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# *Angelica Sinensis* and *Chinese Arborvitae*: A Review on its Phytochemical & Pharmacological Importance

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**ABSTRACT**

*Angelica sinensis* and *Chinese arborvitae* has had a long history of use in traditional Chinese medicinal herbs and have been used to heal various ailments such as heartburn, overnight urination, arthritis, circulation problems and androgenic alopecia, pain, hemorrhoids, abnormally heavy bleeding during menstrual periods and many other conditions. The modern pharmacological studies discovered that these two plants have a wide variety of beneficial attributes for human health. Besides, its importance, a review of this both plants have not been properly assessed in the scientific literature to date. Here, we review and summarize the historic and recent literature concerning the botany, phytochemistry, pharmacological activities, and toxicity of this wonder plant. This summary could be advantageous for future research objective to exploit the therapeutic potential of these beneficial medicinal plants.

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## I. INTRODUCTION

Dates back thousands of years, there have been a great interest in biological products gained from megadiversity countries like Malaysia. These invaluable products are explored for the potential discovery of novel biomolecules that have possible future benefits. The popularity of natural products has been on the rise all around for the prevention and treatment of various diseases. Traditional medicines from plants have attracted substantial attention worldwide because of their potential pharmaceutical importance.

The most popular and well-known plants with a long history of use among the Chinese is *Angelica sinensis* and *Chinese arborvitae*. *A. sinensis* commonly known as *Dong quai*, a plant of the family Apiaceae and *C. arborvitae* known as *Platycadus orientalis*, a plant of the family Cupressaceae, *not* only has been used as a medicine for various ailments in the Chinese Archipelago , but also has been distributed in various dosage forms as cream, liquid, syrup, ointments, and leaf tea throughout Malaysia.

This review will unify fragmented information regarding *A. sinensis* and *C. arborvitae* in terms of its botany, traditional uses, phytochemistry, and pharmaceutical effects in order to facilitate better understanding and provide further support for the ethnopharmacological use of this important species.

## II. BOTANY

### A. Botanical Name

Its botanical name is Angelica sinensis and Platycladus orientalis.

### B. Synonyms

A. sinensis (Oliv.) Diels are also called as danggui, dong gwai, and tong-kui [1] whereas the synonyms of C. arborvitae are Biota orientalis, Thuja orientalis, Platycladus stricta, Thuja chengii, Thuja orientalis var. argyi [2].

### C. Common names

A. sinensis is commonly known as Dong quai and female ginseng in Malaysia while the C. arborvitae is known as Oriental arborvitae, oriental thuja, Chinese abor-vitae, it is also called as Tree of Life.

### D. Botanical Description and Distribution

A. sinensis is plant reaches a height of 1.5 meters, where its stem is erect, often thick as an arm at the base, round, finely grooved, hollow, tinged reddish below and branched above, bright green foliage in tripinnate with a

hollow petiole, leaflets shaped to ovate and unevenly serrate with a leaf length between 60 cm to 90 cm. Has creamy-white to greenish-white flowers in flat umbels that are 10 cm to 20 cm wide. The rhizome is short, fleshy and has long fibrous roots and in yellowish brown. The plant has a strong tangy odor; taste is sweetish to burning tangy. This species is indigenous to China Archipelago and has been introduced elsewhere. Other species with similar composition are found in the Americas, Syria, and the coast of the Baltic Sea as far north as Lapland and in Europe [1]. As for

**Figure 1: *Angelica sinensis* also known as female ginseng**

**Figure 2: *Chinese arborvitae* also known as *Platycladus orientalis***

*C. arborvitae, it* is an evergreen tree that grows 15 m to 20 m tall, the foliage forms in flat sprays with scale like leaves 2 mm to 4 mm long, which are bright green in color. The leaves, arranged in four rows, fleshy, opposite, decussate, truncated, imbricated as adults, somewhat curved inwards, of uniform green color and with a resiniferous gland on the underside. The branches are relatively short, loosely arranged and, usually, sharply directed upwards, and the bark, brownish, is detached in narrow vertical strips. The twigs are compressed and are arranged in vertical planes. This plant is also native to the northwestern China and has been introduced elsewhere. It is distributed in Manchuria, Russian Far East, and now it is naturalized in Korea, Japan, India, Florida, and Iran as well. [2].

