Volume 2, Issue 4, 2023, Page 546-566

International Journal of Pharma Research and Technology

Anticancer Medicinal Plants: A Review

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Abstract

Cancer is a condition in which abnormal cells multiply uncontrollably and can infiltrate surrounding tissues. The lymphatic and vascular systems of the body are further routes by which cancer cells might spread Research on cancer treatments has advanced significantly. Choices for cancer therapy range from the most traditional to the most cutting-edge. Surgery, chemotherapy, radiation therapy, and other techniques are used as therapies. The therapies used have some adverse effects on the normal cells of body, so the medicinal plants are used for anticancer effects. By blocking cancer-causing enzymes, promoting the creation of protective enzymes, stimulating DNA repair mechanisms, and inducing antioxidant reactions, many plants produce products that are effective in the treatment of cancer. This review covers the need for naturally occurring compounds that originate from various traditionally and currently used medicinal plants and their features which make them potential targets for cancer therapy. The principal antioxidant characteristics of medicinal plants chemical constituents contribute to their anticancer potential. Due to the wide range of pharmacological properties of medicinal plants which include cytotoxic and chemo preventive effects, natural substance produced from plants like flavonoids, terpenoids, and steroids have drawn a lot of attention. This article examines the desire for naturally occurring chemicals obtained from medicinal plants and how those compounds could potentially be used to treat cancer.

Keywords: Cancer; Medicinal Plants; Phytocompounds; Anticancer activity; Chemotherapy

Introduction

In order to create new anticancer medicines, there has been extensive research on a variety of plant resources. The past few years have shown that medicinal herbs are an essential less harmful natural source for cancer treatment. Existing natural cytotoxic medications need to be improved upon and replaced by brand-new medications[1]. Cancer treatment research has grown tremendously. Cancer treatment options range from the most conventional to the very contemporary. The treatments include surgery, radiation therapy, chemotherapy, and more. All of them, however, have some drawbacks Conventional chemical use has negative effects and toxicities. However, because conventional chemotherapeutic techniques have failed,

new strategies are required for the control of diseases as the issue endures. Hence, in order to reduce the number of deaths caused by cancer, innovative cancer preventive and treatment methods are required[2]. According to estimates, about 50% of prescription drugs sold in Europe and the United States come from natural sources or are derived from them from the 500,000 to 250,000 plants about 1-10% of the species on Earth have had their potential medical usefulness investigated chemically and pharmacologically[3].The most often used drug in both conventional and complementary medicine is phytotherapy. Over 60% of the global population works there, also it is a really essential part in the community health systems of multiple nations; because of screening, numerous plants, many medications, and currently widely utilised in therapy were developed. The plants have an edge over synthetic ones when it comes to the requirement for the launch of new pharmaceuticals to the market because of their molecular variety and as a result, modifications to biological function are more intricate[4].

Cancer

What is Cancer?

Cancer is a hereditary condition that is characterized by uncontrolled cell growth that develops from a single normal cell that has undergone malignant transformation. This uncontrolled cell growth multiplies swiftly and uncontrollably before spreading to other cells through body fluids including blood and lymph nodes[5]. Malignant tumors are created when cancer cells infect neighboring cells and then spread to nearby lymph nodes or other body parts. This process is known as metastasis or carcinogenesis[6]. Cancer chemoprevention entails the use of manufactured or naturally occurring chemicals in pharmacologic intervention to stop, block, or reverse cancer development or stop the growth of aggressive cancer[7].

Figure No.1: Types of Cancer

Role of Medicinal Plants

In advanced nations, certain plants are consumed for their wellbeing benefits., while people in Asia and Africa have employed medicinal plants for thousands of years in traditional medicines[8]. The principal antioxidant characteristics of medicinal plants' chemical constituents contribute to their anticancer potential[9]. Due to the wide range of pharmacological properties of medicinal plants which include cytotoxic and chemo preventive effects, natural substance produced from plants like flavonoids, terpenoids, and steroids have drawn a lot of attention[10].

A few of the numerous antioxidants included in medicinal plants include vitamins (A, C, E, and K), carotenoids, flavonoids (flavones, isoflavones, flavanones, anthocyanins, catechins, and isocatechins),polyphenols (ellagic acid, gallic acid, and tannins), saponins, enzymes, and minerals. (selenium, copper, manganese, zinc, chromium, iodine, etc)[10]

Vinca alkaloids are derived from Catharanthus roseus and include vinblastine and vincristine. were among the most significant and useful medications made from higher plants. These pharmaceuticals are used to treat leukemia, bladder cancer, and testicular cancer[11]

Compounds derived from medicinal plants that have anticancer properties may do this viaa variety of pathways, including actions on cytoskeletal proteins that are essential for cell division, inhibition of DNA topoisomerase enzymes, antioxidant or antiprotease activity, immune system stimulation, etc[12].

The ideal strategy for finding promising leads will be to combine structural chemistry, in vitro tests, and cell biology. There is strong scientific support for the idea that plant-based diets, both nutritive and non-nutritive, can successfully suppress the development of cancer[7].

This article examines the desire for naturally occurring chemicals obtained from medicinal plants and how those compounds could potentially be used to treat cancer[1]

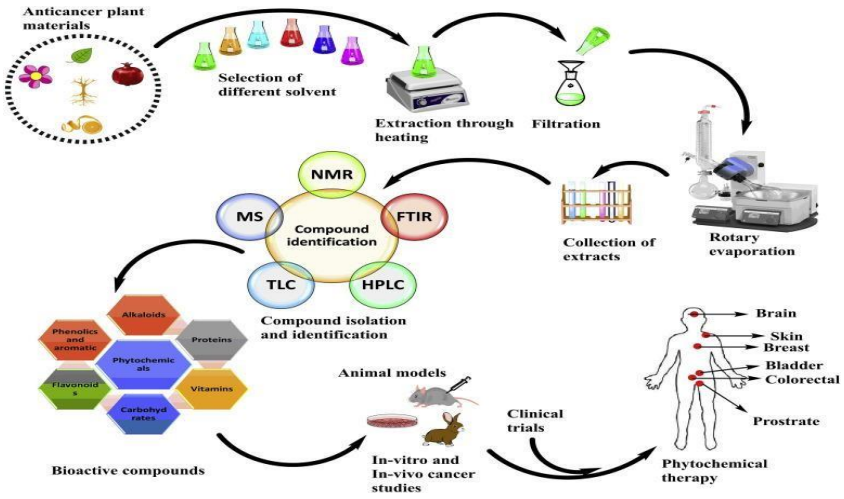


Figure No.2: Pharmacology Activity of Plant as Anti-Cancer Effect

Anticancer Agents in Medicinal Plants

Plant-based chemicals found in plants are in charge of protecting against disease and boosting health, thus it's important to understand their effectiveness and how they work. These studies have involved chemical component recognition and isolation, biological potency testing on lab animals both in vivo and in vitro, and case monitoring and case studies research on humans[14]. The discovery of the bisindole alkaloids vinblastine and vincristine in the Madagascar periwinkle Catharanthus roseus marked the start of a new period in the application of using plants as anti- cancer medications. They were the initial plant-based cancer therapies to be used in clinical trials[15].

