

RECENT ADVANCES IN THE PHYTOCHEMICAL AND PHARMACOLOGICAL POTENTIAL OF *IPOMOEAE OBSCURA* (L.): A COMPREHENSIVE REVIEW

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ABSTRACT

Ipomoea obscura (L.) Ker Gawl., which is known as Laksmana in Ayurveda, is a herb of medicinal value from the family Convolvulaceae. It has for a long time been used in various traditional systems of medicine for the treatment of inflammatory disorders, microbial infections, gastrointestinal problems, liver diseases, and a number of chronic conditions. Recent phytochemical studies have shown that the plant contains a wide variety of bioactive compounds such as flavonoids, alkaloids, phenolic compounds, glycosides, terpenoids, steroids, saponins, tannins, and fatty acids. These phytoconstituents are linked to a wide range of pharmacological actions including antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, nephroprotective, cytotoxic, and antidiarrhoeal effects. This review gives a thorough summary of the botanical features, taxonomy, geographical distribution, ethnomedicinal significance, phytochemical composition, and the pharmacological activities that have been experimentally verified for *Ipomoea obscura*. Special attention is given to the mechanistic connection between oxidative stress and inflammation, a relationship that lies at the root of many chronic diseases. The review also examines the existing research gaps and outlines future directions regarding phytochemical standardization, mechanistic studies, toxicological evaluation, and clinical translation. The evidence currently available indicates that *I. obscura* represents a promising source of multifunctional phytotherapeutic agents for the management of disorders associated with oxidative stress and inflammation.

KEYWORDS: *Ipomoea obscura*, Convolvulaceae, phytochemistry, antioxidant, anti-inflammatory, oxidative stress, medicinal plant, pharmacological activity.

1. INTRODUCTION

Medicinal plants still have an important role in the discovery and in the development of new therapeutic agents, since a great many people all over the world use plant-based traditional medicines as part of their primary healthcare and because a number of modern drugs have been obtained from natural products. The plants in the genus *Ipomoea* have attracted a great deal of scientific interest among medicinal plants due to their rich variety of phytochemicals and the wide range of biological activities they show.

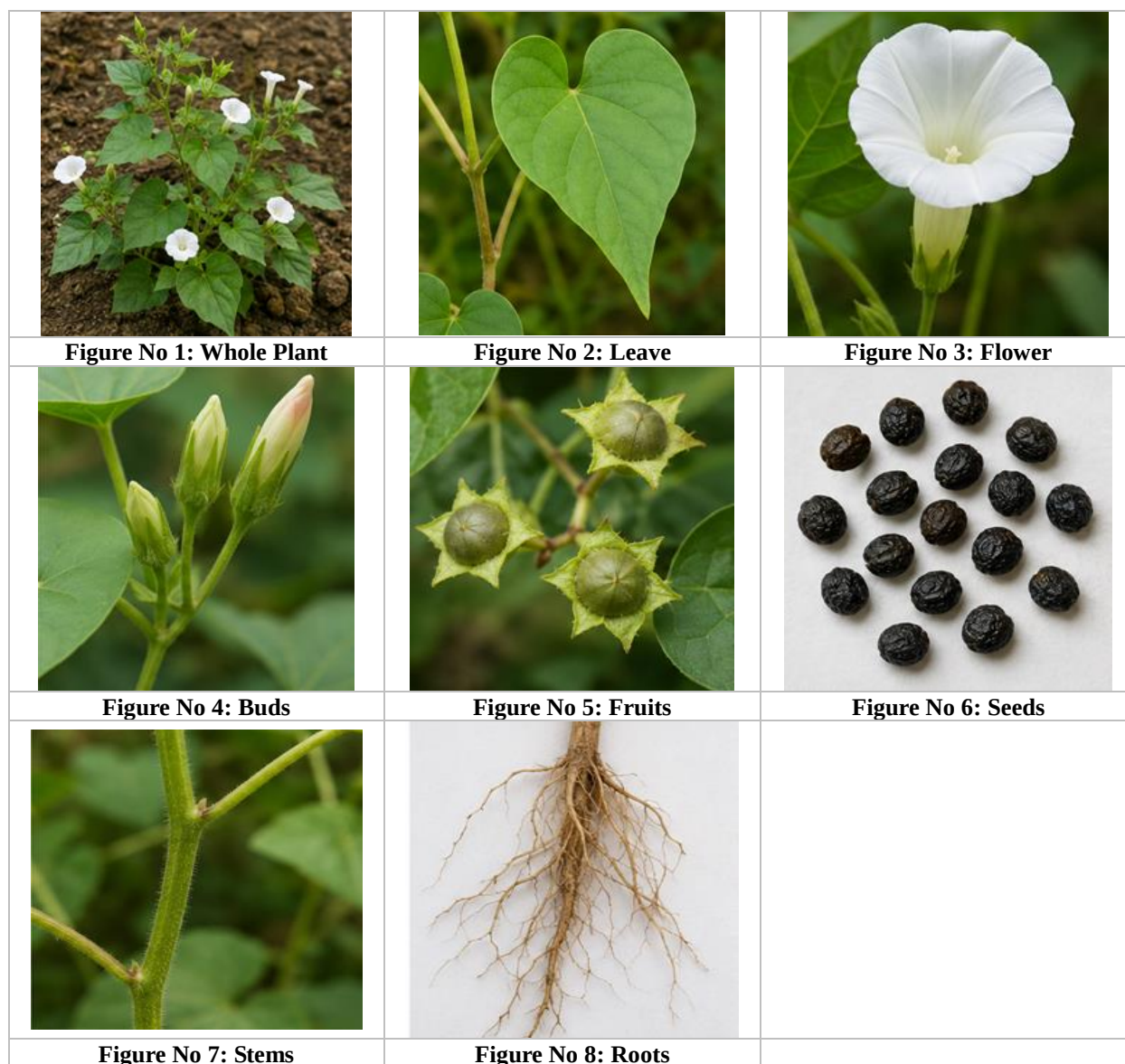
Ipomoea obscura (L.) Ker Gawl., which is known as Laksmana in Ayurveda, is a slender, twining perennial herb from the family Convolvulaceae. It has heart-shaped leaves with a pointed tip and flowers that are pale yellow in colour and have a purple throat. The plant is usually found in grasslands, hedges, waste areas, and in

