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Review Article

Potential anticancer activity of some medicinal plants *in vitro* and *in vivo* study

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ABSTRACT

The public health burden caused by cancer is significant in both developing and developed nations. The ability of biological, chemical, or synthetic substances to prevent, inhibit, or stop the progression of carcinogenic is known as anticancer activity. To treat the condition, several synthetic drugs are utilized, however because of their toxicity, research is now being done to examine chemotherapeutic medicines produced from plants. A review of several *in vivo* and *in vitro* techniques for determining the anticancer activities of natural compounds from medicinal plants has thus been undertaken. In this study, 50 Indian anticancer medicinal plants from 35 families are presented, together with comprehensive data on the parts and extracts utilized, the model type employed, the cancer cell line types that were tested, etc. These plants are still utilized to treat numerous tumor forms, including lymphoma, sarcoma, leukemia, and carcinoma. All of plants are likely candidates for *in vivo* research since they have strong anticancer action *in vitro*.

Keywords: Tumors, Indian origin, Anticancer medicinal plants, *in vitro* and *in vivo* processes

INTRODUCTION

Since its inception, Indian traditional medicinal practice of Ayurveda, which relies on plant-based medicines, has proved effective in avoiding or suppressing several tumor forms with different therapy lines.[1] People from many ethnic groups and geographical regions of India each have their own unique culture, religious practices, dietary habits, and richness of knowledge in traditional drugs.[2] They use herbal medicine to treat wide range of illnesses. Since ancient times, different ailments have been treated using natural remedies, particularly plants. From ancient times, terrestrial plants utilized as drugs in India, Egypt, China, and Greece; a significant number of contemporary medicines have been produced from them. Akkaidians and sumerians produced 1st recorded accounts of plant therapeutic usage about 2600 BC.[3]

Cancer is a group of disorders occurred due tocell cycle control loss. Uncontrolled irregular cell proliferation is related to cancer.[4] Both internal (immune conditions, hormones, inherited mutations, and mutations resulting from metabolism) and external variables (radiation, chemicals, tobacco, and contagious organisms) may cause cancer. The inadequacy of wide- ranging early cancer detecting tools, the related poor prognosis of individuals detected in later illness stages, and its rising occurrence on a worldwide scale all contribute to cancer's prominent role as a global health concern. Undoubtedly, one of the major issues facing humanity is the fight against cancer.[5]

The national cancer institute has tested over 114,000 extracts for anticancer efficacy after collecting roughly 35,000 plant samples from 20 different nations.[6] More than 3000 plant species are having anti-tumor potential.[7] One of

the mostcommon illnesses affecting people is cancer, and the continuing development of novel anticancer drugs derived from natural product sources is now of great scientific and economic interest.[8]

Recent research has concentrated on the search forsuitable chemopreventive drugs since chemoprevention is considered an essential strategy for controlling malignancy. New chemopreventive medicines have greatly benefited from the use of natural ingredients, especially dietary components.[9] Cardenolides, quassinoids, or lignans are examples of well-known classes of chemicals that display interesting patterns of differential cytotoxicity.[10] A model based on ethnobotanical and ethnopharmacological data may be more advantageous and cost-effective in any cancer drug development effort than the mass screening of plant species for potential anticancer compounds.[11] Many anticancer agents have their roots in natural compounds, which have been recognized as key sources of prospective chemotherapeutic drugs.[12]

Over 50% of the medicines in clinical studies for anticancer characteristics, according to Newman and Cragg, were obtained from or are related to natural sources.[13] Several organic substances with plant origins have the potential to be effective chemotherapeutics. Taxol, podophyllotoxin, camptothecin, and vincristine are some of the presently used plant-based anticancer medicines.[14] The utilization of medicinal plants as a resource for drug development is most prevalent in the fields of cancer and infectious disorders. Medicines derived from natural sources accountfor 60% and 75% correspondingly of all anticancer and anti-infectious drugs authorized by the FDA.[15]

The effectiveness of natural anticancersubstances, either as pure chemicals or as plant extracts, has been evaluated using a wide varietyof *in vitro* and *in vivo* approaches. Natural compounds from medicinal plants are often estimated to have anticancer effects using *in vitro* approaches such as LDH (Lactic sehydrogenase) assay, MTT assay, tryphan blue dye exclusion test, sulforhodamine B assay, and XTT assay. Most often used for determining anticancer activity are the sulforhodamine B and MTT assays, both of which are *in vitro* procedures.

ANTICANCER ACTIVITY SCREENING METHODS

In vitro methods

Tryphan blue dye exclusion test

The most widely used test for cell viability is the trypan blue dye exclusion assay. In this test, the cells are centrifuged for 10 to 15 minutes at 10,000rpm after being rinsed with Hank's Buffered Salt Solution (HBSS). The process is carried out three times. When the cell count is adjusted to $2x10^6$cells/ml, the cells are suspended in a standard volume of HBSS. Each Eppendorf tube is given a portion of the cell suspension (0.1ml consisting of 2 lakhs cells). Cells are treated with dilutions of the drugs at 37°C forthree hours. After 3 hours, cells of equivalent quality that have been treated with the drug are mixed with tryphan blue (0.4% concentration) and left for 1 minute for a dye exclusion test. Within two minutes, the viable and non-viable count is measured after it has been placed into a hemocytometer. Dead cells absorb color, while viable cells don't. But when preserved for a longer period, living cells also produce and absorb color [16]. The following formula is used to compute the growth inhibition percentage:

$$\text{Growth inhibition (\%)} = 100 - \frac{(\text{Total cells} - \text{Dead cells})}{Total\ cell} \times 100$$

LDH assay[17]

By observing NADH decrease during the pyruvate- lactate transition, lactic dehydrogenase activity in the culture media and the cellular lysates is spectrophotometrically assessed at 340 nm. Sonicating the cells and then centrifuging them at 13,000x g for 15 minutes further break down the cells after being lysed with 50 mM Tris-HCl buffer, pH 7.4 + 20 mM EDTA + 0.5 percent SDS (Sodium dodecyl sulfate). The 33 µl of sample is mixed with 48 mM PBS, pH 7.5, 0.2 mM NADH, and 1 mM pyruvate to make an assay mixture with a final volume of 1ml for the enzymatic analysis. Calculating the proportion of released LDH is as follows: % of the total calculated as the total of the enzymatic activity found in the culture medium and the cellular lysate.

