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Review Article

Unlocking the therapeutic potential of *Agapanthus Africanus* (L.) Hoffmanns: A systematic review of a salt-tolerant medicinal plant with potential healing properties.

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Abstract

Introduction
Agapanthus africanus, commonly known as the African Lily, is a salt-tolerant plant native to South Africa's coastal regions and has long been used in traditional African medicine for treating various ailments. This review aims to synthesize current ethnobotanical and scientific knowledge on *A. africanus*, focusing on its traditional uses, phytochemical composition, pharmacological potential, salt stress tolerance, and ecological adaptability.

Methods
A systematic literature search was conducted using Scopus, Web of Science, Google Scholar, and other academic databases. The search was limited to English-language publications from the past decade. A total of 82 records were identified, of which 63 studies met the inclusion criteria for quality and relevance.

Results
The plant is traditionally used to manage pregnancy-related conditions, respiratory issues, infections, and inflammatory diseases. Phytochemical analysis reveals bioactive compounds such as saponins, flavonoids, and anthocyanins, which contribute to its antifungal, antibacterial, anti-inflammatory, and CNS-modulating properties. Emerging evidence suggests additional roles in managing hypertension and depression through ACE and serotonin reuptake inhibition. Conservation concerns are rising due to habitat degradation; although not formally assessed by the IUCN, some subspecies are locally protected in South Africa.

Conclusion
With its therapeutic potential and natural adaptation to saline environments, *A. africanus* presents a promising candidate for eco-friendly pharmaceutical development and sustainable agriculture. Realizing this potential requires interdisciplinary research integrating ecology, pharmacology, horticulture, and indigenous knowledge systems to support both conservation and utilization.

Recommendations
Future research should prioritize the development of standardized extraction techniques and dosing guidelines to enhance repeatability and facilitate the clinical translation of these findings. In vivo and clinical trials will be conducted to validate the pharmacological claims that are now supported by in vitro and ethnobotanical evidence. Ecological monitoring and conservation assessments, with a focus on habitat fragmentation and the implications of climate change.

Keywords: *Therapeutic, Traditional medicine, Ethnopharmacology, Ethnobotany, Phytoconstituents, Pharmacology, Therapeutic potential*
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Introduction

The genus *Agapanthus* L'Heritier (family Amaryllidaceae; subfamily Agapanthoideae Endlicher) *A. africanus* is an evergreen plant occurring wild from the

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south-western Cape, eastwards to KwaZulu-Natal and further north into Mozambique (Nunes et al., 2023). The plant vernacular names used in the country included Sotho (leta-la-phofu), Zulu (mathunga, icakathi), Xhosa (isilakati), Afrikaans (Haakleli), and English (blue lily) (Makhoahle, 2022). Literature indicates that the unusual ability of this species to occur under the most different climatic conditions is correlated with the environmental changes that the Cape region was subjected to over the previous 30 million years (Nunes et al., 2023).

Agapanthus is an ancient Greek name that means "flower of love" (Younis et al., 2022). Younis et al. (2022) further alluded that "The Nile lily" or "African lily" are common names for some species in this genus. *A. africanus* is a beautiful medicinal and ornamental plant, and it is commonly known by various names worldwide (Table 2). The taxonomy of genus *A. africanus* was complex and difficult (Reis et al., 2016; Nunes et al., 2023). Zonneveld et al. (2003) indicate that this genus includes six species such as *A. africanus* (L.) Hoffmanns, *A. campanulatus* Leighton, *A. caulescens* Spreng, *A. coddii* Leighton, *A. praecox* Willd, and *A. inapertus* Beauv. According to Zonneveld et al. 2003), Younis et al. 2022, *A. africanus* was the first member to be recorded in the genus in 1679. This genus was not only praised for its ornamental prominence but also substantially acclaimed for its folkloric and medicinal values (Nath et al., 2013; Chawla et al., 2022; Younis et al., 2022). Younis et al.(2022), further indicate that plants in the genus *Agapanthus* have been used from time immemorial to treat pain from a range of diseases that claimed to be the root of a range of bioactivities including, antioxidant, antibacterial, antifungal, anti-inflammatory, uterotonic, anti-hypertension, and cAMP phosphodiesterase inhibition effects, in addition to central nervous system (CNS) activities, because of their abundant pharmacologically active metabolites, which include flavonoids, sterols, saponins, sapogenins, lignan, and lignan precursor.

