

SOME IMPORTANT ANTICANCER HERBS: A REVIEW

Pandey Govind*

Ex-Professor / Principal Scientist & Head of Pharmacology (Pharmacy); presently Officer-In-Charge of Rinder Pest (Animal Husbandry Department, Govt. of MP), Jabalpur Division, Jabalpur, MP, India

Article Received on: 12/05/11 Revised on: 20/06/11 Approved for publication: 08/07/11

*Officer-In-Charge of Rinder Pest (Animal Husbandry Department, Govt. of MP), Jabalpur Division, Jabalpur-482001, MP, India; E-mail: drgovindpandey@rediffmail.com

ABSTRACT

A great deal of pharmaceutical research has considerably improved the quality of herbal drugs used against various types of cancer. With the advanced knowledge of molecular science and the refinement in isolation and structure elucidation techniques, we are in a much better position now to identify various anticancer herbs. Scientists all over the world are concentrating on the use of herbs to boost immune system of the body against cancer. Scientists have contributed for a number of years to identify hundreds of anticancer herbs, and developed various herbal formulations from their active principles that inhibit growth and spread of cancer without any side effect. Such herbs possess anticancer, immunoenhancing, antiangiogenesis, antioxidant and antimutagenic properties. They inhibit growth and spread of cancer by modulating the activity of hormones, enzymes and other biological factors. The therapeutic effect of these herbs is executed by the complex synergistic interaction among their various active principles. Some important anticancer herbs have been discussed here.

KEYWORDS: Anticancer activities, Cancers, Herbs/medicinal plants, Phytoconstituents.

INTRODUCTION

A large number of medicinal plants act as anticancer herbs in experimental and/or clinical cancers/tumours of various organs. Some of those cancers are sarcoma, leukaemia, lymphoma and carcinoma¹⁻². This review article contains 35 anticancer herbs (anticancer medicinal plants) which have been described ahead. The general data of these plants have been collected from some books authored by different authors³⁻⁶. However, the particular phytoconstituents (phytochemicals) present in these plants, their mechanism of action and uses against the various cancers as reported by different authors have been cited under each medicinal plant/herb.

Medicinal plants are known to have versatile immunomodulatory and antioxidant properties, leading to anticancer activities. These act by stimulating both non-specific and specific immunity. They may promote host resistance against infection by re-stabilizing body equilibrium and conditioning the body tissues^{1-2,7-10}. Many reports describe that the anticancer activity of the medicinal plants is because of the presence of certain phytoconstituents, which possess strong antioxidant activities. The antioxidants may prevent and cure the cancer and other diseases by protecting cells from damage caused by 'free radicals'- the highly reactive oxygen compounds. Thus, consuming a diet rich in antioxidant plant foods will provide a milieu of phytoconstituents, non-nutritive substances in plants that

possess health-protective effects. The main phytoconstituent antioxidants with anticancer activity include vitamins (e.g., A, C, E and K), carotenoids or carotene, terpenoids, flavonoids, polyphenols (e.g., ellagic acid, gallic acid and tannins), flavonoids (e.g., quercetin, anthocyanins, catechins, isocatechins, flavones, flavonones and isoflavones), enzymes (e.g., superoxide dismutase, catalase and glutathion peroxidase), minerals (e.g., selenium, copper, manganese, zinc, chromium and iodine), polysaccharides, alkaloids, saponins, lignins, xanthonenes and certain pigments^{1-2,7-12}.

Some Important Medicinal Plants or Phytoconstituents with Anticancer activities***Aegle marmelos* Correa ex Roxb.****(Bel; Family: Rutaceae)**

Lupeol, isolated from pulp and seeds of *A. marmelos*, possesses strong anticancer activity against breast cancer, malignant lymphoma, malignant melanoma, malignant ascites and leukaemia. *A. marmelos* possesses significant antioxidant activity and reduces side effects of chemotherapy and radiotherapy.

Allium cepa* Linn.*(Piyaz/Onion; Family: Liliaceae/Alliaceae)**

Diallyl disulphide, quercetin flavonoid, allicin, allin and vitamins (C, E), isolated from bulb of *A. cepa*, detoxify carcinogen, inhibit *Helicobacter pylori* and arrest cell cycle from S to G2M phase. Diallyl disulphide inhibits

stomach cancer, and quercetin may cure lung and other cancers⁸.

Allium sativum Linn.

(Lasun/garlic; Family: Liliaceae/Alliaceae)

Sulphur compounds (diallyl sulphide, diallyl disulphide, allyl propyl disulphide) and allicin have been isolated from *A. sativum* bulb. Allicin inhibits growth of stomach, liver, colon, breast and endometrium cancers; while sulphur compounds inhibit the cancer cells⁸.

Aloe vera Tourn. ex Linn./A. barbadensis Mill.

