

## Plants with potential anticancer activities - A review

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### Abstract

This article has been made to review some medicinal plants used for the treating cancer disease. The plant sources of India are likely to provide effective anticancer agents. Herbs have a vital role in the prevention and treatment of cancer. Examples are provided in this review of promising bioactive compounds obtained from various plants with medicinal and other therapeutic uses. The photochemical exploration of these herbs has contributed to some extent in this race for the discovery of new anticancer drugs. In recent years owing to the fear of side effects people prefer to use of natural plant products for cancer treatment. This review also helps to summarize the diverse methodologies and various ways to evaluate the potential natural compounds having anticancer activity. Although drug discovery from medicinal plants continues to provide an important source of new drug leads, numerous challenges are encountered including the procurement of plant materials and their selection.

**Keywords:** Medicinal plants, Anticancer agents, Bioactive compounds.

### Introduction

Cancer is a leading cause of mortality, and it strikes more than one-third of the world's population and it's the cause of more than 20% of all deaths. Among the causes for cancer are tobacco, viral infection, chemicals, radiation, environmental factors, and dietary factors.[1] Surgery, chemotherapy and radiotherapy are the main conventional cancer treatment often supplemented by other complementary and alternative therapies in China.[2] Plants has been used as an age old remedy of cancer history of use in the treatment of cancer. Extensive research at Sandoz laboratories in Switzerland in the 1960s and 1970s led to the development of etoposide and tenoposide as clinically effective agents which are used in the treatment of lymphomas, bronchial and testicular cancer. [3] These plants may promote host resistance against infection by re-stabilizing body equilibrium and conditioning the body tissues. Several reports describe that the anticancer activity of medicinal plants is due to the presence of antioxidants present in them. In fact, the medicinal plants are easily available, cheaper and Possess no toxicity as compared to the modern (allopathic) drugs. [4] The development of novel plant derived natural products and their analogs for anticancer activity details efforts to synthesize new derivatives based on bioactivity- and mechanism of action-directed isolation and characterization coupled with rational drug design – based modification.[5] Oncogenes are regulators of cellular communication with the outside environment. They are derived through the mutation of proto-oncogenes. Mutated oncogenes are stimulated by exposure to chemical, environment or viral carcinogens, which leads to cell changes and they produce proteins which are either wrongly expressed within their normal cell or expressed in inappropriate tissue which leads to

cellular proliferation and there by result in cancer formation. Tumor suppressor genes are intended to keep oncogenes in check by halting uncontrolled cellular growth. In direct opposition to oncogenes, which induce cancer when stimulated or amplified, tumor suppressor genes promote cancer when inactivated or attenuated. Two of the most prevalent tumor suppressor genes involved in the generation of cancer are p53 and retinoblastoma or Rb. [6]

### Anticancer plants

#### *Ginseng (Panax ginseng)*

Ginsenosides (panaxadiol and panaxatriol saponins) isolated from *Panax ginseng* inhibits growth & spread of various cancers such as cancers of breast, ovary, lung, prostate, colon, renal cell carcinoma, malignant melanoma, malignant lymphoma and leukaemia. Panaxadiol ginsenosides (Rb1, Rb2, Rc, Rd, Rg3, Rh2) and Panaxatriols ginsenosides (Re, Rf, Rg1, Rg2, Rhi) have both preventive and therapeutic role in cancer treatment. Ginsenosides possess strong anticancer activity against lung cancer and also prevent lung metastasis by blocking angiogenesis. Compound K (a metabolite of ginsenosides) inhibits growth & spread of chemo-resistant lung cancer. Ginsenosides Rc, Rd, Rg1 and Re overcome (reverse) P-glycoprotein mediated multidrug resistance to chemotherapy. Ginsenoside Rf helps in reducing doses of morphine in terminally ill cancer patients. Polysaccharides of *Panax ginseng* possess strong immunoenhancing and anticancer activities against many cancers, particularly lung cancer. These polysaccharides also reduce side effects of chemotherapy & radiotherapy. *Panax ginseng* also possesses antistress, hepatoprotective, haemopoietic, immunoenhancing, antioxidant,

radioprotective, chemoprotective, and anti-inflammatory properties. *Panax ginseng* inhibits proliferation and seeding (metastases) in various cancers by inducing cell differentiation and apoptosis. *Panax ginseng* is effective in both hormone-responsive & hormone-refractory prostate and breast cancers. (*Panax ginseng*), which is traditionally used in some parts of the world as a popular remedy for various diseases including cancer. It was hypothesized that the ginsenoside Rp1, a component of ginseng, reduces cancer cell proliferation through inhibition of the insulin-like growth factor 1 receptor (IGF-1R)/Akt pathway. Firstly, the efficacy of Rp1 was tested against human breast cancer cell lines. Treatment with Rp1 inhibited breast cancer cell proliferation and inhibited both anchorage-dependent and -independent breast cancer cell colony formation. In addition, to it the treatment with 20  $\mu$ M Rp1 induced cycle arrest and apoptosis mediated cell growth suppression. Findings further indicated that Rp1 decreased the stability of the IGF-1R protein in breast cancer cells. Therefore, it is suggested that Rp1 has potential as an anticancer drug and that IGF-1R is an important target for treatment and prevention of breast cancer. [7]

### *Pfafia paniculata*

Roots of *Pfafia paniculata* have been well documented for multifarious therapeutic values and have also been used for cancer therapy in folk medicine. Study has been performed in a human breast tumor cell line, the MCF-7 cells. These are the most commonly used model of estrogen-positive breast cancer, and it has been originally established in 1973 at the Michigan Cancer Foundation from a pleural effusion taken from a woman with metastatic breast cancer. Butanolic extract of the roots of *P. paniculata* showed cytotoxic effect MCF-7 cell line, as determined with crystal violet assay, cellular death with acridine orange/ethidium bromide staining, and cell proliferation with immunocytochemistry of bromodeoxyuridine (BrdU). Subcellular alterations were evaluated by electron microscopy. Cells treated with butanolic extract showed degeneration of cytoplasmic components and profound morphological and nuclear alterations. The results show that this butanolic extract indeed presents cytotoxic substances, and its fractions merit further investigations. [8]

### *Podophyllum*

The plant *Podophyllum peltatum* produces podophyllytoxin, a resin, throughout the entire plant but especially in the rhizome. It is produced as a form of protection from insects and other herbivores. When ingested it causes gastroenteritis or even death in humans. Edema (swelling) and eventual deterioration of the spinal cord, brainstem, cerebellum, and cerebral cortex have been reported in rats treated with various amounts of the toxin. Toxicities of other organs (although not specifically mentioned) have been documented historically, this plant was widely used as a Chinese herbal medicine because it is a wild Asian plant. It was used to treat snakebites, general weakness, poisons, condyloma accuminata, lymphadenopathy, and certain tumors. It was also

used by the Penobscot Indians to treat cancer. [9] Three anthraquinones, Cdc25B phosphatase inhibitors, were isolated from the methanolic extract of the roots of *Polygonum multiflorum* Thunb. (*Polygonaceae*). Anthraquinones, physcion, emodin, and questin, inhibited the enzymatic activity of Cdc25B phosphatase with IC<sub>50</sub> values of 62.5, 30, and 34  $\mu$ g/mL, respectively. Emodin and questin strongly inhibited the growth of human colon cancer cells, SW620 with GI<sub>50</sub> values of 6.1 and 0.9  $\mu$ g/mL, respectively. Commercially available anthraquinones, chrysophanol, and rhein also inhibited Cdc25B phosphatase with IC<sub>50</sub> values of 10.7 and 22.1  $\mu$ g/mL, respectively. [10]