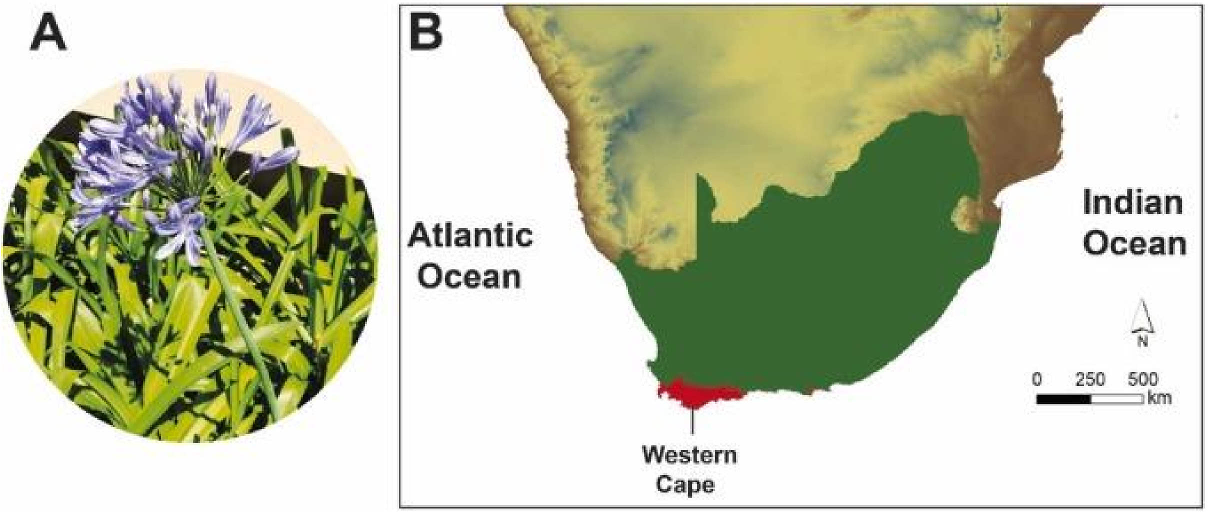

Figure 1: (A). *Agapanthus africanus*, (B). Distribution map (Nunes et al., 2023)

According to Nunes et al. (2023), during the (Oligo) Mio-Pleistocene period, the vegetation where *A. africanus* is found to have evolved from ancient laurophyllous formations to the current Mediterranean flora. Trivedi et al. (2022) indicate that the changes in the vegetative communities can be understood as responses to climate conditions. Sánchez et al. (2023) allude that the glacial processes that occurred throughout the Pleistocene period that followed, concentrated most of the precipitation during the winter season. The seasonality of moisture and soil infertility caused the vegetative cover to evolve into sclerophyll formations, which provided the necessary skills to resist seasonal aridity (Laughlin, 2023). *A. africanus* is an excellent illustration of the evolution of vegetative landscapes with laurophyllous origins (Nunes et al., 2023). Despite its limited natural range, *A. africanus* must adapt to any environmental variations (Nunes et al., 2023).

Fernández et al. 2021) González-Valenzuela et al. 2023) identified the cuticles of vascular plants to have several essential physiological tasks, but one of the most crucial is to act as a sufficient limiting barrier for water diffusion. Literature found that cuticles prevent non-stomatal water loss and provide protection to plants during periods of drought (Chen et al., 2020). Xin et al. 2021; Nunes et al. 2023 indicate that cuticles are made up of an insoluble high molecular weight polymer and solvent-soluble waxes. The waxes are heterogeneous combinations of aliphatic molecules derived from very long-chain fatty

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acids with hydrocarbon chains of C20 or higher. (Soleimanian et al., 2020; Gozdzik, 2023), (Nunes et al., 2023) pointed out that the soluble waxes are composed mostly of alcohols, fatty acids, aldehydes, ketones, alkanes, and alkyl esters. Almeida et al. (2020) indicate that some cyclic chemicals, such as triterpenoids, appear occasionally. The cuticle's structural and chemical diversity determines water permeability, while water permeability, on the other hand, has no correlation with cuticular thickness, total intracuticular wax, or epicuticular wax coverage (Liu et al., 2020).

The genus *Agapanthus* is well-known for its traditional usage against reproductive and central nervous system problems (Younis et al., 2022). Mbhele et al. (2022) allude that *Agapanthus* has been shown to have promising anti-inflammatory, antioxidant, antibacterial, antifungal, uterotonic, anti-hypertensive, and cAMP phosphodiesterase inhibition properties. Younis et al. (2022) indicate that among all the genus species, *Agapanthus africanus* (L.) Hoffmanns has the highest antimicrobial properties. The genus *A. africanus* has 28 secondary metabolites documented, including sterols, saponins, sapogenins, flavonoids, lignans, and lignan precursors. Saponins are the most numerous identified phytoconstituents, with *Agapanthus* saponin A and B exhibiting the greatest potential as effective fungicidal medications (Younis et al., 2024).

Rationale of the study

Traditional Uses: Although *Agapanthus africanus* has long been utilized in African traditional medicine to cure a variety of diseases, much of this knowledge remains undocumented in mainstream science.

Pharmacological Potential: Recent research has proven the presence of bioactive chemicals with antibacterial, anti-inflammatory, and central nervous system actions, indicating that it has the potential for modern medication development.

Ecological Adaptability: Due to its salt tolerance, it is valuable for sustainable agriculture and ecological restoration, particularly in the face of climate change.

