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Overview of chemical composition, biological activity, and application potential of *Aganonerion polymorphum*

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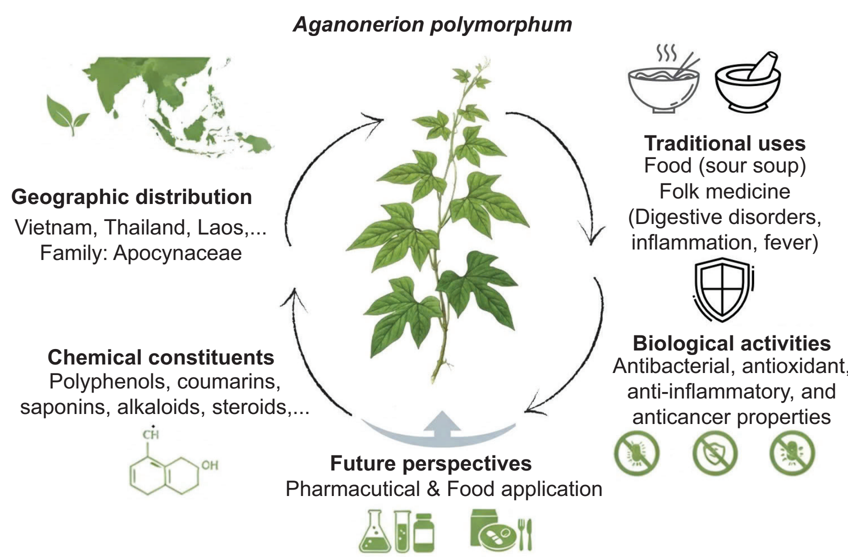
ABSTRACT: *Aganonerion polymorphum* Pierre ex Spire, a plant species belonging to the Apocynaceae family, is predominantly distributed across Southeast Asian countries, such as Vietnam, Thailand, and Laos. Traditionally, this species has been used in folk medicine to treat digestive disorders, inflammation, and fever. Recent studies have shown that *A. polymorphum* leaves are rich in bioactive compounds, including flavonoids, polyphenols, coumarins, and sterols, which contribute to its antibacterial, antioxidant, anti-inflammatory, and potential anticancer properties. In addition to its medicinal uses, this plant is also employed in Vietnamese cuisine, especially as an aromatic herb in sour soups and traditional dishes in the Mekong Delta region. This review compiles current research on the botanical characteristics, chemical composition, and biological activities of *A. polymorphum*, as well as its traditional applications and potential uses. Moreover, it proposes future research directions to effectively explore and utilize this native plant for pharmaceutical and food industry purposes.

GRAPHICAL ABSTRACT



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1. INTRODUCTION

Aganonerion polymorphum Pierre ex Spire (*A. polymorphum*) is a climbing vine belonging to the *Apocynaceae* family, widely distributed across Southeast Asian countries such as Thailand, Vietnam, Laos, and Cambodia. The stems range from 1.6 to 4.0 m in length, are smooth, and contain a small amount of white latex. The leaves are thin, ovate, or heart-shaped at the base with pointed tips, measuring approximately 3.5–10 cm in length and 2–5 cm in width. The upper leaf surface is lighter than the lower. Flowers typically appear in clusters of 2–5 and are either red or white in color (Anh and Dat, 2019; Ho, 1999) (Figure 1).

Regarding its chemical composition, a phytochemical screening conducted in Vietnam revealed that the leaves of *A. polymorphum* contain major classes of bioactive compounds, including triterpenoids (notably ursolic acid, which was isolated for the first time from this species), alkaloids, steroids, cardiac glycosides, phenolics, flavonoids, and coumarins (Phuong et al., 2023; Rani et al., 2025). In contrast, Tanaka & Nguyen (2007) reported the presence of flavonoids, saponins, sterols, coumarins, tannins, lipids, organic acids, and more than twelve trace elements across the whole plant, encompassing the stem, leaves, and roots.

