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Anticancer Activity of Plant Derived Compounds: A Literature Based Review

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Abstract

Since the dawn of time, plants have been employed as therapeutic agents. The high expense and severe side effects of conventional chemotherapy have lowered public acceptance and fueled the hunt for alternatives. Alternative therapy methods such as phytochemicals, have become more widely available and cost-effective. Loss of mitochondrial membrane potential, release of cytochrome-c, and other processes and pathways are all involved in the anticancer activity of plant-derived therapeutic substances. Anti-apoptotic proteins are down regulated, while pro-apoptotic proteins are up-regulated. Caspase, Fas, FADD, p53, and c-Jun signaling pathways are activated. Akt signaling pathway is inhibited; phosphorylation of ERK, P13K, Raf, survivin gene, STAT 3, and NF-kB is inhibited. *In-vitro* testing of skin cancer cell lines models allows researchers to discover the mechanisms of action of chemicals derived from plants against a variety of skin malignancies. As a result, the goal of this study is to provide an overview of plant-derived anti-cancer chemicals that have been found to have promising anti-carcinogenic activities.

Keywords: Plant derived; Anti-carcinogenic; Cancer; Phytochemicals; Phytoconstituents

Introduction

Cancer is a term used to describe a collection of diseases characterized by abnormal cell proliferation with the ability to infiltrate or spread to other sections of the body [1]. It's a compilation of more than a hundred distinct diseases. A lump, irregular bleeding, persistent cough, unexplained weight loss, and a change in bowel motions are the most frequent cancer signs and symptoms [1]. Annual cancer cases increased to 23.6 million individuals in 2019 and 10 million fatalities worldwide, showing rises of 26% and 21% over the preceding decade, respectively [2]. It is the second leading cause of death, accounting for one out of every six fatalities worldwide. The alarming and frightening rise in the number of people dying from various types of skin cancer has prompted researchers to look for effective anticancer drugs with fewer side effects to battle the illness [3]. Because the ultimate goal of anticancer therapy is to find selective chemotherapeutic drugs that exclusively kill or render malignant tumor cells harmless while having no effect on healthy cells. However, contemporary oncology chemotherapeutic drugs are, sadly, harmful to normal cells. As a result, novel, more effective and nontoxic substances derived from natural sources, such as phytochemicals with anticancer properties, are urgently needed. Since the dawn of time, plants have been employed as therapeutic agents. Plant-derived therapeutic compounds have a number of advantages in terms of accessibility [4]. They're being used to treat and prevent a variety of deadly diseases, including AIDS, hepatitis, and cancer. As a result, there is a rise in research into novel phytochemicals for cancer prevention and treatment [5]. Alternative therapy options, such as phytochemicals, have emerged as a result of their accessibility, low toxicity, and cost efficiency [6].

Plant Derived Compounds

Maplexins C-D and maplexins E-1

The red maple (*A. rubrum* L.) species is local to eastern North America that are used for medicinal purposes by Native Americans [7]. Maplerins A-I are a group of structurally related gallotannins that are isolated from the red maple species [8,9]. Gonzalez-Sarrias et al. [10] provide evidence that Maplexins A-I provide anticancer activity against human tumorigenic (colon. HCT-116; breast, MCF-7) and non-tumorigenic cell lines. It contained three (maplexins E-I) or two (maplexins C-D) galloyl derivatives each compound show effect to inhibit cancer cell growth while those with only one galloyl group (maplexins A-B). Moreover, maplexins C-D had greater antiproliferative effects than maplixins E-I (IC50=59.8-67.9 and 95.5-108.5 µM *vs.* 73.7-165.2 and 115.5-182.5 µM against

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HCT-116 and MCF-7 cells). On the other hand cancer cells were up to 2.5 fold more sensitive to the maplexins than normal cells. In further studies, maplexins C-D (at 75 μM concentrations) induced apoptosis and arrested cell cycle (in the S-phase) of the cancer cells.

Cuphiin D1

Cuphiin D1 is recent macrocyclic hydrolysable tannin that was isolated from *Cuphea hyssopifolia* it shows antitumor mobility both *in vitro* and *in vivo* [11]. Wang et al. [12] suggest that cuphiin D1 induced antitumor effect on human promyelocytic leukemia (HL-60) cells. It showed cytotoxicity in HL-60 cells and the IC50 was 16 μM after 36 h treatment. At the presence of apoptotic cells with low DNA content, a decrease of cell population at G2/M phase and a concomitant increase of cell population at G1 phase. Cuphiin D1 also sake DNA fragmentation and suppress Bcl-2 expression in the HL-60 cells. Inhibition of Bcl-2 expression in HL-60 might account for the mechanism of cuphiin D1 induced apoptosis.