Table 1: The most popular names used for *Agapanthus africanus* worldwide

Common Names Used Worldwide	
African Lily	This is one of the most widely used common names for *Agapanthus africanus.*
Lily of the Nile	This name is often used, although it is not entirely accurate, as the plant is not from the Nile region.
African blue Lily	This name refers to the plant's blue-purple flowers.
Agapanthus	This is a widely used name, especially in horticultural circles.
Blue African Lily	This is another variation of the African Blue Lily name.

Aim of the study

Agapanthus africanus has been extensively researched, and various studies have revealed its therapeutic potential. This review aimed to synthesize the current ethnobotanical and scientific knowledge on *A. africanus*, with emphasis on traditional uses, phytochemical profiles, salt stress tolerance mechanisms, and ecological adaptations.

Research questions

This systematic review aimed to address the following research questions

What are the medicinal properties of *Agapanthus africanus*, and how has it been traditionally utilized?
What are the physiological mechanisms and adaptive strategies employed by *A. africanus* in response to salt stress?
What sustainable harvesting practices and conservation initiatives are currently in place for this species?
How is *A. africanus* being integrated into modern herbal medicine systems and the pharmaceutical industry?

Materials and methods

A comprehensive literature search was conducted using multiple academic databases, including Scopus, Google Scholar, Google Books, ScienceDirect, ResearchGate, and Web of Science. The search was limited to publications from the past decade to ensure relevance and current scientific context. Additional sources were identified through cross-referencing within selected journal articles. Only English-language literature was considered for inclusion.

The review focused specifically on peer-reviewed studies that detailed the medicinal properties, bioactive compounds, salt tolerance mechanisms, and conservation strategies related to the genus *Agapanthus*, with

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emphasis on *A. africanus*. Search terms included: *Agapanthus*, traditional medicine applications, therapeutic potential, ethnopharmacology, ethnobotany, phytoconstituents, pharmacology, therapeutic potential, taxonomy, distribution, adaptive responses to salt stress, and salt tolerance mechanisms. The literature search was undertaken between August 2024 to February 2025.

To guarantee scientific rigor, all inclusion and exclusion criteria were predefined. Only studies with empirical data on traditional medicine applications, therapeutic potential, ethnopharmacology, ethnobotany, phytoconstituents, pharmacology, therapeutic potential, taxonomy, distribution, adaptive responses to salt stress, and salt tolerance mechanisms. Articles chosen for inclusion were separately screened and appraised for relevance and quality, with data retrieved by the authors using a standardised procedure. A total of 82 scientific papers were initially discovered, with 63 satisfying the criteria for inclusion in the review.

The systematic approach adopted aimed to synthesize existing knowledge immediately and cohesively, ensuring an evidence-based understanding of *A. africanus*'s medicinal value, ecological adaptability, and potential for sustainable use in pharmaceutical contexts. All referenced materials are duly cited in the reference section.
Studies were excluded if they lacked original empirical data, did not focus on *Agapanthus africanus*, or did not address relevant topics such as traditional use, phytochemistry, or salt stress adaptation. Low-quality studies without proper methods, peer review, or data transparency were also excluded. Additionally, non-English publications and duplicate or repetitive studies without new findings were not considered.

Results and discussions

Taxonomy and distribution of *Agapanthus africanus*

Agapanthus africanus is native to South Africa, primarily in the Cape Provinces, Lesotho, Mozambique, Swaziland, KwaZulu-Natal, and the Free State (Figure 1). (Younis et al., 2022; Chawla et al., 2022). The bulk of the species are found in the eastern and northeastern parts of South Africa, ranging from the Cape Peninsula to the hilly areas south of the Limpopo River (Zonneveld et al., 2003). Literature reveals that for many decades, the genus *Agapanthus* has had a questionable taxonomic classification (Meerow, 2023).
The genus was divided into several families, including Liliaceae, Alliaceae, and Agapanthaceae, and after a lengthy period of dubious taxonomy, *Agapanthus* is currently classified as a part of the Amaryllidaceae (Table 2). (Younis et al., 2022). Chawla et al. (2022) allude that based on genotyping research, *A. africanus* is morphologically similar to the Amaryllidaceae, which includes umbellate inflorescences but lacks the alkaloids found in the Amaryllidaceae family, and has superior ovaries.

Table 2: Scientific classification of *Agapanthus africanus* (L.) Hoffmanns

Rank	Scientific Name
Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Asperagales
Family	Amaryllidaceae
Genus	Agapanthus L. 'Her'
Species	*Agapanthus africanus*

Singh and Baijnath (2018) defined the genus into 10 species and 13 subspecies based on the growth conditions based on the DNA content, and colour of the pollen grains. Younis et al. (2022) discovered six species of the genus *Agapanthus,* such as *Agapanthus campanulatus* Leight., *Agapanthus africanus* (L.) Hoffmann's., *Agapanthus caulescens* Spreng., *Agapanthus coddii* Leight., *Agapanthus praecox* Willd., *Agapanthus inapertus* Beauv, and demoted *Agapanthus walshii* L.Bolus, *Agapanthus comptonii* F.M.Leight, *Agapanthus dyeri* F.M.Leight., *Agapanthus nutans* F.M.Leight., to subspecies.

