A Comprehensive Review of the Ethnotraditional Uses and Biological and Pharmacological Potential of the Genus *Mimosa*

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**Abstract:** The *Mimosa* genus belongs to the Fabaceae family of legumes and consists of about 400 species distributed all over the world. The growth forms of plants belonging to the *Mimosa* genus range from herbs to trees. Several species of this genus play important roles in folk medicine. In this review, we aimed to present the current knowledge of the ethno-geographical distribution, ethnotraditional uses, nutritional values, pharmaceutical potential, and toxicity of the genus *Mimosa* to facilitate the exploitation of its therapeutic potential for the treatment of human ailments. The present paper consists of a systematic overview of the scientific literature relating to the genus *Mimosa* published between 1931 and 2020, which was achieved by consulting various databases (Science Direct, Francis and Taylor, Scopus, Google Scholar, PubMed, SciELO, Web of Science, SciFinder, Wiley, Springer, Google, The Plant Database). More than 160 research articles were included in this review regarding the *Mimosa* genus. *Mimosa* species are nutritionally very important and several species are used as feed for different varieties of chickens. Studies regarding their biological potential have shown that species of the *Mimosa* genus have promising pharmacological properties, including antimicrobial, antioxidant, anticancer, anti-diabetic, wound-healing, hypolipidemic, anti-inflammatory, hepatoprotective, antinoceceptive, antiepileptic, neuropharmacological, toxicological, antiallergic, antihyperurisemic, larvicideal, antiparasitic, molluscicidal, antimutagenic, genotoxic, teratogenic, antispasmodic, antiviral, and antivenom activities. The findings regarding the genus *Mimosa* suggest that this genus could be the future of the medicinal industry for the treatment of various diseases, although in the future more research should be carried out to explore its ethnopharmacological, toxicological, and nutritional attributes.

**Keywords:** *Mimosa*; genus; Fabaceae; pharmacology; nutrition; leaves

1. Introduction

The *Mimosa* genus belongs to the *Fabaceae* family of legumes (subfamily: *Mimosoideae*) and consists of almost 400 species of shrubs and herbs [1]. The species are distributed mainly in Bangladesh, Indonesia, Malaysia, Japan, India, Pakistan, Sri Lanka, China, Cambodia, Taiwan, Africa (Nigeria, Mauritius, and Reunion Island), Australia, Brazil, Venezuela, Mexico, Philippines, Cuba, northern Central America, Paraguay, Argentina, Uruguay, Thailand, several Pacific Islands, Papua New Guinea, and North America [2–11].
Figure 1 presents the ethnogeographical distribution of the *Mimosa* species in different countries of the world. Almost 20–25 species of this genus are well known to the world, including *Mimosa tenuiflora* (Wild.) pior, *Mimosa pudica* L., *Mimosa pigra* L., *Mimosa caesalpinifolia* Benth., *Mimosa hamata* Willd., *Mimosa diplopticha* Sauvalle, *Mimosaa xanthocentra* Mart., *Mimosa artemisiana* Heringer and Paula, *Mimosa invisa* Mart. ex Colla, *Mimosa scabrella* Benth., *Mimosa somnians* Humb. and Bonpl. ex Willd., *Mimosa binucrouted* (DC.) Kuntze, *Mimosa verrucosa* Benth., *Mimosa arenosa* (Willd.) Poir., *Mimosa rubicaulis* Lam., *Mimosa linguis*, and *M. albida* Willd. *Mimosa ophthalmocentra* Mart. ex Benth. (http://mpns.kew.org/MPNS.kew.org 2018; www.theplantlist.org 2017) (Accessed on 18 May 2021). Leaves of this genus may be bipinnate or binate, compound or branched, with one or two pairs of branchlets or much larger branched leaves. Some species have the ability to fold their leaves when touched, with *M. pudica* being one common example. The flowers may be pink and globular in the form of clusters and with prickles or may be white and grouped in dense heads 3–6.5 mm long. The fruit are lance-shaped with 2–6 articulations. The fruit wall is compressed between the seeds. Huge amounts of starch and calcium oxalate crystals are present in the bark [12]. Some species are prickly leguminous shrubs [13]. The plants of this genus usually grow across roadsides, walkways, marshes, and hillsides, and on margins of rivers and lakes on wet soil, where several individuals can form dense aggregations [14]. The plants are commonly used for ornamental purposes. They also serve as sleeping shelters for animals [15]. Economically, their wood is used for fence posts, firewood, coal, plywood, particle board, and lightweight containers, and more recently has been introduced in furniture and flooring [16]. Leaves of the plants are used for poultry diets [17]. In the food industry, the leaves are used as additives, while in the leather and textile industry they are used as colorants [18,19]. The plants provide wood for market purposes and add nitrogen in warm-climate silvopasture systems [20]. This genus has remarkable economic importance in the cosmetics industry [21]. Traditionally, species of this genus are used in folklore medicines for the treatment of various ailments, including head colds, wounds, toothaches, jaundice, eye problems, fever, weak heart, skin burns, asthma, diarrhea, piles, gastrointestinal ailments, liver disorders (such as hepatitis and diuresis), and respiratory [22–26] disorders. They are also used as coagulants and in tonics for urinary complaints. The genus *Mimosa* has been demonstrated to possess various pharmacological activities, including antiseptic, antimicrobial [27,28], antioxidant [29–34], anticonvulsant [35], antifertility [36], antigout [37], anti-inflammatory [38–40], antinociceptive [41,42], antiulcer [43], antimalarial [44], antiparasitic [45], antidiabetic [46,47], anticancer [48,49], antidepressant [50], antidiarrheal [51,52], antihistamic [53], wound-healing [54], antisapmosolytic [55], hypolipidemic [56], hepatoprotective [57], hypolipidiemic [58], antivenom [40], antiproliferative [59], antiviral [60], and aphrodisiac activities [61]. Phytochemicals studies of plants have revealed the presence of secondary metabolites, such as alkaloids, tannins, flavonoids, terpenoids, saponins, steroids [62,63], and coumarins [64]. The green synthesis of nanoparticles is cheap, simple, comparatively and reproducible, resulting in the production of more stable and useful materials [65]. The *Mimosa* genus has been used in the green synthesis of pharmacologically important gold [66], silver [67], iron [68], cadmium [69], platinum [70], and zinc oxide [71]-based nanoparticles; however, data regarding all species of the *Mimosa* genus have not been compared and organized to date in proper review form (to the best knowledge of the authors). Our research group is currently working on compiling data regarding bioactive constituents isolated from the genus *Mimosa* and their pharmacological effectiveness.
Figure 1. Ethnogeographical distribution of *Mimosa* species.

2. Materials and Methods

A detailed bibliographic study that included papers published from 1931 to 2020 was carried out. Several databases (Science Direct, Francis and Taylor, Scopus, Google Scholar, PubMed, SciELO, Web of Science, SciFinder, Wiley, Springer, Google, and The Plant Database) were explored in order to collect information on this genus. Various books, full text manuscripts, and abstracts were consulted. The genus name and the synonyms and scientific names of *Mimosa* species were used as keywords. The scientific names of all plants of the genus Mimosa and their synonyms were validated using a standard database (http://mpns.kew.org/MPNS.kew.org 2018; www.theplantlist.org 2017) (accessed on 15 May 2021).

3. Nutritional Potential of Genus *Mimosa*

Nworgu and Egbunike [17] reported on the nutritional potential of *M. invisa* leaves by preparing meals for different varieties of cockerel chicks, cockerel growers, broiler starters, and finishers within the years 2004–2009. The diets were formulated for cockerel chicks, broiler starters, and finishers. Leaves were found to be rich in crude protein (23.34%), ash (4.25%), dry matter (89.99%), crude fiber (11.29%), nitrogen-free extract (58.74%), oxalate (0.065%), phytate (0.37%), and tannins (1.57%). High mineral elements were found in *M. invisa* leaves, including zinc (40.00% of DM), iron (10.11% of DM), potassium (1.60% of DM), calcium (1.26% of DM), phosphorus (0.38% of DM), and magnesium (0.24% of DM). Inclusion of more than 20 g/kg *M. invisa* leaf meal to the diets of cockerel chicks and cockerel growers resulted in decreased feed intake, weight gain, and feed conversion ratio. Dietary inclusion of leaf meal in broiler starters and finishers resulted in significant
reductions in feed, weight gain, and feed conversion ratio. These results were found to be progressive and comparable within different chicken types. A schematic illustration of the nutritional value of the Mimosa genus is presented in Figure 2.

![Figure 2. Schematic presentation of the nutritional value of the Mimosa genus. Note: % represents percentage of dry matter content.](image)

Rajan et al. [72] measured trace elements present in *M. pudica* leaves with the help of the proton-induced X-ray emission (PIXE) technique. PIXE analysis revealed that trace elements of Fe = 308.467 mg/L, Mn = 65.664 mg/L, Zn = 18.209 mg/L, Cu = 10.707 mg/L, Co = 2.025 mg/L, and V = 0.059 mg/L were present in *M. pudica* leaves. These trace elements are used for curing skin diseases, especially infections on the legs and between the fingers, and are also taken orally. Yongpisanphop et al. [73] estimated lead contamination levels in *M. pudica* roots. The lead contamination level found to be in the root sample was 826 mg/kg, as compared to 496 mg/kg in the soil sample. There are no reports available regarding the trace elements and mineral compositions of other *Mimosa* species.

4. Ethno-Traditional Uses of Genus Mimosa

Various species of Mimosa, including *M. tenuiflora*, *M. pudica*, *M. pigra*, *M. caesalpinifolia*, *M. hamata*, *M. rubicaulis*, *M. somnians*, *M. bimucronata*, *M. linguis*, *M. humilis*, *M. invisa*, *M. arenosa*, *M. ophthalmocentra*, *M. verrucosa*, and *M. albida*, have been reported to be used in traditional medicine for the treatment of various ailments (Figure 3). Due to their potential benefits in phytomedicines, all parts of this genus are used in traditional systems of medicine in Mexico, Brazil, India, Bangladesh, China, Indonesia, Madagascar, South America, and tropical Africa for countless ailments, including toothaches, headache, colds, and eye problems. *M. tenuiflora* is a perennial shrub or tree commonly known as skin tree or Jurema-preta in many parts of the world. In Northeastern Brazil, the bark of *M. tenuiflora* is used in a religious drink called Yurema [74,75], while the leaves, stem, and flowers are used to relieve fever, menstrual colic, headache, hypertension, bronchitis, and coughs [41,55,76–81]. In Mexico, its stem bark is used to treat skin burns, lesions, and inflammation [24].
M. *pudica* is a creeping perennial or annual flowering plant and is the most famous plant of this genus; it is commonly known as touch-me-not, sensitive plant, or shy plant. In Mexico, *M. pudica* is used for the treatment of depression, anxiety, premenstrual syndrome, menorrhagia, skin wounds, diarrhea, and rheumatoid arthritis [50,82–85]. Ayurveda and Unani are the two main medical systems in India, in which *M. pudica* leaves and roots are used for prevention of vaginal and uterine infections [86], ulcers, bile, leprosy, fever, small pox, jaundice, and piles [87,88]. The seeds are combined with sugar and used to control skin and venereal diseases [72]. Indians use it for the removal of kidney stone (vesicle calculi) myalgia, rheumatism, uterus tumors, and edema-type disorders [89]. The leaves are commonly used in Bangladesh as one of the ingredients to control piles, diarrhea, persistent dysentery, and convulsion of children [90]; additionally, the root extracts have antivenomic properties [91]. In China, women use its herbal paste in the form of a solution to narrow their vaginas [92], and it is also used as a dental powder to treat gingiva and bad breath [93].

*M. pigra* is a leguminous shrub known as giant sensitive tree and bashful plant. The people of Africa, the America, Indonesia, and Mexico use *M. pigra* to deal with several health disorders, such as liver ailments, hepatitis and respiratory disorders [94], and snakebite [95]. It is also used for mouthwash to treat toothaches and in eye medicines [96]. Additionally, the leaves are used by the local people of Bangladesh to lower their blood sugar [97], while Indonesian people use the roasted ground leaves to stabilize a weak heart or weak pulse [98,99].

*M. caesalpinifolia* is a spiny, deciduous tree or shrub with white flowers that is commonly found in Brazil. Its bark and flowers are used as an effective remedy to prevent skin infections, injuries [100], and hypertension [77].

*M. hamata* is a flowering shrub found in India that is known as Jinjani, which is used as animal feed. The roots and leaves are used in customary medications for the treatment of numerous health ailments, such as jaundice, diarrhea, coagulant, fever, wounds, piles, gastrointestinal and liver disorders (such as hepatitis), and respiratory issues [3], as well as being used in tonics for urinary complaints. A paste made from the leaves is applied to reduce glandular swelling, piles, sinus issues, and sores [101,102]. The seed extract is used as a blood purifier [33,103].

*M. albida* is a leguminous shrub commonly found in rain forests. In Brazil, roots are used for cardiovascular and renal system disorders [104], as well as inflammation of...
Table 1. Ethnotraditional uses of different species of the genus Mimosa.

| Plant   | Plant Parts           | Country           | Common Names in Different Languages | Uses                                      | References     |
|---------|-----------------------|-------------------|------------------------------------|-------------------------------------------|----------------|
| M. tenuiflora | Stem bark              | Mexico            | Tepescohuite                        | Used for to treat cutaneous wounds, burns, and inflammations | [9,24,108–111] |
|         | Stem bark, leaves, flowers | Northeastern Brazil, Venezuela | Skin tree, jurema-preta, calumbi | Used for injury, odontalgia, inflammations, fever, menstrual colic, headache, hypertension, bronchitis, cough, external ulcers | [41,55,76–81] |
|         | Root bark              | Northeastern Brazil | Jurema preta, black jurema, Vinho de jurema | Used for Jurema, a psychoactive beverage consumed for medicoreligious purposes | [74,75] |
|         | Bark                   | Northeastern Brazil | Some indigenous tribes use it as a miraculous drink | Used for eczema | [55,112] |
|         | Whole plant            | Mexico            | English—“Touch me not”; Urdu—Chhimui; Punjabi—Lajan; Hindi—Lajauni, Chhuimui; Marathi—Lajalu; Gujarati—Lajavanti, Risaman, Lajamani; Bengali—Lajavanti, Lajaka; Telugu—Mudugudamara; Tamil—Tottavadi, Tottalchurungi; Oriya—Lajakuri; Kannada—Lajavati, Muttidasenui, Machikegida; Sanskrit—Namaskari, Samanga, Varakranta; Malayalam—Thottavati | Used for halucinogenic compounds | [114] |
| M. pudica | Roots                  | India             | Namaskari, Lajjalu                  | Used for to treat fever, dysentery, piles, jaundice, uterine and vaginal illnesses, burning sensation, leucoderma, asthma, inflammations, leucosy, fatigue, blood infections | [86] |
|         | Stem                   | Touch-me-not      | Aphrodisiac properties, antivenom activities, antihypototoxic effect, diuretic effect, hyperglycemic effect, wound-healing effect | Used for to treat piles, diarrhea, persistent dysentery, convulsion of children | [115] |
|         | Leaves                 | Bangladesh        | Ilok—Bain bain; Tagalog—Makahiya | In Unani and Ayurvedic methods of medication. *M. Pudica* is used for treatment of ulcers, bile, leucosy, fever, small pox, jaundice, piles, ulcers, inflammation, burning sensations, asthma, hemorrhoids, spasmodic fistula, strangury, hydrocele, scrotula, conjunctivitis, wounds, hemorrhages | [116,117] |
|         | Leaves and roots       | India             | Namaskari, Lajalu                  |                                                                                     | [87–89,118]    |
| Plant         | Plant Parts          | Country                | Common Names in Different Languages                  | Uses                                                                 | References       |
|--------------|----------------------|------------------------|------------------------------------------------------|----------------------------------------------------------------------|------------------|
| M. pudica    | Whole plant          |                        |                                                      | Used internally to treat vesicle calculi and externally to treat myalgia, rheumatism, uterus tumors, edema-type disorders | [89]             |
| M. pudica    | Roots                | Bangladesh             |                                                      | Antivenom effects                                                    | [91]             |
| M. pudica    | Bark                 | China                  |                                                      | Treatment of traumatic injury to dissipate blood stasis              | [93]             |
| M. pudica    | Herb                 | China                  |                                                      | In women is used in vagina-narrowing solution                        | [92]             |
| M. pudica    | Paste                | China                  |                                                      | Used in dental powder to treat gingiva and bad breath                | [93]             |
| M. pudica    | Seeds+5 g sugar      | India                  | Chunimui                                             | Venereal diseases                                                    | [72]             |
| M. pigra     | Leaves               | Africa                 |                                                      | Used for asthma, respiratory diseases, diarrhea, typhoid fever, genitourinary tract infections | [94]             |
| M. pigra     | Roots, leaves, stem  | Madagascar, tropical Africa, South America, Indonesia | Used for head colds, mouthwash for toothaches, eye medicines |                                                                 | [96]             |
| M. pigra     | Leafy stem fruits    | Africa                 |                                                      | Antivenom effects                                                    | [95]             |
| M. pigra     | Leaves               | Mexico                 |                                                      | Used in Mayan medicine for treatment of diarrhea                     | [23]             |
| M. pigra     |                      | Bangladesh             |                                                      | Used to lower blood sugar in diabetic patients and for the treatment of pain | [97]             |
| M. pigra     | Roasted and ground leaves | Indonesia        | English name—bashful plant; vernacular name—Alfas | Used to treat a weak heart or weak pulse                             | [98,99]          |
| M. caesalpinifolia | Bark and flowers   | Northeastern Brazil | Cascudo, sabia                                      | Used for bronchitis, skin infections, injuries, inflammation, hypertension, cough, gastritis | [27,77,100,105,119–121] |
Table 1. Cont.

