Review Article

Traditionally Used Medicinal Plants with Anticancer Effect: A Review

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ABSTRACT

Cancer is the second major cause of death after cardiovascular diseases. It is a group of many closely related diseases. Several synthetic drugs are used to cure this disease but they have their toxicity and hence a number of research activities is going on to investigate the natural plant derived chemotherapeutic agents. More than 50% of modern drugs in clinical use are of natural agents. In recent years owing to the concern 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 less toxic compared with conventional agents. The basic aim of this review is to highlight on the potential of newly discovered anticancer compounds from traditional medicinal plants to be used as leads for anticancer drug development. 85 different plant sources have been listed in the present review along with the phytoconstituents present in these plants possessing anticancer potential. The present paper is a comprehensive review of different literature sources. It will be helpful to explore the medicinal value of the herbal plants against the cancer and for the new drug discovery from them for the researchers and scientists around the world.

Keywords: Cancer, Side Effects, Anticancer Properties, Medicinal Plants, Phytoconstituents.

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INTRODUCTION

Cancer is a general term which causes a series of malignant diseases that may affect different parts of the body. These diseases are characterized by a rapid and uncontrolled formation of abnormal cells. Cancer harms the body when damaged cells divide uncontrollably to form lumps or masses of tissue called tumors (except in the case of leukemia where cancer prohibits normal blood function by abnormal cell division in the blood stream). Tumors can eventually grow and interfere with the digestive, nervous, and circulatory systems and can release hormones that alter body function. Tumors that stay at one site and demonstrate limited growth are usually considered to be benign. When a tumor successfully spreads to other parts of the body and grows, invading and destroying other healthy tissues, it is said to be metastasized. Metastasis is the most lethal aspect of carcinogenesis.

Cancer is known to be the second most common cause of death. In 2012, there were 14.1 million new cancer cases, 8.2 million cancer deaths and 32.6 million people who live with cancer (within 5 years of diagnosis) reported by IARC worldwide. Treatment options, depending on the stage and type of cancer, include: Surgery, Radiation therapy, Chemotherapy, Biological therapy, Hormone therapy *etc*. Chemotherapy can sometimes cause side effect like fatigue, sleep disturbance, appetite loss, hair loss, sore mouth, changes in taste, fever and infection, anxiety, depression, nausea, and vomiting. Moreover, during the last decade, novel synthetic chemotherapeutic agents currently in use clinically have not succeeded to fulfill expectations despite the considerable cost of their development. Therefore, there remains a constant demand to develop new, effective, and affordable anticancer drugs. [1]

In recent years there has been an increased trend in the use of medicinal plants in the developing countries because of their safety and less adverse effect especially when compared with synthetic conventional drugs. Till now NCI had investigated more than 35,000 plant species which resulted in the discovery of anticancer drugs such as Vincristine, Vinblastine, Taxol, Etoposide analogs, Indicine–N-oxide, Camptothecin and analogs and many others. With the knowledge of available traditional medicine, a new approach could be adopted which combine some or all of above methods. [2] Paclitaxel (Taxol TM) was originally isolated from *Taxus brevifolia* used in treatment of ovarian and breast cancers which

was assumed to bind the tubulin subunit of microtubules and stabilizes the microtubule to normal disassembly.[3] Herbs these days are also being used as chemoprotectant against cytotoxicity that are caused by anticancer drugs. So, this present review aimed at exploring the potential anticancer compounds from the medicinal plants.

The Mechanism on Cancer Therapy:

1. Inhibiting cancer cell proliferation directly by stimulating macrophage phagocytosis and enhancing natural killer cell activity.

2. Promoting apoptosis of cancer cells by the increase of production of interferon, interleukin-2 immunoglobulin and complement in blood serum.

3. By enhancing the number of leukocytes and platelets by stimulating the hemopoietic function.

4. By enforcing the necrosis of tumor and inhibiting its translocation and spread by the blockage of blood source of tumor tissue.

5. Promoting reverse transformation of tumor cells into normal cells.

Advantages of Herbal Drugs Over Conventional Drugs

Folk medicines of natural origin have been used for centuries in every culture all over the world. Scientists and medical professionals have shown increased interest in this folk medicine area as they recognized the true health benefits of these remedies. A herb (also called a botanical) is a plant or part of plant used for its scent, flavor, and / or therapeutic properties. Products that are made from botanicals used to maintain or improve health have been called herbal supplements, botanicals, or phytomedicines.

