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Review Article

# Ethnobotanical uses, phytochemistry and biological activities of *Clerodendrum paniculatum* L. (Lamiaceae): A comprehensive review

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### ABSTRACT

*Clerodendrum* L. is an important genus in the family Lamiaceae in terms of its medicinal values and pharmacological properties. The genus comprises of more than 500 species distributed worldwide. In this review, we present an updated information on ethnobotanical uses, phytochemistry and biological activities of *Clerodendrum paniculatum* L. (Lamiaceae). The plant is one of the most spectacular *Clerodendrum* species and is grown commonly for ornamental purpose. The plant is reported to have ethnomedicinal importance as the plant is used as remedy for ailments and disorders such as wounds, typhoid, snakebite, jaundice, giddiness, malaria, anemia and hemorrhoids. Various phytochemicals such as rutin, quercetin,  $\beta$ -sitosterol,  $\beta$ -amyrin, lupeol, oleanolic aldehyde acetate, stigmasta-4,25-dien-3-one, and (3 $\beta$ )-stigmasta-4,22,25-trien-3-ol have been identified in *C. paniculatum*. The plant is shown to exhibit biological activities such as antimicrobial, antioxidant, anthelmintic, anti-inflammatory, antimutagenic, cytotoxic, hypolipidemic, insecticidal and anti-ageing activity.

**Keywords:** *Clerodendrum paniculatum* L., Ethnobotanical, Traditional, Phytochemicals, Biological activities

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## 1. INTRODUCTION

Since ancient time human beings depend on plants for meeting various daily needs such as food, medicine and for construction and other purposes. Plants are considered as an integral part of daily life. An estimate highlights that around 80% of individuals in developing countries rely on plant based medicines for their primary healthcare. Plant based medicines are gaining much importance nowadays because of some drawbacks that are associated with the use of modern medicines. Indigenous systems of medicines widely employ plants as a remedy for dreadful ailments.<sup>1-5</sup> The genus *Clerodendrum* L., belonging to the family Lamiaceae (previously placed in Verbenaceae, now included correctly in Lamiaceae based on phylogenetic data),

comprises of several species (>500) that occurs in tropical and subtropical regions worldwide. Several species of the genus are known to have medicinal values and widely used in different parts of the world.<sup>6-10</sup> The study of Melapu *et al.*<sup>9</sup> showed a significant correlation between phylogeny, chemical diversity and biological activities of the genus *Clerodendrum* L.

*Clerodendrum paniculatum* L. (Kingdom: Plantae; Order: Lamiales; Family: Lamiaceae) is a shrub and is commonly known as pagoda flower. The species was first described by Swedish botanist Linnaeus. The species epithet is because of the large 'paniculate' clusters of flowers. It is often cultivated in garden as ornamental plant due its showy orange red to scarlet colored flowers in terminal panicles. The plant is

distributed in countries such as India, Sri Lanka, Malaysia, Australia, China, Taiwan, Laos, Cambodia, Vietnam, Indonesia, Bangladesh and many other Asian countries. It is known as Rathapushpa or Ratha hoo in Kannada.<sup>9,11,12</sup> The flowers are often visited by butterflies and the pollination process is mainly through butterflies. The plant is reported to have traditional medicinal values and is shown to exhibit a range of biological activities.<sup>8,13-16</sup> In the present review, we present an updated information on the ethnomedicinal uses, phytochemistry and biological activities of *C. paniculatum* by an intensive literature survey carried out by referring standard flora, journals and online search engines viz. PubMed, ScienceDirect and Google Scholar.

## 2. PLANT DESCRIPTION

*C. paniculatum* is an erect, semi-woody shrub reaching a height of 1-2m (Figure 1). Leaves are simple, large, opposite, up to 30cm in diameter. Leaves are membranous, cordate-ovate, 3-7 lobed (lobes shallow), margins minutely denticulate, glandular beneath and petiole is up to 30cm long with acuminate apex. Flowers are in large terminal panicles. Calyx is red to orange-red in color and divided nearly to the base. Corolla are orange-red to scarlet with slender tube which is up to 2cm long and the lobes are approximately 7mm long. Flowering occurs more or less throughout year. Fruit is a drupe, globose, bluish-black in color and approximately 1cm across.<sup>12,17,18</sup>



Figure 1: *Clerodendrum paniculatum* L.

