Role of Herbal Medicine in Cancer Therapy and Chemoprevention

Chapter 3

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ABSTRACT

Cancer is a complex and diverse disease that significantly impacts global health, prompting researchers to seek novel and complementary treatment approaches. Herbal medicine, recognized as a safe and effective source of bioactive compounds and secondary metabolites, has the potential to enhance traditional cancer therapies and support chemotherapy prevention. This chapter explores how herbal medicine may suppress tumor development, induce apoptosis, and modify key signaling pathways involved in cancer treatment.

The anticancer properties of different herbal extracts and their phytochemicals are summarized, along with preclinical and clinical data and an explanation of their mechanisms of action. The chapter also highlights the need for rigorous scientific investigation and standardization, addressing the challenges and potential for integrating medicinal plants into evidence-based cancer treatments. Research on the medicinal uses of herbal medicine could result in the creation of innovative cancer prevention and treatment plans, which would improve patient outcomes and quality of life in the long run.

Keywords: Cancer, Chemoprevention, Secondary metabolites, Bioactive, Compounds

INTRODUCTION

A class of disorders known as cancer is defined by excessive cell growth and the migration and dissemination of cells from the original site, or place of origin, to other parts of the body. It is necessary to highlight a few points in this definition. About 80–85% of most malignancies are categorized as carcinomas and arise in epithelial cells. Sarcomas are malignancies originating from mesoderm cells, while adenocarcinomas are tumors of glandular tissue. Lung cancer, breast cancer, colorectal cancer, colon cancer, stomach cancer, and cervical cancer are the most common types of cancer diagnosed globally. Several cancer

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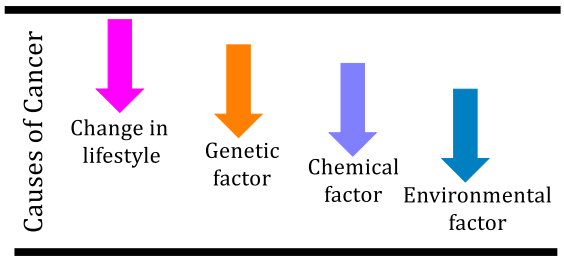
malignancies and the rare cells that comprise the malignant cells have been further recognized by the appellation of the cells from which the atypical cells emerged.

Cancer can occur in several organs due to a variety of reasons. Tobacco usage, for instance, is responsible for 25% of deaths. In contrast, inadequate nutrition, overweight or obese people, drunkenness, along with other variables like a history of radioactive substances, polluting substances, and illnesses account for 10-15% of deaths.

Most chemical malignancies cannot interact easily with abundant biochemicals; instead, biological processes that have evolved to purge the organs of toxic substances and alternative components convert them to carcinogenic and mutagenic electrophiles. For instance, although tobacco use is linked to other deadly illnesses including heart disease, only 10% of smokers get lung cancer *(H.Yuspa 2000).* Plant-based drug research gave rise to a platform for synthesizing safe and effective anti-tumor medications by fully understanding the synergistic relationship between several anti-tumor herb constituents. Plant-based remedies provide an environmentally friendly and effective approach to treating various illnesses, including cancer. Recently, the significance of natural products and bioactive compounds as sources of anticancer medications has been emphasized through a multidisciplinary, integrated, and cooperative approach. More than half of modern clinical medications come from natural sources and can help treat cancer cells.

This chapter aims to draw attention to the importance of different herbal extracts, medicinal plants, and bioactive substances that might have anticancer effects. The information provided is intended to assist researchers in developing new anticancer medications that offer several crucial advantages, including high specificity and efficacy against cancer, low toxicity, minimal side effects, cost-effectiveness, and environmental sustainability. Furthermore, these substances may contribute to cancer prevention by boosting the immune system.



SECONDARY METABOLITES AND THEIR MECHANISM INVOLVE

Affordable natural chemicals, specifically secondary metabolites, that have comprehensive bioactivities, notably anticancer therapy, and an arrangement of intricacy that makes production challenging or impossible at this moment, can be found in abundance in plants *(N. Nwodo et al. 2015; Habli et al. 2017)*. Most secondary metabolites are tiny natural substances a living organism generates, but they have no significance for its development, maturation, or reproduction. They can be categorized according to the biosynthesis pathway *(Badal and Delgoda 2017)*. Furthermore, an intuitive grouping comprises three major groups: phenolics *(biosynthesized from shikimate routes)*, terpenoids *(polymerized isoprene derivatives biosynthesized from acetate via the mevalonic acid pathway)*, and the incredibly varied alkaloids.

