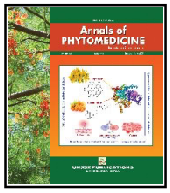
Annals of Phytomedicine 14(1): 345-352, 2025

DOI: http://dx.doi.org/10.54085/ap.2025.14.1.33

Annals of Phytomedicine: An International Journal
http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885



Review Article : Open Access

A comprehensive review on therapeutic, phytochemical and pharmaceutical potential of agathi, *Sesbania grandiflora* (L.) Pers.

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Article Info

Article history
Received 14 February 2025
Revised 28 March 2025
Accepted 29 March 2025
Published Online 30 June 2025

Keywords
Agathi
Sesbania grandiflora (L.) Pers.
Medicinal properties
Bioactive compounds
Therapeutic profile

Abstract

Sesbania grandiflora (L.) Pers., commonly known as agati or vegetable humming bird, is a fast growing tree, recognized for its rich phytochemical and medicinal properties. Belonging to the Fabaceae family, it is part of the *Sesbania genus*, which comprises approximately 60 species, distributed globally. These species are predominantly found in tropical and subtropical regions, particularly in Africa, Australia, and Asia. Due to its rapid growth and adaptability, *S. grandiflora* is widely cultivated for its nutritional, medicinal and ecological benefits, making it an important plant in traditional and modern herbal medicine. This plant is rich in bioactive compounds, including terpenoids, flavonoids, alkaloids, saponins, tannins, and phenolic acids which contribute to its diverse pharmacological activities. Studies have demonstrated its potent antioxidant, anti-inflammatory, antidiabetic, antiulcer, anticancer, antimicrobial and cardio-protective effects. The leaves, bark, flowers and seeds of *S. grandiflora* are traditionally used in Ayurvedic and folk medicine for treating ailments such as fever, wounds, respiratory disorders and digestive issues. Its high polyphenol content and radical-scavenging activity make it a promising natural source for pharmaceutical and nutraceutical applications. The current review is about the pharmacological activity, medicinal properties and nutritional properties of *S. grandiflora*. Overall, the evidence suggests that *S. grandiflora* holds promise as a natural source for the development of novel therapeutics aimed at mitigating inflammation, oxidative stress and related chronic diseases.

1. Introduction

Sesbania grandiflora (L.) Pers. is a fast growing tree, belonging to the Fabaceae family (Wagh *et al.,* 2009). It thrives in both wet and dry tropical regions, but is sensitive to frost. It is a rapidly growing, soft wooded tree that reaches a height of 5 to 20 meters (16 to 66 feet) and exhibits an open branching structure. The leaves are uniformly shaped, rounded and range from 15 to 30 cm (6 to 12 inches) in length, featuring 10 to 20 or more pairs of leaflets along with a terminal leaflet. The plant produces large pea-like flowers in varying colors, including white, pink and red (Gupta and Apte, 2018). The fruits or seed pods of *S. grandiflora* resemble long, flat and slender green beans. They can be either slightly curved or straight, typically measuring between 30 to 45 cm (12 to 18 inches) in length. Each pod has a thick suture and contains around thirty seeds, each approximately 8 mm (0.3 inches) in size (Jiraungkoorskul *et al*., 2015). Agathi keerai is a South Indian dish made from the tender, edible leaves and is typically served as a flavorful soup. Fritters are also made using the flowers of the plant. The flowers are known for their strong antioxidant properties due to the presence of polyphenols and flavonoids. Studies indicate that the red flowered variety contains higher levels of anthocyanins, which contribute to its potent anti-inflammatory and pain relieving effects (Dethe *et al.,* 2014). In addition to the flowers, *S. grandiflora* leaves also contain antioxidant compounds such as gallic acid, caffeic acid, kaempferol, quercetin and rutin (Suresh Kashyap and Sanjay Mishra, 2012). The enhanced antioxidant activity of the red flowered variety, attributed to its bioactive pigments and major phenolic compounds, suggests potential benefits in preventing cancer and Alzheimer's disease. *S. grandiflora* is a plant, widely cultivated across India for its edible flowers. It is a small ornamental tree with a straight trunk, producing white flowers that resemble little birds. The bark, leaves, gums and flowers of the plant all have medicinal properties. The dried bark powder is also used in cosmetics. *S. grandiflora* plays an important role in agroforestry, improving soil fertility due to its nitrogen fixing ability, making it beneficial for sustainable agriculture. Various parts of the plant are utilized in the Siddha system of traditional Indian medicine to treat a wide range of conditions such as anemia, bronchitis, fever, leprosy, eye infections, headaches, nasal congestion, inflammation, gout and rheumatism. The flowers and young leaves of *S. grandiflora* are edible and used to enhance meals. In some regions, dried leaves of *S. grandiflora* are brewed into tea, believed to possess antibiotic, antitumor, anthelmintic and contraceptive effects. Additionally, it is recognized as a powerful remedy for tobacco and smoking based illnesses (Ambastha *et al.,* 2022).

