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Diarylheptanoids of *Alpinia* Species (Zingiberaceae): A Review of Phytochemistry and Pharmacological Potential

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Abstract

Introduction: Diarylheptanoids, a distinctive class of secondary metabolites characterized by a 1,7-diphenylheptane backbone, are widely distributed in Alpinia species (Zingiberaceae) and have attracted considerable scientific interest due to their diverse structural variations and promising bioactivities. **Methods:** This review summarizes the current state of knowledge on diarylheptanoids isolated from *Alpinia*, focusing on their phytochemical diversity, structural classifications, and biosynthetic considerations. **Results:** To date, numerous diarylheptanoids, including linear, cyclic, and rearranged derivatives, have been identified, reflecting the remarkable chemodiversity of this genus. Pharmacological studies reveal that these compounds exhibit a wide spectrum of biological activities, notably anti-inflammatory, antioxidant, anticancer, antimicrobial, antidiabetic, and neuroprotective properties, supporting their therapeutic potential. Special emphasis is placed on structure–activity relationships, which provide insights into the molecular features governing their bioactivity. **Conclusion:** The review highlights research gaps, such as limited mechanistic studies and in vivo validations, and suggests future directions for drug discovery and development from *Alpinia*-derived diarylheptanoids. By integrating phytochemical and pharmacological perspectives, this work provides a comprehensive resource for researchers exploring natural product-based therapeutics.

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Introduction

The Zingiberaceae, commonly known as the ginger family, is the largest family within the order Zingiberales, comprising approximately 53 genera and 1,600-1,800 species. These plants are distributed predominantly across the tropical and subtropical regions of Southeast Asia, the Indian subcontinent, Africa, and the Pacific islands, with Southeast Asia recognized as the primary center of diversity. Members of the family are perennial, aromatic, and rhizomatous herbs that often dominate the understorey of tropical forests (Peng *et al*., 2022). Morphologically, plants in Zingiberaceae are easily recognized by their sympodial rhizomes, which function as storage organs and enable vegetative propagation. The pseudo-stems are formed by overlapping leaf sheaths, while leaves are simple, distichous, and generally large, with conspicuous sheathing bases. Inflorescences are usually terminal or radical spikes, racemes, or panicles, often subtended by brightly colored bracts. Flowers are zygomorphic and bisexual, with a complex floral morphology: a three-lobed labellum formed by fusion of sterile stamens (staminodes), fertile stamens reduced to a single functional anther, and an inferior ovary (Benedict *et al*., 2016).

The Zingiberaceae is one of the most culturally and economically important plant families, with many species widely cultivated as spices, condiments, medicinal plants, and ornamentals. Among the most well-known examples, *Zingiber officinale* (ginger) is globally recognized and used both as a spice and as a traditional herbal medicine. *Curcuma longa* (turmeric) is valued not only for its role in culinary practices and as a natural dye, but also for its medicinal applications, largely attributed to its bioactive curcuminoids (Sharifi-Rad *et al*., 2020). *Elettaria cardamomum* (cardamom) is another significant member, regarded as a high-value spice with extensive culinary and pharmaceutical uses (Katwara *et al*., 2023). Meanwhile, *Alpinia galanga* (greater galangal) plays a central role in Southeast Asian cuisine and traditional medicine, reflecting the wide-ranging utility and significance of the Zingiberaceae family (Criley, 2014).

Within Zingiberaceae, the genus *Alpinia* is the largest, comprising about 250-300 species widely distributed in Asia, Oceania, and the Pacific islands. The genus was named in honor of the 16th-century Italian physician and botanist Prospero Alpino (Kress *et al*., 2005). *Alpinia* species are robust perennial herbs, often taller than other members of the family, with heights ranging from 1 to 3 meters or more. Their leaves are lanceolate, distichous, and aromatic, and the inflorescences occur as terminal panicles, racemes, or spikes, often with showy, brightly colored bracts. Flowers are usually white, yellow, or red, with distinct markings on the labellum. The fruits are capsular or berry-like, sometimes aromatic, and can contain multiple seeds with arillate structures (Kress *et al*., 2005; Zhang *et al*., 2012).

The genus *Alpinia* is distinguished not only by its wide geographical distribution and ethnomedicinal importance but also by its remarkable phytochemical diversity. Members of this genus produce a rich array of secondary metabolites, many of which serve as chemical markers and bioactive principles. Among these, diarylheptanoids are particularly characteristic of Alpinia, representing a distinctive class of compounds with a 1,7-diphenylheptane backbone that has been linked to potent anti-inflammatory, antioxidant, and anticancer activities (Uehara *et al*., 1987; Mu *et al*., 2024). This chemical richness underscores the genus as a significant reservoir for drug discovery and functional food development, while also highlighting the evolutionary adaptations of *Alpinia* to its ecological niches.

Therefore, the objective of this study is to provide a comprehensive review of diarylheptanoids isolated from *Alpinia* species, focusing on their phytochemical diversity, structural classifications, and biosynthetic considerations. It aims to highlight the broad pharmacological potential of these compounds.

Methodology

The protocol for performing this study was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) (Moher *et al*., 2009) (a) the first

step was to exclude duplicate articles, (b) titles and abstracts were then read and the inclusion and exclusion criteria were applied and (c) all articles resulting from this stage were read in full, and the inclusion and exclusion criteria were applied again. Following this step, we reached the articles chosen for the present study. This systematic review was conducted through searches using Scopus, PubMed, and Google Scholar. The keywords used were '*Alpinia*', diarylheptanoids', and 'biological activity' articles over the period from the beginning of the database until June 2025. **Figure 1** shows the flow diagram of the identification and selection of articles. In addition, as a second search strategy, we included studies obtained by a manual search of the reference lists of the included studies. In addition, as a second search strategy, we included studies obtained by a manual search of the reference lists of the included studies. Articles on the genus of *Alpinia* that reported traditional uses, phytochemicals, and their biological activities were included. The inclusion of articles considered the following criteria: (1) type of publication - original journal articles, (2) only articles in English (3) articles must present diarylheptanoids compounds, (4) articles must discuss the biological activity of the isolated diarylheptanoids. The following were used as the exclusion criteria: (1) articles that did not show the search terms in the title and in the abstract; (2) review articles (3) full-text articles not found, (4) articles without one of the keywords, and (5) articles that did not isolate diarylheptanoids compounds.

Results and discussion

Medicinal Uses of Genus Alpinia

The traditional medicinal applications of Alpinia species are deeply rooted in various ethnobotanical practices across Asia. **Table 1** shows the medicinal uses of various *Alpinia* species across different geographical regions, illustrating the genus's widespread ethnopharmacological significance. China emerging as the most frequently mentioned country. Several species such as *A. blepharocalyx*, *A. oxyphylla*, *A. katsumadai* and *A. kwangsiensis* are commonly used in Chinese traditional medicine for treating digestive ailments, urinary issues, oxidative stress, and kidney-related conditions (Zhang *et al*., 2018; Zhang *et al*., 2018; An *et al*., 2022; Wu *et al*., 2015). Vietnam also holds a significant place, where species like *A. breviligulata*, *A. globosa*, *A. oxymitra*, and *A. tonkinensis* are traditionally utilized to relieve abdominal pain, nausea, indigestion, arthritis, and inflammation (Nguyen *et al*., 2025; Hanh *et al*., 2014; Dai *et al*., 2020). India demonstrates consistent use of *A. galanga* in Ayurvedic medicine, targeting eczema, bronchitis, gastrointestinal disturbances, and skin infections (Dash *et al*., 2023). Other countries with notable ethnomedicinal practices involving *Alpinia* include Malaysia (*A. pahangensis*) (Phang *et al*., 2013), Indonesia (*A. malaccensis*) (Muchtaridi *et al*., 2014), Japan (*A. intermedia*) (Youn *et al*., 2024) and Taiwan (*A. japonica, A. nantoensis*) (Sheng *et al*., 2024; Kumar *et al*., 2020).

Among the wide range of medicinal claims, the most consistently reported traditional use is for treating digestive-related disorders. Species such as *A. allughas*, *A. globosa*, *A. breviligulata*, *A. mutica*, *A. oxyphylla*, *A. suishaensis*, and *A. vietnamica* are frequently cited for their effectiveness in managing indigestion, stomach discomfort, vomiting, flatulence, and diarrhea (Indrayan *et al*., 2012; Zou *et al*., 2012). Inflammatory conditions and rheumatic pain are also commonly addressed using species like *A. jianganfeng* and *A. nantoensis* (Kumar *et al*., 2020; Zhao *et al*., 2002). Notably, the rhizome stands out as the most widely used plant part, featured in nearly every species documented. Rhizomes are traditionally employed to alleviate a broad spectrum of conditions, including digestive issues (*A. globosa*), respiratory ailments (*A. smithiae*), pain and inflammation (*A. chinensis*), and infections (*A. macroura*), likely due to their rich content of volatile oils and bioactive compounds.