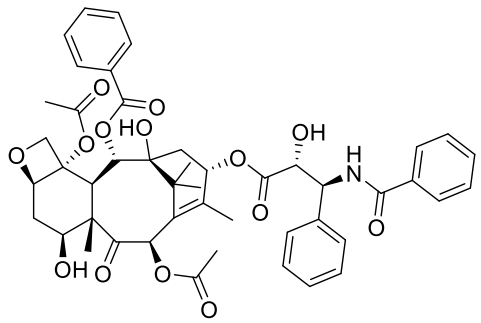
Several novel lethal secondary metabolites are found in plants every year, creating fresh opportunities for studying possible cancer therapies.

While many organic compounds exhibit unique anticancer properties, their toxicity, and physical and chemical characteristics—such as low absorption—limit their use in clinical practice. On the other hand, secondary metabolites in plants are frequently great places to start when creating novel medications. Therefore, altering these potential

chemicals' molecular structure is a calculated move to improve their distribution, metabolism, excretion, and absorption. This can enhance their anticancer activity and selectivity while lowering their toxicity and adverse effects. *(Z. Guo 2017; Yao et al. 2017).*

Paclitaxel

One of the most effective chemotherapy medications for cancer is paclitaxel, derived from the bark of the Taxus brevifolia Nutt. Tree. It has been marketed under the trade name Taxol® since 1993. Paclitaxel features a complex structure consisting of a tricyclic diterpenoid known as the "taxane" ring system, fused with a four-member oxetane ring. This unique chemical structure is sometimes referred to as a false alkaloid *(Weaver 2014; Bernabeu et al. 2017)*.



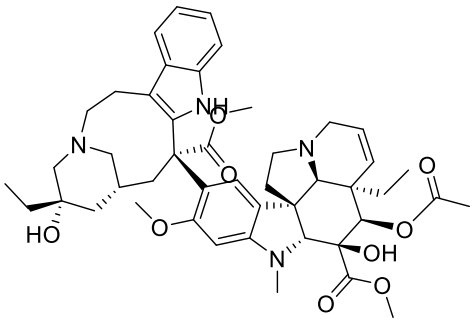
Paclitaxel

The treatment's distinct mechanism, which targets crucial elements of cancer characteristics like DNA damage repair and cell proliferation, demonstrates a broad range of anticancer activity.

The ongoing investigation of paclitaxel's mechanism of action, quantitative structure-activity relationship *(QSAR)*, and standard structure-activity relationship *(SAR)* has identified and allocated pharmacophores and structural features that should not change. This information has led to the origin of new, more potent, and less hazardous substances. Consequently, two partially synthetic derivatives, docetaxel and cabazitaxel, have been successfully created *(Z. Guo 2017; Xiao, Morris-Natschke, and Lee 2016).*

Vinblastine

Vincristine is an unbalanced non-symmetrical dimeric compound made up of two indole-type nuclei joined by a carbon-carbon bond. These components consist of vindoline and catharanthin. The clinical use of vincristine in cancer treatment was approved by the Food and Drug Administration *(FDA)* in 1963, making it Perhaps the initial anticancer medications derived from plants to receive this approval *(Newman and Cragg 2016).* The leaves of Catharanthus roseus *(known as Vinca rosea L.)* contain this naturally occurring alkaloid. Vincristine is primarily used in pediatric oncology to treat juvenile lymphocytic lymphoma, although it is also utilized in adult chemotherapy regimens *(X. Wang et al. 2016)*. Vincristine can influence cell division in a concentration-dependent way. However, the most well-known way that vincristine inhibits tumor growth is by combining with tubulin, which is essential for mitotic spin small tubules and inhibits the formation of mitosis. Consequently, it interferes with the mitotic spindle's setup, which causes actively dividing cells to die. Vincristine generally works better when taken with other anticancer medications. Combining drugs with distinct mechanisms of action with chemotherapy can improve the destruction of tumor cells and lessen toxicity and drug resistance. Vincristine-containing combination therapies are presently being investigated in ongoing research studies *(e.g., NCT02879643; NCT01527149)*.