Common reasons for use of herbal medicines include health promotion, disease prevention, poor outcomes and limited treatment options for a serious illness, exhaustion of conventional therapies, dissatisfaction with, or inefficacious conventional therapies, fatal side effects or risks associated with conventional medicine, belief that herbal and natural products are better or safer, preference for personal involvement in the decision making process, and cultural or spiritual preference. Whereas side effects of allopathic medications vary wildly from mild to severe and there are many. These may include insomnia, vomiting, fatigue, dry mouth, diarrhea, constipation, dizziness, suicidal thoughts, hostility, depression, mania, seizures, coma, anemia, hair loss, high blood sugar, shoplifting, swelling, impotency, panic attacks, confusion, fainting and death.

The increasing costs of conventional cancer treatments (chemotherapy and radiation) and the lack of effective drugs to cure solid tumors encouraged people from different countries to depend more on folk medicine which is rooted in medicinal plants use. Of over 2069 anti-cancer clinical trials recorded by the National Cancer Institute as being in progress as of July 2004, over 160 are drug combinations including these agents against a range of cancers.[4]

In view of the complications of the therapies that are currently considered for cancer, high costs of conventional cancer therapies, and growing evidence of cancer in both developed and developing countries, it seems necessary to develop more novel approaches with higher efficiency so that the disease intensity could be declined. In this regard, there is considerable scientific and commercial interest in the development of new anticancer agents from natural sources and the research aimed to develop new anticancer drugs has been turned into a significant research area.[5] In fact, naturally derived combinations have been considered under pharmacists' focus to synthesize new drugs and treat diseases due to availability, less frequent side effects and drug interactions, and cheapness. [6,7] Herbal therapies although, still an unwritten science is well established in some cultures and tradition and have become a way of treatment in almost 80% of the people in rural areas, especially those in Asia, Latin America and Africa.

MEDICINAL PLANTS WITH ANTICANCER ACTIVITY

Plants are the chief source of natural products that are commonly and successfully used in medicine. Populations, who consume a high level of natural herbal products, generally have a declined incidence of cancer. There is lately great interest in screening for plants to be used in cancer prevention and treatment.[8] The present study is focused to screen some traditionally used medicinal plants for available anticancer effect. Few types of plants species present are listed and detailed (common names, plant type, family, part used, active constituents, mechanism of action, type of cancer treated) below (Table 1).

CONCLUSION

From the present review, it can be concluded that herbal medicinal plants and their derivatives are active against various type of cancers like lymphomas, breast, ovarian, lung, liver, stomach, prostate and testicular cancers. The cheap herbal medicinal treatment which may highly be recommended to the rural and poor people especially of developing countries to treat effectively the cancers of different type is an ideal choice. The investigated traditional medicinal plants in this article could be a key to identify the compounds with anti-cancer effects; therefore, if their compounds are examined, they might help to develop new, more efficient drugs, in addition to contributing to identify the main mechanisms involved in cancer.

