



Review Article

BOTANICAL, PHYTOCHEMICAL, AND PHARMACOLOGICAL POTENTIAL OF DIOSCOREA WALLICHII, IPOMOEA CAIRICA, AND MERREMIA DISSECTA: A COMPREHENSIVE REVIEW

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ABSTRACT

Medicinal plants remain an important source of bioactive compounds for the discovery of novel therapeutic agents. Among them, *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* have attracted increasing scientific attention because of their diverse phytochemical constituents and broad spectrum of pharmacological activities. Although these plants have been traditionally used in different systems of medicine, a comprehensive evaluation of their phytochemistry and biological properties is limited. The present review summarizes the available scientific evidence on the botanical characteristics, traditional uses, phytochemical composition, and reported pharmacological activities of these three medicinal plants. Published studies indicate that they contain several bioactive compounds, including flavonoids, phenolic compounds, alkaloids, terpenoids, and steroidal saponins, which contribute to antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, antidiabetic, and other biological activities. The review also highlights current research gaps, including the need for standardized phytochemical characterization, toxicity assessment, and detailed pharmacological investigations. Collectively, the available evidence suggests that *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* represent valuable medicinal resources with considerable potential for future drug discovery. Further experimental and clinical studies are warranted to validate their therapeutic applications and elucidate their underlying mechanisms of action.

Keywords: *Dioscorea wallichii*; *Ipomoea cairica*; *Merremia dissecta*; Phytochemistry; Medicinal plants; Pharmacological activities; Bioactive compounds.

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1. INTRODUCTION

Medicinal plants have served as an invaluable source of therapeutic agents for centuries and continue to play a significant role in modern healthcare and drug discovery. According to the World Health Organization (WHO), traditional medicine remains an important component of healthcare systems worldwide, particularly in developing countries where medicinal plants are widely accessible and culturally accepted. The increasing prevalence of chronic diseases, antimicrobial resistance, and adverse effects associated with synthetic drugs has renewed scientific interest in plant-derived natural products as potential therapeutic alternatives [1,2].

Plants produce a wide range of secondary metabolites, including flavonoids, alkaloids, phenolic compounds, terpenoids, tannins, glycosides, and saponins, which exhibit diverse biological activities. These bioactive constituents have attracted considerable attention because of their antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, cardioprotective, and immunomodulatory properties. Several clinically important drugs, including aspirin, quinine, artemisinin, and paclitaxel, have originated from natural products, emphasizing the importance of medicinal plants in modern drug discovery and pharmaceutical development [3,4,26].

Among the numerous medicinal plants investigated in recent years, *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* have emerged as promising species due to their rich phytochemical composition and diverse pharmacological potential. These plants are distributed across tropical and subtropical regions and have traditionally been used for the management of various ailments. Recent phytochemical investigations have reported the presence of steroidal saponins, flavonoids, phenolic compounds, alkaloids, terpenoids, and other secondary metabolites that may contribute to their therapeutic effects [5–7].

Experimental investigations have demonstrated that medicinal plants belonging to the *Dioscorea*, *Ipomoea*, and *Merremia* genera exhibit antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, antidiabetic, and other biological activities. These effects are primarily associated with modulation of oxidative stress, inflammatory pathways, microbial growth, and cellular signaling mechanisms. However, available information remains fragmented, with many studies focusing on individual compounds or isolated pharmacological effects rather than providing a comprehensive evaluation of their medicinal potential [8–10].

A systematic review of available literature is therefore required to consolidate current knowledge regarding the botanical characteristics, ethnomedicinal importance, phytochemical composition, and pharmacological activities of these plants. Such an approach may provide valuable insights into their therapeutic significance, identify existing research gaps, and establish a scientific foundation for future pharmacological investigations. Furthermore, comprehensive evaluation of these species may contribute to the development of standardized herbal formulations and support future studies assessing their safety, efficacy, and mechanisms of action [11,12].

Therefore, the present review aims to provide a comprehensive overview of *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* by summarizing their botanical characteristics, ethnomedicinal significance, phytochemical profiles, and reported pharmacological activities. The review also highlights current research limitations and future perspectives for exploring these medicinal plants as potential sources of novel bioactive compounds for pharmaceutical applications.