Diarylheptanoids

Subclasses

Diarylheptanoids represent a distinctive group of secondary metabolites characterized by a 1,7-diphenylheptane skeleton, consisting of two aromatic rings connected by a seven-carbon aliphatic chain. This unique structural framework allows for a variety of modifications, including

hydroxylation, methoxylation, glycosylation, and oxidative cyclization, giving rise to diverse subclasses such as linear diarylheptanoids, cyclic diarylheptanoids, and rearranged derivatives (Ganapathy *et al*., 2019).

Linear diarylheptanoids: Linear diarylheptanoids are the most common and widely studied class of this metabolite group. Structurally, they consist of two aromatic rings connected by an open, flexible seven-carbon chain, which may carry various substituents such as hydroxyl, methoxy, carbonyl, or glycosidic groups. This structural flexibility allows for significant chemical diversity and contributes to their broad spectrum of biological activities. Their structural variations, especially substitution patterns on the aromatic rings and the degree of conjugation in the carbon chain, strongly influence their biological properties (Sun *et al*., 2016).

Cyclic diarylheptanoids: Cyclic diarylheptanoids differ from their linear counterparts in that the seven-carbon chain undergoes intramolecular cyclization with one of the aromatic rings, resulting in a more rigid cyclic framework. The type of ring closure can vary, producing meta, para, or ortho connections, as well as biphenyl or diphenyl ether-type bridges. This conformational rigidity often enhances the stability and receptor-binding capacity of the molecules, providing distinct biological advantages (Jahng and Park, 2018).

Rearranged diarylheptanoids: Rearranged diarylheptanoids represent a structurally diverse but less common class, arising from oxidative cleavage, intramolecular rearrangements, or further cyclization of the heptane backbone. These structural modifications result in unusual frameworks that distinguish them from the more classical linear and cyclic types. Their rarity and unique molecular architectures provide valuable opportunities for discovering novel mechanisms of action and expanding the chemical space available for therapeutic exploration (Alberti *et al*., 2018).

Biosynthetic pathway

The biosynthesis of diarylheptanoids is generally explained through the polyketide pathway, with contributions from the shikimate pathway that supplies the phenyl units (**Figure 2**). The process begins with the formation of cinnamoyl-CoA or related phenylpropanoid precursors derived from phenylalanine through the shikimate pathway. These aromatic starter units undergo chain extension via polyketide synthase (PKS) enzymes, where successive condensations with malonyl-CoA build the seven-carbon heptane backbone. The result is the characteristic 1,7-diphenylheptane skeleton, which serves as the central scaffold for further modifications. Enzymatic tailoring steps, such as hydroxylation, methylation, glycosylation, and oxidative coupling, generate the remarkable structural diversity observed among diarylheptanoids (Sun *et al*., 2016). In some cases, intramolecular cyclization occurs, yielding the cyclic diarylheptanoids, whereas oxidative cleavage or rearrangement of the carbon chain produces the structurally rare, rearranged types. The interplay of these biosynthetic steps explains not only the chemical diversity of diarylheptanoids but also their distribution across plant families such as Zingiberaceae, Betulaceae, and Myricaceae. Despite progress in characterizing some PKS enzymes and intermediates, the detailed enzymology and genetic regulation of diarylheptanoid biosynthesis remain poorly understood, representing an important area for future phytochemical and molecular studies (Sudarshan *et al*., 2024).

Diarylheptanoids Isolated from Genus Alpinia

The compilation in **Table 2** demonstrates the remarkable structural diversity of diarylheptanoids isolated from *Alpinia* species, distributed across linear, dimeric, and hybrid subclasses (**Figure 3**). A dominant trend emerges in the prevalence of linear diarylheptanoids, particularly from *A. officinarum* rhizomes, which account for the majority of the reported compounds. This reflects the rhizome's role as a major biosynthetic reservoir for phenolic derivatives, where high concentrations of curcuminoid-related metabolites are expected due to its evolutionary adaptation for storage and defense. Notably, several structurally simple linear diarylheptanoids such as yakuchinone A (**2**), yakuchinone B (**22**), and oxyphyllacinol derivatives

(**23–30**) were consistently reported from *A. oxyphylla* fruits, suggesting that fruit tissues are equally specialized sites for diarylheptanoid accumulation but with a narrower chemotype bias compared to rhizomes.

A second striking observation is the concentration of dimeric diarylheptanoids in *A. katsumadai* seeds, represented by an extensive series of katsumadainol and calyxin derivatives (**49–102**). This chemical clustering may indicate a distinct biosynthetic strategy in seed tissues, possibly linked to the plant's need for chemical defense during seed dispersal and germination. The dimerization of diarylheptanoid units, which is relatively rare in other genera, underscores a unique evolutionary feature of *A. katsumadai*. Importantly, dimeric derivatives often exhibit increased molecular complexity and stereochemical diversity (e.g., calyxin stereoisomers), which may translate into more potent or selective biological activities, as previously suggested for polyphenolic dimers with enhanced antioxidants and enzyme-inhibitory properties. This distribution also implies a chemotaxonomic marker, where the abundance of dimeric diarylheptanoids could be characteristic of *A. katsumadai* seeds.

Hybrid diarylheptanoids, though fewer in number, are particularly intriguing. They have been reported from *A. zerumbet*, *A. officinarum*, *A. katsumadai*, and *A. coriandriodora* (**103–113**), highlighting a relatively recent focus in phytochemical exploration. These hybrids, which often incorporate diarylheptanoid backbones with other structural motifs, may represent evolutionary metabolic "crossroads," where biosynthetic pathways intersect to generate novel scaffolds. The discovery of the coriandralpinin series (**106–113**) from *A. coriandriodora* rhizomes is especially noteworthy, as it points to species-specific specialization and opens possibilities for unique pharmacological applications.

From a critical standpoint, these results reveal two layers of chemodiversity: (i) species-specific specialization (e.g., *A. officinarum* → linear, *A. katsumadai* → dimeric, *A. coriandriodora* → hybrid), and (ii) organ-specific partitioning (rhizomes vs. seeds vs. fruits). Such compartmentalization suggests that diarylheptanoid biosynthesis is tightly regulated by both genetic and ecological factors. However, while the structural catalog is impressive, the data also highlights research gaps. First, most studies remain descriptive, focusing on isolation and structural elucidation, with limited pharmacological evaluation beyond a few well-studied compounds such as yakuchinones. Second, stereochemical assignments, particularly in dimeric forms, are often tentative, and their biosynthetic origin remains speculative. Advanced metabolomics and biosynthetic gene cluster studies could resolve these uncertainties and clarify whether these compounds arise from convergent or divergent pathways.

In summary, the table underscores that *Alpinia* species are prolific sources of diarylheptanoids with distinct subclass distributions shaped by species identity and plant organ specificity. This chemodiversity not only provides a chemotaxonomic framework for differentiating *Alpinia* species but also highlights untapped potential for pharmacological innovation.

Pharmacological Importance of Isolated Diarylheptanoids of Alpinia Species

Diarylheptanoids from *Alpinia* species have been widely studied for their pharmacological activities. Their structural variation, including linear, dimeric, and hybrid types, leads to different interactions with biological targets. Several compounds have shown promising therapeutic effects in both *in vitro* and *in vivo* studies. The range of activities includes antioxidant, anticancer, antitubercular, anti-inflammatory, antidiabetic, and neuroprotective effects (**Table 3**). Hexahydrocurcumin displayed strong antioxidant potential through inhibition of tyrosinase (IC_{50} 6.26 μM), suggesting use in cosmetic or dermatological formulations to control oxidative stress and hyperpigmentation (Chen et al., 2024). This result shows that diarylheptanoid scaffolds can serve as useful sources of natural antioxidant agents.

Mechanistic insights

Diarylheptanoids act through several cellular signaling pathways that regulate inflammation, oxidative stress, apoptosis, and glucose metabolism. The main pathways affected include nuclear factor κB (NF-κB), mitogen-activated protein kinases (MAPK), phosphatidylinositol-3-kinase/Akt (PI3K/Akt), and protein tyrosine phosphatase 1B (PTP1B). Their hydroxyl, methoxy, and carbonyl groups allow strong binding to enzymes and receptors, which explains their anti-inflammatory, anticancer, antidiabetic, and neuroprotective properties (Cho et al., 2024; He et al., 2021).

Across these studies, several molecular nodes appear repeatedly include NF-κB (p65 translocation), p38 and ERK MAPKs, PI3K/Akt, caspase-3, PTP1B, α-glucosidase, and glycogen phosphorylase a. These shared targets link inflammation, apoptosis, and glucose homeostasis, suggesting that *Alpinia* diarylheptanoids operate as network-level modulators rather than single-pathway agents. Identifying and validating these intersections provides a mechanistic bridge between chemical diversity and pharmacological breadth.