(Ghee-Kunwar/Indian Aloe; Family: Liliaceae)

Acemannan (a polysaccharide) isolated from root, pulp, leaves or aerial parts of *A. vera* stimulates immune system and possesses significant anticancer activity. Emodin and lectins isolated from this herb exhibit strong anticancer and immunoenhancing activities. Aloe-emodin inhibits growth and spread of stomach cancer and various sarcomas by inducing apoptosis. Aloe-emodin has selective anticancer activity against neuroectodermal tumours. Alexin B isolated from *A. vera* possesses strong anticancer activity against leukaemia. Its polysaccharides have strong immunoenhancing and anticancer properties. *A. vera* contains "super carbohydrates" that protect against many cancers, particularly the liver cancer. This herb prevents genesis of cancer, regresses growth of cancer and prevents metastasis of cancer. *A. vera* stimulates immune system response of the body by activating macrophages and releasing cytokines such as interferon, interleukin and tumour necrosis factor. *A. vera* has an extraordinary antioxidant profile and reduces side effects of chemotherapy and radiotherapy. Its leaves contain glycosides-anthracene derivatives or hydroxyanthraquinone derivatives⁷.

Alpinia galanga Willd.

(Barakulanjan; Family: Zingiberaceae)

Acetoxy-chavicol-acetate, isolated from *A. galanga*, possesses significant anticancer activity against cancers of breast, lung, stomach, colon and prostate, multiple myeloma, and leukaemia. Pinocembrin isolated from this herb inhibits growth and spread of colon cancer by arresting cell proliferation and inducing apoptosis. Galangin, a flavonoid isolated from *A. galanga*, possesses strong anticancer, antioxidant, antimutagenic and antiinflammatory properties. Galangin protects against breast and prostate cancers.

Andrographis paniculata Wall. ex Nees (Kiryat/Kalmegh/Crear; Family: Acanthaceae)

Andrographolide (active diterpine component), isolated from whole plant of *A. paniculata*, has immunoenhancing and strong anticancer activity against cancers of breast, ovary, stomach, colon, prostate, kidney

and nasopharynx, malignant melanoma, and leukaemia. Andrographolide has been observed to be potential enhancers of immune system functions such as production of white blood cells (the defense cells of our body), release of interferon (an antiviral factor) and activity of the lymphatic system (the seat of defense system). 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 *A. paniculata* has strong anticancer activity against colon cancer. *A. paniculata* extract is cytotoxic (cell-killing) against cancer cell as seen in human epidermoid carcinoma of skin, lining of nasopharynx and lymphocytic leukaemia cells.

The chemoprotective potential of *A. paniculata* against chemotoxicity, including carcinogenicity was observed in mice. Thus, *A. paniculata* possesses anticancer, immunostimulant, antioxidant, anti-HIV, antiinflammatory and antihepatotoxic properties. It enhances the activity of protective liver enzymes and reduces side effects of chemotherapy and radiotherapy. *A. paniculata* also contains flavonoid and andrographin⁹.

Aphanamixis polystachya (Wall.) Parker/Amoora rohituka Wight & Arn.

(Harinhara/Amoora; Family: Meliaceae)

Amooranin (a triterpene acid), isolated from *A. polystachya* stem bark, inhibits growth and 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.

Azadirachta indica A. Juss./Melia azadirachta Linn. (Neem; Family: Meliaceae)

Stem bark, leaf and flower of *A. indica* contains about 40 different active principles, known as liminoids, which exhibit immunoenhancing, antioxidant, antimutagenic, anticancer and antimetastatic, antiinflammatory, hepatoprotective, antiulcer, antifungal and antiviral activities. Liminoids regress growth and spread of various cancers, e.g., cancers of breast, lung, liver, stomach, prostate and skin. Nimbolide, a natural triterpenoid, isolated from *A. indica* leaves and flowers inhibits growth and 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 *A. indica* inhibits growth and spread of prostate cancer by

inducing apoptosis and its antiandrogenic effect. This herb reduces side effects of chemotherapy and radiotherapy. *A. indica* also contains polyphenolic myoinositol, dexamethasone, tannin, β sitosterol, nimbin, quercetin and carotene^{2,9}.

***Bauhinia variegata* Linn.**

(Kachnar; Family: Caesalpiniaceae)

Cyanidin glucoside, malvidin glucoside, peonidin glucoside and kaempferol galactoside, isolated from root, stem bark and flower of *B. variegata*, inhibit growth and spread of various cancers, e.g., cancers of breast, lung, liver, oral cavity and larynx, and malignant ascites. *B. variegata* also possesses significant hepatoprotective activity.

