Current Trends in Pharmacology and Clinical Trials
ISSN: 2642-0848

Academic Strive
Researcher's perception is our reality

Review Article *Volume 8 Issue 1*

Medicinal Herbs and Phytoconstituents Proved for Anticancer Activity-A Comprehensive Review

Rakam Gopi Krishna*[1] and Kuchi Manjeera[2]

[1]Department of Pharmaceutical Chemistry, Marri Laxman Reddy Institute of Pharmacy, Dundigal, Hyderabad, Telangana, India-500043

[2]Department of Pharmacology, C.M.R. College of Pharmacy, Kandlakoya, Medchal, Hyderabad, Telangana, India-501401

***Corresponding author:** Rakam Gopi Krishna, M. Pharm. Ph.D, Associate Professor, Department of Pharmaceutical Chemistry, Marri Laxman Reddy Institute of Pharmacy, Dundigal, Hyderabad, Telangana, 500043, India, Tel: +91 9885634356; Email: gopirakam@gmail.com

Received Date: December 24, 2024; **Published Date:** January 08, 2025

Abstract

Globally cancer is a disease which severely effects the human population. There is a constant demand for new therapies to treat and prevent this life-threatening disease. Scientific and research interest is drawing its attention towards naturally-derived compounds as they are considered to have less toxic side effects compared to current treatments such as chemotherapy. The Plant Kingdom produces naturally occurring secondary metabolites which are being investigated for their anticancer activities leading to the development of new clinical drugs. Many plant products exist that have shown very promising anti-cancer properties in vitro, but yet to be evaluated in humans. As commercialization of the herbal medicine has happened, assurance of safety, quality and efficacy of medicinal plants and herbal products has become an important issue. The herbal raw material is liable to a lot of dissimilarities due to several factors, the essential ones being the identity of the plants and seasonal variation (which has a bearing on the time of collection), the ecotypic, genotypic and chemotypic variations, drying and storage conditions and the presence of xenobiotic. Further studies are required to determine the efficacy of these plant products in treating cancers in humans. Worldwide effects are ongoing to identify new anticancer compounds from plants. In recent years owing to the fear of side effects people prefer more and more use of natural plant products for cancer. For these reasons, World Health Organization (WHO) supports the use of traditional medicines which are efficacious and non-toxic. This review has tried to summarize few herbal plants having anticancer activity.

Keywords: Plant Kingdom; Medicinal Plants; Anticancer Activity; Plant Products; Xenobiotic

Introduction

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body [1]. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and multiply (through a process called cell division) to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place. Sometimes this orderly process breaks down, and abnormal or damaged cells grow and multiply when they shouldn't. These cells may form tumour's, which are lumps of tissue

[2]. Tumours can be cancerous or not cancerous (benign). Cancerous tumours spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumours' (a process called metastasis). Cancerous tumour's may also be called malignant tumours [3]. Many cancers form solid tumors, but cancers of the blood, such as leukaemia, generally do not. Benign tumors do not spread into, or invade, nearby tissues. When removed, benign tumors usually don't grow back, whereas cancerous tumors sometimes do. Benign tumors can sometimes be quite large, however. Some can cause serious symptoms or be life threatening, such as benign tumors in the brain.

Signs and symptoms of Cancer

- Signs and symptoms are ways the body lets you know that you have an injury, illness, or disease.
- A sign, such as fever or bleeding, can be seen or measured by someone else.
- A symptom, such as pain or fatigue, is felt or noticed by the person who has it [4].

Signs and symptoms of cancer depend on where the cancer is, how big it is, and how much it affects nearby organs or tissues. If a cancer has spread (metastasized), signs or symptoms may appear in different parts of the body.

Types of Cancer

There are more than a hundred different types of cancer that are characterized by abnormal cell growth. Listed here are a few types of cancer:

Carcinoma

It is the most common form of cancer that affects the epithelial cells which form the lining of internal organs or the skin [5]. Lung cancer, skin cancer, pancreatic cancer and ovarian cancer are some of its common manifestations. Carcinomas can be identified by the different cells that they affect:

Adenocarcinoma: A form of carcinoma that affects mucus or fluid-forming epithelial cells. Common examples of adenocarcinoma are breast cancer, colon cancer, and prostate cancer.

Squamous Carcinoma: A carcinoma that affects the epithelial cells which are present beneath the outermost surface of the skin. These cells also form the lining of many vital organs in the human body such as the stomach, kidneys, lungs, intestines, and bladder.

Basal Cell Carcinoma: A type of carcinoma that affects the basal cells found in the deepest layer of the epidermis. It is a form of skin cancer which appears as a lump or ulcer in the affected area

Transitional cell carcinoma: It affects cells of transitional epithelium found in the lining of the bladder, ureters and certain parts of the kidney

Sarcoma

These cancer cells develop in the bones and soft tissues such as fat tissues, cartilages, blood vessels, lymph and other supporting tissues of tendons and ligaments.

The most common form of sarcoma in the bone is osteosarcoma, and in soft tissues include Kaposi sarcoma, liposarcoma, malignant fibrous histiocytoma, leiomyosarcoma, and dermatofibrosarcoma protuberans.

Leukaemia

Commonly known as blood cancer, leukaemia affects the tissues of the bone marrow which is responsible. Leukaemia is completely different from other types of cancer. It is caused by the uncontrolled production of white blood cells (Lymphoid cells and myeloid cells). These abnormal white blood cells damage the tissues of the bone marrow and crowd the normal blood cells. These abnormal white blood cells continue to divide and damage the complete normal blood cells. As a result, the Leukaemia patient fails to provide adequate red blood cells to supply oxygen, adequate normal white blood cells to fight infections and adequate platelets for blood coagulation.

Lymphoma

Lymphoma is a form of cancer that affects the lymphocytes in the lymph nodes, which are a part of the immune system. There are two kinds of lymphoma:

- Hodgkin lymphoma – originates in the B cells
- Non-Hodgkin lymphoma, – originates in B or T cells.

Melanoma

It is a form of skin cancer that targets melanin – the pigment responsible for skin colour. In this form of cancer, the melanocytes are affected resulting in the abnormal formation of melanin. It may also affect other tissues that are pigmented, such as the eyes.

Myeloma

Myeloma targets another part of the immune system- the plasma cells. The affected plasma cells, called myeloma cells divide in the bone marrow causing multiple tumours in the bones (Multiple Myeloma also called Kahler disease) [6].

CNS Cancers

CNS (Central Nervous System) cancers originate from the brain and the spinal cord. Gliomas, vestibular schwannomas, meningiomas, primary CNS lymphomas, pituitary adenomas,

and primitive neuroectodermal tumours are a few CNS cancers.

Types of Cancer Treatment

There are many types of cancer treatment. The types of treatment that you receive will depend on the type of cancer you have and how advanced it is.

Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotherapy and radiation therapy. When you need treatment for cancer, you have a lot to learn and think about. It is normal to feel overwhelmed and confused. But, talking with your doctor and learning about the types of treatment you may have can help you feel more in control.

Biomarker Testing for Cancer Treatment

Biomarker testing is a way to look for genes, proteins, and other substances (called biomarkers or tumor markers) that can provide information about cancer. Biomarker testing can help you and your doctor choose a cancer treatment [7].

