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Tulbaghia Violacea Harv.: A Potential Functional Food Source

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ABSTRACT: The *Tulbaghia violacea* Harv. (Alliaceae) is a perennial plant native to South Africa, widely recognized for its role in traditional healing practices and, to some extent, as a functional food. This review explores its potential integration into the everyday diet to ensure consistent intake of beneficial compounds and nutrients. A comprehensive literature search was conducted across databases including Google Scholar, DOAJ, SCOPUS, and Semantic Scholar using targeted keywords. Current evidence highlights the plant's ethnopharmacological, nutritional, and therapeutic properties, with specific focus on its secondary metabolites, in vitro and in vivo assessments, cultivation, processing, and food applications. For *T. violacea*, water-based extraction has emerged as a safer, more effective solvent system with high bioactivity. The leaves and roots were identified as safer for consumption compared to stems. There is a need for further nutritional studies in order to evaluate all plant parts to support balanced dietary integration. The plant's distinctive aroma and volatile compounds suggest culinary potential, while its adaptability and sustainability make it suitable for home cultivation and broader food industry utilization. Collectively, findings position *T. violacea* as a promising functional food and nutraceutical resource with the capacity to enhance food security, promote health, and contribute to safe, sustainable dietary practices.

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GRAPHICAL ABSTRACT

1. INTRODUCTION

Medicinal plants have long been recognized as valuable sources of bioactive compounds, known as phytochemicals, which confer both nutritional and therapeutic properties. Historically employed in home remedies, these plants continue to play a vital role in promoting health and preventing disease, while their bioactive molecules also classify them as functional foods (Li et al., 2025; Oyewole et al., 2018; Pachisia, 2025; Rampana et al., 2022). From the earliest days of trial and error, humans learned to harness plants from their surroundings to meet nutritional and therapeutic needs, gradually developing sophisticated systems of food and medicine (Jamshidi-Kia et al., 2018). Herbs and dietary plants till date continue serving as both food and folk medicine due to their nutritive and curative properties (Ivanišová et al., 2021; Jaradat et al., 2017; Thalia, 2025).

The dual role of medicinal plants as food and medicine has led to their classification as functional foods, capable of promoting health and preventing disease. In many developing regions, rural and tribal communities rely heavily on medicinal and wild edible plants to meet daily nutritional needs, particularly where access to conventional food sources is limited. These plants are rich in dietary fibers, vitamins, minerals, and antioxidants, making them essential for immunity and overall well-being (Pandey et al., 2025; Rumicha et al., 2025). Increasing global interest in sustainable and holistic approaches to health has further highlighted the importance of dietary diversification through the incorporation of underutilized and indigenous food plants. Dietary herbs and plant-based supplements have long been integral to managing diseases, and are increasingly incorporated into fortified foods and functional products to enhance nutritional value. Such strategies not only enhance food and nutrition security but also reduce dependence on staple crops, offering ecological and economic advantages (Arooj and Khalid, 2024; Bvenura and Kambizi, 2024; Kumari et al., 2025; Wani and Upadhyay, 2026).

The growing demand for natural antioxidants and preservatives in food, cosmetics, and pharmaceuticals underscores the relevance of medicinal plants in modern industries. Plant-derived phenolic compounds, flavonoids, and essential oils have demonstrated significant antioxidant and antimicrobial activities, making them promising alternatives to synthetic additives (Agregán et al., 2018; Ghout et al., 2018; Jongberg et al., 2018a, 2018b; Makhoahle and Rampana, 2023; Nieto et al., 2018). Plant-derived phenolic extracts are now used to prevent lipid oxidation in meat products, including essential oils and aromatic compounds also being valued for both their preservative qualities (Grigoriadou et al., 2023; Jongberg et al., 2018a, 2018b; Malini et al., 2023). Moreover, food-medicine plants, edible flowers, and aromatic herbs are increasingly valued for their nutritional composition, sensory attributes, therapeutic qualities and potential biomedical applications (Marchioni et al., 2023; Rivas-García et al., 2022; Xu et al., 2020; Zambrano Núñez et al., 2025).

Despite the growing body of research into functional foods, many medicinal plants remain underexplored. While commonly used herbs such as oregano, sage, lavender, mint, lemon balm, and rosemary are widely recognized for their nutritional and medicinal value, other species with equal or greater potential are still overlooked (Ivanišová et al., 2021). This gap underscores the need for more comprehensive research on the sensory characteristics, bioactivity properties, and the optimization of plant extracts for food applications which iclude a better knowledge of the mechanisms of the implication on shelf life of food (Nieto, 2020). At the same time, it calls for the development of targeted healthcare programs that promote healthy diets and lifestyles by incorporating lesser-known edible wild plants, thereby reducing nutritional deficiencies and strengthening food security (Pandey et al., 2025). Ensuring medicinal plants' quality, efficacy, and safety has become a critical concern in the development of functional foods (Kumari et al., 2025).

Among these, *Tulbaghia violacea* Harv. (wild garlic), a perennial plant native to Southern Africa, stands out as a unique example of a medicinal plant that also serves as a wild edible plant that can serve as daily dietary additive/staple (Ranglová et al., 2015; Street et al., 2010). Traditionally used to treat various ailments, *T. violacea* has gained popularity not only in medicine but also in food and household applications (Alaouna et al., 2025; Kader et al., 2025; Madike, Pillay, et al., 2020). Its dual role as both a therapeutic agent and a dietary component positions it as a potential cost-effective food source. Furthermore, the cultivation of medicinal plants offers opportunities for biodiversity conservation, sustainable supply of bioactive compounds, and the development of functional foods tailored to modern health needs (Netshiluvhi and Eloff, 2024).

The primary aim of this review is to consolidate current research on *T. violacea* and evaluate its potential applications in food systems, as the plant remains underexplored as a source of functional foods. This work provides an overview of existing knowledge and highlights recent trends in the use of *T. violacea,* which ultimately can be translated to potential nutritional purposes.