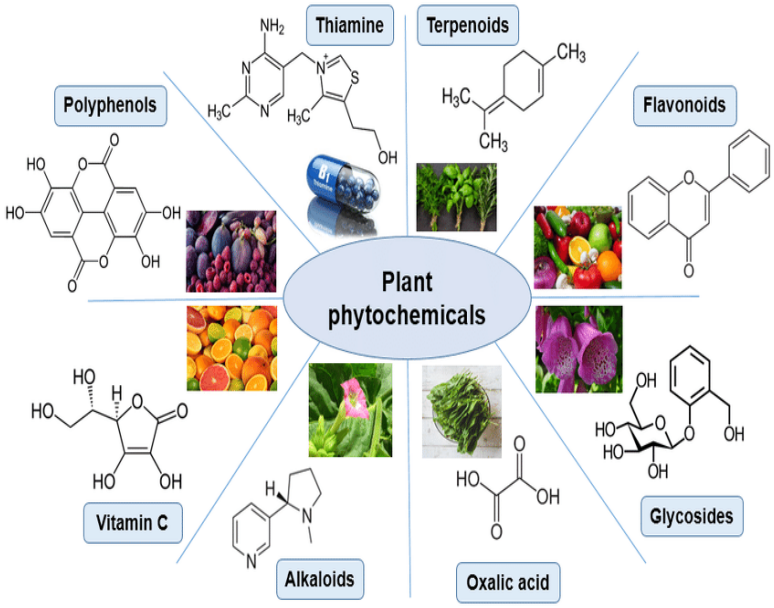


Figure No.3: Phytochemical Agents in Medicinal Plants

Alkaloids, terpenes, flavones, phenolics, and polyphenols are among the phytopharmaceuticals that make up the majority of plant-derived active ingredients

1. Alkaloids

The typical heterocyclic nitrogen compounds known as alkaloids are biosynthesized from amino acids. Depending on their biological activity, chemical composition, or metabolic process, they can be categorized. According to the biosynthetic amino acid that each alkaloid is made of, alkaloids are frequently categorized into five major groups: benzylisoquinoline, indolequinoline, pyridine (pyridine), quinolizidine and piperidine alkaloids (lysine), and pyrrolizide alkaloids[16].

2. Vincristine Sulfate Kyocristine

Apocynaceae plant Vinca rosea Linn. yields the natural alkaloid vincristine sulfate, which has strong anti-cancer properties. Vincristine inhibits mitosis and depolymerizes microtubules, which further stops tumor cells in the cell cycle's S and M phases. This medication is a key component of a major

chemotherapy regimen that reduces the development of cancer cells in a variety of ways, including both cell cycle phase arrest and apoptosis, which halts cell division. For the treatment of solid tumors for the entire group as well as leukemias including acute lymphoblastic leukemia (ALL) with Philadelphia chromosome-negative (Ph-) and Burkitt lymphoma, vincristine was licensed by the US FDA in 1963 under the brand name Oncovin[17]. Vinblastine and vincristine are frequently used in conjunction with other types of chemotherapeutic medications to treat a variety of malignancies, such as leukemias, metastatic tumors, breast and lung carcinomas, and Kaposi's sarcoma[18].

3. Terpenoids

Terpenoids are categorized as polyterpenes, hemi-, mono-, di, tri & tetraterpenes depending on how many isoprene units they contain. According to a number of studies, terpenoids' anticancer action is caused by the suppression of swelling, malignant tumors, metastasis, activation of programmed cell death, and maturation. Triterpens, which contain isopentenyl formate, and sodium pyrophosphate oligopeptides, are one significant class of terpenoids. They come in a variety of structural subclasses and are biogenesised by herbs through the formation of one or more rings in the chemical structure of the 30-carbon intermediate metabolite and isoprenoid molecule in the production of cholesterol. There is evidence that certain triterpenoids have anticancer properties[19].

4. Betulinic Acid

The plant Betula pubescens (Betulaceae) produces betulinic acid, which has anti-inflammatory and anti-cancer properties. It is a nucleic acid that is a class of enzymes that alter the supercoiling of double-stranded DNA that causes programmed cell death by disrupting the mitochondria and triggering caspase cascades. As an application to the body surface of emollient for the therapy of cancer that arises from the skin, a phase-I trial is currently being conducted[17]. A frequent secondary metabolite of plants, betulinic acid is a pentacyclic triterpene that ismostly found in Betula species. In isolated Zizyphus species, such as mauritiana, rugosa, and oenoplia, betulinic acid showed specific injuriousness to human cancer cell lines[19].

5. Phenolic Compounds

Phenolic molecules are biogenesised by medicinal plants through the shikimic, cinnamic acids, and flavonoid pathways. These substances were identified as having cytotoxic, antiproliferative, and antioxidant effects. The same medicinal herbs that are conventionally used to treat carcinoma in Ethiopia have a wealth of phenolic chemicals that have been discovered elsewhere. For instance, the Maytenus senegalensis compound (-) epigallocatechin (25) has demonstrated strong cytotoxic action against a mouse cancer cell line[18].

6. Flavopiridol

The plant organic compound rohitukine N-oxide, which was isolated from Dysoxylum gotadhora, is the source of the synthetic flavone flavopiridol. Clinical trials are currently being conducted on it in phases I and II for different forms of cancers, including leukemia, lymphomas, and solid tumors. Phase II clinical studies for the artificial substance Seliciclib, which is generated from the pure substance olomucine that was initially separated from Raphanus sativus L. are being conducted in Europe[19].

7. Steroids

Both their anticancer and immune-boosting characteristics have been described for steroids and their conjugates derived from plant sources. Withaniasomnifera also referred to as Ashwagandha, is a medicinal herb that yields withanolides, which are steroidal chemicals. Withaferin-A, one of its steroidal lactones, stops the growth of tumors by covalently attaching to cysteine-303 of -tubulin. This statement is intended to inform readers that steroidal conjugates, such as Pregnane alkaloids, Dioscin (67), and cardioactive steroids are also well known for their cancer prevention, non-steroidal, and antibacterial properties[20].