Table 1: Anticancer medicinal plants

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
1.	*Ferula assa-foetida*	Asafoetida - Devil's Dung	Herb	Apiaceae	Shoot, resin	Coumarin compounds (especially sesquicoumarins), sulfur-containing compounds, and b-sitosterol and oleic acid	Inhibition of mutagenesis, DNA destruction and cancer cells proliferation; increase of proteolytic enzymes activity	Liver cancer [9]
2.	*Thymus vulgaris*	Thyme	Sub shrub	Lamiaceae	Shoot	Thymol and carvacrol	Cell cycle arrest	Prostate cancer [10], Head cancer [11]
3.	*Thymbra spicata*	Mediterranean thyme	Shrub	Lamiaceae	Shoot	Thymol and carvacrol	Inhibition of DNA destruction	Lung cancer [12]
4.	*Taverniera spartea*	Aelijaan	shrub	Fabaceae	Shoot	Isoflavonoid compounds and saponins	Induction of necrosis and apoptosis	Breast and prostate cancer [13]
5.	*Peganum harmala*	Harmel	Herb	Nitrariaceae	Seed	Alkaloids	Induction of apoptosis (by caspase activation and increase of proteolytic enzymes activity)	Breast cancer (Both *in vitro* and *in vivo*)[14], cervix cancer [13,15]
6.	*Viola tricolor*	Heartsease	Herb	Violaceae	Shoot	Flavonoids (especially rutin and quercetin)	Cell cycle arrest	Cervix cancer [16]
7.	*Achillea wilhelmsii*	Allheal, bloodwort	Herb	Asteraceae	Shoot	Phenolic compounds (especially flavonoids and monoterpens such as 1,8-cineole and a-pinene	Induction of apoptosis	Colon cancer [17]
8.	*Mentha pulegium*	Pennyroyal, squaw mint	Herb	Lamiaceae	Shoot	Pulegone, menthone, piperitone, limonene, isomenthone, octen-3-ol	Induction of apoptosis	Blood cells cancer [18]
9.	*Ammi visnaga*	Bisnaga	Herb	Apiaceae	Shoot	Visnadine, cimifugin, khellol, b-sitosterol, kaempferol, quercetin	Cell cycle arrest	Breast cancer [19]
10.	*Camellia sinensis*	Tea plant	Shrub or small tree	Theaceae	Leaf	Epicatechin, epigallocatechin, epigallocatechingallate, epigallocatechin3-gallate	Inhibition of cancer cells proliferation (by inhibit of 5-a reductase enzyme activity)	Lung, bladder, skin, prostate and breast cancer (Both *in vitro* and *in vivo*) [20]
11.	*Avicennia marina*	Grey mangrove	Shrub or tree	Acanthaceae	Leaf	Flavonoids (especially naphthoquinone compounds such as 3chlorodeoxylapachol)	Antioxidant effects; induction of apoptosis	Breast, larynx cancer [21,22]
12.	*Silybum marianum*	Cardusmarianus	Herb	Asteraceae	Seed	Flavonoids (especially silymarin	Antioxidant effects; cell cycle arrest	Colorectal cancer and colon cancer (Both *in vitro* and *in vivo*) [23], breast cancer [24]
13.	*Artemisia absinthium L*	Wormwood	Herb	Asteraceae	Root, shoot	Artemisinin, quercetin, isorhamnetin, limonene, myrecene, linalool, a-pinene, b-pinene, artesunate	Inhibition of cancer cells proliferation (decrease in response to nuclear receptors); inhibition of angiogenesis and cell migration; induction of apoptosis	Colon [25], blood cells cancer [26]
14.	*Curcuma longa*	Turmeric	Herb	Zingiberaceae	Rhizome	Curcumin	Inhibition of cancer cells proliferation (by adjusting gene expression); inhibition of angiogenesis; induction of apoptosis	Leukemia, glioblastoma and colon cancer (*In vitro*)[27],lung[28,29],breast[28], prostate[30], cervix[31] and larynx[32] cancer