MTT test[18]

This test relies on metabolically active cells transforming the yellow tetrazolium salt-MTT into purple-formazan crystals, offers a quantitative assessment of live cells. 100µL of RPMI 1640 and$2\times10^5 mL^{-1}$ of cells in each well are plated onto 96-well plates, where they are then allowed to develop for 24h in a CO_2 incubator (37°C, 5% CO_2). After that, the medium is taken out and a new medium with various sample levels is mixed for 48h. Then, each well receives 20 µL of MTT stock solution ([3- (4, 5-dimethylthiazol-yl)-2, 5-diphenyltetrazolium bromide]) and 5 mg/mL of PBS. 200 µL of DMSO is injected into each well for dissolving the MTT metabolic product once the medium has been withdrawn. The optical density is then determined at 560 nm after the platehas been shaken for 5 minutes at 150 rpm. Thefindings are given as percent viability (log)compared to the control, with untreated cells (basal) serving as a 100% viability control.

XTT assay[19]

The 2,3-bis[2-Methoxy-4-nitro-5-sulfophenyl]- 2H-tetrazolium-5-carboxyanilide inner salt (XTT) test is performed to determine the proliferationresponse. When determining the number of live cells, the tetrazolium salt

XTT is very helpful.This test is based on the tetrazolium salt cleavage, XTT, by metabolically active cells to generate an orange formazan dye, and it is used for the spectrophotometric determination of cell viability and growth without using radioactive isotopes. Only live cells possess the mitochondrial enzyme dehydrogenase, which converts XTT into anorange formazan dye. In 96-well plates, cells are cultured in growth media with 10% FBS until theyare 70-80% confluent. They are then given the proper medicine sample for 24 h of treatment. After the incubation period, an XTT test is conducted. In short, each well receives 50mL of the XTT labeling solution, and cells are then incubated for 4 hours at 37°C.

A screening multi-well spectrophotometer ELISA (enzyme-linked immunosorbent assay) reader isused to compare the optical density at 450 nm of the produced formazan dye with that of control wells. There are aqueous solutions that candissolve the formazan dye. 650nm is the standard wavelength.

SRB test

A vivid pink aminoxanthene dye which attachs to amino acids and dissociates in basic conditions. Approximately 5,000 to 10,000 cells are platedinto each well of a 96-well flat bottom plate. The growth rates of different cell lines are equalized by plating different quantities of cells. Following an overnight period of cell attachment, substances areintroduced to triplicate wells in a series of 3-fold dilutions. The medium is diluted 1:10 with water before being introduced to the control wells. Theseplates are then tested for growth inhibition using an SRB (sulforhodamine B) assay after incubating at 37°C and 5 percent CO_2 for three days.[20] To fix the cells, an emulsion of cool, 50% trichloroacetic acid is added to the cells, bringing the final concentration to 10%. After the cells being incubated for 1h at 4°C, the cells are rinsed with deionized water five times. Once the cells have been stained for 15 to 30 min with 0.4% SRB (Sigma) diluted in 1.0% acetic acid, they are rinsed in 1.0% acetic acid five times to eradicate any unbound dye. The plates are then analyzed at 595nm on a microplate reader after the bound dye has been solubilized using a 10 mm Tris base (Molecular devices) after being air dried at room temperature.

$$\text{The growth inhibition (\%)}=\frac{Control-sample}{Control}\times 100$$

In vivo model

EAC induction[21]

The EAC ("Ehrlich ascites carcinoma") tumor model in mice is used to assess the antitumor efficacy of the test drugs. Ascitic carcinoma- bearing mice (donors) are enrolled in the trial fifteen days following tumour transplantation. Each group of 12 animals comprises the whole animal group. (a) Tumor-bearing mice, (b) Normal mice (c) mice with tumors that were given a normal drug, (d) groups of mice with tumors that received a test drug). A sterile syringe and an 18-gauge needle are used to extract the ascitic fluid. For microbiological contamination, a small sampleis being tested. Tryphan blue exclusion testing is used to assess the vitality of tumors, and hemocytometers are used to count cells. To obtain a 10^6cells/ml concentration of tumor cell suspension, ascitic fluid is diluted with normal saline to the adequate content. To obtain an ascitic tumor, this is intraperitoneally administered. After receiving a tumor injection, the mice are weighed again every three days. On 10^{th} day after tumor inoculation, therapy is initiated. And on this day, a standard injection(one dosage) is given intraperitoneally. A five-dayintraperitoneal course of the medicine is initiated on 10^{th} day. Anticancer activity and hematologicalparameters are evaluated by sacrificing six mice from each group after the administration of the last dosage and an 18 h fast. To monitor the MST ("Mean survival time") of the tumor-bearing hosts, the remaining animals in each group are preserved. The following parameters are observed to evaluate a drug's antitumor effectiveness. Percent change from day-0 weight in terms of weight, hematological parameters and MST and lifespan expansion [%ILS].

Anticancer Indian medicinal plants: Numerous natural substances that were extracted from various plant extracts from India have been shown to have anticancer activities. Global efforts are being made to identify a molecule that may prevent the progression of cancer in people. Natural factors have historically made significant contributions to this end. Due to their wide range of pharmacological characteristics, which include cytotoxic and chemopreventive effects, plant-derived natural compounds like steroids, flavonoids, and terpenoids have drawn a lot ofinterest.[22] With the discovery of the vinca alkaloids vincristine and vinblastine in the Madagascar periwinkle *Catharanthus roseus*, a phase using plant compounds as anticancer medicines were initiated. They were the initial cancer-related substances to reach clinical usage.[23]

Vitamins (A, C, E, K), flavonoids (isoflavones, flavones, anthocyanins, flavonones, isocatechins, catenchins), carotenoids, polyphenols (tannins, gallic acid, ellagic acid,), enzymes, saponins, as well as minerals (copper, chromium, selenium, zinc, iodine, manganese) are just a few of the numerous antioxidants found in medicinal plants.[24]

In this study, 50 Indian anticancer plant species from 35 families are presented, together with comprehensive data on the parts and extracts utilized, the model type employed, the cancer cell line types that were tested, etc. (Table 1). These plants are still utilized to treat several tumor forms, including lymphoma, sarcoma, leukemia, as well as carcinoma. Most of these plant species have shown to be quite successful in treating tumors and malignancies in both clinical and experimental settings.

Table 1: List of medicinal-derived plants, including information on their family, the parts utilized, the extraction solvents, and the assays used in anticancer trials in India.