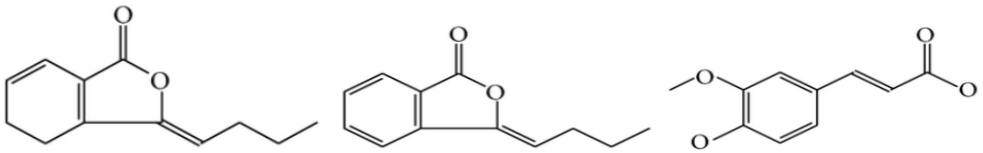
## III. ETHNOBOTANICAL USES

*A. sinensis* plant has long been used for tonifying, and invigorating blood and pain relieving, lubricating the intestines, and to treat disorders of the menstrual cycle and amenorrhea. In addition, *A. sinensis* has also been used as a health product and become increasingly popular in China, Japan, and Korea. [1] However, for *C. arborvitae,* the powdered leaves are used to treat fever, bleeding of the nose, vomiting of blood, blood in the urine and as an astringent. Besides, it also increases the flow of menstruation. Additionally, the seeds, sweet to the taste, are used as a sedative in the treatment of minor headache, insomnia, palpitation and as a coagulant [2]

## IV. CHEMICAL COMPOSITION

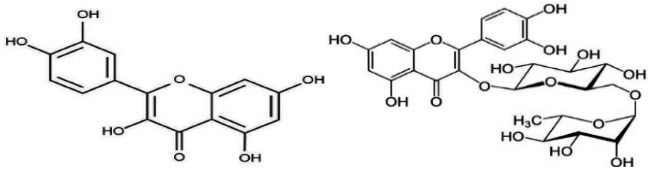
A wide range of chemical compounds have been isolated and characterized from *A. sinensis,* particularly from its roots. An initial comprehensive study on metabolite components produced by the roots in oral solution was conducted by Wang et al. using chromatographic fingerprint technique by liquid chromatography-diode array detection-atmospheric pressure chemical ionization mass spectrometry in negative mode. Up to 70 compounds have been isolated and identified from the roots of *A. sinensis,* including those from the essential oil (mainly including monomeric phthalides), phthalide dimers, coumarins, organic acids and their esters. The study also shows three bioactive constituents known as Z-ligustilide, Z-butylenephthalide and ferulic acid and in particular, ferulic acid has always been used in quality control and pharmacokinetic studies of these species [3, 4]. The metabolites identified from *A. sinensis* to date are presented in Table 1.

From a study performed in 2012, by Seyed Mehdi Hashem et al. on the chemical constituents of essential oils of *C. arborvitae* by using both leaves and fruits. The main components of from the leaves and fruits of *C. arborvitae* were α-pinene, α-cedrol, Δ-3-carene, limonene, β-caryophyllene, and myrcene [5]. In 2004, Zhu et al. isolated and identified quercetin and rutin using TLC and RT of HPLC as main flavonoid constituents of *C. arborvitae* with those of the authentic samples of powdered leaves [6]. The metabolites identified from *C. arborvitae* to date are presented in Table 1.