| Plant          | Plant Parts | Country | Common Names in Different Languages | Uses                                         | References |
|----------------|-------------|---------|-------------------------------------|----------------------------------------------|------------|
| *M. arenosa*   | Bark        | Brazil  |                                     | Used for asthma                              | [77]       |
| *M. ophthalmo-centra* | Bark       | Brazil  | Jurema                              | Used for bronchitis, cough                    | [77]       |
| *M. verrucosa* | Stem bark   | Brazil  | Jurema-preta                        | Used for gastritis, ulcer, asthma, inflammation of the uterus | [77,105] |
| *M. albida*    | Roots, leaves and flowers | Mexico     |                                     | Used for pain and anxiety, chronic pain       | [106]      |
|                | Roots       | Honduras |                                     | Used for abortion                            | [107]      |

5. Pharmacological Activities of Genus *Mimosa*

During the past decades, the genus *Mimosa* has been extensively studied for its broad biological and pharmacological potential. Different preparations and extracts from this genus have demonstrated multiple health benefits and pharmacological effects, including antimicrobial, antioxidant, anticancer, wound-healing, hypolipidemic, anti-inflammatory, hepatoprotective, antinoceptive, antiepileptic, neuropharmacological, toxicological, antiallergic, antihyperurisemic, larvicidal, antiparasitic, molluscicidal, antimutagenic, genotoxic–teratogenic, antispasmodic, antiviral, and antivenom activities. These pharmacological effects have been studied through in vitro and in vivo assays. These activities are presented in detail in this review article (Table 2).

Table 2. Pharmacological studies of different species of the genus *Mimosa*.

| Activities          | Plant          | Plant Part | Extract/Fraction | Assay                  | Model                                                | Results/Outcome/Response                                                                 | References |
|---------------------|----------------|------------|------------------|------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------|------------|
| Antimicrobialactivity | *M. tenella* | Bark       | Ethanol 95%       | Disc diffusion method  | *E. coli*, *B. subtilis*, *M. luteus*, *P. vulgaris* | Active doses of extract: *E. coli* = 5.0 µg/disk, *B. subtilis* = 10.0 µg/disk, *M. luteus* = 20.0 µg/disk, *P. vulgaris* = 10.0 µg/disk | [134]      |
|                     |                |            | Minimum inhibitory concentration (MIC) | Well diffusion method | *S. aureus*, *E. coli*                              | Active doses of extract: *S. aureus* = 5.0 µg/well, *E. coli* = 15.0 µg/well | [135]      |
| Activities | Plant | Plant Part | Extract/Fraction | Assay | Model | Results/Outcome/Response | References |
|------------|-------|------------|-----------------|-------|-------|-------------------------|------------|
| Antimicrobial activity | M. tenuiflora | Bark | EtOH extract | Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) | S. aureus ATCC 25.925 and ATCC 25.213, E. coli ATCC 8559 and ATCC 25236, P. aeruginosa ATCC 25.619 | For S. aureus (ATCC 25.925) and P. aeruginosa (ATCC 25.619), MIC = 128 and MBC = 256 μg/mL, respectively; for S. aureus ATCC 25.213 (MIC = 512, MBC = 1024 μg/mL), E. coli ATCC 8559, and E. coli ATCC 25236 (MIC = 1024, MBC ≥ 1024 μg/mL) | [136] |
| | | | EtOH | Minimum inhibitory concentration (MIC) | S. aureus, E. coli, C. albicans, T. interdigitale | Active dose of extract showed MIC against S. aureus = 15.6 μg/mL, E. coli = 1000 μg/mL, C. albicans = 156.28 μg/mL, T. interdigitale = 156.28 μg/mL | [137] |
| | | | EtOH extract | Disc diffusion method | S. aureus, B. subtilis, C. albicans | ZOI: E. coli = 4.61%, B. subtilis = 4.5%, C. albicans = 1.96% | [136,137] |
| | | | Aq. | Disc diffusion method | E. coli, staphylococcus sp., Bacillus sp., Penicillom sp., Streptococcus sp. | ZOI: E. coli = 18 mm > Bacillus sp. = 12.5 mm > Pseudomonas sp. = 12 mm > Staphylococcus sp. = 11 mm > Streptococcus sp. = 9 mm | [138] |
| | | | Aq, EtOH, PE, Aq | Well diffusion method | E. coli, P. aeruginosa, L. bacilus, S. typhi, S. aureus, P. fedinans, F. oxysporum, P. varioti | Concentration (30–120 μL/mL) antibacterial activity of extract increased with increasing dose of extract. At 120 μL/mL, more ZOI was observed | [139] |
| | | | MeOH | Disc diffusion method | P. aeruginosa, S. aureus, V. harveyi | ZOI at 25 and 100 mg concentration against B. cereus = 5 and 10 mm, E. coli = 9 and 22 mm, P. vulgaris = 0 and 9 mm, P. aeruginosa = 4 and 15 mm, S. aureus = 11 and 18 mm, A. flavus = 5 and 25 mm, A. niger = 5 and 14 mm, A. terreus = 8 and 17 mm, F. oxysporum sp. = 6 and 15 mm, Penicillom sp. = 6 and 11 mm | [140] |
| | | | MeOH | Agar well diffusion method | B. cereus, E. coli, P. vulgaris, S. aureus, P. aeruginosa, A. flavus, A. niger, F. oxysporum sp., Penicillom sp., A. terreus, | ZOI B. subtilis = 14 mm; S. aureus = 12 mm, P. vulgaris = 11 mm; S. typhi = 15 mm; P. aeruginosa = 12 mm; penicillom (100 μg/disc) and gentamicin (10 μg/disc) used as standards | [141] |
| | | | EtOH and Aq | Agar well diffusion method | T. verrucosum, M. ferrugineum, T. schonleinii, T. rubrum, M. canis, M. gypseum, M. concentricum, T. soudanense | ZOI at 150–300 mg/mL, in EtOH extract = 0–6 mm, in Aq extract = 0–7 mm | [142] |
| | | | MeOH | Disc diffusion and agar well diffusion method | M. tuberculosis | ZOI in disc diffusion method = 7.00 mm, agar well diffusion method = 4.33 mm, streptomycin = 25 mm | [143] |
| | | | HyOH | Disc diffusion method | E. coli, S. aureus, P. aeruginosa, B. cereus | Extract showed significant results at 25, 50, and 100 mL/disk concentrations. | [144] |
| | | | EtOH and Aq extracts | Agar well diffusion method | In vitro E. coli, S. aureus, B. cereus, S. typhi | At 100 μL of EtOH extract, ZOI against E. coli = 11 mm; S. aureus = 19 mm; B. cereus = 17 mm; S. typhi = 16 mm. In Aq extract, S. aureus = 14 mm; B. cereus = 15 mm | | |
| | | | Leaves, flowers, roots | EtOH, CF, MeOH | Disc diffusion method | S. aureus, E. coli, Pseudomonas sps, M. phaseolina, A. niger, R. solani | ZOI in leaves: S. aureus = 23.5 mm, E. coli = 20 mm, Pseudomonas sps = 14 mm; In flower; Pseudomonas sps = 22.5 mm, E. coli = 14 mm, S. aureus = 12 mm; in root: R. solani = 29 mm, A. niger = 21 mm, M. phaseolina = 17.7 mm | [144] |
| Activities          | Plant      | Plant Part           | Extract/Fraction | Assay                  | Model                                | Results/Outcome/Response                                                                 | References |
|--------------------|------------|----------------------|------------------|------------------------|--------------------------------------|----------------------------------------------------------------------------------------|------------|
| Antimicrobial      | *M. pudica*| Whole plant          | EtOH 98%         | Disc Diffusion method  | *S. aureus*, *E. faecalis*, *P. aeruginosa*, *E. coli*, *M. smegmatis* | ZOI at 25 mg/mL concentration; *S. aureus* = 3.5 mg/mL; *P. aeruginosa* = 12.0 mg/mL; *E. coli* = 5.5 mg/mL. At 100 mg/mL concentration *S. aureus* = 9.8 mg/mL; *P. aeruginosa* = 18.0 mg/mL; *E. coli* = 14.0 mg/mL. Standard chloramphenicol at 100 mg/mL showed significant results | [145]     |
| Antimicrobial      | *M. pudica*| Absolute EtOH        | Disc diffusion method | *A. flavus*, *T. rubrum* | Plant was found to be active against all strains except *E. coli*, *A. niger* | ZOI at 100 mg/mL concentration of extract against *A. flavus* = 22 mm; *T. rubrum* = 17 mm. At 25 mg/mL concentration of extract; *A. flavus* = 13 mm; *T. rubrum* = 11 mm | [146]     |
| Antimicrobial      | *M. pigra* | Leaves               | MeOH EtOH and Aq. extract | Agar well diffusion method | *S. aureus*, *E. coli*, *A. niger*, *P. aeruginosa*, *B. subtilis*, *C. albicans* | All strains showed antifungal activity except *E. floccosum* | [23]      |
| Antimicrobial      | *M. pigra* | Leaves               | MeOH 60%         | Broth microdilution method | *S. aureus*, *E. coli*, *K. pneumonia*, *A. flavus* | Significant results were observed against strains | [147]     |
| Antimicrobial      | *M. pigra* | Whole plant and callus tissue | MeOH 60%, Hex, DCM, EtOAc fractions | Minimal inhibitory concentration (MIC) | | | |
| Antimicrobial      | *M. hamata*| Whole plant          | Crude MeOH extract | Agar tube diffusion method | *B. subtilis*, *A. niger*, *P. aeruginosa*, *E. coli*, *K. pneumonia*, *A. flavus* | Potent activity was obtained against bacteria, while no activity was found against fungi | [5]       |
| Antioxidant        | *M. terruiflora*| Whole plant and callus tissue | EIOH extract and its fractions (Aq, CF, PE, BZ) | Disc diffusion method | *E. coli*, *K. pneumoniae*, *A. flavus*, *P. aeruginosa*, *P. vulgaris*, *S. aureus*, *F. moniliforme*, *R. bataticola* | EIOH extract and Aq. fraction showed significant activity against all tested strains PE found to be active against fungi | [60]      |
| Antimicrobial      | *M. verrucosa*| Barks               | EtOH             | Minimum inhibitory concentration (MIC) | *S. aureus*, *E. coli*, *C. albicans*, *T. interdigitale* | Active dose of extract showed MIC against *S. aureus* = 250 µg/mL; *E. coli* = 1000 µg/mL; *C. albicans* = 1250 µg/mL; *T. interdigitale* = 78.13 µg/mL | [137]     |
| Antimicrobial      | *M. pteridi- folia*| Barks               | EtOH             | Minimum inhibitory concentration (MIC) | *S. aureus*, *E. coli*, *C. albicans*, *T. interdigitale* | Active dose of extract showed MIC against *S. aureus* = 500 µg/mL; *E. coli* = 1000 µg/mL; *C. albicans* = 625 µg/mL; *T. interdigitale* = 312.5 µg/mL | [137]     |

**Table 2. Cont.**
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| Activities | Plant | Plant Part | Extract/ Fraction | Assay | Model | Results/Outcome/Response | References |
|------------|-------|------------|-------------------|-------|-------|--------------------------|------------|
| *M. tenuiflora* | Bark | EtOH | DPPH radical and ABTS radical cation scavenging assay | DPPH (IC50) = 17.21 µg/mL, ABTS (IC50) = 3.75 µg/mL | | | [137] |
| | | n-Hex | DPPH, OH, NO, and superoxide radical scavenging assays | n-Hex at 5–25 mM concentration showed DPPH (IC50 = 20.83 mM); OH (IC50 = 19.37 mM); NO (IC50 = 21.62 mM); O2 (-IC50 = 22.19 mM); BHT and vitamin C used as standards | | | [30] |
| | | ACE-Aq- AA (8.0 mL, 70:29.5:0.5) | ORAC assay, DPPH free radical scavenging activity | ORAC = 1187.9 µmol TE g⁻¹ FW, DPPH EC50 = 243.2 mg/kg, vitamin C content = 259.1 µg/g FW | | | [150] |
| | | MeOH | DPPH free radical scavenging assay | DPPH scavenging; IC50 = 126.71 µg/mL, ascorbic acid; IC50 = 20.13 µg/mL; total antioxidant capacity of extract = 5.038 mg (mg AAE/g) | | | [151] |
| | | PE, EtOAc, EtOH, Aq. extract | ABTS assay | PE; EC50 = 40.6 µg/mL, EtOAc; EC50 = 27.2 µg/mL; EtOH; EC50 = 73.8 µg/mL; Aq.; EC50 = 13.2 µg/mL, ascorbic acid; EC50 = 11.5 µg/mL | | | [152] |
| | | Isolated flavonoids | DPPH free radical scavenging assay | DPPH = % inhibition at 20–140 µg/mL, standard ascorbic acid at 0–100 µg/mL, OH radical scavenging at 240–1000 µg/mL, quercetin standard at 0–300 µg/mL showed significant results | | | [153] |
| | | EtOH | Hydrogen peroxides and superoxide scavenging activity | H2O2 scavenging for 0.2 and 1.0% extract concentration = 34.6 and 58.3%, respectively; reducing power for 0.2 and 1.0% extract = 59.8 and 86.3% activity, respectively; while standard thiobarbitaric acid extract at 0.2 and 1.0% = 59.7 and 86.3% activity, respectively | | | [62] |
| *M. pudica* | Aerial parts | MeOH extract and fractions (Hex, EtOAc, ACE, and MeOH) | DPPH free radical scavenging activity | DPPH assay; MeOH extract = (IC50 = 7.18 µg/mL) Fractions; MeOH = (IC50 = 158.4 µg/mL); Hex = (IC50 = 92.30 µg/mL); EtOAc = (IC50 = 49.59 µg/mL); ACE = (IC50 = 45.63 µg/mL). Ascorbic acid = (IC50 = 20.13 µg/mL) | | | [46] |
| | | MeOH extract and fractions (Hex, EtOAc, ACE, and MeOH) | DPPH free radical scavenging assay | DPPH = 1268 µmol TE/g; ORAC = 2207 µmol TE/g; chlorogenic acid (reference drug), DPPH = 2927 µmol TE/µmol; ORAC = 11.939 µmol TE/µmol; quercetin (reference drug); DPPH = 6724 µmol TE/µmol; ORAC = 22.218 µmol TE/µmol | | | [155] |
| | | Isolated flavonoids | DPPH free radical scavenging activity, oxygen radical absorbance capacity (ORAC) | DPPH = 53.3 µmol TE/g; ORAC = 106.6 µmol TE/g | | | [32] |
| | | | EIOH extract = 35.3 g vitamin C eq/kg; EIOAc fraction = 65.3 g vitamin C eq/kg | | | | |
Table 2. Cont.

