**A REVIEW OF TRADITIONAL MEDICINAL PLANTS HAVING ANTIOXIDANT, ANTIMICROBIAL AND WOUND HEALING ACTIVITIES**

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**Abstract**

Medicinal plants have been used for the treatment of numerous diseases since prehistoric times. Even today, the utilisation of medicinal plants based on traditional knowledge is still common in local communities. The majority of people, especially in rural areas, still depend on these plants, mainly due to the undesirable side effects of contemporary medications. However, it is important to figure out the appropriate and safe dosage of these plants to prevent any potential adverse effects it may cause in the long-term. This emphasises the necessity for increased focus and scientific investigation of therapeutic characteristics shown by medicinal plants that are often used in traditional folklore. This review paper aims to provide an overview of 21 traditional medicinal plants and their scientifically verified properties that may contribute to their healing potential.

**Key words**: Phytochemical, Free radical, Antioxidant, Antimicrobial, Infection, Wound healing.

**Introduction**

Nature has served as a great source for an astounding number of contemporary pharmaceuticals; many components of modern medicines have been separated from natural sources [1]. Man has employed diverse plant components for both the treatment and prevention of various illnesses [2]. Medicinal plants serve as an inherent repository of therapeutic compounds that are mostly devoid of the adverse effects often associated with manufactured drugs [3]. Consequently, there has been an increasing interest towards exploring therapeutic approaches that are less detrimental to the human body [4]. Several contemporary pharmaceuticals have been derived from natural sources, with many of these discoveries being influenced by the historical use of these substances in traditional medicine [5]. These medicinal plants exert their effects by means of their antioxidant and antibacterial capabilities [6]. Nevertheless, several therapeutic plants, as well as their active components, exert their effects via the modulation of gene expression [7].

**Phytochemical**

Phytochemicals are naturally occurring bioactive compounds found in plants, that serve the purpose of safeguarding them against invasion, illness, and infection [8, 9]. Phytochemicals derived from natural sources include a wide array of chemical entities such as polyphenols, flavonoids, steroidal saponins, organosulphur compounds, and vitamins [10]. The potential wound healing properties shown by several phytochemicals may be attributed to their antioxidative, antimicrobial, platelet aggregation inhibition, and anti-inflammatory actions, which together contribute to mitigating the risk of wound-related complications [11]. Several research investigations have demonstrated the diverse health benefits associated with phytochemicals, including tannins and flavonoids as antioxidants and free radical scavengers [12]. Additionally, saponins and glycosides have been found to have hypotensive and cardiodepressant effects [13]. Other studies have shown that tannins and alkaloids possess anti-hyperglycaemic and anti-inflammatory properties [14, 15]. Furthermore, steroids have been identified as having anti-inflammatory, immunosuppressive, and anti-bacterial properties [16, 17]. Terpenoids have been found to exhibit anti-inflammatory, anticancer, and anti-microbial activities [18, 19]. Saponins, flavonoids, tannins, and terpenoids have been well recognised for their notable antimicrobial properties, effectively inhibiting the growth of bacteria and fungus [20, 21].

**Free radical**

Free radicals are characterised by their extreme reactivity and instability, resulting from an unequal number of electrons. These substances have the potential to have considerable deleterious effects on macromolecules such as nucleic acids, proteins, lipids, etc. [22].  In short, free radicals are molecular entities that have undergone electron loss and then seek to restore electron balance via interactions with other molecules [23]. The extreme reactivity and instability of these molecules may be attributed to their overall net charge [24]. These compounds engage in chemical reactions with other substances in an attempt to acquire the necessary charge or electron for achieving stability. They typically target the nearest stable molecule. When the attacked molecule loses an electron, it becomes a free radical itself. As the series of chain reactions continues, more free radicals are produced [25].

**Antioxidant**

Antioxidants are a class of compounds that possess the ability to transfer electrons to free radicals without suffering any instability as a result. This phenomenon leads to the stabilisation of the free radical, resulting in a reduction of its reactivity [26]. Oxidative stress refers to the state of imbalance between free radicals and antioxidants inside the body [24].

