

Review Article

**DEMYSTIFYING THE ETHNOMEDICINAL PLANT *MORINDA PUBESCENS* WITH ETHNOPHARMACOLOGICAL, PHYTOCHEMICAL, AND PHARMACOTOXICOLOGICAL EVIDENCE**

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**ABSTRACT**

Indian plants have been the predominant source of medicines throughout the vast majority of human history. For centuries, indigenous Indian cultures have used herbal medicine traditionally to treat a myriad of maladies. One of the most versatile and infrequent concerning its phytochemistry and pharmacology is *Morinda pubescens* (*M. pubescens*) plant discovered by J. E. Smith. Interest in this plant has been renewed in recent years, first from its identification as a chemopreventive agent for wound healing, cancers and subsequently from reports that it has phytochemicals contributing to antimicrobial, antioxidant, hepatoprotective and plant growth stimulatory effects. Although skepticism concerning its standardization, a growing body of *in vivo* evidence indicates that *M. pubescens* plant has protective effects in rodent models of stress and disease. In this comprehensive review, the ethnomineral reports on the *M. pubescens* plant demystified with both *in vitro* and *in vivo* shreds of evidence which would be further tempting to reveal the book buried facts of this traditional medicine through modern scientific approach. In the knowledge of our literature survey, this is the first review to be done on the *M. pubescens* plant from overall Tamil Nadu.

**Keywords:** *Morinda pubescens*, Traditional use, Phytochemistry, Therapeutic values, Ethnomineral plant

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**INTRODUCTION**

*Morinda pubescens* (*M. pubescens*) plant discovered by J. E. Smith is a Rubiaceae species, with extensive distribution in Southern Asia: it displays a full repartition in westwards to eastern slopes of Ghats and predominates the arid regions of Southern Deccan and Southern Travancore. According to the plantlist. org, *Morinda pubescens* is the unresolved name to refer to this plant which later accepted as a synonym of *Morinda coriea* Buch Ham. The other scientific names such as *Morinda tinctoria* (Roxb), *Morinda tomentosa* (Roxb) relegated to synonymy [1]. Commonly, the plant is described under many different names including the Morinda tree, Brime stone tree or wild ach root [2-4].

Traditionally, all parts of the plant especially the leaves and root, are widely used by indigenous people for medicating a full spectrum of ailments and diseases ranging from the topical application to heal wounds, inflammation, gout and stomach pains to oral administration for diabetes, malaria, fever, rheumatism and infectious diseases. Several *in vitro* and *in vivo* studies provided diverse evidence supporting most of the traditional therapeutic claims of *M. pubescens*. Bioassay-guided phytochemical screening of *M. pubescens* extracts led to the identification of affluence of bioactive principles such as flavonoids, alkaloids, phenolic acids with noteworthy therapeutic implications. However, besides extensive use in folk medicine, there are numerous other possible applications of *M. pubescens*, the most investigated being as green manure and green dye adsorbent.

With the upward popularity of *M. pubescens*, there are significant concerns about its efficacy, toxicity, and allergenicity. Therefore, a comprehensive review of the current understanding of this plant is needed to provide a source of information for anyone potentially interested in, but also to pinpoint research gaps for future investigation. To this end, we systematically retrieved and critically summarized the extant literature on the pharmacotoxicology of *M. pubescens* and its relationship with local/traditional use and phytochemistry. The botanical characterization of *M. pubescens* performed as well.

**Morphological features**

*M. pubescens* can be gaudily depicted as a flowering shrub-like species, growing up to over 6-10 cm high. The flowers are white, and

several together united at the base into a small head. The head (capitulum) is 3.5 cm long and appearing leaf-opposed or subtended by reduced leaf. The capitulum bears white corolla (15 mm), short-limbed calyx, oblong lobes and anthers (6-8 mm and 5 mm), and stigma two-lobed with styles (18 mm). Flowering occurred in March, and each mature stem can bear several flowers. *M. pubescens* leaves (6-20 cm) can be described as elliptic to linear-lanceolate or obovate, petiolate (2.5 cm) and alternately to oppositely arranged. The plant has branchlets often with a characteristic thin pallid to yellowish bark: it is usually glabrous above and pale in the inferior part possessing fissured thick bark. Drupes are coalescent into ovoid fleshy head possessing oblong seeds, stony pyrenes, and oblong seeds. Young fruits occur in April with green color and mature in June with black [5-8].