Botanical Overview of the Selected Plants

Medicinal plants have long been recognized as important sources of bioactive compounds with diverse therapeutic applications. Botanical characterization provides the foundation for accurate identification, authentication, and quality control of medicinal plant materials. *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* belong to different botanical families but possess significant ethnomedicinal value due to their traditional uses and phytochemical richness. Understanding their botanical characteristics, geographical distribution, and ethnomedicinal importance is essential

for future phytochemical and pharmacological investigations [13–15].

Dioscorea wallichii

Dioscorea wallichii Hook.f. belongs to the family *Dioscoreaceae* and is a perennial climbing vine distributed throughout the Himalayan region, Northeast India, Nepal, Bhutan, Myanmar, and other parts of Southeast Asia. The plant produces underground tubers that have traditionally been utilized as both nutritional and medicinal resources. Morphologically, it is characterized by slender twining stems, cordate leaves with reticulate venation, and small unisexual flowers arranged in elongated spikes.

Taxonomic and phylogenetic investigations have confirmed the classification and evolutionary relationships of *Dioscorea* species within the *Dioscoreaceae* family [14]. The tubers contain important bioactive metabolites, particularly steroidal saponins, diosgenin derivatives, phenolic compounds, and other secondary metabolites. Traditionally, *D. wallichii* has been used for inflammatory disorders, digestive problems, and general weakness. The nutritional importance and phytochemical richness of *Dioscorea* species have stimulated increasing scientific interest in their pharmacological evaluation [5,13,15].

Ipomoea cairica

Ipomoea cairica (L.) Sweet is a perennial climbing plant belonging to the family *Convolvulaceae*. It is widely distributed in tropical and subtropical regions of Asia, Africa, Australia, and South America. The plant is characterized by deeply palmately divided leaves and attractive purple to lavender funnel-shaped flowers.

Taxonomic studies have described the morphological features and systematic classification of *Ipomoea* species, supporting accurate identification of *I. cairica* and related species [5,16]. Traditionally, different parts of the plant have been used for fever, inflammation, skin disorders, and pain-related conditions. Phytochemical investigations have revealed the presence of flavonoids, alkaloids, phenolic compounds, terpenoids, coumarins, and glycosides, which may contribute to its reported pharmacological activities [6,17].

Merremia dissecta

***Merremia dissecta* (Jacq.) Hallier f. belongs to the family *Convolvulaceae* and is distributed in tropical and subtropical regions, including India, Central America, South America, and Africa. It is a vigorous twining herb characterized by deeply dissected leaves and large white flowers with a purple center.**

Traditionally, different plant parts have been used for inflammatory conditions, gastrointestinal disorders, infections, and other common ailments. Phytochemical studies of the genus *Merremia* have reported the presence of flavonoids, phenolic compounds, tannins, saponins, terpenoids, steroids, and glycosides. Although research specifically focused on *M. dissecta* remains limited, available evidence indicates that this species represents a promising source of bioactive natural products requiring further investigation [6,7].

Phytochemical Profile of the Selected Plants

Phytochemicals are naturally occurring secondary metabolites that contribute significantly to the therapeutic potential of medicinal plants. These compounds play essential roles in plant defense mechanisms and exhibit a broad range of biological activities, making them important targets in pharmaceutical and pharmacological research. Major classes of phytochemicals include flavonoids, phenolic compounds, alkaloids, terpenoids, tannins, glycosides, saponins, steroids, and polysaccharides. The diversity, concentration, and structural characteristics of these metabolites largely determine the biological and pharmacological properties of medicinal plants. *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* possess diverse phytochemical profiles, supporting their potential as valuable sources of bioactive natural products [18–20].

Phytochemical Profile of *Dioscorea wallichii*

The genus *Dioscorea* is well recognized for producing a wide variety of biologically active secondary metabolites, particularly steroidal saponins and steroidal sapogenins. Phytochemical investigations of *Dioscorea* species have reported the presence of diosgenin, steroidal saponins, flavonoids, phenolic compounds, tannins, alkaloids, polysaccharides, terpenoids, and organic acids [5,21].

Among these constituents, diosgenin and related steroidal saponins are considered characteristic compounds of *Dioscorea* species because of their importance as precursors in the synthesis of steroidal drugs. These compounds have demonstrated diverse biological activities, including anti-inflammatory, antioxidant, immunomodulatory, and metabolic regulatory effects. Furthermore, flavonoids and phenolic compounds contribute significantly to antioxidant activity through free radical scavenging and modulation of oxidative stress pathways, whereas polysaccharides have been associated with immunomodulatory properties [5,23].

