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Review Article

Hadga (*Sesbania grandiflora*) Based Nutraceutical Tablet: A Review on its Pharmacological and Therapeutic Potential

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ABSTRACT

Hadga flower, scientifically known as *Sesbania grandiflora*, is a traditional medicinal plant widely used in Ayurvedic and folk medicine. It is rich in bioactive compounds such as flavonoids, vitamins, antioxidants, and minerals, which contribute to its therapeutic potential. The present review focuses on the formulation and evaluation of nutraceutical tablets containing Hadga flower extract. Nutraceuticals play a crucial role in bridging the gap between nutrition and pharmaceuticals by offering preventive and therapeutic benefits. The Hadga flower exhibits properties such as anti-inflammatory, antioxidant, antimicrobial, and immunomodulatory effects, making it a promising candidate for nutraceutical development. The review discusses phytochemical composition, extraction methods, formulation approaches (especially direct compression), and evaluation parameters for tablet dosage forms. Additionally, it highlights the health benefits and future prospects of Hadga-based nutraceutical tablets. The integration of herbal ingredients into modern dosage forms enhances patient compliance and ensures standardized dosing. This review emphasizes the potential of Hadga flower extract as a safe, effective, and natural nutraceutical product for improving overall health and preventing chronic diseases. This review compiles current scientific evidence on its phytochemical composition, pharmacological activities, and clinical relevance. The plant is rich in flavonoids, terpenoids, alkaloids, and phenolic compounds that contribute to its diverse biological effects, including anti-cancer, anti-diabetic, antioxidant, and antimicrobial properties. Mechanistic studies reveal modulation of signaling pathways such as PI3K/Akt and NF- κ B. Despite promising preclinical outcomes, clinical evidence remains limited, and challenges such as poor bioavailability and safety concerns persist. Future research should focus on standardization, pharmacokinetics, and large-scale clinical validation.

INTRODUCTION

Nature has long served as a rich source of therapeutic agents, with plants playing an essential

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role in both nutrition and healthcare. Medicinal plants contain bioactive constituents that are effective in managing various diseases, and their use in traditional medicine spans thousands of years. According to the World Health Organization, more than 21,000 plant species are utilized globally for medicinal purposes. Approximately 10% of the global population depends on these plants not only for healthcare but also for their livelihood.

The genus *Sesbania* is classified under the tribe Robinieae, within the subfamily Papilionoideae of the family Fabaceae. The Fabaceae family is recognized as the third-largest group of flowering plants and holds considerable economic importance due to its diverse applications.(1)

Several species within the *Sesbania* genus have been extensively studied, including *Sesbania grandiflora*, *Sesbania cannabina* (aculeata), and *Sesbania sesban* (aegyptiaca). Among these, *Sesbania grandiflora*—commonly referred to as Agati, vegetable hummingbird tree, or West Indian pea—is indigenous to regions of India and Indonesia. It is a perennial leguminous tree that may be evergreen or deciduous and can reach heights of approximately 10–15 meters. The plant exhibits well-developed root nodules, and under waterlogged conditions, it is capable of forming floating roots.

The leaves are pinnately compound, consisting of about 20 to 50 oblong leaflets, each measuring roughly 1–4 cm in length and 0.5–1.5 cm in width, with the entire leaf reaching up to 30 cm long. The flowers are borne in axillary racemes and display a range of colors, including white, pink, crimson, and yellowish hues. Its pods are smooth (glabrous), non-splitting (indehiscent), and elongated, typically measuring 50–60 cm, and they hang vertically. Each pod contains around 15–50

dark brown seeds, approximately 5 mm long and 2.5–3 mm wide.

Traditionally, *Sesbania grandiflora* has been valued in folk medicine for managing conditions such as dysentery, stomatitis, fever, smallpox, sore throat, headache, tuberculosis, anemia, and various microbial infections. The leaves, in particular, are widely used in traditional systems of medicine for their diuretic, laxative (purgative), anthelmintic, and liver-protective (hepatoprotective) properties (2,3,4,5)

Recent pharmacological research indicates that different parts of *Sesbania grandiflora*, along with its active phytochemicals, exhibit a broad spectrum of biological activities. These include antibacterial, antifungal, antidiabetic, and antitumor effects, as demonstrated through both in vitro and in vivo studies. However, many of these bioactive compounds remain insufficiently explored due to their poor lipophilicity and limited bioavailability. The application of nano-based drug delivery systems offers a promising strategy to address these limitations by improving absorption and therapeutic efficacy.