**Ecogeographical features**

Geographically the *M. pubescens* distribution extends from Southern Deccan and Carnatic to Southern Travancore in dry forests whereas wet wards to eastern slopes of Ghats at lows levels [5]. Reportedly, the plant is native to Southern Asia and then spread to other parts of Asia such as Srilanka, the Malay Archipelago, and the drought-prone area of Osmanabad, Andaman, and the Nicobar Islands. As well as in Bandar ban, Chittagong and Dinajpur in Bangladesh [6, 9]. In the mainland of India, where it grows wild as a weed in roadsides, wastelands, crop fields, and homesteads along the coastal areas of Jhabua, Kerala, Karnataka, Pune, Maharashtra, and Tamil Nadu. Indeed it has also found to be cultivated in Boda hills, Eastern Ghats of Kolli hills for the medicinal purpose [8, 10].

**Ethnopharmacological relevance**

For centuries, indigenous Indian cultures have used herbal medicine traditionally to treat a myriad of maladies. One of the most vital and infrequent ancient book buried ethnomineral plant is *M. pubescens* [11, 12]. Ayurveda, Siddha, Unani, Tibbi, and Amchi are natural systems of medicine which have writings on the use of Morinda plant [13, 14]. Perhaps, there are reports that South Indian ancestors perceived the therapeutical values of *M. pubescens* and used in Siddha and Ayurveda medicinal systems [15]. Besides, as early as 1685, in Kerala, it has been long recognized as traditional medicine named, "Paphanah." Moreover, complex traditional formulations,

"Paphanadi tailam" and "Phaphanadi ghrtam" prepared from the plant used in the treatment of different ailments [5, 16]. It was traditionally used as folk medicine by tribes as astringent and for curing rheumatism, cholera, hypertension, diabetes, blood cleansing and treatment of renal toxicity symptoms [17-19]. Furthermore, the bark used in the treatment of eczema, fever, ulcers, and leaves for digestive disorders in children [20]. Root is bitter, styptic, constipating, anti-inflammatory, antibiotic, alexiteric and tonic for physical obstructions, renal dropsy, and ascites whereas leaves serve as the excellent fomentation for haemorrhoidal pains and piles [5, 21]. Indeed, reports also have shown the extract of its leaves, stems, and fruits used in the treatment of gastropathy, gastralgia, stomach ulcer, wounds, gout, inflammation, hernia, sarcocele, and

fever [22-24]. Stem bark decoction has been used orally by rural people of Kurnool District as well as Seshachalam hills located at Andhra Pradesh, locally named, Mulugu chettu and Togaru chettu to cure rheumatic diseases and jaundice [25, 26]. Leaf paste has been used by local people of Maharashtra and tribal people of Tirunelveli hills in southern India for healing wound among various medicinal plants [27, 28]. Besides, Siddha healers of Katpadi taluk in the Vellore district of Tamil Nadu prescribe leaf preparations such as Nuna tailam and Nuna kadugu for leucoderma [29]. Moreover, the leaf boiled in water and the decoction is administered to children for two days to cure dysentery by villagers around Gin gee hills of Villupuram District [30]. The traditional uses of *M. pubescens* have been summarized in table 1 as follows:

**Table 1: Traditional remedial values**

<i>M. pubescens</i> plant part	Mode of preparation	Therapeutic effect	References
Leaves	Infusion, Poulitice, Decoction, paste	Children's digestive disorder, haemorrhoidal pains, and piles, wound healing, dysentery, leucoderma	[20, 5, 27-30, 77]
Bark	NS	Eczema, fever, ulcers	[20]
Root	Infusion	Anti-inflammatory, visceral obstructions, renal dropsy and ascites	[5, 21]
Leaves stem and fruits	NS	Gastropathy, dyspepsia, diarrhea, stomach ulcer, wounds, gout, inflammation, hernia, sarcocele and fever	[22-24]
Stem bark	Decoction	Rheumatic diseases and jaundice	[25, 26]