***Berberis vulgaris* Linn.**

(Kashmal; Family: Berberidaceae)

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

***Catharanthus roseus* G. Don/*Vinca rosea* Linn./*Lochnera rosea* (Linn.) Reichb. (Sadabahar/Madagascar Periwinkle; Family: Apocynaceae)**

C. roseus whole plant 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, i.e., they inhibit microtubule formation and arrests mitosis in metaphase. Vinca alkaloids also induce apoptosis (programmed cell death) and inhibit angiogenesis (formation of new blood vessels). These alkaloids inhibit growth and spread of various cancers, including breast, ovary, cervix, lung, colon, rectum, kidney and testis cancers, neuroblastoma, Hodgkin's disease, malignant lymphoma, multiple myeloma, various sarcomas, rhabdomyosarcoma, and leukaemia^{2,7}.

***Curcuma longa* Linn./*C. domestica* Valetton (Haldi/Turmeric; Family: Zingiberaceae)**

Curcumin (Diferuloyl methane) and curcuminoids, isolated from *C. longa* rhizome (tuber) suppress cancer at every step, i.e., initiation, growth and metastasis. Curcumin (pigment colour of haldi) arrests the cancer cells proliferation in G2/S phase and induces apoptosis (programmed cell death). Curcumin has shown antiinflammatory, antitumour and antioxidant properties. 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 and spread of oestrogen-positive breast cancer. Curcumin acts even in multidrug-resistant breast cancers. Curcumin suppresses adhesion of cancer cells, thus preventing metastasis. It inhibits growth and 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. It is effective even in advanced stages of cancer. Curcumin showed chemopreventive effect against N-nitrosodiethylamine/phenobarbital induced-hepatocarcinogenesis in wistar strain male albino rats. It also protects from stomach and colon cancers. *C. longa* rhizome is also antimutagenic, antioxidant, immunostimulant, antiinflammatory, radioprotective, stimulant, carminative, alterative, blood purifier, hepatoprotective, antiperiodic and tonic. Rhizomes are also effective in colon, bladder and prostate cancers, intravesical tumour, fibrosarcoma, hepatocellular carcinoma, oesophageal carcinogenesis, leukaemia, stomach papilloma and solid tumours^{2,13}.

***Emblica officinalis* Gaertn./*Phyllanthus emblica* Linn. (Amla/Amlika/Indian Gooseberry; Family: Euphorbiaceae)**

E. officinalis fruit contains ellagic acid, gallic acid, quercetin, kaempferol, emblicanin, flavonoids, glycosides and proanthocyanidins. It is valued for its unique tannins and flavanoids, which possess powerful immunomodulatory, antioxidant and anticancer activities. Ellagic acid is a powerful antioxidant and has the ability to inhibit mutations in genes. Ellagic acid also repairs chromosomal abnormalities. Quercetin has hepatoprotective effect. Emblicanins A and B (tannins) possess strong antioxidant and anticancer properties. *E. officinalis* inhibits growth and spread of various cancers, including that of the breast, uterus, pancreas, stomach and liver, and malignant ascites. *E. officinalis* is an excellent rejuvenator and antioxidant herb. It is highly nutritious and an important source of vitamin C (a powerful antioxidant), phyllembic acid, lipid, emblicol, colloidal complexes, micic acid amino acids and

minerals. *E. officinalis* protects against many cancers, particularly the liver cancer. It reduces side effects of chemotherapy and radiotherapy. Amla fruits are also acrid, cooling, aperient, refrigerant, astringent, diuretic and laxative. The dried fruits are useful in inflammation, haemorrhage, cough, diarrhoea, anaemia, jaundice and dyspepsia. Flowers of *E. officinalis* are cooling, refrigerant and aperient, while root and bark are astringent. *E. officinalis* seeds are used for asthma, bronchitis and biliousness. Due to rich vitamin C (ascorbic acid or ascorbate), amla is successfully used in the treatment of human scurvy. Phyllembin, from fruit pulp identified as ethyl gallate; tannin from fruit, bark and leaves; fixed oil, essential oil and phosphatides from seeds; and leucodelphinidin from bark of *E. officinalis* have also been isolated. Amla fruit contains 18 compounds that inhibit growth of gastric, uterine and breast cancers. It enhances natural killer cell activity in various tumours. Its extract reduced the ascites and solid tumours induced by Dalton's lymphoma ascites cells in mice. The extract also increased the life span of tumour bearing animals^{2,14}.

***Fragaria vesca* Linn.**

(Strawberry; Family: Rosaceae)

Flavonoid, tannin, borneol, ellagic acid, vitamin C, bioflavonoid and chalcone of *F. vesca* leaf and fruit possess antioxidant and anticancer activities. *F. vesca* acts against various cancers¹⁻².