Ellagitannin

Ellagitannin (ETs) are known as hydrolysable tannins which are found from strawberries, raspberries, walnuts, pomegranate, oak-aged red wine etc. [13]. Larrosa et al. [14] provide evidence that ETs and their hydrolysis product Ellagic Acid (EA) induce apoptosis in tumour cells. ETs are not absorbed *in vivo* but it can reach into the colon and have the ability to release EA that is metabolized by the human microflora. ET [pomegranate punicalagin (PUNI)] and EA aggravated the same effects on Caco-2 cells: Down regulation of cyclins A and B1 and upregulation of cyclin E, cell cycle arrest in S phase, induction of apoptosis by intrinsic pathway (FAS-independent, caspase 8-independent) through bcl-XL down regulation with mitochondrial release of cytochrome c into the cytosol, activation of initiator caspase 9 and effect or caspase 3. EA and PUNI (30 and 100A mol/L) both decrease the proliferation of normal colon CCD-112CoN cells from the fourth day of treatment. EA showed apoptosis *via* mitochondrial pathway in colon cancer Caco-2 cells but did not show their activity in normal colon cells.

1-O-galloyl castalagin and casuarinin

Eugenia jambos L. (Myrtaceae) is an herb of Asian folk medicine that shows antipyretic and anti-inflammatory activity [15,16]. Yang et al. [17] provide evidence that 70% acetone extract of *Eugenia jambos* L. given highest cytotoxic activity to Human Leukemia cells (HL-60). Hydrolysable tannin 1-O-galloyl castalagin and casuarinin were isolated from 70% acetone extract. All of this significantly inhibited human promyelocytic leukemia cell line HL-60 and gave less cytotoxicity to human adenocarcinoma cell line SK-HEP-1 and normal cell lines of human lymphocytes and changed liver cells. These compounds were exhibited in the dose dependent manner in HL-60 cells and the IC50 were 10.8 and 12.5 nM respectively. At the presence of apoptotic cells with low DNA content, a decrease of cell population at G2/M phase and a concurrent increase of cell population at G1 phase. The cytotoxic mechanism of both antitumor principle constituents might be the induction of apoptosis in HL-60 cells.

Gallotannin

Gallotannin was an extract of Red Alder (RA) bark of *Alnus rubra* bong that are the tree mainly found abundantly in the Pacific Northwest coastal forests of North America [18,19]. Gali-Muhtasib et al. [20] suggest that the extract of gallotannin that was found from Red Alder (RA) bark used to inhibit 1,2-Dimethylhydrazine (DMH) induced colonic Aberrant Crypt Foci (ACF) and tumors in Balb/c mice. It has the ability to inhibit the proliferation and to induce apoptosis in the human colon cancer cell line (T-84). At 10 μg/ml, GT induced apoptosis in T-84 cells as determined by the Hoechst DNA staining technique.

Punicalagin

Pomegranate is a fruits that are widely consumed as a juice found from *Punica granatum* L [21]. Punicalagin a standardized total pomegranate tannin extract and pomegranate juice were evaluated for *in vitro* apoptotic activities [22]. Seeram et al. [23] suggest that the anti-proliferative assays targeted no metastatic HT-29 colon cancer cell lines, SW620 metastatic colon cancer cells, Metastatic prostate cancer cells and Oral cancer cells. Punicalagin was evaluated for anti-proliferative activity at 12.5 μg/ml to 100 μg/ml on human oral (KB, CAL27), colon (HT-29, HCT116, SW480, SW620) and prostrate (RWPE-1, 22Rv1) tumor cells. Apoptotic effects were evaluated against the HT-29 and HCT116 colon cancer cell lines. The juice of Pomegranate showed greatest anti-proliferative activity against all cell lines by inhibiting proliferation from 30% to 100%.

