fraction 7 and fraction 9 revealed the highest amount of total flavonoid. GC-MS analysis of fraction 1-3 confirmed R- (-) - latifolin from *D. latifolia* wood [33].



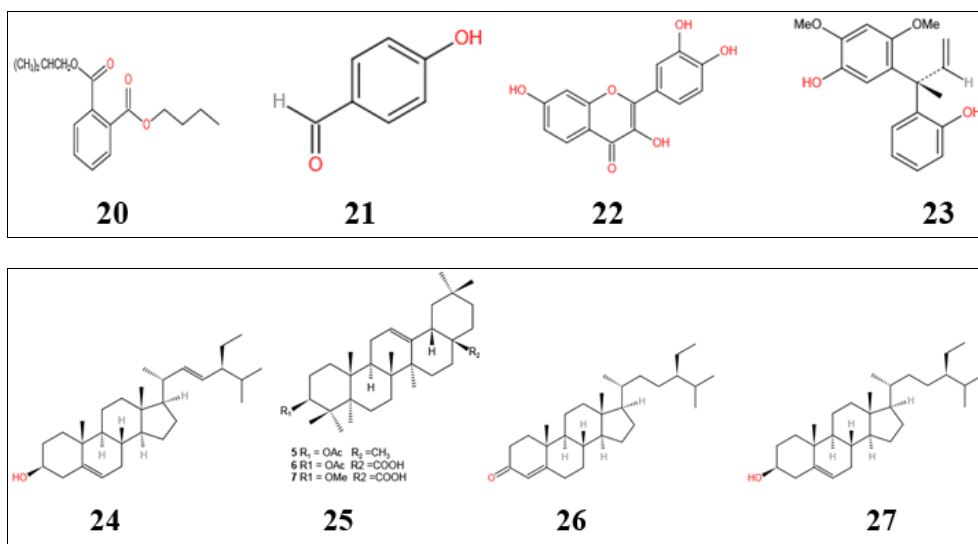


Fig 1: Structures of (+)-obtusafuran (1), 1-(2,5-dihydroxy-4-methoxyphenyl)-2-phenylethane-1,2-dione (2), 2,2-[5-hydroxy-4-methoxy-2-(3-phenyl-trans-allyloxy)benzyl]-5-hydroxy-6-methoxy-3-phenyl benzofuran (3), 2-ethoxy-5-methoxy-1,4-benzoquinone (4), 3-O- α -L-arabinopyranosyl-28-O- β -D-glucopyranosyl pomolic acid (5), 4-methoxydalbergione (6), all-E-lutein (7), catechin (8), dalbergin (9), dalbergiphenol (10), dalbin (11), dalbinol (12), dibutyl phthalate (13), ethyl-4-hydroxybenzoate (14), eucomic acid (15), isoparvifuran (16), latifolin (17), methyl-4-hydroxybenzoate (18), phenyl β -D-glucopyranoside (19), phthalic acid butyl isobutyl ester (20), *p*-hydroxybenzaldehyde (21), quercetin (22), R-(-)- latifolin (23), stigmasterol (24), β -amyirin acetate, β -amyirin-3-palmitate and 3-acetoxy-oleanoic acid (25) β -sitostenone (26), β -sitosterol (27), extracted from various parts of *Dalbergia latifolia* [26-28, 33-36, 20-21].