Anticancer activity

Compounds such as yakuchinone A, yakuchinone B, and oxyphyllacinol derivatives show notable cytotoxic and antiproliferative effects. (3S)-oxyphyllacinol-3-O-β-D-glucopyranoside displayed micromolar IC_{50} values against melanoma and other human cancer cell lines (Huo et al., 2016). Mechanistic studies show that these molecules trigger apoptosis by activating caspase-3, cleaving PARP, and promoting mitochondrial cytochrome c release. They also suppress PI3K/Akt/mTOR and ERK1/2 MAPK signaling, leading to growth arrest. Structural features such as hydroxylation and glycosylation improve solubility and receptor affinity, which may contribute to potency. These results indicate that *Alpinia* diarylheptanoids can serve as leads for new anticancer agents (Huo et al., 2016; Wei et al., 2016).

Antitubercular activity

Several diarylheptanoids are active against *Mycobacterium tuberculosis*. 5-hydroxy-1,7-diphenylheptan-3-one and (4E)-1,7-diphenyl-4-hepten-3-one showed IC_{50} values from 0.3 to 9 μM mL^{-1} (Honmore et al., 2016). Their activity is thought to involve disruption of mycolic-acid biosynthesis and inhibition of cell-wall lipid metabolism. Because drug-resistant tuberculosis is a major health concern, these results highlight the potential of diarylheptanoids as new antimycobacterial templates (Honmore et al., 2016).

Anti-inflammatory activity

The anti-inflammatory effects of diarylheptanoids are linked to inhibition of NF-κB and MAPK signaling. (4E)-1,7-diphenyl-4-hepten-3-one and 7-(4''-hydroxy-3''-methoxyphenyl)-1-phenylhept-4-en-3-one markedly reduced nitric-oxide and prostaglandin E_2 production in LPS-stimulated RAW 264.7 macrophages by lowering iNOS and COX-2 expression (Cho et al., 2024). These compounds also reduced phosphorylation of p38 MAPK and prevented NF-κB p65 nuclear translocation, which in turn decreased TNF-α and IL-6 levels. Such combined inhibition suggests that diarylheptanoids act as transcriptional modulators of inflammation rather than simple antioxidants (Cho et al., 2024; Zhang et al., 2021; Cheng et al., 2021).

Antidiabetic activity

Antidiabetic activity is one of the most consistent findings for *Alpinia* diarylheptanoids. Katsumadainol and calyxin derivatives inhibit α-glucosidase, glycogen phosphorylase a, and PTP1B (He et al., 2021). By blocking PTP1B, they help maintain insulin-receptor and IRS-1 phosphorylation, which improve insulin sensitivity. Inhibition of α-glucosidase delays carbohydrate digestion and glucose absorption, while suppression of glycogen phosphorylase A reduces hepatic glucose output. Multitarget compounds such as Katsumadainol B4 and B5 act on all three enzymes, offering broad metabolic control suited to the treatment of type 2 diabetes (He et al., 2021).

Neuroprotective activity

Neuroprotective effects have been observed in alpinin A and related hybrid diarylheptanoids. Alpinin A decreased α-synuclein aggregation by

about 66 % and protected neuronal cells from oxidative stress by reducing intracellular ROS and increasing superoxide dismutase (SOD) and glutathione peroxidase (GPx) activity (Fu et al., 2017). These effects prevented mitochondrial damage and limited apoptosis. Diarylheptanoids also reduced microglial activation and NF-κB signaling, lowering neuroinflammation (Fu et al., 2017; Cheng et al., 2021). These combined mechanisms suggest therapeutic relevance for neurodegenerative diseases such as Parkinson's and Alzheimer's.

Structure–activity relationship (SAR) insight

Phenolic hydroxyl and methoxy substitutions on the aromatic rings correlate with stronger inhibition of NF-κB and p38/ERK signaling, whereas glycosylation of the heptanone chain improves aqueous solubility and cell uptake, often translating to enhanced apoptotic or antioxidant effects. Diarylheptanoid–chalcone hybrids show the most consistent dual inhibition of PTP1B and α-glucosidase, implying that a flexible linker between the aryl termini favors multi-target engagement. These structural–activity patterns form a testable hypothesis for future mechanistic and SAR studies aimed at optimizing potency and selectivity.

Integrated mechanistic overview

In general, diarylheptanoids act on several related molecular targets. The main ones include NF-κB, MAPKs, and systems that control oxidative stress, apoptosis, and glucose metabolism. They also influence caspases involved in cell death and metabolic regulators such as PTP1B and glycogen phosphorylase a. The recurrence of these targets across different disease models shows that diarylheptanoids are multitarget compounds capable of restoring cellular balance. Understanding these shared mechanisms provides a basis for rational design of diarylheptanoid derivatives with improved potency and selectivity for future therapeutic development (He et al., 2021; Cho et al., 2024).

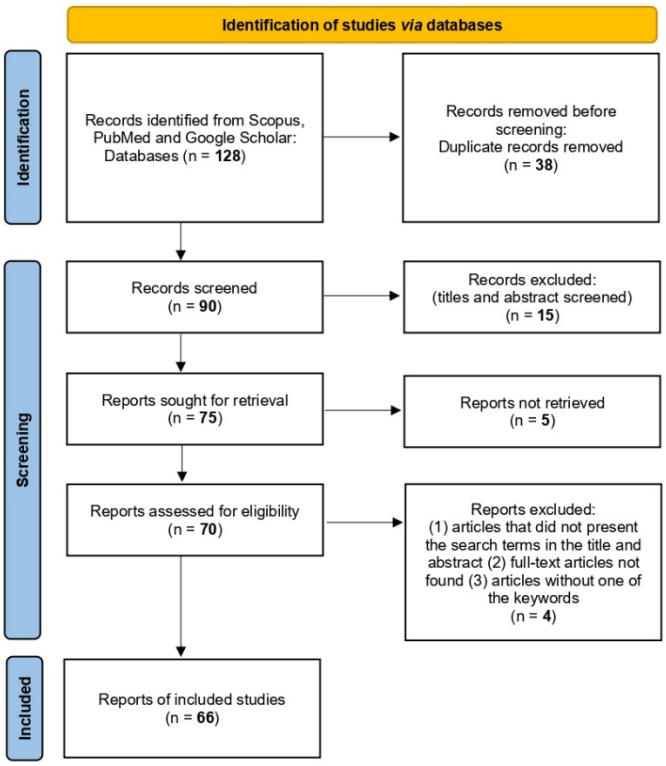


Fig. 1: PRISMA flow diagram of included studies

Table 1. Medicinal uses of several *Alpinia* species

Species	Part	Medicinal Uses
A. allughas	Rhizome	Traditionally used for the treatment of gout, colic, rheumatism, bronchial inflammation, digestive disorders, and respiratory issues, particularly in children (Indrayan *et al*., 2012)
A. blepharocalyx	Seed	Traditionally used in Chinese medicine to treat stomach disorders (Zhang *et al*., 2016)
	Rhizome	Traditionally utilized to treat skin conditions (Hung *et al*., 2018)
A. blongifolia	Rhizome	Used to stimulate digestion and treat abdominal pain caused by cold, stomach aches, cough, respiratory inflammation, arthritis, and muscle pain (Hanh *et al*., 2014)
A. breviligulata	Rhizome	Used in traditional Vietnamese medicine to treat abdominal pain by either drinking water infused with it or applying it topically to the abdomen (Nguyen *et al*., 2025)
A. calcarata	Rhizome	It is commonly used to treat cough, respiratory conditions, bronchitis, asthma, arthritis, and diabetes (Ahmad *et al*., 2025)
A. chinensis	Rhizome	Traditionally used asthma-relieving and analgesic (pain-relieving) properties (Sy *et al*., 1997)
A. conchigera	Rhizome	Traditionally utilized for post-partum care, managing fungal and skin infections (Humaidi *et al*., 2020)
A. elegans	Rhizome	Traditionally used to treat musculoskeletal diseases, haemoptysis, headaches, stomach aches, and to prevent relapse in women (Caasi *et al*., 2023)
A. galanga	Rhizome	Traditionally utilized in Ayurveda medicine for treating eczema, bronchitis, colds, measles, pityriasis versicolor, ear infections, gastritis, ulcers, and cholera (Dash *et al*., 2023)
A. globosa	Rhizome	Used in Vietnam as anti-nausea (Hanh *et al*., 2014)

