RESEARCH PAPER

Phytochemicals and anticancer potential of Alangium hexapetalum wang: advances in in silico and experimental investigations

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ABSTRACT
Alangium hexapetalum is a medicinal plant that grows naturally in the Western Ghats. It has been necessary in the typical know-how of nearby communities and Ayurvedic and different normal remedy structures for a lengthy time. People have used it to deal with quite a number fitness issues, which include fever, inflammation, insect bites, and positive apprehensive device problems. New scientific lookup has proven that this plant may be a suitable supply of new cancer treatments. The plant carries many lively compounds, such as triterpenoids, alkaloids, flavonoids, and phenolic acids. These compounds have numerous fitness benefits, consisting of combat free radicals, lowering inflammation, and killing most cancers cells. Lab assessments have determined that extracts from this plant can make most cancers cells die and quit them from growing, specifically in lung and cervical most cancers cells. Studies additionally recommend that the plant motives most cancers cells to behave differently, triggers detrimental consequences on the cells, and stops the formation of new blood vessels that assist tumors grow. Animal experiments have proven that the plant can reduce tumours whilst inflicting little damage to the relaxation of the body. These effects recommend that Alangium hexapetalum may additionally be a treasured cure for cancer, working in a couple of ways, and in addition lookup is wanted in each laboratory and human studies.

Keywords: Alangium hexapetalum, Anticancer activity, Phytochemicals, Apoptosis induction, Ethnomedicinal plant.
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INTRODUCTION

Cancer remains a serious problem for global health, being one of the main reasons for illness and death around the world. The World Health Organization (WHO) reports that in 2020, cancer led to about 10 million deaths, showing how big a challenge, it is today(1). Because cancer has many causes,including genetic, environmental, and lifestyle factors,using different methods for prevention and treatment is important. Even though there have been big improvements in cancer treatments like chemotherapy, radiation, and surgery, there are still many problems. These include strong side effects, resistance to multiple drugs, and the treatments not being very specific to cancer cells(2). Because of these issues, there is more focus on finding new and better treatments. A lot of attention is being given to natural products, especially those from plants. Plants have been important in medicine for a long time. They have a wide variety of structures and can affect many different biological processes, making them useful in cancer research. Over 60% of the drugs used today to treat cancer are either natural products or made from natural sources(3). Examples include vincristine and vinblastine from the plant *Catharanthus roseus*, paclitaxel from *Taxus brevifolia*, and camptothecin from *Camptotheca acuminata*(4,5). All of these have shown strong cancer-fighting abilities and have helped create new medicines. In this area, a lesser-known plant called *Alangium hexapetalum* has recently become interesting for its possible cancer-fighting qualities. This plant is part of the *Alangiaceae* family and is found in the Western Ghats of southern India, a region known for its rich biodiversity. It has been used in traditional medicine systems like Ayurveda and by local tribes for a long time(6). *Alangium salvifolium* subsp.*Hexapetalum* (wangerin) is also known for a variety of traditional uses like haemorrhoids, rheumatism, and an antidote for snake bite (7). The potential of *A. hexapetalum* in medicine comes from the variety of chemical substances it contains, like triterpenoids, alkaloids, flavonoids, and phenolic compounds (8). These chemicals have been found to fight cancer in different plants. Early tests, like chromatography, show that there are active compounds such as isoquinoline alkaloids, quercetin derivatives, phenolic acids, and terpenoids. These substances are known to make cancer cells die, stop their growth, and control harmful levels of oxygen in the body (9,10). Even though people have used *A.*