Corilagin

Phyllanthus niruri L. (*P. niruri* L.) from Euphorbiaceae family and native in India. Corilagin extracted from *Phyllanthus niruri* L. [24]. Jia et al. [24] provide evidence that corilagin acts as a natural, effective therapeutic agent that shows activity against the growth of ovarian cancer cells via targeted action against the TGF-β/AKT/ERK/Smad signaling pathways. It inhibited the growth of the ovarian cancer cell lines SKOV3ip and Hey, with IC50 values of approximately 160 μM and induced cell arrest at the G2/M stage and enhanced apoptosis in ovarian cancer cells.

Tannic acid

Doxorubicin (DXR) mainly obtained from the source of soil actinomycetes *Streptococcus peucetius* that is used for the treatment of different types solid tumors such as those arising in the breast, bile ducts, endometrial tissue, esophagus and liver, osteosarcomas, soft tissue sarcomas and non-Hodgkin's lymphoma [25]. Tikoo et al. [26] suggest that tannic acid ameliorates doxorubicin- induced cardiotoxicity and potentiates its anticancer activity both *in vitro* (H9c2 and MDA-MB-231 cells) also *in vivo* model of DMBA-induced mammary tumor animals. Tannic acid prevents activation of PARP-1, reduces Bax and increases Bcl-2 expression in H9c2 cells; it also reduces the cell viability of MDA-MB-231 breast cancer cells, increases p53 expression in mammary tumors and shows maximum tumor volume reduction.

Oenothein B, woodfordin C and woodfordin D

Sakagami et al. [27] provide evidence that macrocyclic ellagitannin oligomers, such as oenothein B, woodfordin C and woodfordin D showed the greatest cytotoxic activity. These compounds [Oenothein B (CCSO=0.060 μm), woodfordin C (CCSO=0.026 mm), woodfordin D (CCSO=0.026 μm) [induced apoptotic cell death characterized by DNA fragmentation (as demonstrated by the TUNEL method) and cleavage of cytokeratin 18 by activated caspase (s) (as demonstrated by M30 monocolonal antibody).

8-cetylberberine

Berberine (BBR) is an isoquinoline alkaloid that is extracted from mainly two plants such as *Coptis chinensis* and *Hydrastis canadensis*. It has massive anti-tumor potential *in vitro* and *in vivo* on a sort of tumor cell lines including breast [28], colorectal [29],

lung [30], hepatocellular [31], lymphoma [32] and pancreatic [33]. 8-cetylberberine (HBBR) is a new Berberine (BBR) derivative which have anti-tumor efficacy. Xiao et al. [34] provide evidence that HBBR induce G1-phase cycle arrest by interfering with the expression of Cyclins D1 and Cyclin E1, increased apoptosis by inducing caspase pathway and probably inhibited the P13K/AKt pathway in A549 cells. Oral administration of HBBR at a dose of 10 mg/kg could significantly inhibit tumor growth which is stronger than the 120 mg/kg dose of BBR treatment.

Evodiamine

Evodiamine have anti-angiogenesis [35], anti-tumor growth [36,37], anti-invasive and metastatic activities [38-40], up-regulating apoptosis [40], anti-allergic effects [41], and anti-inflammatory effects [42]. Wang et al. [43] says that evodiamine extracted from the Chinese herb, Evodiae fructus, it has anticancer effects in estrogen dependent and independent human breast cancer cells, MCF-7 and MDA-MB-231cells. It inhibits the proliferation of MCF-7 and MDA-MB-231 cells in a concentration *via* up regulation of caspase 7 activation, PARP cleavage (Bik and Bax expression). The expression of ER α and β in protein and mRNA levels was down regulated by evodiamine.

Sanguinarine

Sanguinarine [13-methyl(1,3) benzodioxolo(5,6-c)-1,3-dioxolo(4,5) phenanthridinium] which obtain from the root of *Sanguinaria canadensis* and other poppy-fumaria species, that is most widely-used benzophenanthridine alkaloid [44]. Xu et al. [45] suggest that sanguinarine has been shown anticancer activity *in vitro* and *in vivo*. *Sanguinarine* caused a dose dependent inhibition of growth in HeLa and Siha human cervical cancer cells, concentration at 2.43 μmol/l (IC50) in HeLa cells and 3.07 μmol/l in SiHa cells. It significantly increased the sub-G1 population from 1.7% to 59.7% in HeLa cells and from 1.7% to 41.7% in SiHa cells. It caused a dose dependent decrease in Bcl-2 and NF-κB protein expression and a significant increase in Bax protein expression. It is an effective anticancer drug candidate that inhibits the growth of cervical cancer cells with the induction of apoptosis.