Medicinal Plants Used With Anti-Cancer Effects

1. Curcuma longa linn

Turmeric, haridra, and haldi are some of the common names for Curcuma longa in English, Sanskrit, and Hindi. The plant's rhizome is typically used in cooking. Curcumin, produced from the plant's rhizome, is the active component of this plant. Both cancer prevention and cancer treatment involve turmeric[21]. It has both anti-inflammatory and anti-cancer effects. Regarding its non-steroidal anti-inflammatory properties, curcumin was discovered to inhibit the most common proinflammatory signaling cascades, such as the LOX, MAPK, NF-B, and COX pathways[22]. Turmeric has also been shown to impede the spreading and metastasis of cancerous cells in vitro by reducing MMP-2 activity and by inhibiting HEp2 cell invasion[21]

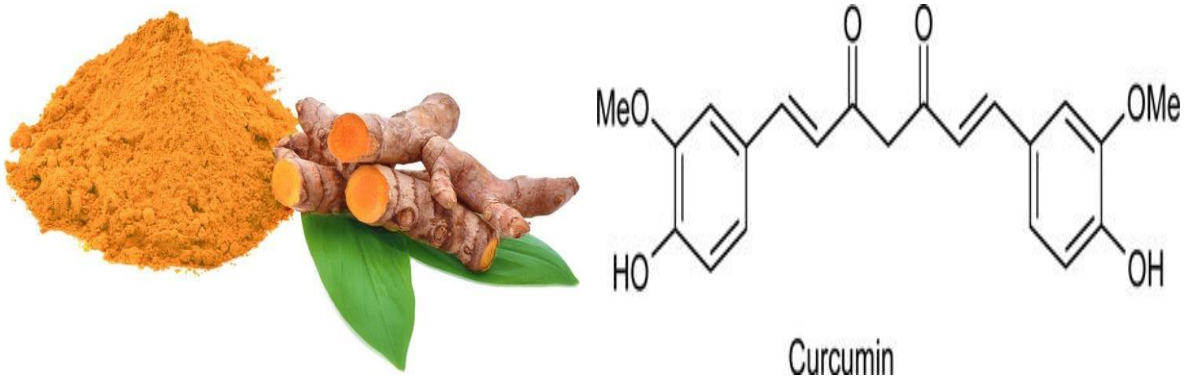


Figure No.4: Curcuma longa linn and its Chemical Structure

The mRNA and protein expression of COX-2 was inhibited by curcumin, whereas COX-1 did not exhibit a similar inhibitory impact. This information suggests that a curcumin concentration that is not harmful and has a considerable impact on the in vitro proliferation of HT-29 cells. Therefore, curcumin might be crucial in preventing colon cancer[2].

1. Withania somnifera

Withania somnifera is often called Ashwagandha, Winter cherry, also known as Indian ginseng, is a well-known plant that has been used for millennia in Ayurvedic medicine to promote longevity and optimal health and to increase the body's resilience to disease[4]. Undoubtedly, Ashwagandha is one of the plants that is most frequently used in

Ayurveda and other traditional medical practices. This plant is said to have performance enhancer, immune-stimulating, and life-extension characteristics in the traditional medical system. The ability of W. somnifera to reverse the oxidative damage caused by the tumor cells and lessen inflammation may be responsible for its anticancer properties. Another significant benefit is its capacity to augment established antineoplastic drugs' therapeutic effects while being unaffected by them[23].

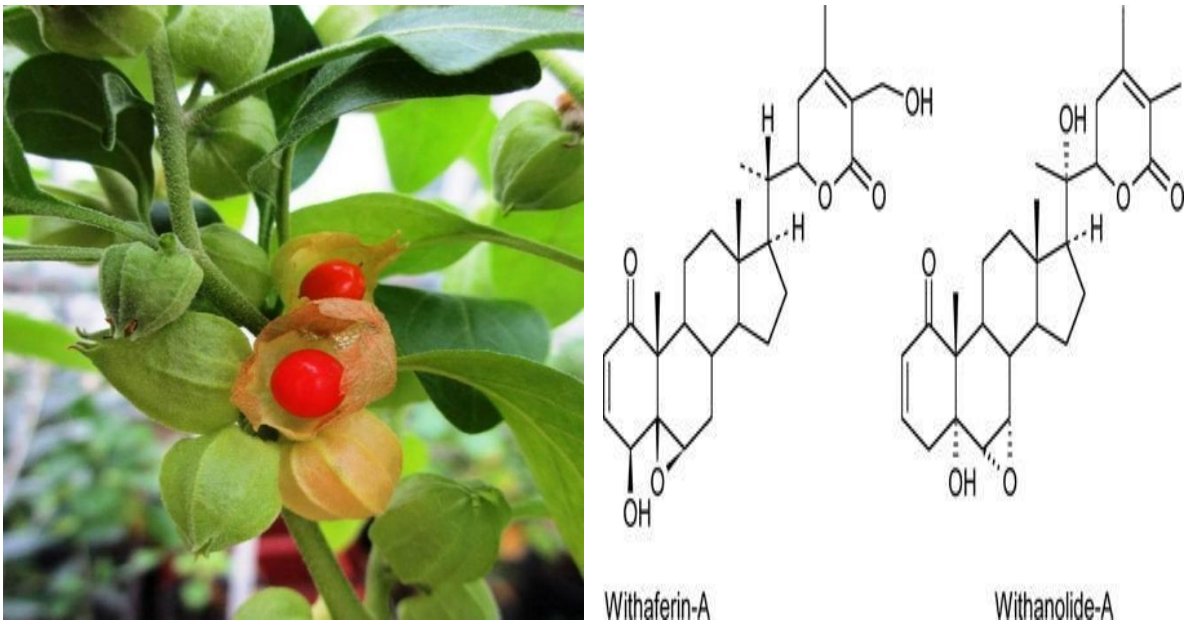


Figure No.5: Withania somnifera and its Chemical Structure

An elite variety of Ashwagandha's root and leaf tincture are combined in a specific ratio by researchers in Jammu Kashmir, India, to create a specific pharmacological formula that contains significant amounts of withanolide A and withaferin A. According to their most recent investigations, this Withaniasomnifera's formulation appears to give a multi-media activity to fightthe cancer sickness. In various human cancer cell lines, the Withaniasomnifera. It has been shown that the formulation causes cell necrosis[21].

2. Zingiber officinale

Zingiber officinale, also referred to as ginger, is a plant in the Zingiberaceae family that is frequently used in cancer-preventing conventional medicinal formulations for gastrointestinal, hepatic, and oesophageal cancers. It is also known as "ingi" in Tamil and "inguru" in Sinhalese. The rhizome is mostly utilized in multi-herbal mixtures for therapeutic purposes. In Sri Lankan cooking, it is a frequently used ingredient. This plant contains a variety of active compounds, such as gingerols, which are transformed into shogaols, paradols, and zingerone[24]. The anticancer properties of Zingiber officinale ethanol extract were examined in a model of skin carcinogenesis. Mice's skin was pre-applied with Zingiber officinale ethnol extract, and it significantly

inhibited the induced activation of ODC, cyclooxygenase, and lipoxygenase activities as well as ODC mRNA expression[25].