Chemotherapy: Chemotherapy is a type of cancer treatment that uses drugs to kill cancer cells. Learn how chemotherapy works against cancer, why it causes side effects, and how it is used with other cancer treatments.

Hormone Therapy: Hormone therapy is a treatment that slows or stops the growth of breast and prostate cancers that use hormones to grow. Learn about the types of hormone therapy and side effects that may happen.

Hyperthermia: Hyperthermia is a type of treatment in which body tissue is heated to as high as 113 °F to help damage and kill cancer cells with little or no harm to normal tissue. Learn about the types of cancer and precancers that hyperthermia is used to treat, how it is given, and the benefits and drawbacks of using hyperthermia [8].

Immunotherapy: Immunotherapy is a type of cancer treatment that helps your immune system fight cancer. This page covers the types of immunotherapy, how it is used against cancer, and what you can expect during treatment.

Photodynamic Therapy: Photodynamic therapy uses a drug activated by light to kill cancer and other abnormal cells. Learn how photodynamic therapy works, about the types of cancer and precancers it is used to treat, and the benefits and drawbacks of this treatment [9].

Radiation Therapy: Radiation therapy is a type of cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. Learn about the types of radiation, why side effects happen, which side affects you might have, and more.

Stem Cell Transplant: Stem cell transplants are procedures that restore stem cells that grow into blood cells in people who have had theirs destroyed by high doses of chemotherapy or radiation therapy. Learn about the types of transplants, side effects that may occur, and how stem cell transplants are used in cancer treatment [10].

Surgery: When used to treat cancer, surgery is a procedure in which a surgeon removes cancer from your body. Learn the different ways that surgery is used against cancer and what you can expect before, during, and after surgery.

Targeted Therapy: Targeted therapy is a type of cancer treatment that targets the changes in cancer cells that help them grow, divide, and spread. Learn how targeted therapy works against cancer and about common side effects that may occur.

S.no	Name of plant	Common name	Parts used	Chemical constituents
1	*Catharanthus roseus*	Vinca rosea	Leaves	Vincristine, Vinblastine
2	*Allium Sativum*	Garlic	Clove, Leaves	Allicin, Allin
3	*Glycyrrhiza glabra*	liquorice	Root and rhizome	Isoliquirtin, Licocholcone
4	*Podophyllum hexandrum*	Himalayan may apple	Rhizome	Podophyllotoxin, etoposide, teniposide.
5	*Zingiber officinale*	ginger	Rhizome, extracts	gingerol, zingerone, shogoals
6	*Curcuma longa*	Turmeric	Rhizome	Curcumin-I, Curcumin-II, Curcumin-III

List of herbs used

Catharanthus roseus

Synonym: Sadabahar, perwinkle, vinca rosea.

Biological source: Vinca is the dried entire plant of *Catharanthus roseus linn.*

Family: Apocynaceae

Scientific classification:

Kingdom	Plantae
Division	Magnoliophyta(flowering plants)
Class	Magnoliopsida(dicotyledons)
Order	Gentiales
Family	Apocyanaceae
Genus	*Catharanthus*
Species	*roseus*

Geographical Source

The plant is a native of Madagascar and is found in many tropical and subtropical countries especially in India,

Australia, South Africa, North and South America [11]. The plant is cultivated as garden plant in Europe and India. It is found in rainforest of south eastern and eastern Madagascar in tropical and subtropical areas of world. It is well grown in Australia. It grows well in sandy loam soil. The plant is found in subtropical and tropical regions where temperature is never below 5-7°C, also the plant naturally occurs as a warm season bedding plant in temperate region [12]. Plant survives in hot and humid habitat and exhibits normal growth in area of full sun as well as in shady region. However, the propagation of plant is sensitive to excessive watering and also the plant is unable to tolerate frost. The plant is known to be propagated through seeds as well as by cuttings. This plant is commercially cultivated for medicinal as well as for ornamental purpose [13].

Figure 1: Leaf of *Vinca rosea* plant.

Active Constituents

In Catharanthus roseus each part of plant has been reported to possess several bioactive compounds belonging to different classes such as alkaloids, flavonoids, terpenoids and tannins. All these compounds exhibit one or the other biological activity. The flower part contains a greater number of tannins and triterpenoids and alkaloid compounds which have been very effective for wound healing and antidiabetic property. Leaves are rich in carbohydrate and alkaloids, whereas roots and stems of plant have rich content of quinones which has antibacterial property. The root part of C. roseus is rich in ajmalicine and serpentine which are used as anti-hypersensitive drug. Among different types of compounds alkaloids are most important bioactive metabolite of *Catharanthus roseus* [14].

Alkaloids are present in entire shrub but leaves and roots contain more alkaloids. About 90 alkaloids have been isolated from Vinca from which some like Ajmalicine, Serpentine and Tetrahydroalstonine are known and are present in other species of Apocynaceae. The important alkaloids in Catharanthus are the dimer indole indoline alkaloids Vinblastine and Vincristine and they possess definite anticancer activity. Vindoline and Catharanthine are indole monomeric alkaloids. It also contains monoterpenes, sesquiterpene, indole and indoline glycoside [15].

Parts of plant	Biochemical compounds (alkaloids)
Leaf	Catharanthine, vinblastine, vincristine, leurosine, lochnerine, vindoline.
Stem	Leurosine, lochnerine, catharanthine, vindoline.
Root	Catharanthine, vindoline, leurosine, reserpine, alstonine
Flower	Catharanthine, vindoline, leurosine , lochnerine, tricin.
Seed	Vingramine, methylvingramine.

Table 1: Different alkaloids present in various parts of *Catharanthus roseus.*

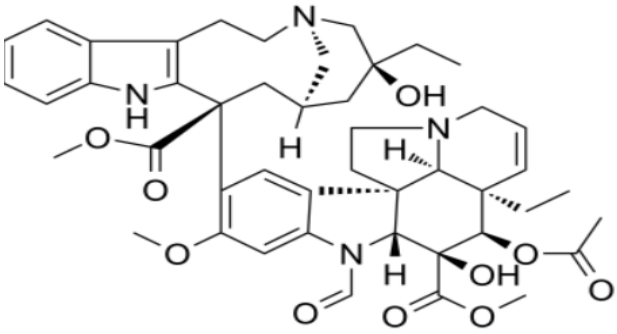

Figure 1.1: Structure of Vincristine.

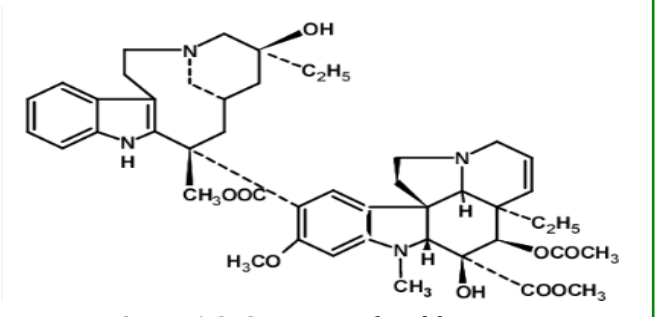

Figure 1.2: Structure of Vinblastine.

Mechanism of Action

1. Vincristine sulfate acts on mitotic cell division of metaphase and arrest the cell for further division, hence used as an

antineoplastic drug [16].