A particularly noteworthy recent application is the use of *A. polymorphum* leaf extract in the green synthesis of silver-based nanomaterials (AgNPs and Ag/AgCl), which exhibited significantly enhanced antibacterial activity compared to conventional nanoparticles. This approach also contributes to the development of biomedical and advanced material technologies (Vu et al., 2019).

Figure 1. *Aganonerion polymorphum*.

Moreover, in a study by Huong et al. (2025), a composite of *A. polymorphum* leaf extract and titanium dioxide nanoparticles demonstrated excellent anticorrosion efficacy (>80%) in ethanol fuel blend environments, outperforming traditional corrosion inhibitors when applied to steel surfaces.

Despite the evident phytochemical richness and biological potential, most current pharmacological investigations have focused primarily on *A. polymorphum* roots rather than its leaves. In Vietnam, *A. polymorphum* leaves are not only widely used as a sour-tasting vegetable in traditional cuisine, such as in sour soups, but also serve as raw materials in traditional medicine, employed for their antipyretic, anti-inflammatory, diuretic, and antimicrobial purposes (Tanase et al., 2019). These ethnobotanical uses reflect the plant's multidisciplinary potential; however, they remain underexplored through the lens of modern phytochemistry and pharmacology.

The objective of this review is to provide a comprehensive and up-to-date analysis of scientific research related to the phytochemical profile, antioxidant and antimicrobial activities, and biomedical–industrial applications of *A. polymorphum* leaves. This aims to establish a logical, evidence-based foundation for the future development and use of this promising medicinal plant.

2. METHODOLOGY

To facilitate a comprehensive review of the chemical composition, biological activities, and application potential of *A. polymorphum*, a systematic literature search was performed. The search was conducted across several major academic databases, including Web of Science, Scopus, PubMed, Science Direct, Springer, and Google Scholar.

The scope of the search encompassed both preclinical and clinical studies. To ensure a thorough understanding, we also consulted traditional medicine monographs, such as "Vietnamese Medicinal Plants," to incorporate data on its historical and traditional medicine uses.

The primary search terms were "*Aganonerion polymorphum*," "chemical composition," "biological activity," "antibacterial activity," "nutritional value," and "culinary applications." Articles that did not directly address these identified aspects of *A. polymorphum* were excluded to maintain the focus and depth of the review.

3. PHYTOCHEMICALS OF *A. POLYMORPHUM* LEAVES

Existing studies have shown that *A. polymorphum* contains a wide range of important secondary metabolites, including alkaloids, steroids, saponins, polyphenols, triterpenoids, and flavonoids. Qualitative phytochemical analyses conducted in three different regions—Binh Dinh, Vietnam (Phuong et al., 2023), Binh Duong, Vietnam (Doan et al., 2019), and Nakhon Phanom, Thailand (Somdee et al., 2016; Sakong et al., 2011)—consistently revealed the presence of alkaloids, steroids, saponins, and polyphenols across all surveyed sites (Table 1). These compound classes are well known for their essential roles in biological activities such as antibacterial, anti-inflammatory, and antioxidant effects.

However, significant differences were observed in the presence of two compound groups: triterpenoids and flavonoids. Specifically, triterpenoids were detected only in the two Vietnamese studies (Binh Dinh and Binh Duong) but were absent in samples collected from Thailand. In contrast, flavonoids were not found in samples from Binh Dinh, while they were present in the other two studies. Notably, the Nong Bua Lamphu region in Thailand, characterized by a humid tropical monsoon climate, may favor the accumulation of flavonoids (Phumkokrux & Trivej, 2024; Uddin & Alam, 2022). Meanwhile, Binh Dinh, Vietnam is a dry region with mineral-rich soils—an environment that has been reported to support triterpenoid biosynthesis in plants (Guo et al., 2023).