	Fruit	Used to treat stomach aches, indigestion, dysentery, abdominal pain, cholera, vomiting, and premature ejaculation (Hanh *et al*., 2014)
A. hainanensis	Rhizome	Nutritional and dietary supplement for managing ulcerative colitis (Ji *et al*., 2022)
A. hankei	Rhizome	Traditionally used to treat fever and gastrointestinal discomfort (Zou *et al*., 2012)
A. intermedia	Rhizome	Traditionally used to relieve the symptoms of physical exhaustion, upper respiratory infection and other illnesses (Amagai *et al*., 2017)
A. japonica	Root	Traditionally employed to dispel dampness, reduce swelling, pain relief, and improve blood circulation to clear meridian blockages. It has been used in treating dyspepsia, rheumatoid arthritis and traumatic injuries (Sheng *et al*., 2024)
A. jianganfeng	Rhizome	Used in traditional Chinese medicine to treat rheumatism (Zhao *et al*., 2002)
A. katsumadai	Seed	Markedly reducing oxidative stress and enhancing retinal function, it is also utilized in Chinese medicine to aid digestion, prevent nausea, soothe skin irritation, and treat gastric disorders (An *et al*., 2022)
A. kwangsiensis	Rhizome	In Chinese traditional medicine, it is used to treat abdominal pain, stomach cold-induced vomiting, and traumatic injuries (Wu *et al*., 2015)
A. latilabris	Rhizome	Traditionally used as a folk remedy for treating gastrointestinal diseases (Van *et al*., 2021)
A. macroura	Rhizome	Used to treat wounds, reduce fever, and manage intestinal infections (Huong *et al*., 2017)
A. malaccensis	Fruit	Historically utilized to prevent nausea and vomiting (Muchtaridi *et al*., 2014)
	Leaf	Acts to freshen mouth and prevent vomiting (Muchtaridi *et al*., 2014)
	Rhizome	Used as hair oil and massage oil (Muchtaridi *et al*., 2014)
A. monopleura	Rhizome	Utilize to reduce body aches (Musdalipah *et al*., 2023)
A. mutica	Rhizome	Traditionally utilized by locals to alleviate stomach gas issues (Pulipaka *et al*., 2020)
	Fruit	Utilized to minimize inflammation (Pulipaka *et al*., 2020)
A. nantoensis	Rhizome	Traditionally employed to ease pain, treat rheumatoid arthritis, support bruise healing, reduce toothache discomfort, and soothe stomach issues (Kumar *et al*., 2020)
	Flower	Traditionally used to aid digestion, relieve gastric disorders, and counteract the effects of food or drug poisoning (Kumar *et al*., 2020)
	Fruit	Traditionally used to dispel dampness, reduce vomiting, relieve diarrhea and nausea, and enhance appetite (Kumar *et al*., 2020)
A. nigra	Root	Traditionally mixed with rice whisky and applied to the skin to treat fungal infections such as ringworm and melasma, it is also used in traditional medicine to manage gastric ulcers and jaundice (Kumar *et al*., 2020)
	Rhizome	Used to treat obesity ((Das *et al*., 2024)
A. nutans	Rhizome	Widely used in folk medicine, primarily for treating indigestion, intestinal disorders, and high blood pressure (Joshi *et al*., 2010)
A. officinarum	Rhizome	Involved in regulating nociception, respiratory defense mechanisms and gastrointestinal protection, it is also used for treating arthritis and microbial infections (Bhattacharya, 2014)
A. oxymitra	Flower	Used to treat arthritis (Hanh *et al*., 2014)
	Rhizome	Traditionally used as a carminative and a remedy for diarrhoea (Jitsaeng *et al*., 2009)
A. oxyphylla	Rhizome	Helps enhance the effectiveness of nootkatone in preventing acute kidney injury (Deng *et al*., 2025)
	Fruit	Traditionally used to treat kidney deficiency, urinary issues, gonorrhea, digestive disorders, and excessive saliva production, it is also used for healing ulcers and managing dementia (Zhang *et al*., 2018)
A. pahangensis	Rhizome	Used to treat flatulence (Phang *et al*., 2013)

A. pinnanensis	Rhizome	Used to treat coughs, fever, abdominal pain, flatulence, and stomach aches (Huong *et al*., 2017)
A. pricei	Rhizome	Possesses the ability to reduce and prevent hypercholesterolemia and is also used to alleviate abdominal discomfort, stimulate stomach secretions, and promote peristalsis (Kumar *et al*., 2020)
A. purpurata	Rhizome	Used to treat headaches, rheumatism, sore throat, and kidney infections (Chan & Wong, 2025)
A. rafflesiana	Rhizome	Utilized to treat nausea, vomiting, ulcers, and bacterial infections (Akram *et al*., 2021)
A. rugosa	Rhizome	Used to treat stomach ailments and nausea (Zou *et al*., 2012)
A. smithiae	Rhizome	Used in folk medicine for treating respiratory infections (Zou *et al*., 2012)
A. suishaensis	Rhizome	Used to help with digestive issues, improve circulation, and ailments related to wind or cold in traditional herbal formulation (Zhao *et al*., 2002)
A. tonkinensis	Rhizome	Used to treat stomach aches, indigestion, and arthritis (Hanh *et al*., 2014)
A. tonrokuensis	Rhizome	Used to treat fevers, muscle spasms, intestinal gas, and inflammation (Zou *et al*., 2012)
A. velutina	Rhizome	Used to treat digestive issues, respiratory conditions, and infections Zou *et al*., 2012)
A. villosum	Rhizome	Protective substances for the digestive system (Zhang *et al*., 2018)
A. vietnamica	Rhizome	The essential oil used for traditional, food, and medicinal purposes (Zou *et al*., 2012)
A. vitellina	Rhizome	Traditionally used to relieve stomach pain and indigestion (Zou *et al*., 2012)
A. zerumbet	Rhizome	Traditionally used in medicine to treat colds, flu, fever, flatulence, stomach issues, indigestion, cardiovascular diseases, high blood pressure, and inflammation, it also serves as an antispasmodic agent and plays a role in preventing atherosclerosis (Xiao *et al*., 2020)

Table 2. Diarylheptanoids isolated from *Alpinia* species

Compounds	Species	Part	References
LINEAR-DIARYLHEPTANOID			
Hexahydrocurcumin **(1)**	*A. officinarum*	Leaf	Zhang *et al*., 2015
Yakuchinone A **(2)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
	A. officinarum	Leaf	Zhang *et al*., 2015
5-Hydroxy-1,7-bis(4-hydroxyphenyl)heptan-3-one **(3)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
5-Hydroxy-1,7-diphenylheptan-3-one **(4)**	*A. officinarum*	Rhizome	Lee *et al*., 2018
7-(4''-Hydroxy-3''-methoxyphenyl)-1-phenylheptan-3-one **(5)**	*A. officinarum*	Rhizome	Honmore *et al*., 2016
7-(4''-Acetoxy-3''-methoxy phenyl)-1-phenylheptan-3-one **(6)**	*A. officinarum*	Rhizome	Honmore *et al*., 2016
5'-Hydroxyyakuchinone A **(7)**	*A. oxyphylla*	Fruit	Park *et al*., 2022
(5*S*)-Ethoxyl-7-(4-hydroxy-3-methoxyphenyl)-1-phenyl-3-heptanone **(8)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
(4*E*)-1,7-Diphenyl-4-hepten-3-one **(9)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
(4*E*)-7-(4-Hidroxyphenyl)-1-phenyl-4-hepten-3-one **(10)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
7-(4''-Hydroxy-3''-methoxyphenyl)-1-phenylhept-4-en-3-one **(11)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
5-Hydroxy-7-(4-hydroxyphenyl)-1-phenyl-3-heptanone **(12)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
5-Hydroxy-7-(4'-hydroxy-3'-methoxy-phenyl)-1-phenyl-3-heptanone **(13)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
5-Methoxy-1,7-diphenyl-3-heptanone **(14)**	*A. officinarum*	Rhizome	Cho *et al*., 2024