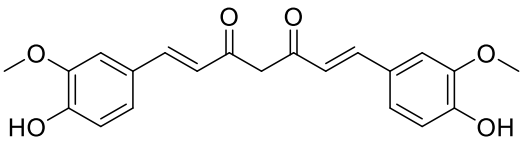


Vinblastine

Lately, a case study described the treatment of juvenile sarcoma with vincristine and dactinomycin as adjuvant therapy following surgical removal of the tumor. The duration of chemotherapy was determined based on the tumor's response. After 18 months of treatment, the patient showed no signs of diminished function or relapse *(Yoshihara et al. 2017).*

Curcumin

Curcumin, a polyphenolic compound also referred to as diferuloylmethane *(a bis-α, β-unsaturated diketone)*, is derived from the rhizome of turmeric *(Curcuma longa L.)*, a tropical plant native to Southeast Asia that is widely used as a spice. Turmeric powder, which contains 2-5% curcumin, has been utilized in ancient Chinese and Indian traditional medicine *(Kocaadam and Şanlier 2017)*. In solution, curcumin coexists in harmony with its keto-enol tautomeric forms, and a bright orange-flake is a strongly lipophilic phenolic product. It is neither highly volatile nor solvable in water, although it degrades more in basic media *(Sinha et al. 2003).* Curcumin's anticancer properties have drawn attention due to the low rate of gastrointestinal mucosal cancers in Southeast Asian populations and its association with regular turmeric use in their diets.

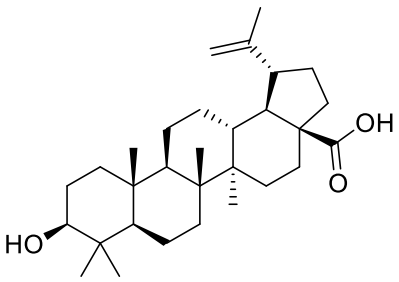


Curcumin

Reports indicate that curcumin can enhance the effectiveness of certain cancer medications, including gemcitabine, paclitaxel, 5-fluorouracil, and doxorubicin. Additionally, it may work synergistically with various natural products such as resveratrol, honokiol, epigallocatechin-3-gallate, and omega-3 fatty acids. This approach could help defeat tumor resistance and lower the risk of cancer returning *(Klippstein, Bansal, and Al-Jamal 2016; Pimentel-Gutiérrez et al. 2016)*. However, its clinical efficacy has been severely impeded because curcumin is poorly absorbed, improperly processed, and has weak systemic bioavailability. To achieve apparent levels in the bloodstream, patients must take up a few grams of free curcumin orally regularly *(Gupta, Patchva, and Aggarwal 2013)*.

Betulinic Acid

Betulinic acid, scientifically known as 3-hydroxy-lup-20*(29)*-en-28-oic acid, was initially discovered and extracted from the plant Gratiola officinalis L. This compound is a lupine-type pentacyclic triterpene, biosynthesized from six distinct isoprene units, and is also referred to as "graciolon." It is now widely recognized that betulinic acid is distributed in significant quantities across various plant species, including those from the genera Betula, Diospyros, Syzygium, Ziziphus, Paeonia, Sarracenia flava L., Anemone raddeana Regel, and Lycopodium cernuum L. *(Ali-Seyed et al. 2016)* A University of Illinois investigator claimed the initial anticancer activity of betulinic acid in 1995. Because studies show that betulinic acid has a broader range of action against different cancer cells, the National Cancer Institute has decided to include it in the Rapid Access to Intervention in Development program.



Betulinic Acid

Similar to several clinically used drugs, betulinic acid suppresses the growth of hard tumors in vivo and exhibits significant in situ cell death in a variety of tumor cell strains. Even at 500 mg/kg b.w. dosages, it exhibits a good

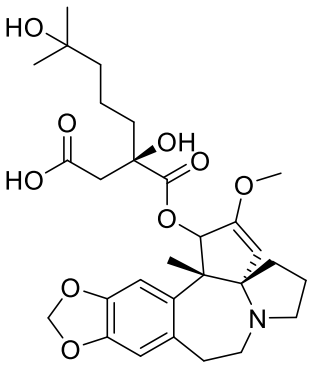
affinity ratio for cancerous cells over healthy ones *(Lee, Kim, and Park 2015; Zhang et al. 2015).*

On a variety of molecular targets, betulinic acid exhibits strong anticancer properties. The direct control of the mitochondrial apoptotic pathway, which results in apoptosis, is its main mechanism. This process, which is linked to mitochondrial collapse, is accomplished by downregulating Bcl-2 family members, lowering the outer membrane potential of the mitochondria, and directly activating the permeability transition pore. It also raises caspase activity, releases pro-apoptotic molecules such cytochrome c, and reduces STAT3 phosphorylation, nuclear translocation, and DNA binding.