hexapetalum for a long time, the exact ways it fights cancer are not well understood. Recent lab studies show that extracts from this plant can kill several types of cancer cells, such as those from cervical, breast, and lung cancers. These extracts lower the number of living cancer cells, change how their energy works, and cause them to die. They also stop the cells from dividing at a specific stage and activate certain death pathways. Tests using flow cytometry and MTT methods show that the plant harms cancer cells more than healthy ones, which means it may be a good treatment option (11). Studies in animals have also found that giving extracts from *A. hexapetalum* roots or bark can shrink tumors, stop the growth of new blood vessels, and cause little harm to the body. Looking at tissues from treated animals shows that the structure is better and that cancer cells are not growing as much, supporting the idea that this plant can help fight cancer in the body (12). Computer models have also shown that some of the chemicals in *A. hexapetalum* can bind well to important targets in cancer, like enzymes in the PI3K/Akt and MAPK pathways, Bcl-2, Bax, and VEGF. These chemicals seem to have good absorption, distribution, metabolism, and excretion properties and are unlikely to be toxic. These computer results match the lab findings and help scientists understand how to improve the structure of these chemicals for better drug development (13). Despite the positive results, there are several issues that prevent the use of *A. hexapetalum* in real medical treatments. Most studies so far are just early tests and do not follow standard methods for extracting compounds, testing their effects, or understanding how their structure affects their activity (10). There is little information about how the body processes these compounds, their long-term safety, and whether they work in people. Also, since the plant's chemical makeup can change based on where it grows, it's hard to get consistent results when isolating, identifying, and measuring its chemicals. There's not enough research on how these compounds work at a molecular level or how they interact with other substances in the body. To fix these problems, future research should use a variety of approaches from different scientific fields. Using tools like genomics, proteomics, and metabolomics can help understand the biological pathways affected by *A. hexapetalum*. Computer-based tools can predict how these compounds might affect other parts of the body and help improve their effectiveness and safety (14). Also, using special delivery systems like nanoparticles might make it easier for the body to absorb the chemicals, especially those that are not easily dissolved. Modifying these chemicals in a semi-synthetic or synthetic way could also improve how well they work in the body. Overall, *A. hexapetalum* has a lot of potential as a treatment for cancer because of its ability to target multiple pathways, its traditional use in medicine, and the variety of chemicals it contains. This review brings together information from lab experiments, animal studies, and computer modeling to give a full picture of the plant's anticancer abilities. It also highlights the need for better research to standardize its use, understand how it works, and move closer to using it in real-world medical treatments.

Botanical Description and Ethnomedicinal Uses

Taxonomy and Botanical Characteristics of *Alangium hexapetalum*:

Alangium hexapetalum (Lam.) Wang is a type of shrub or small tree in the *Alangiaceae* family. It can sometimes grow by climbing, depending on where it is found (15). Its branches are usually round or zigzag-shaped, which helps identify the plant. The leaves have a stem, grow one per node, and have an asymmetrical base. The leaves can be simple or have lobes, and their veins can be either pinnate or palmate (16). This plant grows small, fragrant flowers that are both male and female. The flowers are usually pale white or yellowish and grow in clusters in the leaf axils. The flower parts are fused at the bottom. The flower has four to ten petals that meet at the edges (17). There are many stamens, usually twice as many as petals, with thick filaments and anthers that split lengthwise to release pollen. The flower has a two-chambered ovary with one seed, which grows into a fleshy, oval or round fruit (18). The mature fruit has a seed in the center, and the lower part of the flower remains attached. The genus *Alangium* has about 30 species found mainly in tropical Asia, Oceania, and parts of Africa. Nine of these species are native to China (19). The unique features of *A. hexapetalum* help scientists identify it and also show its importance in the environment and for traditional medicine.

Traditional medicinal uses:

Ethnobotanical studies show that *A. hexapetalum* and its related plant *A. salvifolium* have been widely used in traditional medicine by indigenous peoples and in Ayurvedic practices, especially in southern India (20). These plants are known for their ability to act as a purgative, astringent, antiepileptic, anthelmintic, and antiulcer. The people living in the Western Ghats region of Tamil Nadu and Kerala use extracts from the roots and bark to treat fever, ulcers, epilepsy, and skin problems. They also use these extracts to deal with bites from scorpions and snakes (21). In some tribal groups, the plant is also used to protect animals from diseases [6]. In other parts of the world, like the Philippines and East Africa, people use decoctions made from *A. hexapetalum* externally to treat hemorrhoids, skin infections, and different kinds of inflammation (22, 23). In traditional Chinese

medicine, the leaves of the plant are said to help with asthma and other breathing problems.