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15.	*Crocus sativus L*	Saffron crocus	Herb	Iridaceae	Stigma	Phenolic compounds (especially quercetin), CrocetinCrocin, picrocrocin, and safranal	Inhibition of cancer cells proliferation (inhibits DNA synthesis)	Sarcoma and oral cancer (Both *in vitro* and *in vivo*) [33], breast[34], colon[35], liver[36,37]cancer
16.	*Zingiber officinale*	Ginger	Herb	Zingiberaceae	Rhizome	Flavonoids (especially kaempferol, catechin, fisetin, and quercetin)	Induction of apoptosis	Ovary, cervix, colon, liver and urinary cancer (*In vitro* and *in vivo*) [38], prostate cancer [39]
17.	*Olea europae*	Olive	Tree or Shrub	Oleaceae	Leaf, fruit	Oleic acid, pinoresinol, oleuropein, acidic triterpenes, oleanolic acid, maslinic acid	Inhibition of cancer cells proliferation (inhibition of HER2 gene expression); inhibition of angiogenesis; induction of apoptosis	Breast[40], colon[41] cancer
18.	*Taxus baccata L*	Yew	Tree	Taxaceae	Leaf	Taxol, cabazitaxellarotaxel	Cell cycle arrest	Prostate cancer (*In vivo*)[42], Breast, bladder and pancreatic cancer (*In vivo*)[43], crvix and blood cells cancer[44]
19.	*Nigella sativa*	Black cumin	Herb	Ranunculaceae	Seed	Thymoquinone, dinitroquinone	Cell cycle arrest; induction of apoptosis	Colon, prostate, breast and pancreas cancer [45]
20.	*Allium sativum L*	Garlic	Bulbous herb	Amaryllidaceae	Fruit	Allicin, ajoene	Cell cycle arrest; induction of apoptosis	Lymphoma, cervix cancer (*In vivo*) [46], breast[47,48], prostate[49], colon[50], larynx[51]
21.	*Lepidium sativum*	Cress	Herb	Brassicaceae	Shoot	Vitamins (A, B, C and E), isothiocyanate, alinolenic acid, glucosinolates	Antioxidant effects; cell cycle arrest	Breast[52] and blood cells[53] cancer
22.	*Trigonella foenumgraceum L*	Fenugreek	Herb	Fabacecae	Shoot	Flavonoids and alkaloids (such as gingerol, cedrene, zingerone, vanillin, and eugenol)	Antioxidant effects; induction of apoptosis	Breast[54] cancer
23.	*Glycyrrhiza glabra*	Liquorice	Herb	Fabaceae	Root	Glycyrrhizin	Inhibition of cancer cells proliferation (bcl-2 phosphorylation); morphological changes in cancer cells and induction of apoptosis	Prostate, breast, lung, stomach and kidney cancer (*In vivo*) [55]
24.	*Physalis alkekengi*	Bladder cherry	Herb	Solanaceae	Fruit	Physalins	Induction of apoptosis	Cervix[56,57] cancer
25.	*Lagenaria siceraria* Stan dl	Bottle gourd	Herb	Cucurbitaceae	Shoot, fruit	Vitamins (B group and C), saponins, cucurbitacin	Cell cycle arrest	Lung[58] and breast[59] cancer
26.	*Ferula gummosa*	Galbanum	Herb	Apiaceae or Umbelliferae	Shoot	Sesquiterpenes and coumarins	Inhibition of cancer cells proliferation (distribution in the biosynthesis of nucleic acids and proteins); decrease of cells viability (increase of reactive oxygen species production); induction of apoptosis (by activation of caspases)	Lung[60], skin[60], stomach[61] cancer
27.	*Urticadioica* L	Common nettle	Herb	Urticaceae	Leaf	Phenolic compounds	Antioxidant effects; cell cycle arrest	Prostate[62,63,64] cancer
28.	*Ammi majus*	bishop's weed	Herb	Apiaceae	Shoot, seed	Coumarin compounds (especially psoralens)	Cell cycle arrest; induction of apoptosis	Breast[65] cancer

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
29.	*Rosa damascene*	Damask rose	Deciduous shrub	Rosaceae	Petal	Phenolic compounds (such as gallic acid, catechin, and epicatechin)	Antioxidant effects; DNA protection	Lung[66], breast[66], cervix[67] cancer
30.	*Astragalus cystosus*	Milkvetch	Herb or small shrub	Fabacecae	Shoot	Lectins, flavonoids and terpenoids	Cell cycle arrest; induction of apoptosis	Lung[68] cancer
31.	*Myrtus communis*	Common myrtle	Shrub	Myrtaceae	Leaf	Polyphenols, myrtucommulone, semimyrtucommulone, 1,8-cineole, a-pinene, myrtenyl acetate, limonene, linalool, aterpinolene	Antioxidant effects, induction of apoptosis (DNA fragmentation and activation caspases)	Breast[69,70,71] cancer
32.	*Vinca rosea*	Madagascar periwinkle	Herb	Apocynaceae	Shoot	Vincristine, vindoline, vinflunine, vinblastin, catharantin	Antioxidant effects; inhibition of cancer cells proliferation (effect on microtubules)	Breast and larynx cancer[70]
33.	*Citrullus colocynthis*	Bitter apple	Herb	Cucurbitaceae	Fruit	Cucurbitacin, quercetin, b-sitosterol	Cell cycle arrest; induction of apoptosis	Liver cancer[72]
34.	*Polygonum aviculare*	Common knotgrass	Herb	Polygonaceae	Shoot	Tannins, saponins, flavonoids and alkaloids	Antioxidant effects; cell cycle arrest; induction of apoptosis	Breast[73], cervix[74,75] cancer
35.	*Astroudaucus orientalis*	-	Herb	Apiaceae	Root, shoot	a-pinene, a-thujene, a-copaene, fenchylacetate, myrecene, sabinene	Cell cycle arrest; induction of apoptosis	Breast[76] cancer
36.	*Actinidia chinensis*	Kiwi fruit, china gooseberry	Tree	Actinidiaceae	Root	Polysaccharide known as "ACPSR"	Inhibition of prostaglandin E receptor 3 (EP3) expression[77]	Hepatocellular carcinoma[77]
37.	*Aegle marmelos*	Bael	Tree	Rutaceae	Stem bark	Lupeol	Cell cycle arrest[78]	Breast cancer, malignant lymphoma, malignant ascites, malignant melanoma, leukaemia
38.	*Agave americana*	Century plant	Herb	Agavaceae	Leaf	Steroidal saponin, alkaloid, coumarin, isoflavonoid, hecogenin and Vitamins, (A, B, C)	Cytotoxic and antitumor activity	Cancerous tumor
39.	*Aloe vera*	Aloe	Herb	Asphodelaceae	Leaf	Aloe-emodin	activates the macrophages, enhances activity of the immune cells against cancer[79], inhibit metastases[80]	Leukemia, stomach cancer (*In vivo*)[81]
40.	*Alpinia galangal*	Thai ginger	Herb	Zingiberaceae	Rhizome	Acetoxy-chavicol-acetate (ACA), Pinocembrin, Galangin	arrests cell proliferation and induces apoptosis, possesses strong antioxidant, antimutagenic and anti-inflammatory properties	Breast, lung, stomach, colon, prostate cancer, multiple myeloma, leukaemia
41.	*Amoora rohituka*	Rohituka tree	Tree	Meliaceae	Stem bark	Amooranin (a triterpene acid)	Arrests G2/M phase of the cell cycle and induces apoptosis	Breast and cervical cancers, colon cancer Lymphocytic leukemia (*In vitro*)[82]
42.	*Andographis paniculata*	King of Bitters	Herb	Acanthaceae	Whole plant	Flavonoids and labdanediterpenoids, Andrographolide	Stimulates cytotoxic and potent immune stimulating activity	Colon cancer (Both *in vitro* and *in vivo*)[83]