## 3. ETHNOMEDICINAL USES OF *C. PANICULATUM*

Various species of the genus *Clerodendrum* have been widely used ethnobotanically as ornamental plants as well as for treating several diseases and disorders.<sup>14,19-23</sup> The plant *C. paniculatum* is reported to have some ethnobotanical uses as ornamental as well as medicinal plant in some parts of the world. The plant is used traditionally in countries such as India, China and Japan for treating rheumatism, ulcer, neuralgia, inflammation, and wounds. It is used as anti-inflammatory and

antipyretic drug in traditional Thai medicine.<sup>24</sup> *C. paniculatum* is classified as ornamental species in Lao PDR. The plant is also reported as medicinal.<sup>23</sup> In Lombok, Indonesia, the plant is used to treat sore eyes.<sup>25</sup> *C. paniculatum* is commonly used in herbal bath preparation by Yunnanese group in Thailand.<sup>2</sup> The Nicobarese of Nancowry group of Islands in Andaman and Nicobar uses the plant traditionally for treating wounds, jaundice, body ache, snake bite and giddiness.<sup>14</sup> More detail on ethnomedicinal uses of *C. paniculatum* is presented in Table 1.

Table 1: Ethnomedicinal uses of *C. paniculatum*

Geographical area	Part	Use	Reference
Cherpu block, Kerala, India	Leaves	Treatment of wounds	Vijayan and Gopakumar <sup>26</sup>
Dhalai district, Tripura, India	Roots	Treatment of typhoid	Shil and Choudhury <sup>27</sup>
Ri-Bhoi district, Meghalaya, India	Leaves	Treatment of anemia, liver complaints and for purification of blood	Sen <i>et al.</i> <sup>28</sup>
Northern Thailand	Flowers and leaves	Treatment of hemorrhoids	Khuankaew <i>et al.</i> <sup>4</sup>
Southern Nigeria	Leaves and roots	Treatment of malaria	Iyamah and Idu <sup>15</sup>

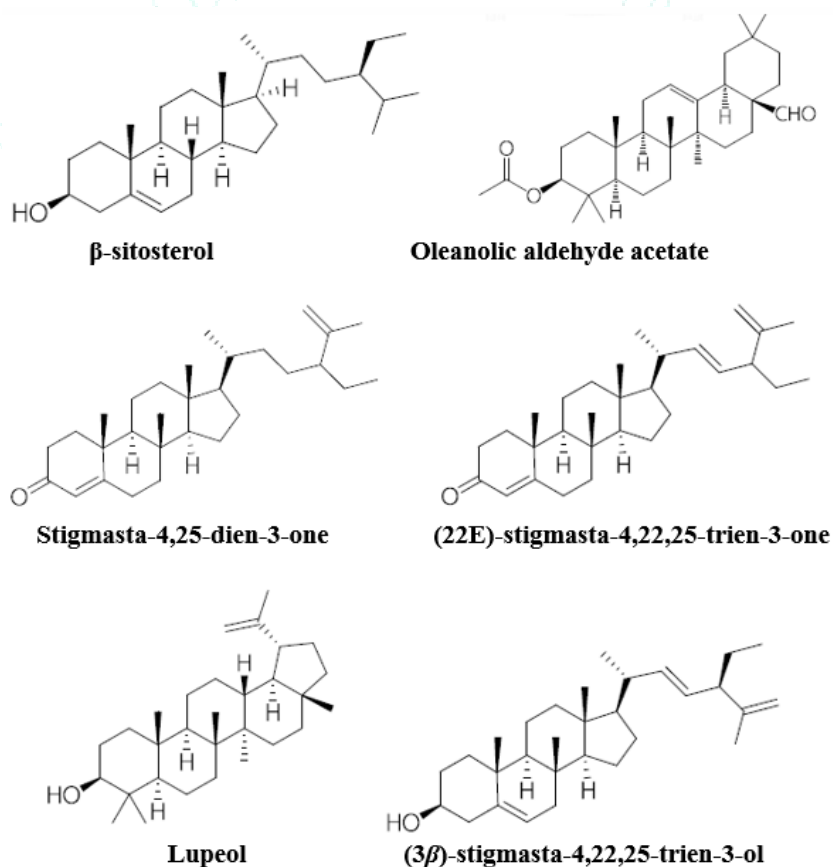
#### 4. PHYTOCHEMISTRY OF *C. PANICULATUM*