***Ginkgo biloba* Linn.**

(Maidenhair Tree; Family: Ginkgoaceae)

Ginkgetin and ginkgolides (A and B), isolated from *G. biloba*, inhibits growth and spread of various aggressive cancers such as invasive oestrogen-receptor negative breast cancer, glioblastoma, hepatocellular carcinoma, and cancers of ovary, colon, prostate and liver by inducing apoptosis. *G. biloba* extract is well known for its antioxidant activity. It also reduces side effects of chemotherapy and radiotherapy.

***Glycine max* Merrill/*G. soja* Sieb. & Zucc./*G. hispida* Maxim/*Soja max* Piper**

(Bhat/Soybean/Soyabean/ Soya; Family: Papilionaceae/Fabaceae)

Isoflavones (e.g., genistein and daidzein) and saponins, isolated from *G. max* beans (seeds), inhibit growth and spread of various cancers such as cancers of breast, uterus, cervix, ovary, lung, stomach, colon, pancreas, liver, kidney, urinary bladder, prostate, testis, oral cavity, larynx, and thyroid. *G. max* is also effective in nasopharyngeal carcinoma, skin cancer, malignant lymphoma, rhabdomyosarcoma, neuroblastoma, malignant brain tumours and leukaemia. Isoflavones and saponins possess wide ranging anticancer properties like

inhibition of cancer cell proliferation, promotion of cell differentiation and induction of apoptosis. Genistein acts by blocking angiogenesis, acts as a tyrosine kinase inhibitor (the mechanism of action of many new cancer drugs) and induces apoptosis. Genistein is an excellent intracellular antioxidant, which 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 decrease invasiveness of glioblastoma cells. Anthocyanins of *G. max* induce apoptosis in leukemic cells. *G. max* protects against many cancers, including that of colon, lung and ovary.

***Glycyrrhiza glabra* Linn.**

(Mulathi/Mulhatti/ Licorice/Liquorice); Family: Papilionaceae/ Fabaceae/Leguminosae)

Flavonoids (e.g., flavones, flavonols, isoflavones, chalcones, licochalcones and bihydrochalcones), derived from root, rhizome or whole plant of *G. glabra* possess strong anticancer, antioxidant, antimutagenic, antiulcer, anti-HIV and hepatoprotective properties. Licochalcone-A inhibits growth and 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 and kidney, and leukaemia. Triterpenoid saponins (e.g., glycyrrhizin and glabranin) isolated from *G. glabra* inhibits growth and spread of lung cancer and fibrosarcomas. Glycyrrhizic acid isolated from this herb protects against aflatoxins (powerful fungal carcinogens of the liver). *G. glabra* also contains coumarin, triterpene sterol (β amerin stigmaterol), eugenol, indole, glycyrrhetic acid, chalcone glycosides (viz., isoliquiritin and neoisoliquiritin), and liquiritoside (a flavanoside). This herb stimulates immune system response of the body and protects against colon cancer and oestrogen-positive breast cancer. The rhizomes and roots are also tonic, expectorant, demulcent, laxative and emollient, and used in genito-urinary diseases, coughs, sore throat, catarrhal affections and in scorpion-sting. Licorice is an extract prepared from the dried roots and stems of *G. glabra*. For more than three thousand years, licorice has been used to treat cancer, hepatitis and some other diseases. Antitumour and antimetastatic effects of cyclophosphamide are potentiated by licorice extract^{7,9}.

***Malus domestica* Borkh./*M. pumila* Mill./*M. communis* DC/*M. sylvestris* Hort., non Mill./*Pyrus malus* Linn. in part**

(Seb/Sev/Apple; Family: Rosaceae)

Fruit (Apple) of *M. domestica* possesses antioxidant and anticancer activities, and may be useful in various cancers².

***Morinda citrifolia* Linn.**

(Al/Ach/Bartundi/Noni; Family: Rubiaceae)

M. citrifolia has 23 different phytochemicals, including five vitamins and three minerals. *M. citrifolia* heartwood contains active constituents as anthraquinones, viz., damnacanthal, rubiadin-methyl ether, alizarin, morindone and anthragalol-2, 3-dimethyl ether. Damnacanthol, NB10 and NB11, isolated from *M. citrifolia* fruit, possess strong anticancer activity against various cancers, particularly lung cancer and sarcomas. *M. citrifolia* possesses strong antioxidant, hepatoprotective and immunoenhancing properties. The flowers on ethanolic extraction yielded acacetin 7-O-(-D(+)-glucopyranoside; 5, 7-dimethyl-apigenin-4'-O-(-D(+)-galactopyranoside and a new anthraquinone glycoside. The fruit juice of *M. citrifolia* showed antitumour activity against intraperitoneally implanted Lewis lung carcinoma in syngenic mice. Noni fruit extract acts indirectly on cancer cells by enhancing host immune system. There is a polysaccharide compound (6-D-glucopyranone pentaacetate) found in the Noni which increases the ability of immune system to produce chemicals that enhance the killing power of the white blood cells against cancer. Noni fruit provides a safe and effective way to increase xeronine levels, which exert a crucial influence on cell health and body protection. Its fruit contains proxeronine (a precursor of xeronine), which initiates the release of xeronine in the intestinal tract after it comes in contact with a specific enzyme (present in the fruit). Thus, xeronine is an alkaloid to which the body produces in order to activate enzymes, so they can function properly. This particular alkaloid has never been found because the body makes it, immediately uses it, and then breaks it down. Xeronine is so basic to the functioning of proteins, we would die without it. Its absence can cause many kinds of illness. Noni, which is probably the best source of proxeronine, acts as an immunostimulant, inhibits the growth of certain tumours, enhances and normalizes cellular functions, and boosts tissue regeneration¹⁵.