The phytochemical richness of *Dioscorea wallichii* provides a strong scientific basis for its traditional medicinal applications and highlights its importance as a potential source of pharmacologically active natural compounds. However, detailed phytochemical characterization specifically focused on *D. wallichii* remains limited, indicating the need for further investigation using advanced analytical approaches.

Phytochemical Profile of *Ipomoea cairica*

Phytochemical investigations of *Ipomoea cairica* have demonstrated the presence of diverse secondary metabolites distributed among different plant parts, particularly leaves and aerial tissues. Reported phytoconstituents include flavonoids, phenolic acids, alkaloids, coumarins, lignans, resin glycosides, anthocyanins, terpenoids, tannins, and other glycosidic compounds [6].

Flavonoids and phenolic compounds are considered important contributors to the antioxidant activity of *I. cairica* due to their ability to neutralize reactive oxygen

species and regulate oxidative stress-associated pathways. Terpenoids and alkaloids further enhance its pharmacological diversity by contributing to antimicrobial, anti-inflammatory, and other biological effects [6,19].

The presence of multiple classes of phytochemicals indicates that *Ipomoea cairica* represents a promising medicinal plant for natural product research. Nevertheless, further studies involving isolation, structural characterization, and mechanistic evaluation of individual compounds are required to fully understand its therapeutic potential.

Phytochemical Profile of *Merremia dissecta*

Compared with *Dioscorea* and *Ipomoea* species, *Merremia dissecta* has received relatively limited phytochemical investigation. However, studies conducted on the genus *Merremia* have reported the presence of flavonoids, phenolic compounds, tannins, saponins, steroids, terpenoids, and glycosides [7].

These secondary metabolites are considered responsible for many of the traditional medicinal applications attributed to *Merremia* species. Flavonoids and phenolic compounds may contribute to antioxidant and anti-inflammatory effects, whereas terpenoids and saponins may be associated with antimicrobial and other pharmacological activities [7,20].

Although specific phytochemical information regarding *M. dissecta* remains insufficient, the chemical diversity reported within the genus suggests significant potential for future research. Advanced analytical techniques such as high-performance liquid chromatography (HPLC), liquid chromatography–mass spectrometry (LC–MS/MS), gas chromatography–mass spectrometry (GC–MS), and nuclear magnetic resonance (NMR) spectroscopy may facilitate identification and characterization of novel bioactive molecules.

Comparative Phytochemical Profile

Although *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* belong to different botanical families, they share several important phytochemical classes, including flavonoids, phenolic compounds, terpenoids, tannins, and glycosides. These compounds contribute significantly to their antioxidant, anti-inflammatory, antimicrobial, and other biological activities [18–20].

However, each plant possesses unique phytochemical characteristics. *Dioscorea wallichii* is particularly distinguished by its abundance of steroidal saponins and diosgenin derivatives, which are valuable due to their pharmaceutical importance and diverse biological effects [5,23]. In contrast, *Ipomoea cairica* exhibits greater chemical diversity, including flavonoids, alkaloids, coumarins, lignans, resin glycosides, and phenolic compounds, contributing to its broad pharmacological profile [6]. *Merremia dissecta* contains flavonoids, phenolics, tannins, terpenoids, and saponins; however, detailed phytochemical characterization remains comparatively limited [7].

The complementary phytochemical profiles of these plants support their medicinal significance and justify further investigations aimed at isolation, structural elucidation, biological evaluation, and development of standardized herbal formulations.

Table 1. Major Phytochemical Constituents Reported in *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta*

Plant	Major Phytochemicals	Plant Part	Reported Biological Importance
<i>Dioscorea wallichii</i>	Diosgenin, steroidal saponins, flavonoids, phenolics	Leaves, Tuber	Antioxidant, anti-inflammatory
<i>Ipomoea cairica</i>	Flavonoids, alkaloids, terpenoids, phenolics	Leaves	Antioxidant, antimicrobial
<i>Merremia dissecta</i>	Flavonoids, tannins, phenolics, saponins	Leaves, roots	Antioxidant, anti-inflammatory

Pharmacological Activities of the Selected Plants

Medicinal plants exhibit a wide range of pharmacological activities due to the presence of diverse bioactive secondary metabolites, including flavonoids, phenolic compounds, alkaloids, terpenoids, tannins, glycosides, and steroidal saponins. These phytoconstituents contribute to therapeutic effects through multiple mechanisms, including regulation of oxidative stress, modulation of inflammatory pathways, inhibition of microbial growth, and improvement of cellular defense mechanisms. The reported pharmacological properties of *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* indicate their potential therapeutic significance; however, further pharmacological, toxicological, and clinical investigations are necessary to establish their efficacy, safety, and mechanisms of action [12,21].