other disturbed habitats throughout India and in other tropical and subtropical regions.^[1]

The genus *Ipomoea* includes almost 2,000 species which are found all over the world, a large number of them having important medicinal properties. In traditional and folk medicine the entire plant of *I. obscura* has been widely used as a remedy for inflammatory conditions, microbial infections, liver diseases, gastrointestinal problems, and other chronic illnesses. Studies of the plant's phytochemical composition have revealed the presence of flavonoids, tannins, alkaloids, glycosides, phenolic compounds, steroids, terpenoids, saponins, polyphenols, coumarins, and volatile oils rich in sesquiterpenes. These components are linked to a variety of pharmacological effects such as antimicrobial, antifungal, hepatoprotective, antioxidant, nephroprotective, cytotoxic, anti-inflammatory, and

antidiarrhoeal actions.^[2] Since interest among scientists has been rekindled regarding medicinal plants that have multiple therapeutic effects because of the growing incidence of chronic inflammatory diseases, disorders associated with oxidative stress, and cancer, *I. obscura*

has become a promising candidate for use in the development of future phytopharmaceuticals since it shows both antioxidant and anti-inflammatory activities through its phytochemical constituents.



2. Botanical Description and Taxonomy

2.1 Taxonomic Classification

The accepted taxonomic classification of *Ipomoea obscura* is presented in Table 1.

Table 1: Taxonomic classification of *Ipomoea obscura*.^[3]

Taxonomic	Classification
Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Solanales
Family	Convolvulaceae
Genus	<i>Ipomoea</i>
Species	<i>Ipomoea obscura</i> (L.) Ker Gawl.

2.2 Morphological Characteristics

Ipomoea obscura is a slim perennial herb which grows by climbing or trailing over the neighbouring vegetation, having smooth and flexible stems. Its root system is made up of a moderately branched taproot. The leaves are simple, arranged alternately, cordate to ovate in

shape, with entire margins and a pointed tip. The flowers are either single or appear in small groups and have a typical funnel-shaped corolla that is pale yellow or cream in colour with a purple throat. The fruit is a small, round capsule containing one to four dark brown or black seeds.^[4]

Table 2: Morphological characteristics of *Ipomoea obscura*.^[4]

Plant part	Morphological characteristics
Habit	Slender, twining or climbing perennial herb with smooth and flexible stems
Root	Moderately branched taproot with fibrous roots
Stem	Cylindrical, green to light purple, smooth or sparsely hairy
Leaves	Simple, alternate, heart-shaped or ovate, entire margin, pointed apex
Flowers	Solitary or clustered, funnel-shaped, pale yellow or cream with purple throat
Fruit	Small globose capsule that turns brown upon maturity
Seeds	Dark brown to black, triangular, rough-textured