5-Methoxy-7-(4-hydroxy-3-methoxy-phenyl)-1-phenyl-3-heptanone **(15)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
(5*R*)-1,7-Diphenyl-5-hydroxy-heptan-3-one **(16)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
(5*R*)-5-Hydroxy-7-(4-hydroxy-3-methoxyphenyl)-1-phenyl-3-heptanone **(17)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
(5*R*)-5-ethoxy-7-(4-hydroxy-3-methoxyphenyl)-1-phenylheptan-3-one **(18)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
(5*S*)-5-Hydroxy-7-(3,4-dihydroxy-phenyl)-1-phenyl-3-heptanone **(19)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
(5*R)*-5-Hydroxy-7-(4-hydroxy-phenyl)-1-phenyl-3-heptanone **(20)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
(5*R*)-5-Hydroxy-1,7-diphenyl-6*E*-hepten-3-one **(21)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
Yakuchinone B **(22)**	*A. oxyphylla*	Rhizome	Li *et al*., 2015
(3*S*)-Oxyphyllacinol **(23)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-7-Hydroxyphyllacinol **(24)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-2''-Hydroxyphyllacinol **(25)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-3''-Hydroxyphyllacinol **(26)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-4''-Hydroxyphyllacinol **(27)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-Oxyphyllacinol-4'-*O*-β-D-glucopyranosinade **(28)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-2''-Hydroxyoxyphyllacinol-2''-*O*-β-D-glucopyranosinade **(29)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
(3*S*)-Oxyphyllacinol-3-*O*-β-D-glucopyranosinade **(30)**	*A. oxyphylla*	Fruit	Huo *et al*., 2022
1,7-Diphenylheptane-3,5-dione **(31)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
1-(3',4'-Dihydroxyphenyl)-7-phenylheptane-3,5-dione **(32)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
1,7-Bis(4-hydroxy-3-methoxy-phenyl)heptane-3,5-dione **(33)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
(1*E*,6*E*)-1,7-Bis(4-hydroxyphenyl)hepta-1,6-diene-3,5-dione **(34)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
(1*E*,6*E*)-1-(4'-hydroxy-3'-methoxy-phenyl)-7-(4''-hydroxyphenyl)-hepta-1,6-diene-3,5-dione **(35)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
(1*E*,6*E*)-1,7-Bis(4-hydroxy-3-methoxy-phenyl)hepta-1,6-diene-3,5-dione **(36)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
(*E*)-1,7-Bis(4-hydroxy-3-methoxy-phenyl)hept-1-ene-3,5-6-dione **(37)**	*A. officinarum*	Rhizome	Yoo *et al*., 2021
1,2-Dihydro-bis(de-*O*-methyl)curcumin **(38)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
(4*E*,6*E*)-5-Hydroxy-1-(4-hydroxy-3-methoxyphenyl)-7-phenylhepta-4,6-dien-3-one **(39)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
(4*Z*,6*E*)-5-Hydroxy-1,7-diphenylhepta-4,6-dien-3-one **(40)**	*A. officinarum*	Rhizome	Tang *et al*., 2015
1,7-Diphenyl-5-heptene-3-one **(41)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
(-)-(*R*)-4''-Hydroxy-yashabushiketol **(42)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
(3*S*,5*S*)-Alpinikatin **(43)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
Oxyphyllacinol **(44)**	*A. oxyphylla*	Rhizome	Li *et al*., 2015
DIMERIC-DIARYLHEPTANOIDS			
Alpinioficinoid A **(45)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
Alpinioficinoid B **(46)**	*A. officinarum*	Rhizome	Cho *et al*., 2024
Alpinidinoid B **(47)**	*A. officinarum*	Rhizome	Liu *et al*., 2020
Katsumadainol B_1 **(48)**	*A. katsumadai*	Seed	He *et al*., 2021

Katsumadainol B_2 **(49)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_3 **(50)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_4 **(51)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_5 **(52)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_6 **(53)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_7 **(54)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_8 **(55)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_9 **(56)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol B_{10} **(57)**	*A. katsumadai*	Seed	He *et al*., 2021
(±)-Alpinidinoid A **(58)**	*A. officinarum*	Rhizome	Liu *et al*., 2020
Alpinisin A **(59)**	*A. officinarum*	Rhizome	Wei *et al*., 2016
Alpinidinoid C **(60)**	*A. officinarum*	Rhizome	Liu *et al*., 2020
(±)-Alpininoid A **(61)**	*A. officinarum*	Rhizome	Liu *et al*., 2018
(±)-Alpininoid B **(62)**	*A. officinarum*	Rhizome	Liu *et al*., 2018
(±)-Alpininoid C **(63)**	*A. officinarum*	Rhizome	Liu *et al*., 2018
(±)-Alpininoid D **(64)**	*A. officinarum*	Rhizome	Liu *et al*., 2018
(±)-Alpininoid E **(65)**	*A. officinarum*	Rhizome	Liu *et al*., 2018
Calyxin T **(66)**	*A. katsumadai*	Seed	Wang *et al*., 2017
ent-Calyxin T **(67)**	*A. katsumadai*	Seed	Wang *et al*., 2017
Calyxin U **(68)**	*A. katsumadai*	Seed	Wang *et al*., 2017
ent-Calyxin U **(69)**	*A. katsumadai*	Seed	Wang *et al*., 2017
Calyxin V **(70)**	*A. katsumadai*	Seed	Wang *et al*., 2017
Calyxin W **(71)**	*A. katsumadai*	Seed	Wang *et al*., 2017
Katsumain H **(72)**	*A. katsumadai*	Seed	Nam & Lee, 2017
Katsumadainol A_1 **(73)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_2 **(74)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_3 **(75)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_4 **(76)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_5 **(77)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_6 **(78)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_7 **(79)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_8 **(80)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_9 **(81)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{10} **(82)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{11} **(83)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{12} **(84)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{13} **(85)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{14} **(86)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{15} **(87)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumadainol A_{16} **(88)**	*A. katsumadai*	Seed	He *et al*., 2021
Calyxin F **(89)**	*A. katsumadai*	Seed	He *et al*., 2021
epi-Calyxin F **(90)**	*A. katsumadai*	Seed	He *et al*., 2021
(3*S*,5*S*,6*S*,7*R*)-6-Hydrocalyxin F **(91)**	*A. katsumadai*	Seed	He *et al*., 2021
(3*S*,5*S*,6*S*,7*S*)-6-Hydrocalyxin F **(92)**	*A. katsumadai*	Seed	He *et al*., 2021

Calyxin L **(93)**	*A. katsumadai*	Seed	He *et al*., 2021
epi-Calyxin B **(94)**	*A. katsumadai*	Seed	He *et al*., 2021
Calyxin B **(95)**	*A. katsumadai*	Seed	He *et al*., 2021
Alpinnanin A **(96)**	*A. katsumadai*	Seed	He *et al*., 2021
Alpinnanin B **(97)**	*A. katsumadai*	Seed	He *et al*., 2021
Calyxin H **(98)**	*A. katsumadai*	Seed	He *et al*., 2021
epi-Calyxin H **(99)**	*A. katsumadai*	Seed	He *et al*., 2021
Katsumain C **(100)**	*A. katsumadai*	Seed	He *et al*., 2021
7-*epi*-Katsumain C **(101)**	*A. katsumadai*	Seed	He *et al*., 2021
HYBRID-DIARYLHEPTANOIDS			
(3*S*,7*S*)-5,6-Dehydro-4″-de-*O*-methylcentrolobine **(102)**	*A. zerumbet*	Rhizome	Zhang *et al*., 2021
Alpinin E **(103)**	*A. officinarum*	Rhizome	Liu *et al*., 2016
(3*R*,7*S*)-5,6-Dehydro-4''-de-*O*-methylcentrolobine **(104)**	*A. katsumadai*	Seed	An *et al*., 2023
Alpinin A **(105)**	*A. officinarum*	Rhizome	Fu *et al*., 2017
Coriandralpinin A **(106)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin B **(107)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin C **(108)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin D **(109)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin E **(110)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin F **(111)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin G **(112)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021
Coriandralpinin H **(113)**	*A. coriandriodora*	Rhizome	Cheng *et al*., 2021

Table 3. Biological activities of selected diarylheptanoids

Compounds	**Bioactivities**
Hexahydrocurcumin **(1)**	**Antioxidant:** Potent tyrosinase inhibition (IC_{50} 6.26 μM) (Chen *et al*., 2024)
Yakuchinone A **(2)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 31.73 μM), (B16F10) (IC_{50} 21.71 μM), and Human melanoma (A375P) (IC_{50} 14.75 μM) (Huo *et al*., 2016)
5-hydroxy-1,7-diphenylheptan-3-one **(4)**	**Antiproliferative:** Human monocytic (THP-1) (IC_{50} <300 μM) (Honmore *et al*., 2016)
	Antitubercular: *Mycobacterium tuberculosis* strains (IC_{50} 0.27 to 8.93 μM/mL) (Honmore *et al*., 2016)
7-(4''-Hydroxy-3''-methoxyphenyl)-1-phenylheptan-3-one **(5)**	**Antitubercular:** *Mycobacterium tuberculosis* strains (IC_{50} 4.2 μg/mL) and *M. bovis* (IC_{50} 4.7 μg/mL) (Honmore *et al*., 2016)
	Antiproliferative: Human lung adenocarcinoma (A549) cancer cells (IC_{50} <300 μM) (Honmore *et al*., 2016)
7-(4''-Acetoxy-3''-methoxy phenyl)-1-phenylheptan-3-one **(6)**	**Antitubercular**: *Mycobacterium tuberculosis* strains (IC_{50} 4.74 to 39.71 μg/mL) (Honmore *et al*., 2016)
(4*E*)-1,7-Diphenyl-4-hepten-3-one **(9)**	**Antitubercular:** *Mycobacterium tuberculosis* strains (IC_{50} 0.34 to 47.69 μM) (Honmore *et al*., 2016)
	Anti-inflammatory: NO inhibition assay in LPS-stimulated RAW264.7 cells (IC_{50} 6.6 μM) (Cho *et al*., 2024)
7-(4''-Hydroxy-3''-methoxyphenyl)-	**Anti-inflammatory:** NO inhibition assay in LPS-stimulated RAW264.7 cells (IC_{50}