2. METHODOLOGY

Manuscripts and books focused on topic-related research were collected for this review. A comprehensive literature search was conducted using electronic databases including Google Scholar, DOAJ, SCOPUS, and Semantic Scholar, with targeted keywords such as medicinal plants, functional foods, *Tulbaghia violacea*, and ethnopharmacology. Relevant articles were screened based on titles, abstracts, and keywords, while unrelated works were excluded. To ensure thorough coverage, both recently published papers (up to 2026) and older studies were included. Additionally, bibliographies of retrieved articles were examined to identify further sources of relevance. All references were systematically organized and managed using the Mendeley reference manager.

3. HABITAT AND DISTRIBUTION

Tulbaghia is a monocotyledonous genus of herbaceous perennial bulbs predominantly distributed across Africa. Comprising approximately 63 species, the genus is valued for its nutritive, ornamental, and medicinal properties. For centuries, several *Tulbaghia* species have been employed in diverse traditional medicinal practices, with both ethnobotanical findings and scientific evaluations consistently highlighting *Tulbaghia violacea* as the most widely used and culturally significant species (Aremu and Van Staden, 2013).

Endemic to Southern Africa, the genus belongs to the Alliaceae family and is classified as a geophyte plant, which are those characterized by underground storage organs and aerial parts. Its ecological adaptability is notable, with habitats ranging from semi-desert landscapes to wet and boggy terrains, reflecting its resilience and versatility (Styger et al., 2016).

Within this genus, *Tulbaghia violacea* William Henry Harvey (Harv., Alliaceae) is recognized as a small bulbous herb of significant medicinal importance. Indigenous to South Africa, where it can be found in rocky slopes and cliffs in grassland and near rivers. It is also widely cultivated and utilized for its therapeutic potential (Maleka et al., 2024; Ncise et al., 2017; Oyerinde and Risenga, 2025; Raji et al., 2015).

4. TRADITIONAL USES

Tulbaghia violacea (wild garlic) has long been employed in South African traditional medicine to treat infectious diseases and a variety of ailments (Ncube et al., 2012). It is widely used for fungal infections, gastrointestinal disorders, asthma, fever, colds, pulmonary tuberculosis, and skin conditions, including wound healing (Madike et al., 2019; Ndlovu et al., 2025). Zulu traditional healers have historically relied on *T. violacea* to manage respiratory tract diseases, while other communities have used it to treat paralysis, rheumatism, and fever (Soyingbe et al., 2013; Styger et al., 2016). Moreover, recent studies suggest that the plant may have applications in the pharmaceutical and cosmetic industries, expanding its relevance beyond traditional medicine (Maleka et al., 2024).

Different parts of *T. violacea* are traditionally used for diverse ailments. Rhizomes and bulbs are consumed orally to treat fever, colds, influenza, asthma, tuberculosis, stomach problems, hypertension, and intestinal worms, while leaves are eaten as vegetables and used against esophageal cancer. Rhizome pieces are often placed in castor oil for the making of eardrops. For high blood pressure, tea is made from bulbs or rhizomes, and a small cup is taken three times daily (Styger et al., 2016).

5. SECONDARY METABOLITES

5.1. General phytochemical profile

Phytochemical studies of *Tulbaghia violacea* have revealed a wide array of secondary metabolites across different plant parts. Fruits and seeds contain saponins, terpenoids, glycosides, steroids, volatile oils, coumarins, phlobatannins, alkaloids, phenolics, tannins, quinones, cardiac glycosides, flavonoids, and proanthocyanidins. These constituents are largely similar to those found in leaves, stems, roots, flowers, stalks, and rhizomes. Notably, alkaloids were detected only in seeds, raising caution regarding their consumption (Gbemisola et al., 2022; Kader et al., 2025; Maleka et al., 2024; Oyerinde and Risenga, 2025). While in a study by Makhuvele et al (2022) found extracts of the plant parts to consistently be rich in terpenoids, flavonoids, and saponins, except for tannins which were detected exclusively in leaf extracts.

5.2. Sulfur-Containing Constituents

Sulfur compounds are a defining feature of *T. violacea*. HPLC-MS/MS confirmed their abundance, while LC-ESI-MS/MS identified unique sulfur metabolites such as S-propyl thiosulfate, Di-(1-S-sulfoxymethyl-butyl)-disulfide, S-(2-pyrrolyl) cysteine S-oxide, and 2,4,5,7-tetrathiaoctane4-oxide (marasmicin) (Krstin et al., 2018). GC-HRTOF-MS analyses revealed sulfur dominance across plant parts: bulbs contained 93.34% sulfur compounds, stems 51.2%, rhizomes 40.11%, and leaves 48.37%, alongside fatty acid esters and amides, butyl alcohol, vitamins, terpenoids, sterols, phenols, and miscellaneous compounds (Makhuvele et al., 2022).

5.3. Essential Oils, Callus, and Flower Extracts

Gas chromatography/mass spectrometry (GC/MS) analysis of essential oils extracted from *T. violacea* rhizomes identified major constituents including 2,4-dithiapentane (51.04%), ρ-xylene (20.59%), chloromethylmethyl sulfide (8.69%), σ-xylene (7.38%), thiodiglycol (6.43%), and ρ-xylol (5.88%) (Soyingbe et al., 2013). These volatile compounds contribute to the plant's distinctive aroma and biological activity. GC/MS studies of n-hexane extracts calli and flowers revealed 33 and 32 components, respectively. Hydrocarbons dominated calli (55.0%), while oxygenated compounds were more abundant in flowers (74.6%). Trans(E)-anethole (39.1%) was the major compound in flowers, whereas 16-hentriacontanone (30.3%) dominated calli (Eid and Metwally, 2017).