Members of *Clerodendrum* L. are shown to contain myriad of phytochemicals and over 280 phytochemicals have been described from different *Clerodendrum* species.<sup>6,10,29,30</sup> Standard phytochemical tests, chromatographic and spectral methods have been used to identify phytochemicals in *C. paniculatum*. Chemicals viz. (24s)ethylcholesta-5,22,25-triene-3 $\beta$ -ol,  $\beta$ -amyrin and  $\beta$ -sitosterol were obtained from the roots of *C. paniculatum*.<sup>31</sup> Phytoconstituents viz.

alkaloids, coumarins, flavonoids, glycosides, phenols, phytosterols, saponins, terpenoids have been detected in the leaves of *C. paniculatum* by standard phytochemical tests.<sup>7</sup> The presence of terpenes, flavonoids, tannins, alkaloids, phenolic acid, sterols, and glycosides in the leaf extract was detected in a study by Joseph *et al.*<sup>32</sup> More information on the phytochemicals in *C. paniculatum* is presented in Table 2. Figure 2 shows the structures of some compounds that have been identified in *C. paniculatum*.

**Table 2: Phytochemicals in *C. paniculatum* L.**

Part	Phytochemical	Reference
Leaves	Poriferasta-5.22E.25-trien-3 $\beta$ -ol	Musa <i>et al.</i> <sup>33</sup>
Root	Quercetin	Leena and Aleykutty <sup>34</sup>
Root	$\beta$ -sitosterol; lupeol; oleanolic aldehyde acetate; (22E)-stigmasta-4,22,25-trien-3-one; stigmasta-4,25-dien-3-one; and (3 $\beta$ )-stigmasta-4,22,25-trien-3-ol	Phontree <i>et al.</i> <sup>13</sup>
Leaves	Tannins, phenols, sterols	Praveen <i>et al.</i> <sup>35</sup>
Root	Phenolic compounds, flavonoids, saponins, tannins	Leena <i>et al.</i> <sup>36</sup>
Leaves	Rutin and quercetin	Krishnan <i>et al.</i> <sup>37</sup>



**Figure 2: Some compounds identified in *C. paniculatum*<sup>38</sup>**

#### 5. BIOLOGICAL ACTIVITIES OF *C. PANICULATUM*

*Clerodendrum* species are versatile with respect to biological or pharmacological activities they display. It is shown from several studies that crude extracts and

purified compounds from *Clerodendrum* species exhibit a range of biological activities.<sup>10,24,38,39,40</sup> A number of studies, which were carried out on *C. paniculatum*, highlighted its potential to exhibit a range of biological activities such as antimicrobial, antioxidant, insecticidal, hypolipidemic, anti-inflammatory, anthelmintic,

antimutagenic, cytotoxic and anti-ageing activities. A brief description on the biological activities of *C. paniculatum* is presented below.

#### Antioxidant activity

Hafiz *et al.*<sup>41</sup> investigated scavenging of DPPH radicals by ethanolic extract obtained from leaves of *C. paniculatum*. The extract revealed concentration dependent scavenging of radicals with an IC<sub>50</sub> value of 27.73 µg/ml. John *et al.*<sup>42</sup> revealed the potential of ethanolic extract of roots of *C. paniculatum* to exhibit antioxidant activity by DPPH and ABTS radical scavenging assays. Arun *et al.*<sup>43</sup> revealed the antioxidant potential of methanolic extract of leaf and root of *C. paniculatum* as evaluated by DPPH radical, hydroxyl radical and superoxide radical scavenging assays and reducing power assay. Krishnan *et al.*<sup>37</sup> revealed potent antioxidant activity of aqueous and methanolic extract of *C. paniculatum* as evaluated by reducing power assay.