NS: not specified

### Phytochemistry of *M. pubescens*

Chemical studies of *M. pubescens* leaves in different solvents have identified major active compounds, para-hydroxy quinine [31], octonyl glucopyranose, phytol, hexonyl glucopyranose, phytolacetate, artemol, linoleic acid, caproic acid, caprylic acid [32]. Along with stigmasteroid, ergosteroid, E-phytol, campesta-5-22-trien-3-ol, stigmasta-4-en-3-one, stigmasta-4-22-dien-3-one, sistosterol and alkaloid hyoscyamine [33]. As well as ursolic acid, taraxerol,  $\beta$  sitosterol and stigmasterol [34], morindone, tintomrone, damnacanthal, nor-damnacanthal, anthraquinones. Besides soranjidol, ibericin, rubiadin, D-mannitol, anthragallol-2 and 3-dimethyl ether [35-40]. Besides the leaves also have been reported to biologically reduce the silver ions into silver nanoparticles which serve as a capping material of plant extract [41]. Perhaps, plant parts such as aqueous extracts of mature leaves, stem, dried bark of stem, roots, flower petals, and fruits could biosynthesize zinc oxide nanoparticles from zinc nitrate hexahydrate ( $Zn(NO_3)_2 \cdot 6H_2O$ ) due to the presence of phytochemicals [42]. Indeed a recent study showed phytochemical, and HPTLC profile of *M. pubescens* bark extract in ethanol contains flavonoids [19]. Also, fatty acids observed in seed oil are palmitic acid, caproic acid, caprylic acid, myristic acid, palmitoleic acid, stearic acid, arachidic acid, behenic acid, oleic acid, linoleic acid [43]. Several phytochemical studies on *M. pubescens* fruits, leaves and stem extracts in different solvents have conducted. The secondary metabolites identified were alkaloids, flavonoids, steroids, terpenoids, anthraquinones, cardiac glycosides [44, 45]. In addition to them, coumarin, phenols, saponins, tannins, catechin, leucoanthocyanins, lignin and emodin [46, 9, 14, 47]. Furthermore screening led to the identification of bioactive compounds such as 2,6,6,9,2,6,6,9-octamethyl (8,8) tricyclic (5.4.0.0.)2,9) undecyl: 1,2-benzenedicarboxylic acid butyl 2-ethylhexyl ester: prosta-5,13-diene-i-oic acid, 9,11,15-tris(trimethylsilyl) oxy time: 1 7,9-di-ter-butyl-1-oxaspiro (4,5) deca-6,9-diene-2, 8-dione: distearyl sulfide: squalene: progesterone: 1-eicosanol: hydroxylamine O-decyl: cholesta-4,6-diene-3-ol (3-beta): 3,5-di-ter-butyl-4-hydroxybenzaldehyde: beta-carotene: 2,5-di-ter-butyl-1,4-benzoquinone [2]. Besides, fruit extract of *M. pubescens* found in Boda and Kollu Hills have been shown to possess high protein, carbohydrate, fiber contents, and low lipid and sugar content. Along with low juice recovery with acidic pH 3.8 acts as the preservative of fruit content [8]. *M. pubescens* aerial parts also contain trace elements including manganese, calcium, potassium, magnesium, phosphorous, zinc, copper and iron [48].

### Pharmacological evidence

Studies conducted on cell lines, microorganisms, and model animals of human diseases, showed a broad spectrum of bioactivities for different parts and varying extracts of *M. pubescens*. The antidiabetic, antioxidant,

anticancer, antimalarial and wound healing effects do stand out, but there is also a stunning array of other relevant biological effects. Below are critically summarized the main findings of the pharmacological activities of *M. pubescens* retrieved from the literature.