Medicinal properties and traditional uses of *A. africanus*

For many years, *Agapanthus* species have been widely employed in South African culture and numerous traditional medical systems against a variety of diseases (Maroyi, 2022). Kekana et al. (2020) point out that South African traditional healers utilize the *Agapanthus africanus* plant in herbal treatments to treat pregnancy-related problems and to help with labour. Literature has demonstrated that an aqueous extract of *A. africanus* produces smooth muscle spasms in isolated uterine and ileum preparations (Younis et al., 2022). Mawere et al.

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(2022); Younis et al. (2022) allude that the Xhosa women in the Eastern Cape, Republic of South Africa, utilize *Agapanthus* root as a decoction during the last months of pregnancy, orally or per rectum, to augment labour.

The AmaMpondo women use *Agapanthus* daily from the fourth to fifth months of pregnancy to aid in the delivery of healthy babies with no intestinal problems and a smooth placental delivery (Mawere et al., 2022). Literature indicates that in Transkei, women drink a decoction of a blend of *Agapanthus africanus* roots and *Typha* species beginning with the sixth month of pregnancy or use a tie charm necklace of the roots to produce healthy infants and relieve pregnant women's constipation (MUIA, 2020; Younis et al., 2022). Additionally, *A. africanus* aids in memory improvement and the treatment of numerous illnesses, particularly in South Africa's traditional treatments (Chaitanya et al., 2021).

Some plants of this genus, *Agapanthus,* are used to generate visions (in isiZulu, imibono) and dreams (Nunes et al., 2023; Younis et al., 2022). Kekana et al. (2020) allude that traditional herbal medicines for pregnant mothers in South Africa include *Agapanthus africanus*, *Clivia miniata,* and *Typha capensis*. Many African societies believe that pregnant women should consume herbal medication to protect themselves and their unborn child, while also maintaining reproductive health. Isihlambezo, a Zulu herbal treatment, extracts mineral salts from plant roots, bark, and wood, is consumed to promote healthy childbirth (Kekana et al., 2020; Musie et al., 2022). *Agapanthus* leaf and root preparations are used to treat coronary heart disease, chest pain, colds, paralytic coughs, and difficulty breathing. Younis et al. (2022) state that *Agapanthus* has been reported to treat potential tuberculosis-related disorders and hypertension. The roots of *A. inapertus* are used to ease headaches and wound healing, whereas *A. africanus*, *A. campanulatus*, and *A. praecox* are plants that are traditionally used for psychoactive purposes (Younis et al., 2022). Literature further indicates that in the Eastern Cape province, dried root powder of *Agapanthus* is soaked in water and administered orally to treat cancer (Sagbo et al., 2021; Makhoahle et al., 2022).

Younis et al. (2022) indicate that *Agapanthus praecox* is used as an aphrodisiac in Zulu culture to treat erectile dysfunction and infertility, and the leaves are used to reduce fevers by wrapping them around wrists. Baskaran et al. (2014) allude that *A. praecox* has been identified as a plant species that has traditionally been used in Southern Africa to control infections and cure a variety of central nervous system disorders. Moteetee et al. (2017) state *that Agapanthus* leaf sap is used to cure newborns' skin rashes and 'crust' on their heads, whereas Basotho indigenous healers use a combination of Agapanthus species to initiate various traditional medical practices as a reproductive herb. Devi et al. (2023) indicate that *Agapanthus* also alleviates menstruation cramps and gastrointestinal issues in children. Africans have utilized the *Agapanthus* genus as a magical charm to protect themselves from lightning (Younis et al., 2022). Koli et al. (2023) state that *Agapanthus* has been used to cure diarrhoea in goats and sheep, as well as to manage gastrointestinal parasites.

The incidence of herbal medicine use in pregnancy ranges from 7% to 96%, with a higher frequency in underdeveloped nations (Illamola et al., 2020; Kekana et al., 2020). Kekana et al. (2020) allude that herbal medicines have been utilized since ancient times to treat pregnancy-related disorders, promote safe pregnancies, and improve overall well-being. Herbal medicine has been recommended by some midwives to facilitate labour (Levett et al., 2016). Despite a lack of safety and efficacy data on the use of herbal medications during pregnancy, it is estimated that 4 to 62% of pregnant women continue to take them (Healy et al., 2020; Illamola et al., 2020; Kekana et al., 2020). Herbal medicines are seen as natural, safe, complementary alternatives to existing conventional medicines. However, some plants have toxic bioactive components that have the potential to elicit adverse reactions like synthetic drugs, which stimulate uterine muscle and are therefore not recommended for use during pregnancy (Kekana et al., 2020).