### *Paclitaxel (Taxol)*

Paclitaxel (Taxol), is an effective and commonly used cancer drug approved for treating a variety of cancers, and it is under evaluation for the treatment of Alzheimer's disease and coronary heart disease also. As such, it is a crude drug success story. Isolated from the bark of the slow growing and endangered Pacific yew- *Taxus brevifolia* (from the tree family *Taxaceae*), paclitaxel is considered a terpenoid, a member of a natural organic family of chemicals. It was first extracted from the Yew tree in the US in 1971 and, by 1992, received approval from the US Food and Drug Administration (FDA) for clinical use. Today, paclitaxel has proved effective for the treatment of many types of cancers, such as ovarian [11-14] breast [11, 14, 15] lung [16, 17] esophageal [18] and liver cancers. [19] Unique activities of paclitaxel are that it binds to  $\beta$ -tubulin in the microtubule specifically and reversibly with a stoichiometry of almost one (relative to the  $\beta$ -tubulin dimer) [20, 21] inhibits cell division, blocks cell mitosis, stabilizes cytoplasmic microtubules, and induces the formation of the characteristic microtubule bundles in cells. [22]

### *Turmeric (Curcumin)*

Although turmeric is promoted mainly as anti-inflammatory herbal remedy, some scientists believe that the anti-oxidant curcumin present in turmeric may prevent or slow the growth of many cancers including tumor of esophagus, stomach and intestine, breast cancer and also skin cancer in experimental animals. However, clinical research is needed to determine its efficacy in cancer prevention and treatment in human beings. But, the laboratory studies have confirmed the curcumin interferes with several molecular pathways involved in cancer development, growth and spread. Further, a study found that ethanolic extract of turmeric produces remarkable symptomatic relief in patients with external cancerous lesions. There was a reduction in smell in 90 percent of cases and reduction in itching in almost all cases. Other than paclitaxel (Taxol), quite a few natural compounds from fruit and vegetables are being investigated for its potential medicinal qualities. For example, curcumin (from the plant *Curcuma longa*) as shown in Figure 1B, used in Chinese medicine and in the Indian traditional food of curry as the yellow coloring agent in turmeric, is known for its antioxidant, anti-inflammatory, antiviral, antibacterial, antifungal, and anticancer activities and potentially combat various



other disorders including diabetes, allergies, arthritis, and Alzheimer's disease. [23] Goel et al. [24] reported on curcumin and posited that because most cancers are caused by dysregulation of as many as 500 different genes, agents, such as curcumin, that target multiple genes are needed for the prevention and treatment of cancer. In studies to date, curcumin has been shown to interact with a wide variety of proteins and modify their expression and activity. These proteins include inflammatory cytokines and enzymes, transcription factors, and gene products linked with cell survival, proliferation, invasion, and angiogenesis. [24] As of 2007, 22 Phase I or II cancer-related clinical trials [25] involving curcumin have been ongoing. Several of these trials indicate that curcumin is safe and may exhibit therapeutic efficacy. For example, curcumin has inhibited the spread of various tumor cells in culture, prevented carcinogen-induced cancers in rodents, and inhibited the growth of human tumors in xenotransplant or orthotransplant animal models either alone or in combination with chemotherapeutic agents or radiation. [23] Recent studies reported that curcumin decreased survival of RT4V6 and KU7 bladder cancer cells in part at least through increased DNA fragmentation and other parameters associated with apoptosis. [26] In addition, curcumin potentiated the effects of other drugs and cytokines in bladder cancer cells, an action observed in other studies. [26-29] What has been observed was that while curcumin alone had minimal effects on NF- $\kappa$ B in RT4V6 or KU7 cells, it inhibited NF- $\kappa$ B activation when that activation was induced by agents, such as gemcitabine, tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), and cigarette smoke, that induce NF- $\kappa$ B. Investigators concluded that suppression of induced NF- $\kappa$ B by curcumin may play a role in sensitizing bladder cancer cells and other cancer cell lines to various chemotherapeutic agents. [26] What has also been observed is that, possibly by inducing apoptosis and decreasing the expression of pro-apoptotic protein survival and the angiogenic proteins vascular endothelial growth factor (VEGF) and VEGF receptor 1 (VEGFR1), curcumin inhibited 253JB-V and KU7 bladder cancer cell growth in an animal model. [30, 21] Details of curcumin's anticancer mechanisms that qualify it as a potential multi-targeted cancer therapeutic agent can be found in. [23] Another anticancer effect of curcumin was observed in an unpublished Phase II study at MD Anderson Cancer Centre in which 25 pancreatic cancer patients were monitored while taking curcumin and no other treatment. A 73% tumor reduction was observed in one patient while on curcumin (it did grow back one month later). The disease in four patients stabilized (one patient lived 2.5 years longer than predicted) [23]. Other research provides support for the anticancer activity of curcumin in a wide variety of tumors including colon [20, 30, 31] pancreas [25] bladder [32, 33] and breast cancer. [34]

### Carotenoids

Similar to curcumin, carotenoids, found in nearly all brightly colored fruits and vegetables or seafood, have strong cancer-fighting properties. Their anticancer effect comes from their antioxidant properties. Antioxidants protect cells from free radicals, substances that work to destroy cell membranes and DNA. Contrary to popular

belief, while the carotenoid  $\beta$ -carotene has a very high amount of vitamin A activity, not all carotenoids can be converted into vitamin A. As antioxidants, carotenoids have many benefits. For example, smokers tend to have higher concentrations of free radicals in their blood due to the chemicals they inhale. Studies suggest that antioxidants may lower a smokers' risk of lung cancer. [35, 36] Studies also suggest that carotenoids may help to prevent prostate, breast [36-46] and skin [47, 48] cancer as well as endometrial cancer. [46] Astaxanthin is another carotenoid, found in salmon, red fish, shrimp and crab, which shows anti-carcinogenic effects in mouse lung and liver cancer models. In the HepG2 human liver cancer cell line, astaxanthin significantly inhibited, in a dose-dependent manner, the proliferation of liver cancer cells. Flow cytometric analysis demonstrated that astaxanthin restrained the cell cycle progression at G1 and induced apoptosis. Further examinations through real-time quantitative RT-PCR revealed that astaxanthin enhanced the expression of p21CIP1/WAF1, GADD153 and c-myc genes, suggesting that astaxanthin will be a promising agent for use in chemoprevention or as a cancer therapeutic. [49]