3(a) 3(b) 3(c)

**Figure 3: (a) Z-Ligustilide (b) Z-butylenephthalide and (c) Ferulic acid chemical structures.**



4(a) 4(b)

**Figure 4. (a) Quercetin and (b) Rutin chemical structures**

## V. PHARMACOLOGICAL PROPERTIES

### A. Angelica sinensis

***Anti-inflammatory effects:*** *A. sinensis* consist of ferulic acid and isoferulic acid which enable to inhibit the production of macrophage inflammatory protein-2 (MIP-2) through the murine macropharge cells, which suggest that these compounds contribute to the anti-inflammatory activity of the plant species [7,8]. Z-ligustilide compound also plays anti-inflammatory activity which is usually, related to inhibition of the TNF-α and NF-κB effects [9]. Ferulic acid and Z-ligustilid are two vital compounds in *A. sinensis*, reduction of NF-κB luciferase activity, that contribute to the anti-inflammatory properties of *A. sinensis* [10]. A study by Chao WW et al., (2010), shows that the *in vivo* experiment able to inhibit the production of inflammatory mediators through the alleviation acute inflammatory hazards as well as by giving protection to the mice from endotoxic shock using the ethyl acetate extract of *A. sinensis* [11].

***Anti-cancer effects:*** A study reported by Tsai NM et al., (2005) confirmed that in brain tumor cells lines, *A. sinensis* fraction able to induce apoptosis and cause the cell cycle to be arrested at $G_0/G_1$ [12]. *A. sinensis* extract has the ability to reduce the expression of the angiogenic effect vascular endothelial growth factor (VEGF) in brain astrocytoma [13]. In addition, n-butylidenephthalide and Z-ligustilide are compounds that are cytotoxic against brain tumor [14] as well as leukemia cells [15]. The three major constituents of *A. sinensis* phthalides, which are n-butylidenephthalide, senkyunolide A and Z-ligustilide, reduces the cell viability of colon cancer HT-29 cells dose-dependently, study confirmed by Kan WLT et al., (2008) [16]. Pretreatment of the PC12 cells with Z-ligustilide decreases $H_2O_2$-induced cell death, attenuates a rise in intracellular reactive oxygen species (ROS) level, reduces the expression Bax and cleaves caspase-3 as well as cytochrome [17]. A polysaccharide isolated from *A. sinensis* inhibits the growth of HeLa cells in nude mice *through an* increased parameters in the caspase-9, caspase-3 and poly (ADP-ribose) polymerase (PARP) [18].

***Anti-oxidant activity:*** *A. sinensis with water* extract can be purified further into different *A. sinensis* polysaccharide fractions that includes a highly acidic polysaccharide fraction that consist of galacturonic acid. Yang X et al., (2007) experimented that numerous *A. sinensis* polysaccharide fractions can be pretreated for *BALB/c* murine peritoneal macrophages with alleviate the reduction in cell survival due to *tert*-butylhydroperoxide, with a rising content of intracellular GSH [19]. Besides, polysaccharide fraction which are acidic is also the most active fraction in terms of inhibiting the reduction of cell viability due to the $H_2O_2$. The MDA formation reduce by the acidic polysaccharide fraction, also decrease the decline in SOD effects as well as inhibits the depletion of GSH in murine peritoneal macrophages which is because of the $H_2O_2$ [20]. *A. sinensis* with ethanol extract together with eight Chinese medicinal herbs significantly rises the radical scavenging ability of 1,1-diphenyl-2-picryl hydrazine (DPPH), study reported by Yang et al., (2009) [21].

***Anti-hepatotoxic effects:*** The liver has cytochrome P450s (CYPs). Which contains a series of microsome hemoproteins. CYPs acts as metabolic oxygenation of a variety of lipophilic chemicals such as drugs, pesticides, food additives and environmental pollutants, however it plays a vital role. Several important isoenzyme forms of cytochrome include CYP1A2 (13%), CYP2C (20%), CYP2D6 (2%), CYP2E1 (7%) and CYP3A (29%) based on the study reported by Cedric G et al., (2004) [22]. The study by Tang *et al*. (2006) shows that extracts of *A. sinensis* with water and ethanol increases the CYP2D6 and CYP3A activity firmly in the microsome fraction of male Wistar rat livers [23]. Gao *et al*. (2008) investigated that *Danggui Buxue Tang* (DBT) being treated, consist of the roots of *Astragali* and *A. sinensis*, induces erythropoietin mRNA expression in a dose-dependent manner in human hepatocellular carcinoma cell line Hep3B [24]. Moreover, Dietz *et al*. (2008) resulted that Z-ligustilide compound of *A. sinensis* targets cysteine residues in human Keap1 protein which then activates the Nrf2 as well as the transcription of antioxidant response element (ARE) genes regulated with inducing NADPH: quinine oxidoreductase 1 (NQO1) [25].