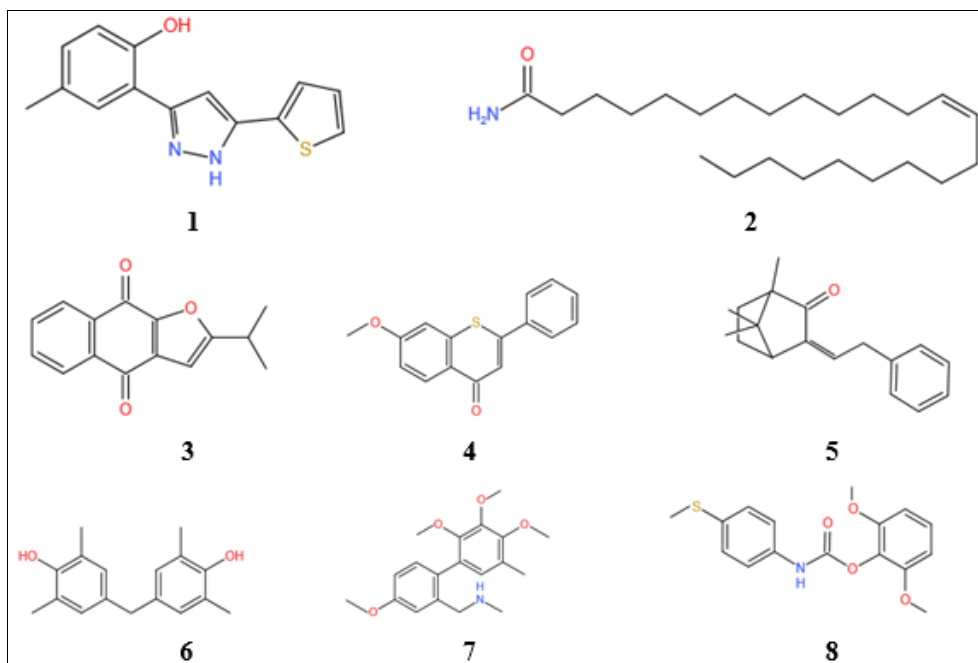


Fig 2: Structures of Phenol,4-methyl-2-[5-(2-thienyl)pyrazol-3-yl]- (1), 13-Docosamide, (Z)- (2) Naphtho[2,3-b]furan-4,9-dione, 2-isopropyl- (3), 1-Thioflavone,7-methoxy (4), 1,7,7-Trimethyl-3-phenethylidenebicyclo[2.2.1]heptan-2-one (5), Phenol,4,4'-methylenebis[2,6-dimethyl]- (6), 1,1'-Biphenyl,4,2',3',4',4'-tetramethoxy-5'-methyl-6-methylaminomethyl- (7), (4-Methylsulfanylphenyl) carbamic acid, 2,6-dimethoxyphenyl ester (8), identified from heartwood of *Dalbergia latifolia* using GC-MS [30].

Pharmacology

Antibacterial activity

Hydro-alcoholic extract of *D. latifolia* leaves revealed moderate inhibitory action against *E. coli* and *B. subtilis* with MIC of 250 μ g/ml respectively [37]. All MDR *Salmonella enterica* isolates were prone to methanolic extracts of leaves and observed MIC ranges 3.125 to 75 mg/mL. Combination of leaves extract and antibiotics revealed better synergetic effect compared to individuals [8]. Compound, 1-(2,5-dihydroxy-4-methoxyphenyl)-2-phenylethane-1,2-dione derived from *D. latifolia* heartwood revealed antibacterial action against *S. aureus* ATCC 6538 and *E. coli* ATCC21530 with MIC of 10 mg/mL respectively [26]. Methanol extract of

D. latifolia leaves reported moderate activity against all tested urinary tract infection causing bacteria except *Klebsiella pneumoniae* and least observed MIC and MBC were 3.41 and 4.27 mg/mL, respectively [9]. Amongst the ethanol, methanol, and chloroform extracts of *D. latifolia* roots, ethanol extract revealed the highest zone of inhibitions against *S. aureus*, *K. pneumoniae*, *E. coli* and *B. subtilis* compared to other examined extracts [10].