3. Geographical Distribution and Ethnobotanical Importance

Ipomoea obscura is found in many parts of the tropical and subtropical areas of Asia, Africa, and a number of the Pacific islands. It occurs in East, West, Central, and Southern Africa; in the islands of the Western Indian Ocean; in the Arabian Peninsula; in China and Taiwan; and in a large part of South and Southeast Asia, which includes India, Sri Lanka, Bangladesh, Nepal, Myanmar, Thailand, and Vietnam. The plant is also present throughout the Malesian region and on several islands in the South Pacific.^[5]

The plant has, from an ethnomedical point of view, been used in the treatment of inflammation, fever, microbial infections, gastrointestinal disorders, liver problems, skin diseases, wounds, and general weakness. Traditional practitioners usually make use of the entire plant, including the leaves, the roots and other parts, in the form of decoctions, powders, pastes and infusions. The fact that these traditional uses are so widespread offers a solid basis for current pharmacological research.

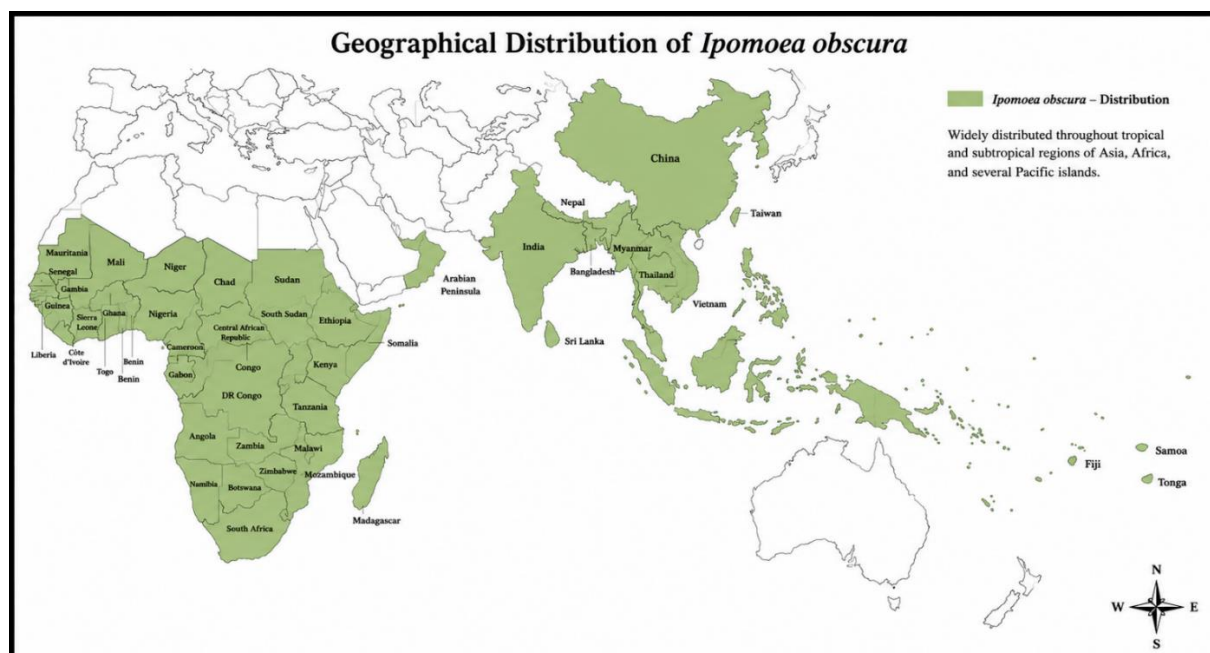


Figure No 9: Geographical Distribution.