| Activities       | Plant          | Plant Part           | Extract/Fraction                  | Assay                                      | Model                  | Results/Outcome/Response                                                                 | References |
|------------------|----------------|----------------------|-----------------------------------|--------------------------------------------|------------------------|------------------------------------------------------------------------------------------|------------|
| Antioxidant      | *M. hamata*    | Whole plant          | Crude EtOH extract and sub-fraction (EtOAc and diethyl ether) | DPPH radical scavenging, hydrogen peroxide scavenging assay | % inhibition at 100 µg/mL; DPPH scavenging; crude EtOH extract = 76.01% EtOAc, diethyl ether sub-fraction = 96.63%; ascorbic acid = 93.52%; H₂O₂ scavenging; extract = 67.81% EtOAc, diethyl ether sub-fraction = 88.43%; ascorbic acid = 86.87% scavenging activity | [29]       |
|                  |                | Stem                 | MeOH, cycloHex, and EtOAc         | DPPH free radical scavenging assay         | In vitro              | DPPH radical scavenging assay IC₅₀: MeOH = 0.70 µg/mL, EtOAc = 0.85 µg/mL, cycloHex = 0.95 µg/mL, ascorbic acid = 0.60 µg/mL, ABTS assay IC₅₀: MeOH = 0.35 µg/mL, EtOAc = 0.37 µg/mL, cycloHex = 0.40 µg/mL, ascorbic acid = 0.32 µg/mL | [33]       |
|                  | *M. albida*    | Whole fresh plant    | Aq.                               | DPPH radical, ferric reducing antioxidant power (FRAP), Trolox-equivalent antioxidant capacity (TEAC), oxygen radical absorption capacity (ORAC), low-density lipoprotein (LDL) assays |                        | DPPH = 1540 µmol TE/g; FRAP = 1070 µmol TE/g; TEAC = 1770 µmol TE/g; ORAC = 1870 µmol TE/g; LDL = 50% inhibition | [157]      |
|                  | *M. invisa*    | Leaves               | Aq. Extract                        | DPPH radical scavenging assay              | In vitro              | Aq. extract IC₅₀ = 0.119 mg/mL; Ascorbic acid IC₅₀ = 0.058 mg/mL                           | [127]      |
|                  | *M. verrucosa* | Bark                 | EtOH                              | DPPH radical and ABTS radical cation scavenging assay | -                      | DPPH (IC₅₀) = 33.22 µg/mL, ABTS (IC₅₀) = 4.91 µg/mL                                       | [137]      |
|                  | *M. pteridifolia* | Bark               | EtOH                              | DPPH radical and ABTS radical cation scavenging assay |                        | DPPH (IC₅₀) = 51.82 µg/mL, ABTS (IC₅₀) = 4.88 µg/mL                                       | [137]      |
| Anticancer       | *M. tenuiflora*| Biofilm of cortex and chitosan | Biocomposite film                | (3T3) fibroblast by MTT assays             |                        | Cells decreased significantly in the 90:10 and 80:20 chitosan/M. tenuiflora films. Cytotoxicity increased in high-concentration M. tenuiflora (70:30) and chitosan films (100:0) | [129]      |
| activity         |                |                      |                                   |                                            |                        | Extract displayed IC₅₀ ≥ 50 µg/mL against all cell lines, while no activity was observed against HCT-116 | [137]      |
Table 2. Cont.

| Activities           | Plant         | Plant Part | Extract/Fraction | Assay                  | Model                          | Results/Outcome/Response                                                                 | References |
|----------------------|---------------|------------|------------------|------------------------|-------------------------------|----------------------------------------------------------------------------------------|------------|
| Anticancer activity  | *M. pudica*   | Leaves     | PE, EtOAc, EtOH, Aq. extract | MTT assay              | In vitro: Human cancer cell lines from lungs (CHAGO), liver (HepG2), colon (SW620) | CHAGO cell; absolute EtOAc (IC50 = 29.74 μM), SW620 cell; EtOAc (IC50 = 11.12 μM) and absolute EtOH (IC50 = 5.85 μM); HepG2 cell; EtOAc (IC50 = 2.90 μM) and absolute EtOH (IC50 = 10.11 μM) | [152]      |
|                      |               | Whole plant| HyEtOH extract and L-mimosine compound | MTT assay              | In vitro: Daudi cell line    | At concentration 12.5–400 μg/mL; Extract showed IC50 = 201.65 μg/mL and L-Mimosine (IC50 = 86.61 μM) | [31]       |
|                      | *M. pigra*    | Leaves     | HyMeOH           | MTT assay              | In vitro: Male Wistar rats, endothelial and arterial smooth muscle cell | Extract (0.01–1 mg/mL) showed no significant effect on cellular viability/proliferation | [155]      |
|                      |               | Fruit      |                  |                        | Intake orally                | Active against tumor           | [98]        |
|                      | *M. caesalpiniofida* | Leaves    | EtOH             | SRB assay              | Human breast cancer cell line MCF-7 | Extract showed maximum effect at 320.0 μg/mL                                           | [158]      |
|                      |               | Stems, bark| EIOH extract, n-Hex, DCM, EtOAc, Aq. fractions | MTT assay              | HCT-116 (colon), OVCAR-8 (ovarian), SF-295 (glioblastoma) tumor cell lines | EIOAc and Aq. fractions showed minimum inhibition of cell proliferation while EIOH showed IC50 values of 69.5–84.8%, n-Hex fraction IC50 was 65.5–86.4%, DCM fraction and betulinic acid ≤ 86.5%, doxorubicin ≥ 83.0% | [49]       |
|                      | *M. rubicaculislam* | Stems      | MeOH             | XTT assay (EAC, MCF-7, MDA-MB 435S cell lines) | In vivo: Swiss albino mice | At dose of 200 mg/kg; IC50 values of extract; EAC = 72.326 μg/mL; MCF-7 = 69.692 μg/mL; MDA-MB 435S = 80.565 μg/mL; IC50 tamoxifen (stranded); EAC = 22.42 μg/mL; MCF-7 = 20.7 μg/mL; MDA-MB 435S = 20.87 μg/mL | [122]      |
|                      | *M. verrucosa* | Barks      | EtOH             | MTT assay              | Human tumor cell lines HL-60 (acute myeloid leukemia), HCT-116 (colorectal carcinoma), PC-3 (prostate adenocarcinoma), SF-295 (glioblastoma) | Extract displayed IC50 ≥ 50 μg/mL against all cell lines                                  | [137]      |
|                      | *M. pteridifolia* | Barks     | EtOH             | MTT assay              | Human tumor cell lines HL-60 (acute myeloid leukemia), HCT-116 (colorectal carcinoma), PC-3 (prostate adenocarcinoma), SF-295 (glioblastoma) | Extract displayed IC50 ≥ 50 μg/mL against all cell lines                                  | [137]      |
| Antidiabetic activity | *M. pudica*   | Aerial parts| MeOH extract and fractions (Hex, EtOAc, ACE, and MeOH) | α-Amylase inhibitory assay, α-glucosidase inhibitory assay | In vitro | % inhibition in α-amylase and α-glucosidase inhibitory assays showed by MeOH extract = 33.86 and 95.65% (fractions; Hex = 10.58 & 0.884%, EtOAc = 18.65 and 51.87%, ACE = 15.64 and 16.04%, MeOH= 27.21 and 4.83%), respectively. Standard acarbose = 28.24 and 36.93% | [46]       |
|                      |               | Whole plant| 80% EtOH | Oral glucose tolerance test (OGTT) and fasting blood glucose test | Streptozotocin (STZ)-induced diabetic male albino Wistar rats | Extract 500 mg/kg bw did not decrease blood glucose in STZ-induced diabetic rats as compared to 0.5 mg/kg bw. After 1 week, blood glucose reduction shown by extract (500 mg/kg bw) = 421.00 mg/dL, glybenclamide (0.5 mg/kg bw) = 572.67 mg/dL | [159]      |
| Activities          | Plant       | Plant Part   | Extract/ Fraction | Assay                      | Model                                      | Results/Outcome/Response                                                                 | References |
|--------------------|-------------|--------------|-------------------|----------------------------|--------------------------------------------|------------------------------------------------------------------------------------------|------------|
| Antidiabetic activity | M. pudica   | Whole plant  | Aq. and HyEtOH extracts | Fasting blood glucose test (FBG) | Streptozotocin (STZ)-induced diabetic male albino Wistar rats | Significantly decreased FBG levels At 250 mg/kg bw concentration of Aq. = 517 mg/dL, Hy-EtOH = 484.00 mg/dL. At 500 mg/kg bw concentration Aq. = 309.88 mg/dL, HyEtOH = 484.00 mg/dL, glibenclamide (0.5 mg/kg bw) = 419.00 mg/dL | [160]      |
|                     |             | Leaves       | ACE–Aq.–AA (8.0 mL, 70:29.5:0.5) | α-Amylase and α-glucosidase inhibitory assay | In vitro | α-Amylase = 189.3 µmol AE/g; α-glucosidase = 6.6 µmol AE/g. Acarbose was used as the positive control. | [150]      |
|                     | M. pigra    | Stems        | MeOH              | Glucose oxidase method        | Swiss albino male mice                     | Significant blood glucose reduction by extract at 400 mg/kg/bw = 50.50%, glibenclamide (10 mg/kg/bw) = 56.33% | [97]       |
|                     |             | Roots        | EtOH              | Fasting blood glucose (FBG)   | Albino rats                                | Significant blood glucose reduction in acute study extract (250 and 500 mg/kg) = 360.00 and 391.80 mg/dL respectively; glibenclamide (10 mL/kg) = 485.8 mg/dL. In prolonged study, extract (250 and 500 mg/kg) = 140.00 and 125.00 mg/dL, respectively. Glibenclamide (10 mL/kg) = 273.60 mg/dL | [161]      |
| Wound-healing effects | M. tenuiflora | Leaves       | Herbal mix of leaf extract (20%) and A. Vulgaris (20%) | In vitro/scratch assay | In vivo: Human keratinocyte (HaCaT) and umbilical vein endothelial cells (HUVECs), mouse fibroblast 3T3-L1 cells | Rapid wound healing observed | [162]      |
|                     |             | Bark         | Aq. extracts, EtOH-precipitated compounds (EPC) | Mitochondrial activity (MTT, WST-1), proliferation (BrdU incorporation), necrosis (LDH) | In vitro: Human primary dermal fibroblasts and HaCaT keratinocytes | Aq. extract (10 and 100 µg/mL) loss of cell viability was observed proliferation in dermal fibroblasts. EPC (10 µg/mL) only stimulated mitochondrial activity and proliferation of dermal fibroblasts. EPC at 100 µg/mL showed minor stimulation of human keratinocytes | [108]      |
|                     | Whole plant | 10% concentra- | Crude EtOH cortex extract standardized in its tannin concentration (1.8%) | Double-blind, randomized, placebo-controlled clinical trial | Patients diagnosed with venous leg ulceration (VLU) | Ulcer size was reduced by 92% | [24]       |
|                     | Whole plant | Adult human external use | MeOH | Chorionsallantoic membrane (CAM) model | Ex vivo: Fertilized chick eggs | Significant results observed | [163]      |
| Activities                  | Plant          | Plant Part | Extract/Fraction | Assay                        | Model                                      | Results/Outcome/Response                                                                 | References |
|-----------------------------|----------------|------------|------------------|------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------|------------|
| Hypolipidemic activity      | M. pudica      | Whole plant| 80% EtOH         | TC, TG, HDL, LDL             | Streptozotocin (STZ)-induced diabetic male albino Wistar rats | Extract at 500 mg/kg bw increased HDL level = 46.33 mg/dL but decreased TC = 111.67 mg/dL, TG = 121.67 mg/dL, LDL = 41.00 mg/dL in the diabetic rats as compared to standard glybenclamide (0.5 mg/kg bw) | [159]      |
|                             |                | Leaves     | EtOH             | TG, TC, VLDL, LDL, HDL      | Wistar albino rats, induced hepatic injury by (CCl₄) | Extract at the dose of 400 mg/kg showed significant decreases in TG, TC = 98.7 mg/dL, VLDL = 26.9 mg/dL, LDL = 37.4 mg/dL, HDL = 34.3 mg/dL | [58]       |
|                             | M. tenuiflora  | Bark       | MeOH/NaOH precipita-| Edematogenic effect | Wistar rats of acute inflammation (paw edema and peritonitis) | Edematogenic effect at 1 mg/kg− concentration of polysaccharides extracted from M. tenuiflora bark was = 40x as compared to saline, while inhibited by L-NAME = 52%, dexamethasone = 26% | [164]      |
|                             |                | Leaves     | Aq.              | Bovine serum albumin, egg   | In vitro                                   | Reduced activity of extract in serum albumin at 0.2 and 1.0% concentration = 59.7 and 83.7%, respectively; while drug diclofenac sodium = 51.5%; In egg at 0.2 and 1.0% conc = 39.6 and 76.7%, respectively. Standard drug diclofenac sodium = 42. 5% | [62]       |
| Anti-inflammatory and hepato- | M. pudica      | Leaves     | Aq.              | Sperm motility, sperm morphology, sperm count | Adult male Sprague–Dawley rats, cadmium-induced testicular damage | (1) Significant activation of sperm motility shown by extract at 250 mg/kg = 9.00%, control group (Aq.) = 15.00%. (2) Both doses showed significant effects on sperm morphology. (3) Sperm counts were significantly increased at 250 mg/kg = 4.18 × 10⁶/cc; 500 mg/kg = 2.54 × 10⁶/cc; control group = 12.78 × 10⁶/cc | [165]      |
| protective activities       |                |            | Crude powder     | ALP, ACP, LPO, γ-GT, AST, ALF | Male albino rats, induced jaundice by (CCl₄) | 100 mg/kg dose of extract significantly reduced the levels of all parameters and protected the hepatic cells | [57]       |
| M. caesalpii-                  |                | Leaves     | HyOH extract, EtOAc fraction | Histopathological analysis | Adult male Wistar rats | HyOH extract (125 and 250 mg/kg), EtOAc fraction (25 and 50 mg/kg) were effective | [166]      |
| nisifolia                    |                |            | TTNFα-induced    | In vitro: male Wistar rats, endothelial cells | | Extract (0.01–1 mg/mL) inhibited 90% and pyrrolidine dithiocarbamate (200 mM) inhibited 98% TTNFx | [155]      |
| M. pigra                     |                | Leaves     | HyMeOH           | Chronic hypoxic PAH          | In vivo: Male Wistar rats                   | Decreased pulmonary arterial pressure = 22.3%, pulmonary artery = 20.0%, cardiac remodeling = 23.9% was observed | [155]      |
### Table 2. Cont.