**Wound infection**

A wound can be defined as an opening or breaking of the skin resulting from physical injuries. Wound healing is an important process required for restoring the damaged anatomical structure as well as repairing all the disturbed function of the cell caused by the injury [27, 28].Wound infection is a common problem that can lead to severe complications if not treated properly. Infection of wounds by bacteria can result in interference with the wound healing process [29]. There can be several mechanisms involved in the way bacteria interfere with the wound healing process. This can be through the release of endotoxins by the invading bacteria that may reduce the proliferative capacity of the fibroblast and epithelial cells. Secreted toxins may even lead to lysis of collagen, fibrin and degradation of growth factors [30]. The natural tendency of medicinal plants to respond to various environmental stresses is due to the presence of phytochemicals in them. These important plant compounds are believed to have bountiful medicinal properties, including antioxidant properties [31]. Since oxidative stress has now become a major causative factor in contributing to several life threatening diseases, medicinal plants have drawn more attention being an important source of natural antioxidant [32, 33].

**Medicinal plant and their healing property**

***Pilea microphylla*:** An investigation on the antioxidant and antibacterial properties of *Pilea microphylla* was carried out by Chahardehi et al. (2010). This plant, which is a ground covering succulent herb, is a member of the family *Urticacea*e. It prefers to thrive in regions that are damp and shaded. Usually it is distributed in tropical and subtropical regions. The research assessed the antioxidant activity by DPPH assay, while also determining the total phenolic content and total flavonoid content. The antimicrobial activity was tested in vitro using the disc diffusion method. The experimental findings indicate that whole plant extract of *P. microphylla* using different solvents has radical scavenging activity, which may be linked to its phenolic and flavonoid composition. Additionally, the plant extracts have shown inhibitory effects against several bacteria, suggesting its potential as an antibacterial agent [34].

**Traditional use:** Allergies, wounds [35], infertility, inflammations, womb cleanser [36], diabetes, asthma, and balancing insulin levels [37].

***Aesculus indica*:** *Aesculus indica* is a plant that belongs to the family *Sapindaceae*. It is characterised as a herbaceous, soft perennial plant that exhibits a high prevalence in the Northern Western Himalayas region. It has long been used to treat a number of illnesses. In a study conducted by Chakraborthy et al. (2009), the authors investigated the free radical scavenging activity of *A. indica* leaf extract. Their findings revealed that the chloroform extract of this plant exhibited the ability to scavenge nitric oxide and superoxide radicals. These results provide support for the traditional medicinal use of *A. indica*, which may be attributed to its radical scavenging activity [38].

**Traditional use:** Rheumatism, diabetes, colic disorder [39, 40], cancer, haemorrhoids, varicose veins, ulcers, migraines, blood effusions, frostbite [41], solace from pain, rheumatism, and to ease achiness [42].

***Caesalpinia crista*:** The antioxidant and reactive oxygen species scavenging activities of *Caesalpinia crista* was investigated by Mandal et al. (2011). *C. crista* belongs to the family *Fabaceae* and is characterised as a large, sprawling, and thorny shrub that mostly inhabits the tropical and subtropical areas of Southeast Asia. Primarily the stems, roots, and seeds are used in traditional medicinal preparations. This research demonstrates that the 70% methanolic leaf extract of *C. crista* has significant levels of phenolic and flavonoid content, has free radical scavenging action, and promotes the generation of antioxidant enzymes [43].

**Traditional use:** burns, wounds, ulcers, leprosy, skin problems, diarrhoea, dysentery, epilepsy, convulsions, menorrhagia, leucorrhoea, diabetes, and haemorrhages [44].