### Polysaccharide

Oranges not only contain the carotenoid  $\beta$ -carotene that is responsible for their orange color, but also contain another anticancer agent, GCS-100, a polysaccharide derived from citrus pectin. In multiple myeloma cells, GCS-100 overcomes bortezomib resistance and enhances dexamethasone-induced apoptosis. In other words, even in the presence of bone marrow derived stromal cells (BMSCs), GCS-100 inhibits the growth of multiple myeloma cells and even blocks VEGF-induced migration of the cells, suggesting anti-angiogenic activity [40]. GCS-100 also overcomes both the growth/ survival advantage conferred by NF- $\kappa$ B and the cytoprotective effects of the antiapoptotic protein Bcl-2. Biochemically, GCS-100-induced apoptosis occurs predominantly via the caspase-8-to-caspase-3 signaling pathway; GCS-100 does not significantly alter mitochondrial apoptotic signaling, including alterations in DYM, O<sub>2</sub> production, or the activation of caspase-9. When combined with dexamethasone, low dose GCS-100 triggers additive anti-multiple myeloma activity via both the caspase cascade as well as through the inhibition of the anti-apoptotic protein Galectin. [50]

### Mushrooms

Another natural ingredient with potential as a crude drug, given its anti-tumor as well as antiviral, and antibacterial properties, is the mushroom. Studies to date report mushroom supplementation enhanced natural killer (NK) cell activity and IFN- $\gamma$  and TNF- $\alpha$  production. [51-53] It increases IL-2 ( $p = 0.09$ ) but not IL-10 production by splenocytes. Significant correlations were found between NK cell activity and production of IFN- $\gamma$  ( $r = 0.615$ ,  $p < 0.001$ ) and TNF- $\alpha$  ( $r = 0.423$ ,  $p = 0.032$ ) in splenocytes. Mushroom supplementation did not affect macrophage production of IL-6, TNF- $\alpha$ , prostaglandin E(2), nitric oxide (NO), and H<sub>2</sub>O<sub>2</sub>, nor did it



alter the percentage of total T cells, helper T cells (CD4 (+)), cytotoxic or suppressive T cells (CD8(+)), regulatory T cells (CD4(+)/CD25(+)), total B cells, macrophages, or NK cells in spleens. These results suggest that increased intake of white button mushrooms may promote innate immunity against tumors and viruses through the enhancement of a key component, NK cell activity that is mediated through increased IFN- $\gamma$  and TNF-production. [53, 54] The effects of mushrooms are thought to be due to their ability to modulate immune cell functions. [53] These compounds from macromycetes fungi belong mainly to polysaccharides especially beta-dglucan derivates, glycopeptide/protein complexes (polysaccharide-peptide/protein complexes), proteoglycans, proteins, and triterpenoids. Among polysaccharides, beta (1-->3)-dglucans and their peptide/protein derivates, and other proteins- fungal immunomodulatory proteins (Fips) have an important role in immunomodulating and anti-tumor activities. [54, 55]

### Resveratrol

Another possible crude drug or crude drug element found in the skin of red grapes and, therefore, in red wine that has been identified on the basis of its ability to inhibit cyclooxygenase (COX) activity is resveratrol. Resveratrol inhibits cellular events associated with tumor initiation, promotion, and progression. Further, it suppresses TNF- $\alpha$ -induced activation of nuclear transcription factors NF- $\kappa$ B, activator protein-1 (AP-1) and apoptosis, suggesting a potential role in reducing oxidative stress and lipid peroxidation. [56-58]

### Green tea

Polyphenols in green tea and sometimes black tea, help in killing cancerous cells and stop their progression. Mayo Clinic studies have revealed that a substance called epigallocatechin gallate (EGCG) in green tea reduces the number of leukemia cells in patients with CLL (chronic lymphocytic leukemia), a form of blood cancer. Similarly, another study found that women who drank powdered green tea were less likely to develop bladder cancer. Again, men who drank the most green tea were 37 percent less likely to develop pancreatic cancer. A large Chinese clinical study found that the risk of prostate cancer declined with increasing frequency and quantity of green tea consumption. However, scientists found that green tea could reduce the chances of recurrence of breast cancer but it could not prevent or improve breast cancer. Like resveratrol in the skin of grapes, green tea is now well-known to most people for having medicinal benefit. Green tea polyphenol- (-)- epigallocatechin-3-gallate (EGCG) has various beneficial properties including chemopreventive, anticarcinogenic, and antioxidant actions. [59] One of EGCG's benefits is that it may cause cancer cells to die in much the same way as normal cells. In a recent study, the MAPKKK protein MEKK1, which plays a role in the JNK-mediated signaling pathway, also activates NF- $\kappa$ B via activation of IKK $\beta$ . Dysregulation of the NF- $\kappa$ B pathway plays an important role in the development of various types of cancer. [60-

62] EGCG inhibited a tumor promoter 12-O-tetradecanoylphorbol-13-acetate (TPA)-induced DNA binding of NF- $\kappa$ B and CREB in mouse skin *in vivo*. EGCG also suppressed TPA-induced phosphorylation and subsequent degradation of I $\kappa$ B, and prevented nuclear translocation of p65. [63] EGCG has been reported to exert an anti-inflammatory effect in endothelial cells by controlling monocyte chemotactic protein-1 (MCP-1) expression, at least in part, mediated through the suppression of p38 and NF- $\kappa$ B activation. [64] EGCG has been shown to be helpful in regulating mast-cell-mediated allergic inflammatory response by inhibiting the production of TNF- $\alpha$ , IL-6, and IL-8 through the inhibition of the intracellular Ca<sup>2+</sup> level, ERK1/2, and NF- $\kappa$ B activation. [65] EGCG markedly inhibited IL-1 $\beta$ -mediated IL-1 $\beta$ -receptor-associated kinase (IRAK) degradation and the signaling events downstream from IRAK degradation such as IKK activation, I $\kappa$ B degradation, and NF- $\kappa$ B activation. In addition, EGCG inhibited phosphorylation of the p65 subunit of NF- $\kappa$ B. The functional consequence of this inhibition was evident by inhibition of IL-8 gene expression. [66] It has been reported that EGCG-induced apoptosis in human prostate carcinoma LNCaP cells by negative regulation of NF- $\kappa$ B activity, thereby decreasing the expression of the proapoptotic protein Bcl-2. [67] The natural ingredients of curcumin, carotenoids, mushrooms, EGCG in green tea, resveratrol in red grape skin, and GCS-100 in citrus pectin are only some of the natural ingredients that can, like paclitaxel (Taxol), become crude drugs with potential multi-targeting efficacy in fighting cancer. Below we detail a few other ingredients with similar potential: the herbal elements *Scutellaria baicalensis* and *Artemisia asiatica* as well as red and white ginseng extract, isoliquiritigenin in licorice and capsaicin in hot chili peppers.