5.4. Other Secondary Metabolites

Methanolic extracts yielded eleven individual phenolic compounds quantified by mass spectrometry (Rivas-García et al., 2022). HPLC analysis identified ferulic acid and coumaric acid (Ndlovu et al., 2025). Nuclear magnetic resonance spectroscopy revealed 61 chemical components in water-soluble extracts, including DDMP, d-glycero-d-galacto-heptose, 1,2,4-triazine-3,5(2H,4H)-dione, vanillin, schisandrin, taurolidine, and α-pinene, many associated with anti-cancer properties (Alaouna et al., 2024). GC-MS analyses identified additional compounds such as Beta-1,5-O-dibenzoyl-ribofuranose, 4-methoxybenzaldehyde, oleyl alcohol trifluoroacetate, disulfide bis(2-sulfhydrylethyl)-, benzene 1-methyl-4-(methylthio)-, 2,4-dithiapentane, n-propyl 9,12-octadecadienoate, and methyl 5,13-docosadienoate (Moodley et al., 2015).

5.5. Phytochemistry and Applications

Phytochemical composition and bioactivity vary with environmental conditions such as soil type, pH, season of harvest, and extraction methods, explaining differences in pharmacological differences such as antioxidant and radical scavenging activities across regions (Kader et al., 2025). For example, the key antimicrobial compound, marasmicin, is best preserved at low temperatures, emphasizing the importance of proper handling to retain activity (Ranglová et al., 2015). Research has extensively documented bioactive compounds in leaves and roots, but recent studies have expanded to flowers and stalks, validating their medicinal relevance and suggesting potential applications in pharmaceutical and cosmetic industries (Maleka et al., 2024).

6. *IN VITRO* AND *IN VIVO* ASSESSMENTS

The *T. Violacea* plant has shown potential in diverse therapeutic areas. Its broad spectrum includes antimicrobial and antifungal activity, immunomodulatory properties, antioxidant, and antidiabetic properties and cardiovascular and metabolic effects, which highlight its versatility.

6.1. Antimicrobial and Antifungal Activity

Various preparations of *T. violacea* are extensively used to combat microbial infections (Ranglová et al., 2015). Scientific studies confirm its antibacterial and antifungal properties, though some studies reported weak activity (Krstin et al., 2018; Ncise et al., 2017). It aqueous extracts show a broad spectrum of antifungal efficacy by targeting β-glucan and chitin synthesis, thus reducing the risk of fungal resistance (Belewa et al., 2017). Its sulphur compounds have also been shown to exhibit strong anti-Candida activity (Jäger and Stafford, 2012).

6.2. Cytotoxicity and Proliferation Effects

Crude water extracts of *Tulbhaghia violacea* reduced macrophage proliferation only at high concentrations ($p < 0.001$). At lower concentrations, extracts from leaves and roots were nontoxic, whereas in comparison stem-derived extracts exhibited greater cytotoxicity against RAW 264.7 cells. These findings emphasize that preparation and usage of herbal remedies from *T. violacea* must be approached with caution, considering extract concentration, solvent, and plant part (Madike, Takaidza, et al., 2020). Ethanol extracts from all plant parts demonstrated cytotoxicity, underscoring water as a safer solvent system for extraction.

A study by Ndlovu et al (2025) reported that *T. violacea* extracts showed no cytotoxic effects on immortalized human keratinocytes (HaCaT). However, genotoxicity assays using *Allium cepa* revealed significant genotoxic effects at higher concentrations, with stem extracts being more toxic than leaf and root extracts (Madike et al., 2019). Overall, the leaf and root of the plant are a safer option for consumption than the stems. Studies of mechanisms for the stem's toxicity must be conducted.

6.3. Immunomodulatory Properties

Bulb extracts of *T. violacea* demonstrated potential pharmacological activity by inducing detoxifying enzymes (Makhuvele et al., 2022). Essential oil extracts exhibited low cytotoxicity against HEK293 and HepG2 cell lines (Soyingbe et al., 2013). Similarly, RAW264.7 cell viability remained above 80% following exposure to ≤50 μg/mL of both water and acetone extracts. Moreover *T. violacea* extracts showed immunomodulatory activity in LPS-stimulated RAW264.7 cells, suggesting potential for development of novel anti-inflammatory and immune-boosting agents (Takaidza et al., 2025). *In vitro* assays on HaCaT cells demonstrated enhanced cell viability (40–80 μg/mL), reduced intracellular ROS, and accelerated wound closure (88% within 24 h), confirming antioxidant and wound-healing properties (Ndlovu et al., 2025). Understanding of the immunomodulatory properties of *T. violacea* can provide avenues for the development of novel immune-targeted therapies.

6.4. Anti-Cancer Activity

Studies have also highlighted the anticancer activity of *T. violacea*, particularly in inhibiting cancer cell growth (Motadi et al., 2020). Water-soluble extracts from *T. violacea* leaves inhibited invasion and metastasis of triple-negative breast cancer (TNBC) cells (MCF-10A and MDA-MB-231), promoted cell adhesion, and exhibited moderate antioxidant activity, thereby protecting cells from ROS-induced damage (Alaouna et al., 2024). Cytotoxicity assays revealed IC_{50} values of 400 μg/mL (water extract) and 820 μg/mL (methanol extract) against TNBC cells, with the water extract inducing apoptosis more effectively (Alaouna et al., 2025).

Infusions of *T. violacea* demonstrated anti-cancer activity across multiple cancer cell lines (HepG2, MCF7, H157, and HT29), with bioactivity localized to leaf extracts (Saibu et al., 2015). Additional studies confirmed antitumoral activity against ovarian cancer cells via ROS activation and caspase-independent cell death (Rivas-García et al., 2022). Chemical profiling of water-soluble extracts identified bioactive compounds such as DDMP, vanillin, schisandrin, taurolidine, and α-pinene, many of which are linked to cancer research (Alaouna et al., 2025). In particular, the plants Leaf extracts have shown strong anticancer activity, outperforming bulbs and roots in assays against PC-3, HeLa, and TK-10 cell lines (Rampana et al., 2022; Saibu et al., 2015).