1-phenylhept-4-en-3-one **(11)**	5.0 μM) (Cho *et al*., 2024)
5-Hydroxy-7-(4-hydroxyphenyl)-1-phenyl-3-heptanone **(12)**	**Antiproliferative:** Human pancreatic (Panc-1) (IC_{50} <300 μM) (Honmore *et al*., 2016)
5-Hydroxy-7-(4-hydroxy-3-methoxy-phenyl)-1-phenyl-3-heptanone **(13)**	**Antiproliferative:** Inhibit activity against human pancreatic cancer cell line (Panc-1) (IC_{50} <300 μM) (Honmore *et al*., 2016)
	Antitubercular: *Mycobacterium tuberculosis* strains (IC_{50} 0.13 to 22.91 μM) (Honmore *et al*., 2016)
(3*S*)-Oxyphyllacinol **(23)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 56.03 μM), (B16F10) (IC_{50} 59.31 μM); human melanoma (A375P) (IC_{50} 45.52 μM) (Huo *et al*., 2016)
(3*S*)-2''-Hydroxyphyllacinol **(25)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 29.28 μM), (B16F10) (IC_{50} 33.58 μM); human melanoma (A375P) (IC_{50} 38.79 μM) (Huo *et al*., 2016)
(3*S*)-3''-Hydroxyphyllacinol **(26)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 33.73 μM), (B16F10) (IC_{50} 46.55 μM); human melanoma (A375P) (IC_{50} 47.91 μM) (Huo *et al*., 2016)
(3*S*)-4''-Hydroxyphyllacinol **(27)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 17.84 μM), (B16F10) (IC_{50} 33.38 μM); human melanoma (A375P) (IC_{50} 29.58 μM) (Huo *et al*., 2016)
(3*S*)-Oxyphyllacinol-4'-*O*-β-D-glucopyranosinade **(28)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 22.97 μM), (B16F10) (IC_{50} 46.13 μM); human melanoma (A375P) (IC_{50} 45.62 μM) (Huo *et al*., 2016)
(3*S*)-2''-Hydroxyoxyphyllacinol-2''-*O*-β-D-glucopyranosinade **(29)**	**Cytotoxicity:** Moderate activity against murine melanoma (B16F1) (IC_{50} 38.37 μM) and (B16F10) (IC_{50} 64.58 μM) (Huo *et al*., 2016)
(3*S*)-Oxyphyllacinol-3-*O*-β-D-glucopyranosinade **(30)**	**Cytotoxicity:** Strong activity against murine melanoma (B16F1) (IC_{50} 6.09 μM), (B16F10) (IC_{50} 9.74 μM), and Human melanoma (A375P) (IC_{50} 8.36 μM) (Huo *et al*., 2016)
Alpinioficinoid A **(45)**	**Anti-inflammatory:** NO inhibtion assay in LPS-stimulated RAW264.7 cells (IC_{50} 14.7 μM) (Cho *et al*., 2024)
Katsumadainol B_1 **(48)**	**Antidiabetic:** Protein tyrosine phosphate 1B (PTP1B) (IC_{50} 136.1 μmol/L) (He *et al*., 2021)
Katsumadainol B_3 **(50)**	**Antidiabetic:** α-Glucosidase (IC_{50} 51.0 μmol/L) (He *et al*., 2021)
Katsumadainol B_4 **(51)**	**Antidiabetic:** Glycogen phosphorylase a (GPa) (IC_{50} 13.2 μmol/L); α-Glucosidase (IC_{50} 7.1 μmol/L); Protein tyrosine phosphate 1B (PTP1B) (IC_{50} 42.8 μmol/L) (He *et al*., 2021)
Katsumadainol B_5 **(52)**	**Antidiabetic:** Glycogen phosphorylase a (GPa) (IC_{50} 11.3 μmol/L); α-Glucosidase (IC_{50} 12.4 μmol/L); Protein tyrosine phosphate 1B (PTP1B) (IC_{50} 40.7 μmol/L) (He *et al*., 2021)
Katsumadainol B_6 **(53)**	**Antidiabetic:** α-Glucosidase (IC_{50} 17.5 μmol/L); Protein tyrosine phosphate 1B (PTP1B) (IC_{50} 52.8 μmol/L) (He *et al*., 2021)
Katsumadainol B_7 **(54)**	**Antidiabetic:** α-Glucosidase (IC_{50} 32.8 μmol/L) (He *et al*., 2021)
Katsumadainol B_8 **(55)**	**Antidiabetic:** α-Glucosidase (IC_{50} 20.2 μmol/L); Protein tyrosine phosphate 1B (PTP1B) (IC_{50} 172.7 μmol/L) (He *et al*., 2021)
Katsumadainol B_9 **(56)**	**Antidiabetic:** Glycogen phosphorylase a (GPa) (IC_{50} 41.5 μmol/L) (He et al., 2021); α-Glucosidase (IC_{50} 23.7 μmol/L) (He *et al*., 2021)

Katsumadainol B_{10} **(57)**	**Antidiabetic:** Glycogen phosphorylase a (GPa) (IC_{50} 41.8 μmol/L); α-Glucosidase (IC_{50} 28.0 μmol/L) (He *et al*., 2021)
Alpinisin A **(59)**	**Cytotoxicity:** Human gastric carcinoma (SGC-7901) ((IC_{50} 11 μM); Human breast cancer (MCF-7) ((IC_{50} 15 μM); Epidermoid cervical carcinoma (caSki) (IC_{50} 15 μM) (Wei *et al*., 2016)
Katsumadainol A_1 **(73)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 22.0 μM) (He *et al*., 2021)
Katsumadainol A_2 **(74)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 62.9 μM) (He *et al*., 2021)
Katsumadainol A_3 **(75)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 38.4 μM) (He *et al*., 2021)
Katsumadainol A_5 **(77)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 72.3 μM) (He *et al*., 2021)
Katsumadainol A_6 **(78)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 94.0 μM) (He *et al*., 2021)
Katsumadainol A_7 **(79)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 71.5 μM) (He *et al*., 2021)
Katsumadainol A_{11} **(83)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 90.9 μM) (He *et al*., 2021)
Katsumadainol A_{12} **(84)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 47.7 μM) (He *et al*., 2021)
Katsumadainol A_{13} **(85)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 74.2 μM) (He *et al*., 2021)
Katsumadainol A_{14} **(86)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 55.0 μM) (He *et al*., 2021)
(3*S*,5*S*,6*S*,7*S*)-6-Hydrocalyxin F **(92)**	**Antidiabetic:** Moderate PTP1B inhibitory effects (IC_{50} 100.3 μM) (He *et al*., 2021)
Calyxin L **(93)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 96.7 μM) (He *et al*., 2021)
epi-Calyxin B **(94)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 27.3 μM) (He *et al*., 2021)
Calyxin B **(95)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 22.5 μM) (He *et al*., 2021)
Alpinnanin A **(96)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 35.9 μM) ((He *et al*., 2021)
Alpinnanin B **(97)**	**Antidiabetic:** Strong PTP1B inhibitory effects (IC_{50} 32.6 μM) (He *et al*., 2021)
Calyxin H **(98)**	**Antidiabetic:** Moderate PTP1B inhibitory effects (IC_{50} 186.8 μM) (He *et al*., 2021)
(3*S*,7*S*)-5,6-Dehydro-4″-de-*O*-methylcentrolobine **(102)**	**Anti-inflammatory:** Inhibited NO release in RAW 264.7 cells (IC_{50} 8.3 μM) (Zhang *et al*., 2021)
Alpinin A **(105)**	**Neuroprotective:** Reduced α-syn aggregation by 66% (Fu *et al*., 2017)
Coriandralpinin C **(108)**	**Anti-inflammatory:** NO inhibition assay in LPS-stimulated RAW264.7 cells (IC_{50} 36.9 μM) (Cheng *et al*., 2021)
	Antioxidant: ROS inhibition (IC_{50} 18 μM) (Cheng *et al*., 2021)
Coriandralpinin G **(112)**	**Antioxidant:** ROS inhibition (IC_{50} 12 μM) (Cheng *et al*., 2021)

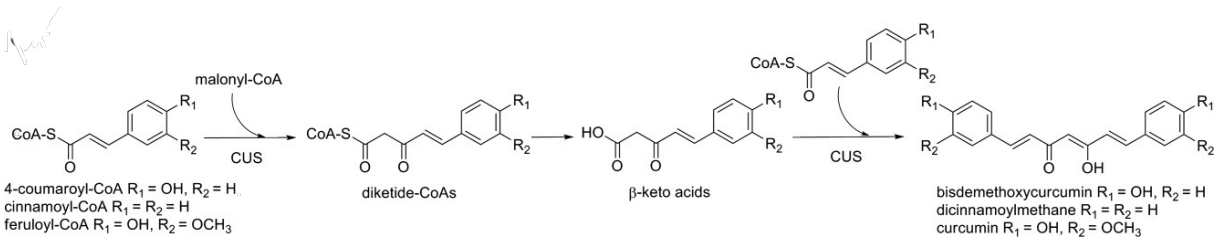
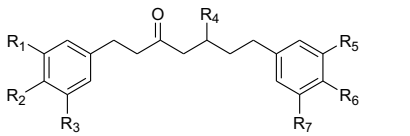
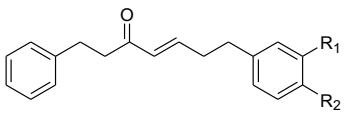