| Activities       | Plant   | Plant Part | Extract/Fraction | Assay                                           | Model                           | Results/Outcome/Response                                                                 | References |
|------------------|---------|------------|------------------|-------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------|------------|
| Antinociceptive activity |         |            |                  |                                                 |                                 | **M. pudica** Leaves EtOAc Hot plate test, tail flick test, AA-induced writhing test Adult Wistar rats | [167]     |
|                  |         |            |                  |                                                 |                                 | Hot plate test after 30 min significantly increased analgesic activity by extract at 100 mg/kg = 8.03; 200 mg/kg = 8.31; 400 mg/kg = 8.93; standard diclofenac sod. = 9.66. Tail flick test after 30 mins significantly increased analgesic activity at 100 mg/kg extract = 6.78; 200 mg/kg = 8.16; 400 mg/kg = 7.98; standard diclofenac sod. = 8.11. Significant reduced writhing shown by extract at 100, 200, and 400 mg/kg = 20.18, 33.42, and 43.46%, respectively; standard diclofenac sodium = 52.01% |           |
|                  |         |            |                  |                                                 |                                 | **M. Pigra** Stems MeOH AA-induced writhing test Swiss albino mice male | [97]       |
|                  |         |            |                  |                                                 |                                 | Significant reduction in writhing; extract (400 mg/kg/bw) = 85.01%, aspirin (400 mg/kg/bw) = 59.97% |           |
|                  |         |            |                  |                                                 |                                 | **M. albida** Roots Aq. AA-induced writhing test, hot plate test Male ICR mice | [106]     |
|                  |         |            |                  |                                                 |                                 | Extract (50 mg/kg) and dyiprine (500 mg/kg) reduced writhing. Fentanyl (0.1 mg/kg) and extract at variable concentrations showed pain latency |           |
| Antiepileptic activity |         |            |                  |                                                 |                                 | **M. pudica** Leaves EtOAc Electric shocks, PTZ-induced convulsions, INH-induced convulsions Swiss albino mice | [167]     |
|                  |         |            |                  |                                                 |                                 | In electric shock test, extract at 100, 200, and 400 mg/kg and diazepam 04 mg/kg exhibited delayed onset time of convulsion = 1.87, 2.69, 3.21, and 3.53 s, as well as decreased duration of convulsion of 68.09, 53.54, 42.21, and 38.89 s, respectively. In PTZ-induced convulsion test, extract at 100, 200, and 400 mg/kg and diazepam 04 mg/kg showed delayed onset time of convulsion = 5.38, 6.08, 6.98, and 7.31 min and decreased duration of convulsion of 14.76, 12.65,11.13, and 9.39 min, respectively. In INH-induced convulsion test, extract at 100 mg/kg = 37.21, 200 mg/kg = 45.49, 400 mg/kg = 58.62 min, diazepam 04 mg/kg = 69.14 min delayed convulsion latency |           |
|                  |         |            |                  |                                                 |                                 | **M. pudica** Roots EtOH Maximal-electroshock-induced seizures (MES) and pentylenetetrazole (PTZ)-induced seizures Adult Swiss albino mice | [35]       |
|                  |         |            |                  |                                                 |                                 | In MES, the % inhibition of convulsions in mice at different doses (1000 mg/kg = 42.41%; 2000 mg/kg = 52.35%) were noted and standard valproate showed 73.86% inhibition at 200 mg/kg. In PTZ-induced seizure, the clonic convulsion onset time, duration of clonic convulsions, and postictal depression were observed for a period of 30 min. Extract (1000 and 2000 mg/kg) showed significant decreases in numbers and durations of myoclonic jerks, clonic seizures, and postictal depression. |           |
| Activities | Plant | Plant Part | Extract/Fraction | Assay | Model | Results/Outcome/Response | References |
|------------|-------|------------|------------------|-------|-------|--------------------------|------------|
| Neuropharmacological activities | | | | | | | |
| | | | | | | | |
| | M. tenuiflora | Whole plant | MeOH | Acetylcholinesterase inhibitory therapy | Ex vivo | Plant showed anti-Alzheimer’s properties | [163] |
| | | Whole plant | EtOH | Swimming endurance test, radial arm maze, Morris Aq, maze and retention phase | In vivo: Albino Wister rats suffering from chronic Alzheimer’s | Oral dose of 300 mg/kg of extract and 2 mg/kg diazepam standard were effective in swimming endurance test. In all other tests, extract was found to effective in reducing stress as compared to standard D-galactose + Piracetam | [154] |
| | | Whole plant | Aq. | Vertical grid test, horizontal grid test, immunohistochemistry | In vitro: Male C57BL/6j mice | In vertical grid test, extract at 100 and 300 mg/kg significantly increased time taken to climb the grid. In horizontal grid test, extract at 100 and 300 mg/kg decreased the hang time, extract at 100 and 300 mg/kg decreased SYN and increased DAT and TH-positive cells | [168] |
| | M. pudica | Leaves | EtOAc | Locomotor activity, rotarod and traction test | Swiss albino mice | Significant decreased in locomotor activity was observed in extract at 100 mg/kg = 362.43, 200 mg/kg = 331.24, 400 mg/kg = 276.12, diazepam 04 mg/kg = 152.41. In rotarod test, the fall time was decreased significantly by extract at 100 mg/kg = 173.45, 200 mg/kg = 149.13, 400 mg/kg = 121.43, diazepam 04 mg/kg = 19.21. In traction test, the holding time of mice was significantly decreased by extract at 100 mg/kg = 4.83, 200 mg/kg = 3.47, 400 mg/kg = 2.75, diazepam 04 mg/kg = 1.03 | [167] |
| | | Leaves | Aq. | Locomotor activity, elevated plus maze test, rotarod test | Adult Swiss albino mice | % change in locomotor activity shown by extract 200 mg/kg = 56.33%, while standard diazepam 0.5 mg/kg = 79.61%. Elevated maze test; extract 200 kg/mg and diazepam 0.5 mg/kg; increased number of open arm entries = 67.92% and 78.59%; decreased time spent in closed arms = 7.32% and 8.64%. In rotarod test, the fall time was decreased significantly by extract 200 kg/mg = 152.1 and diazepam 0.5 mg/kg 157.6 | [169] |
| | | Whole plant | Aq. | Cell viability or MTT assay | In vitro: Human neuroblastoma SH-SY5Y cells | At 300 µg, extract showed IC50 = 211.05 µg/mL against parkinsonism | [170] |
| | M. albida | Roots | Aq. | Elevated plus maze hole board test, open field test, rotarod test | Male ICR mice | In both elevated plus maze and hold board tests, the extract showed non-significant results at 3.2, 12.5, 25, and 50 mg/kg concentration, while diazepam (1 mg/kg/ip) showed significant results. In open field test, the significant effects at variable concentrations (50, 100, 200 mg/kg) extract of 200 mg/kg and diazepam (1 mg/kg/ip) showed significant results in rotarod test | [106] |
### Table 2. Cont.

| Activities                                      | Plant               | Plant Part | Extract/Fraction | Assay               | Model                                      | Results/Outcome/Response                                      | References |
|------------------------------------------------|---------------------|------------|------------------|---------------------|--------------------------------------------|---------------------------------------------------------------|------------|
| Antiallergic and antihyperuricemic activities  | M. tenuiflora       | Bark       | Glycemic extract  | Patch test          | Women suffering from acute eczema         | Inhibition % of uric acid formation in M. pudica tablet IC<sub>50</sub> = 68.04 ppm, extract IC<sub>50</sub> = 32.75 ppm, allopurinol (standard) IC<sub>50</sub> = 18.5 ppm | [113]     |
|                                                | M. pudica           | Leaves     | EtOH 70%          | Inhibitory activity assay | In vitro: Male rats (Rattus norvegicus) | Ex vivo: Swiss–Webster mice (Mus musculus) Inhibitory activity on uric acid | [171]     |
|                                                |                     |            |                  |                     |                                             |                                                                |            |
|                                                |                     | Leptin and stem | Parasitological and histological analysis | Female lambs | No significant effect observed | REFERENCES |            |
| Larvicidal, antiparasitic, and molluscicidal activities | M. tenuiflora       | Leaves     | Hex, ACE, MeOH | Antiprotozoal assay | In vitro: E. histolytica, G. lamblia | At concentration of 2.5–200 µg/mL; E. histolytica and G. lamblia showed activities in Hex (IC<sub>50</sub>) = 65.9 and 80.2 µg/mL, ACE = 80.7 and 116.8 µg/mL, MeOH = 73.5 and 95.5 µg/mL, respectively | [173]     |
|                                                |                     | Stems      | EtOH             | MTT assay and counting parasites | In vitro: Biomphalaria glabrata | At 100 µg/mL; IC<sub>50</sub> = 6.59 mg/L; LC<sub>50</sub> = 20.22 mg/L; LC<sub>90</sub> = 62.05 mg/L | [174]     |
|                                                | M. pudica           | Leaves     | Aq. extract      | Larvicidal assay    | Larvae (Aedes aegypti) Poor larvicidal action at dose of 2000 mg/kg | REFERENCES |            |
|                                                |                     |            |                  |                     |                                             |                                                                |            |
|                                                | M. caesalpinifolia  | Leaves     | Dry plant leaves and condensed tannin | Worm burden | In vivo: Goats | Significantly controlled the gastrointestinal nematodes (Haemonchus, Trichostrongylus, Oesophagostomum) in goats | [177]     |
|                                                |                     |            |                  |                     |                                             |                                                                |            |
|                                                | M. tenuiflora       | Bark       | Aq. extract and fractions (DCM, BuOH and EtOAc) | Envenomation | Male BALB/c mice (in vitro) | Inhibition (%) at 30 mg/kg Aq. extract = 76%; at 40 mg/kg; DCM fraction = 73% by volume, alcohol, fraction = 81%; EtOAc fraction = 86% | [40]      |
|                                                |                     | Whole plant and callus tissue | EIOH extract, fractions (Aq., CF, PE, BZ) | Plaque inhibition method | In vivo: H. simplex, Poliomielitis type 1, V. stomatitis | EioH extract showed significant activities against all three viruses, while PE and CF fractions were found to be active against V. stomatitis | [60]      |

### 5.1. Antimicrobial Activity

Valencia-Gómez et al. [129] determined the antibacterial activity of biofilms made from chitosan and M. tenuiflora bark. Composite biofilms in different concentrations (100:0, 90:10, 80:20, and 70:30) successfully inhibited the growth of E. coli and M. lysodeikticus. Souza-Araujo et al. [130] measured the antimicrobial activity of pyroligneous acid (PA) obtained from slow pyrolysis of wood of M. tenuiflora against E. coli, P aeruginosa, S. aureus, C. albicans, and C. neoformans using the agar diffusion method. The growth of all microorganisms was inhibited by pyroligneous acid at different tested concentrations (20, 50, and 100%), whereas gentamicin was used as a standard drug. The antimicrobial potential of EtOAc (95%) extract of M. tenuiflora bark against different bacterial and fungal strains has been reported. Active doses of the extract inhibited the growth of E. coli, B. subtilis, M. luteus, and P. oxalicum. Gonçalves et al. [131] reported the antimicrobial potential of the hydroalcoholic extract of M. tenuiflora bark against various bacterial strains using the agar well diffusion method. The results revealed that the extract successfully inhibited the growth of S.
pyogenes, P. Mirabilis, S. sonnei, S. pyogenes, and Staphylococcus spp. Padilha et al. [132] described the antibacterial activity of the EtOH extract of M. tenuiflora stem bark against S. aureus by using the minimum inhibitory concentration (MIC) with the agar dilution method and time-kill assay. At concentrations up to 4x MIC, only a bacteriostatic effect was observed, while at 8.x MIC a fast bactericidal effect was observed [133]. The minimum inhibitory concentration shown by active doses of 95% M. tenuiflora EtOH extract against S. epidermidis and A. calcoaceticus were >10.0 µg/mL, S. aureus and M. luteus = 10.0 µg/mL, E. coli and K. pneumonia = 20.0 µg/mL, and C. albicans = 70.0 µg/mL [134]. The antimicrobial potential of BuOH, MeOH, and EtoAc extracts of M. tenuiflora bark against S. aureus, E. coli, and C. albicans has been reported [135]. De Morais-Leite et al. [136] determined the antibacterial potential of the EtOH extract of M. tenuiflora bark via the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) values against S. aureus (ATCC 25.925 and ATCC 25.213), E. coli (ATCC 8859 and ATCC 2536), and P. aeruginosa (ATCC 25.619). S. aureus (ATCC 25.925) and P. aeruginosa (ATCC 25.619) showed MIC and MBC values of 128 and 256 µg/mL, respectively, while S. aureus (ATCC 25.213) showed MIC = 512 and MBC = 1024 µg/mL. For E. coli (ATCC 8859) and E. coli (ATCC 2536), the observed values were MIC = 1024 and MBC >1024 µg/mL. Silva and his colleagues reported on the antimicrobial potential of the EtOH extract of M. tenuiflora bark using the minimum inhibitory concentration (MIC) values against S. aureus, E. coli, C. albicans, and T. interdigitale. Lower MIC values were observed against S. aureus [137].

Racadio [116] and Molina [117] reported on the antimicrobial activity of the EtOH extract of M. pudica leaves against S. aureus, B. subtilis, and C. albicans using the Kirby–Bauer disc diffusion method. Inhibition zones were observed against S. aureus = 21.8 mm (4.61%), B. subtilis = 23.7 mm (9.56%), and C. albicans = 6.1 mm (1.96%). Nagarajan et al. [139] determined the antibacterial activity of Aq. extracts of M. pudica leaves and stems against E. coli, staphylococcus sp., Bacillus sp., Pseudomonas sp., and Streptococci sp. by disc diffusion method. Zones of inhibition were observed against order E. coli (18 mm) > Bacillus sp. (12.5 mm) > Pseudomonas sp. (12 mm) > Staphylococcus sp. (11 mm) > Streptococci sp. (9 mm). Abirami et al. [139] reported on the antimicrobial potential of extracts (ACE, EtOAc, petroleum ether, and Aq.) of M. pudica leaves using the well diffusion method. The antimicrobial efficacy levels of all of the extracts were determined against E. coli, P. aerogios, L., Bacillus, S. typhi, S. aureus, P. foedians, F. oxysporum, and P. variotii at different concentrations of 30, 60, 90, and 120 µL/mL. ACE extract showed a maximum zone of inhibition against S. aureus, while Aq. extract showed a maximum activity against E. coli. Petroleum ether showed a higher zone of inhibition against S. typhi. Durgeidevi and Karthika [62] determined the antimicrobial potential of Aq. extract of M. pudica leaves by using the agar well diffusion method against B. cereus, E. coli, P. vulgaris, P. auruginosa, S. aureus, A. flavus, A. niger, A. terreus, Fusarium sp., and Penicillium sp. at different concentrations (25, 50, 75 and 100 mg). The extract showed significant zones of inhibition at 100 mg concentration. Sheeba et al. [140] determined the antibacterial activity of the MeOH extract of M. pudica leaves using the disc diffusion method against P. aeruginosa, S. aureus, and V. harveyi. The plant extract showed zones of inhibition against S. aureus (10.66 mm), P. aeruginosa (8.66 mm), and V. harveyi (8.00 mm), while ampicillin was used as the standard antibiotic. Sheeba et al. [140] determined the antimycobacterial activity of MeOH extracts of M. pudica leaves against M. tuberculosis using disc diffusion and agar well diffusion methods. Extract exhibited a zone of inhibition against M. tuberculosis (disc diffusion = 7.00 mm; agar well diffusion method = 4.33 mm), Kakad et al. [141] determined the antibacterial activity of MeOH extract of M. pudica leaves against two Gram-positive (B. subtilis, S. aureus) and three Gram-negative (P. aeruginosa, P. vulgaris, and S. typhi) bacterium using the agar well diffusion method. Significant results were obtained and data were compared with the standard antibiotics penicillium (100 µg/disc) and gentamicin (10 µg/disc). Muhammad et al. [82] measured the antifungal activity of extracts (EtOH and Aq.) of M. pudica leaves against T. verrucosum, M. ferrugineum, T. shoenleinii, T. rubrum, M. canis, T. concentricum, T. soudanense, and M. gysem at four different
concentrations (150, 200, 250, and 300 mg). T. verrucosum, M. ferrugineum, T. shoenleinii, M. canis, T. soudanese, and M. gyseum were sensitive to EtOH extract.