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Figure 1: Different colored variant flowers of *S. grandiflora*.

2. Origin and distribution of different species of *Sesbania*

S. grandiflora is a vegetable humming bird or West Indian pea (Arfan *et al.,* 2016), is native to India and Indonesia. It is widely distributed across Asian countries, particularly in India, Malaysia and Thailand where its flowers and leaves are traditionally consumed as food (Wagh *et al.,* 2009). It is a perennial, evergreen or deciduous leguminous tree that can grow up to 10-15 meters in height. Its roots are highly nodulated and in wet conditions it can develop floating roots. The leaves are pinnately compound with 20 to 50 oblong leaflets each measuring 1- 4 cm in length and 0.5-1.5 cm in width and the total leaf length can reach up to 30 cm. The flowers which appear in axillary racemes can be white, pink, crimson or yellowish in color. The pods are glabrous, indehiscent and range from 50 to 60 cm in length. Each pod contains 15- 50 dark brown seeds which measure about 5 mm in length and 2.5- 3 mm in width (Vijayakumar *et al.,* 2021). *S. grandiflora* has been used as folk medicine to treat various ailments including dysentery, stomatitis, fever, smallpox, sore throat, headache, tuberculosis, anemia and microbial infections. *S. cannabina* commonly known as sesbania pea or corkwood tree. It has compounded, alternating leaves with up to 35 pairs of leaflets. Its flowers are pear shaped and yellow, featuring a calyx that is 3-5.5 mm long and wings that are yellow without any purple streaks. The pods are 12-20 cm long and 2-3 mm wide, displaying a pale to yellowish brown color (Balan *et al.,* 2023).

S. sesban also known as Egyptian pea is native to Egypt (Saptarshi *et al.,* 2017) and is a perennial leguminous tree that can grow up to 8 meters in height. It is known for its rapid growth rate. The plant features a shallow root system and stems that can reach up to 12 cm in diameter. Its pinnately compound leaves consist of six to twenty seven leaflets with each pair being distinct. The leaflets are linear oblong range from 26 mm in length and 5 mm in width. The inflorescences are racemes of about 30 cm long. The fruit consists of straight or slightly curved pods which containing between 10 and 50 seeds (Gomase *et al*., 2012).

3. Nutritive composition of *S. grandiflora*

The leaves, flowers, bark and seeds of *S. grandiflora* contain water, carbohydrates, proteins, fats, fibers, high content of vitamins such as C, A and B, minerals such as iron, calcium, sodium and potassium (Dange *et al*., 2022). They also provide vitamins including thiamine, riboflavin, niacin, ascorbic acid and β-carotene along with essential amino acids like arginine, lysine, isoleucine, histidine, methionine and leucine. *S. grandiflora* seeds contain 30-40% crude protein but currently, they are not being utilized for any other agricultural or industrial applications due to the presence of antinutritional factors. Among the different species mature seeds of *S. bispinosa* are traditionally cooked and consumed by Indian tribal communities (Siddhuraju *et al*., 1995). The roots of the plant contain isoflavonoids, including isovestitol, medicarpin and sativan. Cyanidin and leucocyanidin are the active compounds found in agati seeds. The leaves contain high nutritive value compared with other economic part (Bhokre *et al.*, 2002; Jiraungkoorskul *et al.,* 2015).