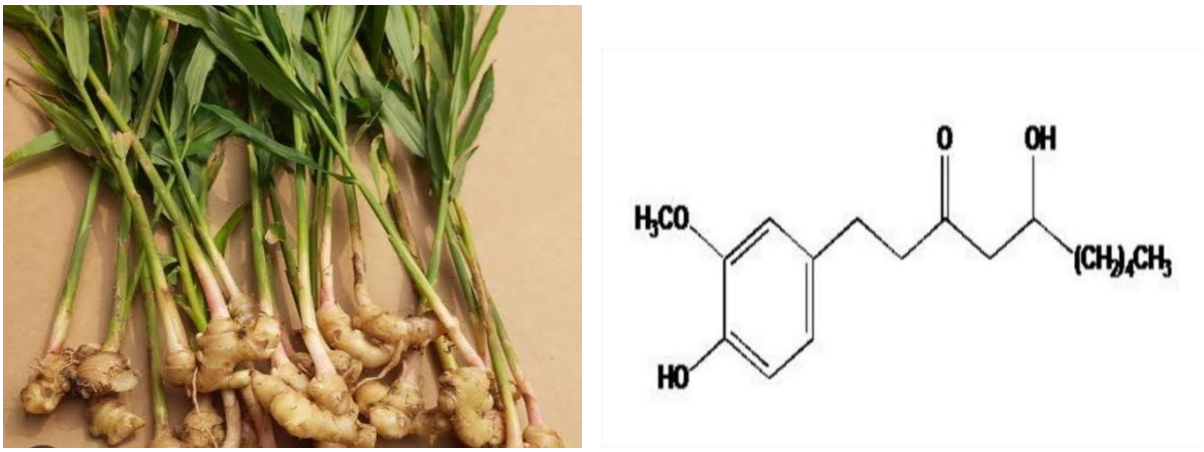


Figure No.6: Zingiber offcinale and its Chemical Structure

In lab investigations, this herb exhibits anti-inflammatory and anti-cancer properties. It can help lessen nausea and vomiting brought on by chemotherapy. However, ginger must be completely avoided both before and after surgery. Patients with low platelet counts should avoid it since it encourages bleeding[26]

3. Azadirachta indica

'Neem' is the popular name for the plant Azadirachta indica. The Meliaceae family includes this particular plant. This plant's entire body is used for medical purposes[27].Neem has long been utilised in Ayurvedic treatment, and the Hindu scriptures describe it as a tree that can cure any disease. It is frequently found in personal care products and has proven skin benefits[28]

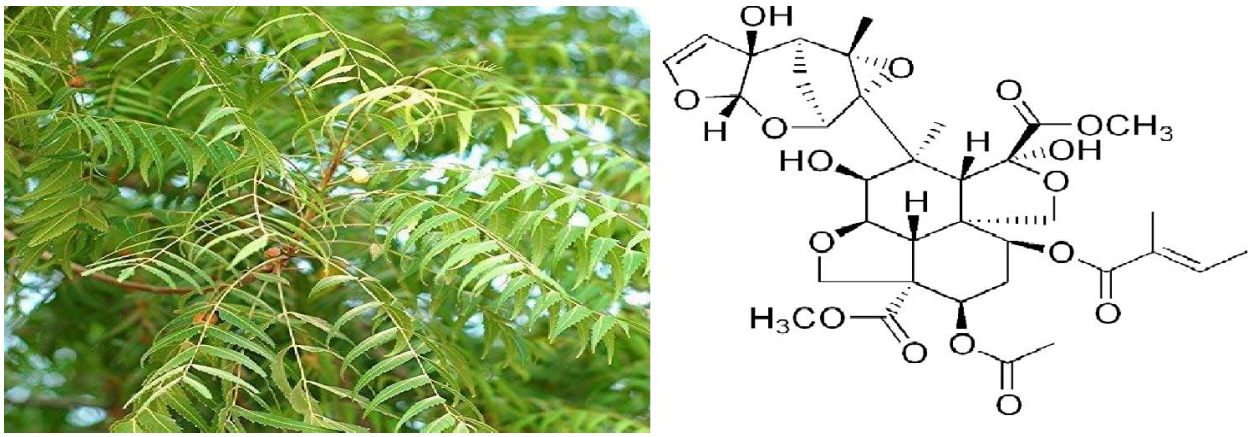


Figure No.7: Azadirachta indica and its Chemical Structur

It is made up of substances such as nimbin, nimbidin, nimbidol, and nimbolide that are biologically active. All of those substances contributed to the development and treatment of cancer by their anticancer, antioxidant, and inhibitory effects on the occurrence of uncontrollable cells caused by altering cellular proliferation, cancer suppressor genes, and programmed cell death29. Cyclins, kinases that are cyclin-dependent (CDKs), drugs that inhibit CDK (CKIs), the cell-cycle checkpoint proteins, and gene transcription factors like E2F make up a complicated network of regulatory proteins., closely regulate the progression of the cell cycle. Numerous target proteins have been identified as a result of research into how neem or its constituents affect tumor cell proliferation and the cell cycle13

Aloe vera

Aloe vera family is Xanthorrhoeaceae it is a perennial green herb that grows in the Southern Mediterranean, the Middle East of Asia, North Africa, the Canary Islands, and other desert regions. It has vivid yellow tubular flowers[30]. Aloe vera has demonstrated promising anticancer properties, including the ability to inhibit cell division, induce apoptosis, reduce inflammation, upregulate tumor suppressor genes, downregulate oncogenes, control hormone levels, control growth factors, and inhibit invasion and metastasis[31]

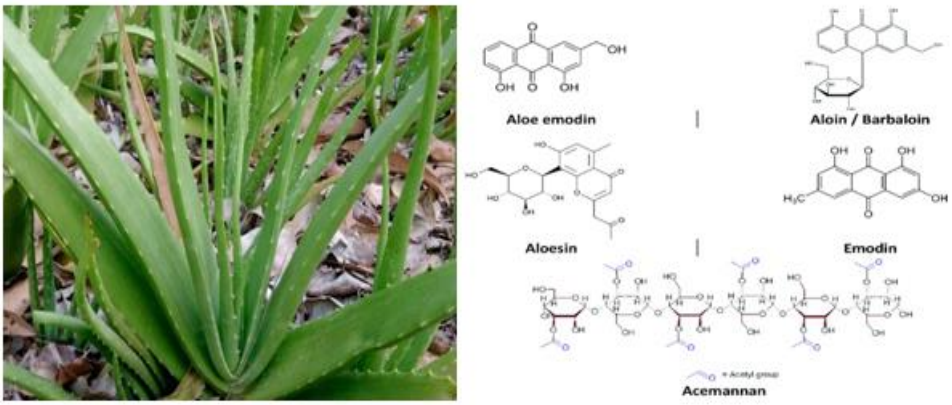


Figure No.8 Aloe vera and its Chemical Structure

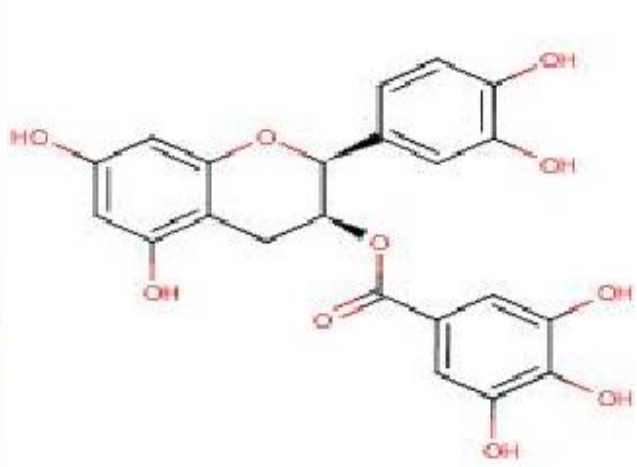
Aloe vera is a vital component of C. comosum which impedes the growth of tumor cells. Apoptosis may be regulated by the cytotoxic activity of A. vera and C. comosum, which is why both extracts showed anticancer effects against HepG2 cells. In response to extracts, p53 and Bcl2 gene and protein expressions were both considerably changed. The human HCC cell line, a key route for regulating programmed cell death, showed a time- and dose-dependent elevation of the expression of p53 and dose-dependent decreased levels of bcl2. Each extract has the potential tobe cytotoxic and genotoxic. The level of morphological changes caused by apoptosis, DNA damage, and altered gene and protein expressions were higher in C. comosum[13].