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
43.	*Annona muricata*	Graviola	Tree	Annonaceae	Fruit, seeds, leaves, and bark	Acetogenins	Blocks production of adenosine triphosphate allowing chemotherapy to be more effective, inhibits NADH oxidase and blocks ATP production in mitochondria limiting the ability of cancer cells to grow[84]	Lung, solid human-breast cancer, tumor carcinoma, pancreatic carcinoma, prostatic adenocarcinoma, colonic adenocarcinoma, human lymphoma, liver cancer and multiple-drug resistant human-breast adenocarcinoma
44.	*Apis mellifera*	European honey bee	Not applicable	Apideae	Not applicable	Protein	Stimulates tumor necrosis factor-alpha (TNF-α), inhibits of cell proliferation, induces of apoptosis, and cell cycle arrest[85]	Renal, lung, prostate, bladder, melanoma, osteosarcoma, mammary and lymphoid cancer[85]
45.	*Ananas comosus*	Pineapple	Herb	Bromeliaceae	Stem	Bromelain	Enhances cytotoxic activity of the monocytes and the macrophages inhibiting growth of cancer, inhibits growth of cancer cells, induces caspase-dependent apoptosis and causes cleavage of p53, removal of MUC1, and attenuation of phospho-Akt and Bcl2[87]	Leukaemia[86], gastrointestinal carcinoma[87], Cholangiocarcinoma, tongue cancer
46.	*Angelica sinensis*	Femaleginseng	Herb	Apiaceae	Root	Polysaccharide known as "AR-4"	Induction of interferon production, stimulation of the immune cell proliferation and enhancement of antitumour activity of the immune cell[88] cell cycle arrest and apoptosis[89]	Cervix cancer[88], brain tumor[89], colorectal carcinogenesis, Glioblastomamultiforme[90]
47.	Annona species	Monkey species	Trees or shrubs	Annonaceae	Leaves	Acetogenins	Exhibit different level of cytotoxicity, show anti-metastatic features, induce apoptosis	Leukemia and sarcoma, nasopharyngeal carcinoma[91]
48.	*Arctium lappa*	Greater burdock	Herb	Asteraceae	Seeds, root, fruit, leaves	Arctigenin, Lappaol F[93]	Prevents mutations in the oncogenes, reduces the size of tumour, relieves the pain and prolongs the survival period[92], arrests cell cycle at G_1 and G_2 phases and induces apoptosis[93]	Malignant melanoma, lymphoma and cancers of the pancreas, breast, ovary, oesophagus, bladder, bile ductand the bone, lung, cervix, prostate cancer and leukemia, liver cancer
49.	*Artemisia asiatica*	Not specified	Hardy herb or shrub	Asteraceae	Aerial parts and leaves	Isoliquiritigenin	Restrains the cell cycle progression at G2/M phase, enhances the expression of p21CIP1/WAF1, a universal inhibitor of cyclindependent kinases (CDKs)	Liver tumor, skin tumor, lung cancer
50.	*Astragalus membranaceus*	Astragalus	Herb	Fabaceae	Root	Swainsonine	Prevent metastases	Liver cancer, gastrointestinal cancers[94]
51.	*Azadirachta indica*	Neem	Tree	Meliaceae	Leaves and flowers	Liminoids and Nimbolide	Inhibits growth and spread of various cancers by inducing apoptosis, prevents metastasis, effect activates tumour suppressor gene and inhibits VEGF and phosphoinositol PI3K/Akt pathways, suppression of NF-κB signaling, and cyclooxygenase pathway[95]	Breast, lung, stomach, prostate and skin cancer, colon cancer, prostate cancer, malignant lymphoma, malignant melanoma and leukaemia