***Marrubium peregrinum*:** The study conducted by Stankovic (2011) aimed to investigate the phenolic and flavonoid composition, as well as the antioxidant activities, of *Marrubium peregrinum*. This plant that belongs to the family *Lamiaceae*, is a perennial plant often seen on arid sandy substrates and dry rocky meadows. It is usually distributed in Europe and Middle Asia. Certain species of *Marrubium* exhibit numerous pharmacological qualities and have been extensively used in traditional medicinal practices. The plant was subjected to extraction using a total of five solvents, including water, methanol, ethyl acetate, acetone, and petroleum ether. The research demonstrates that the plant extracts have significant antioxidant activity, which is positively associated with their significant phenolic content [45].

# Traditional use: Certain species of the genus Marrubium have been reported to be used as a traditional treatment for coughs, colds, skin complications, liver, stomach, heart, immune system [46], bronchitis, whooping cough, expectorant, antispasmodic [47], arrhythmia, asthma, jaundice, lung diseases, tonic, anti-infective agent, ulcers, and wounds [48].

***Tabebuia pallida*** : Rahman et al. (2015) investigated *Tabebuia pallida's* antioxidant and free radical scavenging activities. *T. pallida*, sometimes known as the white trumpet tree, is a member of the *Bignoniaceae* family. It is often found in Central America, West India, and South America. It is frequently used as an alternative treatment for various maladies, particularly in remote areas. This research was conducted using the methanolic extract of the stem bark, root bark, leaf, and flowers of the plant, and was shown to have a high level of phenols and flavonoid content as well as antioxidant and free radical scavenging activity [49].

**Traditional use:** Syphilis, malaria, cutaneous infections, stomach problems, cancer, inflammation, pain, infections, anxiety, poor memory, irritability, depression, diabetes, prostatitis, constipation, allergies, treatment of infectious illnesses, and snake bites [50].

***Colebrookea oppositifolia, Mussaenda macrophylla, Pilea symmeria, Thysanolaena maxima*, *Mallotus philippensis*, *Celosea argentea* and *Pogostemon cablin* :** In a study performed by Subba and Basnet (2014), the ethanolic extract of the roots of *Colebrookea oppositifolia, Mussaenda macrophylla, Pilea symmeria, Thysanolaena maxima*, bark of *Mallotus philippensis*, whole plant of *Celosea argentea,* and leaves of *Pogostemon cablin* were assessed for their antioxidant activity using the DPPH radical scavenging method, and the antimicrobial activity was tested against *Staphylococcus aureus, Klebsiella pneumoniae, Proteus vulgaris,* and *Escherichia coli* using the disc diffusion method. The experimental findings indicate that the ethanolic extract of the plants exhibits significant antibacterial and antiradical properties, which may be primarily attributable to the presence of phenolic compounds within the extracts [51].

**Traditional use of *Colebrookea oppositifolia* :** Headache, fever, dysentery, peptic ulcer, dermatitis, wounds, hemostatic, antifungal, treatment for fertility [52, 53], and epilepsy [54, 55].

**Traditional use of *Mussaenda macrophylla* :** Sour mouth, sour throat, oral infections, fever, cough, dysentery, diarrhoea, indigestion, chronic ulcers, cancers, and snake bites [56-58].

**Traditional use of *Pilea symmeria*:** Fracture [59], and wound [60].

**Traditional use of *Thysanolaena maxima* :** Eye infection, tonsillitis, boils, skin diseases [61-63], for curing flatulence, digestion, tonsillitis, antiemetic, anthelmintic, and fever [64, 65].

**Traditional use of *Mallotus philippensis* :** Typhoid and meningitis, intestinal worms, purgatives, dermal problems, nonhealing wounds, skin infections, burns [66], bronchitis, antifungal, anti-parasitic, eye-disease, cancer, diabetes, diarrhoea, jaundice, malaria, urinogenital infection, and acute rheumatism [67].

**Traditional use of *Celosea argentea****:* Diarrhea, pile problem, bleeding nose, mouth sore, itching, wound, jaundice, gonorrhea, aphrodisiac, inflammation, liver and eye problem, treatment of white discharge, diabetes ,gastroenteritis, leucorrhea, uterine problem, haemorrhage,cough, as haemostatic, snakebite, constipation, aphrodisiac, antipyretic, sarcoptidosis, and to cure ovarian disease [68].