Geographical distribution and conservation status:

Alangium hexapetalum grows only in the Western Ghats of southern India, which is a well-known area with a lot of different plant and animal life (24). This plant is mostly found in wet forests that lose their leaves seasonally and in forests that have some evergreen trees, usually at middle elevations. It plays a role in the variety of life in that area. Even though people have used this plant for traditional medicine for a long time, there is not much known about its overall conservation status worldwide. Studies in the region show that things like the destruction of its natural habitat, overharvesting, and the plant's limited ability to regrow could be big threats to its survival (25,26). Because of these challenges, there is a big need for conservation efforts that focus on harvesting in a way that doesn't harm the plant, managing the habitat with help from local communities, and proving the plant's benefits through scientific research (27). Combining traditional knowledge with modern science can help protect both the plant and the culture connected to it, while also supporting discoveries in medicine.

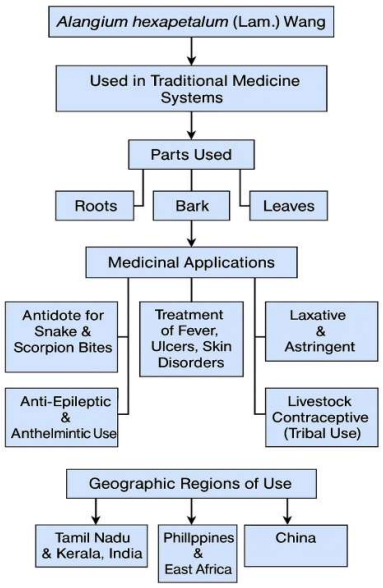

Figure 1: Uses of A.hexapetalum

Phytochemical Profile of *Alangiu. hexapetalum*

Extraction Techniques:

Phytochemical studies on *Alangium hexapetalum* mostly use solvent-based methods to extract active chemicals. The choice of solvent depends on the type of active compounds being targeted. Common solvents used are methanol, ethanol, chloroform, and water, as they help get the maximum amount of different plant chemicals (28,29). Among traditional methods, Soxhlet extraction and cold maceration are the most commonly used. Soxhlet extraction uses heat continuously to extract compounds, which helps get more of the stable chemicals like alkaloids and flavonoids. It is often used when high recovery is needed. On the other hand, cold maceration is used for compounds that are sensitive to heat or easily break down, so it helps keep those chemicals intact during extraction (30). In recent times, methods like microwave-assisted extraction and ultrasound-assisted extraction have become popular because they use less solvent, take less time, and are more efficient. These methods are seen as better options for modern plant chemical studies (31).

Phytochemical Constituents: Phytochemical testing of *A. hexapetalum* has found a wide range of secondary metabolites, many of which have drug-like effects and match the plant's traditional uses in medicine. The main types of compounds found are:

Alkaloids: This group includes isoquinoline-type alkaloids, which are known to affect the nervous system and can be harmful to cells (32).

Flavonoids: Quercetin and related compounds have been found, and they are strong antioxidants and may help in fighting cancer (28).

Phenolic compounds: These include phenolic acids, which help in removing harmful free radicals and reducing inflammation (29).

Terpenoids: Both sesquiterpenes and triterpenoids have been identified, and they are known for their anti-inflammatory properties and ability to stop cell division (33).

Glycosides and Saponins: These compounds help in breaking down cell membranes, support the immune system, and improve the overall effectiveness of the plant (34).

Together, these compounds are thought to explain the wide range of health benefits of *A. hexapetalum*, especially in cancer treatment, fighting infections, and managing inflammation.

Comparison with other species in the genus *Alangium*:Within the *Alangium* group, *A. salvifolium* is the most studied species. It's known for its antioxidant, anti-inflammatory, and anticonvulsant properties. Studies have found unique chemicals in *A. salvifolium,* like alangiside, alangine, and salvifoline. These chemicals are similar to those found in *A. hexapetalum*(35). Both plants share some common chemicals, but *A. hexapetalum* has its special types of phenolic and flavonoid compounds. These differences might explain why *A. Hexapetalum* has stronger anticancer effects (32). *A. salvifolium* mainly affects the central nervous system, while *A. Hexapetalum* shows good potential against cancer. This is supported by lab and computer-based studies that show it can affect blood vessel growth and cause cell death in the mitochondria (19,37). However, *A. hexapetalum* is not well studied in terms of its chemical makeup and how it works in

the body. To better understand the active compounds in these plants, there is a need for more detailed research methods. Techniques like bioassay-guided fractionation, activity-based screening, and tools like nuclear magnetic resonance (NMR) and mass spectrometry (MS) can help identify the exact chemicals responsible for their effects. This will help move these compounds closer to being developed as medicines.