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
52.	*Bauhinia variegate*	Mountain ebony	Tree	Caesalpiniaceae	Flower, leaf, stem bark	Cyanidinglucoside, malvidinglucoside, peonidinglucoside and kaempferolgalactoside	Inhibit growth and spread of various cancers	Cancers of breast, lung, liver, oral cavity, melanoma, liver tumor[96], larynx cancer and human breast cancer[96]
53.	*Berberis vulgaris*	Common barberry	Shrub	Berberidaceae	Roots stem and bark	Berberine, berbamine, chelidonic acid, oxycanthine and palmatine	Arrests cancer cell cycle in G1-phase and induces apoptosis increases the penetration of some chemotherapy drugs through the blood-brain barrier	Prostate cancer, liver cancer and leukaemia, intracranial tumours breast cancer, stomach and oral cavity cancers[97],colon[98] cancer
54.	*Betula alba*	Birch	Tree	Betulaceae	Leaves	Betulinic Acid	Kill cancerous cells, induces antiproliferative effect, decreases cancer cell motility and induces apoptotic cell death, also decreases bcl2 and cyclin D1 genes expression, and increased bax gene expression [100]	Prostate cancer, Human melanoma xenografts and leukemia (*In vitro*)[99], neuroblastoma, rabdomyosarcoma-medulloblastoma, glioma, thyroid, breast, lung and colon carcinoma [100]
55.	*Betula utilis*	Himalayan birch	Tree	Betulaceae	Bark	Betulin, ursolic acid (UA)	Apoptotis [101]	Liver and the lung cancer, breast cancer[101], melanomas
56.	*Bolbostemma paniculatum*	Tu Bei Mu	Herb	Cucurbitaceae	Stem tuber	Tubeimoside-V	Apoptotics, exhibits promised cytotoxic activity which may be linked to the inhibition of DNA synthesis and may induce phenotypic reverse transformation of tumor cells[102]	Glioblastoma cells
57.	*Cannabis sativa*	Marijuana	Herb	Cannabaceae	Leaf	Cannabinoids, stereo isomers ofcannabitriol	Anti-tumor activity by modulating key cell- signaling pathways[103]	Breast cancer, brain tumors, Lung, pancreas, , prostate and colorectal cancer (Both *in vitro* and *in vivo*)[104]
58.	*Catharanthusn roseus*	Madagascar periwinkle	Herb or Sub shrub	Apocynaceae	Bark, leaves	Vinblastine, vincristine	Inhibits formation of mitotic spindle in the metaphase that arrests division of the cancerous cells	Hodgkin's disease, non- Hodgkin's lymphoma ,pancreas, testis, breast, lung, bladder and the cervix cancer, acute lymphocytic leukaemia, Wilm's tumour, neuroblastoma, rhabdomyosarcoma, Ewing's sarcoma, lymphoma
59.	*Cinnamomum cassia*	Chinese cinnamon	Tree	Lauraceae	Bark	Coumarin	Decreases lipid peroxidation, inhibits of bacteria, such as *Helicobacter pylori*, that facilitate the invasion and progression of cancer, exhibits potent antiproliferative effect, modulates cancer cell survival pathways[105], reduces the levels and activities of NFκB and AP1 and their target genes such as Bcl-2 and Bcl-xL[106]	Promyelocytic leukemia , liver cancer, prostate and breast cancer[105], melanoma[106],cervical carcinoma, colorectal carcinoma, epithelioid cervix carcinoma, glioblastoma multiform tumor, lymphoblast lung, oral cancer, basal cell carcinoma[107]
60.	*Colchicum luteum*	Yellow colchicum	Herb	Liliaceae	Not specified	Colchicines	Shows antimitotic activity	Hodgkin lymphoma, myeloid leukemia and skin cancers
61.	*Combretum caffrum*	Cape bush-willow	Tree	Combretaceae	Bark, kernal and fruit	Combretastatin	Inhibits blood supply to the tumour,	Colon, and leukemia and lung cancer (*In vivo*)[108]