6.5. Antioxidant and Antidiabetic properties

The plant is also widely recognized for its antioxidant activity, which contributes to its therapeutic potential (Gbemisola et al., 2022; Kader et al., 2025; Maleka et al., 2024; Oyerinde and Risenga, 2025). The antidiabetic potential of *T. violacea* has been validated through both *in vivo* and *in vitro* studies. In streptozotocin-induced diabetic rats, extracts exhibited hypoglycemic, antioxidant, hepatoprotective, and hypolipidemic effects (Moodley et al., 2015). *In vitro* assays also revealed α-amylase and α-glucosidase inhibitory activities, supporting its ethnomedicinal use for diabetes management (Kader et al., 2025).

Methanolic rhizome extracts of *T. violacea* reduced blood glucose, increased plasma insulin, lowered triglycerides, total cholesterol, and VLDL, while elevating HDL in diabetic rats. Improvements in renal morphology and elevated blood urea nitrogen (BUN) further support hypoglycemic and renoprotective effects (Moodley and Mackraj, 2016). These findings suggest that *T. violacea* exerts hypoglycemic effects through multiple pathways, making it a promising therapeutic agent or adjunct in conventional diabetes therapies (Moodley and Mackraj, 2016).

6.6. Cardiovascular and Metabolic Effects

Traditionally, *T. violacea* has been used to treat hypertension, and modern research supports its antihypertensive properties (Moodley et al., 2014). Evidence suggests that it may modulate the renin-angiotensin system, autonomic nervous system, oxidative stress, and haemostasis, thereby offering cardiovascular protection (Raji et al., 2015). Extracts have also demonstrated antiplatelet and antithrombogenic properties, indicating potential applications in reducing cardiovascular events (Madike et al., 2021; Madike, Pillay, et al., 2020).

Methanolic extracts also protected against atherogenic diet-induced aortic pathology, glomerulosclerosis, and hepatic damage by mitigating hyperlipidemia and oxidative stress (Olorunnisola et al., 2012). Long-term administration (49 days) improved renal function and morphology in Dahl salt-sensitive rats (Moodley et al., 2014). Additionally, crude methanol leaf extracts demonstrated antihypertensive effects in spontaneously hypertensive rats, potentially via muscarinic receptor stimulation and reduced plasma aldosterone levels (Raji et al., 2013). This shows that the plant can be safely administered to induce pharmacological effects *in vivo* for extended periods of time.

7. CULTIVATION, PROCCESSING AND STORAGE

7.1. Traditional Systems and Sustainable Harvesting

The tradition of cultivating both food and medicinal plants in home gardens is deeply rooted in many cultures, with some species serving dual roles as food and medicine (Pranskuniene et al., 2021). The *Tulbaghia violacea* plant is widely recognized as a home remedy herb in Southern Africa (Makhoahle and Rampana, 2023). However, uncontrolled wild collection and reliance on natural populations threaten its abundance, particularly since both above- and underground parts are used in traditional medicine. This destructive harvesting highlights the need for deliberate domestication, organized propagation, and sustainable harvesting strategies to ensure continuous supply and conservation (Aremu and Van Staden, 2013; Oyewole et al., 2018; Styger et al., 2016).

7.2. Cultivation Potential and Ecological Considerations

Beyond medicinal use, *T. violacea* has ornamental value as a perennial bulbous plant suitable for nursery cultivation (Phelan et al., 2007). Its integration into small organic plots could provide edible plant parts and additional income for farmers without disrupting main cultivation lines (Zambrano Núñez et al., 2025). Importantly, ecological factors such as soil quality, pH, and seasonal variation influence phytochemical yields, highlighting the role of environment in shaping bioactivity (Kader et al., 2025). To draw out the much anticipated benefits from the species without compromising their conservation status, the use of different biotechnological approaches will help ensure their continuous availability (Aremu and Van Staden, 2013).

Traditional healers often perceive wild-harvested plants as more potent than cultivated ones. However, studies on *T. violacea* show no significant increase in activity under water and temperature stress, suggesting that cultivation of plants with desired traits can yield high-quality biomass and bioactivity (Netshiluvhi and Eloff, 2024). Evaluating and monitoring the soil for heavy toxic metals in that can cause contamination is an essential step in improving the overall safety and quality of *T. violacea* , which will in turn result in safeguarding the consumer (Street et al., 2010). Given its potential for large-scale utilization in both the food and pharmaceutical industries, conservation concerns may arise. Thus, cultivating *T. violacea* in home gardens is recommended, not only for conservation purposes but also because the plant performs optimally when consumed fresh. Not forgetting that the quality of the soil plays an important role in the distribution of nutrients in the plant. By examining its unique nutritional profile and local adaptability, researchers and advocates can promote its broader use to strengthen resilient and sustainable food systems.

7.3. Extraction, Solvent Choice, and Storage

Water remains the solvent of choice for extracting bioactive compounds from *T. violacea*, consistently outperforming methanol and dichloromethane in terms of yield and activity (Rampana et al., 2022). Comparative studies of seeds and fruits extracted with multiple solvents confirmed that aqueous extracts provided the highest yield, while hexane extracts yielded the lowest (Oyerinde and Risenga, 2025). Fresh homogenization in water maximizes marasmicin formation, further supporting water as the preferred solvent (Ranglová et al., 2015). These scientific reports add weight to the knowledge by herbalists, as water is the solvent of choice for infusions of *T. violacea* used in traditional medicine in Southern Africa when treating numerous diseases (Saibu et al., 2015).