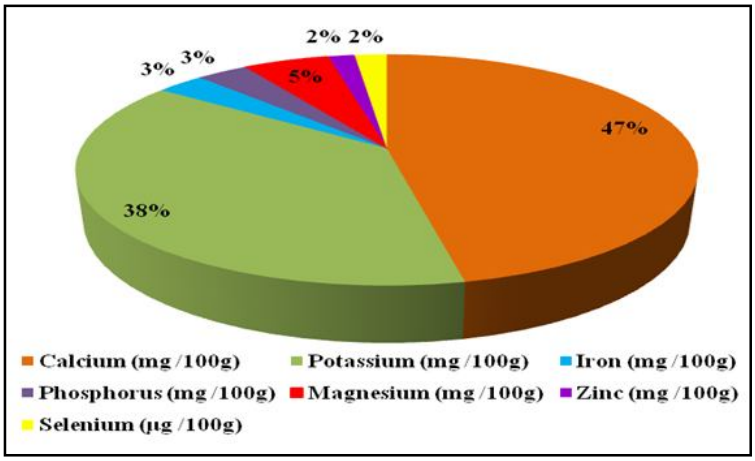

Figure 2: Mineral content of *S. grandiflora* leaves.

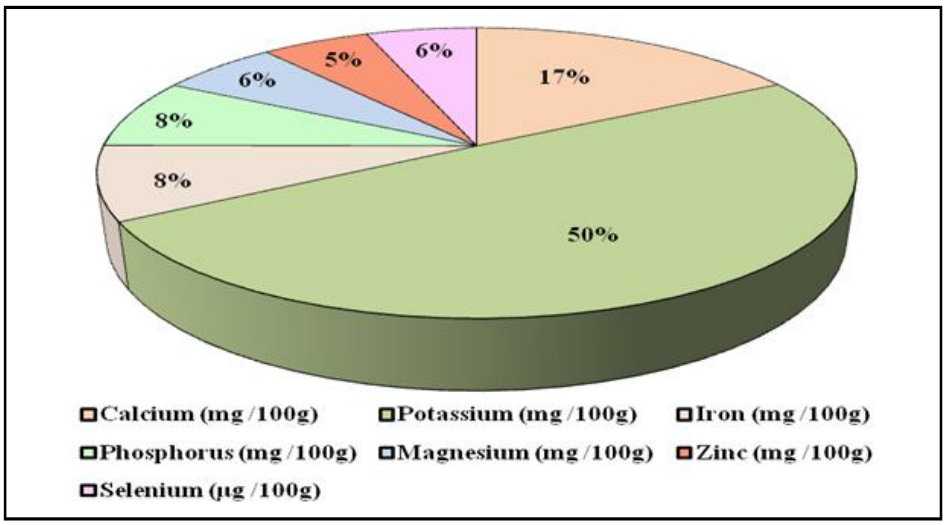

Figure 3: Mineral content of *S. grandiflora* flower (Bhokre *et al.* (2002); Jiraungkoorskul *et al.* (2015)).

Table 1: Medicinal uses of *S. grandiflora*

Parts		Medicinal uses
Leaves	Dried leaves	Tea, contraceptive, antitumour and antibiotic
	Juice	Cough, vomiting, ulcers, dysentery, bronchitis and wounds
	Powder	Iron and folate improve haemoglobin level
	Decoction	Leucorrhoea and vomiting of blood
Fruits		Anaemia, bronchitis, antitumor, laxative and stimulant
Roots	Powder	To treat a perverse condition of arthralgia
		Poultice or rub for rheumatic swelling
Seeds	Oil	Antiplaque toothpaste, antimicrobial activity, headache, nasal catarrh, phthisis, amenorrhea and night blindness
		Antioxidant, antianalgesic, antipyretic, anthelmintic, protein rich, anti inflammatory
Flowers	Decoction	To cure nyctalopia, fever, headache and constipation
		To treat leucorrhoea and vomiting of blood
Bark		Astringent, mouth ulcers, small pox, harsh tonic, malaria, gastrointestinal problems in babies, diarrhea, scabies. Also, it is used as anthelmintics.
Whole plant		Antiproliferative, antiurolithiatic, anti-inflammatory, antihelminthic, antibacterial, anxiolytic activity, neuroprotective, anti ligament, antioxidant, anticonvulsive

Source: Mohiuddin (2019); Patil and Shah (2022); Mokhtar *et al.* (2025).

4. Medicinal uses of various parts of *S. grandiflora*

Different parts of this plant like leaves, fruits, roots, flowers, barks and seeds possess distinct therapeutic properties and their preparations have been traditionally used as medicine to treat various diseases and infections (Table 1).