4. Phytochemical Constituents of *Ipomoea obscura*

Studies into the phytochemical composition have shown that *I. obscura* contains a wide variety of secondary metabolites which play a significant role in its pharmacological activities. The main groups of active compounds are alkaloids, flavonoids, phenolic

compounds, glycosides, terpenoids, steroids, saponins, carbohydrates, mucilage, and fatty acids.^[6,7]

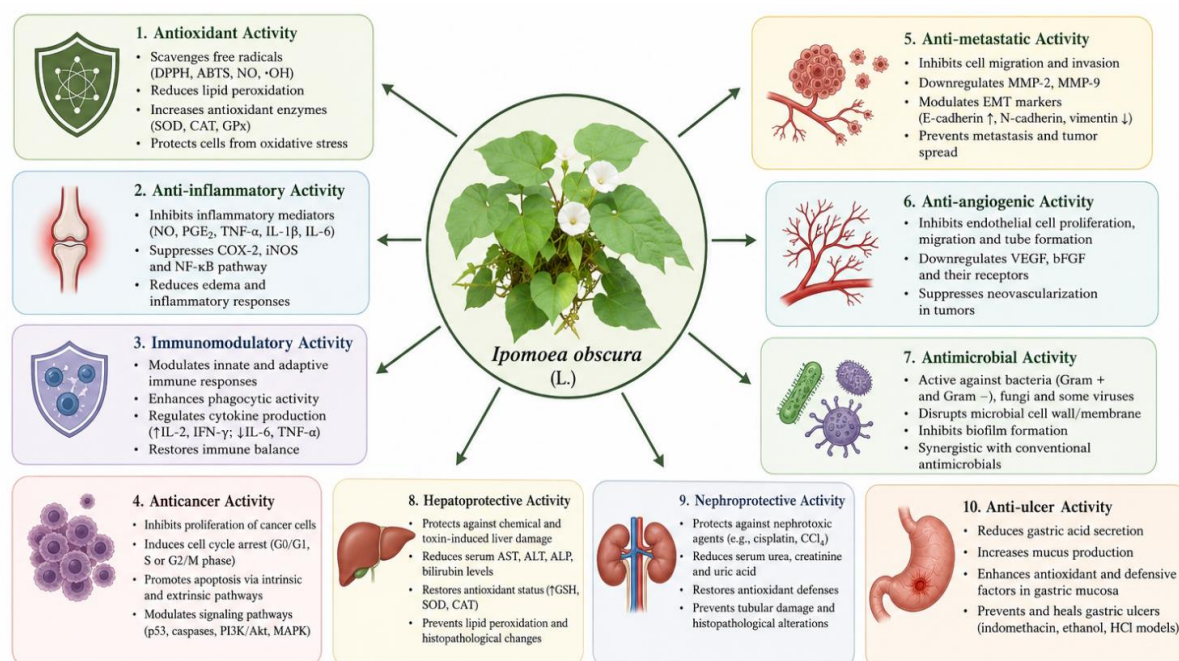
Table 3: Major phytochemical constituents of *Ipomoea obscura*.^[6,7]

Name	Constituents
Alkaloids	Ergoline-type alkaloids, indole alkaloids
Flavonoids	Quercetin, kaempferol, apigenin, luteolin derivatives
Phenolic compounds	Tannins, caffeic acid, ferulic acid
Glycosides	Flavonoid glycosides, cardiac glycoside-like compounds
Terpenoids and steroids	β -Sitosterol, stigmasterol, triterpenoids
Saponins	Various saponin constituents
Carbohydrates and mucilage	Polysaccharides, resin glycosides
Fatty acids	Palmitic acid, oleic acid, linoleic acid

It is particularly important that flavonoids and phenolic compounds have strong free-radical scavenging, metal-chelating, anti-inflammatory, and cytoprotective properties. Phytosterols such as β -sitosterol and stigmasterol can help to stabilise membranes and exert an anti-inflammatory effect, while terpenoids are generally linked to antimicrobial and immunomodulatory effects. The complicated mixture of phytochemicals found in *I. obscura* indicates that the plant's therapeutic value comes about due to the synergistic action of a number of active components rather than being due to a single active compound.

8. Pharmacological Activities of *Ipomoea obscura*

The pharmacological potential of *Ipomoea obscura* (L.) has gained attention due to its rich phytochemical composition, especially flavonoids, alkaloids, phenolic compounds, terpenoids, steroids, and glycosides. Experimental studies have shown that extracts of *I. obscura* have significant antioxidant, anti-inflammatory, immunomodulatory, anticancer, anti-metastatic, anti-angiogenic, antimicrobial, hepatoprotective, nephroprotective, and anti-ulcer activities. The plant's multitarget therapeutic profile is mainly due to its ability to modulate oxidative stress, inflammatory mediators, cytokine production, and immune responses. The major pharmacological activities are summarized below.