2. Vinblastine sulfate acts on mitosis of metaphase and interferes in amino acid metabolism.

3. Vincristine and Vinblastine binds to microtubule ends and induce microtubule depolarisation which inturn inhibit mitotic progression and promotes cell death.

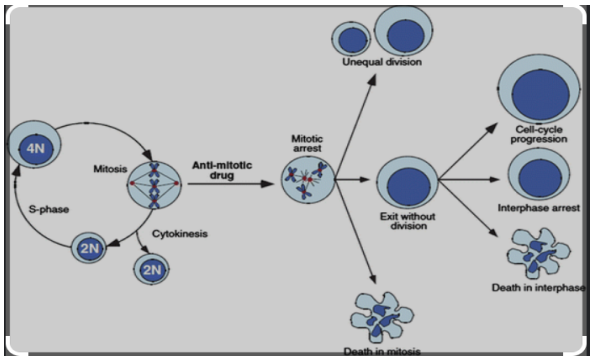

Figure 1.3: Mechanism of action of Vinca alkaloids.

Uses

- Vinblastine is an antitumour alkaloid used in the treatment of Hodgkin's disease.
- Vincristine is a cytotoxic compound and used to treat leukaemia in children.
- Vinca is used in herbal practice for its astringent and tonic properties in menorrhagia and in haemorrhages.
- In cases of scurvy and for relaxed sore throat and inflamed tonsils, it may also be used as a gargle.
- For bleeding piles, it may be applied externally, as well as taken internally.
- It is also used in the treatment of diabetes.
- The flowers of the Periwinkle are gently purgative, but lose their effect on drying.
- If collected in the spring and made into a syrup, they impart all their virtues, and used as a gentle laxative for children and also for overcoming chronic constipation in adults.
- Vinca alkaloids are also used in diabetes and high blood pressure.
- Vinca leaves are used to treat acne and scars [17].

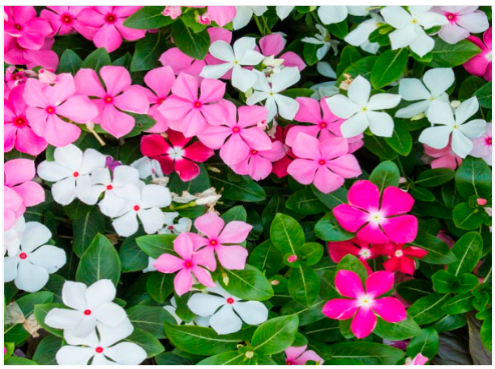

Figure 1.4: Flowers of *Vinca rosea* plant.

Allium sativum

Synonym: Garlic, allium, lasan.
Biological source: Garlic is the ripe bulbs of *allium sativum.*
Family: Amaryllidaceae.
Scientific classification:

Kingdom	Plantae
Division	Angiospermae
Class	Monocotyledons
Order	Aspargales
Family	Amaryllidaceae
Genus	*Allium*
Species	*sativum*

Geographical Source

Garlic occurs in Central Asia, Southern Europe and Unites states. It is widely cultivated in India. Garlic is believed to originate from Central Asia (Kazakhstan, Uzbekistan and western China). Garlic spread to the Mediterranean in ancient times. It was already grown in Egypt in 1600 BC and is an ancient crop in India and China as well. At present garlic is grown all over the world from the equator to latitudes of 50° in both hemispheres, but is most popular in China, the Mediterranean and Latin America. In tropical Africa, garlic is grown during the cold season in the Sahel and at high elevations in East and southern Africa. It is rarely found in hot and humid lowlands. Typically, it is grown in a temperate climate similar to those of central Asia. It can be found growing in the north and south hemispheres.

Figure 2: *Allium sativum* plant.

Active Constituents

Garlic bulbs are made up of numerous minerals, vitamins, carbohydrates, amino acids, volatile oils and other trace elements. Amongst all the members of the Allium species, garlic is said to have to the highest sulphur content. Volatile oils are present in about 0.1-0.5% concentration in garlic. These constitute of sulphur containing compounds like diallyl disulphide, diallyl trisulphide, methyl allyl trisulphide, allyl propyl disulphide, alliin, ajoene etc. When the garlic clove is crushed, alliin (S-allyl-l-cysteine sulfoxide) by the action of

the enzyme alliinase get converted to 2-propene-2-sulfenic acid which in turn dimerizes to allicin (diallyl thiosulfinate). Allicin is responsible for the pungent odour of crushed garlic and also for some of its pharmacological activities. The other sulphur compounds alliin, allicin, diallyl disulphide etc. are also responsible for the pharmacological activities of garlic. Vitamins like Vit B1, Vit A, Vit C etc.17 amino acids including 8 essential amino acids and minerals like phosphorus, calcium, magnesium, potassium, iron, selenium, germanium etc are present [18].

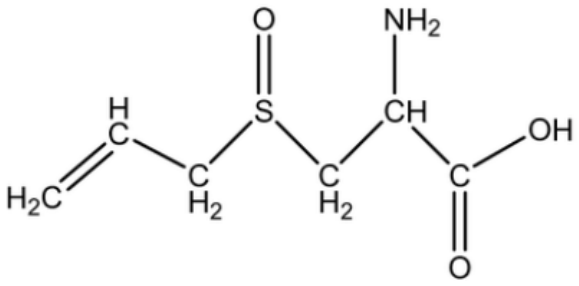

Figure 2.1: Structure of Alliin.

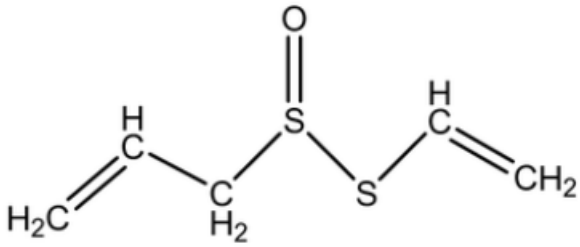

Figure 2.2: Structure of Allicin.

Figure 2.3: Alliin Allicin

Mechanism of Action

- Allyl sulphides (sulphur compounds) are characteristics flavour components of garlic. These compounds inhibit both initiation and promotion stages of tumorigenesis in experimental carcinogenesis for various types of cancer.
- Allicin, which is from an assistance food-garlic (*Allium Sativum L),* was found to be effective in gastric cancer treatment.
- Allicin can be chemopreventive to gastric cancer by inhibiting the growth of cancer cells, arresting cell cycle at G2/M phase, endoplasmic reticulum (ER) stress, and mitochondria-mediated apoptosis, which includes the caspase-dependent/-independent pathways and death receptor pathway.
- Those mechanisms probably involve in modulating enzymatic activity, restraining DNA formation, scavenging free radicals, and affecting cell proliferation and even tumor growth.

Figure 2.4: Clove of *Allium sativum*

Uses

- Garlic has been used as a medicine to treat a variety of illnesses and disorders including high blood pressure, high cholesterol, coronary artery disease. [19]
- It is used in the treatment of different types of cancers such as colon, rectal, stomach, breast, prostate, and bladder cancers, as well as lung cancer.
- The plant treats fever, cough, headache, abdominal pain, sinus congestion, gout, rheumatism, hemorrhoids, asthma, bronchitis, shortness of breath, low blood pressure, low blood sugar, high blood sugar, and snake bites.
- It also boosts immunity.
- Garlic or its constituents exhibit various biological activities, such as antibacterial, antifungal, antiviral, antitumor and antidiabetic effects.