#### In vitro anti-inflammatory activity

Different solvent extracts of *C. paniculatum* leaves were tested for in vitro anti-inflammatory potential by human red blood cell membrane stabilization method. Solvent extracts showed concentration dependent activity with marked activity being exhibited by petroleum ether and chloroform extracts.<sup>32</sup> The ethanolic extract of *C. paniculatum* root was screened for in vitro anti-inflammatory activity on the basis of evaluation of nitric oxide, tumor necrosis factor (TNF- $\alpha$ ) and prostaglandin E2 in murine macrophage J774A.1 cells stimulated by lipopolysaccharide. The root extract was shown to significantly inhibit LPS induced nitric oxide, TNF- $\alpha$  and prostaglandin E2 production in macrophage cells.<sup>24</sup>

#### In vivo anti-inflammatory activity

Hafiz *et al.*<sup>41</sup> studied anti-inflammatory potential of ethanolic extract obtained from leaves of *C. paniculatum* by paw edema and granuloma cotton pellet method in rats. In both the assays, the leaf extract showed concentration dependent activity. A significant anti-inflammatory activity was observed at dose 50mg/kg body weight. The study by Joseph *et al.*<sup>32</sup> also revealed anti-inflammatory activity of petroleum ether and chloroform extracts of *C. paniculatum* leaves as evaluated by carrageenan induced paw edema model in male Wistar rats.

#### Anthelmintic activity

Praveen *et al.*<sup>44</sup> evaluated anthelmintic activity of various solvent extracts of *C. paniculatum* leaves in terms of time taken for paralysis and death of the earthworm *Eudrilus Eugenia*. Methanol extract showed significant activity as it took less time to cause paralysis and death of worms. Aqueous extract was not active while chloroform and ethyl acetate extracts revealed less anthelmintic activity.

#### Mutagenic and antimutagenic activity

Ethanolic extract of *C. paniculatum* root was investigated for mutagenic and antimutagenic activity by Ames test using *Salmonella typhimurium* strain

TA98 and *S. typhimurium* strain TA100. The extract was not mutagenic. Besides, the extract was shown to inhibit mutagenicity of nitrite treated 1-aminopyrene on both strains of *S. typhimurium*.<sup>24</sup>

#### Cytotoxic/anticancer activity

Anticancer activity of ethanolic extract of *C. paniculatum* roots was assessed using tumor model in mice. The administration of extract in animals, although increased the mean survival time and reduced the tumor volume, the anticancer effect observed was not significant when compared to cisplatin.<sup>42</sup> Compounds viz. Oleanolic aldehyde acetate and (3 $\beta$ )-stigmasta-4,22,25-trien-3-ol isolated from the dichloromethane extract of root showed cytotoxic activity against the KB cell line with an IC<sub>50</sub> value of 9.58 µg/mL and 13.14 µg/mL, respectively.<sup>13</sup> Oleanolic aldehyde acetate and (3 $\beta$ )-stigmasta-4,22,25-trien-3-ol also exhibited cytotoxicity against HeLa cells with IC<sub>50</sub> values of 31.43 µg/mL and 28.52 µg/mL, respectively.<sup>38</sup> The study of Praveen *et al.*<sup>35</sup> revealed dose dependent cytotoxic effect of solvent extracts of *C. paniculatum* leaves in terms of mortality of brine shrimp larvae. Petroleum ether extract showed potent activity than methanol extract. The study carried out by John *et al.*<sup>45</sup> showed a dose dependent in vitro cytotoxicity of various solvent extracts of *C. paniculatum* against cell lines viz. HeLa, HepG2, and MCF7 as evaluated by trypan blue exclusion test, MTT assay and SRB assay. Sundaraganapathy and Leena<sup>46</sup> showed anticancer activity of ethanolic extract of root of *C. paniculatum* and phytosome formulated from root extracts against DLA induced tumor in Swiss albino mice. Administration of root extract and phytosome resulted in reduction in tumor volume and tumor weight, an increase in mean survival time and restoration of haematological parameters indicating anticancer potential.