4. Camellia sinensis

Camellia sinensis is a kind of small, evergreen plant or shrub that belongs to the Theaceae family of blossoming plants. Tea, a well-known beverage, the plant's leaves, and leaf buds are used to make. Tea shrubs, tea trees, and tea plants are some of their common names[32].

The cell cycle's arrest in the growth 1 phase, a rise in apoptosis, as well as antioxidant and anti-estrogenic effects, maybe the mechanisms underlying these qualities of green tea. It has been demonstrated that green tea extracts work in concert with tamoxifen, a common anti-estrogen medication. When examined on oestrogen receptor-positive MCF-7, ZR75, and T47D human breast cancer cells, mixture of tea extracts and medicines have been shown to perform better at reducing cell growth more effectively than any drug used individually[33].

Figure No.9: Camellia sinensis and its Chemical Structure



The most prevalent catechin form, epigallocatechin-3-gallate (EGCG), which makes up between 50 and 75 percent of all catechins, is found in green tea. In terms of its positive effectson health, ECGC is also the most powerful antioxidant. EGCG has been shown in experiments to be harmful to cancer cells. Additionally, EGCG can stop the action of growth factors that are necessary for the development and growth of new blood vessels, halting the rapid growth and spread of tumor cells from one place to another. Negative effects of excessive green tea drinking include too much caffeine, poor iron absorption, and too many calories[34].

5. Allium sativum:

The plant Allium sativum belongs to the Liliaceae family and also contains a variety of different chemical compounds. In Bangladesh, this is often known as "Rashun." They are utilised in a number of cancer preventative and therapy methods. Isolated from Allium sativum, allicin exhibits anticancer properties.[29] Allium sativum, consumption has been shown in epidemiological research to have a preventive effect against gastrointestinal cancer[34]

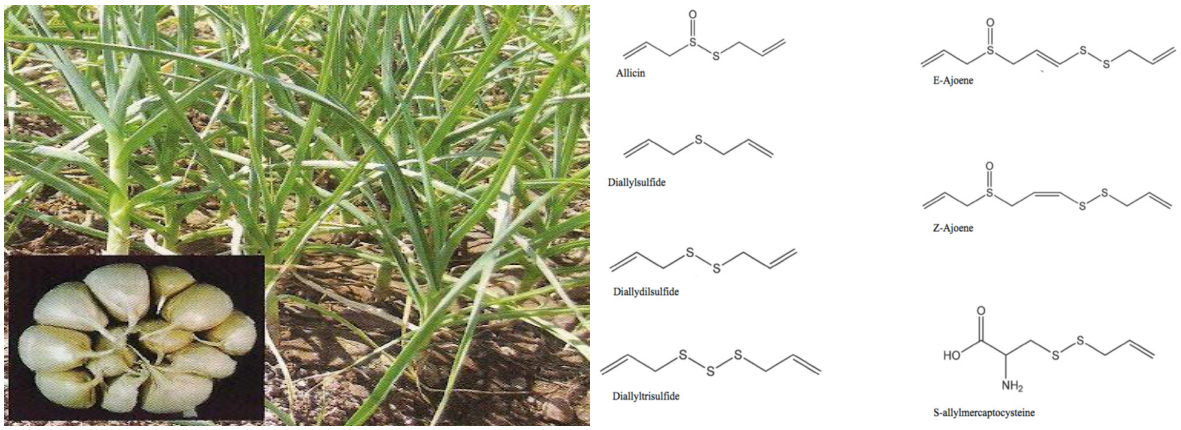


Figure No.10: Allium sativum and its Chemical Structure

The anti-cancer effect of Allium sativum (Alliaceae) aerial portion and bulb aqueous extract-derived organosulfur compounds (OSCs) causes cell cycle arrest, inhibits cancer (HeLa) cell line growth, and produces reactive oxygen species (ROS). Additionally, it was noted that increased GAE concentrations inhibited lymphocyte proliferation[35].

6. Garcinia indica Linn

Garcinia indica Linn, a member of the Clusiaceae family, is a fruit primarily found in Konkan and Maharashtra commonly known as Kokum. The Garcinia indica fruit has been suggested for treating a variety of illnesses in the Indian medical system, including as an appetizer, for allergic skin rashes, for treating burns, for easing sunstroke, for treating dysentery and mucous diarrhea, to treat ulcers, liver tonic, for quenching dryness, and to increase the efficiency and improve the contraction of the heart muscle36.

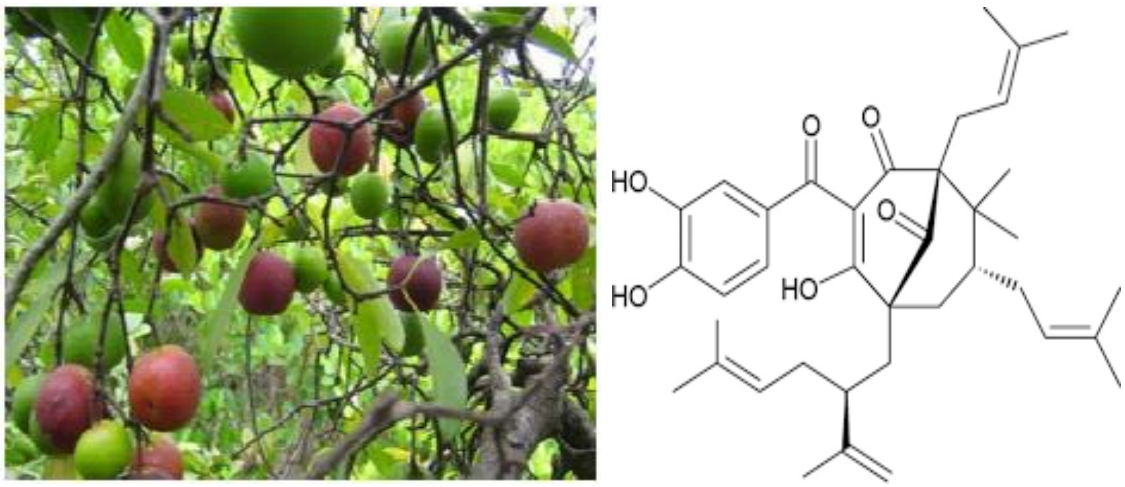


Figure No.11: Garcinia indica linn and its Chemical Structure.

Garcinol significantly reduced the development of oral cancer brought on by 4-NQO. Additionally, tongue cancer is reduced. By scavenging the hydroxyl radical and inhibiting carcinogenesis, garcinol avoided DNA damage. Cambogin, garcim-1, and garcim-2, which are derivatives of garcinol, have also demonstrated potent expansion-inhibitory properties on both normal immortalized gut cells and neoplastic colon cancer cells. Garcinol inhibited the proliferation of HeLa cells, HL-60 human leukemia cells, human breast carcinoma cells, prostate and pancreatic carcinoma cells, colorectal cancerous cell lines, and human leukemia. In cancerous cells, isogarcinol and xanthochymol cause apoptosis by activating caspase-3[37].