Future investigations should aim to isolate and identify key active molecules from this plant and evaluate their potential integration into modern medical therapies.

Sesbania grandiflora is a fast-growing tree that typically attains a height of about 4–10 meters. Its root system is generally shallow but widely spread and is characterized by numerous nodules containing nitrogen-fixing bacteria, which enhance soil fertility. The bark is distinctly furrowed and forms thick, corky plates that may appear grayish, pinkish, or whitish in color, with a slightly bitter taste.

The leaves are alternately arranged and pinnately compound, measuring around 15–40 cm in length. They are narrower at the ends of the rachis compared to the middle and consist of 20–60 pairs of small, oblong to rounded leaflets. The leaflet surfaces may bear closely pressed purplish-brown glands and are initially hairy but tend to become smoother with maturity. Leaves are mainly clustered at the branch tips and turn bright yellow before shedding.

The plant produces pendulous racemes, approximately 4–7 cm long, each bearing 2–5 large flowers that may be pink, red, yellowish, or white. The flowers themselves are about 5–10 cm long, curved in shape, and roughly 3 cm wide when closed. The calyx is bell-shaped, about 2 cm long, and shows slight lobing with five shallow teeth.

The fruit consists of long, slender pods, typically 20–60 cm in length and 6–9 mm in width. These pods hang downward and are divided internally, containing about 15–50 red-brown seeds along swollen margins. The petiole measures about 7–15 mm, while the rachis is cylindrical, densely hairy in young stages, and becomes smooth as it matures. The corolla is composed of five fleshy petals, either white or red, including a broad standard petal, two curved wing petals, and two fused inner petals. The seeds are ellipsoid to slightly kidney-shaped, measuring approximately 5–6.5 mm in length and 2.5–4 mm in width.(6,7,8)

The present review focuses on the formulation and evaluation of Hadga-based nutraceutical tablets. Various parts of the plant, especially leaves and flowers, possess anti-inflammatory, antimicrobial, hepatoprotective, and antioxidant properties

The formulation of tablets involves standard procedures including drying, powdering, granulation, and compression using suitable

Excipients Evaluation parameters such as hardness, friability, weight variation, disintegration time, and dissolution are essential to ensure product quality. Hadga tablets offer a promising, cost-effective, and natural alternative to synthetic supplements. Further research and clinical validation are necessary to establish their efficacy and safety.

TAXONOMY

Botanical name : *Sesbania grandiflora*

Kingdom : Plantae

Subkingdom : Viridiplantae

Infrakingdom : Streptophyta

Superdivision : Embryophyta

Division : Tracheophyta

Subdivision : Spermatophytina

Subphylum : Angiospermae

Class : Magnoliopsida

Superorder : Rosiflorae

Order : Fabales

Family : Fabaceae

Genus : Sesbania

Species : *Sesbania grandiflora* (L.) Pers.(9)

PHYTOCHEMICALS:

Mainly alkaloids, carbohydrates, flavonoids, glycosides, saponins, tannins, steroids, anthraquinone, proteins and terpenoids are present as phytochemical constituents of *Sesbania grandiflora*.(10,11,12,13,14,15)



NUTRITION VALUE

Protein : 1.28 g (per 100 g)

Calcium : 19 mg (per 100 g)

Energy : 27.01 Calories (per 100 g)

PHARMACOLOGICAL EFFECTS

Antioxidant and Anti-inflammatory

The strong antioxidant and anti-inflammatory activities of *Sesbania grandiflora* play a key role in many of its therapeutic benefits. These properties contribute significantly to its protective effects on the heart and liver, as well as its potential anticancer activity. The underlying mechanisms responsible for these effects have been extensively studied and clearly established.