**Figure No 10: Pharmacological Activities of *Ipomoea obscura*.**

8.1 Antioxidant Activity

Oxidative stress arises due to a discrepancy between the formation of reactive oxygen species (ROS) and the antioxidant defence system, causing lipid peroxidation, DNA damage, protein oxidation, and cellular dysfunction. The flavonoids and phenolic compounds found in *I. obscura* are able to neutralise free radicals, donate electrons, and stabilise the reactive intermediates, thus protecting biological systems against oxidative damage.^[8,16]

Recent studies have shown that ethanolic extracts of *I. obscura* show considerable antioxidant activity in DPPH radical scavenging tests and in other in vitro antioxidant assays. This antioxidant effect is closely linked to the high level of phenolics and flavonoids in the plant. Compounds that have been isolated, such as kaempferol and myricetin, make a substantial contribution to free-radical scavenging, to the inhibition of lipid peroxidation, and to the increase of endogenous

antioxidant enzymes, including superoxide dismutase (SOD), catalase, and glutathione peroxidase.^[1,8,9]

In experiments on animals, extracts of *I. obscura* have been found to enhance the activity of antioxidant enzymes and decrease oxidative tissue injury, which shows that it has potential as a natural antioxidant and cytoprotective agent.^[10,17]

8.2 Anti-inflammatory Activity

Inflammation is a fundamental pathological process that plays a role in a number of chronic diseases, such as arthritis, cardiovascular disorders, inflammatory bowel disease, and cancer. The anti-inflammatory properties of *I. obscura* have been widely studied using both in vitro and in vivo models.

The methanolic extract of *I. obscura* markedly decreases the production of pro-inflammatory cytokines and nitric oxide in macrophages which have been stimulated with lipopolysaccharide (LPS). It lowers the increased levels of the inflammatory mediators TNF- α , IL-1 β , and IL-6 and prevents the production of inducible nitric oxide synthase (iNOS), as a result reducing the inflammatory response.^[11]

Mechanistic studies have shown that *I. obscura* inhibits NF- κ B signaling and reduces the expression of cyclooxygenase-2 (COX-2), iNOS, and other inflammatory mediators which are responsible for chronic inflammation. The fact that these findings exist offers a solid pharmacological basis for the traditional use of the plant in cases of inflammatory disorders.^[12,13]

8.3 Immunomodulatory Activity

The immunomodulatory action of *I. obscura* is one of its properties that has been studied most extensively. Botanical immunomodulators are especially useful as auxiliary treatments during chemotherapy and in cases involving immune suppression.

In BALB/c mice the administration of an ethanolic extract of *I. obscura* led to a significant rise in the total number of white blood cells, bone marrow cellularity, antibody titre, and plaque-forming cell response. The extract also improved both the humoral and cellular immune responses, which shows that it stimulated the immune system rather than suppressing it.^[11]

Further investigations showed that *I. obscura* and its indole alkaloid fraction, especially Ipobscurine, increase the activity of cytotoxic T lymphocytes (CTL), that of natural killer (NK) cells, antibody-dependent cell-mediated cytotoxicity (ADCC), and antibody-dependent complement-mediated cytotoxicity (ACC). The extract greatly boosted the secretion of IL-2 and IFN- γ , leading to improved immune surveillance and a inhibition of tumor growth in experimental animals.^[14]

8.4 Anticancer and Cytotoxic Activity

The development of cancer includes uncontrolled cell proliferation, resistance to apoptosis, angiogenesis, invasion, and metastasis; extracts of *I. obscura* have shown promising anticancer activity with respect to various experimental tumor models.

Studies carried out in a test tube have demonstrated that *I. obscura* inhibits the proliferation of cancer cells and causes cytotoxicity in melanoma as well as in other tumor cell lines. This anticancer effect is achieved by inducing apoptosis, modifying oxidative stress, suppressing inflammatory signalling, and inhibiting the invasion of tumor cells.^[8,12]

Recent studies which examined the ethanolic extracts of *I. obscura* have confirmed significant anticancer activity in MTT-based cell viability assays, and this provides evidence for the existence of potent bioactive components capable of inhibiting the growth of malignant cells.^[8]

8.5 Anti-metastatic Activity

Metastasis is the main reason for death in the majority of cancers and consists of the migration of tumor cells, their invasion, and the colonization of distant organs. The plant *Ipomoea obscura* shows remarkable anti-metastatic activity in both in vitro and in vivo experimental models.

