REVIEW OF LITERATURE
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On anticancer activity the available literature has been reviewed here. For the purpose of convenience the literature has been arranged chronologically under various headings. In many experiments the active principles of plants were isolated and screened for their activities.

Acids

Acids were isolated from plants and screened for their anticancer activities by many researchers. From *Gossypium* spp. Zang *et al.* (1983) isolated gossypol acetic acid which exerted its action on DNA synthesis as well as cell mitosis. The most prominent changes of the ultrastructures of HeLa cells were the swelling of mitochondria, breakage of its crest and even its vesiculation. Hypatic and other acids have been isolated from the *Hyptis capitata* and these compounds demonstrated significant cytotoxicity in the human lung carcinoma (Yamagishi *et al.*, 1987). Scopadulcic acid isolated from *Scoparia dulcis* increased the survival rate of mice bearing tumors (Hayashi *et al.*, 1992). Anacardic acid from *Anacardium occidentale* showed cytotoxic activity against breast carcinoma cells (Kubo *et al.*, 1993).

Alkaloids

Various plant alkaloids were isolated and screened for their activities on various types of cancers. The crude alkaloidal mixer, isolated from the aqueous alcoholic extract of the plant *Merendera caucasica* which showed a high antitumour
activity (222%) in 3 PS test systems was reported by Ulubelen and Tanker (1978). Gunasekara et al. (1979) isolated an effective anticancer alkaloid Camptothecin and a less effective alkaloid 9-methoxycamptothecin from the stem bark of Ervatamia heyneana. Purushothaman and Bharadwaj (1979) isolated alkamine from Solanum trilobatum which showed antitumour activity in mice. The crude alkaloidal extract when administered along with other indigenous drugs and in combination with surgery or irradiation gave satisfactory results in certain specific cases of cancer. Furusawa et al. (1981) isolated pretazettine an alkaloid from the bulbs of Nacissus tazetta which showed activity against Ehrlich ascites carcinoma. Mukhopadhyay et al. (1981) isolated indole alkaloids from the petroleum ether extract of leaves and roots of Rhazya stricta which showed cytotoxic activity. Silva and Abraham (1981) investigated the antitumour activities of Israeli plants. Nine following plants were confirmed to possess anticancer properties: Daemia tomentosa (leaves), Gundelia tournefortii (roots), Haplophyllum buxbaumii (roots and leaves), Helichrysum sanguineum (leaves and flowers), Hyoscyamus aureus (roots, leaves and inflorescence), Ononis pubescens (roots and leaves), Pariefaria judaica (leaves) and Scilla hyasinthoides (bulbs). The effect of harringtonine isolated from the bark of Cephalotaxus haimanensis on HL 60 was evaluated by Chen et al. (1989). It was concluded that the antileukemic effect of harringtonine is cytotoxicity and not differentiation induction. Pettit et al. (1990) isolated phyllanthostatin-6 from the roots of Phyllanthus accimnatus. It was found to inhibit the growth of murine P-388 lymphocytic leukemia cell lines. Total alkaloids from Thalictrum glandulosissium were found to be effective in the treatment of mice
bearing P-388 leukemia. Hernandezine blocked cell cycle transfer from G1 to S phase and its cytocidal action might be cell cycle specific (Xu et al., 1990).

The bulbs of *Pancratium maritimum* were found to contain a new glucosyloxy phenolic metabolite and Amaryllidacean alkaloids which showed cytotoxic and antitumour activity in potato disc assay (Abou-Donia et al., 1991). The inhibition either on DNA or on protein synthesis by taxanes isolated from the stem and leaves of *Taxus chinensis* was reported by Gu et al., (1991). Taxane alkaloid isolated from the bark of Taxus yunnanensis increased the life span of leukemia bearing mice to 80 per cent (Vhen et al., 1991). The alkaloids extractable with methanol from *Doronicum austriacum* completely inhibited the proliferation of mouse fibroblast cell cultures. The extract also extended the survival period of mice with carcinoma (Petricic et al., 1991). Ar-turmerone was isolated from *Curcuma domestica* and its anticytotoxic activity against L 1210 - cell was determined by Oh et al. (1992). Antitumour metabolite production by some dicots were investigated in cultures and high alkaloid producing cell lines have been established by Ramawat et al. (1992).