Thakur et al. [142] determined the antimicrobial activity of hydroalcoholic extract of M. pudica leaves against E. coli, S. aureus, P. aeruginosa, and B. cereus using the disc diffusion method. The extract showed significant results at 25, 50, and 100 µL/disc concentrations. Le Thoa et al. [143] measured the antibacterial activity of Aq. and EtOH extracts of M. pudica leaves and stems using the agar well diffusion method. The EtOH extract showed significant zones of inhibition against different strains (E. coli = 11 mm, S. aureus = 19 mm, B. cereus = 17 mm, S. typhi = 16 mm), while the Aq. extract significantly inhibited S. aureus = 14 mm and B. subtilis = 15 mm. The results were compared with standard chloramphenicol. Dhanya and Thangavel [144] measured the antimicrobial potential of MeOH extracts of M. pudica leaves, flowers, and roots against S. aureus, E. coli, and Pseudomonas sp. using the disc diffusion method. Zones of inhibition shown by the extract of the leaves in decreasing order were: S. aureus (23.5 mm) > E. coli (20 mm) > Pseudomonas sps (14 mm). The flower extract showed activity against Pseudomonas sp. 22.5 > E. coli 14 > S. aureus 12 mm. The root extract also showed significant activity against R. solani (29 mm) > A. niger (21 mm) > M. phaseolina (17.7 mm). Ahuchaogu et al. [145] screened the antimicrobial potential of the EtOH extract of M. pudica whole plant against S. aureus, P. aeruginosa, E. coli, M. smegmatis, and E. faecalis at various concentrations (25, 50, and 100 mg/disc). At 100 mg/disc, maximum antimicrobial activity was observed and a comparison was made with standard chloramphenicol. Chukwu et al. [146] determined the antimicrobial activity of absolute EtOH extract of M. pudica whole plant against the tested microorganisms (A. flavus and T. rubrum) at three different concentrations (25, 50, and 100 mg/mL). At 100 mg/mL, the extract was very found to be highly active against A. flavus and T. rubrum (100 mg/mL = 22 and 17 mm, respectively). Rosado-Vallado et al. [23] screened the antimicrobial potential of MeOH and Aq. extracts of P. pigmentatus against various microorganisms (S. aureus, E. coli, P. aeruginosa, B. subtilis, A. niger, and C. albicans) using the agar–well diffusion method. Itraconazole (0.025 mg/µL), nystatin (50 IU/mL), and amikacin (0.03 mg/mL) were used as positive controls for bacteria, yeast, and fungi. Both plant extracts were found to be active against P. aeruginosa, C. albicans, S. aureus, and B. subtilis and inactive against E. coli and A. niger. De Morais et al. [147] determined the antifungal activity of 60% MeOH, DCM, and EtOAc fractions of P. pigmentatus leaves by measuring the minimum inhibitory concentration (MIC) values against dermatophyte strains (T. mentagrophytes, E. floccosum, M. gyseum, and T. rubrum). The MeOH extract showed the lowest MIC values against all dermatophytes (1.9 to 1000 mg/mL). DCM, EtOAc, and Hex fractions showed significant results. Jain et al. [60] determined the in vitro antimicrobial activity of EtOH extracts and fractions (Aq., CF, PE, and BZ) of M. hamata whole plant against E. coli, K. pneumonia, P. aeruginosa, S. aureus, P. vulgaris, A. flavus, F. moniliforme, and R. bataticola by disc diffusion method. At 500 mg/disc, the EtOH extract and Aq. fraction inhibited the growth of all bacteria and fungi, although the activity of the Aq. fraction was less than that of the EtOH extracts. PE was found to be active against fungi. Ali et al. [148] measured the antimicrobial activity of crude Hex and MeOH extracts of M. hamata whole plant. The Hex extract showed potent % growth inhibition against B. cereus (29.75%), C. diptheriae (1.40%), P. aeruginosa (74.11%), A. niger (30.50%), M. canis (36.21%), and M. phaseolina (89.95%), while the MeOH extract also showed potent activity against B. cereus (59.49%), C. diptheriae (30.16%), E. coli (6.31%), S. sonii (73.13%), P. aeruginosa (32.74%), S. typhi (16.84%), S. pyogenes (57.18%), T. longisettes (67.26%), P. boydii (95.10%), M. canis (45.51%), T. simii (75.00%), F. solani (54.75%), and T. schoenleinii (84.18%). Standard ampicillin and rifampicin showed 99–100% growth inhibition. Mahmood et al. [5] investigated the antimicrobial potential of crude MeOH extract of M. pigmentatus leaves against E. coli, B. subtilis, P. aeruginosa, K. pneumonia, A. niger, and A. flavus by agar tube diffusion and agar tube dilution methods for bacteria and fungi, respectively. The plant showed significant inhibition of E. coli, P. aeruginosa, and K. pneumonia bacteria and minor activity against B. subtilis, while no activity was observed against fungi. Silva and his colleagues
reported the antimicrobial potential of the EtOH extracts of *M. verrucosa* and *M. pteridifolia* bark via the minimum inhibitory concentration (MIC) values against *S. aureus, E. coli, C. albicans, T. interdigitale*. *M. verrucose,* and *M. pteridifolia,* showing lower MIC values of 250 µg/mL and 500 µg/mL, respectively, against *S. aureus* [137] (Table 2).

### 5.2. Antioxidant Activity

Magalhães et al. [149] determined the antioxidant potential of the EtOH extract and various fractions (n-hex, DCM, EtOAc, and HyOH) of *M. tenuiflora* leaves, twigs, barks, and roots using DPPH and ABTS radical scavenging activities. The EtOH extract showed the lowest EC$_{50}$ values against DPPH (EC$_{50} = 132.99$ µg/mL) and ABTS (EC$_{50} = 189.14$ µg/mL) radicals. The EtOAc fraction proved to have potent antioxidant activity against DPPH (EC$_{50} = 141.20$ µg/mL) and ABTS (EC$_{50} = 273.00$) radicals. Silva and colleagues determined the antioxidant potential of the EtOH extract of *M. tenuiflora* bark using DPPH and ABTS scavenging assays. The plant showed potent scavenging effects against DPPH and ABTS radicals, with IC$_{50}$ values of 17.21 and 3.57 µg/mL, respectively. The results were compared with Trolox [137]. Almalki [30] reported the antioxidant potential of *M. pudica* leaves (Hex extract) by using the DPPH, hydroxyl, nitric oxide, and superoxide radical scavenging assays. The extracts showed significant scavenging effects at concentrations between 5 and 25 mM against DPPH (IC$_{50} = 20.83$ mM), hydroxyl (IC$_{50} = 19.37$ mM), nitric oxide (IC$_{50} = 21.62$ mM), and superoxide (IC$_{50} = 22.19$) radicals, while the standards butylated hydroxytoluene and vitamin C showed excellent antioxidant potential as compared to the plant extract. Lee et al. [150] determined the antioxidant potential of hydrophilic extracts (ACE-Aq.-AA (8.0 mL, 70:29.5:0.5) of *M. pudica* leaves using oxygen radical absorbance capacity (ORAC) and DPPH free radical scavenging assays. The extract showed significant results in the ORAC (1187.9 µmol TE g$^{-1}$ FW) and DPPH (EC$_{50} = 243.2$ mg kg$^{-1}$) assays, while the total vitamin C content was found to be 259 µg/g FW. Durgadevi and Karthika [62] measured the antioxidant activity of the Aq. extract of *M. pudica* leaves using the H$_2$O$_2$ scavenging assay. Different concentrations (0.2, 0.4, 0.6, 0.8, and 1.0%) of the extract showed (34.6, 39.4, 49.6, 54.6, and 58.3%) significant antioxidant activity. The results were compared with standard thiobarbituric acid. Das et al. [151] determined the antioxidant potential of the MeOH extract of *M. pudica* leaves via DPPH free radical scavenging assay. The IC$_{50}$ values of extracts and ascorbic acid were found to be 126.71 and 20.13 µg/mL, respectively, while the total antioxidant capacity of the extract was IC$_{50} = 5.038$ mg/g AAE. Chimsook [152] screened the antioxidant activity levels of PE, EtOAc, absolute EtOH, and Aq. extract of *M. pudica* leaves using ABTS assay. The extract showed significant results (EC$_{50}$; PE = 40.6, EtOAc = 27.2, absolute EtOH = 73.8, Aq. = 13.2 µg/mL), while standard ascorbic acid showed EC$_{50} = 11.5$ µg/mL. Parmar et al. [31] screened the antioxidant activity of the HyEtOH extract and L-mimosine compound of *M. pudica* whole plant (stems, leaves, roots, and flower buds) using the DPPH free radical scavenging assay. L-mimosine treatment exhibited lower antioxidant activity than the extract.

Jose et al. [153] screened the in vitro antioxidant activity of isolated flavonoids from EtOAc-soluble fractions of *M. pudica* whole plant by using DPPH and hydroxyl radical scavenging assays. Significant DPPH radical scavenging was observed (IC$_{50} = 56.32$ µg/mL) as compared to the reference standard (ascorbic acid IC$_{50} = 21.11$ µg/mL). The isolated flavonoid also showed significant % inhibition at concentrations of 20–140 µg/mL, while ascorbic acid showed significant % inhibition. Ittiyavirah and Pullochal [154] measured the antioxidant activity of the EtOH extract of *M. pudica* whole plant by using H$_2$O$_2$ and superoxide scavenging assays. The plant showed significant H$_2$O$_2$ scavenging (IC$_{50} = 19$ mg/mL), while standard ascorbic acid showed IC$_{50} = 5.2$ mg/mL. Significant superoxide scavenging was also observed (IC$_{50} = 80.4$ mg/mL) and gallic acid was used as the standard (IC$_{50} = 50.10$ mg/mL). Tunna et al. [46] determined the antioxidant potential of the MeOH extract and fractions (n-hex, EtOAc, ACE, and MeOH) of *M. pudica* aerial parts using the DPPH free radical scavenging assay. The plant showed significant
DPPH radical scavenging and the results were compared with standard ascorbic acid (IC\textsubscript{50} = 20.13 µg/mL). Silva et al. [32] measured the total phenol and antioxidant potential of the EtOH extract and EtOAc fraction of M. caesalpinifolia leaves using the DPPH free radical scavenging assay. The results for the total phenol and antioxidant activity showed a concentration of 46.8 g gallic acid eq./kg with an antioxidant activity of 35.3 g vitamin C eq./kg in the EtOH extract and 71.50 g gallic acid eq./kg with an antioxidant activity of 65.3 g vitamin C eq./kg in the EtOAc fraction. Rakotomalala et al. [155] determined the antioxidant capacity of the HyMeOH extract of M. pigra leaves using DPPH free radical scavenging activity and oxygen radical absorbance capacity (ORAC) assays. The extract showed significant antioxidant potential (DPPH = 1268 and ORAC = 2287 µmol TE/g) as compared to the standard drugs chlorogenic acid (DPPH = 2927 and ORAC = 11.939 µmol TE/µmol) and quercetin (DPPH = 6724 µmol TE/µmol and ORAC = 22,218 µmol TE/µmol).

Saxena et al. [29] determined the in vitro antioxidant properties of the EtOH extract and sub-fractions (EtOAc and diethyl-ether) of M. hamata whole plant using DPPH free radical and H\textsubscript{2}O\textsubscript{2} scavenging assays. The EtOH extract (76.01%) and EtOAc and diethyl-ether sub-fractions (96.63%) showed % inhibition of DPPH scavenging at 100 µg/mL concentration, while the standard drug ascorbic acid showed 93.52% inhibition. The EtOH extract (67.81%) and EtOAc and diethyl-ether sub-fractions (88.43%) showed significant H\textsubscript{2}O\textsubscript{2} scavenging activity at 100 µg/mL. The results were compared to the standard drug ascorbic acid (86.87%). Chandarana et al. [33] determined the antioxidant potential of cycloHex, EtOAc, and MeOH extracts of M. hamata stem using DPPH free radical and ABTS scavenging assays. The MeOH (IC\textsubscript{50} = 0.70 µg/mL), EtOAc (IC\textsubscript{50} = 0.85 µg/mL), cycloHex (IC\textsubscript{50} = 0.95 µg/mL) extracts showed significant DPPH free radical scavenging as compared to standard ascorbic acid (IC\textsubscript{50} = 0.60 µg/mL). In the ABTS scavenging assay, the MeOH extract showed the highest scavenging activity (IC\textsubscript{50} = 0.35 µg/mL), followed by EtOAc (IC\textsubscript{50} = 0.37 µg/mL) and cycloHex extracts (IC\textsubscript{50} = 0.40 µg/mL), while the standard drug ascorbic acid showed the highest activity (IC\textsubscript{50} = 0.32 µg/mL). Singh et al. [156] screened the antioxidant activity levels of PE, CF, BuOH, and Aq. extracts of M. hamata (stem, leaves, roots, and seeds) using a DPPH free radical scavenging assay. Different extracts of M. hamata showed significant DPPH scavenging levels, as represented by IC\textsubscript{50} values (leaves, 51.30–56.50 µg/mL; stem, 51.80–61.80 µg/mL; roots, 26.33–73.16 µg/mL; seeds, 16.60–51.16 µg/mL). Jiménez et al. [157] determined the antioxidant activity of M. albida whole plant with the help of various assays (DPPH radical scavenging, ferric reducing antioxidant power (FRAP), Trolox equivalent antioxidant capacity (TEAC), oxygen radical absorption capacity (ORAC), LDL-C oxidation inhibition). The plant showed significant antioxidant potential in various assays (DPPH = 1540 µmol TE/g, FRAP = 1070 µmol TE/g, TEAC = 1770 µmol TE/g, ORAC = 1870 µmol TE/g). The LDL-C oxidation inhibition assay showed greater than 50% inhibition at 100 µg/mL concentration of the extract. Manosroi et al. [127] investigated the antioxidant efficacy of the Aq. extract of M. Invisia leaves using a DPPH free radical scavenging assay. M. invisa showed significant free radical scavenging activity (IC\textsubscript{50} = 0.119 mg/mL), which was 0.49-fold that of the positive control (ascorbic acid). Silva and colleagues determined the antioxidant potential of the EtOH extract of M. terrucosa and M. pteridifolia bark using DPPH and ABTS scavenging assays. The plant showed potent scavenging effects against DPPH and ABTS radicals, while Trolox was used as the standard antioxidant [137]. (Table 2).

5.3. Anticancer Activity

Valencia-Gómez et al. [129] screened the cytotoxicity of biocomposite films made from M. tenuiflora cortex and chitosan against (3T3) fibroblasts using MTT assays. Chitosan–M. tenuiflora films at different concentrations (100:0, 90:10, 80:20, and 70:30) were used. The cells decreased significantly in the 90:10 and 80:20 chitosan–M. Tenuiflora films. Cytotoxicity increased for high–concentration M. tenuiflora (70:30) and chitosan films (100:0). Silva and colleagues reported on the cytotoxicity of M. tenuiflora bark EtOH extract against four
human cancer cell lines (HL-60, HCT-116, PC-3, and SF-295). No activity was observed against any tested cancer lines up to 50 µg/mL concentration [137]. Chimsook [152] reported on the in vitro anticancer activity levels of different extracts (PE, EtOAc, absolute EtOH, and Aq.) of *M. pudica* leaves against three human cancer cell lines derived from lung (CHAGO), liver (HepG2), and colon (SW620) samples using an MTT assay. The EtOAc extract was found to be potent (IC\(_{50}\) = 29.74 µM) against CHAGO cells, while the EtOAc and absolute EtOH extracts inhibited the SW620 cells, with IC\(_{50}\) values of 11.12 and 5.85 µM, respectively. HepG2 cell growth was inhibited by EtOAc (IC\(_{50}\) = 29.81 µM) and absolute EtOH (IC\(_{50}\) = 10.11 µM) extracts. The results were compared with standard amonafide, which showed significant cytotoxicity in CHAGO (IC\(_{50}\) = 1.05 µM), SW620 (IC\(_{50}\) = 0.32 µM), and HepG2 (IC\(_{50}\) = 1.71 µM) cell lines. Parmar et al. [31] screened the anticancer activity of the EtOH extracts of *M. pudica* whole-plant samples (stems, leaves, roots, and flower buds) and L-mimosine using MTT assay against the Daudi cell line. At concentrations of 12.5–400 µg/mL, the IC\(_{50}\) values were found to be 201.65 µg/mL and 86.61 µM at 72 h for *M. pudica* extract and L-mimosine, respectively. Rakotomalala et al. [155] screened the cell viability and proliferation of smooth muscle in male Wistar rats from HyMeOH extract of *M. pigra* leaves using an MTT assay. No significant effects were observed by the extract (at a concentration of 0.01 to 1 mg/mL) on smooth muscle cell proliferation or cell viability. Saeed et al. [98] measured the antitumor activity of *M. pigra* fruit extract via oral administration. This plant has been used by Sudanese healers against tumors.

Silva et al. [158] screened the anticancer activity of an EtOH extract of *M. caesalpinifolia* leaves against the human breast cancer cell line MCF-7 by using the SRB assay. The extract at 5.0 µg/mL for 24 h the reduced protein (50%) and cyclophosphamide (30%) contents, while treatment for 48 h reduced protein to 80% and cyclophosphamide to 55%, with the extract showing maximum effect at 320.0 µg/mL, which demonstrates that the extract exhibited cytotoxic effect against MCF-7 cells. Monçao et al. [49] reported on the anticancer activity of an EtOH extract and fractions (n-Hex, DCM, EtOAc, and Aq.) of *M. caesalpinifolia* stem bark using an MTT assay against HCT-116, OVCAR-8, and SF-295 cancer cells. The percentage inhibition of cell proliferation for the EtOH extract and n-Hex fraction varied from 69.5% to 84.8% and 65.5% to 86.4%, respectively, while the DCM fraction and betulinic acid showed inhibition levels above 86.5% and doxorubicin (at 0.3 µg/mL) >83.0%. EtOAc and Aq. fractions showed minimal inhibition of cell proliferation. Nandipati et al. [122] determined the cytotoxicity of the MeOH extract of *M. rubicaulis* stem against an Ehrlich ascites carcinoma (EAC) tumor model in Swiss albino mice against cancer cell lines (such as EAC, MCF-7, and MDA-MB 435S) using an XTT assay. The extract at a concentration of 200 µg/mL reduced the cytotoxicity of the cell lines (EAC 78.3%, MCF-7 = 79%, MDA-MB 435S = 83%), while standard amoxifen exhibited maximal cytotoxic effects on EAC (99.3%), MCF-7 (95.5%), and MDA-MB 435S (99.4%) cell lines. They also measured the antitumor activity of the *M. rubicaulis* (MeOH extract) against an Ehrlich ascites carcinoma (EAC) tumor model in Swiss albino mice who received 100, 200, and 400 mg/kg bw by measuring hematological parameters IRBC, WBC, hemoglobin, and PCV). At a dose of 400 mg/kg, the level of WBC increased while decreases in RBC and PCV were observed as compared to the standard drug 5-FU 20 mg/kg ip. Silva and colleagues reported on the cytotoxicity of *M. verrucosa* and *M. pteridifolia* bark EtOH extracts against four human cancer cell lines (HL-60, HCT-116, PC-3, and SF-295). No activity was observed against any of the tested cancer lines up to 50 µg/mL concentration [137] (Table 2).