It is necessary to overcome betulinic acid's low water solubility in order to improve its metabolism and absorption. Given betulinic acid's considerable promise as an anticancer medication, phase I and II clinical trials were carried out to assess the drug's safety and effectiveness *(Luo et al. 2016).*

Homoharringtonine

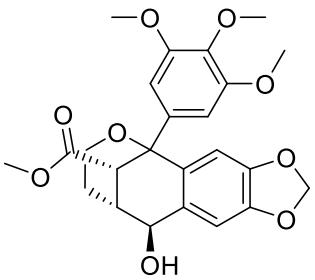
The cephalotaxine nucleus, specifically cephalotaxine 4-methyl-2*(R)*-hydroxy-2-*(4-hydroxy-4-methylpentyl)* succinate, is found in the alkaloid homoharringtonine. Traditional Chinese medicine has utilized bark extracts from the trees Cephalotaxus harringtonii *(Knight ex J. Forbes)* K. Koch and Cephalotaxus fortunei Hook. for cancer treatment, from which homoharringtonine was initially isolated. Homoharringtonine is a translation inhibitor that prevents the elongation phase of protein synthesis. Charged tRNA cannot enter the big ribosomal subunit because homoharringtonine binds to its A-site. Consequently, peptide bond formation is inhibited. When applied for the cure of persistent myeloid leukemia, homoharringtonine has a lengthy history of clinical efficacy and safety. Its application in patients who have grown tolerant or intolerant to other tyrosine kinase inhibitors, including imatinib and sorafenib, is currently the main emphasis. Persons with the T315I mutation, a variant that makes tyrosine kinase inhibitors ineffective, are also being evaluated for it *(Gandhi, Plunkett, and Cortes 2014; Chang et al. 2017).*



Homoharringtonine

Podophyllotoxin Derivatives

Plants belonging to the Podophyllaceae family, specifically Podophyllotoxin emodii Wallich and Podophyllum peltatum Linn., have reportedly been used medicinally for a very long time to treat skin cancer and warts. Native American communities have used Podophyllum peltatum for cancer treatment.



Podophyllotoxin

Originally identified in 1880, the primary cytotoxic medicinal ingredients were found to be podophyllotoxins; however, it wasn't until the 1950s, when spectroscopic techniques advanced, that their precise structure could be determined. During this time, other closely

related podophyllotoxins, such as lignans, were also discovered and put into clinical trials; however, their ineffectiveness and intolerable toxicity led to their withdrawal.

CHEMOPREVENTION

Cancer chemoprevention refers to the use of a combination of organic and synthetic medicines to hinder, avert, or slow down carcinogenesis. This can be achieved by obstruct the initial point of carcinogenesis or by reducing the proliferation point, where initial cancer cells multiply to form a tumor.

Chemoprevention aims to halt or reverse the development of cancer and prevent the progression of cancerous cells. This strategy is widely recognized and supported by physicians and patients, similar to how medications are used to reduce the possibility of heart attack or stroke by lowering blood sugar levels and cholesterol. Furthermore, some individuals who appear healthy but are at a higher risk for cancer may choose to engage in chemoprevention to lower their chances of developing an incurable cancer. Figure 5 the text illustrates the functioning phases of various chemopreventive categories and the sequential progression of cancer. Generally, substances that hinder the advancement phase are called suppressive compounds, while those that disrupt the initiation stage are referred to as inhibiting compounds.

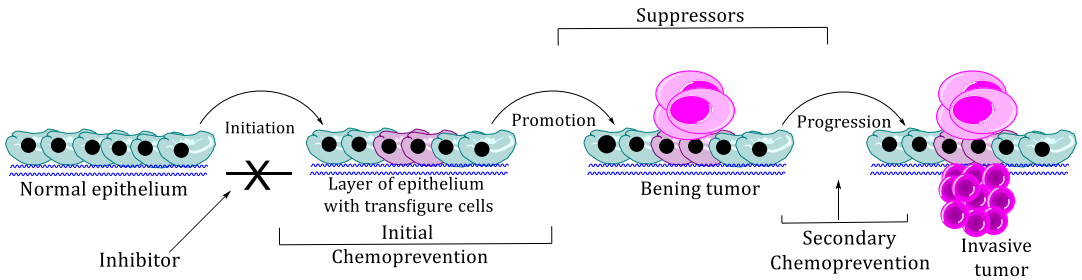


Fig. 1: Visual depiction of the cancer's progressive course, with particular attention to the phases in which various chemopreventive groups work

Table 1: Some clinical trials of main chemopreventive molecules have been conducted using the phytoconstituents as potent chemoprevention.