## Herbals

### *Scutellaria baicalensis*

It is a widely used Chinese herbal medicine historically used as anti-inflammatory and anticancer therapy that is being tested as a treatment for prostate cancer. Two human prostate cancer cell lines (LNCaP, androgen dependent, and PC-3, androgen independent) were assessed for growth inhibition when exposed to *S. baicalensis*. *S. baicalensis* exerted dose- and time-dependent increased growth inhibition in both cell lines. After treatment with *S. baicalensis*, PGE<sub>2</sub> synthesis in both cells was significantly reduced, resulting from direct inhibition of COX-2 activity rather than COX-2 protein suppression. *S. baicalensis* also inhibited prostate-specific antigen production in LNCaP cells. Finally, *S. baicalensis* suppressed expression of cyclin D1 in LNCaP cells, resulting in a G1 phase arrest, while inhibiting cdk1 expression and kinase activity in PC-3 cells, ultimately leading to a G2/M cell cycle arrest. In animal studies, after a 7-week treatment period with *S. baicalensis*, tumor volume was reduced by 50%, demonstrating that *S. baicalensis* may be a novel anticancer agent for treating prostate cancer. [68]





### *Artemisia asiatica*

It has also been frequently used in traditional Asian medicine for the treatment of diseases involving inflammation, cancer, and microbial infection. An extract of *A. asiatica*, DA-9601, with ethanol, blocked TNF- $\alpha$  mediated inflammatory signals by potentially modulating the p38 kinase pathway and/or a signal leading to NF- $\kappa$ B-dependent pathways in gastric epithelial cells. [69] Another potential crude drug or crude drug element are red and white ginseng extract. Oral administration of red ginseng extracts (1% in diet for 40 weeks) in C3H/He male mice resulted in the significant suppression of spontaneous liver tumor formation. The average number of tumors per mouse in the control group and in the red ginseng extracts-treated group was 1.06 and 0.33 ( $p < 0.05$ ), respectively. Incidence of liver tumor development was also lower in red ginseng extracts-treated group, although the difference from control group was not statistically significant. Like red ginseng extracts, white ginseng extracts have also shown anti-carcinogenic activity that is being investigated. In an ongoing study, the administration of white ginseng extracts was proven to suppress tumor promoter-induced phenomena in vitro and in vivo. Interestingly, oral administration of a white ginseng-containing Chinese medicinal prescription known as ren-shen-yang rong-tang, resulted in the suppression of skin tumor promotion by 12-o-tetradecanoylphorbol-13 acetate in 7, 12-dimethylbenz[a]anthracene-initiated CD-1 mice, suggesting the usefulness of ginseng in the field of cancer prevention. [70] Isoliquiritigenin is a natural flavonoid isolated from licorice, shallot and bean sprouts that has significantly inhibited, in a dose- and time dependent manner, the proliferation of cancer cells in the A549 human lung cancer cell line. Flow cytometric analysis demonstrated that isoliquiritigenin restrained the cell cycle progression at G2/M phase. Further examinations using cDNA arrays and real-time quantitative RTPCR revealed that isoliquiritigenin enhanced the expression of p21CIP1/WAF1, a universal inhibitor of cyclin-dependent kinases (CDKs). These results suggest that isoliquiritigenin will be a promising agent for use in chemoprevention or therapeutics against lung cancer. [71] A pungent ingredient of hot chili peppers- capsaicin (8-methyl-N-vanillyl-6-nonenamide), has been reported to possess substantial anticarcinogenic and anti-mutagenic activities; it can induce apoptosis in highly metastatic B16-F10 murine melanoma cells and, in a concentration dependent manner, inhibit their growth. A pro-apoptotic effect of capsaicin was also evidenced by nuclear condensation, internucleosomal DNA fragmentation, in situ terminal nick-end labeling of fragmented DNA (TUNEL), and an increased sub G1 fraction. Treatment of B16-F10 cells with capsaicin caused, in a dose dependent manner, a release of mitochondrial cytochrome c, activation of caspase-3, and cleavage of poly (ADP-ribose) polymerase. Furthermore, Bcl-2 expression in the B16-F10 cells was slightly down-regulated by capsaicin treatment. In contrast, there were no alterations in the levels of Bax in capsaicin-treated cells. Collectively, these findings indicate that, via down regulation of the Bcl-2, capsaicin induces apoptosis of B16-F10 melanoma cells. [72]

### *Autumn Crocus (Colchicum Autumnale)*

Common Names – Naked Ladies, Colchicum, and Meadow Saffron, The Autumn Crocus, of the Lily Family (Liliaceae), is a plant with small flowers of varying colors. This plant is indigenous to Europe, Northern African, and Asian continents. Being a plant with a history of medicinal use, records have shown that it had been used in Ancient Greece, India, and Egypt with records being stored in the oldest medical text, known as the Ebers Papyrus. At present, it is used to treat inflammatory disorders. The Colchicine content of Autumn Crocus is also valued for its' chemotherapeutic properties. [73]

### *Birch (Betula Alba)*

Common Name – Birch

The Birch or *Betula Alba* plant has a variety of different uses. Its medicinal use include diuretic, anti-inflammatory, and a general pain reliever. There are currently several side effects associated with the use of the birch leaf, including chest pains, tightness in the chest or that that may cause breathing problems, and skin irritation. The Birch has sixty species throughout the world, ten of which are native to Canada and the northern part of the United States. The effects of Betulinic Acid, as studied by Dr. Brij Saxena of Weill Cornell Medical College, has been known to kill cancerous cells, and has been especially effective in the treatment of prostate cancer patients. This compound does not cause side effects, in typical patients. However the compound is being researched further for it's compatibility with patients suffering from HIV. [74]

### *Hemp (Cannabis Sativa)*

Common Names – Marijuana, Bhang, Ganja, and Hashish The Hemp is an annual herb that may reach 5 meters in height with leaves that form a fan-like structure with jagged edges. This plant is native to central Asia and as a result of importation, has expanded toward Europe and the Americas. This plant has many uses, some of which are furnishing fiber, oil, in medicine, and narcotics. Commonly referred to as Cannabis, Hemp is a very versatile material and is frequently used to relieve cancer pain, treat depression, and hypothermia, it also works as an appetite suppressant. A controversial plant in the field of medicine, it has been up for the debate of its use being an abused or medically prosperous drug. Compound – Delta-9-Tetrahydrocannabinol Research has shown that the administering of smoked marijuana helped treated the nausea that was caused by cancer chemotherapy, thereby being an aid to the cancer treatment process. Side effects of this compound are not often seen in the physical aspect, rather in the mental or cognitive domain such as inability to distinguish space distances and time intervals, vigilance, and memory processes. [75]



### *Lapacho Tree (Tabebuia Impetiginosa , T. Avellanadae)*

Common Names – Lapacho, Pau D'Arco, Taheebo, and Ipe Roxo Found in the rainforests of South America, especially in Argentina, Paraguay, and Brazil, the Lapacho Tree is an evergreen with blossoms that may be red or purple. It has proven to be medically useful, even since the time of the Incas. Locals still use the tree for many diseases, including the common cold, flue, herpes, psoriasis, as well as other discomforts that cancer patients are more susceptible to due to their decreased immune system. Compound – Beta-Lapachone, Lapachol Beta-lapachone has anti-cancer properties that are being researched with focus on pancreatic cancer. Dr. David Boothman of the Harold C. Simmons Comprehensive Cancer Center, and other colleagues, have conducted study on the properties that betalapachone harnesses and they have discovered that it reacts with NQ01, an enzyme present in lung cancer and solid tumors. The interaction between the betalapachone and the NQ01 form a bond that extinguishes the tumor cells that the NQ01 catalyzes. [76]

### *Nothapodytes Tree (Nothapodytes Foetida)*

Common Name – Nothapodytes Tree

The Nothapodytes Tree has its medicinal use whose wood-extract is used in treating diseases. This tree is found in western Ghats, India, which have become important because of it being an anti-cancerous compound containing plant with medicinal properties similar to the camptothecin plant, due to their remarkably similar chemical makeup.