Post-harvest storage significantly affects phytochemical stability. Sulphur compounds in rhizomes degrade rapidly, with half lost within four weeks. Freezing fresh rhizomes in liquid nitrogen prior to ethanol extraction helps preserve these compounds (Jäger and Stafford, 2012). Marasmicin stability is higher at 4 °C than at 25 °C, at room temperature a substantial decomposition occurring within one week was seen, regardless of solvent. To maximize marasmicin formation Extracts of *T. violacea* should be kept at low temperatures to retain their antimicrobial activity (Ranglová et al., 2015).

8. FOOD SOURCE

8.1. Culinary Potential and Nutritional Benefits

Characteristic alliaceous aroma is of particular interest to the food industry, which is continuously seeking novel sources of unusual flavors to meet growing consumer demands (Aremu and Van Staden, 2013). Garlic itself has played a central role in culinary traditions and medicinal practices throughout human history (Krstin et al., 2018). Similarly, wild garlic preparations are commonly consumed as infusions or boiled extracts taken orally (Styger et al., 2016). *T. violacea* has been shown to have a characteristic aroma, as its compound characterization revealed numerous volatile compounds, which could be of interest to those with a sensory for new cuisine in the culinary world.

Experimental studies have demonstrated that treatment with *T. violacea* extracts (120 mg/kg) improved body weight in diabetic rats, suggesting that higher doses may protect against structural protein degradation, potentially through enhanced glycemic control (Moodley et al., 2015). Further investigations into antioxidant and phytochemical content revealed that *T. violacea* could serve as a novel source of phenolic compounds, supporting its potential application in nutraceuticals and functional food development (Rivas-García et al., 2022).

8.2. Nutritional Composition and Applications in the Food Sector

The flowers of *T. violacea* have been shown to contain dietary fiber and protein, with minimal lipid content and no detectable accumulation of heavy metals. Organosulfur compounds dominate the volatile fraction of the flowers, representing 98% of their aromatic profile. This high sulfur content contributes to both their potent antioxidant activity and their distinctive aroma (Zambrano Núñez et al., 2025). Importantly, the elevated sulfur fraction makes wild garlic flowers attractive substitutes for conventional garlic in culinary applications, offering a milder flavor profile (Zambrano Núñez et al., 2025).

Medicinal plants, including *T. violacea*, have been evaluated for their inhibitory effects against pathogens and their potential as natural food and feed additives. In animal feeds, they are employed to enhance flavor, act as colorants, provide nutritional supplementation, and improve livestock production parameters (Grigoriadou et al., 2023). Although some nutritional studies have focused on flowers, similar investigations across all plant parts are essential to fully understand their dietary potential and ensure balanced nutritional integration.

9. CONCLUSION

The comprehensive review conducted on the *T. violacea* plant provides an in-depth exploration of its diverse aspects, beginning with its habitat and distribution, followed by a highlight on its traditional uses. It further highlights the plant's secondary metabolites, detailing its general phytochemical profile, sulfur-containing constituents and essential oils amongst others. *In vitro* and *in vivo* assessments are also discussed, which reveal the antimicrobial and antifungal activity, cytotoxicity and proliferation effects, immunomodulatory properties, anticancer activity, antioxidant and antidiabetic properties, cardiovascular and metabolic effects of the plant. Additionally, the review highlights the favorable cultivation prospects, processing and storage, emphasizing traditional systems and sustainable harvesting, and suitable methods of extraction, solvent choice, and storage. Finally, the plant's role as a food source is demonstrated, focusing on its culinary potential, nutritional benefits, composition, and potential applications within the food sector, thereby presenting a holistic understanding of *T. violacea* and its multifaceted significance. The review, therefore, presents evidence-based demonstration of *T. violacea* as a potential nutritional source.

MANDATORY DISCLOSURE ON USE OF ARTIFICIAL INTELLIGENCE

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COMPETING INTERESTS

The authors declare that they have no competing interests

AUTHORS' CONTRIBUTIONS

S.L. carried out the experimental work and analyzed the data. S.S. interpreted the data and participated in the manuscript editing.

All authors have read and approved the final manuscript.

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REFERENCES

Agregán, R., Munekata, P., Franco, D., Carballo, J., Barba, F., & Lorenzo, J. (2018). Antioxidant potential of extracts obtained from macro- (*Ascophyllum nodosum*, *Fucus vesiculosus*, and *Bifurcaria bifurcata*) and micro-algae (*Chlorella vulgaris* and *Spirulina platensis*) assisted by ultrasound. *Medicines*, *5*(2), 33. https://doi.org/10.3390/medicines5020033

Alaouna, M., Hull, R., Molefi, T., Khanyile, R., Mbodi, L., Luvhengo, T.E., Chauke-Malinga, N., Phakathi, B., Penny, C., & Dlamini, Z. (2024). Exploring water-soluble South African *Tulbaghia violacea* Harv extract as a therapeutic approach for triple-negative breast cancer metastasis. *Current Issues in Molecular Biology*, *46*(10), 10806–10828. https://doi.org/10.3390/cimb46100642

Alaouna, M., Molefi, T., Khanyile, R., Chauke-Malinga, N., Chatziioannou, A., Luvhengo, T.E., Raletsena, M., Penny, C., Hull, R., & Dlamini, Z. (2025). The potential of the South African plant *Tulbaghia violacea* Harv for the treatment of triple negative breast cancer. *Scientific Reports*, *15*(1), 5737. https://doi.org/10.1038/s41598-025-88417-2

Aremu, A.O., & Van Staden, J. (2013). The genus Tulbaghia (Alliaceae)—A review of its ethnobotany, pharmacology, phytochemistry and conservation needs. *Journal of Ethnopharmacology*, *149*(2), 387–400. https://doi.org/10.1016/j.jep.2013.06.046

Arooj, M., & Khalid, N. (2024). Dietary herbs: Ancient use, modern advancements and health prospects in the 21st century. *Food Science and Nutrition Cases*, fsncases20240011. https://doi.org/10.1079/fsncases.2024.0011