**Table 1. Chemical constituents identified in *A. sinensis and C. arborvitae*.**

| Plant | Compound | Class | Reference |
|---|---|---|---|
| *A. sinensis* | Arginine | Amino acids | [4] |
| | Sucrose | Disaccharide | [4] |
| | Epicatechin | Flavonoids | [4] |
| | Catechin | Flavonoids | [4] |
| | Glyceric acid | Flavonoids | [4] |
| | Z-Ligustilide | Phthalides | [4] |
| | Senkyunolide A | Phthalides | [4] |
| | Butylidenephthalide | Phthalides | [4] |
| | Frucose, | Polysaccharides | [4] |
| | Galactose | Polysaccharides | [4] |
| | Glucose | Polysaccharides | [4] |
| | Arabinose | Polysaccharides | [4] |
| | Rhamnose | Polysaccharides | [4] |
| | Xylose | Polysaccharides | [4] |
| | Vanillic acid | Tannins | [4] |
| *C. arborvitae* | Myrcene | Acyclic | [5] |
| | Linalool | Acyclic | [5] |
| | α-Thujene | Bicyclic | [5] |
| | Sabinene | Bicyclic | [5] |
| | Δ3-Carene | *Bicyclic* | [5] |
| | cis-Sabinene hydrate | *Bicyclic* | [5] |
| | Bornyl acetate | *Bicyclic* | [5] |
| | β-Caryophyllene | Cannabinoids | [5] |
| | Limonene | Cyclic monoterpenes | [5] |
| | Rutin | Flavonoids | [5] |
| | Quercetin | Flavonoids | [5] |
| | Terpinen-4-ol | Menthane | [5] |
| | α-Phellandrene | Menthane | [5] |
| | α-Terpenyl acetate | Menthane | [5] |
| | ρ-Cymene | Monocyclic | [5] |
| | α-Terpineol | Monocyclic | [5] |
| | β-Pinene | Monoterpenes | [5] |
| | α-Fenchene | Monoterpenes and | [5] |
| | β-Elemene | Sesquiterpenes | [5] |
| | β-Cedrene | Sesquiterpenes | [5] |
| | Thujopsene | Sesquiterpenes | [5] |
| | α-Humolene | Sesquiterpenes | [5] |
| | Germacrene-D | Sesquiterpenes | [5] |
| | Δ-Cadinene | Sesquiterpenes | [5] |
| | Elemol | Sesquiterpenes | [5] |
| | α-Cedrol | Sesquiterpenes | [5] |
| | α-Cadinol | Sesquiterpenes | [5] |
| | α-Pinene | Terpenes | [5] |
| | γ-terpinene | Terpenes | [5] |
| | Terpinolene | Terpenes | [5] |

**B. *Chinese arborvitae***

***Antioxidant activity****:* The phenolic compounds toward free radicals is described to have the best antioxidant capability which are produced by cells metabolism [26].Previous study have shown a high antioxidant activity of a mother tincture of *C. arborvitae* by 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) which contains (3.9 mg

GAE/g d.w.) polyphenols, and it's in vitro antioxidant capacity on Caco-2 cells that is exposed to oxidative stress induced by $H_2O_2$, by MDA- as well as GSH-level assessments [**27**]. In 2016, Nazir et al. presented that the antioxidant potential of the *C. arborvitae with* methanolic extract was assumed to have high DPPH radical scavenging activities, ABTS, NO and lipid peroxidation assays [28].