7. Crocus sativus L

Originally from southwest Asia, the plant Crocus sativus L. is widely cultivated elsewhere and grown extensively in other parts of the world today, including Europe, Turkey, Central Asia, India, and China. Saffron is the dehydrated, deep-red stigma of this plant. It has historically been used to treat a variety of illnesses, including various malignancies[38].

It has been demonstrated that the topical application of a saffron extract inhibits both the onset and propagation of cancer by DMBA, a common carcinogen used to produce skin cancer for research purposes [39].

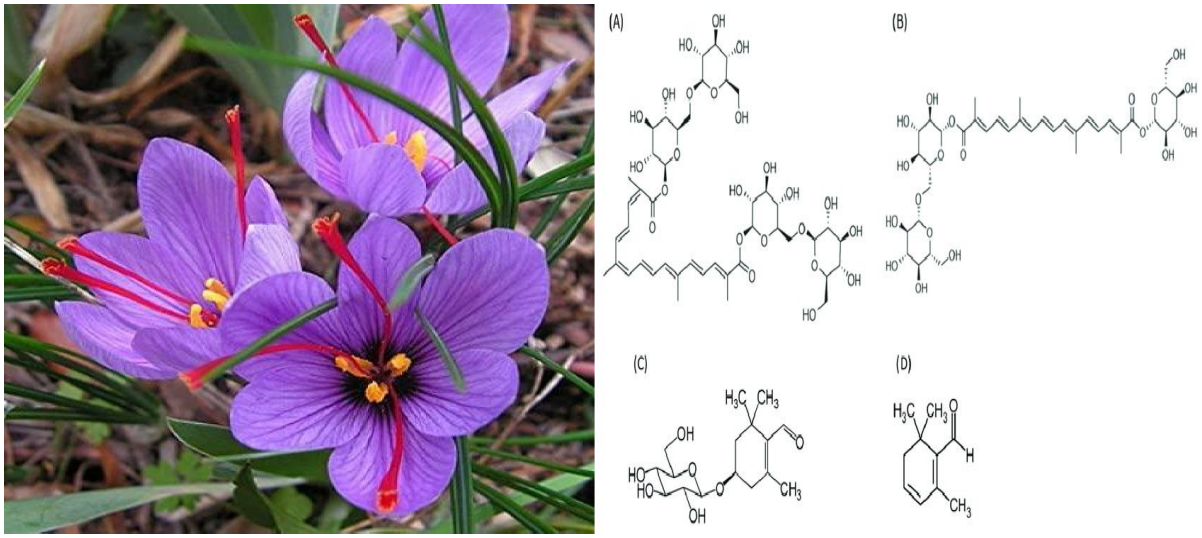


Figure No.12: Crocus sativus L and its Chemical Structure

Oral administration of saffron extracts to rats enhanced β-carotene and vitamin-A serum levels. Saffron extract was liposome-encapsulated to enhance its anti-cancer properties when taken orally as opposed to intravenously[40].

8. Ocimum sanctum L.

Among the most important medicinal herbs, Ocimum sanctum L. is used in traditional medicine in the region of Southeast Asia, also known as holy basil or Ocimum sanctum L, also referred to as Tulsi in various Indian languages or holy basil in English.[42]Preclinical studies have additionally demonstrated that Tulsi and some of its phytonutrients, such as eugenol,

rosmarinic acid, apigenin, myretenal, luteolin, -sitosterol, and carnosic acid, prevent against cancers brought on by chemicals in the skin, liver, mouth, and lung tissues[41].

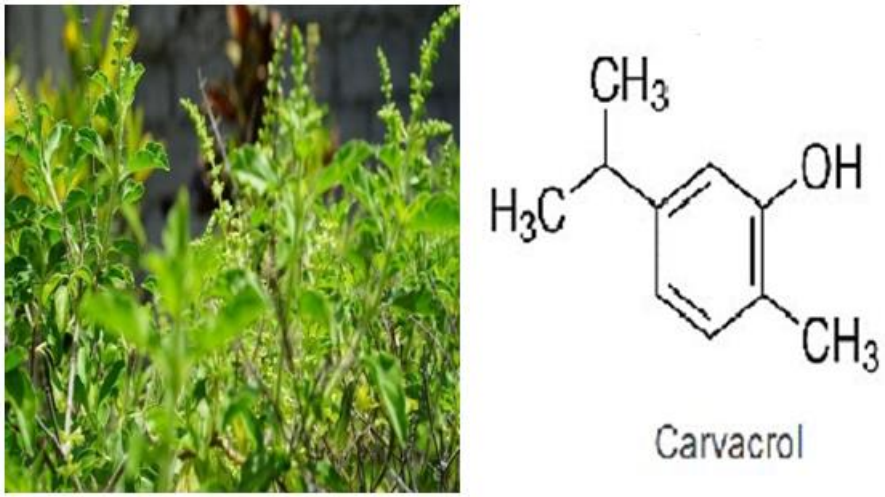


Figure No.13: Ocimum sanctum L. and its Chemical Structure

Numerous researchers have established and cited OS's anticancer properties. Aryl hydrocarbon hydroxylase, cytochrome P450, glutathione S-transferase (GST), and aryl hydrocarbon hydroxylase are crucial for the detoxification of tumourigenesis and mutagens, and the decoction extract (AlE) of OS leaves has a modulatory effect on these enzymes. OS has been found to have an anticancer effect against human fibrosarcoma cell culture, where AlE of this medication caused cytotoxicity[42]. In 2011, the anti-carcinoma activity of 50% alcoholic aqueous leaf extracts from various Ocimum species. Oral administration of leaf extract (200mg/kg, p.o.) caused a significant decrease in tumor volume, a rise in average body weight, and an increase inthe survival rate of mice[43].

9. Betel Vine

Southeast Asia is the primary region where betel vine, a member of the Piperaceaefamily, is cultivated. The plant is a native of Malaysia and the surrounding areas, and it is currently grown extensively in a number of locations in India, Nepal, Bangladesh, Burma, and Sri Lanka[44]. According to certain reports, betelvine leaf helps prevent several cancers. For their anti-cancer capabilities, numerous bioactive elements of betelvine have been examined for their cytotoxic and antimutagenic activities. Topical application of betelvine leaf extract decreased tobacco-induced oral carcinogenesis in rats. This was demonstrated by the prevention of tobacco-specific nitrosamine-induced carcinogenesis of tongues at reduced levels of the carcinogen N′-nitrosonornicotine[4]

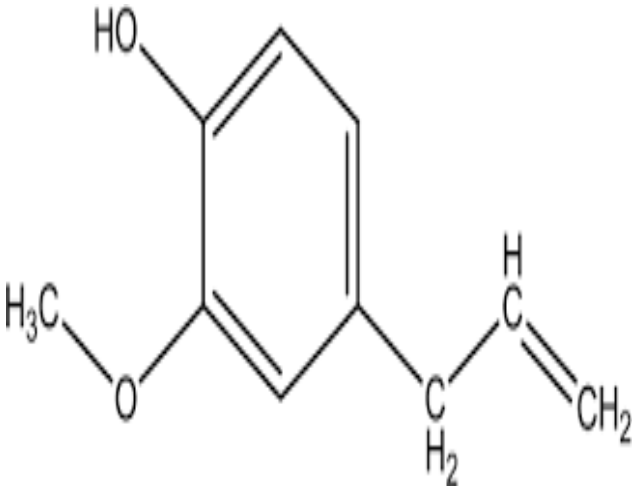


Figure No.14: Betel Vine and its Chemical Structure

The leaves of the betel vine are frequently employed in Asian and African traditional treatments. There is evidence that the abundant plant-based constituents in betel vine leaves have anti-oxidant, immunomodulatory, anti-inflammatory, and anti-proliferative properties[44].