5. Important phytochemical constituents present in *S. grandiflora*

It is nothing but organic compounds produced by plants through primary and secondary metabolism which is crucial for growth, development and defense mechanisms. Primary metabolites like carbohydrates, amino acids and lipids support metabolic processes and plant growth while secondary metabolites, such as alkaloids, terpenoids, flavonoids, tannins, coumarins and saponins aid in defense against herbivores, pathogens and environmental stressors (Praveen Kumar *et al.,* 2024). These secondary metabolites have diverse biological activities and are of interest for potential therapeutic uses in human medicine. *S. grandiflora* and other *Sesbania* species are to be rich in secondary metabolites (Table 2). Phytochemicals are regarded as a rich and promising source of novel therapeutic agents (Usha Nandhini *et al*., 2024; Barathi *et al.,* 2024).

6. Compounds responsible in *S. grandiflora*

The various parts of *S. grandiflora* are abundant in unique and bioactive compounds making them highly valuable for therapeutic,

medicinal and nutritional properties. This plant contains a diverse range of compounds including saponins, steroids, terpenoids, alkaloids, medicarpin, sativan and flavonoids. Among these, flavonoids such as quercetin and kaempferol play a significant role in providing antioxidant and anti-inflammatory benefits. Some important compounds are illustrated below (Figure 4).

Table 2: Phytoconstituents present in different plant parts of *S. grandiflora*

Parts of plants	Phytoconstituents
Leaves	Alkaloids, carbohydrates, glycosides, phenols, saponins, steroids, sugar, tannins, kaempferol, mycerin, triterpenoids, proteins, terpenoids, quercetin
Bark	Flavonoids, proteins, saponins, steroids, triterpenoids, glycosides, alkaloids and tannins
Flowers	Alkaloids, carbohydrates, phenols, saponins, tannins, terpenoids, triterpenoids, steroids, flavonoids
Fruits	Alkaloids, glycosides, coumarin, phytosterol, tannin, flavonoids, saponin, phenols, carbohydrates and proteins.
Seeds	Proteins, carbohydrates, flavonoids, glycosides, phenol, saponin, steroids, tannin.
Roots	Alkaloids, flavonoids, glycosides, hexose sugar, carbohydrates, non-reducing polysaccharides, phenols and tannins

Source: Patil and Shah (2022); Mokhtar *et al.* (2025)