Antioxidant Activity

Oxidative stress, caused by excessive production of reactive oxygen species (ROS) and an imbalance between oxidant generation and antioxidant defense systems, plays a crucial role in the development of several chronic diseases. Plant-derived antioxidants protect biological systems by scavenging free radicals, reducing oxidative damage, enhancing endogenous antioxidant enzymes, and maintaining cellular redox balance [18,20].

Species belonging to the genus *Dioscorea* contain various antioxidant phytoconstituents, including steroidal saponins, flavonoids, phenolic compounds, and polysaccharides. These compounds contribute to antioxidant activity through free radical scavenging,

inhibition of lipid peroxidation, and regulation of oxidative stress-associated pathways. Diosgenin and related steroidal compounds reported from *Dioscorea* species have demonstrated protective effects against oxidative damage in experimental studies [5,23].

Similarly, *Ipomoea cairica* exhibits antioxidant potential due to the presence of flavonoids, phenolic acids, and other polyphenolic compounds. These constituents contribute to neutralization of reactive oxygen species and may protect cells from oxidative injury [6]. Although studies on *Merremia dissecta* are limited, the presence of flavonoids, phenolics, and tannins suggests potential antioxidant activity requiring further scientific evaluation [7].

Anti-inflammatory Activity

Inflammation is a protective biological response; however, prolonged or excessive inflammation contributes to the development of various pathological conditions. Plant-derived compounds such as flavonoids, phenolic compounds, terpenoids, and steroidal saponins possess anti-inflammatory properties through modulation of inflammatory mediators and signaling pathways [9,20].

Extracts of *Dioscorea* species have demonstrated anti-inflammatory effects associated with inhibition of inflammatory mediators, regulation of cytokine production, and modulation of pathways involving cyclooxygenase (COX), lipoxygenase (LOX), and nuclear factor-kappa B (NF- κ B). Steroidal saponins and diosgenin derivatives are considered important contributors to these effects [5,23].

Phytoconstituents present in *Ipomoea cairica*, particularly flavonoids and phenolic compounds, may contribute to anti-inflammatory activity by reducing oxidative stress and controlling inflammatory responses [6]. Similarly, the presence of flavonoids, tannins, and terpenoids in *Merremia dissecta* suggests possible anti-inflammatory potential; however, detailed molecular investigations are required [7].

Antimicrobial Activity

The increasing prevalence of antimicrobial resistance has encouraged research into medicinal plants as alternative sources of antimicrobial agents. Secondary metabolites such as flavonoids, tannins, phenolic compounds, and terpenoids exhibit antimicrobial activity through different mechanisms, including disruption of microbial membranes, inhibition of microbial enzymes, interference with nucleic acid synthesis, and alteration of microbial metabolic processes [21,22,28].

Several *Dioscorea* species have demonstrated antimicrobial activity due to the presence of phenolic compounds, steroidal saponins, and other bioactive constituents. These compounds may inhibit microbial growth and provide protective effects against pathogenic microorganisms [23].

Studies on *Ipomoea* species have reported antibacterial and antifungal activities associated with flavonoids, alkaloids, and phenolic compounds. The antimicrobial

potential of *Ipomoea cairica* may be attributed to the synergistic action of multiple phytoconstituents [6].

The genus *Merremia* has also shown antimicrobial potential due to the presence of flavonoids, tannins, and terpenoids. However, comprehensive antimicrobial evaluation of *Merremia dissecta* against clinically important microorganisms remains limited and requires further investigation [7,22,28].

Antidiabetic Activity

Diabetes mellitus is a metabolic disorder associated with impaired glucose regulation, insulin resistance, oxidative stress, and chronic inflammation. Medicinal plants containing flavonoids, phenolic compounds, and steroidal saponins have demonstrated antidiabetic potential through improvement of glucose metabolism, enhancement of antioxidant defense, and regulation of metabolic pathways [18,23].