Table 1: Comparative Analysis of Selected *Alangiaceae* Subspecies

FEATURES	***A.hexapetalum***	***A.salvifoliium***	***A.chinense***	***A.platanifolliium***
Plant Type	Shrub or small tree:sometimes climbing	Small deciduous tree	Small tree or shrub	Medium size tree
Traditional Uses	Antidote for snake/Scorpion bite,fever, ulcer,epilepsy	Laxative, anti-epileptic, salvifololine	Cough, asthma, constipation and chronic bronchitis	Skin disease. Inflamatory conditions
Major phytochemicals	Alkaloids, Flavonoids, Phenolics, Triterpenoids	Alangiside, Alangine, Salvifoline	Alangine, Alangitanine, Flavonoids	Steroids, Lignans, Iridoids
Primary Pharmacological activity	Anti-cancer	Anti-oxidant, Anti inflammatory	Hepatoprotective, Anti-oxidant	Anti-inflammatory, Anti-microbial
CNS - Related Activity	Mild traditional report: not well documented	Strong anticonvulsant Sedative effects	Neuroprotective (limited studies)	Limited CNS evidence
Anticancer potential	High (in silico, in vivo, in vitro evidence available)	Limited direct evidence	Moderate research coverage	Lack sufficient data
Research Coverage	Emerging focus: underexplored	Most studied within the genus	Moderate research coverage	Locally used in parts southeast asia
Conservation Concerns	Threatened by overharvesting, under sporosis	Widely used across india	Data deficient	Locally threatened

***In Silico* Studies and Computational Approaches**

Role of Molecular Docking and ADME Prediction in Drug Discovery:

In the early stages of finding new drugs, computer-based techniques like molecular docking and ADME (Absorption, Distribution, Metabolism, and Excretion) prediction are very important for checking active compounds before testing them in real lab settings or on animals. Molecular docking helps scientists test plant-based chemicals by showing how they connect with specific targets linked to diseases, which helps predict how strong the connection is and how stable the position is (37,38). At the same time, ADME analysis helps understand how the body handles the compound, including how well it moves through the body, how it's broken down, and any possible harmful effects, which helps find promising drug candidates that are easy for the body to use, don't cause unwanted side effects, and stay effective for longer.

In Silico Evaluation of Phytocompounds from *Alangium* hexapetalum:

Several computer-based studies have looked at the alkaloid and flavonoid compounds in *Alangium hexapetalum*, especially how they might fight cancer. When these plant chemicals were tested against important cancer-related proteins, they showed strong binding, with scores between −7. 5 and −10. 1 kcal/mol. These compounds also had good absorption in the intestines and didn't block CYP450 enzymes much, which suggests they could be good candidates for drug development (37). Later, molecular dynamics simulations confirmed these results. They showed that the complexes formed between the chemicals and the proteins stayed stable and bound consistently throughout 100 nanoseconds, which supports the accuracy of the earlier docking results. Later, molecular dynamics simulations confirmed these results. They showed that the complexes formed between the chemicals and the proteins stayed stable and bound consistently throughout 100 nanoseconds, which supports the accuracy of the earlier docking results.

Molecular Targets in Cancer Pathways:

The main molecules that researchers look at when studying the plant parts of *A. hexapetalum* are:

Bcl-2 and Bax: These are important proteins that control how cells die or live, especially by affecting the mitochondria and keeping cells alive (37,39).

VEGF Receptor 2: This is a key protein involved in forming new blood vessels, and some compounds from *A. hexapetalum*, like apigenin and fisetin, are thought to block this receptor (40,41).

PI3K/Akt and MAPK proteins: These are important for how cells grow, stay alive, and form tumors (42,43).