### Antimicrobial activity

Microbial diseases continued to be significant threats to the world regardless of efforts and progress in developing modern medicine [49, 50]. Currently, the ever-increasing threat from drug-resistant microbes calls for a global effort to search on novel solutions [51] which can also base on natural products from plants that are selected by documented ethnomedicinal use [53]. In this regard, recently many studies have been carried out with the aim of highlighting the capacity of many extracts of *M. pubescens* to prevent the growth of microbial strains due to the presence of active antimicrobial agents such as phenols, triterpenoids, and tannins.

Tyagi et al., (2015) showed the significant antibacterial effect of ethanol and chloroform extracts of *M. pubescens* bark against the selected microbial strains such as *S. aureus*, *B. cereus*, *E. coli*, *P. aeruginosa*. Indeed aqueous extract was ineffective against all tested microbes compared to the effect of reference standard ofloxacin [9]. Besides, the wood extract of *M. pubescens* used as a dye in fabric at pH 8, potentially inhibited *S. aureus* and *C. albicans* comparably no zone formation noticed in the cotton fabric without stain [53]. Moreover, acetone extract of *M. pubescens* fruit inhibited most of the salivary microflora samples with a maximum zone of inhibition when compared with definite standard chlorhexidine. The authors suggested the extract as a therapeutic remedy for the hard tissue diseases of the oral cavity in children [54]. On the contrary, other authors reported little or no inhibitory effect on micro foulers such as *Klebsiella sp.*, *Aeromonas sp.*, *Pseudomonas sp.*, *Bacillus sp.*, by ethanol extract of *M. pubescens* leaves [55]. Furthermore, studies on *M. pubescens* leaves, and stem showed the highest antimicrobial activity in solvents such as ethanol against *S. aureus* and *E. coli* [56]. Besides petroleum ether, chloroform, methanol, water against *S. aureus*, *B. s ubtilis*, *P. aeruginosa*, *K. pneumoniae*, and *S. typhi* among which acetone exhibited maximum inhibition against *P. aeruginosa* comparable with antibiotics tetracycline and chloramphenicol [45, 46]. Indeed, a recent study has shown that silver nanoparticles synthesized by *M. pubescens* roots were found to be highly toxic against bacterial strains such as *S. aureus* and *E. coli* at an increasing dose of concentration. The authors concluded that the antibacterial activity resides on the large surface area of nanoparticles for interaction with microbes [57].

The chloroform extract of *M. pubescens* fruit when tested on the strains *B. oryzae*, *F. udum*, *C. lunata*, *P. infestans*, *R. solani*, and *M. phaseolina*, induced 100% inhibition in *R. solani* and *B. oryzae* through the reduction of new and dry weights of mycelial growth. Besides, extract had significant Minimum Inhibitory Concentration (MIC) in the range of as well as reduced fungal respiration rate as compared with control [12]. Whereas, the maximum zone of inhibition observed after the treatment of *C. albicans* and *A. niger* with ethanol and chloroform extracts from *M. pubescens* bark compared to the effect of the reference standard [9]. Moreover, the chloroform extract of stem and leaf displayed significant antifungal activity against a wide range of fungal strains with the maximum zone of inhibition in *R. oryzae* [45].

#### Antimalarial activity

Malaria is one of the most significant human parasitic diseases in the world and has claimed more children life worldwide than any other conditions. Since there are no adequate vaccines and plant drugs, have been employed for centuries. The need for the assessment of traditional anti-malarials is urgent, particularly in the light of widespread resistance of malarial strains to the operationally useful present day antimalarials. In this regard, the filter-sterilized ethanol extracts of *M. pubescens* leaf and bark investigated for antiplasmodial activity against *P. falciparum* displayed significant activity [58]. On the contrary, the methanol extract of *M. pubescens* leaves was found to be ineffective for the larvicidal activity of *C. Quinquefasciatus* [59].