Pharmacology and bioactive compounds

Medicinal plants are regarded as a trustworthy source of medicinal medications for the management and treatment of a variety of ailments (Khumalo et al., 2022). Younis et al. (2022) indicate that biological investigations have demonstrated that *Agapanthus* has pharmacological actions such as anti-inflammatory, antifungal, and antibacterial properties, as well as uterotonic, cAMP phosphodiesterase inhibition, Central Nervous System, and anti-hypertension properties.

Anti-inflammatory activity

Inflammation is a physiologic reaction of the immune system triggered by the body's exposure to toxins, infections, injury to tissues or cells, or autoimmune illnesses (Megha et al., 2021). Gusev et al. (2022); Younis et al. (2022) state that inflammation is a crucial factor in the evolution of cancer, atherosclerosis, inflammatory bowel disease, and other inflammation-related organ dysfunction. Traditional medicinal plants with anti-inflammatory properties, such as *Agapanthus*, play an important role in treating a variety of disorders that endanger human life (Gutiérrez-Rodelo et al., 2023).

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Central Nervous System (CNS) activity

Only a few of the more than 330 plant species in Southern Africa have been shown to influence the central nervous system, and few active chemicals have been found (Younis et al., 2022). *Agapanthus* plants have been used in Southern Africa for centuries to treat a variety of CNS illnesses. *A. africanus* is an ethnomedicinal herb that has been claimed to be able to alleviate AD-related symptoms (Tettevi et al., 2022).

Antifungal activity

The antifungal action of *Agapanthus* was highlighted and investigated in several articles (Younis et al., 2024). Plants with antifungal action assist in reducing the use of pesticides, preserve the environment, and are safe for human health (Pathak, 2022). The antifungal activity of *A. africanus* was investigated by agar dilution method against eight invasive fungi that affect plant crops, and the *Agapanthus* antifungal efficacy has been found (Younis et al., 2022; Erez and Battal, 2022).

Younis et al. (2022) reported the extracts' efficacy, which was comparatively measured against standard fungicides approved for each pathogen, and the plant significantly showed antifungal activity ($p < 0.05$) against five tested fungi by inhibition of radial mycelial growth using a concentration of the crude extract at 1 gL1. *A. agapanthus* exhibited good mycelial growth inhibition% (>97) against *Botrytis cinerea*, *Botryosphaeria dothidea*, *Mycosphaerella pinodes*, *Rhizoctonia Solano* and *Sclerotium rolfsii*; however, it did not exhibit considerable inhibition against *Alternaria alternate* (60-80%), *Fusarium oxysporum* (77%) and *Pythium ultimum* (64%). Fungi examined (in vitro) utilizing the aerial parts extract of *A africanus* showed antifungal activity against *B. dothidea* with an MIC of 0.8 gL1, and 1 gL1 against *P. ultimum* and *M. pinodes* while *B. cinerea*, *S. rolfsii,* and *R. solani* were sensitive only to a dose of 1.2 gL1, whereas *A. alternata* and *F. oxysporum* exhibited the maximum tolerance (Younis et al., 2022).

Tegegne et al. (2008) reported that the methanolic extract of *A. africanus* (aerial part) exhibited considerable in vivo control against both seed-borne covered sorghum (*Sporisorium sorghi*) and loose kernel smuts (*Sporisorium cruenta*), and its fungicidal effects compared with thiram, which was used as a positive control.

Antibacterial activity and toxicity

A drug delivery strategy previously mentioned in the antifungal activity of the genus, the in vitro antibacterial activity of Pheroid-plant extract was investigated against seven human pathogens, two gram-positive bacteria, such as *Staphylococcus epidermidis, Staphylococcus aureus*, five gram-negative bacteria, such as *Escherichia coli, Klebsiella pneumoniae, Salmonella enterica, Enterobacter aerogenes, and Pseudomonas aeruginosa* (Younis et al., 2022). The *A. africanus* extract was found to have minimal antibacterial action against *S. enterica*, *K. pneumonia*, and *E. coli*, as well as *S. epidermidis* and *S. aureus* (Gram-positive bacteria), but no activity against *P. aeruginosa* or *E. aerogenes*.

Literature reports that the dichloromethane extract of the leaves of *A. campanulatus* revealed good but selective antibacterial potential against *Bacillus subtilis* with MIC = 0.390 mg/mL (Younis et al., 2024). The extracts showed good antimicrobial activity (minimum concentration < 1.0 mg/mL); however, aqueous extracts exhibit weak antibacterial activity. Literature suggests that these findings could be employed as a natural product in disease control systems.

The entire plant of *A. africanus* is used by Southern Sotho diviners to improve memory and prepare initiates mentally for their work activities (Younis et al., 2022; Bonokwane, 2023). The rhizome of *A. campanulatus* is also used in the initiation of traditional healers due to the presence of active principles such as yuccagenin and agapanthagenin, but both cause gastrointestinal tract and kidney problems (Younis et al, 2022). Literature reports that *A. praecox* subspecies *Orientalis* leaves, roots, and sap are poisonous, and they can also irritate the skin, causing severe mouth ulcers, burning sensations, and rashes. Furthermore, when supplied orally to patients, *A. africanus* is suspected to cause mouth ulcers and hemolytic responses (Younis et al., 2022). Literature revealed that the acetone, aqueous, and methanolic extracts of *A. praecox* were not fatal (LC50 > 1 mg/mL) in a brine shrimp toxicity trial, with the aqueous extract being the least dangerous to consumers (Konan et al., 2022).