Studies carried out with B16F10 murine melanoma cells showed that *I. obscura* greatly inhibits tumor cell invasion and experimental lung metastasis. This anti-metastatic effect is due to the suppression of NF- κ B signaling, which in turn causes a decrease in COX-2, iNOS, the pro-inflammatory cytokines, and the matrix metalloproteinases MMP-2 and MMP-9, all of which are necessary for the degradation of the extracellular matrix and for metastatic spread.^[12]

8.6 Anti-angiogenic Activity

The process known as angiogenesis, which involves the formation of new blood vessels from the existing vascular system, is essential for both tumor growth and metastasis; *I. obscura* and the bioactive alkaloid Ipobscurine-A have strong anti-angiogenic properties.

Experimental research has demonstrated that the extract inhibits in human umbilical vein endothelial cells (HUVECs) the proliferation, migration, invasion, and formation of tubes. It also suppresses angiogenesis caused by vascular endothelial growth factor (VEGF) and decreases the expression of VEGF, COX-2, nitric oxide synthase, and the matrix metalloproteinases. When administered in vivo it greatly reduces tumor-induced neovascularization and results in lower levels of VEGF and the pro-inflammatory cytokines in the serum.^[13]

8.7 Antimicrobial Activity

The alkaloids, flavonoids, tannins, terpenoids, and phenolic compounds are what account for the

antimicrobial properties of *I. obscura*, and various solvent extracts have shown inhibitory activity against both Gram-positive and Gram-negative bacteria as well as certain fungal pathogens.

Ethanollic extracts have shown considerable antibacterial activity against pathogenic microorganisms, indicating that they cause disruption of the microbial cell membranes, inhibit essential enzymes, and interfere with nucleic acid synthesis.^[8] The fact that these extracts have broad-spectrum antimicrobial properties confirms the traditional application of *I. obscura* in the treatment of infectious diseases and in wound management.

8.8 Hepatoprotective and Nephroprotective Activity

Oxidative stress and inflammation play a major role in drug- and toxin-induced hepatic and renal injury as well as in that caused by pathological conditions. It has been shown by experimental studies that *I. obscura* has hepatoprotective and nephroprotective properties as a result of its antioxidant and anti-inflammatory actions.

It increases the activity of the body's own antioxidant enzymes, decreases lipid peroxidation, inhibits inflammatory cytokines, and reduces tissue damage in experimental studies. Research carried out on cases of organ injury caused by cyclophosphamide has demonstrated that *I. obscura* reduces oxidative stress, alters cytokine levels, and protects normal tissues against toxicity associated with chemotherapy.^[10]

8.9 Anti-ulcer Activity

For a long time traditional medicinal systems have used *I. obscura* in order to treat gastric ulcers and other gastrointestinal disorders, and the gastroprotective effect of the plant is due to its antioxidant, anti-inflammatory, and mucosal protective properties.

The flavonoids, tannins, and phenolic compounds found in *I. obscura* have the effect of reducing oxidative stress in the gastric mucosa, of suppressing inflammatory mediators, of enhancing the mucosal defence mechanisms, and possibly of inhibiting damage associated with *Helicobacter pylori*. Even though there is currently no clinical evidence, experimental studies strongly indicate its potential as a natural anti-ulcer agent.^[15]

8.10 Therapeutic Significance

The various pharmacological effects of *Ipomoea obscura* are mainly due to a number of closely related mechanisms, including the reduction of oxidative stress, the inhibition of inflammatory mediators, the suppression of NF- κ B signalling, the modulation of cytokine production, the enhancement of immune responses, the inhibition of angiogenesis, and the prevention of tumor invasion and metastasis. Since these pathways play a role in a variety of chronic diseases, *I. obscura* constitutes a promising origin of multifunctional phytotherapeutic agents. It is necessary to carry out further research

concentrating on bioactivity-guided isolation, molecular mechanisms, pharmacokinetics, toxicity assessment, and clinical trials if the medicinal plant is to be transformed into standardized pharmaceutical preparations.

CONCLUSION

Ipomoea obscura is a medicinal plant with a wide variety of phytochemicals, especially flavonoids, alkaloids, phenolics, terpenoids, and glycosides, all of which are responsible for its various pharmacological effects. There is experimental evidence showing that it has antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, nephroprotective, immunomodulatory, and anticancer properties, the effects being due to the modulation of oxidative stress and inflammatory pathways. However, even though there have been promising preclinical results, further research into phytochemical standardization, molecular mechanisms, safety evaluation, pharmacokinetics, and clinical efficacy is still needed if the plant is to be developed into standardized phytopharmaceutical preparations for use in the treatment of disorders related to oxidative stress and inflammation.

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