Additionally, Mighri et al. (2010) investigated on the antioxidant and antimicrobial performance of four types of essential oil, whose main constituents were β-thujone, α-thujone, α-thujone/β-thujone, and 1,8-cineole/camphor/α-thujone/β-thujone, as well as the composition was examined by using capillary GC and GC/MSmethod. However, it resulted that all observed oils had a good antimicrobial potential, and, moreover, they assessed the antioxidant capacity by various in vitro tests [**29**].

In year 2019, a study conducted by Mahomoodally et al. with the essential oils extracted from 19 medicinal plants was assessed on antioxidant potential, antiglycation, and the total content of phenolics [**30**]. In a study by Yogesh et al. in 2014, the antioxidant activity of *C. arborvitae* was examined in raw chicken ground meat during refrigerated storage by using DPPH free-radical scavenging activity technique in order to determine the antioxidant potential of *C. arborvitae* and peach seeds (*Prunus persica*). Besides, the study also identified the total phenolics, flavonoids, and reducing power in both these extracts. *C. arborvitae* extract and peach seeds extract resulted in total phenolics of 7.80 ± 0.04 and 1.92 ± 0.04 mg TAE/g d.w., respectively [**31**]. On top of that, there were a remarkable DPPH radical scavenging activity resulted by both the extracts (25.52 ± 1.92% and 24.99 ± 0.32%). However, as compared to peach seeds extract (3.32 ± 0.01 and 0.49 ± 0.01), *C. arborvitae* extract showed a better reducing power [**31**].

***Anti-inflammatory activity:*** There are not many studies that have examined on the anti-inflammatory activity using *C. arborvitae* species. A study conducted by Silva et al. (2017) emphasized the anti-inflammatory activity of the aqueous extract and the polysaccharide fraction obtained from *C. arborvitae* in models of acute inflammation in form of experimental. Doses of 3, 10, and 30 mg/kg, were used to administer intraperitoneally. It was observed through mechanisms by modulating mediators, which includes histamine, serotonin, PGE2, and bradykinin, and diminishing vascular permeability and neutrophil migration to the site that was affected. The aqueous extract and the polysaccharide fraction of *C. arborvitae* decreased the production of pro-inflammatory cytokines (TNF-α and IL-6), diminished COX-2 and iNOS activity, as well as the oxidative stress. High doses of aqueous extract and fraction of polysaccharides obtained from *C. arborvitae* of 300 mg/kg did not show in gastric toxicity [32].

***Antibacterial and antifungal activity:*** *C. arborvitae* has been resulted to have antibacterial properties against a remarkable number of species, such as *Salmonella* sp., *Enterobacter cloacae*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomona aeruginosa*, *Klebsiella pneumonia*, *Shigella flexenari*, *Candida albicans*, *Proteus vulgaris*, *Entercoccus faecalis*, and *Staphylococcus* [33,34]. The researcher observed two constituents, α-thujone and β-thujone, proven to have protective reaction against gram-negative bacteria such as *Pseudomonas aeruginosa* and *Klebsiella pneumonia* and a mild protective reaction against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* [34]. *C. arborvitae* have also showed significant antibacterial performance against bacteria and fungi [33]. The antimicrobial profile of essential oil of *C. arborvitae* was also proven by Tsiri et al. (2009) [35].

The antifungal characteristics of *C. arborvitae* have been highlighted against *Saccharomyces cerevisiae*, *Aspergillus parasitious*, *Aspergillus niger*, *Aspergillus flavus*, *Trichophyton rubrum*, *Macrophomina*, and *Fusarium solani* [36.37]. In a study by Bellili et al. (2018), essential oil extracted from leaves and cones of *C. arborvitae* resulted to have the ability towards antimicrobial activity against Gram-negative bacteria (*Escherichia coli*, *Salmonella typhimurium*, *Aeromonas hydrophila*, and *Pseudomonas aeruginosa*), and Gram-positive bacteria (*Staphylococcus aureus*, *Listeria monocytogenes*, and *Bacillus cereus*), fungus (*Aspergillus flavus* and *Aspergillus niger*), and yeast (*Candida albicans*) [38].