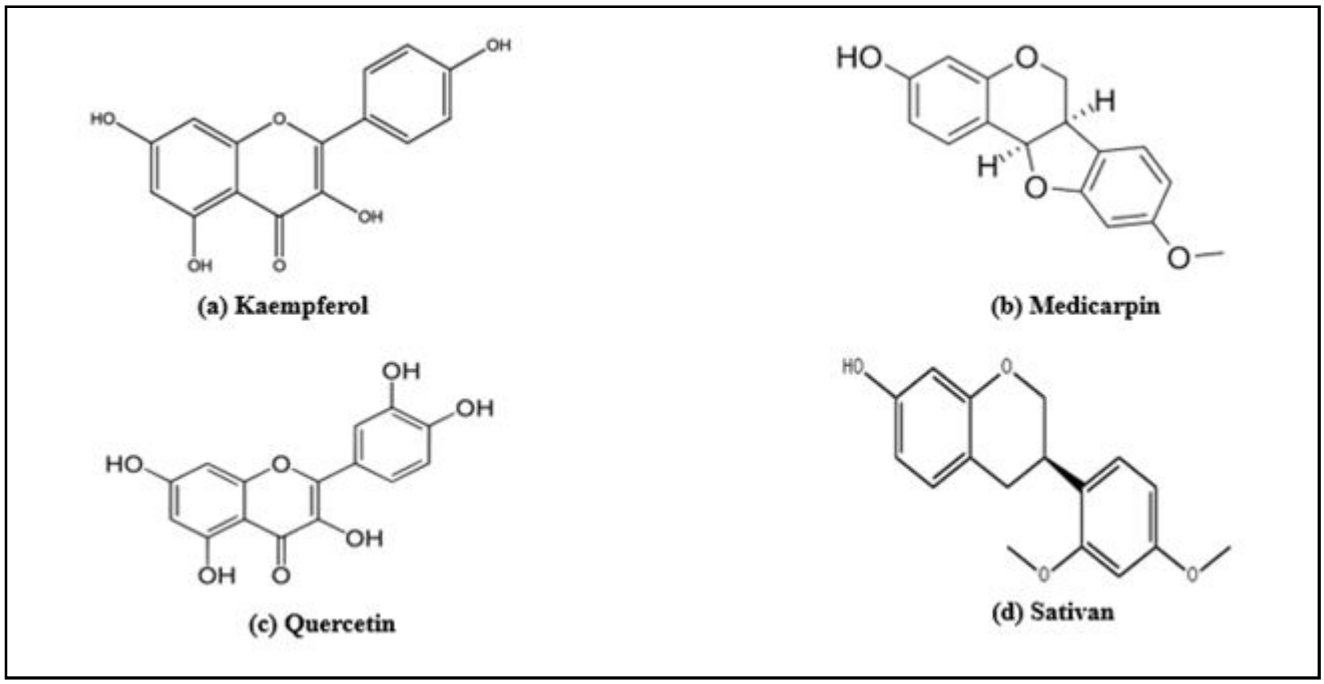

Figure 4: Bioactive compounds in *S. grandiflora* (Mokhtar *et al.* 2025).

7. Therapeutic role of *S. grandiflora*

S. grandiflora has significant therapeutic potential due to its rich phytochemical composition. It exhibits anti-inflammatory, antioxidant, antimicrobial and cardioprotective properties, making it useful for treating conditions like arthritis, infections and heart disease. Additionally, *Sesbania* aids in wound healing, boosts immunity, promotes respiratory health and improves digestion. The high concentration of bioactive compounds, including flavonoids, alkaloids and tannins, also shows promise in cancer prevention and neuroprotection. Traditionally it was used in Ayurvedic and herbal medicine, *S. grandiflora* continues to be explored for its wide ranging health benefits (Famitha *et al.*, 2024; Vasanthkumar *et al.*, 2024).

7.1 Anticancer activity

The anticancer potential of *S. grandiflora* is attributed to their rich phytochemical composition and it is essential to validate *Sesbania* efficacy as a natural anticancer agent and explore its potential in integrative cancer therapy. The ethanolic extract of *S. grandiflora* (leaves and flowers) has demonstrated promising antitumor effects in Swiss albino mice, particularly against the Ehrlich Ascites Carcinoma (EAC) cell line. When administered intraperitoneally at doses of 100 mg/kg and 200 mg/kg body weight, the extract exhibited significant efficacy in suppressing tumor growth. Notably, its activity was comparable to that of the standard chemotherapeutic agent, 5-fluorouracil, in reducing tumor growth in ascitic mice (Laladhas *et al.*, 2010). In addition to its effects on EAC, *S. grandiflora* extracts also showed potential in inducing apoptotic cell death in both neuroblastoma (IMR-32) and colon (HT-29) cell lines during *in vitro* studies. The acetonic, ethanolic and aqueous extracts of the plant's leaves exhibited apoptotic activity across a concentration range of 50.00 µg/ml to 300 µg/ml (Ponnanikajamideen *et al.*, 2015). The

highlights of *S. grandiflora* as a potential crop for further exploration in cancer therapy due to its ability to induce apoptosis and inhibit tumor growth across various cell, lines. The plant's methanolic leaf extracts showed strong antiproliferative effects on the human lung cancer cell line A549 by inducing apoptosis and activating caspase-3 (Sreelatha *et al*., 2011).