Molecules	Target Cancer Part	Consequences	References
Grape seed procyanidin extract	Lung	Low serum level of oncomi Rs	*(Mao et al. 2021)*
Tamoxifen	Breast	Reduction	*(Cuzick et al. 2013)*
Raloxifene	Breast	Tumor reduction	*(Cuzick et al. 2013)*
Celecoxib	Skin	Decrease tumor	*(Elmets et al. 2010)*
5-FU	Skin	Low cutaneous squamous carcinoma	*(Weinstock et al. 2018)*
Resveratrol	Breast	Hypomethylation	*(Zhu et al. 2018)*
Curcumin	Skin	Slight reduction in lesions	*(Kuttan, Sudheeran, and Josph 1987)*
β-carotene	Lung	High incidence	*(Albanes et al. 1995)*
Vitamin E	Prostate	Reduction in tumor	*(Klein et al. 2011)*
Selenium	Prostate	Low tumor incidence	*(Zhong et al. 2021)*

CURRENT AND FUTURE SCENARIO OF USAGE OF HERBAL MEDICINE IN CANCER THERAPEUTICS

Interest in using herbal medicines in conjunction with cancer therapies has grown because they can increase treatment efficacy and improve quality of life of the sufferer. According to latest studies, that various herbal remedies may provide additional benefits when combined with traditional cancer treatments.

Most organically derived medications were introduced between the 1970s and 1980s. With the advent of molecular-targeted cancer treatment in the early nineteens, developed compound databases became the primary goal of tiny-molecule medication research in both industry and university.

In addition to chemotherapy and radiation therapy, different forms of cancer care services have been offered as the number of cancer patients has been increasing annually. As they deal with cancer, more and more patients are turning to complementary and alternative therapy in various forms. Herbal medicine therapy has gained popularity among therapies for multiple reasons, including enhancing mental health, boosting the immune system, and alleviating physical symptoms *(Poonthananiwatkul et al. 2015)*. According to survivors of cancer who have used medicinal products, they reduce symptoms, lessen side effects from traditional cancer therapies, and stop the disease from spreading or reoccurring. A systematic assessment of herbal supplements in the United Kingdom found that 20–24% of cancer patients were using them to cope with their discomfort and boost their quality of life *(Asiimwe et al. 2021; Theuser et al. 2021)*.

Numerous bioactive compounds found in plants have led to extensive research into herbal medicine as a possible source of anticancer medications. A number of compounds derived from plants have demonstrated encouraging anticancer effects by inhibiting angiogenesis, the process by which new blood vessels grow to supply malignancies. These chemicals have the ability to induce cancer cells to undergo apoptosis, or programmed cell death, in addition to interfering with crucial signaling pathways linked to the development and metastasis of cancer.

Some medicinal products, including Chinese herbal medicine, have shown promising results in alleviating symptoms and enhancing the effectiveness of radiation and chemotherapy.

A. Anticancer herbs used as traditional and folklore medium

Various parts of plants, fungi, and algae, along with plant extracts and powdered herbs, have been used as herbal remedies in addition to prescribed medications.

1. The isolation of plant-active chemicals began as a novel trend in the early 1800s. This trend led to the discovery of several important analgesic drugs, including morphine and codeine from opium Papaver somniferum L., cocaine from Erythroxylum coca, and digitoxin, a cardiac glycoside obtained from Digitalis purpurea and Digitalis lanata. Digitoxin has been used as an anti-cancer drug and for treating cardiac conditions *(Balunas and Kinghorn 2005).*
2. Additionally, quinine is derived from Cinchona calisaya Wedd. and Cinchona succirubra Pav. ex Klotzsch, possesses antipyretic *(fever-lowering)*, antimalarial, analgesic, and anti-inflammatory properties. Many of these compounds are still in use today *(Menger et al. 2013; Elbaz et al. 2012)*.
3. Recent studies have demonstrated that extracts from Chaetomium globosum and 5-methyl phenazine-1-carboxylic acid produced by Pseudomonas putida, exhibit cytotoxic effects on cancer cell lines *(Awad et al. 2014; Y. Wang et al. 2012)*.

