

Use of Phytoconstituents for Cancer Therapy

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Abstract

Cancer is a genetic disease marked by uncontrolled cell growth and metastasis. Although conventional therapies are effective, they often cause toxicity and resistance. Phytoconstituents, including alkaloids and polyphenols, exhibit anticancer effects by inducing apoptosis, inhibiting proliferation, and suppressing angiogenesis. Several key anticancer drugs such as vincristine and paclitaxel are plant-derived. These compounds offer promising potential for safer and more effective cancer therapy and prevention.

Introduction

Cancer is an group of disease involving abnormal cell growth with potential to invade or spread to other parts of body.it is an genetic disorder [1-2]. The word cancer come from Greek word (karkinos) , which firstly used by the Hippocrates ‘father of medicine’ it means ‘crab’ and ‘tumors’ mainly it describes the word tumors because blood vessels around tumors looks like crabs legs [3-5]. He classified tumors as benign (harmless) and malignant (harmful) [6].

Pathophysiology of cancer:

“Cancer occurs when mutations in DNA cause uncontrolled cell growth, leading to tumour formation, invasion, angiogenesis, and metastasis.” [7].

1. Normal Cell Growth- In a healthy body, cells grow, divide, and die in a controlled cycle. Then old/damaged cells die (apoptosis) and new cells replace them [8-9].
2. DNA Damage / Mutation- Cancer begins when the DNA of a cell gets damaged or mutated. This damage can be due to: Smoking, alcohol, chemicals or Radiation (UV rays, X-rays) or Viruses (HPV, Hepatitis B/C, EBV) or Inherited mutations (family history) [10-11].
3. Uncontrolled Cell Division- Mutated DNA causes cells to ignore normal “stop signals.” Cells start dividing without control and do not die when they should. This leads to formation of a tumour (mass of abnormal cells) [12-13].
4. Tumour Formation- Benign tumours stays in one place, usually not life-threatening but Malignant tumours are Invades nearby tissues and destroys them [14].
5. Angiogenesis- Cancer cells stimulate growth of new blood vessels to supply nutrients to the tumour which helps tumour grow faster [15-16].
6. Metastasis (Spread of Cancer)- Cancer cells break away from the original tumour. Travel through blood or lymphatic system. Form new tumours in distant organs (lungs, liver, bones, brain). This is what makes cancer dangerous and life-threatening [17].

Types of cancer:

- Carcinoma- which affects skin, lungs, breast, colon, prostate (most common type) [18].
- Sarcoma- which affects bones, muscles, fat, connective tissues [19].
- Leukemia- which affects blood and bone marrow cancer [20].
- Lymphoma & Myeloma- its an cancers of the immune system [21].
- CNS cancers- which affects brain and spinal cord tumours [22].

Signs and symptoms:

“Common cancer symptoms include unexplained weight loss, fatigue, persistent pain, non-healing ulcers, abnormal bleeding, change in bowel/bladder habits, and appearance of lumps or abnormal skin changes.”

• General Symptoms [23].

- Unexplained weight loss (more than 5–10 kg without reason).
- Persistent tiredness / weakness.
- Loss of appetite.
- Fever and night sweats (not due to infection).

• Local Symptoms (tumor-related) [24].

- Lump or swelling in breast, neck, or other body parts.
- Non-healing wound or ulcer.
- Abnormal bleeding – blood in urine, stool, coughing blood, bleeding between periods.
- Change in bowel or bladder habits (constipation, diarrhea, frequent urination).
- Persistent cough or hoarseness of voice.
- Difficulty in swallowing or indigestion.
- Change in a mole / wart – change in size, shape, or color.
- Unexplained pain (chronic headache, bone pain, back pain).

• Special Symptoms (depending on site) [25].

- Breast cancer → lump in breast, nipple discharge.
- Lung cancer → chronic cough, chest pain, breathlessness.
- Oral cancer → white/red patches, mouth ulcers not healing.
- Cervical cancer → abnormal vaginal bleeding, pelvic pain.
- Leukemia (blood cancer) → frequent infections, easy bruising, nosebleeds.

Treatments: [26].

- Surgery_ in this there was an removal of tumor.
- Radiation therapy_ it uses high-energy rays to kill cancer cells.
- Chemotherapy_ in which medicines are used ; that kill or stop growth of cancer cells.
- Immunotherapy_ in which they boosts the body’s immune system to fight cancer.
- Targeted therapy_ use of drugs that target specific molecules in cancer cells.
- Hormone therapy_ which blocks hormones that help some cancers grow.

Why Phytoconstituents are more preferable than other synthetic chemicals ?