Beyond *A. polymorphum*, numerous other species within the Apocynaceae family have also been studied for their leaf chemical compositions. For instance, the leaves of *Nerium oleander* contain phenols, tannins, flavonoids, triterpenoids, and alkaloids (Redha, 2020), while *Catharanthus roseus* has been reported to contain similar compounds, including sugars and quinones (Kabesh et al., 2015). Remarkably, *Thevetia peruviana* leaves are notable for their high content of cardiac glycosides, along with flavonoids, polyphenols, saponins, and tannins (Gezahegn et al., 2015). When compared to *A. polymorphum*, these related species share an abundance of important secondary metabolites-particularly flavonoids, alkaloids, and tannins-which have been widely recognized for their potent biological activities, such as antioxidant, anti-inflammatory, and antimicrobial effects (Lim et al., 2020). This phytochemical similarity underscores the broad medicinal potential of the Apocynaceae family and provides a valuable foundation for further studies exploring the pharmacological applications of its members, including *A. polymorphum*.

In addition to geographical factors, sample processing methods play a critical role in detecting secondary metabolites. Flavonoids and polyphenols are particularly sensitive to degradation under varying temperature, light, and pH conditions (Yang et al., 2022). Therefore, inconsistencies in extraction procedures, sample preservation, or analytical techniques may lead to substantial discrepancies in phytochemical profiles across different studies (Sulaiman et al., 2017).

From a biological activity perspective, the presence of saponins, flavonoids, and polyphenols is of particular interest. Saponins have been demonstrated to exert antibacterial effects by disrupting bacterial cell membranes or inhibiting the biosynthesis of proteins and lipids (Li & Monje-Galvan, 2023). Meanwhile, flavonoids and polyphenolic compounds play crucial roles in counteracting oxidative stress, reducing inflammation, and protecting cells via various mechanisms, including the suppression of inflammatory signaling pathways such as NF-κB and MAPK (Kuljarusnont et al., 2024). Additionally, although underexplored in *A. polymorphum*, triterpenoids are known for their pharmacological properties in other plant species, including anticancer, hepatoprotective, and immunomodulatory effects (Renda et al., 2022).

The study by Somdee et al. (2016) conducted in Nakhon Phanom, Thailand, reported a total polyphenol content (TPC) of 2.81 g/100 g and a total flavonoid content (TFC) of 407.12 mg/100 g in fresh *A. polymorphum* leaves. In contrast, Sakong et al. (2011) recorded a lower TPC value of 647.05 mg/100 g. This discrepancy highlights the influence

Table 1

Phytochemicals of *A. polymorphum* leaves in some countries.

Qualitative compound	Binh Dinh, Vietnam (Phuong et al., 2023)	Binh Duong, Vietnam (Doan et al., 2019)	Nong Bua Lamphu, and Nakhon Phanom, Thailand (Sakong et al., 2011; Somdee et al., 2016)
Alkaloids	+	+	+
Steroids	+	+	+
Saponins	+	+	+
Triterpenoid	+	+	–
Polyphenol	+	+	+
Flavonoid	–	+	+

Note: "+" Present, "–" Absent.

of local environmental conditions, sample status (fresh or dried), harvest timing, and analytical methods on compound concentrations. When compared with *Catharanthus roseus*, another species within Apocynaceae, there is a notable difference in flavonoid content. Specifically, Kabesh et al. (2015) reported flavonoid concentrations ranging from 22 to 99 mg/100 g in *C. roseus* leaves, considerably lower than the 407.12 mg/100 g found in *A. polymorphum*. This indicates that *A. polymorphum* possesses greater potential for natural flavonoid accumulation, reinforcing its biological value in medicinal and nutraceutical applications.

Overall, current data suggest that *A. polymorphum* is a medicinally valuable plant species, particularly for its abundance of highly bioactive compounds, including saponins, flavonoids, polyphenols, and triterpenoids. Nevertheless, further systematic studies are required to assess the variation in chemical composition across geographical regions, seasons, and cultivation conditions. Such investigations are essential to guide its optimal application of this technology in the pharmaceutical and functional food industries.

4. NUTRITIONAL VALUE OF *A. POLYMORPHUM* LEAVES

The nutritional profile of *A. polymorphum* has been compared with that of several other medicinal plant species to clarify its potential applications in the nutraceutical and functional food sectors (Table 2).