Three alkaloids were isolated and identified from *Hymenocallis expansa* and their cytotoxicity were studied in human and murine tumor cell lines (Antoun et al., 1993). Indole alkaloids were isolated from *Stroblanthes cusia* by Li et al. (1993) and the pharmacological tests indicated that they were possessing anticancer activity. Moreno et al. (1993) extracted aporphil alkaloids from the trunk bark of *Nectandra grandiflora*. These alkaloids showed antitumor activity against Sarcoma 180. The
activity of mitomycin C and vinblastine an alkaloid of *Vinca rosea* were tested in metastatic breast cancer patients by Perrone *et al.* (1993). Strychnopentamine an alkaloid from *Strychnos usambarensis* was showed to increase the survival rate of Ehrlich ascites tumour induced mice (Quetin-Leclercq. *et al.*, 1993). *In vivo* anti-neoplastic activity against Ehrlich's Carcinoma and Sarcoma of alkaloids from *Pesschiera australis* was reported by Rates (1993). Cytotoxic activity of alkaloids of *Anona montana* was reported by Wu *et al.* (1993). Alkaloids from various plants and their anticancer activities have been summarised by Zafar *et al.* (1993).

Paltaxel isolated from *Taxus brevifolia* was reported by Ajani *et al.* (1994) to be active against adenocarcinoma and squamous cell carcinoma of oesophagus. Isoplumbagin isolated from the stem bark of *Lawsonia inermis* showed significant anticancer activity. The stem bark has been reported to be a source of new drug which can be used as anticancer agent (Ali, 1994). Paclitaxel isolated from *Taxus brevifolia* was reported by Chang (1994) to be a novel antimicrotubular chemotherapeutic agents with a unique mechanism of action. The preclinical evaluation of paclitaxel revealed a broad spectrum of antitumour activity against various tumours including lung cancer cell lines. Embelin isolated from *Embleica ribes* when administered orally to male albino rats revealed significant tumour regression and prolonged the survival time of fibrosarcoma bearing rats. The mode of action of embelin was also evaluated (Chitra *et al.*, 1994). Taxol extracted from the bark of *Taxus brevifolia* has aroused significant excitement because of its promising activity in breast and ovarian cancer (Joyel, 1994). Camptothecin an anticancer and antiviral
alkaloid was reported by Lopez-Meyer et al. (1994) to be present in the young leaves of *Camptothecia accuminata*. Vinorelbine a new semisynthetic *Vinca* alkaloid was evaluated in 30 advanced breast cancer patients. This alkaloid was pretreated to be effective in pretreated advanced breast cancer patients by Brani (1994).

Herbert et al. (1995) isolated verbascoside isolated from the leaves of *Lantana camara* showed antitumour activity. The antitumour activity of verbascoside measured *in vitro* might be due at least in part to the inhibition of protein kinase. Ping et al. (1995) administered the crude alkaloid of *Fritillaria ebeiensis* bulb administered orally at a given dose and reported strong antitumor activity by inhibiting the growth of solid type of hepatoma in mice. Twenty five Amaryllidacean alkaloids were reported by Weniger et al. (1995). These alkaloids showed cytotoxic activity against fibroblastic murine non tumoral cell lines.

The antitumour activity of plumbagin isolated from *Plumbago zeylanica* was evaluated by Kavimani et al. (1996) against Dalton's ascitic lymphoma in Swiss albino mice. The tumour cell growth was found to be inhibited and enhancement of mean survival time was also noted. Drupangtonin, an alkaloid extracted from *Cephalotaxus harringtonia*, was reported by Takano et al. (1996) to be strongly inhibiting the growth of P-388 leukemia cells. The alcoholic extract of dried roots of *Withania somnifera* yielded withaferin A which was reported to be showing significant antitumour activity against chinese hamster cells by Uma Devi (1996).
Echitamine chloride, an indole alkaloid, extracted from the bark of *Alstonia boonei* was reported by Saraswathi *et al.* (1998) to have antitumour activity.