Figure 2.5: Bulb of *Allium sativum*.

Glycyrrhiza glabra

Synonym: Liquorice, radix glycyrrhiza, sweet liquorice.
Biological source: Liquorice consists of subterranean

peeled and unpeeled stolons, roots and subterranean stems of *Glycyrrhiza glabra linn,* and other species of glycyrrhiza.
Family: Leguminosae.
Scientific classification:

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Rosales
Family	Leguminosae
Genus	*Glycyrrhiza*
Species	*glabra linn*

Geographical Source

Glycyrrhiza glabra is known as mulaithi in north India. *Glycyrrhiza glabra*, also known as licorice and sweet wood, is native to the Mediterranean and certain areas of Asia. The Glycyrrhiza genus contains more than 30 species and widely distributed all over the world. Glycyrrhizagenus plants are wide spread in Mediterranean, Southern and Central Russia and Asia, being minor to Iran. Many species are now grown throughout Europe, Syria, Asia, UK, USA, Italy, France, Germany, Spain, China, Middle East, Central and South Western Asia and the Mediterranean region, which is basin of Africa, in South Europe, Afghanistan and Northern India (Punjab and Sub-Himalayan regions). Large-scale commercial cultivation is available in Spain, Sicily and England. [20] It is mainly found in China, Europe, India, Iraq, Japan, Kurdistan, Spain, Turkey, and the United States.

Figure 3: Flower of *Glycyrrhiza glabra* plant.

Active Constituents

A number of components have been isolated from the roots of *Glycyrrhiza glabra*, including a water-soluble, biologically active complex that accounts for 40–50% of total dry material weight. This complex is composed of triterpene, saponin, flavonoids, polysaccharides, pectins, simple sugars, amino acids, mineral salts, asparagines, bitters, essential oil, fat, female hormone estrogen, gums, mucilage (rhizome), protein, resins, starches, sterols, volatile oils, tannins, glycosides, and various other substances. Glycyrrhizin, a triterpenoid compound, accounts for the sweet taste of licorice root. This compound represents a mixture of potassium-calcium-magnesium salts of glycyrrhizic acid that varies within a 2–25% range. Among the natural saponin, glycyrrhizic acid is a molecule composed of a hydrophilic part, two molecules of glucuronic acid, and a hydrophobic fragment, glycyrrhetic acid. The yellow color of licorice is due to the flavonoid content of the plant, which includes liquiritin, isoliquiritin (a chalcone) and other compounds.

The chief constituent of liquorice root is glycyrrhizin (6-8%), can be obtained in the form of a sweet, which is 50 times sweeter than sucrose, white crystalline powder, consisting of the calcium and potassium salts of glycynhizic acid. Glycyrrhizic acid on hydrolysis yields glycyrrhetic or glycyrrhetinic acid. [21]

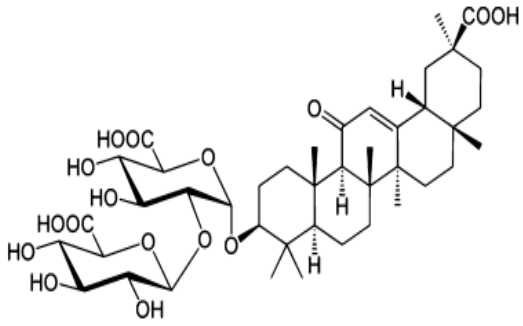

Figure 3.1: Structure of Glycyrrhizin.

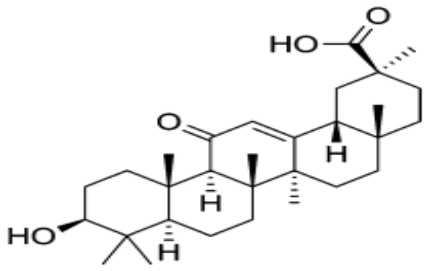

Figure 3.2: Structure of Glycyrrhetic acid.

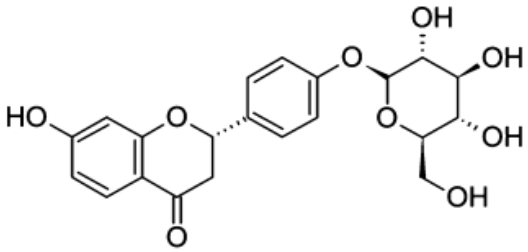

Figure 3.3: Structure of Liquiritin.

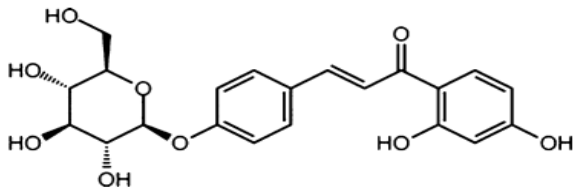

Figure 3.4: Structure of Isoliquiritin

Mechanism of Action

- One of the most active components in the roots of glycyrrhiza is isoliquiritigenin (ISL) that has shown direct inhibitory impact on malignancies such as cervical, hepatoma, colon, breast, prostate, and other types of cancers. ISL can also inhibit multistage carcinogenesis processes by promoting progression, formation, and migration by promoting cell cycle, apoptosis, autophagy, anti-angiogenesis, and other actions.
- The proposed anticancer effect of *Glycyrrhiza glabra* has been illustrated in Licochalcone A (LA), a flavonoid found in licorice, has anti-cancer properties.
- Licochalcone A stops cell cycle advancement at the G1/S and G2/M stages [22].

Figure 3.5: Leaves, flower, root, powder of *Glycyrrhiza glabra*

Uses:

- Glycyrrhiza is widely used as a sweetening agent and in bronchial problems such as catarrh bronchitis, cold, flu and cough.
- Glycyrrhiza is also effective in helping to reduce fevers (glycyrretinic acid has an effect like aspirin), and it may have an antibacterial action as well.
- It is used in the treatment of chronic inflammations such as arthritis and rheumatic diseases, chronic skin conditions, and autoimmune diseases in general.
- It is used in the treatment of chronic inflammations such as arthritis and rheumatic diseases, chronic skin conditions, and autoimmune diseases in general [23].

Figure 3.6: Rhizomes of *Glycyrrhiza glabra*

Podophyllum hexandrum

Synonym: Rhizoma podophylli indici, Indian podophyllum.
Biological source: Indian podophyllum consists of the dried pieces of rhizomes and roots of *Podophyllum hexandrum royle.*
Family: Berberidaceae.
Scientific classification:

Kingdom	Plantae
Division	Magnoliophyta(flowering plants)
Class	Magnoliopsida(dicotyledons)
Order	Ranunculales
Family	Berberidaceae
Genus	*Podophyllum*
Species	hexandrum royle

Geographical Source

Podophyllum hexandrum royle (Himalayan Mayapple) was known as Aindri (a divine drug) in ancient times. Its name in Hindi and Ayurveda is bantrapushi or Giriparpat. The perennial herb Podophyllum hexandrum bearing the common names Himalayan May apple or Indian May apple, is native to the lower elevations of Himalayan countries like Afghanistan, Pakistan, India, Nepal, Bhutan, and in China. In India Podophyllum hexandrum is mostly found in Alpine Himalayas of Jammu and Kashmir, Himachal Pradesh, Sikkim, Uttaranchal and Arunachal Pradesh. In Kashmir it has been used in traditional system of medicine from time immemorial and is locally known as Banwangun, since its red colour fruit (berry) is of the size of a small brinjal. Indian Podophyllum

has a long history of usage amongst natives of the Himalayas, an aqueous extract of the roots being a common cathartic. It is low to the ground with glossy green, lobed leaves on its few stiff branches, and it bears a light pink flower and bright red-orange bulbous fruit.