Scientific name (Vernacular name, family)	Extract	Part/s utilized	Reported and traditional usages	Tested cancer cells types and methods	Refer. no.
***"Abrus precatorius* L. (Chanothi, Fabaceae)"**	50% ET	S	Jaundice, eye disease, fainting, poisoning, leucoderma, and arthritis	DLA (Dalton's lymphoma ascites) cells, small cell lung carcinoma, Yoshida ascites sarcoma, mouse fibro sarcoma, Yoshida sarcoma/ i*n vitro* and i*n vivo*/SRB, MTT assay	25-26
***"Allium sativum* L. (Lasan, Liliaceae)"**		P	Anti-asthmatic, antioxidant effects, antiseptic, anti-thrombotic, anti-cholesterolemic, cholagogue, cancer, diuretic and diaphoretic	Sarcoma 180 cancer cell, oral cancer cell/ *in vivo*	38-39
***"Alstonia scholaris* L. (Saptaparna, Apocynaceae)"**	85% EAL	S	Diarrhea, antioxidant, treat malaria and dysentery	Hepatocellular carcinoma, HeLa, epidermoid carcinoma cell line promyelocytic leukemia cells, and breast adeno carcinoma cancer cell lines, Ehrlich ascites carcinoma/ *in vivo* and i*n vitro*/Willis and Pratt assay	27-28
***"Andrographis paniculata* Burn. f. (Kariyatu, Acanthaceae)"**	95% ET	AP	Antihepatic, antifertility, anti- thrombotic, hepatoprotective, anti-hepatotoxic, immunostimulant, aggregation, antioxidant, antiplatelet, anti-hyperglycemic, anti-inflammatory, and antimalarial	Lymphocytic, prostate, colon, hepatoma cancer cell lines/*In vitro*/MTT assay	69
***"Annona reticulate* L. (Ramfal, Annonaceae)"**	ME	L	Antioxidant, anti-helminthic, and anti-dysentric	Kidney carcinoma	70-71
***"Asparagus racemosus* Willd. (Shatavari, Liliaceae)"**	AQ	R	Dyspepsia, inflammation, gastric ulcers, antioxidant and liver problems	Liver cancer/ *in vivo*	0-41
"Azadirachta indica Juss.(Neem, Meliaceae)"	80% ET	L	Anti-inflammatory, immunomodulatory, antiulcer, anti-bacterial, anti-malarial, anti-fungal, antioxidant, antiviral, anti-carcinogenic, and antimutagenic effects	Prostate cancer/ *in vivo*	57-58
"Bacopa monniera L. (Brahmi, Scrophulariaceae"	9% ET	WP	Tumors, mental diseases, inflammation, antioxidant, and ascites	Trypanblue exclusion assay/Mouse sarcoma Cell line/ *in vitro*	72
"Bauhinia variegate L. (Kanchhanar, Caesalpiniaceae)"	95% ET	S	Leprosy, bronchitis, antibacterial, tumors ulcer, antioxidant and antifungal	Human breast cancer, epithelial larynx cancer, liver cancer cell/In vitro and *in vivo* line/MTT assay	45

Continued.

Scientific name (Vernacular name, family)	Extract	Part/s utilized	Reported and traditional usages	Tested cancer cells types and methods	Refer. no.
"Berberis Vulgaris L. (Barberry, Berberidaceae)"	ME	RB	Diarrhea, antioxidant, liver dysfunctions, gallbladder, malaria, leishmaniasis, urinary tract disorders and stomach infections	SRB test/In vitro/ Breast cancer	73
"Beta vulgaris L. (Beet, Chenopodiaceae)"	95% ET	J	Leukaemia, antioxidant, cancer including oesophagus, breast, head, glands, leg, and intestines	Lung and skin cancer/ *in vivo*	59-60
"Bidens pilosa L. (Shemaro, Asteraceae)"	ME	WP	Wounds, antioxidant, flu, cold, and chronic or acute hepatitis urinarytract diseases	Nasopharyngeal epidermal carcinoma, cervix carcinoma cancer cell lines/In vitro/MTT assay	74-75
"Calycopteris floribunda Lam. (Bukshi, Kokaranj Combretaceae)"	DCM:ME (1:1)	L	Anti-helminthic, astringent laxative, colic, malaria, and diarrhea	MTT test/ *in vitro*/colon cancer cell line	89
"Catharanthus roseus L. (Sadabahar, barmachi Apocynaceae)"	EA	R, L	Antioxidant, Anti-cancer, and menorrhagia	Colorectal Carcinoma cell line/Acute lymphocytic leukemia/ *in vivo* /MTT assay/ *in vitro*	42-44
"Cedrus deodara G. Don (Devdaar, Pinaceae)"	-	W	Antioxidant, astringent, anti- diarrhoeal antiseptic, and febrifuge.	Leukemia, acute lymphoblastic promyelocytic leukemia, lung cancercell lines and prostrate/ trypan blue exclusion test/ *in vitro*	90-91
"Citrullus colocynthis L. (Indrayan, Cucurbitaceae)"	Glucosides	L	Hepatoprotective, cytotoxic, cardiovascular, anti-inflammatory, anti- diabetic and antioxidant properties	Breast cancer cell line/ *in vitro*/MTT assay	76-77
"Crocus sativus L. (Kesar, Iridaceae)"	75% ET	Dry stigmas	Antioxidant effects	Carcinoma cancer cell line/cervical epithelioid/In vitro/MTT assay	78-79
"Curculigo orchioides Gaertn. (Kalimusli, Amaryllidaceae)"	CH, HE, ME and AN	R	Diarrhea, antioxidant, asthma, jaundice, and poultice for skin and itching problems	Breast cancer cell line/ *in vitro*/MTT assay	80-81
"Curcuma longa L. (Haldi, Zingiberaceae)"	-	Rh	Anticarcinogenic, antimutagenic, antigenotoxic, antioxidant, and anti- inflammatory effects	Colon cancer cells/ *in vitro*/Lactate dehydrogenase assay	92-93
"Cymbopogon flexuosus(Steud.) Wats (Lemon grass, Poaceae)"	-	G	Stress-related syndromes, antimicrobial and antifungal effects	Oral, cervix, colon, prostate, leukemia, promyelocytic and cancer celllines/ *in vitro/ n vivo*/SRB assay	29
"Emblica officinalis Gaertn. (Amla, Euphorbiaceae)"	ME	DFr	Antimutagenic, liver protecting activity, anticarcinogenic and antioxidant effects	Liver cancer/ *in vivo*	61-62

Continued.