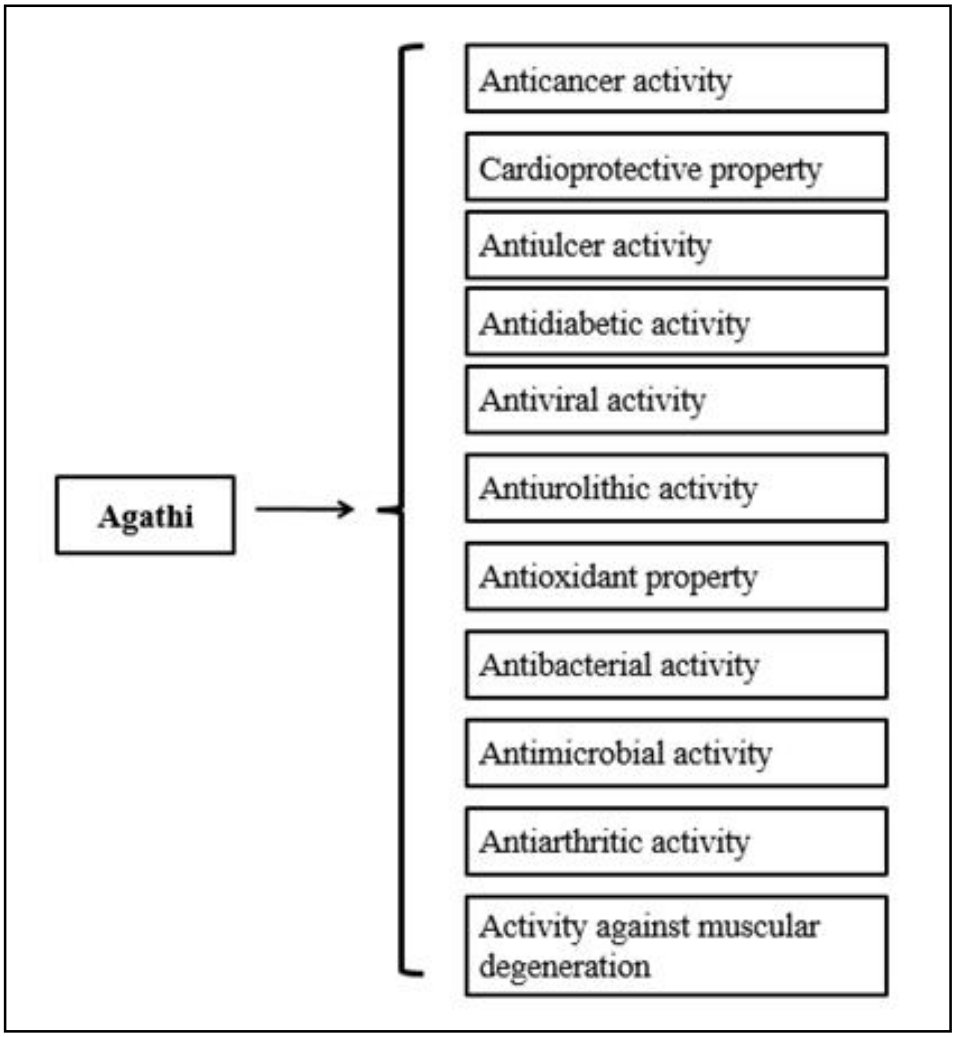

Figure 5: Therapeutic role of *S. grandiflora*.

7.2 Cardioprotective property

S. grandiflora exhibits significant cardioprotective activity due to its bioactive compounds that help protect the heart and improve cardiovascular health. It shows potential in reducing inflammation, a key factor in heart disease, by inhibiting inflammatory pathways. Additionally, it may contribute to lowering blood pressure by promoting blood vessel relaxation, enhancing circulation and alleviating strain on the heart. *S. grandiflora* has also been linked to regulating cholesterol levels, potentially lowering LDL (bad cholesterol) and increasing HDL (good cholesterol) which helps to prevent plaque buildup in arteries (Dange *et al.*, 2022). Chronic exposure to cigarette smoke increases oxidative stress, disrupting the heart's natural defense mechanisms. However, *S. grandiflora* helps protect the heart from oxidative damage due to its strong antioxidant properties. Moreover, its antithrombotic effects may reduce the risk of blood clots, preventing conditions such as heart attacks and strokes making it a valuable natural agent for heart disease prevention (Ramesh *et al.,* 2008).

7.3 Antiulcer activity

The extracts of *S. grandiflora* such as ethanolic, aqueous and methanolic extracts from the leaves, bark and flowers, exhibit antiulcerogenic properties particularly in models of gastric ulcers. *S. grandiflora* extracts may help reduce inflammation and gastric mucosal damage caused by factors like stress, alcohol consumption and the use of non-steroidal anti-inflammatory drugs (NSAIDs) (Gudageri, 2012). The extracts are believed to enhance the secretion of gastric mucus, which helps protect the stomach lining from the corrosive effects of gastric acid. This mucus plays a crucial role in maintaining the integrity of the stomach's epithelial layer. The plant's extracts are rich in antioxidants, which may help neutralize reactive oxygen species (ROS) and prevent oxidative stress-induced gastric damage. *S. grandiflora* might help balance the acid levels in the stomach, reducing hyperacidity which is a common cause of ulcers and also it has potential in accelerating the healing of gastric ulcers, possibly through its ability to promote tissue regeneration and reduce

ulceration in the stomach lining (Bhoumik *et al.*, 2016). These effects are thought to be mediated through several mechanisms.