Compound – Acetylcampothecin, Campothecin, Scopolectin Campothecin found in the Nothapodytes Tree is an inhibitor of the DNA topoisomerase found in cancerous cells. This halts the process of mutation and development of the cancer cells that render them useless and as a result, they die. This means of cancer curation makes use of the property of inhibition that the camptothecin compound has with the DNA of the cancerous cells. Some side effects in using this compound include diarrhea and anemia. [77]

### *Herbs and Anti-Oxidants That Fight against Cancer*

A number of studies from all over the world are pointing to culinary herbs as sources of anti-oxidants and other substances that have anti-cancer characteristics. The scientists found that these herbs help reduce cancer risk and some can even modify tumor behavior. Some of these cancer preventing herbs are discussed here.

### *Oregano: (Origanum vulgare)*

Amongst the dried herbs, oregano has perhaps the highest anti-oxidant levels. Rosmarinic acid is the compound in oregano that has the strong anti-oxidant activity. An Indian study reported that oregano supplementation of 40 mg per kg of body weight had a modulatory role on tissue lipid peroxidation in colon cancer-bearing experimental odents. The dosage for human beings has not yet

been determined, but then, how much of oregano would you need to flavor your dish it depends. [78]

### *Thyme: (Thymus vulgaris)*

Thyme is sweeter and milder than oregano. Thyme as a dried herb contains very high levels of anti-oxidants in the form of rosmarinic acid and phenolic compounds such as thymol and carvacrol. A Turkish study supported by Hacettepe University Research Foundation suggested that these phenolic compounds at concentrations below 0.2 mM and 0.1 mM respectively can significantly reduce the oxidative DNA damage and thus prevent the development of any type of cancer. [79]

### *Cilantro: (Coriandrum sativum)*

Cilantro or, more commonly, coriander is another potent herb that has anti-cancer properties. The prevalent antioxidants in cilantro are beta-carotene, quercetin and rutin. This herb, normally used in chelation therapy for people suffering from lead poisoning, helps remove free radicals by getting rid of the heavy metals in your body. Dr. Yoshiaki Omura from the Heart Disease Research Foundation, New York, NY, USA, has actually found that fresh cilantro removes heavy metals – and with it the free radicals too – from the body in less than 2 weeks. [80]

### *Basil: (Ocimum basilicum)*

Basil is well known for its medicinal value. Apart from having anti-inflammatory, blood pressure lowering, and nervous system stimulating properties, this popular herb has been found to have chemoprotective potential for colon cancer. In fact, a study found that basil played a significant role in reducing colon tumors in experimental animals. However, no human clinical trials have been conducted to confirm this experiment. [81]

### *Garlic: (Allium Sativum)*

The National Cancer Institute (affiliated to the NIH) recognizes garlic to have potential anticancer properties. The sulphhydryl compounds in garlic have the ability to block the formation of cancer-causing substances. Several population studies have shown an association between increased garlic consumption and reduced risk of cancers of the stomach, colon, esophagus, pancreas, and also breast cancer. A study has found that garlic intake of 10 g per day could reduce the risk of prostate cancer by 50 percent. [82]

### *Ginger: (Zingiber officinale)*

Some pungent substances present in ginger rhizome have anti-oxidant and anti-inflammatory activities. The anticancer properties of ginger are attributed to phenolic substances such as 6-gingerol and 6-paradol and other constituents such as shogaols and zingerone. A study published in the journal Biochemical and Biophysical Research Communications reported that 6-gingerol



can reduce viability of gastric cancer cells and limit the spread of cancer. Gingerols isolated from *Zingiber officinale* inhibit growth & spread of various cancers including that of the ovary, cervix, colon, rectum, liver, urinary bladder, oral cavity, neuroblastoma and leukaemia by inducing apoptosis. The most active individual component, 6-shogaol, isolated from *Zingiber officinale*, inhibit growth & spread of many cancers particularly the ovarian cancer by blocking formation of new blood vessels and by inducing apoptosis & autophagy. It is effective even in chemotherapy resistant ovarian cancer. *Zingiber officinale* also possesses antioxidant, antimutagenic and anti-inflammatory properties and reduces side effects of chemotherapy & radiotherapy. [83]

### *Maitake Mushroom: (Grifola frondosa)*

Maitake is an edible mushroom native to the mountains of northeast Japan. Its active ingredient is a polysaccharide called beta glucan. Maitake mushroom extract is said to limit or even reverse tumor growth. It also enhances the benefits of chemotherapy and lessens the side effects of anti-cancer drugs. It acts by activating certain cells and proteins that attack cancer, T-cells and interleukin-1 and interleukin-2. The daily dose of dried mushroom is between 3 to 7 g. Maitake may not be suitable for those on hypoglycaemic medication. [84]

### *Cinnamon bark: (Cinnamomum cassia)*

Cinnamon has antioxidant properties that can significantly decrease lipid peroxidation that lead to cancer. Further, cinnamon bark oil has been found by researchers to be one of the most effective inhibitors of bacteria, such as *Helicobacter pylori*, that facilitate the invasion and progression of cancer. However, high amount of coumarin present in cinnamon can damage liver tissues. Although there are no reports of coumarin related tumor formation, high levels of coumarin did trigger cancer in experimental rodents. [85]

### *Anticancer Potential Herbs in India*

As we can see, herbs and other antioxidants are not only very helpful in preventing cancer and in some cases inhibiting progression of cancer, they also help with overall wellness by improving the immune system. But be sure to consult your doctor before taking any of these herbs for preventing or treating cancer.

### *Aegle marmelos*

Lupeol, isolated from *Aegle marmelos*, possesses strong anticancer activity against breast cancer, malignant lymphoma, malignant melanoma, malignant ascites and leukaemia. *Aegle marmelos* possesses significant antioxidant activity and reduces side effects of chemotherapy & radiotherapy. [86]

### *Aloe vera*

Acemannan (a polysaccharide), isolated from *Aloe vera*, stimulates the immune system, accelerates wound healing and possess significant anticancer property. Emodin and Lectins isolated from *Aloe vera* exhibit strong anticancer and immunoenhancing activities. Aloe-emodin inhibits growth & spread of stomach cancer and various sarcomas by inducing apoptosis. Aloe-emodin has selective anticancer activity against neuroectodermal tumours (PNET). Alexin B isolated from *Aloe vera* possesses strong anticancer activity against leukaemia. Polysaccharides isolated from *Aloe vera* have strong immune enhancing and anticancer properties. *Aloe vera* contains "super carbohydrates" that protect against many cancers, particularly the liver cancer. *Aloe vera* prevents genesis of cancer, regresses growth of cancer and prevents metastasis of cancer. *Aloe vera* stimulates immune system response of the body by activating macrophages and releasing cytokines such as interferon, interleukin and tumour necrosis factor. *Aloe vera* has an extraordinary antioxidant profile and reduces side effects of chemotherapy & radiotherapy. [87]