Belewa, V., Baijnath, H., Frost, C., & Somai, B.M. (2017). *Tulbaghia violacea* Harv. plant extract affects cell wall synthesis in *Aspergillus flavus*. *Journal of Applied Microbiology*, *122*(4), 921–931. https://doi.org/10.1111/jam.13405

Bvenura, C., & Kambizi, L. (2024). *Food Security and Nutrition*. CRC Press. https://doi.org/10.1201/9781003469766

Eid, H.H., & Metwally, G.F. (2017). Phytochemical and biological study of callus cultures of *Tulbaghia violacea* Harv. Cultivated in Egypt. *Natural Product Research*, *31*(15), 1717–1724. https://doi.org/10.1080/14786419.2017.1289206

Gbemisola, M.S., Rahmon, I.K., Kayode, P.O., Grant, G.J., Iyapo, O., Gideon, A.A., Ahmed, O.B., Jelili, A.B., Kazeem, I.M., & Oluwatosin, B.A. (2022). Comparative Evaluation of Sutherlandia frutescens and *Tulbaghia violacea* Antioxidant Potential. *Asian Journal of Biochemistry, Genetics and Molecular Biology*, 1–11. https://doi.org/10.9734/ajbgmb/2022/v11i130255

Ghout, A., Zellagui, A., Gherraf, N., Demirtas, I., Ayse Sahin, Y., Boukhenaf, M., Lahouel, M., Nieto, G., & Akkal, S. (2018). Antiproliferative and antioxidant activities of two extracts of the plant species Euphorbia dendroides L. *Medicines*, *5*(2), 36. https://doi.org/10.3390/medicines5020036

Grigoriadou, K., Cheilari, A., Dina, E., Alexandri, S., & Aligiannis, N. (2023). Medicinal and aromatic plants as a source of potential feed and food additives. In *Sustainable Use of Feed Additives in Livestock* (pp. 117–135). Springer International Publishing. https://doi.org/10.1007/978-3-031-42855-5_6

Ivanišová, E., Kačániová, M., A. Savitskaya, T., & D. Grinshpan, D. (2021). Medicinal herbs: important source of bioactive compounds for food industry. In *Herbs and Spices - New Processing Technologies*. IntechOpen. https://doi.org/10.5772/intechopen.98819

Jäger, A. K., & Stafford, G. I. (2012). Quality assessment of Tulbaghia rhizomes. *South African Journal of Botany*, *82*, 92–98. https://doi.org/10.1016/j.sajb.2012.07.025

Jamshidi-Kia, F., Lorigooini, Z., & Amini-Khoei, H. (2018). Medicinal plants: Past history and future perspective. Journal of Herbmed Pharmacology, 7(1), 1–7. https://doi.org/10.15171/jhp.2018.01

Jaradat, N., Zaid, A., Hussein, F., Zaqzouq, M., Aljammal, H., & Ayesh, O. (2017). Anti-lipase potential of the organic and aqueous extracts of ten traditional edible and medicinal plants in palestine; a comparison study with Orlistat. *Medicines*, *4*(4), 89. https://doi.org/10.3390/medicines4040089

Jongberg, S., Tørngren, M., & Skibsted, L. (2018a). Dose-dependent effects of green tea or maté extracts on lipid and protein oxidation in brine-injected retail-packed pork chops. *Medicines*, *5*(1), 11. https://doi.org/10.3390/medicines5010011

Jongberg, S., Tørngren, M., & Skibsted, L. (2018b). Protein oxidation and sensory quality of brine-injected pork loins added ascorbate or extracts of green tea or maté during chill-storage in high-oxygen modified atmosphere. *Medicines*, *5*(1), 7. https://doi.org/10.3390/medicines5010007

Kader, T., Sibiya, N., Mapfumari, S., & Mothibe, M. (2025). Phytochemical composition, antioxidant and in vitro enzyme-based antidiabetic activities of tulbaghia violacea collected from the Eastern Cape and Gauteng Provinces, South Africa. https://doi.org/10.20944/preprints202506.2086.v1

Krstin, S., Sobeh, M., Braun, M., & Wink, M. (2018). *Tulbaghia violacea* and *Allium ursinum* Extracts Exhibit Anti-Parasitic and Antimicrobial Activities. *Molecules*, *23*(2), 313. https://doi.org/10.3390/molecules23020313

Kumari, M., Singh, S., Puri, S., Thakur, N., Thakur, A., Dulta, K., Shukla, R.K., Dehghani, M.H., & Ghosh, S. (2025). Investigation of nutritional and phytochemical properties of wild medicinal plant species. *Scientific Reports*, *15*(1), 43405. https://doi.org/10.1038/s41598-025-28689-w

Li, X., Liu, Y., Liu, N., Wu, H., Cong, K., Duan, L., Chen, T., & Zhang, J. (2025). Health benefits of medicinal plant natural products via microbiota-mediated different gut axes. *Pharmacological Research*, *215*, 107730. https://doi.org/10.1016/j.phrs.2025.107730

Madike, L.N., Pillay, M., & Popat, K.C. (2020). Antithrombogenic properties of *Tulbaghia violacea*–loaded polycaprolactone nanofibers. *Journal of Bioactive and Compatible Polymers*, *35*(2), 102–116. https://doi.org/10.1177/0883911520903748

Madike, L.N., Pillay, M., & Popat, K.C. (2021). Antithrombogenic properties of *Tulbaghia violacea* aqueous leaf extracts: assessment of platelet activation and whole blood clotting kinetics. *RSC Advances*, *11*(48), 30455–30464. https://doi.org/10.1039/D1RA00926E

Madike, L.N., Takaidza, S., Ssemakalu, C.C., & Pillay, M. (2020). The effect of extracts of *Tulbaghia violacea* on the proliferation of a murine macrophage cell line. *South African Journal of Botany*, *130*, 185–197. https://doi.org/10.1016/j.sajb.2019.12.025