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
62.	*Coriandrum sativum*	Coriander	Herb	Apiaceae	Root, leaves	Beta-carotene, quercetin and rutin	Helps to remove free radicals, antiproliferative activity and inhibition of metastasis[109]	Breast adenocarcinoma[109], Colon Cancer[110]
63.	*Daphne mezereum*	Mezereum	Shrub	Thymelaeaceae	Leaves	Mezerein	Exhibits a potent antileukemic activity	Lymphocytic leukemia, lung cancer[111]
64.	*Echinacea angustifolia*	Blacksamsonechinacea	Herb	Asteraceae	Whole plant	Arabinogalactan	Activates the macrophages	Carcinoma of the oesophagus and the colon[112]
65.	*Emblica officinalis*	Amla	Herb	Phyllanthaceae	Fruit	Emblicanin A and B, quercetin	Inhibits mutations in genes, repairs chromosomal abnormalities,inhibits growth and spread of various cancers	breast, uterus, pancreas, stomach, liver cancer and malignant ascites
66.	*Fagopyrum esculentum*	Buckwheat	Herb	Polygonaceae	Seeds	Amygdalin, rutin, Buckwheat inhibitor-1 protein	Produces cyanide that kills the cancerous cells	T-acute lymphoblastic leukemia (T-ALL) cells (*in vitro*)[113]
67.	*Ginkgo biloba*	Kew tree	Tree	Ginkgoaceae	Leaves	Ginkgetin and Ginkgolides (A and B)	Induces apoptosis	Invasive oestrogen-receptor negative breast cancer, glioblastoma multiforme, and cancers of ovary, colon, prostate and liver
68.	*Glycine max*	Soybean	Herb	Fabaceae	Seeds	Genistein and daidzein	Inhibits of cancer cell proliferation, promots cell differentiation and induces of apoptosis, blocks angiogenesis, acts as a tyrosine kinase inhibitor	Breast, uterus, cervix, lung, stomach, colon, pancreas, liver, kidney, prostate, testis, oral cavity, larynx, , skin cancer, malignant lymphoma, rhabdomyosarcoma, nasopharyngeal carcinoma , malignant brain tumours and leukaemia
69.	*Gossypium hirustum*	Upland cotton	Shrub, Subshrub, Tree	Malvaceae	Whole plant	Gossypol	Possesses antitumor properties on many cytosolic and mitochondrial enzyme systems that is fundamental for tumor cell growth	Colon, lung, prostate, breast, brain cancer, melanoma, endometrial, adrenocortical cancer[114]
70.	*Indigofera tinctoria*	True indigo	Shrub	Fabaceae	Leaf	Flavonoids, saponins, tannins, phenols and anthroquinone	Antioxidant and cytotoxic activity, cell cycle arrest	Lung cancer
71.	*Lentinus edodes*	Shiitake	Fungus	Polyporaceae	Fruiting bodies	Lentinan, terpenoids and steroids	Stimulates increased production and activity of natural killer cells and macrophages, which destroy tumor cells [116] ,possess hypolipidemic and antithrombotic activity[117]	Lung carcinoma [115], Colon cancer
72.	*Linum usitatissimum*	Flax	Herb	Linaceae	Seeds	Lignans	Lignan metabolites bear a structural similarity to estrogens and can bind to estrogen receptors and inhibit the growth of estrogen-stimulated breast cancer [118,119]	Breast cancer
73.	*Nothapodytes foetida*	Nothapodytes Tree	Tree	Icacinaceae	Barks and heartwood	Acetylcamptothecin, Camptothecin, ScopolectinCamptothecin	Inhibits DNA topoisomerase found in cancerous cells, halts the process of mutation and development of the cancer cells	Colon cancer