#### Radical scavenging activity

Nowadays there is frequent and increase in search for new compounds from medicinal herbs with antioxidant potential which inhibit free radicals responsible for oxidative damage to biomolecules such as lipids, proteins, and nucleic acids, which eventually causes diabetes, aging, injury of kidney, liver, and cancer in humans. Besides the antioxidant vitamins as vitamin E and C, there are other compounds as phytolacetate, phytol, octonyl glucopyranose, hexonyl glucopyranose, artenol, linoleic acid, caproic acid, caprylic acid,  $\beta$ -sistosterol, campesta-5-22-trien-3-ol, hyoscyamine. Besides stigmasteroid, ergosteroid, E-phytol, stigmasta-4-en-3-one, stigmasta-22-dien-3-one obtained from the *M. pubescens* leaves are found to possess *in vitro* antioxidant activity which has established against L-Ascorbic acid using DPPH discoloration method. Phytol, octonyl glucopyranose, hexonyl glucopyranose, hyoscyamine have demonstrated highest antioxidant activity with significant IC 50 values [32, 33]. Also, the silver nanoparticles from *M. pubescens* leave exhibited iron chelating and scavenging activities against free hydroxyl radicals (HO $\cdot$ ), superoxide anion radicals (O $_2^{\cdot-}$ ), 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals, phosphomolybdenum, FTC and TBA inhibitory activity [60]. The alcoholic extracts of *M. pubescens* ripened fruits have displayed potent antioxidant activity through reducing the lipid peroxides, GST, GSH, SOD, CAT using TBA and FTC, DPPH, FRAP, Metal chelating and NOX assays [12, 61, 62]. Moreover, the leaves of *M. pubescens* obtained from the cement industry, magnesite mines, Dalmia magnesite of Salem found to have antioxidant activity in NOX, metal chelating. And also in reducing power, phosphomolybdenum assays [63-67].

#### Anticancer activity

Cancer is a significant prevalence of health concern and treatment poses a problem and is frequently unproductive. As such, continuous efforts in the search for novel agents and therapies to perk up survival are obligatory. A substantial number of plant extracts and isolated compounds possess significant anti-proliferative or pro-apoptotic effects [68]. By supporting the avowal, extracts of *M. pubescens* of Rubiaceae family has been shown to sensitize liver and lung tumor cell lines, but not Vero human fibroblasts.

The critical mechanism by which *M. pubescens* could combat tumor formation is the induction of cell cycle arrest and apoptosis. Apoptosis is a highly complicated and elaborate mode of cell death that requires precise regulation of different intracellular signaling pathways to ensure the continuation of the transmission of the death signal [69]. The characteristic executioners of apoptosis are intracellular cysteine proteases called caspases, stored in most cells

as zymogens or procaspases [70]. These caspases are activated by intrinsic and extrinsic pathways which later mediate cleavage of proteins which are essential for cell viability that result in morphological hallmarks of apoptosis [71]. On this subject, a recent study has shown chloroform extract of *M. pubescens* leaves, and its isolated compound octonyl glucopyranose increased the caspase-3 and caspase-9 protein levels to 1.3 folds than the healthy cells and augmented p53 expression in human hepatoma HepG2 cells [32]. Furthermore, hexane extract of *M. pubescens* leaves, and the isolated compound hyoscyamine dose-dependently decreased the cell viability in HepG2 cells. Besides, hyoscyamine induced caspase-3 mediated apoptosis. Up-regulation of p53 gene expression provided the cue for apoptotic activity of hyoscyamine [33]. Moreover, the antiproliferative and pro-apoptotic effects of an ultra-protein extract of *M. pubescens* leaves in A549 lung tumor cell line extensively documented *in vitro*. And that supported by the increase in apoptosis resulting in the cytoplasm and chromatin condensation, nuclear breakdown, and shrinkage of the cell. Followed by fragmentation into membrane-bound apoptotic bodies, eventually subjected to rapid phagocytosis by surrounding cells, whereas similarly treated standard Vero cell line had shown 98% cell viability with no apoptosis induction [72]. The anti-proliferation activity again proved with another study as *M. pubescens* leaf synthesized nanoparticles decreased the cell viability of Human Epithelium cells of liver cancer in MTT assay [60].