10. Phyllanthas Emblica

In India, Emblica officinalis, a member of the Euphorbiaceae family, is referred to as 'Amla' or Indian gooseberry. It is referred to be a "refresh herb" in the conventional Indian medical system. It has been demonstrated to have anti-inflammatory, anti-apoptotic, and antioxidant properties[46].

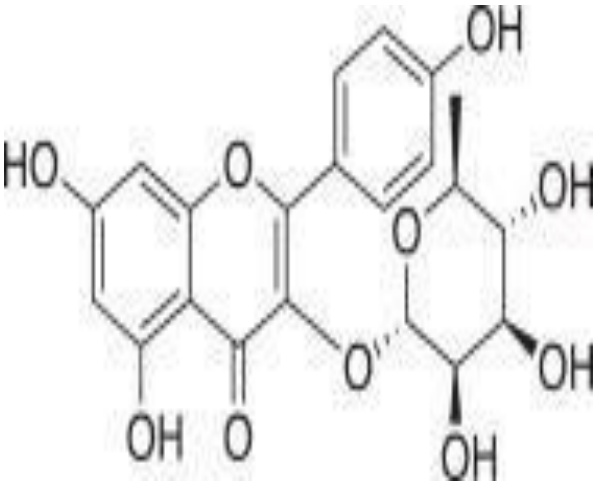


Figure No.15: Phyllanthas Emblica and its Chemical Structure

Simple water-soluble extracts of the Phyllanthus emblica berry or polyphenol-enriched extracts have both demonstrated cytotoxic efficacy over cervical and ovarian carcinoma cells. The antioxidants polyphenols and hydrolysable tannin-derived substances found in Phyllanthus emblica are abundant. Examples that have undergone extensive research include ellagic, gallic, and chebulagic acids. It has been shown that these tannins, along with others from the Phyllanthus emblica, can stop carcinogenesis and lipid peroxidation that occurs in response to carcinogenic and reactive oxygen species that are present [47].

1. Catharanthus roseus

The chemical extraction from Catharanthus roseus, one of the Apocynaceae family's highest medicinally valued plant species that is utilised in conventional herbal therapies around the globe, contributes in the treatment of cancer[48].

The stem and leaves of Catharanthus roseus contain the chemotherapeutic alkaloids vinblastine and vincristine. In in vitro studies of various concentrations of Catharanthus raw extracts revealed considerable anticancer properties against a wide range of cell types, with the highest activity against drug-resistant malignant types[49].

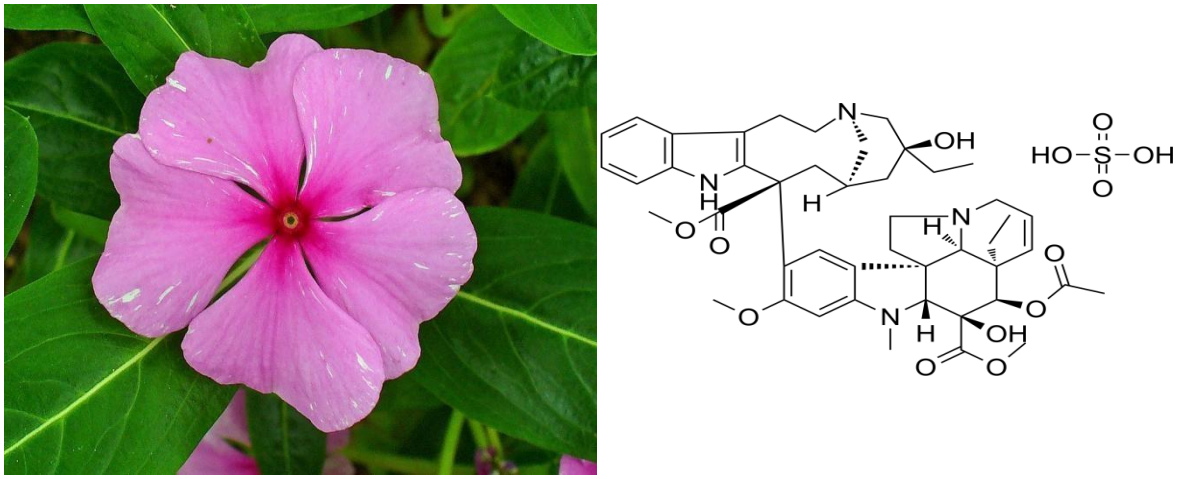


Figure No.16: Catharanthus roseus and its Chemical Structure

The healthcare industry is now interested in Catharanthus roseus since it contains alkaloids like vincristine and vinblastine. Vincristine and Vinblastine are utilized as efficient leukemia treatments. The alkaloid compounds react to tubulin, blocking the production of spindles, which are necessary for chromosomal detachment during mitosis. Additionally, it appears that these alkaloids prevent cells from producing DNA and RNA, preventing cancerous growth[50].

2. Syzygiumaromaticum

An unopened flower bud known as a clove is found on the Syzgiumaromaticum tree, which is a member of the Myrtaceae family. The rich dark shade of cloves is accompanied by a robust, warm, sweet,

aromatic, and somewhat astringent aroma. In Hindi, clove is referred to by a variety of names, including Laung, Lavang, and Laumg[51]. Clove oil is the main source of eugenol, a phenolic fragrant component. Due to its various attributes, eugenol has a wide range of uses. It could also be used in a variety of therapeutic goods. As a result of a rise in interest in conventional medicines that contain natural ingredients, particularly those intended to treat human malignancies.

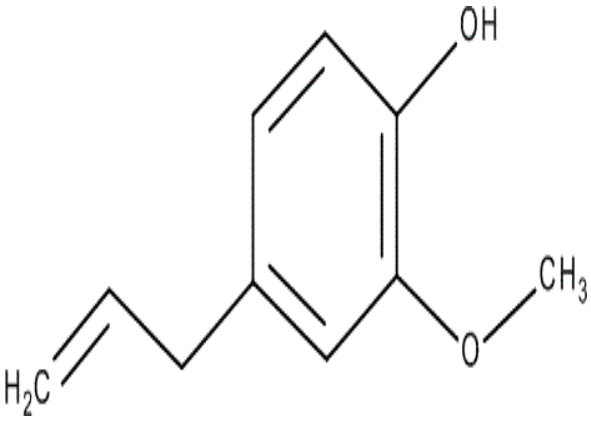


Figure No.17: Syzygiumaromaticum and its Chemical Structure

Leukaemia, lung cancer, colon cancer, colorectal cancer, skin cancer, stomach cancer, breast cancer, cervical cancer, and prostate cancer are only a few of the cancer types against which eugenol has demonstrated antitumor capabilities. These malignant cells' cell death was induced by eugenol through a pathway dependent on increased ROS generation and decreasedthe potential of the mitochondrial membrane, suggesting that it might have apoptosis-inducing properties[52].