4. Extracts from the bark of Taxus brevifolia Nutt. *(Western yew)* have been found to contain the taxane dipertene, which was first shown to have cytotoxic effects by Wani et al. in 1971.
5. Subsequent research revealed that many other species of Taxus also produce this compound. In 1993, it was discovered that the endophytic fungus Taxomyces andreanae produces Taxol, albeit in low quantities. Other endophytic fungi have also been shown to produce Taxol, indicating that future fermentation processes involving microorganisms may be able to generate this compound *(B. H. Guo et al. 2006)*.
6. The most well-known and thoroughly studied chemopreventive agent is curcumin, also referred to as diferuloylmethane. This yellow-orange powder derived from turmeric is a polyphenol found in the rhizome of Curcuma longa. Traditional Indian medicine and Chinese medicine have both used curcumin as a drug to treat several illnesses *(Thangapazham, Sharad, and Maheshwari 2013; Jackson et al. 2013)*.
7. Berberine and palmatine are the anticancer substances found in Tinospora cordifolia. While palmatine is found in both the root and the stem, berberine is found in the stem. Both palmatine and berberine are protoberberine alkaloids with anticancer properties. The isoquinoline alkaloid berberine possesses several beneficial properties, including anti-inflammatory, anti-cancer, antioxidant, and immune-boosting effects. Its antioxidant activity helps reduce free radicals and reactive oxygen species, which are known to contribute to cancer development. Additionally, berberine can interrupt the cancer cell cycle at the G1 phase and promote apoptosis *(programmed cell death)*. As a result, it exhibits strong anticancer activity against various types of cancers, including lymphoma, liver tumors, and prostate cancer *(Mittal, Sharma, and Batra 2014; Umadevi et al. 2013)*.
8. Compounds from Ocimum species studied for their ability to combat cancer in specific clinical trials. By starting the mitochondrial pathway that results in apoptosis, or programmed cell death, these organic compounds have strong anticancer effects. In the treatment of cancer, substances that attack cell mitochondria, such betulinic acid, can offer novel approaches to conquering drug tolerance. The anticancer capabilities of betulinic acid are susceptible to a number of human tumors, including neuroblastoma, glioblastoma, and medulloblastoma, as well as a number of carcinomas, including head and neck region, colon, breast, hepatocellular, lung, prostate, renal cell, ovarian, and cervical carcinoma. *(Galluzzi et al. 2006)*.
9. The bark and branches of Ziziphus nummularia contain betulin and betulinic acid, which have been demonstrated to display anticancer properties. Glycosides of betulinic acid induce differential cytotoxicity, making various cancer cell types more susceptible than healthy cells. By producing reactive oxygen species, inhibiting topoisomerase I, activating the mitogen-activated protein kinase *(MAP kinase)* cascade, inhibiting angiogenesis, and modifying pro-growth gene activators and aminopeptidase-N activity, betulinic acid has been proposed to cause cell death *(Gauthier et al. 2006; Sarek et al. 2005).*
10. Andrographis paniculata is a natural remedy for cholestasis and jaundice caused by hepatotoxins. A broad range of cancer cells are sensitive to the cytotoxic effects of andrographolide. Specifically, andrographolide exhibits cytotoxic effects on HCT-116 colon cancer cells, P388 lymphocytic leukemia cells, MCF-7 breast carcinoma cells, and KB human epidermoid cancer cells. Andrographolide also inhibits

the growth of the HT-29 colon cancer cell line, stimulates the proliferation and division of human peripheral blood lymphocytes, and has pro-differentiative effects on the mouse myeloid leukemia M1 cell line *(Desai et al. 2008).*

11. Allium sativum is a member of the Amaryllidaceae family, the Allioideae sub family, the Aparagales order, and the Allium genus. Garlic and its organosulfur compounds have been shown in studies to reduce the risk of some malignancies, including those of the skin, uterus, esophagus, bladder, lung, throat, and breast. Research has shown that allicin, an essential compound found in garlic, has anti-tumor properties, particularly against prostate and breast cancers. It helps prevent cancer by inducing programmed cell death. When garlic is crushed, an enzymatic reaction converts alliin into allicin, which inhibits the formation of malignant cells. Additionally, another compound derived from garlic, known as ajoene, prevents the proliferation of leukemia cells, ultimately leading to their elimination through programmed cell death *(De Greef et al. 2021)*.