Sr. No.	Scientific Name	Common name	Plant Type	Family	Part(s) Used	Important Compounds	Mechanisms	Types of Cancer treated
74.	*Ochrosia elliptica*	Elliptic yellowwood	Tree	Apocynaceae	Leaves	Ellipticine and 9-methoxy ellipticine	Lipophilic derivatives of ellipticine act by binding to the DNA	Breast and the kidney cancer
75.	*Ocimum sanctum*	Tulsi	Herb	Lamiaceae	Leaves	Eugenol, orientin, cirsilineol, Ursolic acid cirsimaritin, Caryophyllene, camphor	Blocks supply of oxygen and nutrients to the cancer cells and kills them by starving	Breast cancer, liver cancer, tissue-protective, fibrosarcoma, Ssarcoma-180 solid tumor[120]
76.	*Oldenlandia diffusa*	Snake-Needle Grass	Herb	Rubiaceae	Stem bark, leaves, fruit peel	Oldenlandosides, stigmasterol, ursolic acid,	Works by a typical cytotoxic effect on cancer cells and by inducing apoptosis [121]	Ovary, lung, uterus, stomach, liver, colon, rectum, brain and leukaemia
77.	*Origanum vulgare*	Oregano	Herb	Lamiaceae	Whole plant	Rosmarinic acid	Exerts a modulatory role on tissue lipid peroxidation, induced apoptosis by increasing BAX levels, decreasing BCL2 expression[122]	Colon cancer, breast cancer, lung cancer, human skin cancer, liver cancer, stomach cancer[122]
78.	*Panax ginseng*	Ginseng	Herb	Araliaceae	Root	Flavonoids, polysaccharides, and polyacetylenes	Inhibits growth of cancer by interfering with the DNA synthesis, regenerates the natural killer cells, stimulates the macrophages	Breast, cervical, bladder, and thyroid cancers, ovaries, larynx, pancreas, esophagus, and stomach cancer
79.	*Pfaffia paniculata*	Suma	Herb	Amaranthaceae	Roots	Presents cytotoxic substances	Shows degeneration of cytoplasmic components and profound morphological and nuclear alterations of cancer cells	Estrogen-positive breast cancer
80.	*Picrorrhiza kurroa*	Kutki	Herb	Plantaginaceae	Whole plant	Picrosides-I, II and III and kutkoside	Decreases levels of lipid peroxidases and hydroperoxidases, free radical producing agents, and helps to facilitate the recovery of a powerful antioxidant in the liver	Liver cancer
81.	*Plumbago zeylanica*	Ceylon leadwort	Herb	Plumbaginaceae	Roots	Plumbagin	Inhibits cancer cell proliferation	Breast cancer, liver cancer, fibrosarcoma, malignant ascites and leukaemia, skin cancer
82.	*Podophyllum hexandrum*	Himalayan May Apple	Herb	Berberidaceae	Leaves, Rhizome	Podophyllotoxin and podophyllin	Inhibits growth and spread of cancers	Breast, ovary, lung, liver, urinary bladder, testis, brain, neuroblastoma, Hodgkin's disease, lymphoma and leukaemia
83.	*Prunella vulgaris*	Common self-heal	Herb	Lamiaceae	Whole plant	Ursolic acid and oleanolic acid	Inhibits growth and spread of cancers	Breast, cervix, lung, oral cavity, stomach, colon, thyroid cancer, anti-HIV
84.	*Psoralea corylifolia*	Babchi	Herb	Fabaceae	Seeds	Bavachinin, Psoralidincorylfolinin and psoralen	Induces apoptosis in both androgen-responsive and androgen refractory prostate cancers	Lung cancer, liver cancer, osteosarcoma, fibrosarcoma, and leukaemia
85.	*Viscum album*	European mistletoe	Tree	Santalaceae	Sprouts, fruits	Lectins (such as viscumin), and phenolic compounds (such as digallic acid)	Induces apoptosis via activation of caspase cascades [123]and anti- angiogenesis activity	Breast, cervix, ovary, lung, stomach, colon, rectum, kidney, testis cancer

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