It can be propagated by seed or by dividing the rhizome. It is tolerant to cold temperatures, as would be expected of a Himalayan plant, but is not tolerant to dry conditions. [24]

Figure 4: Flower of *Podophyllum hexandrum*

Active Constituents

Podophyllum hexandrum contain a number of compounds with significant pharmacological properties, e.g, epipodophyllotoxin, podophyllotoxin, lignans, flavonoids such as quercetin, podophyllotoxin glycoside, kaempferol.

The main chemical constituent of podophyllum is resin.It is also known as podophyllin. The amount of podophyllin or resin present in American podophyllum is 2-8% and in Indian podophyllum is about 6-12%. Podophyllum rhizomes contain 2–8% resinous material termed as podophyllin.

The major constituents of podophyllum resin are the lignan derivatives which are characterized as podophyllotoxin, α and β-peltatin. The lignans are found in the form of glycosides and also as their free aglycones. It also contains desmethyl podophyllotoxin, desoxypodo phyllotoxin, podophyllotoxone, a flavonoid quercetin and starch. The rhizomes also contain gum, starch, albumin, gallic acid, calcium oxalate, lignin, flavones. [13]

The rhizomes and roots of the plant contain anti-tumor lignans such as podophyllotoxin and podophyllotoxin 4-O-glucoside. Among these non-alkaloid lignans, podophyllotoxin is considered to be the most important, it is currently utilized in the semi-synthesis of the anti-cancer drugs etoposide, teniposide, and etoposide sulphate, which were developed as less toxic derivatives of podophyllotoxin [25].

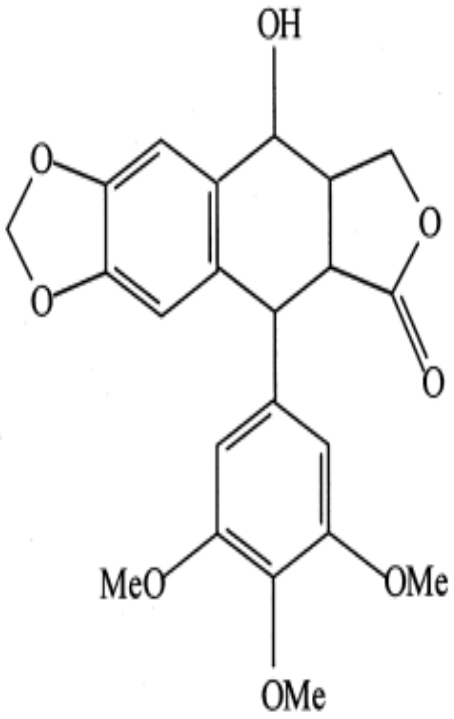

Figure 4.1: Structure of Podophyllotoxin

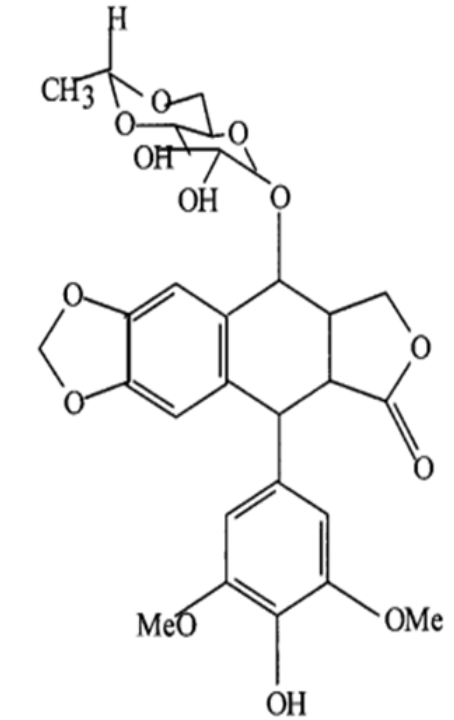

Figure 4.2: Structure of Etoposide.

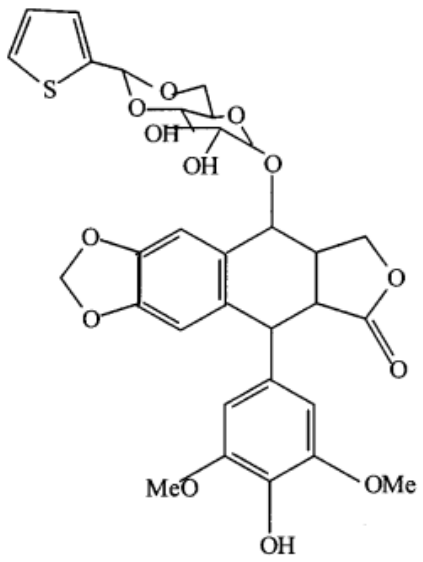

Figure 4.3: Structure of Teniposide

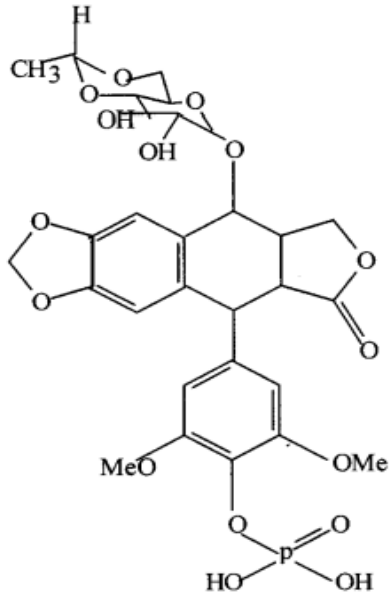

Figure4.4: Structure of Etoposidesulphate.

Mechanism of Action

- Podophyllotoxin has potent cytotoxic activity and also acts as an inhibitor of tubulin polymerization.
- Etoposide is an alkaloid from the plant *Podophyllum peltatum* that has cell cycle-specific activity in the late S phase and G_2 phase. Etoposide inhibits topoisomerase II by stabilizing the enzyme–DNA complex and preventing the unwinding of DNA. Etoposide is indicated for the treatment of patients with germ cell tumors, lung cancer, Hodgkin's and non-Hodgkin's lymphomas, gastric cancer, breast cancer, and testicular cancer [26]
- Etoposide and teniposide differ only in that the methyl group of the former
- Teniposide is approved only for the treatment of refractory childhood leukemias.

Figure 4.3: Rhizome of *Podophyllum* plant

Uses:

- 1.Rhizomes are used for typhoid fever, jaundice, dysentery, chronic hepatitis, scofula, rheumatism, skin diseases, tumor growth, kidney & bladder problems.
- Podophyllum is also used to empty the bowels, kill parasitic worms in the intestine, and counteract snakebite.
- Podophyllum is applied directly to the skin for removal of warts, including plantar warts and sexually transmitted (venereal) warts.
- It is also used topically for treating pre-cancerous white patches on the tongue and mouth.
- Podophyllum resin is a strong gastrointestinal irritant. It acts as a drastic purgative in moderate doses but it has been mostly replaced by other purgative drugs.
- Intravaginally, podophyllum is used to treat gynecologic infections.
- Root paste is applied on ulcers, cuts and wounds.