Tetrandrine (TET)

Tetrandrine is a natural product that is isolated from the Chinese herb *Stephania tetrandra* S. Moore [46]. It has been reported to have anti-proliferation and apoptosis-inducing activity in various malignant tumor cells [47]. Tian et al. [48] suggest that using CCK-8 assay and flow cytometry, TET inhibited proliferation, induced apoptosis and arrested the cell cycle of the 143B cells. Its effects mediated by the upregulation of Phosphatase and Tensin homolog (PTEN). Using a xenograft tumor model of human Osteosarcoma (OS), tetrandrine was found to inhibit tumor growth *in vivo*. According to the CCK-8 assay result, concentration used as 1, 2 and 4 μM of TET to perform the experiments.

Liriodenine

Liriodenine is an isoquinoline alkaloid that is mainly isolated from natural plant species of many genera [49]. It has potent cytotoxic effects that show effect in various types of human cancer cells [50]. Chang et al. [51] suggest that Liriodenine suppressed proliferation of A549 human lung adenocarcinoma cells in dose and time dependent manner. Liriodenine treatment concentration at 20 μM and 50 μM cells caused apoptosis in 67% and 80% of cells, respectively. According to cytometric analysis liriodenine blocked cell cycle progression at the G2/M phase. Induction of G2/M arrest by liriodenine was accompanied by reduction of G1 cyclin (D1) and accumulation of G2 cyclin (B1). *In vitro* kinase activity assay demonstrated that the enzymatic activity of the cyclin B1/cyclin dependent kinase 1 complex was reduced in liriodenine treated cells.

Brucine

Brucine is a traditional medicinal herb that is extracted from the seeds of *Strychnos nux-vomica* L. (Loganiaceae) [52]. It has the ability to exhibit antitumor activity in a variety of cancer models [53]. Xu et al. [54] suggest that in a triple negative breast cancer cell line MDA-MB-231, brucine induced a dose dependent inhibitory effect on cell proliferation along with apoptosis induction at higher concentration (1 mM to 2 mM). It could disrupt F-actin cytoskeleton and microtubule structure, thereby impairing hallmarks of aggressive tumors, like migration, invasion and holding a possibility of suppressing vasculogenic mimicery which might be through the down regulation of erythropoietin producing hepatocellular carcinoma-A2 and matrix metallaoproteinase-2 and metalloproteinase-9.

Cathachunine

Catharanthus roseus (L.) G. Don which consists of a range of dimeric indole alkaloids (cathachunine) [55]. These alkaloids have been found to be worth apoptosis inducing activity against tumor cells *in vitro* and *in vivo* mediated by nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB) and c-Jun N-terminal Kinase (JNK) pathways [56,57]. Wang et al. [58] suggest that cathachunine alkaloids were cytotoxic toward human leukemia cells to a greater extent than toward normal human endothelial cells and the anti-proliferation and pro-apoptosis abilities. The altitude of apoptosis by cathachunine ascended through an ROS dependent mitochondria mediated intrinsic pathway rather than an extrinsic pathway and was regulated by the Bcl-2 protein family.

Clausenidin

Clausena excavate Burm. F. is known as a medicinal plant that is used for the treatment of cancer especially in Asia [59,60]. Clausenidin isolated from C. excavate on caspase-8-induced cell death and also show angiogenesis activity in the HepG2 hepatocellular carcinoma cell line [61]. Waziri et al. [61] suggest that the activity of caspase 8 is significant ($p<0.050$ after treatment with 30, 40 and 50 μg/mL of clausenidin. The increased activity of caspase-8 induced by clausenidin proposed that it has a pro-apoptotic effect on cancer cells. This is reflected by the ultra structural analysis of the clausenidin treated HepG2 cells that has been shown morphological evidence of apoptosis. It was found to suppress VEGF expression of the HepG2 cells that provides that it can potentially inhibit tumors.