Clinical studies and their applications

South African Xhosa tribes use the *Agapanthus africanus* for its magical powers according to indigenous knowledge (Makhoahle, 2022). *Agapanthus africanus* is brewed and drunk by pregnant women in the third trimester to aid in birth, with the belief that it will strengthen and nourish the infant. The baby is bathed in a similar concoction on the first day whereas the Zulu tribes, culturally use *Agapanthus africanus* to treat flue, paralysis, heart conditions, coughs, chest problems (such as tightness or pains), tired feet (when the plaited leaves are applied as a bandage to the feet) and colds. Significantly, the *Agapanthus africanus* (including the roots) may be poisonous to humans, making all these applications rather intriguing given the associated risk (Younis et al., 2024). Literature revealed that when the

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clear sticky sap of *A. africanus* is consumed, symptoms may include nausea, vomiting, abdominal pain, diarrhoea, and severe mouth ulcers (Makhoahle, 2022).

Biotechnological advancements

Agapanthus africanus has been the focus of many biotechnology breakthroughs aiming at increasing its decorative and agricultural characteristics (Nunes et al., 2023). Mekapogu. (2023) indicates that these advances generally focus on improving floral features, disease resistance, and overall plant performance using genetic engineering and biotechnology. Khan et al. (2022) pointed out that this involves modifying flower color, scent, and morphology to generate new decorative kinds that appeal to consumers. Introduction of certain genes can result in the development of unique flower colours that do not occur naturally in *Agapanthus* species (Chawla et al., 2022; Younis et al., 2022). Said et al. (2024) highlighted that another critical aspect of biotechnological advancements is the enhancement of disease resistance in *A. africanus*.
Mekapogu et al. (2021) indicate that researchers intend to add genes that confer resistance to common diseases affecting ornamental plants using genetic editing techniques. Mahato et al. (2025) suggest that this not only increases plant longevity and health but also reduces dependency on chemical pesticides, aligning with sustainable agricultural practices. Biotechnology has also helped increase growth parameters, including flowering period and plant architecture (Huang et al., 2021). Singh et al. (2025); Mahato et al. (2025) allude that the use of biotechnology in *Agapanthus* production promotes sustainable practices by decreasing inputs such as water and fertilizers through better plant resilience. Nawaz et al. (2023); Singh et al. (2024) pointed out that improved understanding of plant responses to environmental pressures enables more effective management approaches that match with ecological sustainability goals. *Agapanthus africanus* has benefited from several biotechnological developments, including genetic engineering for floral trait modification, disease resistance enhancement, enhanced growth characteristics, and sustainable agriculture practices (Adegbaju et al., 2024). Kumar et al. (2024) allude that these changes not only improve the plant's ornamental appeal but also promote environmentally responsible growth methods.

Salt Tolerance Mechanisms and Adaptations of *A. africanus*

Agapanthus africanus has numerous processes that contribute to salt tolerance (Gomaa et al., 2024; Nunes et al., 2023). Understanding these systems is critical for maximizing production and conservation efforts in saline environments. Nunes et al. (2023) indicate that *A. africanus* tolerates salinity mostly by osmotic adjustment. This entails the accumulation of suitable solutes, like proline and carbohydrates, which assist in maintaining cell turgor pressure under saline conditions (Singh et al., 2022). Khan et al. (2023) allude that these solutes serve as osmoprotectants, stabilizing proteins and cellular structures while minimizing the effects of elevated salt concentrations.
Agapanthus africanus has developed mechanisms for preserving ion balance in the midst of salt stress (Liu et al., 2023). Malakar. (2021) indicates that the selective uptake and transport of essential ions occurs while excluding toxic ions like sodium (Na+). *Agapanthus africanus'* leaf shape may potentially contribute to its salt tolerance (Nicolini et al., 2025; Nunes et al., 2023; Younis et al., 2024). Nunes et al. (2023) allude that *A. africanus* usually has thick, leathery leaves that prevent water loss through transpiration. Moreover, the leaf orientation and structure of *A. africanus* can limit direct exposure to daylight and heat, saving water in saltwater environments (Nunes et al., 2023). Literature indicates that a well-developed root system helps *A. africanus* to reach deeper soil layers, where salinity levels may be lower (Sharma et al., 2023). This adaptation enhances both water intake and nutrient absorption in saline conditions (Nunes et al., 2023). Mahajan et al. (2023) indicate that *A. africanus* tolerates salt well by a combination of osmotic adjustment, ion homeostasis, increased antioxidant activity, leaf morphology alterations, and resilient root system development. Nunes et al. (2023) further allude that these processes allow *A. africanus* to grow in conditions where other plants would struggle due to high salt concentrations.