Phytoconstituents are bioactive compounds from plants (alkaloids, flavonoids, terpenoids, lignans, polyphenols) [27]. They act by inhibiting tumour growth, inducing apoptosis, blocking angiogenesis, modulating immune response and preventing metastasis [28]. Many modern anticancer drugs are plant-derived or semi-synthetic analogues of phytoconstituents. Phytoconstituents like Vincristine, Paclitaxel, Camptothecin, Podophyllotoxin, Curcumin, Resveratrol, EGCG, Genistein, Berberine, and Quercetin play an important role in cancer treatment. They act by inhibiting mitosis, blocking topoisomerases, inducing apoptosis, preventing angiogenesis, modulating hormones, and reducing oxidative stress [29]. Many current anticancer drugs are derived from these natural compounds.

Use of phytoconstituents in different treatments :

Phytoconstituents are mainly used in Chemotherapy and Targeted Therapy. They can also act as adjuvants in radiation therapy, immunotherapy, and prevention [30].

- Chemotherapy (Cytotoxic Drugs)- They directly kill or stop growth of cancer cells.
Vincristine, Vinblastine (Catharanthus roseus) → Inhibit mitosis [31].
Paclitaxel (Taxol) (Taxus brevifolia) → Stabilizes microtubules [32].
Camptothecin & Etoposide → Topoisomerase inhibitors [33].
- Targeted Therapy- An drug act on specific molecular pathways.
Curcumin (Turmeric) → Inhibits NF- κ B, angiogenesis.
Resveratrol (Grapes) → Anti-angiogenic, apoptosis inducer.
EGCG or Thea sinesis (Green tea polyphenol) → Inhibits metastasis & signaling pathways.
Genistein (Soy isoflavone) → Blocks estrogen receptor (useful in hormone-related cancers like breast, prostate) [34].
- Immunotherapy (Supportive Role)- Boost immune system response against cancer.
Curcumin → Enhances immune cell activity.
Betulinic acid (Birch bark) → Promotes tumor-specific apoptosis [35].
- Preventive / Chemoprevention_ Prevent transformation of normal cells into cancerous ones.
Carotenoids (β -carotene, lycopene) → Antioxidants, protect DNA.
Flavonoids (Quercetin, Apigenin) → Anti-inflammatory, prevent tumor initiation [36].

ANTICANCER PLANTS:

Anticancer plants are parts of a plant having a derivative compound which is used as an anticancer agent to treat or prevent cancer. It has been discussed that “the use of natural sources has been a great success in the discovery of medicine”.

Plants have a mechanism where they produce anti-fungal chemicals to defend themselves from microorganisms. Those chemical compounds are studied to have an inhibitory effect over human cancer cells therefore they are used as Chemotherapy Drugs [37].

- **VINCA**

SYNONYM: Catharanthus Roseus, Madagascar Periwinkle

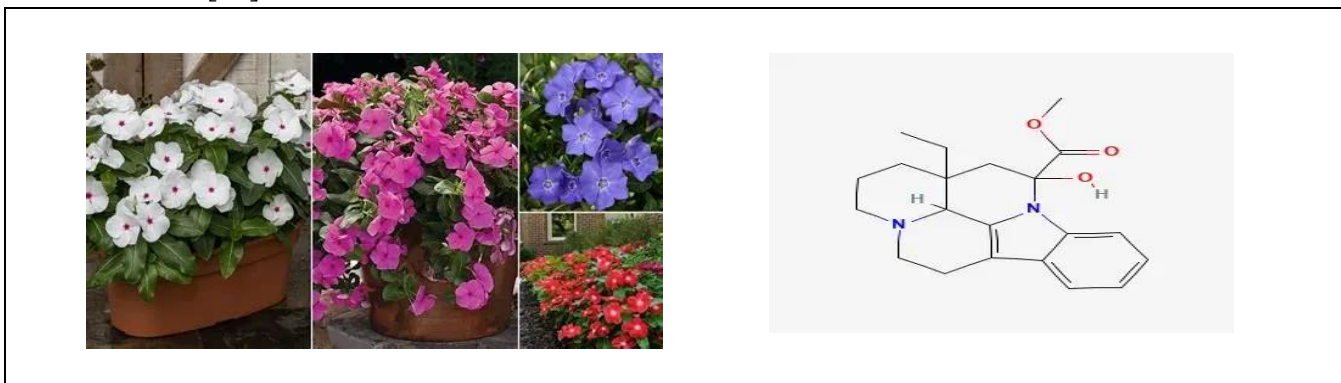
BIOLOGICAL SOURCE: Vinca is obtained from dried plant of Catharanthus roseus linn.