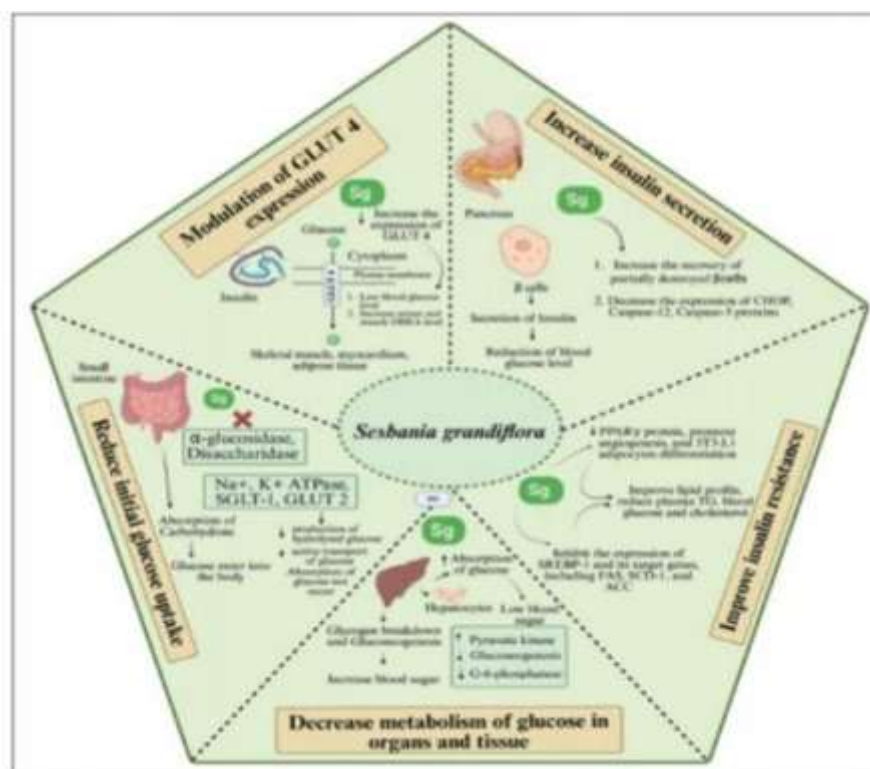


Fig:1

Schematic representation of the anti-diabetic mechanisms of *Sesbania grandiflora*, illustrating its multifaceted actions: (1) modulation of GLUT4 expression in skeletal muscle, myocardium, and adipose tissue to enhance glucose uptake; (2) stimulation of insulin secretion through pancreatic β -cell recovery and reduced expression of ER stress-related proteins (CHOP, Caspase-12, Caspase-3); (3) improvement of insulin resistance via PPAR γ activation, lipid profile enhancement, and suppression of SREBP-1 mediated lipogenesis; (4) reduction of initial glucose uptake

by inhibiting carbohydrate-hydrolyzing enzymes (α -glucosidase, disaccharidase) and glucose transporters (SGLT-1, GLUT2); and (5) decreased metabolism of glucose in organs and tissues through suppression of gluconeogenic enzymes. Together, these pathways contribute to lowering blood glucose levels and improving metabolic health (adapted from [31,32]).

Antidiabetic activity(16,17)

The antidiabetic potential of *Sesbania grandiflora* has been evaluated through in vitro α -amylase

inhibition studies. The plant extract demonstrated significant enzyme inhibition, achieving about 81% inhibition at a concentration of 1000 mg/ml, compared to approximately 93% shown by the standard drug Acarbose. The IC value of the extract was reported as 50.95 µg/ml, while the standard exhibited an IC of 34.83 µM. Phytochemical analysis indicated that lignins and terpenes are key contributors to the observed antidiabetic activity.

Further investigation using HPLC purification and bio-fractionation of *S. grandiflora* leaves identified fourteen metabolites. These compounds were assessed using both α -amylase and α -glucosidase inhibition assays. Among them, vomifoliol, loliolide (a terpenoid), and quercetin (a flavonoid) showed notable inhibitory effects on α -glucosidase, with IC values of 64.5 µM, 388.48 µM, and 17.45 µM, respectively. These findings suggest that specific bioactive constituents of the plant may play an important role in regulating glucose metabolism.