**Traditional use of *Pogostemon cablin:*** Anti-emetic, appetite stimulant, snake bite, inflammatory disease [69], to treat bug bite, stomachache, headache, nausea, and vomiting [70].

***Flueggea virosa*:** Ajaib et al. (2021), investigated the antimicrobial and antioxidant properties of *Flueggea virosa.* This plant is a member of the *Phyllanthaceae* family. It is densely branched shrub with small branches that resemble thorns. They are widespread across tropical Africa and extend towards Asia. In this investigation, the leaf and bark extracts were found to contain phytochemicals with anti-bacterial and free radical scavenging properties [71].

**Traditional use of *Flueggea virosa:*** To cure lactation problems, sick babies at birth, abdominal pain, liver and urinary disease, inflammation, diabetes, eczema, rheumatoid arthritis [72], kidney, venereal disease, bile deficiency, testicular inflammation, frigidity, sterility, menstruation problems [73], pain, fever, malaria, and snakebite [74, 75].

***Argemone Mexicana*:** A study conducted by Arouja et al. (2015) examined the antibacterial properties of *Argemone Mexicana*. This plant species belongs to the *Papaveraceae* family and is mostly distributed in the Central American region. It also occurs in tropical and sub-tropical regions, such as West Africa. The experimental findings of this study indicate that the ethanolic leaf extract of *A. Mexicana* has antibacterial properties [76].

**Traditional use of *Argemone Mexicana:*** Dropsy, jaundice, ophthalmia, scabies, skin problem, as an emetic, laxative, expectorant, demulcent, diuretic, dysentery, ulcer, asthma, intestinal problem, cough, digestion problem, and to maintain normal blood circulation and cholesterol level [77].

***Mimosa pudica*:** Chowdhury et al., (2008) conducted a study on the antioxidant properties of *Mimosa pudica*. This plant belongs to the family *Mimosaceae* and is characterised by its shrub-like growth habit and has compound leaves that exhibit a touch-sensitive response. The use of this plant as a medicinal remedy for a diverse range of maladies has been documented. The experimental findings indicate that the various extracts of *M. pudica* have a notable capacity for scavenging free radicals [78].

**Traditional use of *Mimosa pudica:*** Alopecia, diarrhoea, constipation, leprosy, dysentery, insomnia, tumour, blood disorder, urogenital infection [79, 80], high blood pressure, menorrhagia, leucorrhea, haemorrhoids, wounds, eczema, psoriasis, impotence, and spermatorrhea [81].

***Terminalia superba*:** The study conducted by Dougnon et al. (2014) investigated the in vivo antibacterial and wound healing capabilities of *Terminalia superba* in Wistar albino rats. This plant belongs to the family *Combretaceae* and is distributed in the regions of west and central Africa. Extensive research in the field of literature has shown the use of this plant for the treatment of infectious and parasitic disorders. Furthermore, it has been used in the treatment of bronchopulmonary disorders, diarrhoea, and gonorrhea. The experimental findings reveal that the ethanol extract of the bark of *T. superba* is effective against the tested bacteria strains *E. coli* (ATCC 25922) and *S. aureus* (ATCC 25923) as well as having wound healing activities [82].

**Traditional use of *Terminalia superba:*** Hypertension, diabetes, gastroenteritis, female infertility, abdominal pain [83], bacterial, fungal, and viral infection [84].

 ***Phyllanthus muellerianus:***Boakye et al. (2018) investigated *Phyllanthus muellerianus* in vivo wound healing effectiveness in rats excision and incision wound models. This plant is native to West Africa and belongs to the *Euphorbiaceae* family. Aqueous extracts of *P. muellerianus* and its major isolate geraniin, were used for treating the experimental animals and were found to significantly enhance the wound healing process, which is encountered by an increase in the production of hydroxyproline, collagen, and wound tensile strength [85].