12. The Oleaceae family includes the olive plant, scientifically known as Olea europaea L., which comprises approximately 35 to 40 varieties. Research indicates that oleic acid is a key component contributing to the anticancer effects of olive oil. Olive oil also contains ole europein, a well-known phenolic compound that can directly impact the HER2 genes in breast cancer cells *(Kure et al. 2019)*.

13. A genus belonging to the Asteraceae family, milk thistle is native to the Mediterranean basin and is found throughout Europe. The plant has cone-shaped flowers that are red to purple and can reach a height of 30 to 200 cm. Additionally, studies have shown that the milk thistle ingredient silymarin can halt the cell cycle and induce apoptosis in the 4T1 breast carcinoma cell line *(Jao et al. 2022).*

14. Unlike vincristine and vinblastine, primarily identified as chemotherapy compounds, the aerial parts of the plant contain several alkaloids, including vincristine, vindoline, vinblastine, vinflunine, and catharantin. Two of these alkaloids are currently used as anticancer drugs, and they are involved in the secondary metabolism of the plant. Research has demonstrated that these alkaloids possess antioxidant properties, which have been shown to disrupt the structure of tubular proteins in various cancer tissue line, including MCF-7 *(breast)*, PC3 *(prostate)*, and HeLa *(cervical)*. This disruption impedes cell division and ultimately halts the growth of cancer cells.

15. Avicennia marina, an essential part of the mangrove ecosystem, is a type of mangrove that thrives in salty conditions. This plant produces flowers with four petals, which can be either white or yellowish-orange, and its leaves are typically oval or pointed. Studies have shown that flavonoids in its leaves are effective against breast cancer cells, particularly the BT-20 cell line. Furthermore, extracted naphthoquinone has shown comparable effectiveness against the KB cell line, a type of laryngeal cancer cell. Moreover, the cytotoxic effects of this extract on the MDA-MB-231 breast cancer cell line have been verified

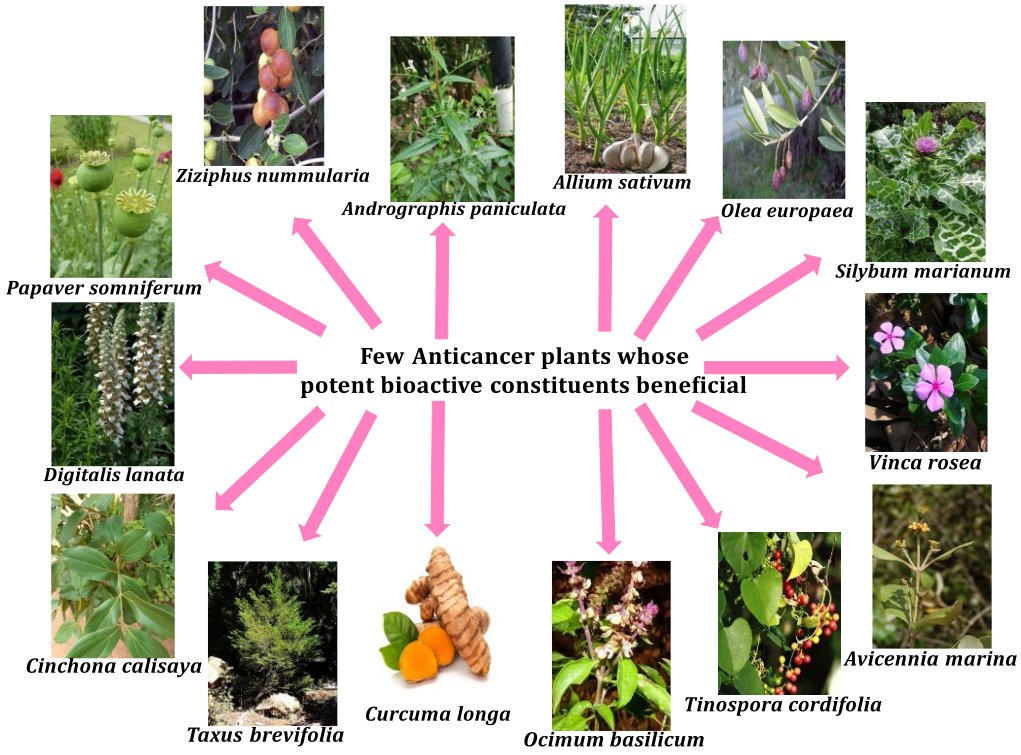


Fig.2: Some medicinal plants having potent anticancer properties

B. Marketed products available

Clinical trials are being conducted to examine several groups of natural items or medications developed from them. One of their most notable is the conjugates of antibody drugs, which use chemical linkers to combine strong cytotoxins and monoclonal antibodies *(mAb)* into a single molecular entity. As the purpose of treating CD33-positive acute myeloid leukemia *(AML)*, gemtuzumab ozogamicin, a humanized anti-CD33 monoclonal antibody conjugate molecular bonded to the cytotoxic antitumor antibiotic calicheamicin, was initially authorized under rapid permission in 2000.