***Nigella sativa* Linn.**

(Kalonji/Kalajira/Black Cumin; Family: Ranunculaceae)

Thymoquinone and dithymoquinone, isolated from *Nigella sativa* seeds, have strong anticancer activity

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

***Ocimum sanctum* Linn.**

(Tulsi/Sacred Basil/Holy Basil; Family: Labiatae/Lamiaceae)

O. sanctum leaves contain volatile oils (comprising of eugenol and methyl eugenol), linolenic acid, oleanic acid, rosmarinic acid, and flavonoids or phenolic compounds as antioxidants (e.g., orientin, vicenin, cirsilin, cirsimaritin, isothymusin, isothymonin and apigenin). The volatile oils also contain carvacrol and sesquiterpene hydrocarbon caryophyllene. Ursolic acid, apigenin, luteolin, apigenin-7-O-glucuronide, luteolin-7-O-glucuronide, orientin and molludistin have also been isolated from the leaf. It also contains a number of sesquiterpenes and monoterpenes, viz., bornyl acetate, β -elemene, neral, α - and β -pinenes, camphene, campesterol, cholesterol, stigmasterol, and β -sitosterol. Eugenol, orientin and vicenin inhibit growth and spread of various cancers such as breast cancer, liver cancer and sarcomas, particularly fibrosarcoma by blocking supply of oxygen and nutrients to cancer cells and killing them by starving. Ursolic acid has immunoenhancing and tissue-protective properties. Polysaccharides isolated from it have antioxidant and radioprotective properties. *O. sanctum* possesses antioxidant, antitumour and immunomodulatory activities and protects against various cancers, particularly breast cancer and reduces side effects of chemotherapy and radiotherapy. The alcoholic extract (AIE) of *O. sanctum* leaves has a modulatory influence on carcinogen metabolizing enzymes such as cytochrome P 450, cytochrome b₅, aryl hydrocarbon hydroxylase and glutathione S-transferase (GST), which are important in detoxification of carcinogens and mutagens. *O. sanctum* significantly decreased the incidence of benzo(a)pyrene induced neoplasia of fore-stomach of mice and 3'-methyl-4-dimethylaminoazo-benzene induced hepatomas in rats. The AIE of the leaves of OS was shown to have an inhibitory effect on chemically induced skin papillomas in mice. Leaf extract of *O. sanctum* blocks or suppresses the events associated with chemical carcinogenesis by

inhibiting metabolic activation of the carcinogen. The anticancer activity of *O. sanctum* was observed in Swiss albino mice bearing Ehrlich ascites carcinoma and sarcoma 180 tumours. Besides above, *O. sanctum* herb is also useful as antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, anthelmintic, antidiarrhoeal, analgesic, antipyretic, antiinflammatory, antiallergic, antihypertensive, cardioprotective, central nervous system depressant, memory enhancer, antihypercholesterolaemic, antihepatotoxic, antidiabetic, antiasthmatic, antithyroidic, chemopreventive, radioprotective, antifertility, antiulcer, antiarthritic, adaptogenic/antistress, anticataract, antileucodermal, anticoagulant, aromatic, stomachic, carminative, demulcent, diaphoretic, diuretic, expectorant, alexiteric, vermifuge and febrifuge. Tulsi is a popular home remedy for many illnesses and everyday ailments like common cold, headache, cough, flu, earache, fever, colic pain, sore throat, bronchitis, flatulence, migraine headaches, insomnia, arthritis, night blindness, wound, liver diseases, catarrhal fever, otalgia, lumbago, hiccough, ophthalmia, digestive disorders, genitourinary disorders, diarrhea, influenza, skin diseases, various forms of poisoning and psychosomatic stress disorders^{2,7,16}.

***Oldenlandia diffusa* Roxb./*Hedyotis diffusa* Willd. (Family: Rubiaceae)**

O. diffusa is a native of China. The whole plant of *O. diffusa* contains oldenlandosides, stigmaterol, ursolic acid, oleanolic acid, beta-sitosterol, p-coumaric acid and flavonoid glycosides. Ursolic acid inhibits growth and spread of various cancers such as cancers of lung, ovary, uterus, stomach, liver, colon, rectum and brain, malignant melanoma, malignant ascites, lymphosarcoma, and leukaemia. Ursolic acid works by a typical cytotoxic effect on cancer cells and by inducing apoptosis¹.