Antidiarrhoeal activity(18,19,20)

The antidiarrhoeal effect of *Sesbania grandiflora* leaves has been evaluated using in vivo experiments on healthy Swiss-Wistar albino mice (8 weeks old, weighing 25–30 g). In this study, diarrhoea was induced using castor oil, and the standard reference drug Loperamide was used for comparison. A total of twenty mice were divided randomly into four groups (n = 5 per group). The positive control group received loperamide, while the test groups were administered the plant extract at doses of 200 mg/kg and 400 mg/kg body weight. The control group was given distilled water.

Following castor oil administration, the animals were monitored at one-hour intervals over a period of four hours for signs of diarrhoea. The onset and frequency of defecation were recorded, and the

percentage inhibition of diarrhoea was calculated. Additionally, the acute toxicity of the crude ethanolic extract (CEE) of *S. grandiflora* leaves was assessed in mice using a modified experimental protocol.

Cardioprotective activity (21)

The cardioprotective potential of *Sesbania grandiflora* has been investigated using experimental rat models exposed to oxidative stress induced by cigarette smoke. In this study, adult male Wistar Kyoto rats were first subjected to cigarette smoke inhalation for 90 days, followed by oral administration of an aqueous suspension of *S. grandiflora* (1000 mg/kg body weight daily) for three weeks.

Exposure to cigarette smoke resulted in a marked increase in cardiac lipid peroxidation and elevated serum lactate dehydrogenase (LDH) levels, indicating cardiac damage. At the same time, there was a significant reduction in key antioxidants such as glutathione, vitamin C, and vitamin E. However, treatment with *S. grandiflora* showed beneficial effects by improving the activity of several antioxidant enzymes in the heart, including glutathione reductase, catalase, glucose-6-phosphate dehydrogenase, superoxide dismutase, glutathione-S-transferase, and peroxidase.

Additionally, cigarette smoke exposure altered mineral balance, leading to increased copper levels and decreased concentrations of zinc, manganese, and selenium in cardiac tissue. Administration of *S. grandiflora* helped modulate these biochemical and antioxidant changes, suggesting its protective role against oxidative stress-induced cardiac damage.

Hepatoprotective activity(22,23)



The liver-protective effects of *Sesbania grandiflora* have been demonstrated in various experimental models of hepatotoxicity. In ethanol-induced liver damage in rats, the petroleum ether extract of the fruit, administered at a dose of 400 mg/kg body weight, significantly reduced key liver enzyme levels such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and total bilirubin. Histopathological analysis further confirmed the restoration of normal liver architecture.

In another model using carbon tetrachloride (CCl₄)-induced hepatotoxicity, different extracts of *S. grandiflora* leaves—including ethanolic, acetone, and aqueous extracts—were evaluated. Among these, the ethanolic extract at a dose of 300 mg/kg body weight showed notable effectiveness by decreasing elevated biochemical markers such as serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase, and total bilirubin levels. These findings indicate the plant's significant potential in protecting liver function against chemically induced damage.