### *Alpinia galanga*

Acetoxy-chavicol-acetate (ACA), isolated from *Alpinia galanga*, possesses significant anticancer activity against cancers of breast, lung, stomach, colon, prostate, multiple yeloma and leukaemia. Pinocembrin isolated from *Alpinia galanga* inhibits growth & spread in colon cancer by arresting cell proliferation and inducing apoptosis. Galangin, a flavonoid isolated from *Alpinia galanga*, possesses strong anticancer, antioxidant, antimutagenic and anti-inflammatory properties. Galangin protects against breast and prostate cancers. [88]

### *Amoora rohituka*

Amooranin (a triterpene acid), isolated from *Amoora rohituka* inhibits growth & spread of breast and cervical cancers by arresting G2/M phase of the cell cycle and by inducing apoptosis. Amooranin and its derivatives are effective in both chemotherapy-sensitive and chemotherapy-resistant cancers. Amooranin has the ability to overcome (reverse) multidrug resistance in breast cancer, colon cancer and leukaemia. [89]

### *Andrographis paniculata*

Andrographolide, active diterpine component, isolated from *Andrographis paniculata*, has immunoenhancing and strong anticancer activity against cancers of breast, ovary, stomach, colon, prostate, kidney, nasopharynx malignant melanoma and leukaemia. Andrographolide exerts direct anticancer activity on cancer cells by arresting G0/G1 phase of cell-cycle and inducing apoptosis. Dichloromethane fraction of methanolic extract of *Andrographis paniculata* has strong anticancer activity against colon cancer. *Andrographis paniculata* possesses anticancer, immunostimulant, antioxidant, anti-HIV and anti-inflammatory properties. *Andrographis paniculata* enhances the activity of



protective liver enzymes and reduces side effects of chemotherapy & radiotherapy. [90]

### *Azadirachta indica*

*Azadirachta indica* contains about 40 different active principles, known as liminoids, which exhibit immunoenhancing, anti-inflammatory, antiulcer, antifungal, antiviral, antioxidant, hepatoprotective, antimutagenic, anticancer and antimetastatic properties. Liminoids regress growth & spread of various cancers such as cancers of breast, lung, stomach, prostate and skin. Nimbolide, a natural triterpenoid, isolated from *Azadirachta indica* leaves and flowers inhibits growth & spread of various cancers including colon cancer, malignant lymphoma, malignant melanoma and leukaemia by inducing apoptosis (programmed cell death), a process that directs the body's immune cells to identify and destroy cancer cells. Nimbolide also prevents metastasis of cancer. Ethanolic extract of *Azadirachta indica* inhibits growth & spread of prostate cancer by inducing apoptosis and its antiandrogenic effect. *Azadirachta indica* reduces side effects of chemotherapy & radiotherapy. [91]

### *Bauhinia variegata*

Cyanidin glucoside, malvidin glucoside, peonidin glucoside and kaempferol galactoside isolated from *Bauhinia variegata* inhibit growth & spread of various cancers such as cancers of breast, lung, liver, oral cavity, larynx and malignant ascites. *Bauhinia variegata* also possesses significant hepatoprotective activity. [92]

### *Berberis vulgaris*

*Berberis vulgaris* root contains berberine, berbamine, chelidonic acid, citric acid, columbamine, hydrastine, isotetrandrine, jacaranone, magnoflorine, oxycanthine and palmatine. Berberine (an isoquinoline alkaloid), possesses anticancer, immunoenhancing, antioxidant and anti-inflammatory properties. Berberine arrests cancer cell cycle in G1-phase and induces apoptosis. Berberine possesses strong anticancer activity against prostate cancer, liver cancer and leukaemia. Berberine interferes with P-glycoprotein in chemotherapy-resistant cancers. Berberine also increases the penetration of some chemotherapy drugs through the blood-brain barrier, thereby enhancing their effect on intracranial tumours. *Berberis vulgaris* root bark contains three phenolic compounds, tyramine, cannabisin-G and lyoniresinol. Cannabisin-G and lyoniresinol exhibit strong antioxidant activity. Cannabisin-G protects against breast cancer. *Berberis vulgaris* also inhibits growth of stomach and oral cavity cancers. [93]

### *Catharanthus roseus*

*Catharanthus roseus* (Vinca rosea, Madagascar periwinkle) contains more than 70 alkaloids, known as vinca alkaloids such as Vinblastine, Vincristine and their derivatives. Vinca alkaloids arrest cancer cell proliferation by binding to tubulin in the mitotic spindle.

Vinca alkaloids also induce apoptosis (programmed cell death) and inhibit angiogenesis (formation of new blood vessels). Vinca alkaloids inhibit growth & spread of various cancers including that of breast, ovary, cervix, lung, colon, rectum, testis, neuroblastoma, Hodgkin's disease, malignant lymphoma, multiple myeloma, various sarcomas, rhabdomyosarcoma and leukaemia. [94]

### *Curcuma longa*

Curcumin (Di-feruloyl-methane) and curcuminoids isolated from *Curcuma longa* suppress cancer at every step, i.e. initiation, growth and metastasis. Curcumin arrests the cancer cells proliferation in G2/S phase and induces apoptosis (programmed cell death). It inhibits angiogenesis, a crucial step in the growth and metastasis of cancer. Curcumin and Genistein (isolated from Glycine max) act synergistically to inhibit growth & spread of oestrogen-positive breast cancer. Curcumin works even in multidrug-resistant breast cancers. Curcumin suppresses adhesion of cancer cells, thus preventing metastasis. Curcumin inhibits growth & spread of various cancers including that of breast, lung, oesophagus, liver, colon, prostate, head & neck and skin. Curcumin is particularly effective in radiotherapy-resistant prostate cancer. Curcumin is effective even in advanced stages of cancer. Curcumin also protects from stomach cancer and colon cancer. *Curcuma longa* also possesses antimutagenic, antioxidant, immunostimulant, anti-inflammatory, hepatoprotective and radioprotective properties. [95]

### *Emblica officinalis*

*Emblica officinalis* contains ellagic acid, gallic acid, quercetin, kaempferol, emblicanin, flavonoids, glycosides and proanthocyanidins. *Emblica officinalis* valued for its unique tannins and flavanoids, which possess powerful antioxidant and anticancer properties. Ellagic acid isolated from *Emblica officinalis* is a powerful antioxidant and has the ability to inhibit mutations in genes. Ellagic acid also repairs chromosomal abnormalities. Quercetin, isolated from *Emblica officinalis* has hepatoprotective effect. Emblicanin A & B (tannins) possess strong antioxidant and anticancer properties. *Emblica officinalis* inhibits growth & spread of various cancers including that of the breast, uterus, pancreas, stomach, liver and malignant ascites. *Emblica officinalis* is an excellent rejuvenator and antioxidant herb. It is highly nutritious and an important source of Vitamin C, minerals and amino acids. *Emblica officinalis* protects against much cancer particularly the liver cancer. *Emblica officinalis* reduces side effects of chemotherapy & radiotherapy. [96]