Antifungal activity

Ethanol extract of *D. latifolia* roots perform better than methanol and chloroform extracts against *C. albicans* with 12.3 \pm 0.8 mm zone of inhibition [10]. Latifolin isolated from

D. latifolia wood revealed most significant activity against *F. palustris* and *C. cladosporioides* compared to other derivatives of Latifolin [38]. Latifolin extracted from heartwood reported very high antifungal activity against *Trametes versicolor* compared to 4-methoxydalbergione and dalbergiphenol who revealed moderate action against *Trametes versicolor* and *Fomitopsis palustris*, *Rhizopus oryzae* and *Cladosporium cladosporioides* respectively [24].

Antioxidant efficacy

A study performed on Indonesian medicinal plants revealed that, ethanol extract of *D. latifolia* leaves exhibited poor antioxidant potential in DPPH assay with 2.6±1.9% of electron donating ability, whereas it performed better in reducing power assay with 273.2±1.0% of Fe³⁺ reduction [39]. Methanolic extract of *D. latifolia* wood showed highest DPPH scavenging activity with IC₅₀ value of 70±2.55 µg/ml [4]. Among the 12 fractions of *D. latifolia* wood, fraction 2 showed best DPPH scavenging activity (82.0 and 41.7%) at 500 and 250 µg/ml respectively with IC₅₀ of 303.3 µg/ml [33]. In DPPH, NO and Ferric thiocyanate scavenging activity assay, ethanolic extract of *D. latifolia* bark exhibited strong antioxidant activity with 92.10±1.10, 86.39±2.12 and 87.22±2.47% of inhibition respectively [14]. Methanol extract of leaves showed significant antioxidant activity against 5-FU-induced oxidative stress in albino rats [40]. Novel benzofuran (compound 1) from heartwood of *D. latifolia* exhibited average DPPH free radical scavenging activity with IC₅₀ = 96.7 ± 8.9 µM however, compound (+)-obtusafuran and isoparvifuran showed poor antioxidant potential with IC₅₀ = 951.4 ± 10.1 and 743.8 ± 12.7 µM, respectively compared to control [28]. Methanolic extract of leaves depicted weak free radical scavenging activity (IC₅₀ = 93.34 µg/ml) in DPPH assay [41]. Ethanolic extract of leaves reported dose dependent strong antioxidant activity in the DPPH method and highest 46.74% of free radical scavenging activity was recorded against 300 µg/ml concentration of extract [42].

Anti-hyperglycemic effect

Methanolic extract of *D. latifolia* leaves revealed strong α-Glycosidase inhibitory potential with IC₅₀ = 0.947 mg/ml [41].

Anti-obesity activity

High-fat diet induced obese rats on treatment with 200 and 400 mg/kg dose of hydro-ethanolic extract of *D. latifolia* bark revealed dose dependent significant changes in weight gain mechanism, lipid profile, biochemical parameters and histopathology observations [32].

Anticancer activity

In MTT assay, methanol fraction of hydro alcoholic extract of *D. latifolia* demonstrate potent anticancer activity against L6, EAC, MCF 7, HEP G2 and HeLa cell lines and most lethal activity was reported against MCF 7 cell lines with IC₅₀ = 30 µg/ml [43].

Cerebroprotective effect

Pre-treatment of rats with methanolic extract of *D. latifolia* bark at a dose of 500 mg/kg p.o. for seven days revealed significant increase in superoxide dismutase and catalase in cerebral region, on the contrary significant drop down in malondialdehyde and myeloperoxidase levels was observed. Histopathological analysis depicts lenient vacuolation, relatively lower congestion and least degeneration neuronal portion [44].

Cytotoxic activity

Against MCF10A ATCC cells, methanol extract of *D. latifolia* wood showed potent cytotoxic activity with IC₅₀ value of 20 µg/ml [4].

Inhibitor activity on nitric oxide production

D. latifolia leaves extract at 50 µg/ml concentration revealed 122.9±14.6% inhibition of nitric oxide production and 79.2±0.5% cell viability of RAW264.7 macrophages [39].