Sustainable harvesting practices

Literature indicates that sustainable harvesting procedures for *A. africanus* require careful management to guarantee that plant populations remain healthy and viable while serving human demands (Kochi et al., 2020). The important procedures include selective harvesting, which harvests only mature plants while enabling younger plants to thrive and reproduce; this helps to preserve the population's genetic variety and resilience. The time of harvesting *A. africanus* takes place at specified periods of the year when the plants are not actively growing or blossoming (Chawla et al., 2022). Nunes et al. (2022) allude that this procedure minimizes stress on the plants and allows *A. africanus* to recover. The minimal disturbance approach involves harvesting rhizomes or seeds of *A. africanus* with care to avoid soil disturbance and damage to neighbouring vegetation (Nunes et al., 2022). This approach helps preserve the ecosystem and promotes biodiversity (Menéndez et al., 2021). Chawla et al. (2023) revealed that monitoring populations entails regular monitoring of *Agapanthus* populations to assess their health and abundance, as well

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as determining sustainable harvesting levels based on population dynamics. Nunes et al. (2023) allude that education and training entail educating harvesters about sustainable methods to enhance understanding of the necessity of preserving healthy plant populations and ecosystems.

Conservation efforts of *Agapanthus africanus* in South Africa

Literature indicates that *A. africanus* conservation efforts are focused on maintaining its natural habitats and supporting its sustainable use (Gomaa et al., 2024).

Arnolds et al. (2024) allude that habitat protection focuses on protecting regions where *Agapanthus* grows naturally, which is critical for its conservation by establishing protected areas or reserves to protect ecosystems from development or invasive species. Negash. (2021) indicates that there are initiatives aiming at restoring degraded habitats to help *Agapanthus* populations thrive again in their natural surroundings. Fajinmi et al. (2023) indicate that there are no widespread international legal protections for *Agapanthus africanus*; local conservation measures in South Africa aim to protect its natural habitats and prevent further decline, particularly for the endangered subspecies.

Jacklin et al. (2021) reported that the species *A. africanus* has not been formally assessed for conservation status by the International Union for Conservation of Nature (IUCN). However, specific subspecies within this species have been evaluated and are subject to protection measures due to their vulnerability (Zink et al., 2022).

Imarhiagbe et al. (2022) allude that implementing policies that promote sustainable harvesting and habitat protection is vital for ensuring long-term conservation success for *A. africanus*. Saliu et al. (2023) indicate that sustainable harvesting practices with robust conservation efforts will ensure that *A. africanus* remains a thriving part of its ecosystem while providing benefits to humans. Researching the ecological role of *Agapanthus* in its native habitat helps inform conservation strategies (Nunes et al., 2023). Literature suggests that ongoing monitoring can track changes in population dynamics and habitat conditions (Shirk et al., 2023). Dawson et al. (2021) reported that engaging local communities in conservation efforts fosters stewardship of natural resources, encouraging sustainable practices that benefit both people and the environment.

Integration into herbal medicine systems and pharmaceutical industries

Agapanthus africanus has a long history of use in traditional medicine systems, particularly among indigenous communities in Southern Africa (Younis et al., 2022). Sumankuuro et al. (2022) indicate that the plant is recognized for its potential health benefits, such as uterotonic effects, antimicrobial activity, anti-inflammatory properties, and cultural significance (Table 3). *Agapanthus africanus* is traditionally used to facilitate childbirth and manage postnatal recovery (Devi et al., 2023). Extracts from *Agapanthus* have shown potential against various pathogens, making it useful for treating infections (Gomaa et al., 2024; Younis et al., 2022). Wang et al. (2021), alludes that the plant contains compounds that may help alleviate inflammation, which can be beneficial for conditions such as arthritis. Salau et al. (2024) point out that cultural integration enhances its acceptance and use within local herbal practices.

Integration into pharmaceutical industries

The promise of *A. africanus* extends beyond traditional uses to modern pharmacological applications (Mtemeli et al., 2022). Literature has found various bioactive chemicals inside *Agapanthus* that contribute to its therapeutic properties, including saponins, flavonoids, and anthocyanins (Table 3) (Younis et al., 2022). Further research into *A. africanus* chemicals may lead to the creation of novel medications addressing specific health conditions (Attah et al., 2021). Younis et al. (2022) indicate that some research suggests that extracts from *Agapanthus* may inhibit the angiotensin-converting enzyme (ACE), indicating possible value in controlling hypertension. Nicolini et al. (2025) mentioned that certain species of the genus *Agapanthus* have exhibited affinity for serotonin reuptake transport proteins, suggesting a potential in the treatment of depression.