***Panax ginseng* Mey./*P. schinseng* Nees**

(Asiatic or Chinese Ginseng; Family: Araliaceae)

Ginsenosides (panaxadiol and panaxatriol saponins), isolated from *P. ginseng*, inhibits the growth and spread of various cancers such as cancers of breast, ovary, lung, prostate and 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 roles 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 and spread of chemo-resistant lung cancer. Ginsenosides Rc, Rd, Rg1 and Re overcome (reverse) P-glycoprotein mediated multi-drug resistance to chemotherapy. Ginsenoside Rf

helps in reducing doses of morphine in terminally ill cancer patients. Polysaccharides of *P. ginseng* possess strong immunoenhancing and anticancer activities against many cancers, particularly lung cancer. These polysaccharides also reduce side effects of chemotherapy and radiotherapy. *P. ginseng* also possesses antistress, hepatoprotective, haemopoietic, immunoenhancing, antioxidant, radioprotective, chemoprotective and antiinflammatory properties. It inhibits proliferation and seeding (metastases) in various cancers by inducing cell differentiation and apoptosis. It is effective in both hormone-responsive and hormone-refractory prostate and breast cancers.

***Plumbago zeylanica* Linn.**

(Chitarak/Chitra; Family: Plumbaginaceae)

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

Podophyllum hexandrum* Royle/*P. emodi* Wall. ex Hook. f. & Thoms./*P. peltatum

(Papra/Indian Podophyllum/Himalayan May Apple; Family: Berberidaceae)

Podophyllotoxin and podophyllin (lignans), isolated from *P. hexandrum* inhibit growth and spread of various cancers, including that of breast, ovary, lung, liver, urinary bladder, testis and brain, neuroblastoma, Hodgkin's disease, non-Hodgkin's lymphoma, and leukaemia. Podophyllotoxin is the most active among all the natural anticancer compounds. *P. hexandrum* also possesses potent radioprotective and haemopoietic properties^{2,7}.

***Prunella vulgaris* Linn./*Brunella vulgaris* Linn. (Dharu; Family: Labiatae/Lamiaceae)**

Ursolic acid and oleanolic acid, isolated from *P. vulgaris*, inhibit growth and spread of various cancers such as cancers of the breast, cervix, lung, oral cavity, oesophagus, stomach, colon and thyroid, malignant lymphoma, intracranial tumours and leukaemia. This herb also possesses immunoenhancing, hepatoprotective, antioxidant, anti-HIV and anti-Herpes properties. It has normoblastic effect on the bone marrow.

***Psoralea corylifolia* Linn.**

(Babchi; Family: Papilionaceae/Fabaceae)

Bavachinin, corylfolinin and psoralen, isolated from *P. corylifolia*, 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 this herb inhibits

growth and spread of stomach and prostate cancers by inhibiting G2/M phase of cell cycle. Psoralidin induces apoptosis in both androgen-responsive and androgen-refractory prostate cancers. *P. corylifolia* also possesses strong antioxidant, immunoenhancing and hepatoprotective properties.

***Punica granatum* Linn.**

(Anar/Pomegranate; Family: Punicaceae)

Fruit (Anar) of *P. granatum* contains alkaloids, anthocyanidines and vitamin C. *P. granatum* acted against solid tumour and ascites tumour in albino mice².

***Rubia cordifolia* Linn. sensu Hook. f.**
(Manjit/Majith/Rosemary; Family: Rubiaceae)

Root of *R. cordifolia* contains rubidianin, rubiadin, rosemary acids (viz., RA-7, RA-700, RC-1 and RC-18), carnosic acid, purpurin, pseudopurpurin, alizarin and xanthopurpurin (purpuroxanthin). *R. cordifolia* root inhibits growth and spread of breast, ovary, cervix, colon and lung cancers, malignant ascites, malignant lymphoma, malignant melanoma (B16 melanoma), P388 cells, L1210 cells, sarcoma, and leukaemia. Rubiadin also possesses hepatoprotective activity^{2,7}.

***Saussurea lappa* C.B. Clarke**

(Kut/Kur/Kuth/Costus;

Family: Compositae/Asteraceae)

Sesquiterpenes and costunolide dehydrocostuslactone, isolated from *S. lappa*, inhibit growth and spread of breast cancer. Cynaropicrin from *S. lappa* possesses strong anticancer activity against malignant lymphoma and leukaemia. Costunolide also inhibits growth and spread of intestinal cancer. Mokolactone content of this herb induces apoptosis in leukaemic cells. Shikokiols obtained from *S. lappa* exhibit anticancer activity against cancers of ovary, lung, colon and central nervous system. *S. lappa* inhibits growth and spread of cancers by arresting cancer cell division in G2 phase and inducing apoptosis.