Scientific name (Vernacular name, family)	Extract	Part/s utilized	Reported and traditional usages	Tested cancer cells types and methods	Refer. no.
"Ephedra sinica Stapf (Ephedra, Ephedraceae)"	ME	AP	Fever, cold, wheezing, headaches, nasal congestion, flu, and asthma	Murine melanomacancer/ *in vivo*	63
"Indigofera aspalathoides (Vahl, Papilionaceae)"	95% ET	S	Antioxidants, cancer, and different skin problems	EAC cancer/ *in vivo*	45-46
"Ipomoea aquatica Forskal. (Kalmisa, Convolvulaceae)"	ME	L	Antioxidant effects	"Small lung carcinoma cancer, normal African green monkey kidney cell line and larynx epithelial carcinoma/In vitro/ SRB and MTT assay	82
"Ipomoea squamosa (Cairo Morning Glory, Convolvulaceae)"	-	L	-	Ovarian cancer cell line/ *in vitro*	94
"Jatropha curcas L. (Ratanjota, Huphorbiaceae)"	ME	S	Antioxidants, skin-related complications, tumors, ulcers	*In vivo*/Skin cancer	67-68
"Lantana camara L. (Ghaneri, Verbenaceae)"	ME	Fr., F, L, S, R	Antioxidant, anti-tumoral, antihypertensive, and anti-bacterial	Lung carcinoma cell line/ *in vitro*/SRB and MTT assay	83
"Mangifera indica L. (Keri, Anacardiaceae)"		Fr, B, L	Antioxidant, antitumor, anti- bacterial, antiviral, anti- inflammatory, analgesic, anti-amoebic, anti-diarrheal, spasmolytic, immunomodulatory, and immunostimulant effects	Lung cancer/ *in vivo*	47
"Melia azedarach L. (White Cedar, Meliaceae)"	70% ET	L	Anthelmintic and anti-parasitic activity	Lung cancer and glioma cancer cell line/ *in vitro*/ Standard CCK (Cell counting Kit)-8 assay	95-96
"Morinda citrifolia L. (Noni, Rubiaceae)"	AQ	R, Fr.	Anti-viral, anti-diabetic, antibacterial, antioxidant, and anticancer	MTT assay/ In vitro/Colon cancer cell line	97-98
"Moringa oleifera L. (Saragavo, Moringacae)"	ET, ME, CH, EA	S	Antimicrobial, antioxidant, anti- inflammatory and antigenotoxic activities	Skin cancer/In vitro/ *in vivo* /Natural red dye assay	36-37
"Nigella sativa L. (Black seeds, Ranunculaceae)"	90% ET	S	Anti-diabetic, anti-oxidant, anti-epileptogenic, anti-histaminic, anti-tumour, anti-peroxidative and anti-infective	Colon cancer/ *in vivo*	48-49
"Ocimum gratissimum L. (Damro, Lamiaceae)"	AQ	S, L	Radioprotective anti-carcinogenic, chemo-preventive, several other pharmaco-logical usages	Breast cancer/ *in vitro*/ *in vivo* /MTT assay	30
"Ocimum sanctum L. (Tulsi, Lamiaceae)"	ET	L	Antioxidant, anti-stress, antiinflammatory, hepato-protective, radio protective, anti-bacterial effects	Skin cancer/ *in vivo*	64

Continued.

Scientific name (Vernacular name, family)	Extract	Part/s utilized	Reported and traditional usages	Tested cancer cells types and methods	Refer. no.
"Phellinus rimosus (Berk, (Hymeno-chetaceae)"	ME, AQE	sporocarps	Antioxidant	DLAs, EAC/In vitro/ *in vivo* /Trypan blue exclusion assay	31-32
"Pinus resinosa Aiton (Pinaceae)"	DCM, HE, AQ, and ME	W	Analgesic, antioxidant, antibacterial, and antifungal	Lung carcinoma cell, colorectal adenocarcinoma cell, normal skin fibroblast cell lines/ *in vitro*/ resazurin reduction assay	84-85
"Polyalthia longifolia Benth. and Hook. f. (Annonaceae)"	ET	L	Antifungal and antibacterial activities	Colon cell and leukemia HL-60 cancer cell line/ *in vitro*/SRB assay	99
"Psidium guajava L. (Jamphal, Myrtaceae)"	AQ	L	Antioxidant	Prostate carcinoma cell/ In vitro/MTT assay	100
"Punica granatum L. (Dadam, Lythraceae)"	70% AC	J, P	Anti-inflammatory and antioxidant	Prostate carcinoma cell / *in vivo* and *in vitro*/MTT assay	33
"Tragia involucrata Linn. (Euphorbiaceae)"	HE, EA	AP	Antifertility anti-inflammatory, antimicrobial, activity	EAC/ *in vivo*	101
"Rubia cordifolia L. (Manjistha, Rubiaceae)"	80% ME	R	Antioxidant, antitumor, antistress, urinary disorders, hepatoprotective, radio protective, anti-microbial, anti-inflammatory	Colon carcinoma, breast carcinoma, and liver carcinoma/ *in vitro* /MTT assay	86-87
"Semecarpus anacardium L. (Bhallika, Anacardiaceae)"	90% ET and ME	DFr	Immunomodulatory, anti-inflammatory, antioxidant, analgesic, ulcerogenic and antipyretic activities	Acute myeloblastic leukemia, chronic myelogenic leukemia, breast adenocarcinoma, colon and cervical epithelial carcinoma cell lines/ *in vitro*/MTT assay	88,11
"Tephrosia purpurea Pers. (Sarapunkha, Fabaceae)"	95% ET	R	Different inflammatory, spleen, kidney, and liver renal disorders, antioxidant	*In vivo*/Ooal squamous cell carcinoma	50
"Terminalia chebula Retz. (Karakkaya, Combretaceae)"	ET	F	Diabetes, digestive, sore throat, chronic cough, asthma, anti- inflammatory, colicpain, anti-oxidant	MTT assay/COLO-205 cell line/ *in vitro*	102
Tiliacora racemosa Coleb. (Tiliacoru, Menispermaceae)	90% ET	R	-	Chronic myelogenic leukemia, acute myeloblastic leukemia, cervical epithelial cancer cell lines, breast adenocarcinoma/ *in vitro* /MTT assay	88
"Tinospora cordifolia (Willd.) Hook. f. and Thom. (Guduchi, Menispermaceae)"	PE, DCM, and CH	S	Antioxidant, general tonic, anti-inflammatory, anti-diabetic antiallergic, anti-arthritic, aphrodisiac, and anti-malarial properties	EAC/ *in vivo*	51-52
"Viscum album L. (Vando, Viscaceae)"	CO2 gas	L	Hypotensive, nervine, anti-oxidant, relaxant, vaso-dilator, cardiac depressant, stimulant diuretic	Ehrlich's tumour cell/ *in vivo*	66

Continued.