### *Ginkgo biloba*

Ginkgetin and Ginkgolides (A & B), isolated from *Ginkgo biloba* inhibits growth & spread of various aggressive cancers such as invasive oestrogen-receptor negative breast cancer, glioblastoma multiforme, hepatocellular carcinoma and cancers of ovary, colon, prostate and liver by inducing apoptosis. *Ginkgo biloba* extract is





well known for its antioxidant activity. *Ginkgo biloba* also reduces side effects of chemotherapy & radiotherapy. [97]

### *Glycine max*

Isoflavones (such as genistein & daidzein) and saponins isolated from *Glycine max* inhibit growth & spread of various cancers such as cancers of the breast, uterus, cervix, ovary, lung, stomach, colon, pancreas, liver, kidney, urinary bladder, prostate, testis, oral cavity, larynx, and thyroid. *Glycine max* is also effective in nasopharyngeal carcinoma, skin cancer, malignant lymphoma, rhabdomyosarcoma, neuroblastoma, malignant brain tumours and leukaemia. Isoflavones & saponins isolated from *Glycine max* possess wide ranging anticancer properties such as inhibition of cancer cell proliferation, promotion of cell differentiation and induction of apoptosis. Genistein works by blocking angiogenesis (formation of new blood vessel), acting as a tyrosine kinase inhibitor (the mechanism of action of many new cancer drugs) and inducing apoptosis. Genistein is an excellent intracellular antioxidant. Genistein also blocks the supply of oxygen and nutrients to cancer cells, thus killing them by starving. Genistein and quercetin have synergistic anticancer effect against ovarian carcinoma. Saponins isolated from *Glycine max* decrease invasiveness of the glioblastoma cells. Anthocyanins isolated from *Glycine max* induce apoptosis in leukaemic cells. *Glycine max* protects against many cancers including that of the colon, lung and ovary. [98]

### *Glycyrrhiza glabra*

Flavonoids (flavones, flavonols, isoflavones, chalcones, licochalcones and bihydrochalcones), derived from *Glycyrrhiza glabra* possess strong anticancer, antioxidant, antimutagenic, antiulcer, anti-HIV and hepatoprotective properties. Licochalcone-A isolated from *Glycyrrhiza glabra*, inhibits growth & spread of various cancers particularly the androgen-refractory prostate cancer by inducing apoptosis and arresting cancer cells division. Licoagrochalcone, possesses strong anticancer activity against cancers of breast, lung, stomach, colon, liver, kidney and leukaemia. Glycyrrhizin isolated from *Glycyrrhiza glabra* inhibits growth & spread of lung cancer and fibrosarcomas. Glycyrrhizic acid isolated from *Glycyrrhiza glabra* protects against aflatoxins (powerful fungal carcinogens of the liver). *Glycyrrhiza glabra* stimulates immune system response of the body and protects against colon cancer and oestrogen-positive breast cancer. [99]

### *Gossypium hirsutum*

Gossypol isolated from *Gossypium hirsutum* inhibits growth & spread of various cancers such as cancers of the breast, oesophagus, stomach, colon, liver, pancreas, adrenal gland, prostate, urinary bladder, malignant lymphoma, malignant as cites, brain tumours, sarcomas and leukaemia by inducing apoptosis and arresting cancer cell division in G0/G1 phase. The negative isomer of gossypol, (-) gossypol, inhibits growth & spread of chemotherapy

& radiotherapy-resistant cancers of prostate, breast, ovary, lung, pancreas, head & neck and brain by inducing apoptosis. Gossypolone, oxidative metabolite of gossypol, inhibits growth & spread of various cancers including that of the breast, cervix, lung, malignant melanoma and leukaemia. [100]

### *Morinda citrifolia*

Damnacanthol, NB10 and NB11 isolated from *Morinda citrifolia* possess strong anticancer activity against various cancers particularly lung cancer and sarcomas. *Morinda citrifolia*, possesses strong antioxidant, hepatoprotective and immunoenhancing properties. [101]

### *Nigella sativa*

Thymoquinone and dithymoquinone isolated from *Nigella sativa* have strong anticancer activity against various cancers including cancers of the colon, prostate, pancreas, uterus, malignant ascites, malignant lymphoma, malignant melanoma, sarcomas and leukaemia. Thymoquinone is effective in both hormone-sensitive and hormone-refractory prostate cancer. *Nigella sativa* kills cancer cells by binding to the asialofectin (lectin) on the surface of cancerous cells, causing their aggregation and clumping. *Nigella sativa* also possesses immunoenhancing and anti-inflammatory properties. It protects against liver cancer. *Nigella sativa* enhances immune function of the body and reduces side effects of chemotherapy & radiotherapy. [102]

### *Ocimum sanctum*

*Ocimum sanctum* contains eugenol, eugenol derivatives, linolenic acid, rosmarinic acid and flavonoids such as orientin, vicenin, cirsilinoleol, cirsimaritin, isothymusin, isothymonin & apigenin. Eugenol, orientin and vicenin inhibits growth & spread of various cancers such as breast cancer, liver cancer and sarcomas particularly fibrosarcoma by blocking supply of oxygen and nutrients to the cancer cells and killing them by starving. Ursolic acid isolated from *Ocimum sanctum* has immunoenhancing and tissue-protective properties. Polysaccharides isolated from *Ocimum sanctum* have antioxidant and radioprotective properties. *Ocimum sanctum* protects against various cancers particularly the breast cancer and reduces side effects of chemotherapy & radiotherapy. [103]

### *Oldenlandia diffusa*

*Oldenlandia diffusa* (Bai Hua She She Cao) contains oldenlandosides, stigmaterol, ursolic acid, oleanolic acid, beta-sitosterol, p-coumaric acid and flavonoid glycosides. Ursolic acid inhibits growth & spread of various cancers such as cancers of lung, ovary, uterus, stomach, liver, colon, rectum, brain, malignant melanoma, malignant as cites, lymphosarcoma and leukaemia. Ursolic acid works by a typical cytotoxic effect on cancer cells and by inducing apoptosis. [104]



### *Plumbago zeylanica*

Plumbagin isolated from *Plumbago zeylanica* inhibits growth & spread of breast cancer, liver cancer, fibrosarcoma, malignant ascites and leukaemia by inhibiting cancer cell proliferation. *Plumbago zeylanica* also possesses strong antioxidant, hepatoprotective, neuroprotective and immunoenhancing properties. [105]

### *Podophyllum hexandrum*

Podophyllotoxin & podophyllin (lignans) isolated from *Podophyllum hexandrum* (Himalayan May Apple) inhibit growth & spread of various cancers including that of the breast, ovary, lung, liver, urinary bladder, testis, brain, neuroblastoma, Hodgkin's disease, non-Hodgkin's lymphoma and leukaemia. Podophyllotoxin is the most active among all the natural anticancer compounds. *Podophyllum hexandrum* also possesses potent radioprotective and haemopoietic properties. [106]

### *Prunella vulgaris*

Ursolic acid and oleanolic acid, isolated from *Prunella vulgaris* (Xia-ku-cao/Self heal), inhibit growth & spread of various cancers such as cancers of the breast, cervix, lung, oral cavity, oesophagus, stomach, colon, thyroid, malignant lymphoma, intracranial tumours and leukaemia. *Prunella vulgaris*, is traditionally used in China to treat sores in mouth and throat. *Prunella vulgaris* also possesses immunoenhancing, hepatoprotective, antioxidant, anti-HIV and anti-Herpes properties. *Prunella vulgaris* has normoblastic effect on the bone marrow. [107]