Binding Affinities and Structure–Activity Relationships (SAR)

Docking data showed strong interactions between the active parts of *A. hexapetalum* and the targets Bcl-2, VEGFR-2, and PI3K. The strength of these interactions, measured as binding scores, ranged from −6. 5 to −10. 2 kcal/mol (37,44). Further detailed analysis of how the structure of these compounds affects their activity provided the following key points:

The way certain flavonoids have hydroxyl groups, especially when these groups are positioned next to each other (ortho-dihydroxy), helps them form stronger hydrogen bonds with the pockets of Bcl-2 and VEGFR-2.

Quercetin-like compounds had a better ability to bind to VEGFR-2. This is because they can form multiple hydrogen bonds and also stack with other molecules in the kinase area of the protein through a type of interaction called π-π stacking.

Alkaloid-based compounds mainly interact with PI3K differently, forming stronger hydrophobic bonds and making contact through π-alkyl interactions in the active site.

These interactions suggest that these compounds might work as allosteric inhibitors, which means they could change the shape of the protein to stop it from working. These computer-based findings show that the chemical features of *A. hexapetalum* compounds are important for their biological effects. They provide a reason for how these compounds can stop cells from growing and cause them to die. These results support the need for more lab-based testing and improvements to these plant-based compounds so that they can be considered for use in early-stage drug development.

***In Vitro* and *in Vivo* anticancer activities**

Cell Lines and Models Used for Evaluation:

An assortment of human cancer cell lines has been utilized in comprehensive in vitro ponders to assess the anticancer properties of *Alangium hexapetalum*. The foremost regularly used models incorporate HeLa (cervical cancer), MCF-7 (breast cancer), A549 (lung cancer), and HT-29 (colorectal cancer)(45). For assessing antitumor adequacy and systemic poisonous quality, in vivo investigate have essentially used strong tumor xenografts in rodents and mice bearing Ehrlich ascites carcinoma (EAC)(46).

Cytotoxicity Results (MTT, Flow Cytometry, Apoptosis Markers):

Methanolic and chloroform extricates of *A. hexapetalum* illustrated dose-dependent cytotoxicity, agreeing with MTT measures; IC_{50} values against HeLa and MCF-7 cells extended from 48.6 to 72.3 µg/mL (46). In conjunction with expanded Annexin V recoloring, which recommends early apoptosis, stream cytometry also confirmed cell cycle capture at the G2/M stage (47). Apoptotic acceptance was affirmed by atomic markers like caspase-3 activation, Bcl-2 downregulation, and Bax upregulation(40).

Dose–Response Relationship:

Higher extricate concentrations were related to more noteworthy cell passing in in vitro cytotoxicity, which showedaclear dose-response relationship. In a dose-dependent mold, an eminent rise in the sub-G1 cell population and a diminish in mitochondrial layer potential were famous(42).Verbal organization of 200–400 mg/kg of the root extricate altogether diminished tumor volume without showing any signs of hepatic or renal poisonous quality, concurring with in vivo studies conducted on tumor-bearing mice (46).

Comparison with Standard Anticancer Agents:

In creature models, *A. hexapetalum*extracts illustrated prevalent survival profiles and lower systemic toxicity, whilealso illustrating comparable cytotoxicity at higher concentrations when compared to routine chemotherapeutics like doxorubicin and 5-fluorouracil(45,46). A noteworthy advantage over numerous conventional solutions is that its compounds displayed specific cytotoxicity, affecting cancer cells more than healthy fibroblasts(37).

Mechanism of action

Through a wide range of natural components that target cancer cell survival, multiplication, and metastasis, *Alangium hexapetalum* shows anticancer potential. These components, which incorporate apoptosis acceptance, cell cycle capture, antioxidant action, and balance of vital oncogenic flagging pathways, have been clarified by a few in vitro, in vivo, and in silico examinations.

Apoptosis Induction:

One imperative instrument in anticancer treatment is apoptosis, or programmed cell death. Extricates from *A. hexapetalum* have been illustrated to enact the natural mitochondrial apoptotic pathway, as illustrated by activation of caspase-3 and caspase-9, loss of mitochondrial membrane potential, and an increasein the Bax/Bcl-2 ratio(40,45). This cascade comes about in DNA fracture and cell passing, showing that the plant may be utilized as a pro-apoptotic operator to treat cancer.