#### Hypoglycemic activity

Plants, herbs and their derivatives owing to their broad spectrum of active principles signifying numerous chemical compounds hold promising potentials for their reliable usages in the treatment of diabetes. *M. pubescens* is one such candidate who has listed as traditional Indian herbal antidiabetics [85]. In this regard, scientific studies prove the antidiabetic effect of *M. pubescens*.

*M. pubescens* fruit extract administered orally to alloxan induced diabetic female rats significantly reduced the blood glucose levels compared to control non-diabetic rats by alloxan. Besides, there was a significant reduction of biomarkers such as reduced GSH, GST, SOD, CAT in the liver and kidney of diabetic rats as compared with non-diabetic control rats. The authors also observed weight loss in diabetic rats as compared to non-diabetic control animals, whereas treatment with *M. pubescens* alcoholic extracts improved the animal weight as compared to diabetic animals [12]. *M. pubescens* is showing promising *in vivo* results as a natural anti-diabetic agent, the however safe range of doses and proven efficacy studies needed for further preclinical studies.

#### Prophylactic activity

Nowadays, studies have raised the possibility that *M. pubescens* might be useful in protecting against liver and kidney damage. Rats given the oral administration of *M. pubescens* fruit extract for 21 d followed by intraperitoneal injection of D-GalN to induce liver damage prevented the increase of LPO and alteration in iron content in experimental animals. Besides, considerably increased the levels of GSH and vitamin E when compared to D-GalN intoxicated animals. Pre-treatment with fruit extract to rats reduced the elevated levels of serum marker enzymes and also improves the levels of fucose, ceruloplasmin, and uric acid which were further confirmed by histopathological studies. The authors concluded that hepatoprotective potential might be due to the presence of alkaloids and phenols [73, 12]. In recent research, gentamicin-induced acute renal failure in male Wistar rats treated with water extract of *M. pubescens* bark and its ethyl acetate fractions once daily for ten days reversed the altered level of biochemical markers. And other parameters such as renal biomarkers creatinine, urea, uric acid, BUN, albumin, protein, and other parameters are kidney weight, body weight, urine volume and histopathology of the kidney to the near normal levels. The authors concluded that the ethyl acetate fraction exhibited the highest nephroprotective activity compared to water extract [74].

#### Wound rejuvenating activity

Traditional plants are fertile ground for materials used in wound healing and anticoagulation. Myths in India use a large number of plants for treatment of cuts, wounds, ulcers, inflammation, and

burns. Plant extracts became popularized because of the lack of unnecessary side effects and effectiveness as crude preparations [75, 76]. Perhaps, reports are supporting that the topical application of leaf paste of *M. pubescens* has potential wound healing activity among various medicinal plants [77]. In this outlook, a study on chloroform extract of *M. pubescens* fruit investigated for its wound healing potential in male Albino rats. The extract showed a wound healing activity at a concentration-dependent manner through significantly increasing wound diminution and fresh hair growth in the entire wounded area within 15 d in animals treated with the compared with only 60% contraction without hair growth in olive oil-treated control rats. The results suggested that mechanisms underlying this effect were fibroplasia, collagen synthesis, and wound contraction [78]. Furthermore, study with ointment prepared from *M. pubescens* roots extract in ethanol has been evaluated in Swiss albino mice using the wound excision model. The extracts exhibited faster-wound healing activity with increasing concentrations when compared to standard Povidone-iodine. The authors concluded that the wound healing property of *M. pubescens* might be due to its enhancing epithelization and collagen deposition mechanisms [79].

### Toxicology

Sprague-Dawley rats fed with "Nuna Kadugu," a Siddha medicine prepared from leaves and fruits of the *M. pubescens* plant for 14 d acute oral toxicity test revealed that LD50 value of NK is more significant than in fasted female rats. Besides, in 28 d repeated dose toxicity study with NK administration had no significant difference in mortality, body weight changes, feed, and water intake, hematology, clinical biochemistry, electrolytes content and histopathological examination [80].

### Other reports on *M. pubescens*

Besides the reports on the bioactivity of *M. pubescens*, the number of different activity as seed stimulant, green dye adsorbent, and pollution indicator reported.