3. Boswellia serrata

One of the most appreciated plants in Ayurveda is Boswellia serrata. It is also referred to as loban, kundur, Salai Guggal, and Indian olibanum.

It has previously been employed in ceremonial religious and cultural practices. The herb Boswellia serrata contains essential active ingredients called boswellic acids (BAs), which have long been utilized for the treatment of a variety of chronic as well as acute inflammatory conditions[53].

In addition to its anti-inflammatory effects, frankincense is a conventional Chinese and Ayurvedic herbal remedy that has been said to have anticancer qualities. In chemically produced mouse skin cancer models, extracts made from gum resins of Boswellia species have been shown to exhibit anticarcinogenic action. They have also been shown to have antiproliferative and pro-apoptotic effects on rat astrocytoma cell lines and human leukemia cell lines[5]

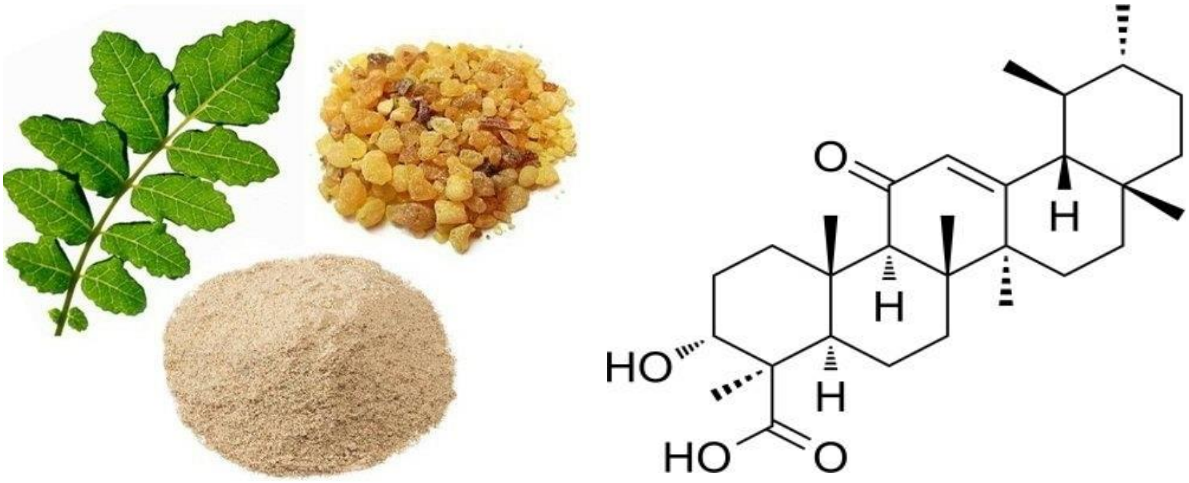


Figure No.18: Boswellia Serrata and its Chemical Structure

Dangerous enzymes are prevented by boswellic acid from damaging human DNA. Boswellic acid may aid in the inhibition of pancreatic tumor cells as well as various other types of cancer, according to several research[55].

4. Piper nigrum

Pepper or Piper nigrum, a member of the Piperaceae family. Black pepper is an essential component of many of the therapeutic compositions practiced in the Indian systems of medicine including Ayurveda, Siddha, and Unani. As the "king of condiments," black pepper is the spice type that is traded the most internationally.The dried, ripened fruit of the black pepper plant is its most important industrial component. It is prized for its distinct scent and flavor due to its incorporation of volatile essential oils and piperine, a significant alkamide that accounts for around 2.8-17.3 mg per gram of dried black pepper. Piperidine is the structural component of piperine, which is joinedto the 3,4-methylenedioxyphenyl moiety via a C5 amide bridge. Black pepper is said to offer anti-tumor, anti-bacterial, anti-insect, and anti-diarrheal effects [56].

Figure No.19: Piper Nigrum and its Chemical Structure

Piperine's primary chemopreventive mechanisms contain stimulating apoptotic signaling cascades, inhibition of cell proliferation, cell cycle arrest, changes in redox homeostasis, controlling of ER stress and autophagy, restriction of blood vessel development, stimulation of detoxification enzymes, and sensitivity of tumors to treatment with chemotherapy and radiotherapy[57].

5. Solanum nigrum

In North America, black nightshade also referred to as Solanum nigrum L., is recognized as a native herb. But both Indian Ayurvedic medicines and Conventional Chinese medicine make extensive use of it as a plant for medicinal purposes. Traditional medicine has employed Solanum nigrum L. as a remedy for inflammatory and venous skin ulcers. In recent years, it has been utilized with other healing plants for the treatment of various cancers [58].

The immune-regulating activity of a polysaccharide component from Solanum nigrum, SN-ppF3, was investigated. These findings showed that the mechanisms of tumor reduction shown in SN-ppF3-treated mice probably resulted from boosting the host immune system reaction.

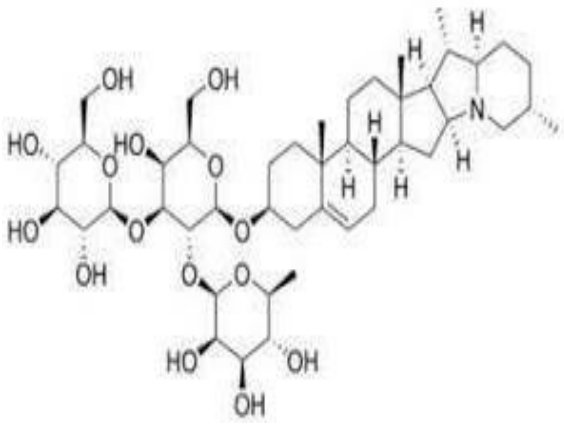


Figure No.20: Solanum nigrum and its Chemical Structure

Studies show the impacts of raw polysaccharides extracted from Solanum nigrum L. on the erythrocyte membranes of mice with tumor-bearing S180 and H22. Solanum nigrum L.-type mice with tumors that might influence red blood cell membrane fluidity and re-close can have their immune systems strengthened through the red blood cell membrane, potentially providing erythrocyte defense against tumor development, according to data from experiments provided by researchers[59].

Conclusion

Complementary to conventional cancer therapies like chemotherapy, medicinal plants have gained importance for their naturally occurring anticancer chemicals, offering therapeutic benefits with fewer adverse effects. Traditionally and currently used medicinal plants, including Turmeric, Ashwagandha, Ginger, Neem, Aloe vera, Green Tea, Allium sativum, and more, have demonstrated chemoprotective properties in research studies. Rich in phytochemical elements, these plants

play a crucial role in treating human ailments and contribute significantly to the recovery process, offering a natural alternative to combat various types of malignant cells and cancers.

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