Scientific name (Vernacular name, family)	Extract	Part/s utilized	Reported and traditional usages	Tested cancer cells types and methods	Refer. no.
"Withania somnifera L. (Ashwagandha, Solanaceae)"	70% EAL	R	Radiosensitizer, anti-tumor, immunomodulatory, anti-stressor, anti-oxidant, anti-bacterial and anti-inflammatory	Skin carcinoma and forestomach cancer/ *in vivo*	53-54
"Woodfordia fruticosa Salisb. (Dhavdi, Lythraceae)"	70% AC	F	Antipyretic, antioxidant, anti- inflammatory, antibacterial activity, and hepatoprotective	Sarcoma 180 cancer/*In vivo*	55-56
"Zingiber officinale Rosc. (Adu, Zingiberaceae)"	50% ET	Rh	Antioxidant, carminative, antispasmodic, expectorant, diaphoretic, astringent, anti-inflammatory substance, peripheral circulatory stimulant, digestive and diuretic, appetite stimulant	Prostate cancer cell line/ *in vivo* / *in vivo* / MTT assay"	34-35

P: Peel, S: Stem, DFr: dry fruits, L: leaves, AP: Aerial parts, Rh: rhizomes, R: root, J: juice, RB: rootbark, WP: whole plant, W: wood, G: grass, B: bark, F: flower, EAL: Ethyl alcohol, ET: Ethanol, ME: Methanol, EA: Ethyl acetate, AQ: Aqueous, DCM: dichloromethane, CH:Chloroform, AC: Acetone, HE: Hexane, AN: Acetonitrile.

In different *in vivo* and *in vitro* processes, certainplant species have been investigated, and they have demonstrated a significant reduction incancer cell growth. For example, to inhibitYoshida's sarcoma, DLAs cells and carcinoma by using *Abrus precatorius*, Ehrlich ascites carcinoma by *Alstonia scholaris*; EAC, sarcoma 180 and leukemia by *Cymbopogon flexuosus* breast cancer by *Ocimum gratissimum*; carcinoma and lymphoma by *Phellinus rimosus*; prostate cancer by *Punica granatum*; carcinoma by *Zingiber officinale*; Human multiple myeloma cancer and skin cancer by *Moringa oleifera*; sarcoma 180 by *Allium sativum*; liver cancer by *Asparagus racemosus*. P-1534 leukemia by *Catharanthus roseus*; EAC by *Indigofera* aspalathoides; lung cancer by *Mangifera indica*; colon cancer by *Nigella sativaI*; oral carcinoma by *Tephrosia* purpurea; EAC by *Tinospora cordifolia*; skin carcinoma by *Withania* somnifera; sarcoma 180 by *Woodfordia* fruticosa; prostate cancer by *Azadirachta indica*; lung and skin cancer by *Beta vulgaris*; liver cancer by *Emblica officinalis*; Murine melanoma by*Ephedra* sinica; skin cancer by O*cimum sanctum*; Ehrlich's carcinoma by *Viscum album*; skin cancer by *Jatropha curcas*; lymphoma and carcinoma by *Andrographis paniculata*; kidney and colorectal carcinoma cancer by *Annona reticulate*; sarcom by *Bacopa monniera*; breast cancer by *Berberis vulgaris*; cervix cancer by *Bidens pilosa*; breast cancer by *Citrullus colocynthis*; cervical epithelioid carcinoma cancer by *Crocus sativus*. To inhibit breast cancer by *Curculigo* orchioides; small lung carcinoma cancer and larynx epithelial carcinoma by*Ipomoea Aquatica*; lung carcinoma by *Lantana camara*; normal skin Fibroblast, Colorectal adenocarcinoma cell and lung carcinoma cell by *Pinus resinosa*; carcinoma by *Rubia cordifolia*; carcinoma and leukemia by *Tiliacora racemosa*; colon cancer by *Calycopteris floribunda*; acute lymphoblastic leukemia, lung and prostate cancer by *Cedrus deodara*; colon cancer by *Curcuma longa*; ovarian cancer by *Ipomoea* squamosa; glioma and lung cancer by *Melia azedarach*; colon cancer by *Morinda citrifolia*; colon and leukemia HL-60 cancer by *Polyalthia longifolia*; prostate carcinoma cancer by *Psidium gujava*; carcinoma cancer by *Tragia involucrata*; chronic and acute myelogenic leukemia, breast adenocarcinoma, colon carcinoma, and cervical epithelial cancer by *Semecarpus Anacardium*; colon cancer by *Terminalia chebula.*[11,25-102]

Thepresent article gives details on some plants that have positive anticancer effects. To make it simple for the investigator, it includes a variety of techniques for determining anticancer activity. It underlines that although *in vivo* anticancer tests have been performed on the majority of the plants, *in vitro* assays have not.

CONCLUSION

This article is an overview of certain Indian plant-derived anticancer drugs. As a result of their high antioxidant content, such medicinal herbs are useful in combating cancer. This study aims to provide a summary of the development of anticancer medicine plant study in Indian continental with an emphasis on the most significant discoveries made by researchers in this area. We have made an effort to investigate the plant compounds that have been shown to have anticancer action, *in vitro* and *in vivo*. In terms of extracting new physiologically active compounds from flora, India is one of the most promising places. Moreinitiatives are required to investigate strong anticancer plants from mother earth and protect people from cancer.