The moisture content in the leaves of *A. polymorphum* is relatively high, reaching up to 85.3%, which is considerably greater than that of *Catharanthus roseus* (70.5%) and *Moringa oleifera* (75.9%) (Seav et al., 2021; Ekwealor et al., 2016; Joshi & Mehta, 2010). This indicates a higher water proportion in *A. polymorphum* leaves, which corresponds to a lower dry matter yield and increased susceptibility to postharvest wilting and moisture loss. The high moisture content also impacts preservation and processing methods, requiring appropriate drying or storage protocols to prevent quality deterioration.

In terms of energy, *A. polymorphum* provides 122 Kcal/100 g, which is higher than that of *M. oleifera* (92 Kcal/100 g)—a species often considered highly nutritious (Seav et al., 2021; Joshi & Mehta, 2010). This suggests that *A. polymorphum* holds promise as a plant-based source of natural energy. However, energy data for *C. roseus* was not available in the referenced sources, thus preventing a comprehensive comparison for this criterion.

Regarding protein content, *C. roseus* ranks highest at 8.08 g/100 g, followed by *M. oleifera* (6.7 g/100 g), while *A. polymorphum* shows a lower value of 3.5 g/100 g (Seav et al., 2021; Ekwealor et al., 2016; Joshi & Mehta, 2010). Although *A. polymorphum* has a relatively lower protein content, it still offers potential as a moderate source of plant-based protein. On the other hand, its iron content (2.1 mg/100 g) is significantly higher than that of *M. oleifera* (0.85 mg/100 g), suggesting that *A. polymorphum* could serve as an effective natural iron supplement, particularly beneficial in addressing iron-deficiency anemia (Seav et al., 2021; Joshi & Mehta, 2010; Suzana et al., 2017).

Overall, *A. polymorphum* stands out for its high moisture and energy content, along with valuable mineral content, particularly iron. Although it does not excel in protein content, its rich composition of highly bioactive secondary metabolites, including alkaloids, steroids, saponins, triterpenoids, polyphenols, and flavonoids, supports its potential for diverse applications, especially in herbal medicine and functional foods (Doan et al., 2019). It should be noted, however, that these nutritional values may vary depending on cultivation conditions, harvesting stage, and analytical methods. Therefore, future studies should aim to standardize these factors to enable more accurate comparisons and evaluations.

5. ANTIOXIDANT OF *A. POLYMORPHUM* LEAVES

Previous studies have reported significant antioxidant activity in the leaves of *A. polymorphum*, with notable

Table 2

Nutrition value of *A. polymorphum* leaves.

Qualitative compound	*Aganonerion polymorphum* (Seav et al., 2021)	*Catharanthus roseus* (Ekwealor et al., 2016)	*Moringa oleifera* (Joshi & Mehta, 2010)
Moisture (%)	85.3	70.50	75.9
Energy (Kcal/ 100 g)	122.0	–	92
Protein (g)	3.5	8.08	6.7
Iron (mg/100 g)	2.1	–	0.85

Note: "–" Not tested.

variations in both the evaluation methods and quantitative values across different geographic regions (Table 3).

Specifically, according to the study by Sakong et al. (2011) conducted in Nong Bua Lamphu Province, Thailand, the total antioxidant activity (TAA) of *A. polymorphum* leaves reached 1865.19 µmol Fe/100 g dry weight (DW), indicating strong antioxidant potential. Additionally, the DPPH radical scavenging capacity was measured at 3.24 mmol TEAC/100 g DW, while the ABTS radical scavenging activity was also high, reaching 291.60 mmol TEAC/100 g DW. These values highlight the potent antioxidant capacity of bioactive compounds present in the plant extracts from the surveyed samples.

In contrast, the study by Somdee et al. (2016) conducted in Nakhon Phanom Province employed different evaluation parameters but similarly confirmed the antioxidant efficacy of *A. polymorphum*. The DPPH scavenging activity was reported at 23.99%, and the ferric reducing antioxidant power (FRAP) reached 142.23 mmol $FeSO_4$/100 g DW. Although TAA and ABTS values were not provided, the FRAP result demonstrates the plant's ability to neutralize free radicals via electron transfer mechanisms (Ou et al., 2022), reinforcing its potential as an effective antioxidant agent.