7.4 Antidiabetic activity

The ethanolic leaf extract of *S. grandiflora* will lower blood glucose level, glycosylated hemoglobin, blood urea, uric acid and serum creatinine. Additionally, it will decrease the activity of aspartate transaminase (AST), alanine transaminase (ALT) and alkaline phosphatase (ALP) (Wagh *et al.*, 2009). Leaves contain bioactive compounds such as flavonoids, alkaloids and phenolic acids, which may contribute to their antidiabetic effects. These bioactive compounds are thought to play a role in regulating blood glucose levels by improving insulin sensitivity, minimizing oxidative stress and safeguarding pancreatic beta cells from damage (Jiraungkoorskul *et al.,* 2015). Furthermore, traditional medicinal practices have long incorporated *Sesbania* leaves, seeds and flowers in the management of diabetes related symptoms (Janani and Aruna, 2017).

7.5 Antiviral activity

Flowers from *S. grandiflora* have been shown to exhibit antiviral properties against vaccinia, vesicular stomatitis, coxsackie, herpes simplex-1 and herpes simplex-2 in methanolic extract form. Flavonoids are primarily responsible for the antiviral properties (Ambastha *et al*., 2022).

7.6 Antiurolithic activity

S. grandiflora leaf juice demonstrates significant antiurolithic activity primarily due to its potent antioxidant properties which help to mitigate oxidative stress a key factor in kidney stone formation. The presence of bioactive compounds such as flavonoids, tannins and saponins aids in reducing the aggregation of calcium oxalate crystals, which are the primary agents in urolithiasis (Doddola *et al.*, 2008). These compounds work by inhibiting nucleation, growth and adherence of calcium oxalate crystals to renal tissues, thereby preventing the formation and progression of kidney stones. Additionally, the *Sesbania* leaf juice exhibits diuretic properties, promoting increased urine output, which helps flush out stone-forming minerals before they can crystallize. Its anti-inflammatory effects further reduce renal damage and irritation caused by uroliths making *S. grandiflora* leaf juice a promising natural remedy for preventing and managing kidney stones (Venkataeshwarhu *et al*., 2012).

7.7 Antioxidant property

Antioxidants are essential compounds that counteract harmful free radicals in the body preventing oxidative stress that can lead to cell damage and contribute to chronic diseases. *S. grandiflora* is known for its strong antioxidant properties, attributed to its rich content of bioactive compounds such as flavonoids, phenols and alkaloids (Loganayaki *et al.,* 2012). These antioxidant compounds play a crucial role in reducing oxidative stress by neutralizing free radicals thereby protecting cells and tissues from damage. They also help maintain cellular health by preventing harm to DNA, proteins and lipids. Furthermore, the antioxidant activity of *S. grandiflora* may support detoxification processes and enhance immune system function as reported by Liaotrakoon and Liaotrakoon (2019); Speisky *et al*. (2006).

7.8 Antibacterial activity

The antibacterial properties of *S. grandiflora* were found to be dose dependent with key bioactive compounds such as 7,4'-dihydroxy-2'methoxyisoflavan (Isovestitol) and 3-hydroxy-9-methoxy pterocarpan (Medicarpin) effectively inhibiting the growth of gram-positive bacteria such as *Streptococcus pyogenes, Bacillus cereus* and *Staphylococcus aureus* and also one Gram-negative bacterium *Klebsiella pneumonia* (Patil and Shah, 2022). Among these, *Bacillus cereus* showed the highest sensitivity to the methanol extract. Additionally, all tested Gram-negative bacteria such as *Haemophilus influenzae* and *Klebsiella pneumonia* and also Gram-positive bacteria were inhibited by the acetone fraction (AF) with *Staphylococcus aureus* being the most susceptible. The methanol extract exhibited stronger antibacterial activity than the acetone fraction, likely due to its slightly higher polarity. Traditional medicine has endorsed the use of *S. grandiflora* for managing diseases resulting from bacterial infections (Pari and Uma, 2003).