***Antiviral activity:*** The polysaccharides that was isolated from *C. arborvitae* have been resulted to have antiviral and immune-stimulating effect, has the ability to inhibit the HIV-1 and influenza A [39, 40]. At a concentration of 625 μg/mL, *C. arborvitae polysaccharides* inhibited HIV. They have been proven not to be toxic to MT-4 cells as well as inhibited the expression of HIV-1 specific antigen in newly infected MT-2 cells [40]. According to Gohla et al. (1992, an isolated extract of *C. arborvitae* was resulted to rise the number of cells that produces antibodies in an *in- vitro* study [41]. The research also highlighted the property of the high-molecular-weight polysaccharide fraction from *C. arborvitae* on HIV-1 [39].

***Anticancer activity:*** *C. arborvitae* is used for the treatment of cancer in homeopathy. However, its mechanism of action is not clearly proven. A study performed by Torres et al. (2016) on the effect of α/β-thujone on glioblastoma, by *in-vitro* and *in-vivo* models showed that α/β-thujone have the ability to diminish cell viability as well as antiproliferative, proapoptotic, and antiangiogenic parameters *in-vitro*. In *in-vivo* studies, α/β-thujone have been reported to induce regression of neoplasia and inhibited angiogenic markers of VEGF, Ang-4, and CD31 inhibitors in the tumor [42]. The antitumoral effect of the extract obtained from *C. arborvitae* leaves have been investigated on numerous cancer cell lines [43,44,45,46].

According to a study performed by Siveen and Kuttan (2011) using in-vivo study, demonstrated the antitumor effect

of thujone in the malignant ascites lymphoma model (Dalton). Thujone, is a monoterpene which is naturally found in *C. arborvitae*, has been resulted to rise the number of leukocytes and bone marrow cells. [47]. Thujone also proven that it has the ability to inhibit metastasis in melanoma *in-vivo* [48]. Thujone obtained from the ethanolic fraction of *C. arborvitae* has been shown to have anticancer characteristics on the malignant melanoma cell line A375.

In the similar study, thujone also showed antiproliferative effect as well as the ability to induce apoptosis [49]. In breast cancer *C. arborvitae* has been highlighted [50]. The polysaccharides from the leaf extract of *C. arborvitae* have been proven to decrease mice-induced inflammation. It has the ability to prevent metastasis by diminishing inflammatory cytokines, such as IL-1β, IL-6, granulocyte-macrophage colony stimulating factor (GM-CSF), and TNF-α. Additionally, it helps to stimulate the activity of natural killer (NK) cells, cell-mediated antibody-dependent cytotoxicity (ADCC), and complement-mediated cytotoxicity (ACC) and stimulated the activity of antitumor factors, IL-2, and TIMP [51].

***Protective activity of the gastrointestinal tract:*** In year 2008, a study by Dubey and Batra et al., the ethanolic extract of *C. arborvitae* proved to have hepato-protective effect in acute and chronic liver-induced HCV. The similar researchers disclose that the ethanolic extract of *C. arborvitae* gives a crucial reaction against gastric lesions [52]. Besides, a study by Saeed et al. (2014) on evaluating the effect of low dose of *C. arborvitae* with rabbit, for three months. They execute an investigation on rabbits, on groups treated with and without tetrachloride. Observation of the heart, liver, stomach, and kidney tissues histopathological, on the control groups as well as *C. arborvitae* tested groups. They also examine the $CCl_4$ injected group by performing the liver function test. Their study resulted to have minor harmful effects in the liver and kidney tissues which were treated with carbon tetrachloride, however due to the antioxidant effect of active constituents in *C. arborvitae*; there was no major toxicity [53].