FAMILY: Apocynaceae

CHEMICAL CONSTITUENTS: It is an alkaloid containing vincristine, vinblastine and vinorelbine.

MOA: Anticancer effect is seen when the anticancer agent binds to the microtubule protein and breaks the

microtubule, which inhibits the formation of mitotic spindle in the metaphase. This stops the division of cancerous cells [38].



• **PODOPHYLLUM**

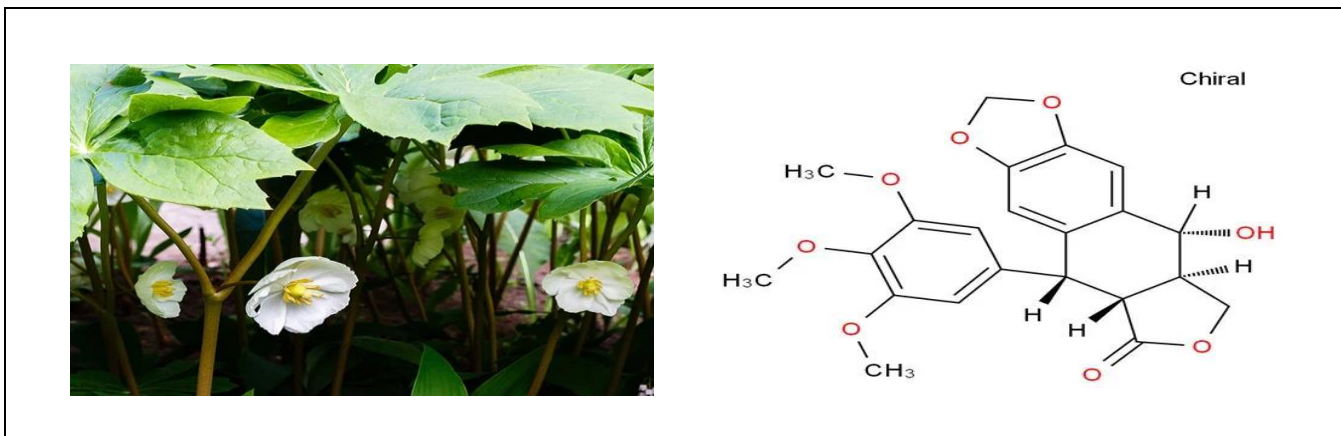
SYNONYM: May apple root, American Mandrake

BIOLOGICAL SOURCE: It is obtained from dried rhizomes and roots of *Podophyllum peltatum* linn.

FAMILY: Podophyllaceae

CHEMICAL CONSTITUENTS: It consists of Epipodophyllotoxins etoposide, Etoposide phosphate, teniposide.

MOA: It works by inhibiting the multiplication of cancerous cells by breaking the micro-tubule into smaller fragments and thus inhibit cell division [39].



• **TOXOL**

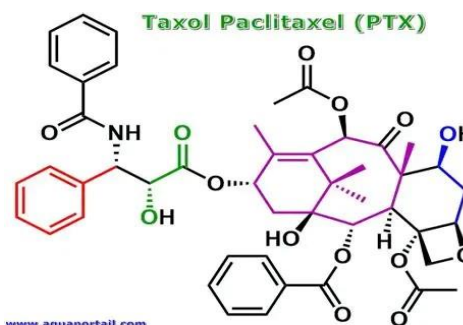
SYNONYM: Taxane, Paclitaxel

BIOLOGICAL SOURCE: It can be obtained from Pacific Yew tree (*Taxus brevifolia* or *Taxus baccata*).

FAMILY: Taxaceae

CHEMICAL CONSTITUENTS: It consists of Paclitaxel and docetaxel.

MOA: It works by interrupting in multiplication of cancerous cells that is it breaks the microtubule into small fragments and inhibit cell division [40].



• **CAMPTOTHECIN**

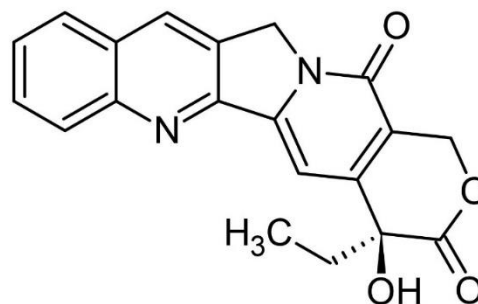
SYNONYM: CPT, Campthecine, Camptothecin .

BIOLOGICAL SOURCE: It is extracted from bark and stem of Chinese tree *Camptotheca acuminata*. *Nothapodytes nimmoniana* is also a source of Camptothecin.

FAMILY: Nysaceae

CHEMICAL CONSTITUENTS: It consists of Camptothecin, Irinotecan and Topotecan.