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REFERENCES

1. Balachandran P, Govindarajan R. Cancer- an ayurvedic perspective. Pharmacol Res. 2005;51:19-30.
2. Parinitha M, Srinivasa BH, Shivanna MB. Medicinal plant wealth of local communities in some villages in Shimoga distinct of Karnataka. India J Ethnopharmacol. 2005;98:307-12.
3. Samuelsson G. Drugs of natural origin. A textbook of pharmacognosy. 4th ed., Stockholm, Swedish Pharmaceutical Press. 1999.
4. Krishnamurthi K. Screening of natural products for anticancer and antidiabetic properties. Health Administrator. 2007;1-2:69-75.
5. Divisi D, Di TS, Salvemini S. Diet and cancer. Acta Biomed. 2006;77:118-23.
6. Mohammad S. Anticancer agents from medicinal plants. Bangladesh J Pharmacol. 2006;1:35-41.
7. Hartwell JL. Plants are used against cancer. A survey. Quarterman Publications, Lawrence. 1982.
8. Kinghorn AD, Farnsworth NR, Soejarto DD. Novel strategies for the discovery of plant-derived anticancer agents. Pharmaceutic Biol. 2003;41:53-67.
9. Surh YJ. Cancer chemoprevention with dietary phytochemicals. Nature Rev Cancer. 2003;3:768-80.
10. Cardellina JH, Gustafson KR, Beutler JA. National cancer institute intramural research on human immunodeficiency virus inhibitory and antitumor plant natural products. Human Med Agents Plants. 1993;15:218-27.
11. Nair PKR, Melnickb SJ, Wnukc SF. Isolation and characterization of an anticancer catechol compound from Semecarpus anacardium. J Ethnopharmacol. 2009;122:450-56.
12. Tan G, Gyllenhaal C, Soejarto DD. Biodiversity as a source of anticancer drugs. Curr Drug Targets. 2006;7:265-77.
13. Cragg GM, Newman DJ. Antineoplastic agents from natural sources: achievements and future directions. Expet Opin Investig Drugs. 2000;9:1-15.
14. Pezzuto JM. Plants derived anticancer agents. Biochem Pharmacol. 1997;53:121-33.
15. Newman DJ, Cragg GM, Snader KM. Natural products as sources of new drugs over the period 1981-2002. J Nat Prod. 2003;66:1022-37.
16. Unnikrishnan MC, Ramadasan K. Cytotoxicity of extracts of spices to cultured cells. Nutr Cancer. 1998;11:251-7.
17. Russo A, Piovano M, Lombardo L. Pannarin inhibits cell growth and induces cell death in human prostate carcinoma DU- 145 cells. Anti- Cancer Drugs. 2006;17:1163-9.
18. Mossman T. Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. J Immunol Methods. 1983;65:55-63.
19. Economou MA, Andersson S, Vasilcanu D. Oral picropodophyllin (PPP) is well tolerated *in vivo* and inhibits IGF-1R expression and growth of uveal melanoma. Acta Ophthalmologica. 2008;86:35-41.
20. Skehan P, Storeng R, Scudiero D. New colorimetric cytotoxicity assay for anticancer- drug screening. J Natl Cancer Inst. 1990;82:1107-12.
21. Devi PU, Rao BSS, Solomon FE. Effect of plumbagin on the radiation-induced cytogenetic and cell cycle changes in mouse Ehrlich ascites carcinoma *in vivo*. Indian J Exp Biol. 1998;36:891-5.
22. Abdullaev FI. Plant-derived agents against cancer. In: Gupta SK, editor. Pharmacology and therapeutics in the new millennium. Narosa Publishing House: New Delhi, India. 2001;345-54.
23. Cragg GM, Newman DJ. Plants as a source of anticancer agents. J Ethnopharmacol. 2005;100:72-9.
24. Gupta VK, Sharma SK. Plants as natural antioxidants. Nat Prod Rad. 2006;17:326-34.
25. Sivakumar R, Alagesaboopathi C. Studies on cytotoxicity and antitumor screening of red and white forms of *Abrus precatorius* L. Afr J Biotechnol. 2008;7:3984-8.
26. Subba RVV, Sirsi M. Effect of *Abrus precatorius L*. on experimental tumors. Cancer Res. 1969;29:1447-51.
27. Jagetia GC, Baliga MS. Evaluation of anticancer activity of the alkaloid fraction of Alstonia scholaris *in vitro* and *in vivo*. Phytother Res. 2006;20:103-9.
28. Kulkarni MP, Juvekar AR. Effect of *Alstonia scholaris Linn*. on stress and cognition in mice. Indian J Exp Biol. 2008;47:47-52.
29. Sharma PR, Mondhe DM, Muthiah S. Anticancer activity of essential oil from *Cymbopogon flexuosus*. Chemico-Biol Interact. 2009;179:160-8.
30. Makker PN, Tait L, Shekhar MPV. Inhibition of breast tumor growth and angiogenesis by a medicinal herb Ocimum gratissimum. Int J Cancer. 2007;121:884-94.
31. Ajith TA, Janardhanan KK. Antioxidant and antihepatotoxic activities of *Phellinus rimosus* (Berk) Pilat. J Ethnopharmacol. 2002;81:387-91.
32. Ajith TA, Janardhanan KK. Cytotoxic and antitumor activities of a polypore macrofungus, *Phellinus rimosus* Pilat. J Ethnopharmacol. 2003;84:157-62.
33. Malik A, Afaq F, Sarfaraz S. Pomegranate fruit juice for chemoprevention and chemotherapy of prostate cancer. Proc Natl Acad Sci. 2005;102:14813-18.
34. Shukla Y, Prasad S, Tripathi C. *In vitro* and *in vivo* modulation of testosterone mediated alterations in apoptosis-related proteins by [6]- gingerol. Mol Nutr Food Res. 2007;51:1492-02.
35. Stoilova I, Krastanov A, Stoyanova A. Antioxidant activity of a ginger extract (*Zingiber officinale*). Food Chem. 2007;102:764-70.
36. Guevara AP, Vargas C, Sakurai H. An antitumor promoter from Moringa oleifera Lam. Mutation Res. 1999;440:181-8.
37. Verma AR, Vijayakumar M, Mathela CS. *In vitro* and *in vivo* antioxidant properties of different fractions of *Moringa oleifera* leaves. Food Chem Toxicol. 2009;47:2196-201.