Medicinal Properties	Health Benefits	Methods
Medicinal	The plant is recognized for its potential health benefits	Various parts of the plant (roots, leaves, flowers) are prepared using different methods, such as decoction or infusion, allowing flexibility in how it can be consumed based on specific health needs
Uterotonic Activity	*Agapanthus* africanus is traditionally used to facilitate childbirth and manage postnatal recovery.	Decoctions made from the roots are administered to pregnant women to ensure easier deliveries and healthy offspring.
Antimicrobial Activity	Extracts from *Agapanthus* have shown potential against various pathogens,	Useful for treating various infections
Anti-inflammatory Activity	The plant contains compounds that may help alleviate inflammation.	Can be beneficial for conditions such as arthritis
Cultural Significance	In many cultures, *Agapanthus* is not only valued for its medicinal properties but also holds symbolic meanings related to fertility and protection during childbirth.	Various parts of the plant (roots, leaves, flowers) are prepared using different methods, such as decoction or infusion, allowing flexibility in how it can be consumed based on specific health needs.
Phytochemical Research	Scientific studies have identified several bioactive compounds within *Agapanthus* that contribute to its medicinal effects.	Bioactive compounds include saponins, flavonoids, and anthocyanins.
Cardiovascular Health	*Agapanthus* may inhibit angiotensin-converting enzyme (ACE),	Potential use in managing hypertension
Antidepressant	Certain species within the genus have shown affinity for serotonin reuptake transport proteins.	Suggest a role in treating depression.

Table 3. Medicinal properties of *Agapanthus africanus (L)* Hoffmans

Obahiagbon et al. (2023) indicate that there is a rising trend toward sustainable and natural solutions in healthcare, adding *Agapanthus* into pharmaceutical formulations aligns with client demands for herbal-based treatments. *A. africanus* may require creating standardized extracts that preserve efficacy while guaranteeing safety through extensive testing protocols (Hossan et al, 2021). Kosoe et al. (2024) allude that for the successful integration into the pharmaceutical industry, goods derived from *Agapanthus* must meet regulatory standards set by health authorities. Thorough clinical trials to assure safety and efficacy before commercial release are crucial.

However, the future research should focus on standardised methodology, wide pharmacological screening, and toxicological profiling, as well as genetic conservation and ecological sustainability. An interdisciplinary strategy that integrates ethnobotany, phytochemistry, molecular biology, and clinical pharmacology will be critical for improving the *A. africanus* study.

The review processes on *Agapanthus africanus* research face several key limitations. Many are narrative rather than systematic, often lacking adherence to established standards like PRISMA, which results in unclear selection criteria and bias. Literature coverage is limited, frequently excluding grey literature, non-English sources, and relying on a few databases. Inclusion and exclusion criteria are inconsistently applied, sometimes incorporating low-quality or non-empirical sources without a clear distinction.

Few reviews critically assess study quality, weakening the reliability of conclusions. There's often an overemphasis on traditional uses without sufficient scientific validation. Data synthesis is mostly qualitative and hampered by methodological differences, making comparisons difficult. Lastly, some reviews are outdated or narrowly focused, missing recent findings and interdisciplinary perspectives.

Due to limited and inconsistent evidence, *Agapanthus africanus* should be used cautiously in herbal medicine. There is a need for standardised preparations and better practitioner training on the current gaps in safety and efficacy.
Regulations should demand scientific validation before approving traditional medicines. Policies must also protect indigenous knowledge and increase funding for research, particularly in regions where the plant is traditionally used.
Research should adopt systematic, rigorous methods and

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expand to include toxicology, clinical studies, and ecological factors. Methodological consistency and inclusion of grey and regional literature are essential to build a reliable evidence base.

Conclusion

Agapanthus africanus holds considerable potential for incorporation into both traditional herbal practices and modern pharmaceutical development, owing to its diverse medicinal properties and deep cultural relevance. Its rich phytochemical composition offers a promising foundation for the development of novel, plant-based therapeutics, supporting efforts to bridge traditional ethnobotanical knowledge with evidence-based medical science.

Although *A. africanus* has a long history of use in traditional medicine, scientific understanding of its pharmacological mechanisms and therapeutic applications remains limited. Expanding this knowledge base is essential for validating traditional uses and exploring new health-related applications.

In the context of climate change, which is altering plant distribution and ecological resilience, studying the adaptive responses of *A. africanus* to environmental stressors such as salinity and temperature fluctuations could provide critical insights for conservation strategies and future habitat modeling.

Additionally, *A. africanus* carries substantial cultural and spiritual importance among indigenous communities. Future research should actively involve local stakeholders to document and preserve this traditional knowledge, fostering community-centered approaches to conservation and utilization.

Further exploration of the plant's phytochemistry and potential for biotechnological innovation may lead to the development of sustainable industries and therapeutic products. Ultimately, advancing an interdisciplinary research agenda integrating ecological science, horticulture, pharmacology, and cultural studies is vital for ensuring the long-term sustainability and responsible use of *A. africanus* as a valuable medicinal and ecological resource.

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Author's contributions

All authors have contributed equally to this research work.

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Data availability

The authors confirm that the data created or analysed in this study are included in this manuscript.

Competing Interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

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