**Acetogenin**

Acetogenins extracted from Annonaceae members show cytotoxicity in different tumour cell lines.

Fang (1993) reviewed 61 compounds of Annonaceous acetogenins, an exciting new class of bio-active natural products, whose antitumour, pesticidal and other bioactivities were reported to be due to the inhibition of electron transport in mitochondria. From the bark of *Annona bulbata*, acetogenins were isolated by Gu *et al.* (1993) and they possess potent activities in the brine shrimp lethality test and also against human solid tumour cells in culture. Zhao *et al.* (1993) extracted from the stem bark of *Asimina triloba*, Annonaceous acetogenins which exhibited potent cytotoxicities against human lung and breast carcinoma. Colman-Saizarbitoria *et al.* (1994) reported two new bio-active monodetrohydrofuran Annonaceous acetogenins from the bark of *Xylopia aromaticca*. Bio-active Annonaceous acetogenins and asimilobine isolated from the seeds of *Ascimina triloba* by Woo *et al.* (1995) showed anticytotoxicity against human solid tumour cell lines. From the seeds of *Annona muricata*, Rieser *et al.* (1996) extracted acetogenins which showed cytotoxicity of human solid tumour cell lines.
Coumarin

A few literatures are available on the anticancer activity of coumarin. From the root of *Peucedanum praeruptorum*, Nishino *et al.* (1987) isolated coumarin which showed antitumour promoting action in cultured cells. Mechanism based anticancer bioassay of twelve coumarins isolated form the plants of Rutaceae was reported by Gunatilaka *et al.* (1994). Detailed investigation of *Hemidesmus indicus* by Mandel *et al.* (1995) has culminated in the isolation of three new and novel coumarinolignoids which were anticancerous.

Curcumin

Soudamani and Kuttan (1988) isolated curcumin from *Curcuma* spp. and found to have cytotoxic and tumor reducing activity in various cell lines. Curcumin from *Curcuma longa* a major constituent was proved by Nishio *et al.* (1992) to have antitumour promoting activity in mouse skin carcinoma. Three curcuminoids from *Curcuma longa* were isolated and compared for their cytotoxic and tumour reducing activities by Anto (1994).

Oils

Garlic oil may blockade cells to progress from G1 phase to S phase and result in the accumulation of cells in G1 phase and directly inhibit the synthesis of DNA and the cell cycle (Xie *et al.*, 1992). Oils extracted from *Cymbopogon citratus* and *Alpinia galanga* showed chemopreventive activities (Zheng *et al.*, 1993). The essential oil obtained from *Cymbopogon citratus* and its isolated principle citral.
was tested by Dubey et al. (1997) for cytotoxicity against P-388 leukemia cells. Dwivedi et al. (1997) investigated the chemopreventive effects of sandalwood oil (5% in acetone, w/v). This oil could be an effective chemopreventive agent against skin cancer. Siegel et al. (1987) reported that fatty acids are effective in prolonging the life span of tumour bearing animals significantly. Zhu et al. (1989) proved the toxic nature of fatty acids to a variety of carcinoma cells. Numata et al. (1994) suggested that the fatty acids alter the rigidity of tumour cell membrane, ultimately causing death.