38. Ejaz S, Woong LC, Ejaz A. Extract of garlic (*Allium sativum*) in cancer chemoprevention. Exp Oncol. 2003;25:93-7.
39. Balasenthila S, Ramachandranb CR, Naginia S. Prevention of 4-nitroquinoline 1-oxide- induced rat tongue carcinogenesis by garlic. Fitoterapia. 2001;72:524-31.
40. Agrawal A, Sharma M, Rai S, et al., The effect of the aqueous extract of the roots of *Asparagus racemosus* on hepatocarcinogenesis initiated by diethyl nitrosamine. Phytother Res. 2008;22:1175-82.
41. Kamata JP, Boloora KK, Devasagayam TPA. Antioxidant properties of *Asparagus racemosus* against damage induced by γ- radiation in rat liver mitochondria. J Ethnopharmacol. 2000;71:425-35.
42. Sayed EA, Cordell GA. Catharanthus alkaloids atharanthamine, a new antitumor bisindole alkaloid from *Catharanthus roseus*. J Nat Prod. 1981;44:289-93.
43. Johnson IS, Wright HF, Svoboda GH. Antitumor principles derived from *Vinca rosea* L. Cancer Res. 1960;20:1016-22.
44. Jaleel C, Gopi AR, Manivannan P. Antioxidant potential and indole alkaloid profile variations with water deficits along different parts of two varieties of *Catharanthus roseus*. Colloids Surf B Biointerfaces. 2008;62:312-8.
45. Raj Kapoor B, Jayakar B, Murugesh N. Antitumor activity of *Indigofera aspalathoides* on Ehrlich ascites carcinoma in mice. Indian J Pharmacol. 2004;36:38-40.
46. Bakasso S, Meda LA, Lamien CE. Polyphenol contents and antioxidant activities of five *Indigofera* species (Fabaceae) from Burkina Faso. Pakistan J Biol Sci. 2008;11:1429-35.
47. Rajendran P, Ekambaram G, Sakthisekaran D. Effect of Mangiferin on benzo(a)pyrene-induced lung carcinogenesis in experimental Swiss albino mice. Nat Prod Res. 2008;22:672-80.
48. Johar DA, Shinwari N, Arif J. Role of *Nigella sativa* and a number of its antioxidant constituents towards Azoxymethane-induced genotoxic effects and colon cancer in rats. Phytother Res. 2008;22:1311-23.
49. Swamy SMK, Tan BKH. Cytotoxic and immune-potentiating effects of ethanolic extract of *Nigella sativa* L. seeds. J Ethnopharmacol. 2000;70:1-7.
50. Kavitha K, Manoharan S. Anticarcinogenic and anti-lipid peroxidative effects of *Tephrosia purpurea* L. in 7,12-dimethylbenz(a)anthracene (DMBA) induced hamster buccal pouch carcinoma. Indian J Pharmacol. 2006;38:185-9.
51. Rao SK, Rao PS, Rao BN. Preliminary investigation of the radiosensitizing activity of guduchi (Tinospora cordifolia) in tumor bearing mice. Phytother Res., 2008; 22: 1482-1489.
52. Prince PSM, Menon VP. Antioxidant activity of *Tinospora cordifolia* roots in experimental diabetes. J Ethnopharmacol. 1999;65:277-81.
53. Padmavathi B, Rath PC, Rao AR. Roots of *Withania somnifera* inhibit forestomach and skin carcinogenesis in mice. Adv Access Publi. 2005;2:99-105.
54. Visavadiya NP, Narasimhacharya AVRL. Hypocholesteremic and antioxidant effects of *Withania somnifera* (Dunal) in hypercholesteremic rats. Phytomedicine. 2007;14(2-3):136-42.
55. Hirota M, Suttajit M, Suguri H. A new tumor promoter from the seed oil of *Jatropha curcas* L., an intramolecular diester of 12- Deoxy-16-hydroxyphorbol. Cancer Res. 1988;48:5800-4.
56. Yan R, Gao S, Yang W. Nickel toxicity induced antioxidant enzyme and phenylalanine ammonia-lyase activities in *Jatropha curcas* L. cotyledons. Plant Soil Environ. 2008;54(7):294-300.
57. Yoshida T, Chou T, Nitta A. Woodfordin C. A Micro-ring hydrolyzable tannin dimer with antitumor activity and accompanying dimmers from *Woodfordia fruticosa* flowers. Chem Pharm Bull. 1990; 38: 1211-1217.
58. Kumaraswamy MV, Satish S. Free radical scavenging activity and lipoxygenase inhibition of *Woodfordia fructicosa* Kurz and *Betula utilis* Wall. Afr J Biotechnol. 2008;7:2013-16.
59. Gangar SC, Koul A. *Azadirachta indica* modulates carcinogen biotransformation and reduced glutathione at peri-initiation phase of benzo(a)pyrene-induced murine forestomach tumorigenesis. Phytother Res. 2008;22:1229-38.
60. Kumar S, Suresh PK, Vijayababu MR. Anticancer effects of ethanolic neem leaf extract on prostate cancer cell line. J Ethnopharmacol. 2006;105:246-50.
61. Kapadia GJ, Tokuda H, Konoshima T. Chemoprevention of lung and skin cancer by *Beta vulgaris* root extract. Cancer Lett. 1996;100:211-4.
62. Jiratanan T, Liu RH. Antioxidant activity of processed table beets (*Beta vulgaris*) and green beans (*Phaseolus vulgaris*). J Agric Food Chem. 2004;52:2659-70.
63. Sultana S, Ahmed S, Jahangir T. *Emblica officinalis* and hepatocarcinogenesis: A chemopreventive study in Wistar rats. J. Ethnopharmacol. 2008;118:1-6.
64. Anila L, Vijayalakshmi NR. Antioxidant action of flavonoids from *Mangifera indica* and *Emblica officinalis* in hypercholesterolemic rats. Food Chem. 2003;83:569-74.
65. Nam NH, Lee CW, Hong DH et al. Antiinvasive, antiangiogenic and antitumor activity of *Ephedra sinica* extract. Phytother Res. 2003;17:70-6.
66. Rastogi S, Shukla Y, Paul BN. Protective effect of Ocimum sanctum on 3-methylcholanthrene,7,12-dimethylbenz(a)anthracene and aflatoxin B1 induced skin tumorigenesis in mice. Toxicol Appl Pharmacol. 2007;224:228-40.
67. Cebovic T, Spasic S, Popovic M. Cytotoxic effects of the *Viscum album* L. extract on Ehrlich tumor cells in vivo. Phytother Res. 2008;22:1097-103.
68. Ucar EO, Karagoz A, Arda N. Antioxidant activity of *Viscum album* ssp. *album*. Fitoterapia. 2006;77:556-60.