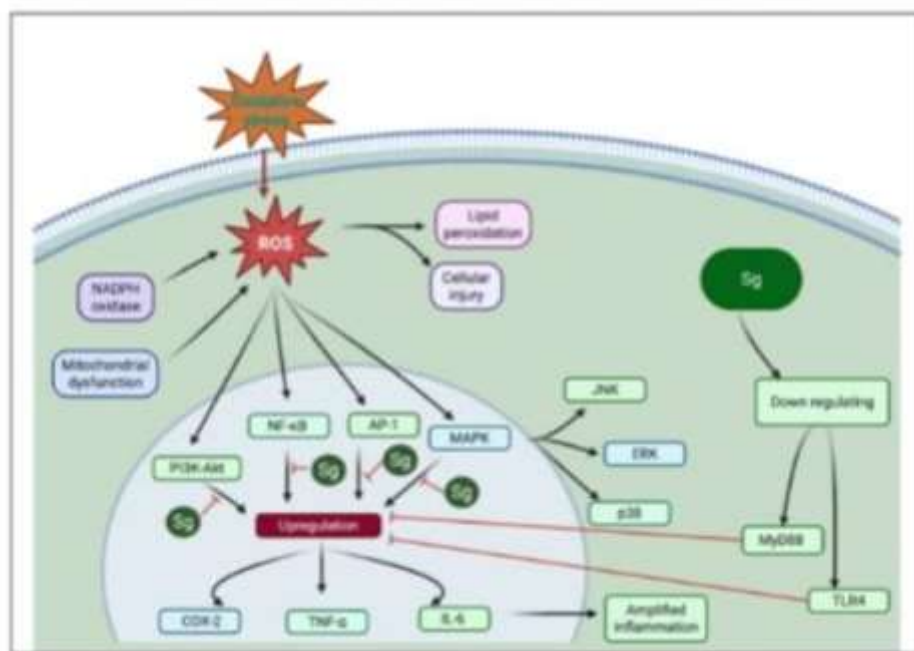


Fig:2

Mechanistic overview of how *Sesbania grandiflora* (Sg) counters oxidative stress-induced inflammatory signaling by downregulating NF-κB, AP-1, PI3K- Akt, MAPK, and TLR4/MyD88 pathways. *Sesbania grandiflora* acts as an antioxidant and anti-inflammatory agent in the human body in a complex mechanism associated with direct free radical scavenging, modulation of enzymes, and inhibition of pro-inflammatory pathways. When exposed to oxidative stress like oxidative stress

generated by environmental toxins or metabolic imbalance, reactive oxygen species (ROS) is produced through NADPH oxidase and mitochondrial dysfunction which result in the lipid peroxidation and cell damage. These ROS causes the activation of the MAPK (Mitogen-Activated Protein Kinase) signalling cascade, comprising of p38 (p38 Mitogen-Activated Protein Kinase), JNK (c-Jun N-terminal Kinase) and ERK (Extracellular Signal-Regulated Kinase), thereby stimulating the pro-inflammatory mediators e.g. TNF-alpha

(Tumor Necrosis Factor- α), IL-6 (Interleukin-6), COX-2 (Cyclooxygenase-2) in an upregulated process. This inflammation process is still enhanced by this transcription factors such as NF- κ B (Nuclear Factor kappa-light-chain-enhancer of activated B cells) and AP-1 (Activator Protein-1) that stimulate the production of cytokines and the gathering of immune cells. Meanwhile, the PI3K (Phosphoinositide 3-Kinase) -Akt (Protein Kinase B) axis and TLR4 (Toll-Like Receptor 4) -MyD88 (Myeloid Differentiation Primary Response 88) pathway preserve chronic inflammation and cell survival, which increases tissue degeneration and disease progression. The protective effect by *Sesbania grandiflora* decreases the expression of TLR4 and MyD88 and breaks the inflammatory cascade. Its high flavonoid and phenolic content too stimulates the Nrf2 (Nuclear Factor Erythroid 2-Related Factor 2)-ARE (Antioxidant Response Element) pathway, and this improves expression of endogenous antioxidant enzymes including superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). The two functions not only reduce oxidative damage but also inhibit inflammatory mediators which enable the cellular intactness and tissue repair (adapted from 33)

Immunomodulatory activity(24)

The immunomodulatory potential of *Sesbania grandiflora* has been evaluated in experimental studies. Administration of a methanolic extract of the flowers at a dose of 400 mg/kg, using sheep red blood cells (SRBC) as an antigen, significantly enhanced the humoral immune response. This was reflected by increased proliferation of B-lymphocytes, differentiation into plasma cells, and elevated levels of circulating antibodies.

In models of cyclophosphamide-induced myelosuppression, the same extract demonstrated a protective effect by restoring white blood cell (WBC) counts. Treated groups showed a notable

increase in WBC levels ($6128.67 \pm 49.74/\text{mm}^3$) compared to the reduced counts ($3575.17 \pm 55.47/\text{mm}^3$) observed in untreated conditions.

Furthermore, a combined extract of *S. grandiflora* flowers and *Cocculus hirsutus* leaves in a 1:1 ratio exhibited consistent immunostimulatory activity. This combination significantly elevated immunoglobulin levels (IgM and IgG) and enhanced antibody production against SRBC in mice. These effects are attributed to the presence of bioactive phytoconstituents in both plants that contribute to strengthening immune responses.

Wound healing activity

The wound healing potential of *Sesbania grandiflora* has been evaluated using both excision and incision wound models in Wistar rats. In these studies, ointments containing 2% and 4% w/w ethanolic extract of the flowers were applied using a simple ointment base. Both concentrations demonstrated significant improvement in wound healing compared to the control group, with Nitrofurazone (0.2% w/w) used as the standard reference.