#### Anti-ageing activity

The potential of polyherbal based cream formulations containing *C. paniculatum* leaf extract to reveal skin anti-ageing benefits was investigated by Krishnan *et al.*<sup>47</sup> The formulation was cytotoxic to least extent and caused an increase in the collagen content in human dermal fibroblast indicating skin anti-ageing property. The formulation was also found to upregulate Collagen-I gene expression. Krishnan *et al.*<sup>37</sup> also revealed anti-ageing activity of methanol and aqueous extract of *C. paniculatum* leaves in human dermal fibroblast.

#### Antimicrobial activity

Various solvent extracts of leaves of *C. paniculatum* were tested for antibacterial activity against gram negative bacteria viz. *Escherichia coli*, *Salmonella newport* and *Vibrio parahemolyticus* by agar well diffusion assay. All extracts were effective in inhibiting *V. parahemolyticus* whereas petroleum ether and chloroform extracts were ineffective against *E. coli* and *S. newport*.<sup>48</sup> Methanol extract of *C. paniculatum* was shown to cause inhibitory activity against antibiotic resistant strains of *Escherichia coli* and *Klebsiella pneumoniae*. Among bacteria, *E. coli* was inhibited to

slightly higher extent when compared to *K. pneumoniae*.<sup>49</sup> Abdullah *et al.*<sup>50</sup> screened methanol extract of leaves, flowers and stem of *C. paniculatum* against *Bacillus subtilis* and *E. coli* by disc diffusion method. The extracts were effective against *B. subtilis* while no inhibitory activity of extracts was observed against *E. coli*. Among extracts, leaf extract showed slightly higher inhibition of *B. subtilis*. The study by Praveen *et al.*<sup>35</sup> revealed the potential of chloroform and methanol extract of leaves of *C. paniculatum* to inhibit *Candida albicans*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Leena and Aleykutty<sup>51</sup> revealed dose dependent antibacterial activity of ethanol extract of *C. paniculatum* root against *B. subtilis*, *E. coli*, *K. pneumoniae* and *S. aureus*. The study of Othman *et al.*<sup>52</sup> revealed slight inhibitory activity of hexane, ethyl acetate and ethanol extract of aerial parts of *C. paniculatum* against *Bacillus subtilis*.

### Hypolipidemic activity

Hypolipidemic activity of leaf extract of *C. paniculatum* was investigated by Selvin and Rakhi<sup>53</sup> in male Wistar rats fed with high fat diet. Administration of extract was shown to significantly decrease the level of lipid profile and lipoprotein levels. A significant increase in the HDL level and a decrease in body weight was observed in extract treated animals.

### Insecticidal activity

Crude ethanolic leaf extracts of various *Clerodendrum* species including *C. paniculatum* were screened for insecticidal activity against *Spodoptera litura* and *Helicoverpa armigera* by antifeedant assay, growth inhibitory assay and larval mortality assay. The extract exhibited dose dependent insecticidal activity, however,

the activity observed was moderate when compared to other *Clerodendrum* species.<sup>54</sup>

### Induction of systemic resistance in plant

In a study by Musa *et al.*<sup>33</sup> a compound identified as Poriferasta-5.22E.25-trien-3 $\beta$ -ol isolated from leaves of *C. paniculatum* was shown to be an inducer of systemic resistance in red chilli (*Capsicum annum* L) against infection caused by cucumber mosaic virus. The compound displayed an inhibitory activity of 82% at 300ppm.

## 6. CONCLUSIONS

*C. paniculatum* is one of the important species of the genus *Clerodendrum* L. distributed in many Asian countries. A detailed literature survey conducted in this study revealed the importance of *C. paniculatum* in terms of its medicinal and pharmacological potential. The details obtained from the ethnomedicinal and pharmacological activities can be helpful in the development of newer and safer formulations containing the plant that can be effectively used in the treatment of several diseases and disorders. Further studies can be undertaken in order to isolate active principles from the plant and to determine their possible therapeutic potential.

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