Madike, L.N., Takaidza, S., Ssemakalu, C., & Pillay, M. (2019). Genotoxicity of aqueous extracts of *Tulbaghia violacea* as determined through an Allium cepa assay. *South African Journal of Science*, *115*(1/2). https://doi.org/10.17159/sajs.2019/4391

Makhoahle, P.M., & Rampana, D.E. (2023). Antioxidant activities, total polyphenol profile and anticancer activity, of leaf, bulb and root extracts of *Tulbaghia violacea* from Bloemfontein. *Pharmacognosy Journal*, *15*(5), 761–767. https://doi.org/10.5530/pj.2023.15.149

Makhuvele, R., Gbashi, S., & Njobeh, P.B. (2022). GC-HRTOF-MS metabolite profiling and antioxidant activity of methanolic extracts of *Tulbaghia violacea* Harv. *Journal of King Saud University - Science*, *34*(7), 102278. https://doi.org/10.1016/j.jksus.2022.102278

Maleka, G., Oyerinde, R. O., & Risenga, I. M. (2024). Comparative phytochemical profiling and biological activities in the flowers and stalks of *Tulbaghia violacea*. *Borneo Journal of Pharmacy*, *7*(1), 14–28. https://doi.org/10.33084/bjop.v7i1.6035

Malini, G., Saranya, B., & Parameswari, A. (2023). Review on extraction techniques for medicinal and aromatic plants. *International Journal of Pharmaceutical Chemistry and Analysis*, *10*(4), 253–256. https://doi.org/10.18231/j.ijpca.2023.042

Marchioni, I., Najar, B., Copetta, A., Ferri, B., Ruffoni, B., Pistelli, L., & Pistelli, L. (2023). Phytonutritional and aromatic profiles of *Tulbaghia simmleri* Beauv. edible flowers during cold storage. *Advances in Horticultural Science*, *37*(1), 25–32. https://doi.org/10.36253/ahsc-13857

Moodley, K., Joseph, K., Naidoo, Y., Islam, S., & Mackraj, I. (2015). Antioxidant, antidiabetic and hypolipidemic effects of *Tulbaghia violacea* Harv. (wild garlic) rhizome methanolic extract in a diabetic rat model. *BMC Complementary and Alternative Medicine*, *15*(1), 408. https://doi.org/10.1186/s12906-015-0932-9

Moodley, K., & Mackraj, I. (2016). Metabolic effects of *Tulbaghia violacea* HARV. in a diabetic model. *African Journal of Traditional, Complementary and Alternative Medicines*, *13*(4), 113–122. https://doi.org/10.21010/ajtcam.v13i4.16

Moodley, K., Naidoo, Y., & Mackraj, I. (2014). Effects of *Tulbaghia violacea* Harv. (Alliaceae) rhizome methanolic extract on kidney function and morphology in Dahl salt-sensitive rats. *Journal of Ethnopharmacology*, *155*(2), 1194–1203. https://doi.org/10.1016/j.jep.2014.07.003

Motadi, L.R., Choene, M.S., & Mthembu, N.N. (2020). Anticancer properties of *Tulbaghia violacea* regulate the expression of p53-dependent mechanisms in cancer cell lines. *Scientific Reports*, *10*(1), 12924. https://doi.org/10.1038/s41598-020-69722-4

Ncise, W., Daniels, C.W., & Nchu, F. (2017). The effect of enviromental stress on the phytochemistry and bioactivity responses of a South African medicinal bulbous plant *Tulbaghia violacea*. *South African Journal of Botany*, *109*, 358. https://doi.org/10.1016/j.sajb.2017.01.140

Ncube, B., Finnie, J.F., & Van Staden, J. (2012). Quality from the field: The impact of environmental factors as quality determinants in medicinal plants. *South African Journal of Botany*, *82*, 11–20. https://doi.org/10.1016/j.sajb.2012.05.009

Ndlovu, B., Fisher, R., & Fisher (née Rahiman), F. (2025). Phenolic-rich extracts of *Galenia africana* and *Tulbaghia violacea* accelerate keratinocyte migration and mitigate oxidative stress to enhance wound healing. *Plants*, *14*(22), 3523. https://doi.org/10.3390/plants14223523

Netshiluvhi, T.R., & Eloff, J.N. (2024). Temperature and water stresses on antioxidant activity of selected medicinal plants have implications for sustainable use and global warming. *South African Journal of Botany*, *170*, 177–180. https://doi.org/10.1016/j.sajb.2024.05.028

Nieto, G. (2020). How are medicinal plants useful when added to foods? *Medicines*, *7*(9), 58. https://doi.org/10.3390/medicines7090058

Nieto, G., Ros, G., & Castillo, J. (2018). Antioxidant and antimicrobial properties of rosemary (*Rosmarinus officinalis*, L.): A Review. *Medicines*, *5*(3), 98. https://doi.org/10.3390/medicines5030098

Olorunnisola, O.S., Bradley, G., & Afolayan, A.J. (2012). Protective effect of *Tulbaghia violacea* Harv. on aortic pathology, tissue antioxidant enzymes and liver damage in diet-induced atherosclerotic rats. *International Journal of Molecular Sciences*, *13*(10), 12747–12760. https://doi.org/10.3390/ijms131012747

Oyerinde, R.O., & Risenga, I.M. (2025). Bioactive compound characterization and phytopharmacological potentials of *Tulbaghia violacea* fruits and seeds. *Chemistry & Biodiversity*, *22*(6), e202403198. https://doi.org/10.1002/cbdv.202403198

Oyewole, S.O., Akinyemi, O., & Jimoh, K.A. (2018). Medicinal plants and sustainable human health: a review. *Horticulture International Journal* , *2*(4), 194-195. https://doi.org/10.15406/hij.2018.02.00051

Pachisia, J. (2025). 8 Medicinal plants as functional food: a review. *Medicinal Plants as Functional Food: A Review*, 8(2), 1-21. https://doi.org/10.1136/bmjnph-2025-nnedprosummit2024.8