**Flavonoid**

Flavonoid was screened for its anticancerous activity frequently by many workers. Prenylflavonoids, prenyl-2arylbenzofurans, prenylflavans and prenyl diphenyl propanes were isolated from *Morus* spp. and *Broussonetia* spp. by Yoshizawa et al. (1987). Some of these compounds inhibited the tumor promoting activity of teleocidin in skin carcinogenesis in mice initiated by DMBA, VSP and DU. Two new prenylated flavonoids 5,7,3,4-tertahydroxy-6,8-diphenylisoflavone (III), flemichin D (IV) isolated from the root of *Flemingia philippinensis* by Chen et al. (1990). These flavonoids showed significant cytotoxic activities against P-388 cell culture. The flavonolignans isolated by Sharma and Hall (1991) form the seeds of *Hydnocarpus wightiana* showed potent antineoplastic activity in mice *in vivo*. An increase in survival days in tumour bearing mice on administration of apigenin, a flavonoid was reported by Hidehiko et al. (1991). The inhibition of mammary tumorigenesis by isoflavones in soya bean containing diets in animal models for breast cancer was reported by Coward (1993).
Chemical constitution of four species of *Verbascum* growing in Europe were investigated and individual compounds of flavonoids, saponins and phenyl propanoids were obtained and the influence of five isolated compounds on a spontaneous proliferation of rat spleen lymphocytes were studied by Klimeck *et al.* (1994). Pomilio *et al.* (1994) extracted 5,6,7-tri substituted flavones from *Gomphrena martiana* decreased the tumour growth of two murine tumour cell lines, sarcoma-180 and Ehrlich's carcinoma. Ryu *et al.* (1994) reported the antitumour property of two common flavonoids, apigenin and luteolin, in human tumor cell lines. Cytotoxicity of flavonoids and sesquiterpene lactones from *Arnica* spp. against the GLC 4 and the COLO 320 cell lines were studied by Woerdenbag *et al.* (1994). Cytotoxic and antimitotic flavonols were isolated from *Polanisia dodecandra* by Shi, *et al.* (1995) and found to be effective against small cell and non small cell lung cancer and leukemia cell lines. Pettit *et al.* (1996) isolated Gallic acid ethylgalate and flavone luteoline from the bark, stem and leaves of *Terminalia arjuna*. These chemicals showed cancer cell growth inhibitory activity. Ryu *et al.* (1997) isolated fifteen flavonoids from the roots of *Sophora flavescens*. These flavonoids were responsible for cytotoxicity against five kinds of cultured tumour cell lines non small cell lung, ovary, skin, central nerve system and colon were evaluated. Inhibition of human fibrosarcoma cell invasion by an extracted of *Solanum melongena* was reported by Nagase *et al.* (1998). The effective component of the plant extract was delphinidin, a flavonoid pigment. Polyphenolic compounds derived from tea catechins were examined for apoptosis-inducing activity in human histiolytic lymphoma U937 cells. These apoptosis-inducible compounds may be useful as a cancer chemopreventive and chemotherapeutic agent (Saeki *et al.*, 1999).
Glycosides

Bark of *Magnolia abovata* on extraction with methanol yielded phenyl ethyl glycoside which are used as antitumour agents (Takashi *et al.*, 1988). Toshiaki and Akira (1989) isolated fructofuranosides from *Nicotiana glutinosa* which showed antitumour activities against Sarcoma-180 in mice. Chemical components from vegetables were isolated and their phytochemical functions against preventing stomach cancer and cancer causing hormones were studied by Madhava Kutty (1994). Deepak (1994) isolated polyoxy steroidal glycosides from some members of Asclepiadaceae and reported the presence of strong biological activities like anticancer and cardiovascular activities.

Lectins

Lectin from the latex of *Synadenium grantii* is non-mitogenic, non-toxic and inhibits protein synthesis in Yoshida ascities sarcoma cells. The effect of two plant lectins wheat germ agglutinin and Soyabean agglutinin on the growth and progression of Dalton's lymphoma - a murine ascitic tumour has been examined. Both the lectins were found to posses antitumour action, which could arrest tumour cell growth, delay progression of tumour and improve host survival. Wheat germ agglutinin was found to inhibit tumour cell DNA synthesis (Ganguly and Das, 1991). Abdullaev *et al.* (1997) reviewed the biological activity of plant lectins as well as the effect of plant lectins on normal and malignant cells and included the antitumour properties *in vivo* and *in vitro*. They also discussed the possible mechanisms of the antitumour effect of plant lectins.
Lignans

Neolignans isolated from the bark of *Magnolia officinalis* by Konoshima et al. (1991) exhibited remarkable inhibitory effect on mouse skin tumour promotion in an *in vivo* two stage carcinogenesis test. Various cyclolignans isolated by Felliciano et al. (1993) from *Juniperus sabina* leaves showed antineoplastic activity against P-388 murine leukemia. Novilo et al. (1993) isolated cytotoxic lignans from the Mexican medicinal plant *Hyptis verticillata* and studied their cytotoxic activity against human cancer cell lines. Four lignans isolated by Wickramaratne et al. (1995) from the stem bark of *Bursera permollis* were found to be cytotoxic when evaluated against human cancer cell lines.