It has been discovered that many herbal bioactive components have anti-cancer effects. For example, in the heartwood of Haematoxylon campechianum, hematoxylin and its derivatives were found to be ATP-competitive antagonists of wide-spectrum enzyme kinase mediators. Their IC50s were found to be most potent at miniature levels *(L.-G. Lin et al. 2008).*

First isolated from the leaves of the therapeutic herb feverfew *(Tanacetum parthenium)*, parthenolide is a sesquiterpene lactone that inhibits Wnt/β-catenin signaling through its impact on the ribosomal enzyme RPL10 *(Zhu et al. 2018).*

The action's process of the primary marine-derived antitumor medication, trameptin, which comes from the Caribbean tunicate Ecteinascidia turbinate, is still unknown.

Table 2: List of a few natural drugs and semisynthetic herbal derivates marketed for anticancer activity

S.No.	Class	Lead Compound	Semisynthetic herbal derivative	Obtained sources
1	Vinca Alkaloid	Vincristine	Vinorelbine, Vinflunine	P
		Vinblastine	Vindesine	P
2	Taxanes	Paclitaxel	Docetaxel, Cabazitel	P
3	Camptothecin	Camptothecin	Topotecan, Irinotecan	P
4	Epothilones	Epothilones	Ixabepilones	B
5	Podophyllotoxins	Etoposide	-	P
		Teniposide	-	P
6	Antibiotics	Doxorubicin	Idarubicin	B
		Daunobicin	Epirubicin	B
		Mitomycin	-	
		Dactinomycin		B
7	Retinoids	Retinol	Tretinoin	P
8	Marine Products	Cytarabine	-	M
		Trabectedin		M

Sources: M, marine; P, plants; B, bacteria

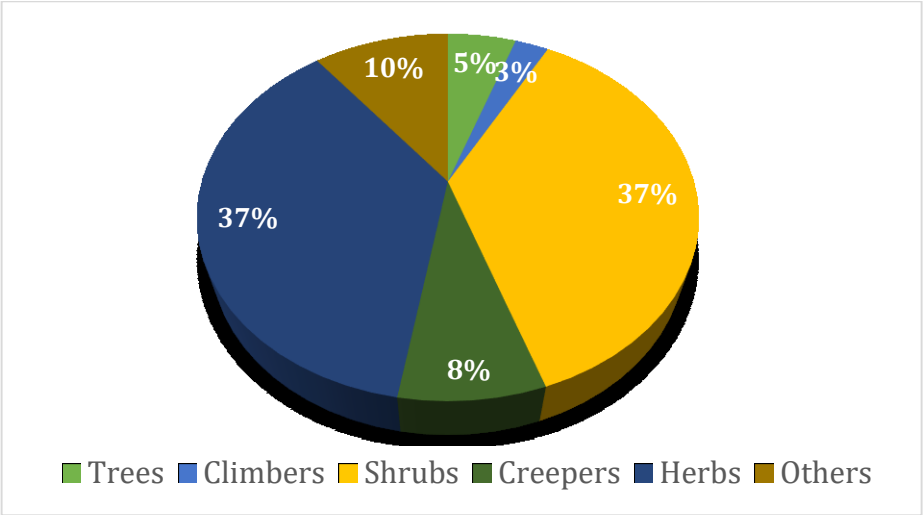


Fig. 3: Various plant species from different genera are used to treat cancer

CONCLUSION

Bioactive compounds with anticancer properties are found in herbal medicine and are crucial for cancer treatment and chemotherapy. Research indicates that these bioactive compounds and herbal extracts can enhance traditional cancer treatments and help inhibit tumor growth. Studies on natural compounds have led to the development of commercially available drugs with significant anticancer effects, providing new treatment options for patients. Integrating herbal products into cancer therapies has the potential to advance the field of oncology and improve patient outcomes.

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