### Seed stimulant

Aqueous extracts of *M. pubescens* leaves displayed significant stimulatory effect on wheat followed by fenugreek plant with increased enhancement in root and shoot length, vigor index and mobilization efficiency as compared to control. In spite of these effects, the extracts at higher concentrations exhibited an allelopathic inhibitory impact on plant growth [81].

### Green dye adsorbent

The activated carbon of *M. pubescens* leaves (MAC) reported as an excellent adsorbent material for the removal of malachite green (MG), crystal violet (CV) and congo red (CR) dyes from aqueous solution. Hence commercially it can be suggested as a low-cost green dye adsorbent [82]. In another study, the *M. pubescens* plant in hot water extract subjected to its dyeing ability and colorfastness in cotton fabric at different pH where the color changes absorbed from yellowish to deep reddish color. The authors suggest the plant as a green dye [53].

### Pollution indicator

Aqueous extract of *M. pubescens* leaves from the experimental site near Cement industry located in Salem showed high Air pollution tolerance index (APTI) at pH 7, along with low ascorbic acid and chlorophyll [83]. On the contrary, a similar study done with leaves obtained near Dalmia magnesite located at Salem had moderate APTI with low ascorbic acid and chlorophyll contents [84].

### CONCLUSION

In this comprehensive review, we reported the results of scientific works carried out on *M. pubescens*, which endow with practical support for further research. Pharmacological studies listed in the document show almost all ethnomedicinal uses of this plant, including anticancer, antimicrobial, antifungal, wound healing and other applications. Moreover, the bioactive potential of this herb justified by concerning the variable phytochemical profile which has

included in the review. Furthermore, it would be tempting to explore the path to isolate and purify the chemical compounds that may be biologically active. Indeed, the mechanism of action, bioavailability, and pharmacokinetics of isolated pure compounds will have the most significant interest in the valuation of the obtained pharmacological effect. Besides, there is the surge in clinical studies which contribute to the development of this herb in relevance with its traditional use.

### ABBREVIATION

APTI, Air pollution tolerance index; *A. niger*, *Aspergillus niger*; *B. cereus*, *Bacillus cereus*; *B. oryzae*, *Bipolaris oryzae*; *B. subtilis*, *Bacillus subtilis*, BUN, Blood Urea Nitrogen; *C. albicans*, *Candida albicans*; CAT, Catalase; CR, Congo Red; *C. lunata*, *Curvularia lunata*; *C. quinquefasciatus*, *Culex quinquefasciatus*; CV, Crystal Violet; D-GalN, D-galactosamine; DPPH, 1,1-diphenyl-2-picrylhydrazyl assay; *E. coli*, *Escherichia coli*; FRAP, Ferric reducing antioxidant power assay; *F. udum*, *Fusarium udum*; FTC, Ferric thiocyanate method; GSH, glutathione; GST, Glutathione-S-transferase; HepG2, Human epithelium cells of liver cancer; HO<sup>-</sup>, Free hydroxyl radicals; HPTLC, High-performance thin-layer chromatography; *K. pneumoniae*, *Klebsiella pneumoniae*; LPO, lipid peroxidation; *M. pubescens*, *Morinda pubescens*; MAC, *M. pubescens* leaves; *M. phaseolina*, *Macrophomina phaseolina*; MG, Malachite green; MIC, Minimum Inhibitory Concentration; MTT, 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide; NK, Nuna Kadugu; NOX, Nitric oxide assay; O<sub>2</sub><sup>-</sup>, Superoxide anion radicals; *P. falciparum*, *Plasmodium falciparum*; *P. aeruginosa*, *Pseudomonas aeruginosa*; *P. infestans*, *Phytophthora infestans*; *R. solani*, *Rhizoctonia solani*; *S. aureus*, *Staphylococcus aureus*; *S. typhi*, *Salmonella typhi*; SOD, Superoxide dismutase; TBA, Thiobarbituric acid method.

### AUTHORS CONTRIBUTIONS

All the authors have equally contributed

### CONFLICTS OF INTERESTS

All authors have none to declare

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