Carbohydrates

Antitumour and immunopotentiating activities of polysaccharides from *Trichosanthes* rhizome was reported by Chung et al. (1990). From the seeds of *Momordica charantia* Zhu et al. (1990) isolated Momorcharaside A which exhibited inhibition of DNA and RNA synthesis in S 180 tumour cells in preliminary pharmacological studies. Wang et al. (1993) reported antitumour polysaccharide from the roots of *Acanthopanax obovatus* not only enhanced the synthesis of DNA and protein but also promoted the mitogenic responses of spleen cells. Tomshich et al. (1997) extracted biologically active polysaccharides from medicinal plants of the Far East and concluded that the polysaccharides obtained exhibited immunostimulating and antitumour against transplanted tumours in mice. An acidic
polysaccharide from *Panax ginseng* found to inhibit autochthonous lung tumours in mice (Kim KiHwan, 1998).

**Proteins**

The pharmacological studies of Imanishi *et al.* (1981) revealed inhibition of the growth of fibrosarcoma by the Aloctin-A a glycoprotein isolated from *Aloe arborescens*.

**Saponins**

From the roots of *Bupleurum wenchuanense* saikosaponins were isolated and their cytotoxic activity against the P-388 cell lines were studied by Luo *et al.* (1993). Triterpenoid saponins from *Solidago virgaurea, Heteropappus altaicus, H. biennis and Helianthus annus* were isolated by Bader *et al.* (1994). *In vitro* investigation of the cytotoxic behaviour against tumour cells were also reported. Nakamura *et al.* (1994) reported the antitumour promoter activity of steroidal saponins from the bulbs of *Lilium*. Steroidal saponins isolated from underground parts of *Hosta longipis* by Mimaki *et al.* (1996) showed antitumour property in HeLa cells.

**Terpenes**

Edgington *et al.* (1991) showed the antineoplastic activity of ethanol extract of dried bark of *Taxus baccata*. The active constituent was found to be the diterpene and taxol. Diterpenoids and taxane alkaloids isolated from the bark of *Taxus yunnanensis* by Vhen *et al.* (1991) increased the life survival of P-388 leukemia bearing mice to 80 percent. Bioassay directed chemical investigation of the stem
bark of *Polyalthia longifolia* has led to a novel clerodon diterpene which strongly inhibited the growth of crown gall tumours on potato discs (Zhao *et al.*, 1991). Polacandrin a triterpene was extracted from *Polanisia dodecandra* by Shi *et al.* (1992) showed potent cytotoxicities against KB, P-388 tumour cells. Triterpenes were extracted from *Syzygium aromaticum* by Umchara *et al.* (1992) and their differentiation inducing activities were observed. Zheng *et al.* (1992) isolated sesquiterpenes from *Eugenia caryophyllata* and these sesquiterpenes showed promise as potential anticarcinogenic agents. They also found the ability of natural anticarcinogens to induce detoxifying enzymes and correlated with their activity in the inhibition of chemical carcinogens. From the stem bark of *Annona senegalensis* Fatope *et al.* (1996) isolated ent-kaurene diterpenoids which exhibited significant cytotoxicity for breast cancer and prostrate cancer. Wang *et al.* (1996) isolated two sesquiterpene lactones, ergoloid and bigelovin, from *Inula hupehensis* and *Helianthus aquaticus*. Both the lactones were effective even in the vinblastine resistant cell lines. From the stem and root barks of *Acanthopanax divaricatus*, Yook *et al.* (1996) extracted diterpenoid which showed anticancer activity. Immunomodulatory and antitumoral effects of triterpenoid saponins from *Solidago virgaurea* were studied by Plohmann *et al.* (1997). Methylene chloride extract of *Picrolemma huberi* stem bark and there from isolated triterpenoid showed significant *in vitro* antitumour activity against several cell lines such as KB, P-388, L-1210, PC-3 and in solid experimental tumours Sarcoma-180 and Ehrlich carcinoma (Rodrigues *et al.*, 1997). Two new triterpenoid saponins named asterlingulatosides A and B were isolated form the whole plant of *Aster lingulatus*. These compounds showed inhibitory
activity on DNA synthesis in human leukemia HL-60 cells (Shao et al., 1997). Three cytotoxic norditerpenoid dilactones were isolated from the alcoholic extracts of bark of *Podocarpus prudieanus* Wang et al. (1997). These compounds exhibited cytotoxicity in 9 PS mouse lymphocytic leukemia and in lung carcinoma breast adenocarcinoma, colon adenocarcinoma.