69. Yan R, Gao S, Yang W. Nickel toxicity induced antioxidant enzyme and phenylalanine ammonia-lyase activities in *Jatropha curcas* L. cotyledons. Plant Soil Environ. 2008;54:294-300.
70. Geethangili M, Rao YK, Fang S. Cytotoxic constituents from *Andrographis paniculata* induce cell cycle arrest in jurkat cells. Phytother Res. 2008;22:1336-41.
71. Mondal S, Mondal NB, Mazumder UK. *In vitro* cytotoxic and human recombinant caspase inhibitory effect of *Annona reticulate* leaves. Indian J Pharmacol. 2007;39:253-4.
72. Baskar R, Rajeswari V, Kumar TS. *In vitro* antioxidant studies in leaves of *Annona* species. Indian J Exp Biol. 2007;45:480-5.
73. Rohini G, Shyamala DCS. *Bacopa monniera* extract induces apoptosis in murine sarcoma cells. Phytother Res. 2008;22:1595-8.
74. Tomosaka H, Chin Y, Salim AA. Antioxidant and cytoprotective compounds from *Berberis vulgaris*. Phytother Res. 2008;22:979-81.
75. Sundararajan P, Dey A, Smith A. Studies of anticancer and antipyretic activity of *Bidens pilosa* whole plant. Afr Health Sci. 2006;6:27-30.
76. Abajo C, Boffill MA, Campo J. *In vitro* study of the antioxidant and immunomodulatory activity of aqueous infusion of *Bidens pilosa*. J Ethnopharmacol 2004; 93: 319-323.
77. Tannin-Spitz T, Grossman S, Dovrat S. Growth inhibitory activity of cucurbitacin glucosides isolated from *Citrullus colocynthis* on human breast cancer cells. Biochem Pharmacol. 2007;73:56-67.
78. Spitz TT, Bergman M, Grossman S. Cucurbitacin glucosides: Antioxidant and free-radical scavenging activities. Biochem Biophys Res Commun. 2007;364:181-6.
79. Abdullaev FI. Cancer chemo-preventive and tumoricidal properties of *Crocus sativus* L. Exp Biol Med. 2002;227:20-5.
80. Escribano J, Alonso G, Coca-Prados M. Crocin, safranal and picrocrocin from *Crocus sativus* L. inhibit the growth of human cancer cells in vitro. Cancer Lett. 1996;100:23-30.
81. Singh R, Gupta AK. Antimicrobial and antitumor activity of the fractionated extracts of *kalimusli* (*Curculigo orchioides)*. Int J Green Pharm. 2008;2:34-6.
82. Venukumar MR, Latha MS. Antioxidant activity of *Curculigo orchioides* in carbon tetrachloride-induced hepatopathy in rats. Indian J Clin Biochem. 2002;17:80-87.
83. Prasad KN, Ashok G, Raghu C. *In vitro* cytotoxic properties of *Ipomoea aquatica* leaf. Indian J Pharmacol. 2005;37:397-8.
84. Raghu C, Ashok G, Dhanaraj SA. *In vitro* cytotoxic activity of *Lantana camara* Linn. Indian J Pharmacol. 2004;36:93-5.
85. Simard F, Legault J, Lavoie S. Isolation and identification of cytotoxic compounds from the wood of Pinus resinosa. Phytother Res. 2008;22:919-22.
86. Pietarinen SP, Willfor SM, Ahotupa MO. Knotwood and bark extracts: strong antioxidants from waste materials. J Wood Sci. 2006;52:436-44.
87. Kaur P, Singh B, Kumar S. *In vitro* evaluation of free radical scavenging activity of *Rubia cordifolia* L. J Chinese Clin Med. 2008;3:278-84.
88. Son JK, Jung SJ, Jung JH. Anticancer constituents from the roots of *Rubia cordifolia* L. Chem Pharm Bull. 2008;56:213-6.
89. Chakraborty S, Roy M, Taraphdar AK. Cytotoxic effect of root extract of *Tiliacora racemosa* and oil of *Semecarpus anacardium* nut in human tumor cells. Phytother Res. 2004;18:595-600.
90. Ali H, Chowdhury AKA, Rahman AKM. Pachypodol a flavonol from the leaves of Calycopteris floribunda, inhibits the growth of CaCo-2 colon cancer cell line in vitro. Phytother Res. 2008;22:1684-7.
91. Sharma PR, Shanmugavel M, Saxena AK. Induction of apoptosis by a synergistic lignan composition from *Cedrus deodara* in human cancer cells. Phytother Res. 2008;22:1587-94.
92. Tiwari AK, Srinivas PV, Kumar SP. Free radical scavenging active components from Cedrus deodara. J Agric Food Chem. 2001;49:4642-5.
93. Lee YK, Lee WS, Hwang JT. Curcumin exerts anti-differentiation effect through AMPKα-PPAR-γ in 3T3-L1 adipocytes and anti-proliferatory effect through AMPKα-COX-2 in cancer cells. J Agric Food Chem. 2009;57:305-10.
94. Hsu Y, Weng H, Lin S. Curcuminoids-Cellular uptake by human primary colon cancer cells as quantitated by a sensitive HPLC assay and its relation with the inhibition of proliferation and apoptosis. J Agric Food Chem. 2007;55:8213-22.
95. Cao S, Norris A, Wisse JH. Ipomoeassin F, a new cytotoxic macrocyclic glycoresin from the leaves of Ipomoea squamosa from the Suriname rainforest. Nat Prod Res. 2007;21:872-6.
96. Wu SB, Ji YP, Zhu JJ. Steroids from the leaves of Chinese *Melia azedarach* and their cytotoxic effects on human cancer cell lines. Steroids. 2009;74:761-5.
97. Szewczuk VD, Mongelli ER, Pomilio AB. In vitro, anthelmintic activity of *Melia azedarach* naturalized in Argentina. Phytother Res. 2006;20:993-6.
98. Kamiya K, Hamabe W, Tokuyama S. Inhibitory effect of anthraquinones isolated from the *Morinda citrifolia* root on animal A, B, and Y families of DNA polymerases and human cancer cell proliferation. Food Chem. 2009;118:725-30.
99. Anekpankul T, Goto M, Sasaki M. Extraction of anticancer *damnacanthal* from roots of *Morinda citrifolia* by subcritical water. Sep Purif Technol. 2007;55:343-9.
100. Verma M, Singh SK, Bhushan S. *In vitro* cytotoxic potential of *Polyalthia longifolia* on human cancer cell lines and induction of apoptosis through mitochondrial-dependent pathway in HL-60 cells. Chemico-Biol Interact. 2008;171:45-56.
101. Chen KC, Hsieh CL, Peng CC. Brain-derived metastatic prostate cancer DU-145 cells are

effectively inhibited in vitro by guava (*Psidium gujava* L.) leaf extracts. Nutr Cancer. 2007;58:93-106.
102. Joshi CG, Gopal M, Kumari NS. Antitumor activity of hexane and ethyl acetate extracts of *Tragia involucrata*. Int J Cancer Res. 2011;7:267-77.
103. Reddy DB, Reddy TCM, Jyotsna G. Chebulagic acid, a COX-LOX dual inhibitor isolated from the fruits of *Terminalia chebula* Retz., induces apoptosis in COLO-205 cell line. J Ethnopharmacol. 2009;124:506-12.

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