Figure 4.4: *Podophyllum hexandrum*

Zingiber officinale

Synonym: Rhizoma zingiberis, zingibere, gingerin.
Biological source: Ginger belongs to the oleo gum resin category and is obtained from the rhizomes of *Zingiber officinale Roscoe.*
Family: Zingiberaceae.
Scientific classification:

Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Zingiberales
Family	Zingiberaceae
Genus	*Zingiber*
Species	*officinale*

Geographical Source

Ginger is supposed to have originated in South-East Asia. Ginger has been cultivated for thousands of years as a spice and also for its medicinal purposes. During the medieval years, ginger plants were carried on ships from the Indian subcontinent and were introduced to different parts of the world.

Currently, India and China are the dominant suppliers to the world market. Ginger is cultivated in countries like India, China, Nigeria, Indonesia, Bangladesh, Thailand, Philippines, Jamaica etc. It is also grown in Australia, Fiji, Brazil, Sierra Leone and Japan. United Kingdom, United States, Japan and Saudi Arabia. Nigeria ranks first with respect to area under ginger covering about 56.23% of the total global area followed by India (23.6%), China (4.47%), Indonesia (3.37%) and Bangladesh (2.32%).

India ranks first with respect to ginger production contributing about 32.75% of the world's production followed by China (21.41%), Nigeria (12.54%) and Bangladesh countries lead in the supply of ginger in the world market. Japan and USA are the major importers.

India exports mainly in the form of whole and dry ginger China, Nigeria and Thailand are competing with India in the recent past in the world market. Australia is the world leader in value added products. India has 50% share in oil and oleoresin trade. Ginger is cultivated in most of the states in India. However, states namely Kerala, Meghalaya, Arunachal Pradesh, Mizoram, Sikkim, Nagaland and Orissa together contribute 70% to the country's total production. In terms of quality, Jamaican and Indian ginger are considered to be superior followed by West African variety. India is biggest producer of Z. officinale in the world [27].

Figure 5: Roots of Ginger plant.

Active Constituents

Phytochemical studies show that ginger rhizome contains a wide variety of biologically active compounds which impart medicinal property. *Z. officinale* is reported to possess essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, saponins, steroids, terpenoids and tannin as the major phytochemical groups. The species contains biologically active constituents including the non-volatile pungent principles, such as the gingerols, shogaols, paradols and zingerone that produce a "hot" sensation in the mouth. The pungency of dry ginger mainly results from shogaols, which are dehydrated forms of gingerols. Gingerols are thermally labile because of the presence of a β- hydroxy keto group and readily undergo dehydration to form the corresponding shogaols. Paradol is similar to gingerol and is formed on hydrogenation of shogoal. Oleoresin, which is isolated by acetone and ethanol extraction, contains 4-7.5% of dried powder, pungent substances namely gingerol, shogaol, zingerone and paradol [28].

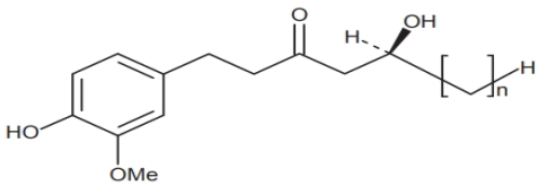

Figure 5.1: Structure of Gingerol

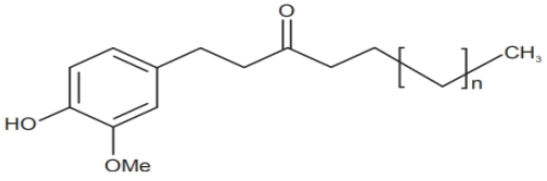

Figure 5.2: Structure of Shogaols

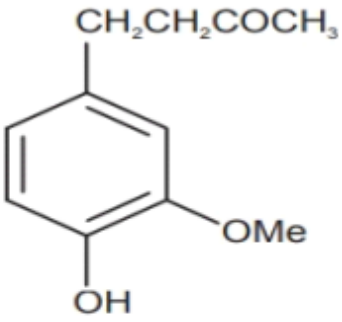

Figure 5.3: Structure of Zingerone

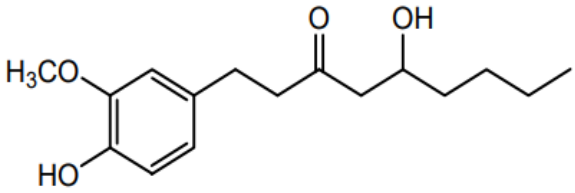

Figure 5.4: Structure of 6-gingerol

Mechanism of Action

- Ginger extract and its constituents possess chemopreventive and antineoplastic properties in gastric cancer.
- *In vitro* study showed that 6-gingerol induces apoptosis of gastric cancer cells.
- Ginger and its active constituents suppress the growth and induce apoptosis of variety of cancer types including skin, ovarian, colon, breast, cervical, oral, renal, prostate, gastric, pancreatic, liver, and brain cancer [29].

Figure 5.5: Rhizome of Ginger.

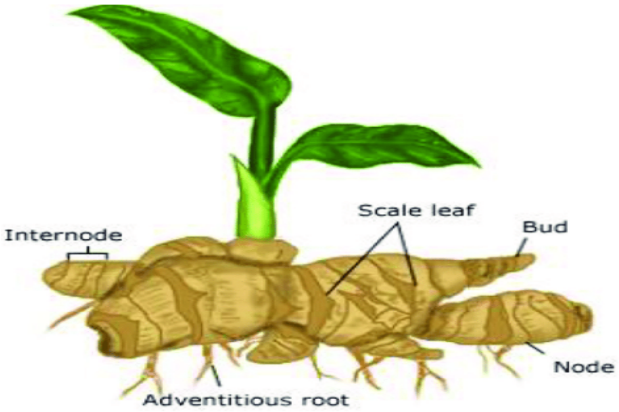

Figure 5.6: Morphology of Ginger.

Uses:

- Ginger is used as an antiemetic, positive inotropic, spasmolytic, aromatic stimulant, carminative, condiment, and flavouring agent.
- The ginger is basically used for treatment of some types of "stomach problems," including motion sickness, morning sickness, upset stomach, gas, diarrhoea, irritable bowel syndrome (IBS), nausea, nausea caused by cancer treatment, nausea caused by HIV/AIDS treatment, nausea and vomiting after surgery, as well as loss of appetites.
- Ginger also has Antiplatelet aggregation property which is due to inhibition of thromboxane synthesis.
- Ginger also lowers cholesterol levels.
- It also possess Antitussive, Anti pyretic and Analgesic effects.
- Ginger rhizome has Antifungal, Anti-bacterial, Anti helminthic properties.
- Sore throat, hoarseness, and loss of voice are benefited by chewing a piece of ginger [30].