Compared to other bioactive plant species such as *N. oleander* (DPPH ranging from 0.19–31.64%; Redha, 2020) and *M. oleifera* (TAA up to 1257.91 µmol/100 g; Ayodele & Olabode, 2015), *A. polymorphum* exhibits relatively strong antioxidant potential, with DPPH values ranging from 23.76–47.24% and TAA reaching 1865.19 µmol/100 g. This suggests that the species not only shows promising quantitative results but also holds competitive potential compared to well-known medicinal plants, particularly in the development of antioxidant-rich functional foods or pharmaceutical products.

Overall, the antioxidant activity of *A. polymorphum* appears to be influenced by geographic origin, ecological conditions, extraction procedures, and assay methods. The high quantitative parameters reinforce the species' promise as a raw material for developing antioxidant-based nutraceuticals or therapeutic applications.

6. PHARMACOLOGICAL ACTIVITY OF *A. POLYMORPHUM*

Recent studies have highlighted the remarkable biological potential of *A. polymorphum*, particularly in its leaves and roots. Leaf extracts, in particular, have demonstrated notable antibacterial activity, as evidenced by inhibition zone diameters of 16.8 mm against *Pseudomonas aeruginosa* and 15.7 mm against *Staphylococcus aureus* (Rattanasuk et al., 2014) (Table 4). These findings indicate that the leaf extract possesses the ability to inhibit pathogenic microorganisms, although its efficacy remains moderate compared to certain other medicinal plants.

Meanwhile, in-depth studies on the roots have revealed numerous compounds with strong anti-inflammatory

Table 3
Antioxidant activities of *A. polymorphum* leaves.

Antioxidant activities	Nong Bua Lamphu, Thailand (Sakong et al., 2011)	Nakhon Phanom, Thailand (Somdee et al., 2016)
Total antioxidant activity	1865.19 µmol Fe/100 g DW	–
DPPH assay	3.24 mmol TEAC/100 g DW	23.99%
ABTS assay	291.60 mmol TEAC/100 g DW	–
FRAP assay	–	142.23 mmol $FeSO_4$/100 g DW

Note: "–" Not tested.

Table 4
Pharmacological activity properties of *A. polymorphum.*

Part	Effect	Test agent	Efficacy index	References
Leaves	Antibacterial	*Pseudomonas aeruginosa*	Antibacterial ring diameter: 16.8 mm	Rattanasuk et al. (2014)
		Staphylococcus aureus	Antibacterial ring diameter: 15.7 mm	Rattanasuk et al. (2014)
Root	Anti-inflammatory	RAW264.7 cells (LPS-activated)	IC_{50} of isolated compounds: • Compound 1: 4.71 ± 0.08 µM• Compound 4: 7.89 ± 0.42 µM• Compound 6: 7.51 ± 0.70 µM• Compound 7: 9.63 ± 0.40 µM	Huong et al. (2025)

Notes: Compound 1: Polymorphum A; Compound 4: Glycerol 1-O-α-D-glucuronide 3-O-benzoyl ester; Compound 6: (–)-5′-methoxysolariciresinol 9′-O-β-D-glucopyranoside; and Compound 7: (–)-lyoniresinol-3α-O-β-D-glucopyranoside.

potential. A study by Huong et al. (2025) isolated seven phenolic compounds, four of which polymorphum A; glycerol 1-O-α-D-glucuronide 3-O-benzoyl ester; (−)-5′-methoxysolariciresinol 9′-O-β-D-glucopyranoside; and (−)-lyoniresinol-3α-O-β-D-glucopyranoside-exhibited inhibitory effects on nitric oxide (NO) production in RAW264.7 cells, with IC50 values ranging from 4.71 ± 0.08 to 9.63 ± 0.40 μM. Additionally, molecular docking analysis showed that these compounds could bind to inflammation-related target proteins, helping to explain their potential mechanisms of action.