Dermatitis action

Sawdust of *D. latifolia* was found to triggered dermatitis in some individuals when they come in close contact [45]. Wearing *D. latifolia* wood earrings and a necklace generated eruptions on ears and neck [46].

Cardio-protective activity

Methanol extract of *D. latifolia* leaves revealed cardio protective capacity against 5-FU-generated cardiotoxicity in albino rats. Extracts at 250 and 500 mg/kg dose revealed dose dependent activity with decreased TC, TG, LDL and increased HDL levels; however 500 mg/kg provide substantial cardio protection as compared to lower dose [40].

Nephroprotective effect

In gentamicin induced nephrotoxic rats, oral application of *D. latifolia* leaves methanolic extract for ten days exhibited nephroprotective potential by declining enhanced serum and urinary components. It also normalised oxidative stress related biomarkers and histopathologically showed reduced tubular nephrosis [12].

Antimutagenic effect

Orally pre-treated rats with methanolic extract of *D. latifolia* leaves at 100, 200 mg/kg body weight shielded against cyclophosphamide induced mutagenic effect in micronucleus and chromosomal aberration tests [13]. Rats treated with cyclophosphamide revealed an increase in percentage of micronucleus polychromatic erythrocytes and normochromatic erythrocytes formation. Oral treatment of mice with methanolic extract of *D. latifolia* roots (200, 100 mg/kg; po/day/7days) revealed decrease in both [47].

Lysenin-induced hemolysis inhibitory action

All-*E*-lutein protein isolated from methanol extract of *D. latifolia* leaves revealed significant inhibitory potential against lysenin induced hemolysis at 0.025–2.5 ng/mL concentration with no sign of any toxicity [35].

Nootropic activity

D. latifolia roots ethanolic extract revealed dose related decline in transfer latency there by reflecting significant enhancement in learning and memory of rats [11].

Neuropharmacological activity

Ethanol extracts of *D. latifolia* roots showed dose dependent reduction in locomotor activity and anxiolytic property [11].

Antitermite activity

Latifolin derivatives such as 2'-*O*-methyl latifolin, latifolin dimethyl ether and latifolin diacetate exhibited doubled insecticidal activity as compared to latifolin against *R. speratus* and mass loss due to 5-*O*-methylatfolin, latifolin dimethyl ether and latifolin diacetate was three time higher than latifolin [38]. Latifolin derived from *D. latifolia*

heartwood exhibited comparatively high termiticidal, termite-antifeedant action against *Trametes versicolor*; moderate termite-antifeedant activity was reported by dalbergiphenol and 4-Methoxy dalbergione against *Fomitopsis palustris*, *Rhizopus oryzae*, *Cladosporium cladosporioides* and *Trametes versicolor* respectively [24]. *n*-hexane and ether soluble fractions of *D. latifolia* heartwood depicted substantial toxicity against *R. speratus* in antifeedant bioassay test [25].

Anthelmintic activity

Ethanol extract of *D. latifolia* leaves demonstrated dose dependent anthelmintic activity against *Endrullus eugeniae*. At 200 mg/ml concentration, extract reported least time taken for paralysis and death (9±0.6 and 27±0.2 min respectively) [42].

Immunomodulatory activity

In rats, cyclophosphamide induced immunosuppression was overcome by hydro-ethanolic extract of *D. latifolia* bark resulting in elevated total WBC count, RBC, % Hb, and % neutrophils adhesion [15].

Conclusions

D. latifolia is one of the important trees for Indian timber industry. Extracts derived from various parts of *D. latifolia* demonstrated inhibitory action against a wide range of microbes revealing its importance in this part of the world where most communities are still relying on plant based medicines. Wide ranges of biomolecules were extracted from this plant revealing antibacterial, antifungal, antioxidant, antitermite, activities. This review highlighted phytoconstituents and pharmacological activities of *D. latifolia* as a potential plant for plant based therapies.

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Conflict of interest

The authors declare no conflict of interests in publication of this article.

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