7.9 Antimicrobial activity

S. grandiflora exhibits potent antimicrobial activity due to its richness in cysteine and cystine, which not only enhance its antioxidant capacity by scavenging free radicals but also contribute to its antimicrobial effects. The leaves of the plant demonstrate significant antifungal activity against *Candida albicans* and *Aspergillus niger*, effectively inhibiting their growth and preventing fungal infections (Deepthi *et al.*, 2023). Additionally, both the leaves and flowers show strong antibacterial properties against *Escherichia coli* and *Staphylococcus aureus*, making them effective in combating bacterial infections. The roots of *S. grandiflora* exhibit remarkable antituberculosis activity against *Mycobacterium tuberculosis,* suggesting its potential use in managing tuberculosis (China *et al.,* 2012). The combined antimicrobial and antioxidant properties of *S. grandiflora* make it a promising natural therapeutic agent for preventing and treating a wide range of microbial infection (Dawah *et al*.2014; Kathiresh *et al.* 2012)

7.10 Antiarthritic activity

S. grandiflora exhibits significant antiarthritic activity due to the presence of stigmasterol, a bioactive phytosterol known for its anti-inflammatory and cartilage protective properties. Stigmasterol suppresses MMP-3 gene expression, which plays a crucial role in extracellular matrix protein degradation, thereby preventing cartilage breakdown and joint damage in arthritis. Additionally, it modulates pro-inflammatory cytokines like IL-6, IL-1β, TNF-α and inhibiting NF-κB signaling to reduce inflammation and pain (Cayme and Ragasa, 2004). Its potent antioxidant properties help in scavenging reactive oxygen species (ROS), thereby reducing oxidative stress induced joint damage. Studies have demonstrated that stigmasterol not only alleviates arthritis symptoms but also promotes chondroprotection enhances synovial fluid production and improves joint mobility, making *S. grandiflora* a promising natural remedy for managing arthritis (Patil *et al*., 2010).

7.11 Activity against muscular degeneration

The leaves of *S. grandiflora* demonstrated significant potential in combating muscular degeneration, attributed to their high concentration of potent antioxidants such as lutein and zeaxanthin. These compounds are essential in neutralizing free radicals and minimizing oxidative stress, thereby supporting muscle health and

preventing degeneration. These carotenoids protect muscle cells from oxidative damage, which is a key factor in age related and degenerative muscular disorders (Patil and Shah, 2022). By scavenging reactive oxygen species (ROS), they help prevent mitochondrial dysfunction and muscle fiber degradation, thereby maintaining muscle strength and function. Additionally, lutein and zeaxanthin are well known for their protective effects on eye health, reducing the risk of cataracts and muscular degeneration by filtering harmful blue light and preventing retinal oxidative damage. Their combined antioxidant and anti-inflammatory properties make *S. grandiflora* a valuable natural source for preserving both muscular and ocular health (Polya, 2003).

8. Conclusion

S. grandiflora exhibits significant therapeutic and medicinal properties due to their rich phytochemical composition, including flavonoids, tannins, alkaloids and saponins. These bioactive compounds contribute to their anti-inflammatory, antioxidant, antimicrobial, antidiabetic and hepatoprotective effects making them valuable in traditional and modern medicine. It is potential in wound healing, immune modulation and cardiovascular health further underscores their pharmacological relevance, supporting their use in herbal remedies and pharmaceutical formulations.

9. Future prospects

The future prospects of *S. grandiflora* in therapeutic and pharmaceutical applications are promising with growing potential for its integration into modern medicine. Further research, including rigorous clinical trials and the development of standardized extracts will be essential to validate its efficacy and also to focus on expanding its phytochemical profiling to identify novel bioactive compounds. Additionally, exploring advanced drug delivery systems, such as nanoparticles, and developing sustainable cultivation practices are needed to ensure its long-term availability and optimize its pharmaceutical applications. With its diverse pharmacological properties, *S. grandiflora* could become a valuable source of natural remedies, offering potential treatments for conditions like inflammation, diabetes, infections and even cancer, particularly when combined with conventional therapies for more comprehensive treatment options. Incorporating indigenous knowledge through ethnopharmacological research and enhancing its genetic characteristics to boost medicinal benefits could unlock new possibilities for *S. grandiflora* in both biotechnological innovations and the natural health product market.

Acknowledgements

Authors are thankful and acknowledge researchers of the original research works whose publications are cited in the present review.

Conflict of interest

The author declares no conflicts of interest relevant to this article.

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Citation **A. Beaulah, K. R. Rajadurai, S. Maanchi and T. Anitha (2025). A comprehensive review on therapeutic, phytochemical and pharmaceutical potential of agathi, *Sesbania grandiflora* (L.) Pers. Ann. Phytomed., 14(1):345-352. http://dx.doi.org/10.54085/ap.2025.14.1.33.**