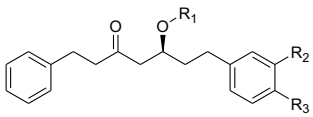
Fig. 2. Biosynthesis pathway of diarylheptanoids



(1) $R_1 = R_5 = OCH_3$; $R_2 = R_4 = R_6 = OH$; $R_3 = R_7 = H$
(2) $R_1 = OCH_3$; $R_2 = OH$; $R_3 = R_4 = R_5 = R_6 = R_7 = H$
(3) $R_1 = R_3 = R_5 = R_7 = H$; $R_2 = R_4 = R_6 = OH$
(4) $R_1 = R_2 = R_3 = R_5 = R_5 = R_6 = R_7 = H$; $R_4 = OH$
(5) $R_1 = R_2 = R_3 = R_4 = R_5 = H$; $R_6 = OH$; $R_7 = OCH_3$

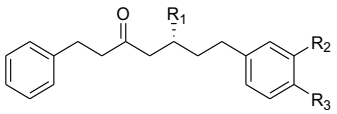


(9) $R_1 = R_2 = H$
(10) $R_1 = H$, $R_2 = OH$
(11) $R_1 = OCH_3$, $R_2 = OH$

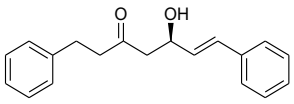


(12) $R_1 = R_2 = R_3 = H$
(13) $R_1 = H$; $R_2 = OCH_3$; $R_3 = OH$
(14) $R_1 = CH_3$; $R_2 = R_3 = H$
(15) $R_1 = CH_3$; $R_2 = OCH_3$; $R_3 = OH$

(6) $R_1 = R_2 = R_3 = R_4 = R_5 = H$; $R_6 = OAc$; $R_7 = OCH_3$
(7) $R_1 = OCH_3$; $R_2 = R_3 = OH$; $R_4 = R_5 = R_6 = R_7 = H$
(8) $R_1 = R_2 = R_3 = R_4 = R_5 = H$; $R_4 = R_7 = OCH_3$; $R_6 = OH$



(16) $R_1 = OH$; $R_2 = R_3 = H$
(17) $R_1 = R_3 = OH$; $R_2 = OCH_3$
(18) $R_1 = R_2 = OCH_3$; $R_3 = OH$
(19) $R_1 = R_2 = R_3 = OH$
(20) $R_1 = R_3 = OH$; $R_2 = H$



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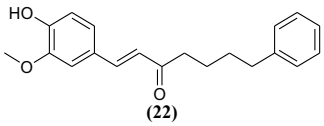

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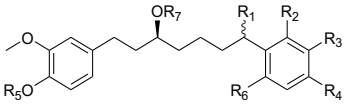
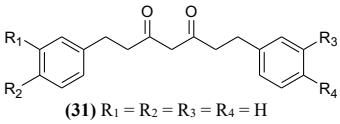
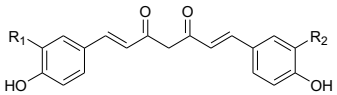


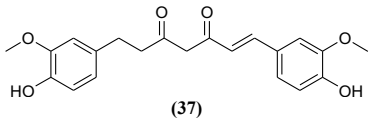
(23) $R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = R_7 = H$
(24) $R_1 = OH$; $R_2 = R_3 = R_4 = R_5 = R_6 = R_7 = H$
(25) $R_1 = R_3 = R_4 = R_5 = R_6 = R_7 = H$; $R_2 = OH$
(26) $R_1 = R_2 = R_4 = R_5 = R_6 = R_7 = H$; $R_3 = OH$
(27) $R_1 = R_2 = R_3 = R_5 = R_6 = R_7 = H$; $R_4 = OH$
(28) $R_1 = R_2 = R_3 = R_4 = R_6 = R_7 = H$; $R_5 = \beta$-Glc
(29) $R_1 = R_2 = R_3 = R_4 = R_5 = R_7 = H$; $R_6 = O$-β-Glc
(30) $R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = H$; $R_7 = \beta$-Glc



(31) $R_1 = R_2 = R_3 = R_4 = H$
(32) $R_1 = R_2 = OH$; $R_3 = R_4 = H$
(33) $R_1 = R_3 = OCH_3$; $R_2 = R_4 = OH$



(34) $R_1 = R_2 = H$
(35) $R_1 = OCH_3$; $R_2 = H$
(36) $R_1 = R_2 = OCH_3$



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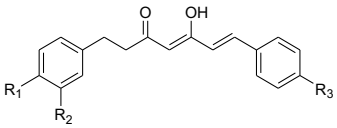
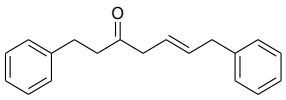


(38) $R_1 = R_3 = OH$; $R_2 = H$
(39) $R_1 = OH$; $R_2 = OCH_3$; $R_3 = H$
(40) $R_1 = R_2 = R_3 = H$



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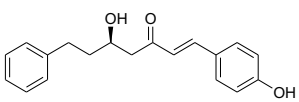

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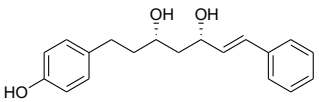

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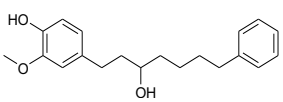

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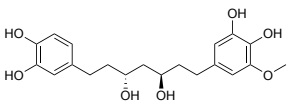

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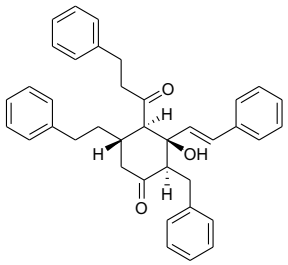

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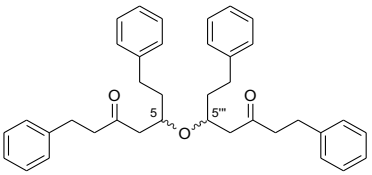
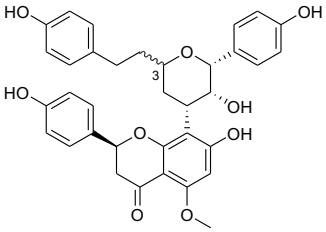
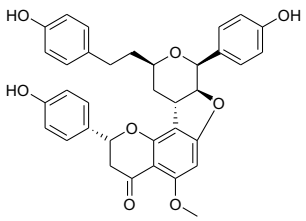


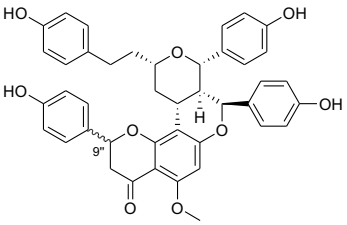
(47) 5*R*; 5‴*S*
(48) 5*S*; 5‴*S*



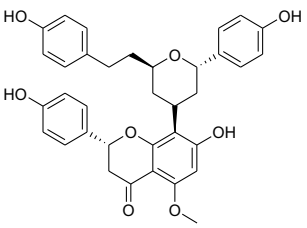
(49) 3 = α-H
(50) 3 = β-H



(51)



(52) 9″ = α-H
(53) 9″ = β-H



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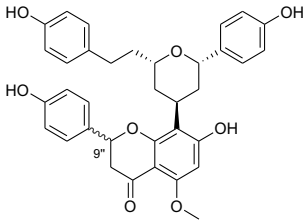
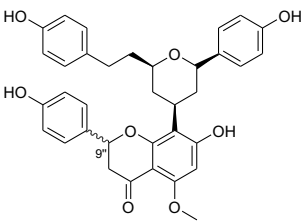
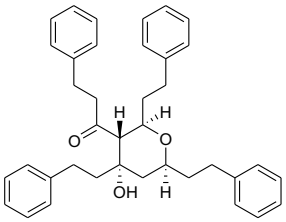


(55) 9″ = α-H
(56) 9″ = β-H



(57) 9″ = α-H
(58) 9″ = β-H



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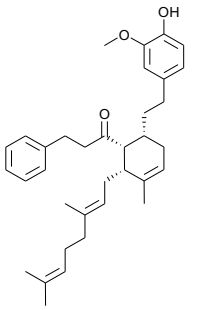

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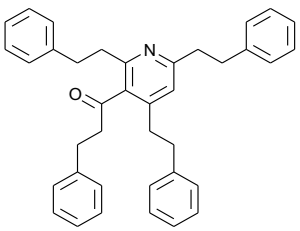