Cell Cycle Arrest:

Phytocompounds from *A. hexapetalum* cause G2/M stage capture, which stops cancer cells from going through mitosis(47).Stream cytometry investigation of treated cells revealed a critical accumulation within the G2/M phase and a diminish within the S stage population. Checkpoint actuation is shown by

cyclin B1 downregulation and p53 upregulation, which regularly go with this capture(48).

Antioxidant Mechanisms:

By causing DNA harm and empowering oncogenic changes, oxidative stress helps in the advancement of cancer. Flavonoids and phenolic compounds, which are inexhaustible in *A. hexapetalum*, have solid free radical scavenging properties(49).By upregulating antioxidant chemicals like Grass (superoxide dismutase), CAT (catalase), and GPX (glutathione peroxidase), these phytochemicals decrease oxidative harm and help in the rebuilding of redox homeostasis in cancer cells (50).

Modulation of signalling pathways:

A. hexapetalum extricates change imperative flagging pathways that are included within the survival and metastasis of cancer cells. The PI3K/Akt and MAPK/ERK pathways, which are fundamental for cellular multiplication, angiogenesis, and resistance to apoptosis, may be hindered, according to atomic docking and test inquiry(37,42). Its work in ending tumor development and spread is encouraged by the concealment of NF-KB activation, downregulation of matrix metalloproteinases (MMP-2 and MMP-9), and hindrance of VEGF expression(51).

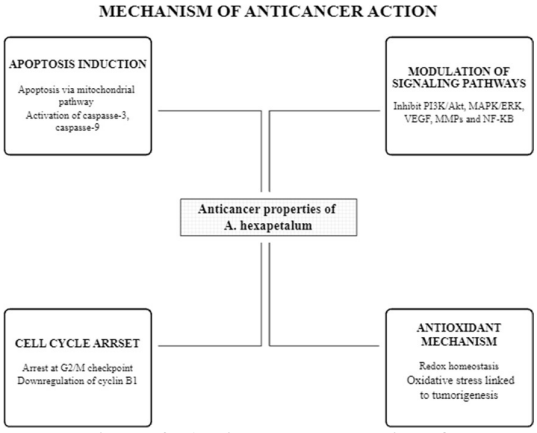

Figure 2: Anticancer properties of *A.hexapetalum*

Challenges and Research Gaps

Even though *Alangium hexapetalum* shows some promise as a potential anticancer treatment, there are several major problems that stop it from moving from early research to real-world use. The current studies are encouraging, but they are not enough. They lack the proper methods needed to move forward. Here are the main issues:

Lack of Standardization and Reproducibility:

Most of the studies use rough, unstandardized extracts from the plant. Different parts of the plant, different solvents for extraction, and different sources from various regions all lead to inconsistent results. This makes it hard to compare findings between studies. Also, there are no clear guidelines on how much of the plant to use or how to test its effects consistently. This lack of standardization makes it hard to develop reliable drug profiles (45,47,50).

Inadequate Bioavailability and Pharmacokinetic Insights:

Many of the compounds from *A. hexapetalum*work well in lab tests, but we don't know much about how the body absorbs and processes them. There is very little research on how the body takes in, spreads, breaks down, and gets rid of these compounds, which is important for figuring out safe and effective dosages. Using computer models and doing experiments on living animals could help us understand (37,52).

Absence of Clinical and Translational Studies:

So far, no human trials have been done on *A. hexapetalum*. Also, there's very little research on how it might work in more complicated body systems. Without data on long-term effects, how it affects the immune system, and how it interacts with other medicines, especially cancer drugs, it's hard to know if it's ready for real-world use (42,46).

Limited Compound Isolation and Mechanistic Elucidation:

We know some of the general types of chemicals in *A. hexapetalum*, but we haven't isolated most of the active compounds. Also, the studies on how these compounds work in the body are too basic, often only showing general effects like antioxidant or cell death processes. More detailed research is needed to understand exactly how these compounds interact with cancer cells. This includes looking at how the structure of a compound relates to its function and using computer models to predict how it works with cancer targets (42,51,53).