The methanolic fraction *C. arborvitae* was administered orally at 200 mg and 400 mg/kg body weight have been proved to have gastroprotective effect in rats, when compared to omeprazole. This fraction decreased gastric acid production by 45% and 69%, respectively, and favored a significant regeneration of the gastric epithelium at a dose of 400 mg/kg body weight. The antiulcer action of this fraction is because of its antioxidant properties [54].Previous results showed that oral administration of *C. arborvitae* mother tincture by gavage, for one week, to mice with experimentally induced ulcerative colitis, succeeded in inhibiting the inflammatory process induced by TNBS in the intestine, and normalized the structure and ultrastructure of the intestinal mucosa [55].

***Lipid metabolism regulation:*** The ethanolic extract of *C. arborvitae* results to have hypoglycemic parameters in rats with aloxan-induced diabetes, with a dose administration of 200 mg/kg, without significant impact on body weight. The study also showed to have an improved lipid profile as well as have a protective effect against oxidative stress by raising the level of glutathione in blood [56].

Based on the study, performed by Dubey and Batra et al. (2009), the ethanolic fraction of *C. arborvitae* showed 77–92% decrease in serum cholesterol, with 53–84% LDL-cholesterol and 27–46% of triglycerides with administration of doses at 200 mg and 400 mg/kg body weight. The ant atherosclerotic activity was marked by the increase in HDL-cholesterol and the decrease in the atherogenic index. Due to the ability to interfere with the absorption, degradation, and excretion of cholesterol, *C. arborvitae* resulted in a significant free-radical neutralization effect [57].

## VI. CYTOTOXIC / ANTICANCER ACTIVITIES

*Chinese arborvitae* and *Angelica sinensis* have cytotoxic and anticancer properties. Extracts from *Chinese arborvitae* have been shown in studies to be cytotoxic against human cancer cell lines, including breast cancer, liver cancer, and lung cancer cells [58]. Similarly, *Angelica sinensis* extracts have been demonstrated to have cytotoxic effects against a variety of cancer cells, including breast cancer, lung cancer, and liver cancer cells. Besides, research into particular compounds found in these plants has revealed their significant anticancer potential. Ferulic acid, an extract of *Angelica sinensis*, has shown significant anticancer activity in a variety of cancer cell lines, including breast, colon, and prostate cancer cells. This multifunctional chemical works against cancer by interfering with cancer cell development and proliferation. Furthermore, Z-ligustilide, another active chemical found in *Angelica sinensis*, has demonstrated potential anticancer activity against a variety of cancer cells, including leukemia and liver cancer cells [59]. These plant-derived chemicals varied anticancer properties open up new areas for study and possible uses in cancer therapy and prevention. However, more research is needed to fully understand the underlying mechanisms of these anticancer actions and determine their possible therapeutic significance in cancer treatment.

## CONCLUSIONS

The scientific research on *A. sinensis* and *C. arborvitae* indicated that this plant has received increasing interest in recent years. *A. sinensis* and *C. arborvitae* has been reported to have beneficial pharmaceutical uses as an anti-inflammatory, anti-oxidant, anti-cancer, anti-hepatotoxic, anti-viral, anti-bacterial and anti-fungal agent and protective activity of the gastrointestinal tract respectively. Phytochemical and pharmaceutical studies have validated the traditional uses of *A. sinensis* and *C. arborvitae*; however, there is a requirement to identify the chemical or bioactive components that are responsible for providing the specific characteristics. The principle bioactive metabolites have to be investigated for their bioactivities and their mechanism of

action needs to be examined, in conjunction with analyzing the pharmacokinetics and physiological pathways of specific components in both the species respectively. These may help to strengthen our understanding of this highly therapeutic plant for commercial exploitation.

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