Several species of *Dioscorea* have shown antidiabetic effects through mechanisms such as improvement of insulin sensitivity, inhibition of carbohydrate-digesting enzymes, and reduction of oxidative stress. Diosgenin and steroidal saponins are considered important phytoconstituents responsible for these metabolic effects [5,23].

Although specific studies on *Dioscorea wallichii* remain limited, evidence from related *Dioscorea* species supports further investigation of its antidiabetic potential. *Ipomoea cairica* has also demonstrated biological activities associated with metabolic regulation, which may be linked to its flavonoid and phenolic content [6]. Further research is required to determine the antidiabetic effects of *Merremia dissecta*.

Hepatoprotective Activity

The liver plays a central role in metabolism, detoxification, and maintenance of physiological homeostasis. Oxidative stress, inflammation, and toxic insults are major contributors to hepatic injury. Medicinal plants rich in antioxidant phytochemicals may protect hepatic tissue by reducing lipid peroxidation, enhancing antioxidant enzymes, and regulating inflammatory responses [24].

Several *Dioscorea* species have demonstrated hepatoprotective activity, which is mainly attributed to steroidal saponins, flavonoids, and phenolic compounds. These phytoconstituents help protect hepatocytes against oxidative damage and improve antioxidant status [23,24].

Species belonging to the *Ipomoea* genus have also shown hepatoprotective potential through antioxidant mechanisms. The presence of phenolic compounds and flavonoids may contribute to protection against hepatic oxidative injury [6]. However, systematic hepatoprotective studies on *Ipomoea cairica* and *Merremia dissecta* remain limited and require further evaluation.

Other Reported Pharmacological Activities

Apart from antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and hepatoprotective effects,

medicinal plants belonging to the *Dioscorea* and *Convolvulaceae* families have been reported to possess several other biological activities, including analgesic, wound-healing, immunomodulatory, cytoprotective, and anticancer effects. These activities are mainly attributed to their diverse phytochemical constituents, including flavonoids, phenolic compounds, alkaloids, terpenoids, and steroidal saponins [5–7].

However, most available pharmacological investigations are based on in vitro studies and experimental animal models. Therefore, further research involving detailed mechanism-based studies, toxicity evaluation, pharmacokinetic investigations, and clinical validation is required to establish the therapeutic potential of these medicinal plants.

2. FUTURE PERSPECTIVES

The increasing interest in plant-based therapeutics has emphasized the need to explore underutilized medicinal plants such as *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta* as potential sources of novel bioactive compounds. Future studies should focus on detailed phytochemical characterization using advanced techniques such as HPLC, LC-MS/MS, GC-MS, and NMR spectroscopy to identify and quantify active constituents responsible for their pharmacological effects [12,27].

Further investigations are required to elucidate their molecular mechanisms, pharmacokinetic properties, safety profile, and therapeutic efficacy. Standardization of plant extracts, quality control evaluation, toxicity studies, and well-designed preclinical and clinical investigations are essential for developing safe and effective herbal formulations [2,11,25].

Modern approaches, including metabolomics, network pharmacology, molecular docking, and artificial intelligence-assisted drug discovery, may facilitate the identification of novel bioactive molecules and their therapeutic targets. Continued research on these medicinal plants may contribute to the development of evidence-based phytopharmaceuticals and novel therapeutic agents [12,27].

3. CONCLUSION

Medicinal plants remain valuable sources of bioactive compounds for the discovery of novel therapeutic agents. This review summarizes the botanical characteristics, phytochemical composition, and pharmacological potential of *Dioscorea wallichii*, *Ipomoea cairica*, and *Merremia dissecta*. These plants contain diverse phytoconstituents, including flavonoids, phenolic compounds, alkaloids, terpenoids, tannins, and steroidal saponins, which contribute to their antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and antidiabetic activities [5–7,12].

Although these plants show promising pharmacological potential, significant research gaps remain regarding detailed phytochemical characterization, molecular mechanisms, pharmacokinetic properties, toxicity evaluation, and clinical validation. Therefore,

further systematic preclinical and clinical studies are required to establish their therapeutic efficacy and safety.

Integration of phytochemistry, pharmacology, toxicology, metabolomics, and modern analytical approaches may facilitate the discovery of novel bioactive compounds and support the development of safe, effective, and evidence-based plant-derived therapeutic agents [12,27].

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