Pandey, A., Mishra, A., Mohanta, S., Manohar Kandileri, A., Shukla, G., & Chakravarty, S. (2025). Wild edible plants and their role in alleviating nutritional deficiency: an indian context. In *Forest Science – Advances towards Sustainable Development and Climate Resilience*. IntechOpen. https://doi.org/10.5772/intechopen.1009820

Phelan, S., Douglas, G., & Hunter, A. (2007). Micropropagation and growth regulation of *Tulbaghia violacea* "SILVER LACE." *Acta Horticulturae*, (764), 113–118. https://doi.org/10.17660/ActaHortic.2007.764.13

Pranskuniene, Z., Bajoraite, R., Simaitiene, Z., & Bernatoniene, J. (2021). Home gardens as a source of medicinal, herbal and food preparations: modern and historical approaches in Lithuania. *Applied Sciences*, *11*(21), 9988. https://doi.org/10.3390/app11219988

Raji, I., Mugabo, P., & Obikeze, K. (2013). The contributions of muscarinic receptors and changes in plasma aldosterone levels to the anti-hypertensive effect of *Tulbaghia violacea*. *BMC Complementary and Alternative Medicine*, *13*(1), 13. https://doi.org/10.1186/1472-6882-13-13

Raji, I., Obikeze, K., & Mugabo, P. (2015). Potential Beneficial Effects of *Tulbaghia violacea* William Henry Harvey (Alliaceae) on cardiovascular system – a review. *Tropical Journal of Pharmaceutical Research*, *14*(6), 1111. https://doi.org/10.4314/tjpr.v14i6.25

Rampana, D. E., Makhoahle, P. M., & Mashele, S. S. (2022). Anticancer, cytotoxicity, and genotoxicity assays of *Tulbaghia violacea* extracts. *Journal of Advanced Pharmacy Education and Research*, *12*(4), 27–31. https://doi.org/10.51847/Ceo7ssgJdO

Ranglová, K., Krejčová, P., & Kubec, R. (2015). The effect of storage and processing on antimicrobial activity of *Tulbaghia violacea*. *South African Journal of Botany*, *97*, 159–164. https://doi.org/10.1016/j.sajb.2015.01.011

Rivas-García, L., Romero-Márquez, J. M., Navarro-Hortal, M. D., Esteban-Muñoz, A., Giampieri, F., Sumalla-Cano, S., Battino, M., Quiles, J. L., Llopis, J., & Sánchez-González, C. (2022). Unravelling potential biomedical applications of the edible flower *Tulbaghia violacea*. *Food Chemistry*, *381*, 132096. https://doi.org/10.1016/j.foodchem.2022.132096

Rumicha, T.D., Belew, S., Hasen, G., Teka, T.A., & Forsido, S.F. (2025). Food, feed, and phytochemical uses of wild edible plants: a systematic review. *Food Science & Nutrition*, *13*(6). https://doi.org/10.1002/fsn3.70454

Saibu, G.M., Katerere, D.R., Rees, D.J.G., & Meyer, M. (2015). In vitro cytotoxic and pro-apoptotic effects of water extracts of *Tulbaghia violacea* leaves and bulbs. *Journal of Ethnopharmacology*, *164*, 203–209. https://doi.org/10.1016/j.jep.2015.01.040

Soyingbe, O.S., Oyedeji, O.A., Basson, A.K., Singh, M., & Opoku, A.R. (2013). Chemical composition, antimicrobial and antioxidant properties of the essential oils of *Tulbaghia violacea* Harv L.F. *African Journal of Microbiology Research*, *7*(18), 1787–1793. https://doi.org/10.5897/AJMR12.1156

Street, R.A., Kulkarni, M.G., Stirk, W.A., Southway, C., & Van Staden, J. (2010). Effect of cadmium on growth and micronutrient distribution in wild garlic (*Tulbaghia violacea*). *South African Journal of Botany*, *76*(2), 332–336. https://doi.org/10.1016/j.sajb.2009.12.006

Styger, G., Aboyade, O.M., Gibson, D., & Hughes, G. (2016). *Tulbaghia*— A Southern African Phytomedicine. *The Journal of Alternative and Complementary Medicine*, *22*(4), 255–261. https://doi.org/10.1089/acm.2014.0406

Takaidza, S., Ssemakalu, C.C., Chukwuneme, C.F., & Pillay, M. (2025). Immunomodulatory effects of crude acetone and water leaf extracts from *Tulbaghia violacea* on RAW264.7 cells stimulated with lipopolysaccharide (LPS). *Journal of HerbMed Pharmacology*, *14*(2), 217–229. https://doi.org/10.34172/jhp.2025.52690

Thalia, O.P. (2025). The Cultural Significance of Medicinal Plants in Treating Chronic Conditions. *Newport International Journal of Research in Medical Sciences*, *6*(2), 59–65. https://doi.org/10.59298/NIJRMS/2025/6.2.5965

Wani, M.A., & Upadhyay, V. (2026). Medicinal plants and their therapeutic advantages: a comprehensive review. *International Journal of Applied Research*, *12*(1), 31–33. https://doi.org/10.22271/allresearch.2026.v12.i1a.13273

Xu, Y., Liang, D., Wang, G.-T., Wen, J., & Wang, R.-J. (2020). Nutritional and functional properties of wild food-medicine plants from the coastal region of South China. *Journal of Evidence-Based Integrative Medicine*, *25*, 2515690X2091326. https://doi.org/10.1177/2515690X20913267

Zambrano Núñez, T.M., Morales Noriega, A.M., García-Martínez, M.D., & Raigón Jiménez, M. D. (2025). Aromatic and nutritional composition of edible flowers of garden garlic and wild leek. *Horticulturae*, *11*(3), 323. https://doi.org/10.3390/horticulturae11030323