### *Psoralea corylifolia*

Bavachinin, corylolinin and psoralen isolated from *Psoralea corylifolia* (Bu Gu Zhi), possess strong anticancer activity against lung cancer, liver cancer, osteosarcoma, fibrosarcoma, malignant ascites and leukaemia. Psoralen enhances immunity of the body by stimulating natural killer cell activity. Psoralidin isolated from *Psoralea corylifolia* inhibits growth & spread of stomach and prostate cancers by inhibiting G2/M phase of cell cycle. Psoralidin induces apoptosis in both androgen-responsive and androgenrefractory prostate cancers. *Psoralea corylifolia* also possesses strong antioxidant, immunoenhancing and hepatoprotective properties. [108]

### *Rubia cordifolia*

Rubidianin, rubiadin, RA-7, RA-700 and RC-18 isolated from *Rubia cordifolia* inhibit growth & spread in cancers of breast, ovary, cervix, colon, lung, malignant ascites, malignant lymphoma, malignant melanoma sarcoma and leukaemia. Rubiadin also possesses hepatoprotective activity. [109]

### *Saussurea lappa*

Sesquiterpenes and costunolide dehydrocostuslactone, isolated from *Saussurea lappa* inhibit growth & spread of breast cancer. Cynaropicrin, isolated from *Saussurea lappa* possesses strong anticancer activity against malignant lymphoma and leukaemia. Costunolide, isolated from *Saussurea lappa* inhibits growth & spread of intestinal cancer. Mokolactone isolated from *Saussurea lappa* induces apoptosis in leukaemic cells. Shikokiol isolated from *Saussurea lappa* exhibit anticancer activity against cancers of the ovary, lung, colon and central nervous system. *Saussurea lappa* inhibits growth & spread of cancers by arresting cancer cell division in G2 phase and inducing apoptosis. [110]

### *Solanum nigrum*

Solamargine and solasonine, isolated from *Solanum nigrum* (Lo-ing-kue) inhibit growth & spread of various cancers including that of the breast, liver and lung. Steroidal glycosides (spirostane, furostane, spirostane and pregnane), isolated from *Solanum nigrum* inhibit growth & spread of colon cancer and pheochromocytoma. Glycoproteins isolated from *Solanum nigrum* have antiproliferative and apoptotic effects on colon and breast cancers. Polysaccharides isolated from *Solanum nigrum* have significant inhibitory effect on growth of cervical cancer. *Solanum nigrum* inhibits growth & spread of liver cancer by two distinct anticancer activities, i.e. apoptosis (programmed cell death) and autophagy (autophagocytosis). Higher doses of *Solanum nigrum* induce apoptotic cell death while lower doses lead to autophagocytic death of cancer cells. Lunasin, isolated from *Solanum nigrum* is a cancer-preventive peptide. *Solanum nigrum* and *Solanum lyrati* (Shu-yang-quan) inhibit growth & spread of stomach cancer, sarcomas, malignant ascites and leukaemia. [111]

### *Tinospora cordifolia*

Sesquiterpenes and diterpenes isolated from *Tinospora cordifolia* inhibit growth & spread of various cancers including cancers of lung, cervix, throat and malignant ascites. Polysaccharide fraction isolated from *Tinospora cordifolia* inhibits lung metastasis. Arabinogalactan, syringine, cordiol, cordioside, cordifoliosides (A & B) isolated from *Tinospora cordifolia* possesses significant immunoenhancing activity. *Tinospora cordifolia* also possesses neuroprotective, hepatoprotective, antistress, antiulcer and antipyretic properties. *Tinospora cordifolia* reduces side effects of radiotherapy & chemotherapy. [112]

### *Viscum album*

Lectins (such as viscumin), polypeptides (viscotoxins) and phenolic compounds (such as digallic acid) isolated from *Viscum album* inhibit growth & spread of various cancers including that of the breast, cervix, ovary, lung, stomach, colon, rectum, kidney, urinary bladder, testis, malignant melanoma, sarcomas, fibrosarcoma, malignant ascites, lung metastasis and leukaemia by inducing apoptosis and anti-angiogenesis activity. Lectins isolated from *Viscum album* possess both anticancer and immunostimulating



activities. Viscumin, responsible for most of the biological activities of *Viscum album*, works by bringing together immune system effector cells and cancer cells. Lectin-II induces apoptosis in cancer cells via activation of caspase cascades. [113]

### *Withania somnifera*

Withanolides isolated from *Withania somnifera*, are similar to ginsenosides (the active principles of *Panax ginseng*) in both structure and activity. Withanolides (including Withaferin A, Sitoindoside IX, Physagulin D, Withanoside IV and Viscosalactone B) inhibit growth & spread of various cancers such as cancers of the breast, lung, colon and central nervous system due to their antiproliferative and antiangiogenic properties. Withaferin-A (the most important withanolides) inhibit growth & spread of various cancers including that of the breast, cervix, colon, prostate, nasopharynx, larynx, malignant ascites and sarcomas by inducing apoptosis. Withaferin A is effective in both androgen-responsive and androgen-refractory prostate cancers. Sitoindosides VII-X and Withaferin A have strong antioxidant, antistress, immunomodulatory, anti-inflammatory and antiaging properties. Withanolide D inhibits the metastatic colony formation in the lungs by malignant melanoma. Ashwagandhanolide, a new dimeric withanolide, isolated from *Withania somnifera*, inhibits growth & spread in cancers of breast, stomach, colon, lung and central nervous system. *Withania somnifera* also possesses immunoenhancing, haemopoietic and neuroprotective properties and reduces side effects of radiotherapy & chemotherapy. [114]

## Conclusion

There are many traditional systems of medicine in the world, each with different associated philosophies and cultural origins. Some of these, such as Tibetan traditional medicine, remain relatively localised in their country of origin; while others such as Ayurvedic and Chinese traditional medicines are increasingly used in many different areas of the world. This paper will concentrate on the issue treatment of chronic diseases and heavy metal poisoning related to herbal traditional medicines. Ayurveda is the most widely practised of the Indian traditional medicine systems, but there are others such as Siddha and Unani which are also used in the Indian subcontinent. Cancer is a major public health burden in both developed and developing countries. Cancer is an abnormal malignant growth of body tissue or cell. A cancerous growth is called a malignant tumor or malignancy. A noncancerous growth is called benign tumour. The process of cancer metastasis is consisting of series of sequential interrelated steps, each of which is rate limiting. Plants with loaded with chemical with chemo protective activities of some of them are undergoing clinical trial. Inhibition of angiogenesis is a novel process of cancer therapy. The selected and careful use of this plant may definitely in anti angiogenic therapy and thus in cancer management. Medicinal plants have contributed a rich health to human beings. Plant extracts and their bioactive compounds present in them which are responsible for anticancer activity have to be screened for their valuable information. This review had given some of the plants possessing anticancer activity for various types of cancer. This review can help others to explore herbs to further extent and its use in various other disease and toxicity studies along with clinical trials.

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