MOA: It helps in cancer therapy by including in anticancer drugs. It works by inhibiting Topoisomerase-1 enzyme and prevent re-ligation of DNA. This helps to stop cancerous cell growth [41].



• **TEA**

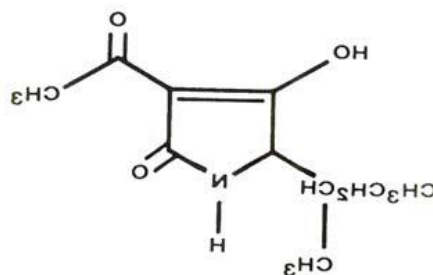
SYNONYM: Black tea and Green tea

BIOLOGICAL SOURCE: It is obtained from leaves of the plant *Camellia Sinensis* (*Thea Sinensis*).

FAMILY: Theaceae

CHEMICAL CONSTITUENTS: It consists of Tannin and Flavonoids.

MOA: There are Gallates present in Green tea, these Gallates protect body from harmful radiations. Regular use of green tea can help body to protect itself from many cancers like oesophagus, stomach, intestine and the lungs. Also tea helps to inhibit growth of cancer by eliminating free radicals from the body [42].



• TURMERIC

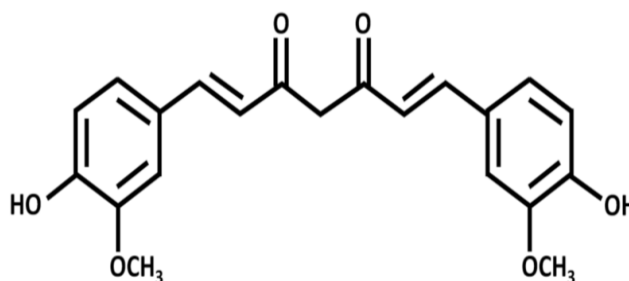
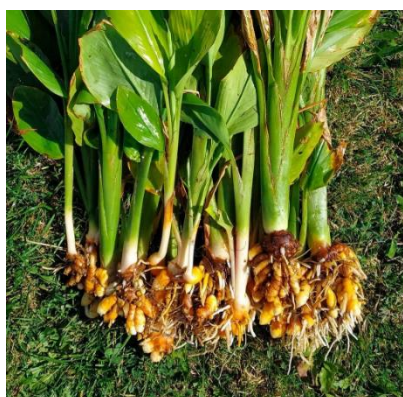
SYNONYM: Jianghuang, Curcumae Longae Rhizoma.

BIOLOGICAL SOURCE: It is obtained from dried rhizomes of the plant *Curcuma Longa* L.

FAMILY: Zingiberaceae

CHEMICAL CONSTITUENTS: It consists of Curcumin which have antioxidant property.

MOA: Turmeric have a potent antitumor activity. Curcumin is the active component which is extracted from the Turmeric. It works by promoting cell apoptosis and it also suppresses the spread of cancer by inhibiting invasion [43].



• COLCHICUM

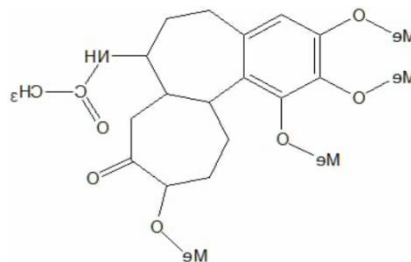
SYNONYM: Autumn Crocus, Meadow Saffron

BIOLOGICAL SOURCE: It is obtained biologically from *Colchicum Autumnale* by drying its seeds and corms.

FAMILY: Liliaceae

CHEMICAL CONSTITUENTS: It consists of Tropolone group of alkaloidal Colchicines which have antimitotic property.

MOA: It works by inhibiting cell division as it has antimitotic activity. It inhibits beta tubulin polymerization and inhibits cell multiplication [44].



• GARLIC

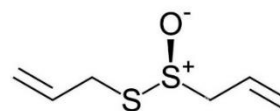
SYNONYM: Ail, Allii Sativi Bulbus, Allium

BIOLOGICAL SOURCE: It is obtained from the ripe bulb of the plant, Allium Sativum.

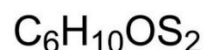
FAMILY: Liliaceae or Alliaceae

CHEMICAL CONSTITUENTS: Alliin, allicin, alliinase, S-allyl cysteine, diallyl disulphide, diallyl trisulphide and methyl allyl trisulphide.

MOA: It protects body from harmful carcinogens by excretion of chemical carcinogens out of the body. It increases the activity of detoxification enzymes which help to excrete carcinogens. Also, it increases immunity of the body [45].



Allicin



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