Figure 5.7: Flower, leaves, powder, roots and rhizomes of *Zingiber officinale.*

Curcuma longa

Synonym: Saffron Indian, haldi, curcuma, turmeric.
Biological source: It consists of dried, as well as fresh rhizomes of plant known as *curcuma longa Linn.*
Family: Zingiberaceae
Scientific classification:

Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Zingiberales
Family	Zingiberaceae
Genus	*Curcuma*
Species	*longa*

Geographical Source

Curcuma longa L., which belongs to the Zingiberaceae family, is a perennial herb that measures up to 1 m high with a short stem, distributed throughout tropical and subtropical regions of the world, being widely cultivated in Asiatic countries, mainly in India and China. In India is popularly known as "Haldi", in Malaysia, Indonesia and India has been well studied due to its economic importance. Its rhizomes are oblong, ovate, pyriform, and often short-branched and they are a household remedy in Nepal. It is a sterile plant and does not produce any seeds. The rhizome is an underground stem that is thick and fleshy ringed with the bases of old leaves and is used for medicinal and food preparation. Rhizomes are boiled and then dried and ground to make the distinctive bright yellow spice, turmeric. The plant has oblong, pointed leaves with funnel-shaped yellow flowers.

It is grown and harvested commercially in India, China, and many regions of tropical south Asia and needs temperatures between 20 °C and 30 °C and a considerable amount of annual rainfall.

Figure 6: Rhizome, powder of *curcuma longa.*

Active Constituents

Turmeric contains protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (13.1%). Phenolic diketone, curcumin (diferuloylmethane) (34%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%). Other phenolic diketones demethoxycurcumin and bis-demethoxycurcumin have also been isolated from the rhizomes of *Curcuma longa*. Presence of tumerones (a and b), curdione, curzerenone, mono- and di-demethoxycurcumin have been reported in the rhizomes. The essential oil (5.8%) obtained by steam distillation of rhizomes has *a*-phellandrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%).
Turmeric contains yellow colouring matter called as curcuminoids (5%) and essential oil (6%). The chief constituent of the colouring matter is curcumin I (60%) in addition with small quantities of curcumin III, curcumin II and dihydrocurcumin [31].

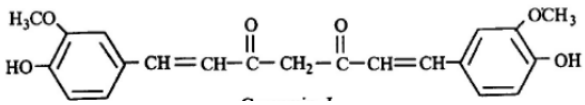

Figure 6.1: Structure of Curcumin-I

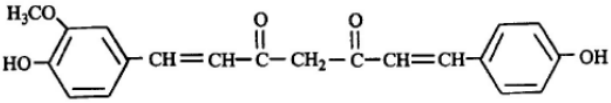

Figure 6.2: Structure of Curcumin-II

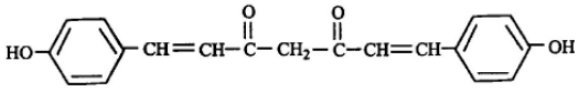

Figure 6.3: Structure of Curcumin-III

Mechanism of Action

- Anti-cancer drugs are classified into different subgroups on the basis of their mechanism of actions as anti-proliferative agents, carcinogen blocking agents or antioxidants.
- *Curcuma longa* contains significant amount of curcumin which exhibited the characteristics of all three subgroups with various biochemical mechanisms of actions like apoptosis and the regulation of survival signals.
- Enzymes, receptors, growth factors, transcription factors and inflammatory cytokinin are the major targets of curcumin from turmeric to manage the cancers.
- Curcumin scavenges the reactive oxygen species, promoting proapoptotic & anti-inflammatory actions,

and reduction in survival signal as combination of different mode of actions as anti-cancer agent.

- Reactive oxygen species' role in the cancer cells is in two ways; on one side Reactive oxidative stress (ROS) acts as carcinogenesis by mutating DNA while on the other side it is able to drive mitochondrial apoptosis in damaged cells. So to prevent the cancer it's important to minimize DNA mutations by scavenging ROS and on treating the tumor it's significant to generate ROS to activate the mitochondrial apoptosis [32].

Figure 6.4: Flowers of *Curcuma longa*

Figure 6.5: Rhizome of *Curcuma longa*

Uses:

- *Curcuma longa* (haldi) is a widespread ingredient uses as a spice in foods as preservative and colouring material in a different part of world.
- Turmeric is used as home remedy for wound healing.
- Turmeric is anti-inflammatory to the mucous membrane which coat the throat.
- Turmeric is used as aromatic, anti-inflammatory, stomachic, uretic, anodyne for billiary calculus, stimulant, tonic, carminative, blood purifier, antiperiodic, alterative, spice, colouring agent for ointments and a common household remedy for cold and cough.
- Curcumin posses broad remedial potential due to its multi-targeting effect against many different carcinomas such as leukemia, genitourinary cancers, gastrointestinal cancers etc.
- It can treat tonic and acute allergies and offers health benefits for asthma and eczema.
- It has been found to be effective in treating acne and psoriasis.
- Externally, it is used in the form of a cream to improve complexion.
- It is also used in menstrual pains.
- Turmeric helps in balanced blood sugar [33].

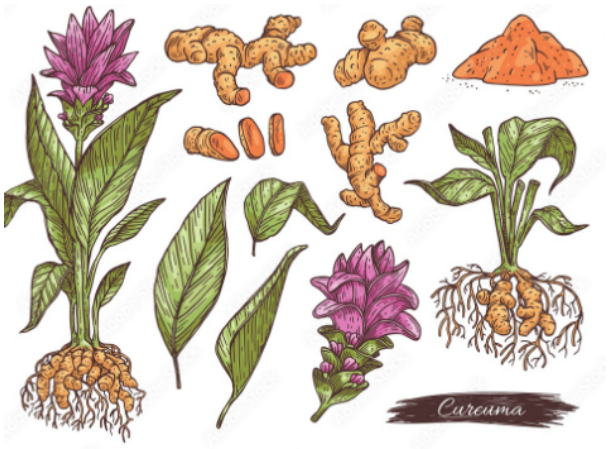

Figure 6.6: Flower, leaves, powder, roots and rhizomes of *Curcuma longa*

Conclusion

This detailed analysis of different plants showed that medicinal herbs promise a huge anticancer potential. This article comprehensively highlights the mechanism of antitumor activity of some of the important plants. Every year, cancer takes the life of millions of people. Various therapies are available for the cancer treatment but they have several limitations such as kidney damage, gastrointestinal disorder, etc., due to which an alternative solution to this problem is required. Plant derived compounds possessing anti-cancer activities have received huge amount of scientific attention. They play vital role in the cancer prevention and treatment. Plants are the major source of secondary metabolites and an important

source of pharmaceutical drugs. Secondary metabolites from medicinal plants inhibits the DNA damage, arrest the cell cycle, inhibits the tumour cell angiogenesis and induce apoptosis thus prevents the cancer. So further investigations of plants in cancer treatment show a promising activity and it must be taken into consideration. Therefore, these selected plants have been explored for their biological activity and further more efforts are required to explore potent anticancer plants from nature to save humans life across the world from cancer.

Conflict of Interest

The authors declare no conflict of interest regarding this study.

Acknowledgements

The management of Marri Laxman Reddy Institute of Pharmacy, Dundigal, Telangana, India, is appreciated by the authors for providing the resources needed to complete the review.

References

1. Gopi Krishna R, Vinuthna N, Sushmitha T, Mounika V, Manikanta T (2024) Extraction, Preliminary Phytochemical Screening & Antibacterial Activity of *Terminalia chebula* Fruit. International Journal of Allied Medical Sciences and Clinical Research 12(3): 285-292.