α-tomatine

Tomatoes (*Solanum lycopersicum*) is the edible, often red berry of the plant that produce the bioactive glycoalkaloid α-tomatine [62]. α-tomatine show effect on CT-26 colon cancer cells *in vitro* and *in vivo* in an intracutaneously transplanted mouse tumor [63,64]. Kim et al. [65] suggest that α-tomatine induces about 50% lysis of the colon cancer cells at 3.5 μM after 24 h of treatment. It induced cell death in CT-26 cancer cells through caspase independent signaling pathways. Intraperitoneally administered α-tomatine (5 mg/kg body weight) also markedly inhibited growth of the tumor using CT-26 cancer cells without causing body organ weight changes.

Myricetin

Myricetin is a member of flavonol that is found from various

berries, herbs and walnuts in the form of glycosides [66,67]. Kim et al. [68] suggest that myricetin induces apoptosis of HCT-15 human colon cancer cells and may prove useful in the development of therapeutic of agents for human colon cancer. It increases the BCL2-associated X protein/B-cell lymphoma 2 ratio, but not cleavage of caspase-3 and 9 and induced the release of apoptosis-inducing factor from mitochondria. It reduced the cell viability of HCT-15 human colon cancer cells at 50 and 100 μM.

Isorhamnetin

Isorhamnetin a flavonoid which is isolated from the source of fruits of herbal medicinal plants such as *Hippophae rhamnoides* L., it exerts anticancer effects as like to other flavonoids [69]. Li et al. [70] suggest that isorhamnetin at five concentrations (0, 10, 20, 40 and 80 μmol/l) suppressed the proliferation of cells from all three types of cell lines, induced cell cycle arrest at the G2/M phase and suppressed cell proliferation by inhabiting the PI3K-Akt-mTOR pathway. It also reduced the phosphorylation levels of Akt (ser474), phosph-p70S6 kinase and phosph-4E-BP1 (t37/46) protein and promoted the expression of cyclin B1 protein. Therefore this compound was stated to be a selective PI3K-AKT-mTOR pathway inhibitor and may be a potent anticancer agent for the treatment of CRC as it restrains the proliferation of CRC cells.

Baicalein

Baicalein is a main compound of *Scutellaria baicalensis* plant which has been widely used to treat disease for thousands of years in China [71]. It inhibits tumor growth in orthotopic human Non-Small Cell Lung Cancer (NSCLS) xenografts *via* targeting Sec/Id1 pathway [72,73]. Zhao et al. [74] suggest that baicalein suppressed the expression of Id1 protein, Epithelial-to-Mesenchymal Transition (EMT) related molecules (N0Cadherin, vimentin) and angiogenesis related protein (VEGF-A) accompanied by upregulation of epithelial markers (such as E- cadherin). Mice in baicalein group were intragastrically administered with baicalein (0.5% CMC-Na solution, 40 mg/kg). In addition phosphorylation of upstream molecular Src was significantly after baicalein treatment.

Naringenin

Naringenin a bioactive compound identified in several fruits that is isolated from citrus displays anti-inflammatory and antitumor effects. Furthermore naringenin mitigates the migration of several human cancer cell types [75]. Chang et al. [76] suggest that a significant alteration in A549 cell proliferation was observed in response to naringenin (0 μM to 300 μM) treatment for 24 h and 48 h. Besides, a dose dependent migration inhibition of A549 in the presence of naringenin was observed by healing and transwell migration assays. It inhibits the migration of lung cancer A549 cells through different mechanisms, including the inhibition of AKT activities and reduction of MMP-2 and MMP-9 activities.

Daidzein

Daidzein is a compound that is belongs to the isoflavones family; this is one of the most commonly ingested and most intensely studied types of phytoestrogen which are found in nuts, fruits, soybeans, and soy-based products [77]. Daidzein used due to its antitumor activity especially in proliferation inhibition [78]. Zheng et al. [79] suggest that daidzein suppress choriocarcinoma cell-lines JAR and JEG-3 growth rate and clone formation in a time and concentration dependent way. Both cells arrested at G1 phase and expression of cyclin D1, c-myc, PCNA was reduced while p21 was upregulated at the time of daidzein treatment. During the same time, the expression of p-ERK was down regulated and translocation into nuclear afterwards was also inhibited.