**Plant extracts**

Charlson (1980) tested plant extract on variety of experimental tumour test systems. *Raphionacme hirsuta* (bulb), *Cheilanthes contracta* (rhizome) showed antitumour activity in some rodent test systems. *Haemanthus natalensis* (leaves, stems and bulbs) and *Urginea capitata* (leaves and bulbs) exhibited significant cytotoxicity in KB cell culture test system. Extract of *Brunsbigia ratulosa* (leaves and bulbs) increased the life span of P-388 leukaemic mice. Extract of *Amaryllis belladonna* also produced significant antitumour activity in P-388 lymphocytic leukemia test systems. Pettit et al. (1980) reported the antineoplastic activity of the ethanol and water extract of aerial parts of *Senecio fendleri*. Ghosh et al. (1981) prepared SKX, a coded Siddha drug from *Semicarpus anacardium* nuts which was effective when administered in cancer patients. No toxic effects were observed in rats. Experimental mice were injected intraperitoneally with a traditional Chinese medicine compound (TCMC) containing water extracts of *Solanum nigrum, Solanum lyrati, Duchesnea indica, Curcuma* spp., *Angelica sinensis, Salvia miltiorrhiza* along with toad tincture Wang et al. (1982). The results indicated that the combined use of TCMC and toad tincture produces a more
marked effect on tumour cell growth than either TCMC or the toad tincture alone. Kuttan et al. (1990) prepared iscador from *Viscum album*. It was found to be cytotoxic to Dalton's lymphoma ascites cells. The mechanism of action was different from other chemotherapeutic drugs. But not cytotoxic to lymphocytes. Arisawa et al. (1992) isolated a cytotoxic principle from *Crysosplenium grayanum* and tested against various human cancer cell lines *in vitro*. Habib-Ur-Rehman et al. (1992) reported the anticancer activity of petroleum, benzene, chloroform and methanol extracts of *Arisaema jacquemontii*. The effect of extract of *Gymnostemma pentaphylla* on human rectal adeno carcinoma cell lines were studied Jin Mei et al. (1992) *in vitro*. The extract decreased the DNA synthesis in a dose dependent manner. Wang Yuzhen et al. (1992) reported anticancer component in the root and stem plus leaves of *Euphorbia fischeriana* which showed recovery about 98.2 percent. Xu et al. (1992) demonstrated the killing effect of ethyl acetate extract of *Tripterygium wilfordii* on human HL 60 cells. Treatment with *Viscum album* extract reduces lymphocytopenia and hence used along with chemotherapy and radiation therapy (Kuttan and Kuttan, 1993). Yew (*Taxus*) has been used in herbal medicine. The plant is now considered to be of major medical importance with one extract approved for its antineoplastic activity. Its monograph is also given by Liberti (1993). Immuno stimulating effect of *Loranthus* extract was investigated by Mary et al. (1993). Yun (1993) reported that the ethanol insoluble fraction of *Panax ginseng* showed antitumour effects as an immunomodulator.