These findings further confirm the biological value of this native plant species and suggest potential for further research into bioactive compounds present in its extracts. A comparison of the two plant parts reveals that while the leaves exhibit mainly moderate antibacterial activity, the roots contain specific phenolic compounds with prominent anti-inflammatory effects. This highlights different avenues for utilizing each part of the plant in the development of natural therapeutic products.

7. TRADITIONAL USES AND APPLICATIONS

The leaves of *A. polymorphum* are not only well-known in traditional cuisine but have also garnered increasing attention in modern scientific research due to their diverse phytochemical composition and potential biological activities (Table 5). Thanks to their rich content of phytochemicals such as flavonoids, polyphenols, tannins, alkaloids, and saponins, this plant species is emerging as a promising candidate for applications in herbal medicine, antioxidant therapies, and biobased materials.

In Vietnamese cuisine, *A. polymorphum* is widely used as a sour-flavored herb that imparts a distinctive taste to many traditional dishes (Delang, 2007). It is commonly added to sour soups cooked with chicken, snakehead fish, shrimp, or eel dishes that are familiar and beloved in Southern and Central Vietnam. In some regions, *A. polymorphum* is also used in hotpot dishes, helping to stimulate the appetite and aid digestion. With its mild aroma, refreshing sourness, and ability to blend harmoniously with other ingredients, this plant has become a familiar component in everyday Vietnamese family meals. Despite its prevalence in local life, *A. polymorphum* is rarely included in major botanical collections and remains underutilized in the West. This represents a significant gap that should be addressed to fully realize its local value through scientific advancement (Mabberley, 2008).

Beyond traditional use, recent studies have expanded its application into areas such as materials science, industry, and pharmaceuticals. Key applications are summarized in Table 5.

Beyond its role as a food source, recent studies have highlighted the wide-ranging industrial potential of *A. polymorphum* leaves in advanced sectors. For instance, leaf extracts have been shown to possess significant metal corrosion-inhibiting properties, achieving over 80% protection for copper at a concentration of 300 ppm, outperforming even the commercial inhibitor imidazoline (Dai et al., 2017). Additionally, when combined with materials such as titanium or under ethanol fuel blend conditions, the extracts enhance the corrosion resistance of steel, opening up new applications in the energy and metal engineering industries (Vu et al., 2017; Vu et al., 2019).

Notably is the use of leaf extracts as bioreducing agents in the synthesis of nanomaterials, especially silver nanoparticles (AgNPs) and Ag/AgCl nanoparticles. These extracts not only

Table 5
Applications of *A. polymorphum* in various fields

Field	Specific application	Details / Featured research	References
Traditional cuisine	Natural souring agent	Used as a substitute for tamarind or lime in traditional dishes	Delang (2007)
Food – Herbal medicine	Edible vegetable / safe medicinal herb	Consumed as a vegetable and traditional medicine with no reported toxicity	Chungsamarnyart & Jansawan (1994)
Metal corrosion inhibition	Anti-corrosion additive	Over 80% efficiency on copper at 300 ppm, outperforming imidazoline; protects steel in SEFB	Dai et al. (2017) Vu et al. (2017)
Nanomaterial synthesis	Reducing and stabilizing agent for AgNPs	Leaf extract-mediated synthesis of AgNPs shows strong antibacterial activity	Doan et al. (2019)
	Synthesis of Ag/AgCl NPs with enhanced bioactivity	Ag/AgCl nanoparticles from *A. polymorphum* show higher antibacterial effects than conventional AgNPs	Ho et al. (2025)
Materials chemistry	Complexing with titanium for corrosion resistance	Improves durability in ethanol fuel blends – potential application in the energy sector	Vu et al. (2019)
Chemical mechanism	Metal-protective compound	Tannins, saponins, alkaloids... interact with metal surfaces via OH groups, N-heterocycles	Awe et al. (2015) Qiang et al. (2017)

facilitate a "green" synthesis process but also yield nanoparticles with outstanding antibacterial activity, demonstrating that compounds from *A. polymorphum* are both environmentally friendly and biologically effective (Doan et al., 2019; Ho et al., 2025). Organic compounds such as tannins, saponins, and alkaloids, which contain hydroxyl groups and nitrogen heterocycles, are believed to play key roles in the adsorption mechanism and the formation of protective films on metal surfaces (Awe et al., 2015; Quiang et al., 2017).