### 5.4. Antidiabetic Activity

Tunna et al. [46] investigated the antidiabetic potential of MeOH extract and fractions (Hex, EtOAc, ACE, and MeOH) of *M. pudica* aerial parts using α-amylase and α-glucosidase inhibitory assays. The percentages of inhibition in α-amylase and α-glucosidase inhibitory assays shown by the MeOH extract were found to be 33.86% and 95.65%, while the fractions also showed potent inhibitory effects (Hex = 10.583% and 0.884%, EtOAc = 18.65% and 51.87%, ACE = 15.64% and 16.04%, MeOH = 27.21% and 4.83%). Standard acarbose
showed 28.24 and 36.93% inhibition effects, respectively. This study has proven the strong antidiabetic activity of tested extracts, which could lead to future studies with respect to obtaining new antidiabetic agents from *M. pudica*. Piyapong and Ampa [159] screened the hypoglycemic activity of 80% EtOH extract of *M. pudica* whole plant in diabetic male albino Wistar rats using an oral glucose tolerance test (OGTT) and fasting blood glucose test (FBG). In the OGGT, after 30 min of extract administration, the extract (500 mg/kg bw) did not decrease blood glucose (572.83 mg/dL) in diabetic rats as compared to standard glybenclamide (0.5 mg/kg bw = 473.50 mg/dL). In the FBG test, after 1 week of administration, the extract (500 mg/kg bw) decreased the blood glucose level to 421.00 mg/dL, while standard glybenclamide (0.5 mg/kg bw) also significantly decreased blood glucose level (572.67 mg/dL). Konsue et al. [160] determined the antidiabetic activity of Aq. and HyEtOH extracts of *M. pudica* whole plant in diabetic male albino Wistar rats using fasting blood glucose levels (FBG) and hematological values, including red blood cell (RBC), white blood cell (WBC), hemoglobin (Hb), platelet, hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) counts, as well as differential white blood cell, lymphocyte, monocyte, neutrophil, and eosinophil counts, at three different concentration (125, 250, and 500 mg/kg bw). At 250 mg/kg bw concentration, Aq. (517.00 mg/dL) and HyEtOH (484.00 mg/dL) extracts significantly decreased fasting blood glucose levels. The results were compared with standard glibenclamide. No effect was observed on RBC, Hb, Hct, platelet, MCH, MCHC, lymphocytes, monocytes neutrophils, or eosinophils, while in diabetic rats the WBC and MCV were decreased by the extract. From this study, it was concluded that use of *M. pudica* Aq. extract could be a potential method of diabetes prevention. Lee et al. [150] determined the enzymatic activity of hydrophilic extracts (ACE–Aq.-AA (8.0 mL, 70:29.5:0.5)) of *M. pudica* leaves using α-amylase and α-glucosidase inhibitory assays. *M. pudica* showed significant inhibition of α-amylase (189.3 µmol AE/g) and α-glucosidase (6.6 µmol AE/g). Acarbose was used as the positive control and statistically significant results were obtained.

Manosroi et al. [127] determined the hypoglycemic activity of *M. invisa* leaves (Aq. extract) in normoglycemic and diabetic male ICR mice. Alloxan monohydrate at 75 mg/kg bw was injected into the mouse tail vein. After the 3rd day, diabetes was confirmed and various doses (100, 200, and 400 mg/kg bw) of the plant extract were orally given to the 18-h-fasted normal and diabetic mice. Insulin and glibenclamide were used as standards and hypoglycemic effect was measured by decreased fasting blood glucose (FBG). *M. invisa* significantly reduced the fasting blood glucose (FBG) by 14.84% in normoglycemic mice at 1 h with the 200 mg/kg bw dose, which was 0.24- and 0.47-fold the values for insulin and glibenclamide, respectively. *M. invisa* also showed significant FBG reductions of 16.60% and 9.28% at doses of 100 and 400 mg/kg bw at 240 min, which were 0.27- and 0.52-fold the values for insulin and 0.15- and 0.29-fold the values for glibenclamide, respectively. In diabetic mice, *M. invisa* only showed a significant reduction in fasting blood glucose (FBG) of 25.01%, at 180 min with the lower dose of 100 mg/kg bw, which was 0.35-fold that of insulin and 0.55-fold that of glibenclamide, respectively. Ahmed et al. [97] determined the glucose tolerance properties of the MeOH extract of *M. pigra* stem in Swiss albino male mice using the glucose oxidase method. Mice orally received different concentrations of extract (50, 100, 200 and 400 mg/kg/bw) and standard drug glibenclamide (10 mg/kg/bw). After 1 h, all mice orally received 2 g glucose/kg bw. All doses of the extract decreased the concentration of glucose almost 37.84, 39.83, 42.39, and 50.50%, respectively, while glibenclamide reduced the concentration of glucose almost 56.33%. Ao et al. [161] screened the antihyperglycemic activity of the EtOH extract of *M. pigra* roots in albino rats by checking fasting blood glucose (FBG) levels. Diabetes was induced through intraperitoneal injection (160 mg/kg) of alloxan monohydrate. Diabetic albino rats orally received EtOH extract (250 and 500 mg/kg) and glibenclamide (10 mg/kg). In an acute study, administration of the extract at 250 mg/kg concentration showed a significant blood glucose reduction (360.00 mg/dL), while at the 500 mg/kg dose no significant results (391.80 mg/dL) were
obtained as compared to diabetic untreated mice; however, the extract showed a significant hypoglycemic effect, while the glibenclamide showed no significant reduction in blood glucose. During prolonged treatment, a fluctuation was observed in the blood glucose levels of the diabetic treated albino rats. The extract (250 and 500 mg/kg) showed a reduction in blood glucose levels (Table 2).

5.5. Wound Healing

Choi et al. [162] measured the wound-healing effects of a herbal mixture of *M. tenuiflora* leaves (20%) and *A. vulgaris* (20%) on human keratinocyte (HaCaT), umbilical vein endothelial cells (HUVECs), and mouse fibroblast (3T3-L1) using a scratch test. Fusidic acid was used as the standard. According to the histological study, synthesis of collagen, re-epithelialization, and re-generation of appendages of skin and hair follicles were promoted by the herbal mixture. Immunohistochemical studies showed that blood vessel stabilization, improvement of angiogenesis, and accelerated granulation tissue formation were also achieved through use of the herbal mixture. The herbal mixture can also promote the migration of keratinocytes, endothelial cells, and fibroblasts and the proliferation of macrophages and lymphatic vessels; therefore, the herbal mixture can be used therapeutically for the treatment of cutaneous wounds. Zippel et al. [108] screened the wound-healing efficiency of Aq. extracts and EtOH-precipitated compounds from *M. tenuiflora* bark by measuring the mitochondrial (MTT, WST-1), proliferation (BrdU incorporation), and necrosis (LDH) activities on human primary dermal fibroblasts and HaCaT keratinocytes. The Aq. extract (10 and 100 µg/mL) caused loss of cell viability and proliferation in dermal fibroblasts, while the EtOH-precipitated compound EPC (10 µg/mL) significantly stimulated mitochondrial activity and proliferation of dermal fibroblasts and showed minor stimulation on human keratinocytes at 100 µg/mL. Molina et al. [50] measured the wound-healing activity of 10% powder of *M. tenuiflora* bark in adult humans for external use. The results were found to be significant for inflammation and venous leg ulceration diseases. Arunakumar et al. [163] reported on the wound-healing activity of the MeOH extract of *M. tenuiflora* whole plant by using a chorioallantoic membrane (CAM) model in 9-day-old fertilized chick eggs. The extract increased the numbers of capillaries on the treated CAM surfaces, which might be beneficial for wound healing. Rivera-Arce et al. [24] determined the therapeutic effectiveness of the *M. tenuiflora* cortex extract in the treatment of venous leg ulceration disease. Patients received a hydrogel containing 5% crude extract standardized in a tannin concentration (1.8%). A randomized, double-blind, placebo-controlled clinical trial was conducted. Therapeutic effectiveness was achieved in all patients in the extract group after the 8th treatment week, with ulcer size being reduced by 92% as compared to the control group (Table 2).

5.6. Hypolipidemic Activity

Piyapong and Ampa [159] screened the hypolipidemic effects of 80% EtOH extract of *M. pudica* whole plant in diabetic male albino Wistar rats using biochemical data, including total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels. In diabetic rats, the levels of TC, TG, and LDL were significantly reduced by plant extract doses and glibenclamide, while plant extract at the dose of 500 mg/kg bw significantly increased HDL. These results indicate that *M. pudica* possesses a hypolipidemic effect in diabetic rats and may lead to decreased risk of cardiovascular disease and related complications. Purkayastha et al. [58] reported on the hypolipidemic effect of an EtOH extract of *M. pudica* leaves in Wistar albino rats with hepatic injury induced by CCl4 by measuring biochemical parameters such as triglyceride (TG), total cholesterol (TC), very low density lipoprotein (VLDL), low density lipoprotein (LDL), and high density lipoprotein (HDL) levels. The extract at the dose of 400 mg/kg showed significant decreases in biochemical parameters (TG = 96.8 mg/dL, TC = 98.7 mg/dL, VLDL = 26.9 mg/dL, LDL = 37.4 mg/dL, HDL = 34.3 mg/dL) (Table 2).
5.7. Anti-Inflammatory and Hepatoprotective Activity

Da Silva-Leite et al. [164] determined the healing efficacy of an alcoholic extract prepared from polysaccharides extracted from *M. tenuiflora* barks (EP-Mt) using MeOH/NaOH and EtOH precipitation. The activity was determined in Wistar rat models of acute inflammation (paw edema and peritonitis). The activity was measured with three different doses (0.01, 0.1, and 1.0 mg kg\(^{-1}\)) of plant extract, with the maximum effect with the 1 mg kg\(^{-1}\) concentration as compared to saline. Durgadevi and Karthika [62] reported on the anti-inflammatory activity of an Aq. extract of *M. pudica* leaves by using bovine serum albumin and egg methods. Extracts at different concentrations (0.2, 0.6, 0.8, and 1.0%) showed significant anti-inflammatory activity (serum albumin: 51.5, 59.7, 55.7, 71.5, and 83.7%, respectively; egg: 42.5, 39.6, 48.2, 56.7, 65.3, and 76.7%, respectively) when compared with diclofenac sodium. Onyije et al. [165] measured the anti-inflammatory activity of Aq. extract of *M. pudica* leaves on adult male Sprague–Dawley rats with cadmium (CdCl\(_2\))-induced inflammation of the testes. A sperm analysis was carried out, measuring motility, morphology, and sperm count. Significant activation of sperm motility was observed at different doses of the extract (250 mg/kg = 13.00%; 500 mg/kg = 9.00%) compared with the control group (Aq. = 15.00%). Both doses of the extract showed significant effects on sperm morphology. The sperm counts at different extracts doses (250 mg/kg = 4.18 \times 10^6/cc; 500 mg/kg = 2.54 \times 10^6/cc) were enhanced as compared to control group (12.78 \times 10^6/cc). This study confirmed that *M. pudica* has ethnomedical uses as a therapeutic intervention for infertility; however, when this plant is used as an aphrodisiac, there is also an added benefit of antiligospermia effects. Kumaresan et al. [57] reported on the hepatoprotective activity of a crude powder of *M. pudica* whole plant on male albino rats. Injection in parallel with CCl\(_4\) and paraffin were given to rats to induce jaundice. Various hepatic parameters such as acid phosphatase (ACP), total bilirubin, gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), and lipid peroxide (LPO) levels in tissue, serum, aspartate transaminase (AST), and alanine transaminase (ALT) samples were checked. All of these parameters played roles in liver impairment. A dose of 100 mg/kg of extract powder significantly reduced the levels of all parameters and protected the hepatic cells.

Silva et al. [166] reported on the protective action of HyOH extract and EtOAc fraction of *M. caesalpinifolia* leaves in adult male Wistar rats suffering from colitis. The HyOH extract (125 and 250 mg/kg) and EtOAc fraction (25 mg/kg) were able to decrease TNF-α immune expression in rats and were found to be effective at lower doses after inducing colitis. The extract showed lower tissue damage at both doses, while the EtOAc fraction was effective at the highest dose (50 mg/kg) only in terms of decreasing COX-2 immune expression. COX-2 and TNF-α played pivotal roles in chronic colitis caused by TNBS. Rakotomalala et al. [155] measured the in vitro anti-inflammatory ability of HyMeOH extract of *M. pigra* leaves in male Wistar rats to reduce TNFα-induced bound vascular cellular adhesion molecule 1 (VCAM-1) expression in endothelial cells. The extract at different concentrations (0.01–1 mg/mL) inhibited the induction of VCAM-1 in response to TNFα, with a maximal inhibitory effect of 90% at 1 mg/mL, while the standard drug pyrrolidine dithiocarbamate (200 mM) showed 98% inhibitory effect. In vivo chronic hypoxic PAH cardiac remodeling was also determined in male Wistar rats. Rats were orally treated with extract (400 mg/kg/day) in a hypobaric chamber for 21 days. The extract reduced hypoxic PAH in rats by decreasing pulmonary arterial pressure by 22.3% and pulmonary artery and cardiac remodeling by 20.0% and 23.9%, respectively (Table 2).

5.8. Antinociceptive Activity

Patro et al. [167] determined the antinociceptive effects of *M. pudica* leaves (EtOAc extract) on adult Wistar albino rats using AA-induced writhing, hot plate, and tail flick models at three concentration (100, 200 and 400 mg/kg). In the hot plate and tail flick tests, after 30 min the extract and the standard diclofenac sodium significantly increased the analgesic activity. The extract doses of 100, 200, and 400 mg/kg decreased the writhing by 20.18, 33.42, and 43.46% respectively, while the standard diclofenac sodium showed
52.01% writhing inhibition against AA. Ahmed et al. [97] determined the antinociceptive activity of the MeOH extract of *M. pigra* stem in Swiss albino male mice via AA-induced writhing test. Mice orally received various extract doses of 50, 100, 200, and 400 mg/kg/bw, decreasing writhing by 70.01, 74.96, 77.51, and 85.01%, respectively. Aspirin was used as the standard drug.

Rejon-Orantes et al. [106] screened the antinociceptive effects of an Aq. extract of *M. albida* roots in male ICR mice via AA-induced writhing and hot plate tests. In the AA-induced writhing test, the Aq. plant extract at different concentrations (12.5, 25, and 50 mg/kg) and the reference analgesic drug (dypirone, 100 and 500 mg/kg) were administered 60 min before the AA (0.6%) administration. Counts of the writhing responses (abdominal wall contractions and rotation of pelvis followed by extension of hind limb) were carried out during the test (20 min). *M. albida* extract (50 mg/kg) and dypirone (500 mg/kg) prevented the abdominal writhing. This study model was also helpful in an investigation of the opioid system involvement in the antinociceptive effects of the *M. albida* extract. The extract and fentanyl decreased the writhing, although naloxone was only able to antagonize the effects of fentanyl, leaving the antinociceptive potential of the *M. albida* extract intact. Fentanyl seemed to be more potent than the extract. In the hot plate test, pain reaction (hind paw licking and jumping) was determined as the response latency. Before the test, the response latency was determined, after administration of either *M. albida* extract, fentanyl (0.1 mg/kg), or the vehicle (NaCl). Fentanyl (30 and 60 min) after treatment and extract (12.5, 25, and 50 mg/kg) at 60 min from its injection produced significant increases in pain latency (Table 2).