In another investigation, the methanolic extract of *S. grandiflora* bark was tested using an excision wound model at a concentration of 10%w/w. The results showed notable wound healing activity, comparable to the standard drug Framycetin sulfate (1%). These findings suggest that different parts of the plant possess promising properties for promoting tissue repair and wound closure.(25)

Antiulcer activity

Studies in experimental rat models have demonstrated that the ethanolic extract of *Sesbania grandiflora* bark possesses protective effects against acute gastric damage. The extract significantly reduced gastric lesions caused by



stress as well as those induced by nonsteroidal anti-inflammatory drugs (NSAIDs). At a dose of 36.75 mg/kg, no signs of central nervous system effects such as stimulation, depression, or sedation were observed, indicating that its antiulcer action is not related to centrally acting mechanisms. These findings suggest that *S. grandiflora* exhibits notable antiulcer potential.(26)

MATERIAL AND METHOD

Direct Compression Method

Direct compression is a simple and widely used tablet manufacturing technique in which powdered materials are compressed directly into tablets without any granulation step. This method is particularly suitable for herbal formulations as it avoids exposure to heat and moisture, thereby preserving active phytoconstituents (27)

1. Principle

- Direct compression involves direct compaction of powder blend into tablets.
- Requires powders with good flowability and compressibility.
- Excipients are used to enhance flow and binding properties (28)

2. Materials Used

- Active ingredient: *Sesbania grandiflora* powder
- Diluents: Microcrystalline cellulose, lactose
- Disintegrants: Starch, croscarmellose sodium
- Lubricants: Magnesium stearate
- Glidants: Talc or colloidal silicon dioxide

These excipients improve flow properties, compressibility, and tablet stability (28)

3. Preparation of Powder Blend

- All ingredients were accurately weighed according to formulation.
- The plant material was dried (if required), powdered, and sieved (#60).
- Excipients were also sieved to ensure uniform particle size distribution (29)

4. Blending Process

- The active ingredient was mixed with diluents and disintegrants. Mixing was performed using the geometric dilution method.
- Blending continued until a uniform and homogeneous mixture was obtained.
- Proper mixing ensures uniform drug content in tablets(28)

5. Addition of Lubricants and Glidants

- Lubricant (magnesium stearate) and glidant (talc) were added.
- The mixture was blended gently for 2–5 minutes.

This step:

- Improves flowability
- Reduces friction
- Prevents sticking to punches and dies(27)

6. Pre-compression Evaluation

The powder blend was evaluated for flow properties:

- Angle of repose – flowability
- Bulk and tapped density – packing ability
- Carr's index and Hausner ratio – compressibility

These parameters ensure suitability of the blend for direct compression (29)

7. Compression of Tablets



- The prepared blend was compressed using a tablet compression machine.
- Appropriate punch size (8–10 mm) was selected.

Compression force was adjusted to obtain tablets with:

- Adequate hardness
- Uniform weight

Tablets were formed by applying mechanical pressure (28)

8. Post-compression Evaluation

The prepared tablets were evaluated as per pharmacopeial standards:

- Weight variation: The prepared blend was compressed using a tablet compression machine.
- Hardness
- Thickness
- Friability
- Disintegration time

These tests ensure quality, uniformity, and performance of tablets (30)

DISCUSSION

The present review emphasizes the importance of *Sesbania grandiflora* as a promising natural source for nutraceutical development. Based on the collected literature, this plant demonstrates a wide range of pharmacological and nutritional properties that support its traditional use as well as its modern application in health-promoting formulations.

A key aspect of Hadga's therapeutic potential lies in its diverse phytochemical composition. It contains biologically active compounds such as

flavonoids, tannins, saponins, and alkaloids, which are known to contribute significantly to its medicinal effects. These compounds work together to produce antioxidant activity, which helps in neutralizing harmful free radicals in the body. Since oxidative stress is linked to the development of several chronic conditions, the antioxidant potential of Hadga makes it highly valuable in preventive healthcare.