Altogether, current evidence suggests that is a promising candidate of a native plant species with the potential to transition from a traditional resource to a component of high-tech applications. This not only contributes to the preservation of indigenous knowledge but also promotes the development of sustainable, eco-friendly natural products with high economic value.

Figure 2. Sour soup with *A. polymorphum.*

8. POTENTIAL AND CHALLENGES OF *A. POLYMORPHUM*

Although *A. polymorphum* has long been widely used in Vietnamese folk cuisine as a sour-tasting leafy vegetable, scientific studies on this plant remain limited and fragmented. Most current research has focused primarily on the leaves and roots, with a few reports documenting antibacterial, anti-inflammatory, and antioxidant activities. However, other parts of the plant, such as stems, flowers, and fruits, have yet to be systematically investigated or evaluated, representing a major gap that needs to be addressed in future studies.

Notably, several bioactive compounds have recently been isolated and structurally identified from the roots of *A. polymorphum*, including: 8′-O-β-D-glucoside of (1′S,6′R)-8′-hydroxyabscisic acid, (+)-lyoniresinol-3α-O-β-D-glucopyranoside, glycerol 1-O-α-D-glucuronide 3-O-benzoyl ester, trans-4-hydroxy-2-nonenoic acid, (–)-5′-methoxyisolariciresinol 9′-O-β-D-glucopyranoside, and (–)-lyoniresinol-3α-O-β-D-glucopyranoside (Huong et al., 2025). This is the first report of these compounds from the roots of this species. Several of them exhibit promising anti-inflammatory and antimicrobial properties, suggesting new avenues for root-based applications alongside the traditionally used leaves. Nonetheless, the pharmacological and food-related potential of the roots remains underexplored compared to the aerial parts. Thus, expanding research to cover other plant organs such as roots, flowers, and fruits to assess their bioactivities and practical applications is a promising direction for future work.

In the field of food science, current applications of *A. polymorphum* are mostly limited to fresh or minimally processed forms used in traditional dishes (Figure 2). There is a lack of studies focused on the development of value-added products such as powdered seasonings, fermented juice concentrates, or natural food preservatives derived from plant extracts. This gap highlights a promising opportunity to explore the bioactive compounds in *A. polymorphum* leaves for the development of functional foods, health-promoting beverages, or natural additives.

However, several challenges need to be addressed, including the lack of a standardized database on chemical composition and long-term safety; the absence of standardized protocols for cultivation, harvesting, and preliminary processing to ensure the stability of active compounds; and the limited number of in-depth clinical or experimental studies to clearly demonstrate biological effects. Additionally, due to the scarcity of international publications, the potential for commercialization or interdisciplinary research expansion remains limited.

In summary, *A. polymorphum* is a native plant species with significant potential for development in the food and pharmaceutical sectors, but further research efforts are required to translate this potential into practical applications.

9. CONCLUSION

A. polymorphum is a plant species with significant potential in both traditional medicine and modern industries. Owing to its diverse array of bioactive compounds, particularly flavonoids and polyphenols, this species has demonstrated promising antibacterial, anti-inflammatory, and antioxidant effects. Additionally, the culinary use of *A.*

polymorphum in Vietnamese cuisine highlights its cultural and nutritional value. However, current research remains limited in elucidating its mechanisms of action and in establishing standardized medicinal preparations. Therefore, further in-depth studies are essential, particularly focusing on toxicity assessment, in vivo efficacy, and the development of applicable products. Such efforts will contribute to the sustainable conservation and utilization of this valuable native plant in the future.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Research concept and design: L.P.T.Q., L.V.N.H.; Collection and assembly of data: L.P.T.Q.; P.M.H.; Data analysis and interpretation: P.T.Q., T.T.M.A.; Writing the article: L.B.B.P., L.P.T.Q.; Critical revision of the article: L.P.T.Q., L.B.B.P.; Final approval of the article: L.P.T.Q. All authors have read and agreed to the published version of the manuscript.

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