### 5.9. Antiepileptic Activity

Patro et al. [167] measured the antiepileptic effects of EtOAc extract of *M. pudica* leaves on Swiss albino mice using a maximal electroshock (MES)-induced seizure model, PTZ-induced seizure model, and INH-induced seizure model at different extract doses (100, 200 and 400 mg/kg/day). In the maximum electric shock test, the extract at 100, 200, and 400 mg/kg concentrations and the standard drug diazepam (0.4 mg/kg) caused delayed onset of convulsion by 1.87, 2.69, 3.21, and 3.53 s, respectively; as well as decreased duration of convulsion by 68.09, 53.54, 42.21, and 38.89 s, respectively. In the PTZ-induced convulsion test, the extract at different concentrations of 100, 200, and 400 mg/kg and diazepam (04 mg/kg) caused delayed onset of convulsion (5.38, 6.08, 6.98, and 7.81 min, respectively) and decreased duration of convulsion (14.76, 12.65, 11.13, and 9.39 min, respectively). Regarding the INH-induced convulsions, the extract at different concentrations (100, 200, and 400 mg/kg) showed delayed convulsion latency times of 37.21, 45.49, and 58.62 min, respectively; the results were compared with diazepam (04 mg/kg = 69.14 min delayed convulsion latency). Prathima et al. [35] measured the antiepileptic activity of the EtOH extract of *M. pudica* roots in adult Swiss albino mice. Maximal electroshock (MES) and pentylenetetrazole (PTZ)-induced seizures were performed. In the maximal electroshock-induced seizures (MES), the durations of tonic hind limb flexion (THLF), tonic hind limb extension (THLE), clonus, and stupor were noted. In the MES tests, the percentages of inhibition of convulsions in mice at different doses (1000 mg/kg = 42.41%; 2000 mg/kg = 52.35%) were noted, while standard valproate showed 73.86% inhibition at 200 mg/kg. In the pentylenetetrazole (PTZ)-induced seizures, the clonic convulsion onset times, durations of clonic convulsions, and postictal depression were observed for a period of 30 min. The extract (1000 and 2000 mg/kg) significantly decreased the number and duration of myoclonic jerks and clonic seizures and the duration of postictal depression (Table 2).

### 5.10. Neuropharmacological Activities

Arunakumar et al. [163] determined the anti-Alzheimer’s potential of the MeOH extract of *M. tenuiflora* whole plant by using acetylcholinesterase inhibitory therapy (AChEIs). The results showed that *M. tenuiflora* is a rich source of compounds with potential anti-
Alzheimer’s activity. Ttiyavirah and Pullochal [154] measured the antistress activity of EtOH extract of *M. pudica* plant in albino Wistar rats by performing swimming endurance, radial arm maze, Morris Aq. maze, and retention phase tests. Adaptogenic activity was assessed by using oral doses of 500 mg/kg of extract and 2 mg/kg diazepam as the standard compound in the swimming endurance test. In the other three tests, the extract was found to effectively reduced stress as compared to standard D-galactose + piracetam. Significant improvements in memory were observed from the test paradigms for the Morris Aq. Maze and radial arm maze tests. The results from the study indicated that the EtOH extract of *Mimosa pudica* possessed significant antistress activity, along with a potential protective effect against a chronic Alzheimer’s model. Mv et al. [168] measured the neuroprotective effects of *M. pudica* plant in a Parkinson’s male C57BL/6 model at 100 and 300 mg/kg concentrations of extracts using a vertical grid test, horizontal grid test, and immunohistochemistry measurements. In the vertical grid test, the extract at different concentrations (100 and 300 mg/kg) significantly increased the time taken to climb the grid. In the horizontal grid test, the extract decreased the hang time. The extract at 100 and 300 mg/kg doses decreased SYN- and increased DAT- and TH-positive cells. Patro et al. [167] measured the motor coordination activity of the EtOAc extract of *M. pudica* leaves in Swiss albino mice by performing locomotor activity, rotarod, and traction tests with three different extract concentrations (100, 200, and 400 mg/kg), while diazepam at 0.4 mg/kg concentration was used as the standard drug. Significant decreases in locomotor activity were observed. In the rotarod test, the fall time was significantly decreased, while in the traction test, the holding time was also significantly decreased. Kishore et al. [169] screened the CNS activities of Aq. extract of *M. Pudica* leaves in adult albino mice using locomotor activity, elevated plus maze, and rotarod tests at a dose of 200 mg/kg. Percentage changes in locomotor activity were caused by the extract (200 mg/kg = 56.33%) and standard diazepam (0.5 mg/kg = 79.61%). In the elevated plus maze test, the extract (200 mg/kg) and diazepam (0.5 mg/kg) increased the numbers of open arm entries by 67.92% and 78.59% while decreasing the times spent in closed arm positions by 7.32% and 8.64%, respectively. In the rotarod test, the fall times were decreased significantly by the extract (200 mg/kg = 152.1) and diazepam (0.5 mg/kg = 157.6). Mahadevan et al. [170] measured the in vitro neuroprotective effects of the Aq. extract of *M. pudica* whole plant against Parkinson’s disease in SH-SY5Y human neuroblastoma cell lines using cell viability assay or MTT assay. The extract significantly upregulated TH and DAT and downregulated α-synuclein expression in intoxicated cell lines. This disease occurs due to decreases in the dopaminergic neurons and tyrosine hydroxylase (TH) and increases in α-synuclein protein levels.

Rejón-Orantes et al. [106] determined the exploratory and motor coordination activities of the Aq. extract of *M. albida* roots in male ICR mice. Various concentrations of the extract (50, 100, and 200 mg/kg) and the vehicle NaCl were given to mice before tests. For exploratory activity, an open field test was performed to evaluate the locomotor activity of mice. Locomotory activity (number of lines crossed by the animal) was recorded for 5 min. The extract produced a significant decrease in the number of lines crossed by the animal as compared to the vehicle. For motor coordination activity, the rotarod test was performed. The number of falls from the rolling rod were recorded during the test (3 min). The number of falls from the rotarod were significantly increased after supplementation of Aq. extract from the roots of *M. albida* (100 and 200 mg/kg) as compared to the vehicle. Rejón-Orantes et al. [106] reported on the anxiolytic activity of Aq. root extract of *M. albida* in male ICR mice by using elevated plus maze and hole board tests. In the elevated plus maze test, the extract at various concentrations (3.2, 12.5, 25, and 50 mg/kg), dypirone (1 mg/kg), and the vehicle (NaCl) were administrated to mice before testing. In the beginning, the mice were placed on the central plate facing the open arms. Then, the time spent (%) on the open arms was calculated. Significant increases in exploration of open arms in the elevated plus maze test were caused by diazepam. Regarding the hole board apparatus, animals were placed in position and head dippings were counted. Head dippings were significantly enhanced
by the diazepam. At all extract doses, *M. albida* showed no significant effect in either test (Table 2).

5.11. Antiallergic and Antihyperurisemic Activity

Lauriola and Corazza [113] determined the antiallergic activity of the glyceric acid extract of *M. tenuiflora* bark in a non-atopic 30-year-old woman who had developed acute eczema of the neck in the retroauricular and laterocervical areas. The plant extract was applied on her skin and patch tests were performed. *M. tenuiflora* potentially soothed the skin with its good antimicrobial properties. Sumiwi et al. [171] measured the antihyperurisemic activity of the EtOH (70%) extract of *M. pudica* leaves in vitro and ex vivo in Swiss Webster mice (*Mus musculus*). The IC<sub>50</sub> values for the inhibition of uric acid formation with *M. pudica* tablet, *M. pudica* extract, and allopurinol were 68.04 ppm, 32.75 ppm, and 18.73 ppm, respectively. The ex vivo results showed that *M. pudica* tablet at 125 mg/kg of body weight and the extract reduced uric acid levels in hyperurisemic mice by 36% and 43%, respectively. Mimosa pudica tablets at 125 mg/kg of bodyweight inhibited uric acid formation in hyperuricemic mice; therefore, this pharmaceutical dosage form could be proposed as an antihyperurisemic drug (Table 2).

5.12. Larvicidal, Antiparasitic, and Molluscicidal Activity

Oliveira et al. [172] measured the effects of *M. tenuiflora* leaves and stem on the larval establishment of *H. contortus* in sheep. The rate of larval establishment was not reduced by the leaves, but stem intake caused a 27.9% reduction; however, no significant reduction was observed. Bautista et al. [173] determined the antiparasitic activity of Hex, MeOH, and ACE extracts of *M. tenuiflora* leaves against *E. histolytica* and *G. lamblia*. The extracts showed significant inhibition (Hex: IC<sub>50</sub> = 65.9 and 80.2 µg/mL; ACE: IC<sub>50</sub> = 80.7 and 116.8 µg/mL; MeOH: 73.5 and 95.5 µg/mL) against both *E. histolytica* and *G. lamblia*, but against *G. lamblia*. Santos et al. [174] determined the molluscicidal activity of the EtOH extract of *M. tenuiflora* stems against the snail species *Biomphalaria glabrata*. The extract showed excellent activity at the 100 µg/mL concentration (LC<sub>90</sub> = 62.05 mg/L; LC<sub>50</sub> = 20.22 mg/L; LC<sub>10</sub> = 6.59 mg/L). Shamsuddini et al. [175] determined the effects of *M. tenuiflora* stem extracts against human leishmaniases by using an MTT assay and by counting parasites with various concentrations (10, 100, 500, and 1000 mcg/mL) of *M. tenuiflora* extracts. Different concentrations of *M. tenuiflora* extract have different effects on the multiplication of *Leishmania protozoa* in culture medium. The multiplication of promastigotes was found to be suppressed at 1000 and 500 mcg/mL concentrations. This finding suggested that *M. tenuiflora* extract contains both inhibitory and acceleratory effects on *Leishmania* growth in vitro. Surendra et al. [176] determined the larvicidal action of Aq. extract of *M. pudica* leaves against *Aedes aegypti* larvae at different doses (250, 500, 750, 1000, and 2000 µg/m). The potential was determined at 0, 1, 2, 3, 4, 6, 12, and 24 h and the percentage mortality rates were calculated. Percentage mortality was approximately zero at all concentrations over 24 h. The Aq. extract was found to possess poor larvicidal actions; thus, it can be concluded that *Mimosa pudica* was not suitable for larvicidal actions. Brito et al. [177] reported in vivo anthelmintic (AH) activity of *M. caesalpinifolia* leaf powder supplementation against nematodes (*Haemonchus, Trichostrongylus*, and *Oesophagostomum*) in male goats. Goats were given a *M. caesalpinifolia* leaf powder that was rich in condensed tannins (days 1–7 and 14–21). After 28 days, the worm burden was estimated. Post-mortem worm counts indicated a decreased in *Haemonchus* adult worm burden (57.7%) in goats. For the CT group, no anthelmintic effect against *Oesophagostomum* was observed; thus, to control gastrointestinal nematode (GIN) infections in goats, feeding with dry *M. caesalpinifolia* leaves proved encouraging (Table 2).

5.13. Antispasmodic, Antivenom, and Antiviral Activity

Lozoya et al. [135] screened the antispasmodic activity of BuOH, EtOAc, and MeOH extracts of *M. Tenuiflora* in guinea pig and mouse models. BuOH, EtOAc, and MeOH at
30.0 µg/mL showed significant results by increasing the muscular tonus and frequency of contraction of the uterus. Increases in muscular tonus in the stomach in rats and relaxation of the ileum in guinea pigs were observed. Bitencourt et al. [40] measured the neutralizing capacity of the extract of *M. tenuiflora* bark on the inflammation induced by *Tityus serrulatus* scorpion venom in male BALB/c mice. Animals were inoculated intravenously with saline, Aq. extracts (20, 30, or 40 mg/kg) and fractions, DCM, butyl alcohol, and EtOAc (40 mg/kg). The EtOAc fraction showed potent inhibition against inflammatory cells. The EtOAc fraction showed 83, 67, and 86% inhibition at doses of 20, 30, and 40 mg/kg, respectively. The Aq. extract showed 76% cell inhibition at a dose of 30 mg/kg. Jain et al. [60] determined the in vivo antiviral activity of EtOH extract and fractions (Aq., CF, PE, and BZ) of *M. hamata* whole plant against *H. Simplex, poliomyelitis,* and *V. stomatitis* using the plaque inhibition method. The EtOH extract was found to be active against all three viruses. CF and PE were found to be active against *V. stomatitis.* None of the fractions were active against poliomyelitis (Table 2).

### 6. Toxicological Studies of the Genus Mimosa Concerning Hemolysis, Antimutagenic, Genotoxic, and Teratogenic Effects

Magalhães et al. [149] determined the toxicity of the EtOH extract and fractions (Hex, DCM, EtOAc, and HyOH) of *M. tenuiflora* leaves, roots, twigs, and barks using non-specific toxicity to *A. salina* L. and cytotoxicity to African green monkey kidney (Vero) cells via MTT assay. Only the HyOH fraction killed 50% of the nauplii (LC₅₀ = 793.70 µg/mL). The fraction of *M. tenuiflora* with the highest antioxidant potential (FATEM) was not toxic to *A. salina* L. (LC₅₀ > 1000.00 µg/mL) or Vero cells (CC₅₀ = 512.6 µg/mL). Meckes-Lozoya et al. [135] investigated the hemolytic effects of BuOH, EtOAc, and MeOH extracts of *M. tenuiflora* stem bark against enterocytes. BuOH and EtOAc extracts at 250.0 g/mL and MeOH at 500.0 µg/mL increased hemolysis by 74%, 48%, and 68%, respectively. Furthermore, de Morais-Leite et al. [136] measured the hemolytic effects of EtOH extract of *M. tenuiflora* bark on human erythrocytes (types A, B, and O). At the concentration of 1000 µg only, hemolysis was observed in erythrocytes type A at 3.0%, but at the concentration of 2000 µg all three human erythrocytes (A, B, and O) presented hemolysis (23.1, 5.17, and 1.08% respectively). Overall, the extract showed low toxicity for the human erythrocyte cells. Silva and colleagues reported the hemolytic potential of EtOH bark extract of *M. tenuiflora* against human RBCs at various concentrations (250, 500, and 1000 µg/mL). At the 1000 µg/mL concentration, highest hemolysis was observed (90%). While at low concentrations (125, 62.5, 31.25, 15.8 µg/mL), no activity was observed [137] (Table 3).