Suresh and Vasudevan (1994) demonstrated aqueous extract of *Phyllanthus emblica* on oral administration has been found to enhance natural killer cell activity
and antibody dependent cellular cytotoxicity in syngeneric BALB/C mice bearing Dalton's lymphoma ascites tumour. Umadevi et al. (1994) reported the intraperitoneal injection of extract from Plumbago rosea increased the mean survival time in mice. Bacoba monnieri plant extracts has been reported to have anticancer property tested with Sarcoma-180 cell culture. The site of action of the drug has been suggested to be at DNA replication stage (Elangovan et al., 1994). Babu et al. (1995) reported that the crude extract and partly purified fractions of Centella asiatica inhibited Erlich ascites tumor cells and Dalton's lymphoma ascites tumor cells. The effects of acid hydrolysis product of Panax ginseng and methanol extract of Euphorbia humifusa on the growth of human brain tumour cells were evaluated by Cha et al. (1996). These plant extracts induced cytotoxicity in a dose dependent manner. Fujioka et al. (1996) showed the cytotoxic effect of methanolic extract of Actinostemma lobatum, the traditionally used herb in China. Ethanol extract of Citrus aurantium was found to be active by the antitumour bioassay in vivo and in vitro. It showed cell growth inhibitory effect against L-1210 and K-562 in vitro (Satoh et al., 1996). Kim Daeloong et al. (1997) studied the potential preventive effects of Chelidonium majis herb extract on glandular stomach tumour development in rats. It was concluded that the extract inhibits the glandular stomach carcinogenesis in rats. Mohanan and Devi (1997) reported the effect of extract of Solanum trilobatum on peritoneal tumours induced by Dalton's Lymphoma Ascites, Ehrlich ascites and Vero cells. The extract significantly inhibited the development of peritoneal tumours induced by DLA and EA cells. Anfisini et al. (1998) studied the effect of aqueous extract of Larrea divaricata and concluded that it has an in vivo antitumour activity.
with the intratumour route being most effective in induction of tumour regression. Kim Young Sook et al. (1998) studied the biochemical and pharmacological effects of ginsenosides \( \text{Rh}_3 \) and \( \text{Rh}_4 \) isolated from *Panax ginseng*. \( \text{G-Rh}_3 \) induced differentiation of HL-60 cells and arrested the cell cycle at \( \text{G}_1 \) phase. Yasukawa et al. (1998) showed that the tumour promotion in mouse skin was inhibited by methanol extract of *Prunus jamasakur*. The active component present in the extract was octacosyl ferulate.

**Root Extract**

Wu et al. (1991) demonstrated antileukemic activity of the root extract of *Euphorbia kansui*, a widely used Chinese folk medicine for the treatment of cancer, against the P-388 lymphocytic leukemia in mice. From the roots of *Panax ginseng* mitomycin was isolated by Tong et al. (1992) and its antitumor activity against Ehrlich ascites carcinoma was investigated *in vitro*. Chloroform extract of the root of *Peucetanum japonicum* showed significant activity against P-388 lymphocytic leukemia cells (Duh et al., 1993). The crude root extract and a purified compound withaferin A from *Withania* produced cytotoxic effect and inhibited tumour growth in transplanted mouse tumors *in vivo* and a mammalian cell lines *in vitro* (Umadevi et al., 1993). Sur and Ganguly (1994) evaluated the antitumour effect of tea (*Camellia sinensis*) root extract against Ehrlich Ascites Carcinoma in balb-C mice. They confirmed significant increase of survival time of tumour bearing mice treated with tea root extract. The root extract of *Hygrophila spinosa* significantly increased the life span in Dalton's lymphoma treated mice. The drug
which is low toxic can be used as anticancer drug (Maiti et al., 1995). Muanza et al. (1995) studied the cytotoxicity of different plant extract. The methanol extract from the root bark of *Hymenocardia acida*, stem bark of *Mangifera indica* and the leaves of *Sida rhombifolia* exhibited cytotoxic activity against 60 human cell lines tested. Mazumdar et al. (1997) reported the petroleum ether extract from *Hygrophila spinosa* roots exhibited antitumour activity in mice with Ehrlich ascites carcinoma and sarcoma-180. The extract inhibited the rapid increase of body weight of tumour bearing mice. The antitumour effect of *Camellia sinensis* root extract was evaluated against a 3-methylcholantherene induced solid tumour model in ICR mice by Chaudhuri et al. (1998). The extract exhibited tumour weight and the tumours were non-necrotic.