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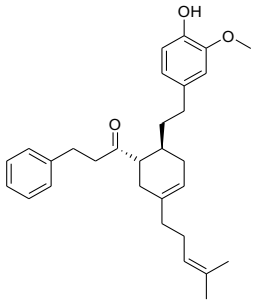

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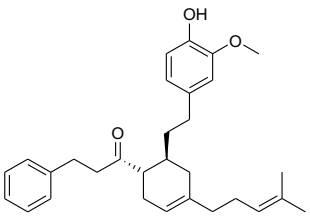

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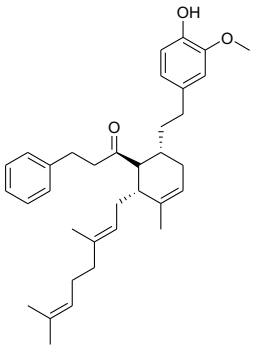
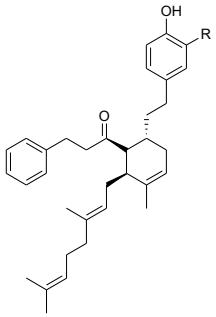
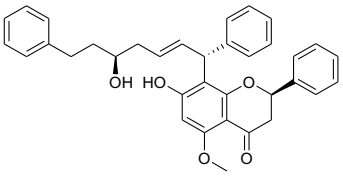


(64)



(65) R = OCH_3
(66) R = H



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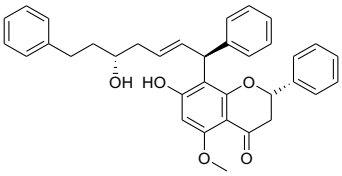
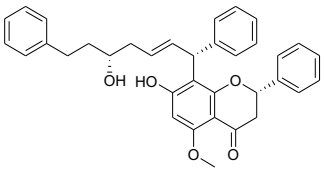


(68)



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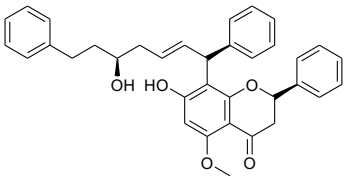

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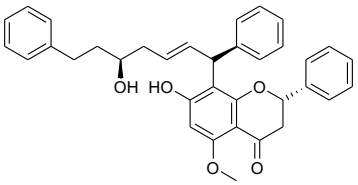

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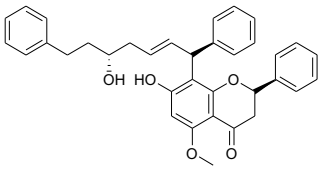
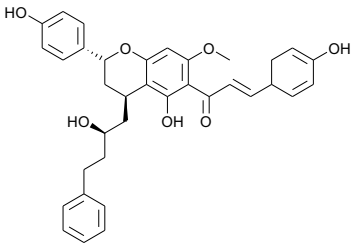


(72)



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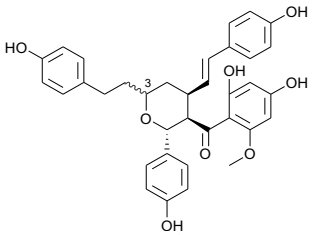
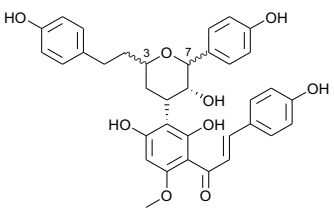


(74) 3 = β-H
(75) 3 = α-H



(76) 3 = β-H; 7 = β-H
(77) 3 = α-H; 7 = β-H

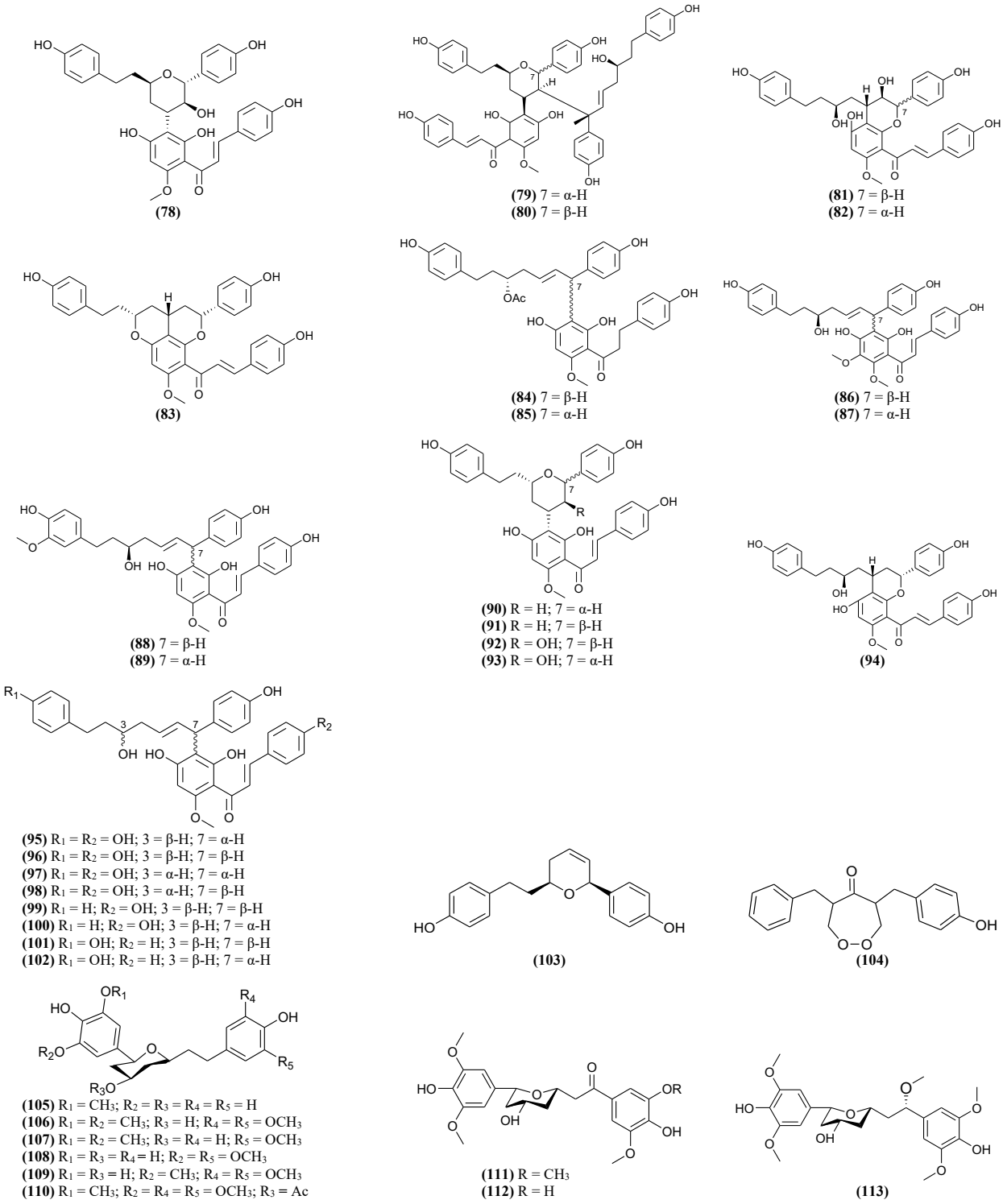


Fig. 3. Chemical structures of isolated diarylheptanoids

Conclusion

Diarylheptanoids from *Alpinia* species represent a structurally diverse and pharmacologically rich class of natural products with significant therapeutic promise. Their distribution across linear, dimeric, and hybrid subclasses reflects both species-specific and organ-specific biosynthetic specialization. Extensive *in vitro* studies highlight potent anti-inflammatory, antioxidant, anticancer, antimicrobial, antidiabetic, and neuroprotective activities, often linked to distinct structural motifs. However, current evidence remains largely preclinical, with limited mechanistic insight, stereochemical resolution, and *in vivo* validation. Future research should focus on systematic structure–activity relationship mapping, detailed mechanistic elucidation, and identification of key molecular targets such as NF-κB, MAPKs, and PTP1B. Integrating metabolomics, biosynthetic pathway analysis, molecular docking, and pharmacokinetic studies will be essential to translate these findings into clinically relevant outcomes. Harnessing the chemodiversity of *Alpinia* diarylheptanoids offers a promising route toward the discovery of novel multi-target drug leads and functional therapeutics.

Authors contributions

Conceptualization, methodology, investigation, and writing original draft preparation, A.R.; Review and editing, supervision, W.M.N.H.W.S., A.S.S. and S.A.A. All authors have read and agreed to the published version of the manuscript.

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Ethical approval statement (if applicable)

Not applicable.

Informed consent statement (If applicable)

Not applicable.

Conflict of interest

None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author declare using AI (ChatGPT) in order to improve readability and language. After using this tool/service, the author review and edit the content as needed and take full responsibility for the content of the publication.

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