Challenges in Formulation and Drug Delivery:

Many of the compounds in *A. hexapetalum* don't mix well with water and are hard for the body to absorb. This makes it hard to make them into a usable medicine. Some techniques, like using tiny capsules, liquid drops, or special particles, might help, but there isn't much research on how to apply these methods to *A. hexapetalum*. These approaches can help the medicine work better, target specific areas, and be more effective (40,48).

Future Perspectives

Because cancer remains a major health problem worldwide and there is an urgent need for new, effective, and safer treatments, it is important and timely to explore the potential of *Alangium hexapetalum* as a source of anticancer drugs. Future studies should focus on filling in the gaps in current knowledge by using modern scientific methods in biology, drug development, and chemical synthesis. This will help make the use of this plant more practical for real-world medical applications.

Integration of Omics Technologies:
Using tools like genomics, transcriptomics, proteomics, and metabolomics can provide a better understanding of how the chemicals in *A. hexapetalum* interact with the body and affect cancer cells (54,55). These techniques can help discover the process by which these chemicals are made and identify the specific targets and markers that make them effective against cancer. Comparing the proteins and gene activity in cancer cells treated with these chemicals can also reveal how they work and what biological pathways they influence, which helps in testing and confirming their effectiveness (56,57).

Development of Nano-Drug Delivery Systems:
Many chemicals from *A. hexapetalum* have poor solubility in water, aren't easily absorbed by the body, and are quickly broken down, which makes them hard to use in medicine. Using nanotechnology, such as liposomes, polymer nanoparticles, dendrimers, and solid lipid nanoparticles, can greatly improve how these chemicals work in the body (58). These delivery systems help keep the chemicals stable, deliver them more accurately to cancer cells, control how they release, and reduce harmful effects on healthy parts of the body, especially in the area around tumors (59,60).

Synthetic Modification and Derivative Development:
The chemical structures of flavonoids, phenolics, and isoquinoline alkaloids in *A. hexapetalum* are useful for making new drugs. By studying how changes to these structures affect their activity and using modeling techniques like structure-activity relationships and molecular docking, scientists can create improved versions of these chemicals. These new versions can be more effective, more targeted, and less likely to be broken down in the body, making them better candidates for clinical use (42,52,61).

Clinical Translation and Synergistic Approaches:
To bring *A. hexapetalum-based* treatments to patients, it is essential to test these treatments in lab animals, study long-term safety, and eventually conduct trials with people. Also, combining the chemicals from this plant with standard cancer treatments like chemotherapy or radiation might lead to better results and fewer side effects (62). Using advanced methods from systems biology and AI-based drug discovery can support the development of treatments that target multiple areas at once, improving effectiveness and helping overcome resistance in cancer cells (63).

Conclusion:
Alangium hexapetalum (Lam.) Wang is a medicinal plant found only in the Western Ghats of India. It has not been studied much yet, but there is hope that it could be a source of drugs to fight cancer. Studies from ethnobotany, chemical analysis, and how it works in the body show that it has many active chemicals, like alkaloids, flavonoids, terpenoids, and phenolics. These chemicals help kill cancer cells and make them die in a controlled way. Tests done in the lab and on living organisms show that this plant can change important cell processes, like problems with mitochondria, activation of certain proteins, and stopping the cell from dividing. It also doesn't cause much harm to the body overall. Computer models also support this, showing it can bind well to targets linked to cancer, like Bcl-2, VEGFR2, and PI3K/Akt. Plus, it has good properties related to how well it is absorbed, distributed, and removed from the body. However, research on this plant is still in the early stages. There are problems like not having standard methods for extracting its chemicals, not enough studies to find the most active parts, no clinical trials, and not enough information on how it moves through the body. To make use of its possible benefits, future work should focus on finding the active ingredients, using new delivery methods like nanotechnology, and using advanced research techniques along with proper clinical testing. In short, *Alangium hexapetalum* is a promising plant-based option for cancer treatment and needs more detailed study to discover new cancer medicines from nature.

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