Another important observation from the reviewed studies is the antiulcer activity of Hadga extracts. Experimental findings indicate that the plant can reduce gastric mucosal damage caused by stress and drug-induced irritation. This protective effect may be due to increased mucus production and reduction in gastric acid secretion. Unlike many synthetic antiulcer drugs, Hadga does not appear to produce central nervous system side effects at therapeutic doses, suggesting a safer profile for long-term use.

In addition to its antiulcer effects, Hadga also shows notable anti-inflammatory properties. The presence of phenolic compounds and flavonoids helps in suppressing inflammatory mediators, thereby reducing inflammation. This makes the plant useful not only in gastrointestinal disorders but also in conditions such as joint pain, skin irritation, and metabolic inflammation.

From a nutritional perspective, *Sesbania grandiflora* is rich in essential nutrients, including vitamins, minerals, and proteins. This dual role as both a nutritional supplement and a therapeutic agent strengthens its suitability as a nutraceutical ingredient. The use of Hadga in formulations like tablets or candies can enhance patient compliance and provide a convenient way to deliver its health benefits.

The formulation of Hadga into nutraceutical dosage forms involves several considerations.



Factors such as powder flow, compressibility, and stability must be carefully managed. The choice of excipients plays a crucial role in ensuring the quality and effectiveness of the final product. While direct compression offers simplicity, other methods like wet granulation may be necessary to improve tablet characteristics. Proper evaluation of parameters such as hardness, friability, and disintegration time is essential to maintain product standards.

Compared to synthetic drugs, Hadga-based nutraceuticals offer multiple advantages, including reduced side effects, better compatibility with the human body, and broader therapeutic action due to the presence of multiple active compounds. However, challenges such as lack of standardization, variability in plant composition, and limited clinical evidence need to be addressed.

Future research should focus on conducting clinical studies to confirm the efficacy and safety of Hadga formulations in humans. Additionally, efforts should be made to standardize extraction methods and establish quality control parameters. Advanced formulation approaches may also help in improving the bioavailability and stability of the active constituents.

In summary, the findings of this review indicate that *Sesbania grandiflora* has strong potential as a nutraceutical ingredient due to its combined nutritional and pharmacological benefits. With further scientific validation and proper formulation strategies, it can serve as an effective and safe alternative for promoting health and preventing disease.

CONCLUSION

Sesbania grandiflora has evolved from a traditional medicinal plant into a scientifically validated source of numerous bioactive

constituents, such as flavonoids, terpenoids, phenolic compounds, 2-arylbenzofurans, and cytotoxic peptides. Contemporary studies suggest that its therapeutic effectiveness arises from a synergistic interaction of multiple components acting on different biological targets. These properties contribute to its reported anticancer, antidiabetic, anti-inflammatory, and antimicrobial activities.

Despite promising preclinical evidence, clinical validation remains limited, with very few human studies conducted so far. This highlights the urgent need for well-designed randomized controlled trials, especially in conditions like type 2 diabetes, chronic inflammatory disorders, and other traditional uses. Additionally, there is insufficient pharmacokinetic data for many of its active constituents, and poor bioavailability of certain lipophilic compounds presents a significant challenge, indicating the necessity for advanced drug delivery approaches.

The synergistic interactions among phytochemicals in *S. grandiflora* are not yet fully understood, and concerns regarding long-term safety, including reports of genotoxicity, require comprehensive investigation. A structured research approach can facilitate its development: in the short term (1–3 years), focus should be on standardizing extracts and validating their use in nutraceutical and cosmeceutical products; in the medium term (3–7 years), efforts should be directed toward pharmacokinetic profiling, improving bioavailability, studying phytochemical synergy, and addressing safety concerns; and in the long term (beyond 7 years), large-scale clinical trials should be conducted to establish its efficacy as a therapeutic agent for diseases such as diabetes, inflammation, and tuberculosis.



The broad therapeutic potential of *S. grandiflora* is attributed to its rich phytochemical profile. Future research may emphasize the development of nano-based drug delivery systems to enhance the solubility and absorption of lipophilic compounds like betulinic acid, thereby improving therapeutic outcomes. Furthermore, chemical modification of bioactive molecules such as Sesba grandiflorain B may enhance their antitubercular activity. Ultimately, extensive randomized clinical trials are essential to confirm both the safety and efficacy of *S. grandiflora* in managing conditions like type 2 diabetes and tuberculosis.

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