Prathima et al. [35] measured the acute toxicity of the EtOH extract of *M. pudica* roots in adult Swiss albino mice at different doses (0.5, 1, 2, 4, and 5 g/kg p.o.). There was no mortality amongst the mice treated with the graded dose of extract up to a dose of 5000 mg/kg at a duration of 72 h. Cadmium (Cd) is a well-recognized pollutant with great neuroendocrine-disrupting efficacy. It damages the hypothalamic–pituitary–testicular axis in mature male Wistar rats. The aqueous (Aq.) extract of *M. pudica* leaves was administered orally to rats at a dose of 200 mg/kg for 40 consecutive days. At the end of the analysis period, the extract was used as a therapeutic intervention for infertility [178]. The acute toxicity of EtOAc [167] and EtOH [58] extracts of *M. pudica* leaves on adult Wistar albino rats was determined. No mortality or signs of toxicity were observed at the dose of 2000 mg/kg. Nghonjuyi et al. [22] measured the in vivo toxicity of HyOH extracts of *M. pudica* leaves in Kabir chicks. Single doses of HyOH extracts were administered orally at doses ranging from 40 to 5120 mg/kg for the acute toxicity test. No death was recorded at doses lower than 2560 mg/kg. Very low hypoactivity was observed at the extract dose of 5120 mg/kg. In the sub-chronic study, these extracts were given orally as a single administration to chicks at doses of 80, 160, 320, and 640 mg/kg/day for 42 days. No toxicity was observed with oral sub-chronic low dose administration. Das et al. [151] measured the cytotoxicity of the MeOH extract of *M. pudica* leaves using a brine shrimp lethality bioassay. The LC₅₀ of the extract was found to be 282.4 µg/mL, whereas the reference standard vincristine sulphate exhibited an LC₅₀ of 0.45 µg/mL. The results of the above findings clearly demonstrated
that the leaves of *M. pudica* showed mild cytotoxic properties. Olusayo et al. [179] screened the acute toxicity of the EtOH extract of *M. pigra* roots in adult Wistar rats. No mortality was observed at 5000 mg/kg, which showed that the plant is relatively safe. In sub-acute toxicity tests, three groups of adult Wistar rats were given different concentration of the extract of 250, 500, and 1000 mg/kg/bw, which corresponded to 1/20th, 1/10th, and 1/5th of the 5000 mg/kg dose, respectively. To determine the biochemical (ast, alt, alp, total protein, cholesterol, urea, creatinine, and total bilirubin) and hematological (pcv, rbc, and hb) parameters, rat blood samples were collected on the 29th day. The results of the study showed that there were significant increases in packed hemoglobin, cell volume, and red blood cell count at different extract doses (500 and 1000 mg/kg). The extract produced no significant changes in the levels of total bilirubin, total cholesterol, total protein, aspartate aminotransferase, or alkaline phosphatase in any of the groups that were treated, although a significant increase in the level of alanine transaminase was observed. Serum levels of urea and creatinine were not affected. The findings of this study showed that the roots of *M. pigra* may be safe at doses below 500 mg/kg but may pose toxicological risks at doses greater than 500 mg/kg, with the liver being most affected with prolonged usage. Monção et al. [180] reported on an in vivo toxicological and androgenic evaluation of the EtOH extract of *M. caesalpinifolia* leaves in adult male Wistar rats using body weight loss and serum biochemical parameters (ALP, AST, urea, and creatinine). In the toxicological evaluation, the extract induced a body weight loss at the highest tested dose (750 mg/kg). No androgenic activity was observed at any dose level (250, 500, or 750 mg/kg). Monção et al. [180] reported on the in vitro cytotoxicity of the EtOH extract of *M. caesalpinifolia* leaves using an MTT assay in murine macrophages and a brine shrimp lethality assay in *Artemia salina*. The extract showed LC$_{50}$ values of 1765 µg/mL against *Artemia salina* and 706.5 µg/mL against murine macrophages. Rejón-Orantes et al. [106] reported acute toxicity of Aq. extract of *M. albida* roots in male ICR mice. Different doses (3.2, 12.5, 25.50, 100, 200, 300, and 400 mg/kg) of *M. albida* extract were given to various mice groups and their mortality rates were recorded until 48 h; no mortality was observed. Nandipati et al. [122] reported acute toxicity of MeOH extract (500–4000 mg/kg) of *M. rubicaulis* stem against Swiss albino mice, administered by oral gavage. No mortality was witnessed at the dose of 4000 mg/kg. No androgenic activity was observed at any dose level (250, 500, or 750 mg/kg). Silva et al. [181] measured the mutagenic and antimutagenic effects of crude EtOH extract of *M. tenuiflora* stem bark against *S. typhimurium* strains (TA97, TA98, TA100, TA102) using the Ames test. No mutation was induced in any of the strains at concentrations of 50 and 100 µg/mL of extract. The extract showed antimutagenic effects in all strains, although no antimutagenic effect was observed in TA98. The genotoxicity of crude EtOH extract of *M. tenuiflora* stem bark using a micronucleus test in the peripheral blood of albino Swiss mice has been reported [181]. The extract (100 to 200 mg/kg) and cyclophosphamide (reference drug, 50 mg/kg) were given to mice, whereby the extract at 100 and 200 mg/kg increased the numbers of micronucleus by 8.75 and 9.91, respectively, as compared to cyclophosphamide (50 mg/kg = 43.5). Medeiros et al. [182] determined the teratogenic effects of *M. tenuiflora* seeds in pregnant Wistar rats, whereby a 10% dose of *M. tenuiflora* seeds was given to rats in a Brazilian semiarid climate. The extract was given from the 6th to the 21st day of pregnancy. No differences were observed in weight gain in the lungs, heart, liver, or kidneys of rats or in food or Aq. consumption between treated and controlled rats. Ninety bone malformations were observed in 40 of the 101 fetuses, including skeletal malformations such as scoliosis, bifid sternum, cleft palate, and hypoplasia of the nasal bone. Scientists measured [183,184] the teratogenic effects of *M. tenuiflora* in pregnant goats and lambs in the semiarid rangelands of Northeastern Brazil. The four goats fed on
fresh green *M. tenuiflora* during pregnancy delivered 4 kids, 3 of which had abnormalities, including cleft lip, ocular bilateral dermoids, unilateral corneal opacity, buphthalmos (with a cloudy brownish appearance of the anterior chamber due to an iridal cyst), and segmental stenosis of the colon. Dantas et al. [185] measured the teratogenic effects of green fresh *M. tenuiflora* in pregnant goats in the semiarid rangelands of Northeastern Brazil. A high frequency of embryonic deaths was observed in pregnant goats if *M. tenuiflora* was ingested in the first 60 days of gestation. Gardner et al. [186] determined the teratogenicity of *M. tenuiflora* leaves and seeds on pregnant rats in Northeastern Brazil. Compounds extracted from *M. tenuiflora* showed higher incidence rates of soft tissue cleft palate and skeletal malformations. Silva et al. [32] measured the antigenotoxic activities of the EtOH extract and EtOAc fraction of *M. caesalpinifolia* leaves using a comet challenge assay and micronucleus test. The extract at a concentration of 125 mg/kg bw inhibited oxidative DNA damage in liver cells, which was induced by hydrogen peroxide (H$_2$O$_2$) in animals intoxicated with cadmium (Cd). Furthermore, the EtOAc fraction decreased the genomic damage and mutagenesis induced by cadmium exposure. The genus *Mimosa* is able to modulate the toxic effects caused by cadmium exposure as a result of antigenotoxic and antioxidant activities in blood and liver cells of rats (Table 3).

### Table 3. Toxicological studies of the genus *Mimosa* regarding hemolysis, antimutagenic, genotoxic, and teratogenic effects.

| Activities          | Plant     | Plant Part | Extract/Fraction | Assay                | Model                                      | Results/Outcome/Response                                                                 | References |
|---------------------|-----------|------------|------------------|----------------------|--------------------------------------------|------------------------------------------------------------------------------------------|------------|
| Toxicological       | *M.       | Leaves,    | EtOH extract and| (1) Non-specific     | Only the HyOH fraction killed 50% of the  |                                                                                          | [149]     |
| studies             | *tenuiflora*| twigs, barks, roots |
|                     |           |            | fractions (Hex, DCM, EtOAc and HyOH) | toxicity (2) Cytotoxicity to Vero cells by MTT assay | nauplii (LC50 = 793.70 µg/mL). Fractions of EtOH extract were not toxic to *A. salina* L. (LC50 > 1000.00 µg/mL). Fractions of EtOH extract were not toxic to Vero cells (CC50 = 512.6 µg/mL)|           |
|                     |           |            |                  |                      |                             |                                                                                          |           |
|                     |           | Stem bark  | EtOH              | Hemolytic assay      | Buthanol 250 µg/mL = 74%; EtOAc 250 µg/mL = 48%; MeOH 500 µg/mL = 68% |                                                                                          | [135]     |
|                     |           |            |                  |                      |                             |                                                                                          |           |
|                     |           |            | BuOH, EtOAc, MeOH | In vitro Erythrocytes | At 1000 µg concentration, only hemolysis of erythrocyte A (3%) was observed, while at 2000 µg concentration, extract showed hemolysis on type A = 23.1%; type B = 5.17%; type O = 1.08% |                                                                                          | [136]     |
|                     |           | Bark       | EtOH              | Hemolytic assay      | % hemolysis at 1000 µg/mL = 90%, 500 µg/mL = 35%, 250 µg/mL = 17% |                                                                                          | [137]     |
|                     |           |            |                  |                      |                             |                                                                                          |           |
|                     |           | Roots      | EtOH              | Acute toxicity       | No mortality was observed at extract dose up to 5000 mg/kg |                                                                                          | [35]      |
|                     |           | Aq.        | Histoarchitecture parameters | Mature male Wistar rats/cadmium-induced toxicity | Extract doses of 200 mg/kg were found effective |                                                                                          | [178]     |
|                     | *M. pudica*| Leaves     | EtOAc             | Acute toxicity       | No mortality or signs of toxicity were observed at the dose of 2000 mg/kg |                                                                                          | [167]     |
|                     |           |            | EtOH              | Acute toxicity       | No mortality as observed up to the dose level of 2000 mg/kg bw |                                                                                          | [58]      |
|                     |           |            | HyOH              | In vivo toxicity/Kabir chicks | Very low toxicity observed at high dose of 5120 mg/kg | Sub-chronic toxicity observed at doses of 80, 160, 320, and 640 mg/kg                  | [22]      |
Table 3. Cont.

| Activities          | Plant          | Plant Part | Extract/Fraction | Assay                        | Model                          | Results/Outcome/Response                                  | References |
|---------------------|----------------|------------|------------------|------------------------------|--------------------------------|-----------------------------------------------------------|------------|
| Toxological studies | M. pudica      | Leaves     | MeOH             | Brine shrimp lethality bioassay | Extract 1–500 µg/mL; LC50 = 282.3495 µg/mL, standard vincristine sulphate; LC50 = 0.45 µg/mL | [151]       |
|                     | M. pigra       | Roots      | EtOH             | Acute toxicity               | Adult Wistar rats              | No mortality observed                                     | [179]      |
|                     | M. caesalpini- nifolia | Leaves | EtOH             | Hematological and biochemical parameters | In vivo: Male adult Wistar rats | Toxicological evaluation induced a body weight loss, which was observed at the highest tested dose of 750 mg/kg | [180]      |
|                     |                |            |                  | Brine shrimp and MTT assay   | LC50 = 1765 mg.L⁻¹ (Artemia salina) LC50 = 706.5 mg.L⁻¹ (murine macrophages) | [180]      |
|                     | M. albida      | Roots      | Aq.              | Acute toxicity               | Male ICR mice                  | No mortality observed at different extract doses (3.2, 12.5, 25.50, 100, 200, 300, and 400 mg/kg) | [106]      |
|                     | M. rubicau- lis | Stems     | MeOH             | Acute toxicity               | Swiss albino mice              | Doses (range of 500–4000 mg/kg) did not lead to acute toxicity | [122]      |
|                     | M. verruca- sa | Bark      | EtOH             | Hemolytic assay              | Human RBCs                     | % hemolysis at 1000 µg/mL = 100%, 500 µg/mL = 72%, 250 µg/mL = 43% | [137]      |
|                     | M. pterali- folia | Bark   | EtOH             | Hemolytic assay              | Human RBCs                     | No activity observed                                      | [137]      |
|                     | Seeds          | 10% of seeds | In vivo          | Pregnant Wistar rats (Rattus norvegicus) | 90 bone malformations were observed in 40 of the 101 rats, including scoliosis, lordosis, and a shorter head | [182]      |
|                     | Green forage   | In vivo    | Pregnant goats and lambs | Fed green forage of M. tenueflora throughout gestation period | 3 of 4 kids had abnormalities including cleft lip, unilateral corneal opacity, ocular bilateral dermoids, buphthalmos with a cloudy brownish appearance in the anterior chamber due to an iridal cyst, and segmental stenosis of the colon | [184]      |
|                     | Seeds          | In vitro   | Pregnant goats    | Embryonic deaths were observed | Soft tissue cleft palate and skeletal malformations were observed in pups | [185]      |
|                     | Leaves and seeds | In vitro | Pregnant rats     | In vitro:                     |                                |                                                          |            |

M. tenuiflora

Antimutagenic, genotoxic, and teratogenic effects

| Activities          | Plant          | Plant Part | Extract/Fraction | Assay                        | Model                          | Results/Outcome/Response                                  | References |
|---------------------|----------------|------------|------------------|------------------------------|--------------------------------|-----------------------------------------------------------|------------|
| Seeds               | 10% of seeds   | In vivo    | Pregnant goats and lambs | Fed green forage of M. tenueflora throughout gestation period | 90 bone malformations were observed in 40 of the 101 rats, including scoliosis, lordosis, and a shorter head | [182]      |
| Green forage        | In vivo        | Pregnant goats | Embryonic deaths were observed | Soft tissue cleft palate and skeletal malformations were observed in pups | [185]      |
Table 3. Cont.

| Activities | Plant Part | Extract/Fraction | Assay Model | Results/Outcome/Response |
|------------|------------|------------------|-------------|--------------------------|
|            | M. caesalpinifolia | Leaves | EtOH and EtOAc fraction | Comet, challenge assay, and micronucleus Test | In vivo: Wister rats | Plant extract significantly prevented genotoxicity in liver and peripheral blood cells |

7. Conclusions

Herbal medicines are used to cure different ailments worldwide. Drugs are becoming resistant to treatment, so there is a dire need to find novel natural sources of traditional compounds. In this review, we presented ethnogeographical distribution and the traditional, nutritional and pharmacological values of Mimosa species. All species showed versatile potential pharmacological activities, such as antimicrobial, antioxidant, anticancer, antidiabetic, wound-healing, hypolipidemic, anti-inflammatory, hepatoprotective, anticoccidial, antiepileptic, neuropharmacological, toxicological, antiallergic, antihyperurisemic, larvicidal, antiparasitic, molluscidal, antimutagenic, genotoxic, teratogenic, antispasmodic, antiviral, and antivenom effects. In the future, the plants from this genus should be promising in the development of new drugs. This genus consists of 400 species but only 20–25 are well known, while the rest have not yet been explored; therefore, the species of the genus Mimosa may hold potential for drug discovery. The best possible efforts have been made to review and summarize the available information. This review could be a useful tool in assisting researchers in discovering new medicinal benefits of the genus Mimosa.

Author Contributions: Conceptualization, I.M. and K.R.; methodology, R.A.; A.A. and H.K.; software, L.G.M. and M.Z.-U.-H.; validation, T.R.; investigation, I.M. and T.R.; resources, K.R.; data curation, I.M. and K.R.; writing—original draft preparation, I.M. and K.R.; writing—review and editing, I.M. and K.R.; visualization, K.R.; supervision, K.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: All the data produced here are available and can be produced when required.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

BuOH Butanol
Hex Hexane
ACE Acetone
MeOH Methanol
EtOAc Ethyl acetate
EtOH Ethanol
DEE Diethyl ether
AA Acetic acid
DM Dry matter
M. lysodeikticus Micrococcus lysodeikticus
E. aerogenes Enterobacter aerogenes
P. aeruginosa Pseudomonas aeruginosa
P. Mirabilis Proteus mirabilis
C. albicans Candida albicans
S. epidermidis Staphylococcus epidermidis
M. luteus  Micrococcus luteus
S. typhi  Salmonella typhi
P. variotii  Paecilomyces variotii
P. vulgaris  Proteus vulgaris
A. niger  Aspergillus niger
T. mentagrophytes  Trichophyton mentagrophytes
M. gypseum  Microsporum gypseum
B. subtilis  Bacillus subtilis
F. moniliforme  Fusarium verticillioides
C. diphtheria  Corynebacterium diphtheria
M. phaseolina  Macrophomina phaseolina
F. solani  Fusarium solani
S. boydii  Shigella boydii
ZOI  zone of inhibition
ABTS  2,2-azinobis-(3-ethylbenzothiazoline-6-sulfonate)
IC\textsubscript{50}  inhibitory concentration
NO  Nitric oxide
RBC  Red blood cell count
WBC  White blood cell count
PCV  Packed-cell volume
ICR mice  Institute of Cancer Research
EPC  EtOH-precipitated compounds
VLU  venous leg ulceration
TNF\textalpha  Tumor Necrosis factor alpha
VCAM-1  vascular cell adhesion molecule 1
TNBS  Trinitrobenzenesulfonic acid
HyOH  Hydroalcohol
Aq.  Aqueous
PE  Pet. Ether
CF  Chloroform
Bz  Benzene
DCM  Dichloromethane
HyMeO  Hydromethanol
HyEtOH  Hydroethanol
E. coli  Escherichia coli
S. aureus  Staphylococcus aureus
K. pneumonia  Klebsiella pneumonia
S. sonnei  Shigella sonnei
S. pyogenes  Streptococcus pyogenes
C. neoformans  Cryptococcus neoformans
A. calcoaceticus  Acinetobacter calcoaceticus
L. bacillus  Lacto bacillus
F. oxysporum  Fusarium oxysporum
B. cereus  Bacillus cereus
A. flavus  Aspergillus flavus
A. terreus  Aspergillus terreus
E. floccosum  Epidermophyton floccosum
T. rubrum  Trichophyton rubrum
P. vulgaris  Proteus vulgaris
R. bataticola  Rhizoctonia bataticola
M. canis  Microsporum canis
P. boydii  Pseudallescheria boydii
T. schoenleinii  Trichophyton schoenleinii
R. solani  Rhizoctonia solani
DPPH  2,2-diphenyl-1-picrylhydrazyl
EC\textsubscript{50}  effective concentration
OH  Hydroxide
TE  Trolox equivalent
SRB assay  sulfourhodamine B
XTT assay  Cell Proliferation Kit II
CCl4  Carbon tetrachloride
CAM  Choriosallantoic membrane
L-NNAME  N-Nitro-l-arginine methyl ester hydrochloride
COX-2  cyclooxygenase-2
PAH  Hypoxic pulmonary hypertension

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