***Solanum nigrum* Linn.**

(Makoi/Kakmachi/Vayasi/Black nightshade; Family: Solanaceae)

Flavonoids (e.g., quercetin) and alkaloids (viz., solasodine, solanine and solamargine) are the main phytoconstituents of *S. nigrum* whole plant or fruit which have been reported to act in various tumours. Solamargine and solasonine inhibit growth and spread of various cancers, including breast, liver, lung and cyst cancers, choriocarcinoma or choriadenoma, and leukaemia. Solanine and solamergine have very strong anticancer actions against murine tumours. Steroidal glycosides (spirostane, furostane, spirosolane and pregnane), isolated from *S. nigrum*, inhibit growth and spread of colon cancer and pheochromocytoma.

Glycoproteins obtained from *S. nigrum* have antiproliferative and apoptotic effects on colon and breast cancers. Polysaccharides of this herb have significant inhibitory effect on growth of cervical cancer. *S. nigrum* inhibits growth and spread of liver cancer by two distinct anticancer activities, i.e., apoptosis (programmed cell death) and autophagy (autophagocytosis). Higher doses of *S. nigrum* induce apoptotic cell death, while lower doses lead to autophagocytic death of cancer cells. Lunasin, isolated from *S. nigrum* is a cancer-preventive peptide. *S. nigrum* and *S. lyrati* inhibit growth and spread of stomach cancer, sarcomas, malignant ascites and leukaemia. *S. nigrum* leaves extract has inhibitory effect against S 180, V 14 and Ec tumour models².

***Tinospora cordifolia* (Willd.) Miers ex Hook. f. & Thoms.**

(Giloe/Amrita/Gulantha/Gulbel/

Gulantha

***Tinospora*; Family: Menispermaceae)**

Stem bark and fruit of *T. cordifolia* contain berberine, tinosporine, giloin and giloinin. Sesquiterpenes and diterpenes, isolated from this herb inhibit growth and spread of various cancers, including cancers of lung, cervix and throat, and malignant ascites. Polysaccharide fraction of *T. cordifolia* inhibits lung metastasis. Arabinogalactan, syringine, cordiol, cordioside, cordifoliosides (A and B) obtained from *T. cordifolia* possesses significant immunoenhancing activity. *T. cordifolia* reduces side effects of radiotherapy and chemotherapy. This herb also possesses antioxidant, neuroprotective, hepatoprotective, antistress, antiulcer, antiasthmatic, antidiabetic (or hypoglycaemic and hypolipidaemic) and antipyretic activities⁷.

***Viscum album* Linn./*V. costatum* Gamble**
(Banda/Ban/Euripean Mistletoe; Family: Loranthaceae/Viscaceae)

V. album whole plant contains lectin alkaloids, acetylcholine, proprionyl choline, lupeol, viscotoxin, flavonoid and sterol A. Lectins (e.g., viscumin), polypeptides (viscotoxins) and phenolic compounds (e.g., digallic acid), isolated from *V. album* inhibit growth and spread of various cancers, including that of breast, cervix, ovary, lung, stomach, colon, rectum, kidney, urinary bladder and testis, malignant melanoma, sarcoma, fibrosarcoma, malignant ascites, lung metastasis, and leukaemia by inducing apoptosis and antiangiogenesis activity. Lectins possess both anticancer and immunostimulating activities. Lectin-II induces apoptosis in cancer cells via activation of caspase-3 cascades. Lectin alkaloids also cause lectin 11-induced apoptosis and inhibition of telomerase via mitochondrial controlled pathway independent of p53. Hexamethylene

bioacetamide obtained from *V. album* causes p53-dependent apoptosis and induction with telomerase. Viscumin, responsible for most of the biological activities of *V. album*, acts by bringing together immune system effector cells and cancer cells^{2,7}.

***Withania somnifera* Dunal**

(Ashwagandha/Asgandh /Punir; Family: Solanaceae)