**Traditional use of *Phyllanthus muellerianus:*** Dysentery, pain, gonorrhoea, stomach sores, boil, wound, menstrual disorder, fever, skin problems [86, 87], constipation, bronchitis, and urethral problems [88, 89].

***Ficus benghalensis*:** Garg et al. (2011) investigated the wound healing activities of *Ficus benghalensis* in rats using an excision and incision wound model. *F. benghalensis* is a member of the *Moraceae* family. All parts of the plant have been used in traditional remedies. The findings of this study suggested that the application of the ethanolic and aqueous bark extract of *F. benghalensis* significantly enhances the pace of wound healing in comparison to the placebo control. This is shown by the increase in wound contraction and tensile strength [90].

**Traditional use of *Ficus benghalensis:*** Swelling, pain, bleeding [91, 92], as a tonic [93, 94], diabetes [95, 96], snake bite, urinary problem, skin complications, dysentery, treatment of pile, joint and muscular pain, sore, ulcer, wound, bruises, rheumatism, oral complications, vomiting, eye problem, sterility in women, bone fracture, leucorrhea, cholera, fever, and as an antiseptic [97].

 ***Plagiochila beddomei*:** Manoj et al. (2012) investigated the wound healing activities of *Plagiochila beddomei* in rat model. This plant belongs to the family *Plagiochilaceae* and is widely distributed throughout India. The findings of the research conducted on the excision and incision wound model demonstrate the efficacy of the methanolic and aqueous extracts of *P. beddomei* in facilitating the process of wound healing. This efficacy is shown by the accelerated remodelling, re-epithelialisation, keratinisation, and increase of wound tensile strength [98].

**Traditional use of *Plagiochila beddomei:*** Skin problems, burns, boils, blisters, to treat cardiovascular disorders, tonsillitis, bronchitis, and tympanitis [99, 100].

***Bacopa monniera:***In a study conducted by Murthy et al. (2013), the wound healing potential of *Bacopa monniera* was investigated in rats using excision, incision, and dead space wound models. *B. monniera* belonging to the family *Scrophulariaceae* is a herbaceous plant that often grows in low-lying areas such as wetlands, marshes, and beside streams and rivers and is distributed throughout India. It has been shown to possess diverse therapeutic activity. The whole plant was extracted using 50% ethanol, and the findings of the study validated the plant's capacity for wound healing, as it exhibited antimicrobial properties against the tested pathogen. It was also shown to enhance the antioxidant levels, wound breaking strength, increase in wound contraction, expedite collagen deposition, shortened epithelialisation period, reduced scar area, and mitigate myeloperoxidase activity and tissue damage caused by free radicals [101].

**Traditional use of *Bacopa monniera:*** To improve verbal learning, delayed word recall, memory acquisition, and anxiety [102, 103].

***Terminalia chebula*:** The wound healing activity of *Terminalia chebula* was also investigated by Singh and Sharma (2009), in experimentally induced diabetic rats using excision and dead space wound model. *T. chebuba* belongs to the family *Combretaceae*. Topical application of the fruit extract on wound was found to promote quicker wound healing. This was shown by an increase in wound contraction and a reduction in epithelialization period. The administration of the extract by oral route was also shown to result in a substantial rise in the mass of granuloma in the tested animals [104].

**Traditional use of *Terminalia chebula*:** Stomachic, alterative, antispasmodic, opthalmia, hemorrhoids, oral problem, inflammation, analgesic, wound, sore throat, loss of appetite, digestive aid, liver stimulant, gastrointestinal problem, diarrhea, nervous system problem, hemorrhage, cough, chorizo, asthma, renal calculi, urinary problem, skin disorder, urticaria, erythematous disorder [105, 106], dementia, constipation, diabetes [107], splenomegaly, epilepsy, leprosy, melancholia, gout and joint pain [108], eye tonic, cardiotonic, blood purifier, dementia, conjunctivitis, cataract, palpitation, as a carminative, astringent, constipation, rejuvenator of the body, detoxification of colon [109], pile problem, to treat hair falling and whitening [110], swelling, burns, brain tonic, stomach tonic [111], to promote memory, thinking and reasoning power, ascites, spleenomegaly, colitis, headache, antiparasitic, epilepsy, hepatitis, anemia, obesity and as a laxative [112].