Genistein

Genistein (GEN), known as a strong cancer chemopreventive agent that is the active ingredients of soy isoflavones and also give different type of biological activities, such as anti-tumor, antibacterial, lipid-lowering, estrogen-like effect [80-83]. GEN also can inhibit the growth of various types of colon cancer cells [84-87], while its particular effects shown on cancer cells and the mechanisms of this activity are still unknown [88,89]. Zhou et al. [90] suggest that genistein inhibited cell migration concentration at 200 μmol/L. It reversed the EMT of colon cancer cells by the way of upregulation of E-cadherin and down regulation of N-cadherin, accompanied through the inhibition of EMT can suppress the expression of notch-1, p-NF-κB and NF-κB, while increase the expression of Bax/Bcl-2 and caspase-3 in HT-29 cells.

Glycitein

Glycitein is an o-methylated isoflavone compound, which is Leguminosae family found from flowers and roots of *Pueraria thunbergiana*, and also the bark of *Maackia amurensis* and soybean [91,92]. Zhang et al. [89] suggest that dietary phytoestrogen, glycitein against human breast carcinoma SKBR-3 cells showed that glycitein exhibits biphasic regulation on SKBR-3 cells. At concentration of less than 10 mg/mL, cells respond to glycitein by increasing cell growth and de novo DNA synthesis whereas the addition of glycitein at concentrations greater than 30 mg/mL significantly inhibited cell growth and DNA synthesis in a dose dependent manner, cells treated with 60 mg/ml of glycitein did not recover normal growth after treatment was stopped. Glycitein was found to be cytostatic at low concentrations and cytotoxic at higher concentrations. Treatment with 100 mg/mL of glycitein severely altered the cell morphology. Glycitein damaged the cell membranes by increasing membrane permeability and suggested a possible mechanism of the action of dietary phytoestrogens on human breast carcinoma SKBR-3 cells.

Formononetin

Oh et al. [93] suggest that formononetin significantly increased FaDu cell death with an estimated IC50 value of 50 μM. the chemotherapeutic effects of formononetin were mediated by the suppression of mitogen activated protein kinase, including extracellular signal-regulated kinase 1.2 and p38 and nuclear factor-κB phosphorylation in FaDu cells.

Chrysin

The Chrysin compound is polyphenolic in nature available in the diet and several herbal products, which have different types of important biochemical and pharmacological activities in the prevention of cancer and health promotion [94,95]. Chrysin also has many biological activities, such as anti-inflammation, anti-oxidation and anti-cancer effects [95]. Bahadori et al. [96] suggest that chrysin give a cytotoxic effect on CT26 cells in a dose dependent manner with the concentration of IC50=80 $\mu g/mL^{-1}$. The biological assays have showed that chrysin administrated cytotoxicity on colon cancer cells by recruitment of the apoptosis. Caspase-3 and caspase-9 colorimetric assays, in addition to Bax expression analysis, have indicated the involvement of intrinsic apoptotic pathway in the cytotoxic effect of the chrysin. The *in vivo* assay revealed a remarkable reduction of the colon tumor volume in treated mice (8.10 mg/kg^{-1})

as compared to the untreated mice. RT-PCR elucidated that chrysin attenuated tumor volume through down regulation of the SALL4 and up-regulation of the Bax.

Galangin

Breast cancer is indicated that it is the most frequent tumor limited to treatment mainly occurs in the female worldwide [97]. Galangin, 3,5,7-trihydroxyflavone is a compound that is found in nature, it is a type of bioflavonoid which is isolated from the *Alpinia galangal* root [98] and expressed to incite apoptosis in various cancers [99]. Song et al. [100] suggest that Galangin regulated ER stress to raise CHOP and DR4 expression levels, sensitizing TRAIL activity, leading to human breast cancer cell apoptosis through Caspase-3 activation, which was linked with AMPK phosphorylation. In culling, AMPK inhibition and silence reduced anti-cancer activity of galangin and TRAIL initiated apoptosis by TRAIL/Caspase-3/AMPK signaling pathway. AMPK signaling pathway promptness by galangin might be of convenience for promoting the effects of TRAIL-regulate anti-tumor therapeutic strategy. Galangin (20 μm) and TRAIL (100 ng/ml) in combinational treatment waned breast cancer cells viability.

Conclusion

Many synthetic antineoplastic drugs have been developed as a result of extensive study over the last few decades. However, because of their exorbitant cost and significant side effects, the majority public prefers to adopt natural therapies. Nature provides us with substances that continue to play a vital part in the elimination of cancer cells. These compounds have a multi-targeted approach to signal transduction pathways, either specifically or non-specifically. The effects of various plant-derived phytochemicals on cancer cell lines are highlighted in this review paper.

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