The majority of the phytoconstituents of *W. somnifera* root are withanolides (steroidal lactones with ergostane skeleton) and alkaloids. They include withanone, withaferin A, and several other withanolides and withasonidienone. Much of the pharmacological activity of *W. somnifera* has been attributed to two main withanolides, withaferin A and withanolide D. Apart from these, *W. somnifera* root also contains withaniol, acylsteryl glucosides, starch, glycosides reducing sugar, resins, saponins, fixed oils, hantreacotane, ducitol, anthraquinones, proteins, amino acids (e.g., aspartic acid, proline, tyrosine, alanine, glycine, glutamic acid, cystine and tryptophan) and high amount of iron, etc. Withaferin A and withanolide D have antioxidant, anticancer and immunoenhancing activities, and act against various cancers. Withanolides are similar to ginsenosides (the active principles of *P. ginseng*) in both structure and activity. Withanolides (including withaferin A, sitoindoside IX, physagulin D, withanoside IV and viscosalactone B) inhibit growth and spread of various cancers such as cancers of breast, lung, colon and central nervous system due to their antiproliferative and antiangiogenic properties. Withaferin A (the most important withanolide) inhibits growth and spread of various cancers, including that of breast, cervix, colon, prostate, nasopharynx and larynx, malignant ascites, and sarcoma 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, antiinflammatory and antiaging properties. Withanolide D inhibits the metastatic colony formation in malignant lung melanoma. Ashwagandhanolide, a new dimeric withanolide, isolated from *W. somnifera*, inhibits growth and spread of breast, stomach, colon, lung and central nervous system cancers. *W. somnifera* reduced the cancer cell proliferation and increased the overall survival time. It enhanced the effectiveness of radiation therapy, and reduced the side effects of radiotherapy and chemotherapy. Given its broad spectrum of cytotoxic and anticancer activity, *W. somnifera* presents itself as a novel therapy for cancer. *W. somnifera* root also possesses other medicinal properties like haemopoietic, neuroprotective, anticonvulsant, hypoglycaemic and hypolipidaemic properties^{2,7,17}.

***Zingiber officinale* Rosc.**

(Adrak/Ada/Ginger; Family: Zingiberaceae)

Gingerols, isolated from *Z. officinale* rhizome inhibit growth and spread of various cancers, including that of ovary, cervix, colon, rectum, liver, urinary bladder and oral cavity, neuroblastoma, and leukaemia by inducing apoptosis. The most active individual component, 6-shogaol, isolated from *Z. officinale*, inhibits growth and spread of many cancers, particularly the ovarian cancer by blocking formation of new blood vessels, and by inducing apoptosis and autophagy. It is effective even in chemotherapy-resistant ovarian cancer. *Z. officinale* reduces side effects of chemotherapy and radiotherapy. It also possesses antioxidant, antimutagenic and antiinflammatory activities².

REFERENCES

1. Madhuri S, Pandey Govind. Some anticancer medicinal plants of foreign origin. *Curr Sci* 2009; 96(6):779-783.
2. Pandey Govind, Madhuri S. Some anticancer agents from plant origin. *Pl Arch* 2008; 8(2): 527-532.
3. Chopra RN, Nayar SL, Chopra IC. *Glossary of Indian Medicinal Plants*. New Delhi: Council of Scientific and Industrial Research; 2002.
4. CSIR. *The Useful Plants of India*. New Delhi, India: Council of Scientific and Industrial Research; 1986.
5. IDMA. *Indian Herbal Pharmacopoeia*. Mumbai, India; 2002.
6. Prajapati ND, Purohit SS, Sharma AK, Kumar T. *A Hand Book of Medicinal Plants*. India: Agrobios; 2003.
7. Madhuri S, Pandey Govind. Ethnomedicinal plants for prevention and treatment of tumours. *Int J Green Pharm* 2009; 3(1):2-5.
8. Pandey Govind. Antioxidant vegetables act against cancer and other diseases. *Int J Pharmaceu Stud Res* 2011; 2(1):32-38.
9. Pandey Govind, Madhuri S. Some medicinal plants as natural anticancer agents. *PHCOG REV* 2009; 3(6):259-63.
10. Pandey Govind, Madhuri S. Therapeutic approach to cancer by vegetables with antioxidant activity. *Int Res J Pharm* 2011; 2(1):10-13.
11. Gupta VK, Sharma, SK. Plants as natural antioxidants. *Nat Prod Rad* 2006; 5(4):326-334.
12. olidori MC. Antioxidant micronutrients in the prevention of age-related diseases. *J Postgrad Med* 2003; 49:229-235.
13. Pandey Govind. Active principles and median lethal dose of *Curcuma longa* Linn. *Int Res J Pharm* 2011; 2(5):239-241.
14. Pandey Govind, Pandey SP. Phytochemical and toxicity study of *Emblca officinalis* (Amla). *Int Res J Pharm* 2011; 2(3):270-272.
15. Hirazumi A, Furusawa E. An immunomodulatory polysaccharide-rich substance from the fruit juice of *Morinda citrifolia* (Noni) with antitumour activity. *Phytother Res* 1999; 13:380-387.
16. Pandey Govind, Madhuri S. Pharmacological activities of *Ocimum sanctum* (Tulsi): A review. *Int J Pharmaceu Sci Rev Res* 2010; 5(1):61-66.
17. Madhuri S, Pandey Govind. Anticancer activity of *Withania somnifera* Dunal (Ashwagandha). *Indian Drugs*, 2009; 46(8):603-609