2. Kadagoni P, Rakam GK, Rani J, Reddy R, Gari SRJ, et al. (2024) A Review on Decoding Diabetic Foot Ulcers. Current Scientific Research in Biomedical Sciences 6(1): 1-7.

3. (2015) Pharmacognosy and Phytochemistry: Drugs Containing Alkaloids (180 pharmacy). Uttaranchal Journal of Applied and Life Sciences U. J. App. Life. Sci 2(1): 1-7.

4. Aruna MS, Prabha MS, Priya NS, Nadendla R (2017) *Catharanthus roseus* Ornamental Plant is now Medicinal Boutique. Journal of Drug Delivery and Therapeutics.

5. Banasik M, Stedeford T (2020) In vitro antioxidant activity of *Bougainvillea glabra* and *Mucun pruriens*. In: Encyclopedia of Toxicology, 3rd (Edn.), Rakam GK, Sundararajan R (Eds.), International Journal of Research in Pharmaceutical Sciences 11(1): 806-812.

6. Sharma V, katiyar A, Agarwal RA (2019) Glycyrrhiza glabra: Chemistry and Pharmacological Activity 4. Rakam Gopi Krishna and Raja Sundararajan (2019) Screening of antioxidant activity of *Mucuna pruriens* by *in vivo* model. International Journal of Research in Pharmaceutical Sciences 10(1): 523-530.

7. Manjeera K, Sundararajan R (2024) Evaluation of Antidiabetic Activity of *Abutilon crispum* on Normal and Streptozotocin induced Diabetic Albino Wistar Rats. Journal of Pharmacology and Pharmacotherapeutics pp: 1-13.

8. Gopi Krishna R, Sundararajan R (2018) Myocardial Protective Impact of *Mucuna pruriens* on Isoproterenol Prompted Myocardial Necrosis. Scholars Research Library, Der Pharmacia Lettre 10(3): 37-56.

9. Thakur AK, Raj P ((2017) Pharmacological Perspective of *Glycyrrhiza Glabra* Linn.: a Mini-Review. J Anal Pharm Res 5(5): 00156.

10. Sami A Shawl, Abil Rashid (2011) International Journal of Pharmacy and Pharmaceutical sciences 3(5):

11. Abila A Rashid, Sami A Shawl (2011) *Podophyllum hexandrum*- A versatile Medicinal plant. International Journal of Pharmacy and Pharmaceutical Sciences 3(5).

12. Gopi Krishna R, Sundararajan R (2018) Myocardial Protective Impact of *Mucuna pruriens* on Isoproterenol Prompted Myocardial Necrosis. Scholars Research Library, Der Pharmacia Lettre 10(3): 37-56.

13. Kumar Gupta V, Yadav P, Prajapati V, Maurya S, Kumar Maurya M (2021) Pharmacognosy of Ginger officinale. International journal of creative research thoughts (IJCRT) 9(1):

14. Dhanik J, Arya N, Nand V (2017) Journal of Pharmacognosy and Phytochemistry.

15. Gopi Krishna R, Sundararajan R (2018) Cardioprotective and antioxidant effects of *Bougainvillea glabra* against isoproterenol induced myocardial necrosis in albino rats. International Journal of Phytomedicine 10 (1): 45-57.

16. Dada Khalandar S, Naga Adithya T, Jilani Basha S, Koshma M, Venkata Subbareddy U et al. (2018) A Current Review on *Curcuma longa* Linn. Plants.

17. Kumar N, Kumar Sakhya S (2013) A Ethnopharmacological Properties of *Curcuma longa* Review.

18. Gopi Krishna R, Srinivasa Murthy M, Kavya V (2021) Method development and validation of RP-HPLC method for the determination of sumatriptan in bulk and pharmaceutical dosage form. Research Journal of Pharmacy and Technology 14(11): 5856-5862.

19. Manjeera K, Sundararajan R (2024) Toxicity Studies of

Abutilon crispum and *Indigofera prostrata* Whole Plants on Wistar Rats. Tropical journal of Natural Product Research 8(11): 9073-9078.

20. Gopi Krishna R, Sundararajan R (2020) Toxicity studies of *Bougainvillea glabra* and *Mucuna pruriens.* International Journal of Pharmaceutical Sciences and Research 11(10): 1000-1008.

21. Gopi Krishna R, Sundararajan R (2018) *In vivo* Antioxidant Activity of *Bougainvillea glabra*. IOSR Journal of Pharmacy 8(6): 11-18.

22. Sunitha N, Gopi Krishna R, Lalitha R, Rajkumar V (2016) Synthesis and Biological Evaluation of New Thiazolidinone Derivatives. International Journal of Medicinal Chemistry & Analysis 6(1): 19-26.

23. Gopi Krishna R, Raja S (2018) Molecular Docking Study of Isolated Phytoconstituents from *Bougainvillea glabra* and *Mucuna pruriens*. European Journal of Biomedical and Pharmaceutical sciences 5(11): 386-394.

24. Gopi Krishna R, Sundararajan R (2017) A complete evaluation on *Bougainvillea glabra*: Ethnomedical information, Active constituents & Pharmacological actions. American Journal of Pharm Tech Research 7(1): 299-307.

25. Kuchi Manjeera, Raja Sundararajan (2024) Standardization and Phytochemical screening of *Abutilon crispum*. Research Journal of Pharmacy and Technology 17(4): 1621-1630.

26. Gopi Krishna R, Raja S (2017) Standardization and Phytochemical Screening of *Bougainvillea glabra*. International Journal of Current Pharmaceutical Research 9(5): 76-80.

27. Gopi Krishna R, Manjeera K, Lalitha R (2013) A validated spectrophotometric method for the estimation of Ezetimibe in bulk and tablet dosage form. Indo American Journal of Pharmaceutical Research 4(4): 2231-6876.

28. Sundararajan R, Krishna Rakam G, konduru R (2014) Evaluation of antioxidant and cardio protective activities of *Bridelia retusa* on isoproterenol induced myocardial necrosis in albino rats. World Journal of Pharmaceutical Research 3(3): 4549-4572.

29. Premalatha A, Kumar VR, Gopi Krishna R, Manjeera K (2015) Formulation and evaluation of Tramadol Hcl sustained Release Matrix Tablets. World Journal of Pharmaceutical Research 4(5): 1999-2009.

30. Gopi Krishna R, Sundararajan R (2017) Standardization and Phytochemical Screening of *Mucuna Pruriens*. European Journal of Biomedical and Pharmaceutical sciences 4(11): 264-270.

31. Gopi Krishna R, Manjeera K, Lalitha R, Sunitha N (2013) Preliminary phytochemical screening and in vitro antibacterial activity of *Bridelia retusa* plant extract. World Journal of Pharmaceutical Research 2(6): 3337-3347.

32. Krishna RG, Pravalika K, Reddy N, Sandhya B, Aradhana S (2024) A Review on Collection of Herbs Used for the Treatment of Psoriasis. International Journal of Pharmaceutical Research and Applications 9(6): 158-166.

33. Haritha VANV, Krishna RG, Geethika A, Harika B, Saraswathi G, et al. (2024) Phytochemical Screening & Comparative study of different extracts on Antifungal Activity of Neolamarckia cadamba leaf. International Journal of Research in Pharmacology & Pharmacotherapeutics 13(3): 254-264.