# Table 1: List of Medicinal plants mentioned in the study and their identified properties.

|  |  |  |  |
| --- | --- | --- | --- |
| **Scientific name** | **Family** | **Part used for the study** | **Plant property proven in the study** |
| *Pilea microphylla* | *Urticaceae* | Whole plant | Antimicrobial and antioxidant properties [27] |
| *Aesculus indica* | *Sapindaceae* | Leaf | Antioxidant property [28] |
| *Caesalpinia crista* | *Fabaceae* | Leaf | Antioxidant property [29] |
| *Marrubium peregrinum* | *Lamiaceae* | Whole plant | Antioxidant property [30] |
| *Tabebuia pallida* | *Bignoniaceae* | Leaf, flower, stem and root bark | Antioxidant and free radical scavenging properties [31] |
| *Colebrookea oppositifolia* | *Lamiaceae* | Root | Antimicrobial and antioxidant properties [32] |
| *Mussaenda macrophylla* | [*Rubiaceae*](https://en.wikipedia.org/wiki/Rubiaceae) | Root | Antimicrobial and antioxidant properties [32] |
| *Pilea symmeria* | *Urticaceae* | Root | Antimicrobial and antioxidant properties [32] |
| *Thysanolaena maxima* | *Poaceae* | Root | Antimicrobial and antioxidant properties [32] |
| *Mallotus philippensis* | *Euphorbiaceae* | Bark | Antimicrobial and antioxidant properties [32] |
| *Celosea argentea* | *Amaranthaceae* | Whole plant | Antimicrobial and antioxidant properties [32] |
| *Pogostemon cablin* | *Lamiaceae* | Leaf | Antimicrobial and antioxidant properties [32] |
| *Flueggea virosa*  | *Phyllanthaceae* | Leaf, bark | Antimicrobial and antioxidant properties [33] |
| *Argemone Mexicana* | *Papaveraceae* | Leaf | Antimicrobial property [34] |
| *Mimosa pudica* | *Mimosaceae* | Aerial part, root | Antioxidant property [35] |
| *Terminalia superba* | *Combretaceae* | Bark | Antibacterial and wound healing properties[36] |
| *Phyllanthus muellerianus* | *Euphorbiaceae* | Aerial part | wound healing property [37] |
| *Ficus benghalensis* | *Moraceae* | bark | wound healing property [38] |
| *Plagiochila beddomei* | *Plagiochilaceae* | Thallus | Wound healing property [39] |
| *Bacopa monniera* | *Scrophulariaceae* | Whole plant | Wound healing property [40] |
| *Terminalia chebuba* | *Combretaceae.* | Fruit | Wound healing property [41] |

 **Conclusion**

Based on a literature survey, it is evident that the phytoconstituents of medicinal plants have the ability to react to many environmental stressors, and therefore they earn considerable interest due to their potential in mitigating oxidative stress. In addition to being a valuable source of therapeutic agents for a range of illnesses, there is a growing interest in identifying and producing new antimicrobial agents to combat microbial resistance. Since most microorganisms are becoming resistant to the effects of many of the modern antibiotics that are now in use, finding safer and more effective medications to treat infections as well as wounds and other diseases is of utmost significance. Given the large amount of data demonstrating the therapeutic properties of medicinal plants and their scientifically proven efficacy for treating a variety of diseases, it is safe to say that they represent significant reservoirs of novel pharmacological constituents. However, more in-depth research still needs to be carried out in order to better understand the precise process and discover ways to make use of them more efficiently.

**Conflict of interest** The authors declare they have no financial interests.

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