**Stem extract**

The antileukaemic activity of some stilbenes from the bark of *Picia abies* was studied by Mannila and Talvitie (1992). Lenaz et al. (1993) studied the crude extract of the bark of *Taxus brevifolia* and showed the cytotoxic activity in ovarian, breast and lung cancer in clinical trials. Extracts from the bulbs of *Hymenocallis litteralis* showed antineoplastic and cell growth inhibition in human tumour cell lines (Pettit et al., 1993). Houghton (1994) studied the activity of extract of the stem bark and fruits of *Kingelia pinnata* against melanoma and renal carcinoma cell lines. Rabi et al. (1994) reported cytotoxicity of ethanol extract of *Amoora rohituka* stem bark against NCF 7 cell lines derived from human mammary adenocarcinoma. Lee et al. (1995) isolated phenanthrenes and denbinobin from the aerial
parts of *Dendrobium nobile* and these substances were found to be cytotoxic against human lung carcinoma and adeno carcinoma. Ethanolic extract of bark of *Amoora rohituka* yielded prieurianin limonoid showed significant cytotoxic activity against experimental mammary tumours (Prasad *et al.*, 1995). Rabi and Gupta (1995) showed that the antitumour activity of ethyl acetate extract derived from stem bark of *Amoora rohituka* on mice inoculated with Dalton's lymphoma ascites cells which prolonged the median survival time of the animals.

Leaf extract


Flower extract

Mukherjee (1993) reported the antitumour effects of methanolic flower extract of *Parthenium hysterophorous* in the host mice bearing transplantable lymphocytic leukemia.

Fruit extract

Yu Liping *et al.* (1992) reported the inhibitory effect of juice prepared from the fruit of *Hippophae rhamnoides* on the growth of S-180 tumour in mice. Fruit extracts of four Egyptian *Ficus* species exhibited antitumour activity in the
potato disc bio-assay (Mousa et al., 1994). Balachandran et al. (1997) studied the effect of Semecarpus anacardium nut extract on hepatocellular carcinoma bearing Wistar rats. Treatment with extract reversed conditions to near normal levels. The reduction of aflatoxin B₁ induced hepatotoxicity provides in vivo evidence for S. anacardium to be regarded as a potent and valuable chemotherapeutic agent against hepatocarcinoma.

**Seed extract**

Increase in the life span up to 70 percent of rats by the seed extract of Cannabis sativa was reported by Iwavo et al. (1992). Hyun et al. (1995) reported that the methanol extract from the seed of Lepidium apetalum exhibited cytotoxicity against three human tumour cell lines. Premalatha and Sachidanandam (1999) reported anticancer activity of Semicarpus anacardium nut extract, a flavonoid containing drug. This activity might be explained by its strong antioxidant capacity and capability to induce the in vivo antioxidant system.

**Other biological activities of flavonoids**

Apart from anticancer activity, flavonoids show various other biological activities. Researchers have reported the use of flavonoids in curing various ailments.

Antifungal activity of flavonoids were reported by Roy et al. (1995), Gafner et al. (1996) and Swiader et al. (1996).
The antibacterial activity of flavonoids were reported by Ratsimamangauverg et al. (1994), Rocha et al. (1995) and Hassan and Ahmad (1996).

Samejima et al. (1995) and Calomme et al. (1996) reported the anti-mutagenic activity of flavonoids. The antiviral activity of flavonoids were reported by Perry and Foster (1994), Saxena et al. (1995) and Malhotra et al. (1996).

Anti-inflammatory activity of flavonoids was reported by del carmen Kim et al. (1994), Williams et al. (1995) and Silvan et al. (1996).

Smati et al. (1993) and Ragunathan et al. (1994) reported the antidiabetic activity of flavonoids.

Jung et al. (1996) reported hypatoprotective role of flavonoids.

Antialcer activity was reported by Alarcon de la Lastra et al. (1994) and Ruiz et al. (1996).

Vasodialatory activity of flavonoid was reported by de Roja et al. (1996). The inhibition of platelet aggregation by flavonoid was reported by Lin et al. (1996).