Food Chemistry Advances 2 (2023) 100239

Contents lists available at ScienceDirect

Food Chemistry Advances

journal homepage: www.elsevier.com/locate/focha

Scientific evidences of anticancer potential of medicinal plants

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ARTICLE INFO

Keywords:
Colorectal
Prostate
Bladder
Tinospora cordifolia
Withanaia somnifera

ABSTRACT

Cancer being a life treating ailment is the second reason of death universally. The growing threats of medication-resistant cancers indicates an crucial need for the improvement of more effective anticancer agents. Herbal medication offers very reasonable alternate to modern medicine against cancer. The investigation of natural products is a valued method for the detection and expansion of newer biologically dynamic compounds having exclusive assemblies and pathways. This work reviews certain medicinal plant with active phytochemicals, methodology of researches and their pharmacological characteristics. This work is created after careful literature review directed through relevant exploration of keywords in Clarivate Analytical, Web of Science, Scopus, Google Scholar, Science Direct, PubMed, MDPI, and Google Academic. This study was planned to accumulate the record of plants having anticancer activity and the evidences supporting their usage in cancer treatment. Fifty plants were selected based on their potenty as anticancer compounds. The thorough research studies exposed that plants and its phytochemicals can play a crucial role against oral, breast, lung, cervical, colon, stomach, hepatic cancers. The in vitro researches displayed that the plant secondary metabolites in extracts causes inhibition of cancer cell through DNA mutilation as well as stimulation of apoptosis-tempting enzymes in different models.

1. Introduction

Cancer is amongst the main reasons of death leading to high health burden universally as it results to significant cost of management for individuals affected with it (Olatunde et al., 2021). The International Agency for Research on Cancer documented that globally prevalence of 36 cancers for the year of 2020 is estimated to be 29.8 million with 19.3 million newer cases of cancer and 10.0 million deaths through cancer (Ferlay et al., 2019). Moreover, lung cancer being the most frequently identified cancer, (11.4%), breast (6.9%) colorectal (10.0%), etc. (Hyuna et al., 2021). In 2020, reports predicted 19.3 million newer cases of cancer with 10.0 million deaths (Ferlay et al., 2015). In a more current global cancer statistics, 18.1 million newer cases of cancer were logged with 9.6 million mortalities induced by the disease. In addition, the main cause of death was lung cancer followed by cancer of the breast, colorectal, stomach and liver (Bray et al., 2018). Some of the regular characteristics of cancers are apoptosis (Snellenberg et al., 2014), angiogenesis, multiple replication (Mar et al., 2015; Frink et al., 2016), growth signal production (Courtnay et al., 2015), insensitivity to signals of anti-growth and metastasis. These features make cancer cells to have continuous growth, long time survival and the potential to invade normal cells. Moreover, if these activities are not blocked, cancer cells will continue to increase, overwhelm and finally kill the patient with cancer (Shonia et al., 2019).

Currently, different therapeutic strategies including chemotherapy agents, surgery and/or radiation are utilized for cancer treatment. Although, the chemotherapeutic agents used for cancer treatment can result to short time relief to patients with cancer and aid to elongate their life span (Weissenstein et al., 2014; Fan et al., 2014; Lu et al., 2014), several of the anticancer agents show adverse side effects (Gao et al., 2013; Shapiro & Recht, 2001). Based on this, the search for alternative potential anticancer agents has been directed to natural products. Many studies have validated the anticancer efficacy of natural bioactive compounds (Lee et al., 2012; Ahmed & Othman, 2013; Sultana, 2011). Some of the anticancer compounds display teratogenic, mutagenic and/or oncogenic actions, which can block the synthesis of antibodies and

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https://doi.org/10.1016/j.focha.2023.100239
Received 25 July 2022; Received in revised form 24 January 2023; Accepted 11 March 2023

also immune response mediated by cell (Penn & Starzl, 1973). Some bioactive agents help to stimulate different biological responses that could partake in fighting the cancer cells and some of the stimuli control the action of proteins and enzymes with a particular role in the biology of cancer (Parker et al., 2014). They also target various cascades that can induce cancer and these include apoptosis, cyclin-dependant kinase inhibitors and nuclear factor-kappa B cascade (Guerra & Issinger, 2019). amongst the natural compounds with anticancer activity, phenolic molecules were reported to inhibit metastasis and invasion by cancer cell (Ngamkitidechakul et al., 2010; Luo et al., 2014). Other compounds such as fucoxanthin Rwigemera et al. (2015), curcumin Nadaf and Killedar (2018), anthocyanin Lu et al. (2017), genistein Xia et al. (2014) and others were reported to have anticancer actions.

In this sense, the present review highlights the different natural anticancer agents from plant origin and their mode of actions in carrying out this therapeutic action. This work appraises the selected plant species and active phytochemicals, their mechanism of action and pharmacological effects in various models. The detailed analysis revealed that plants owing to the presence of phytochemicals can be effective in fighting colon, lung, stomach, cervical, breast, oral, hepatic cancers and blood cancer cell lines.

2. Materials and methods

The data on literature was collected via Science Direct, Web of Science, PubMed, Clarivate Analytical, Google Academic Google Scholar, Core Collection, Scopus, MDPI, and Scientific Electronic Library Online (SciELO) from 2010 to 21. The used search terms were: anticancer potential medicinal plants, anticancer activity, anticancer methods, pharmacological activity, in vivo activity and in vitro activity. These articles were chosen for their potent anticancer action, as demonstrated by scientific evidence such as traditional anticancer activity showing plants and in vivo and in vitro anticancer effect of plant extracts or isolated chemicals from plants investigated. All the collected data and methods used to evaluate the anticancer activity were compiled in a table.

2.1. Anticancer activity of selected plants

So far, research has looked into the anticancer activities of a wide range of plants and phytochemicals substances. Some plants and their phytoconstituents show high efficacy against some various forms of cancer. The plants were chosen for their in vivo and in vitro anticancer effects. Table 1 includes a list of other prominent plants with promising biological properties, as well as their activities.

3. Results and discussion

3.1. Histories of medicinal plants or experiences being used by population

Plants are utilised for treating a variety of diseases from time immemorial. The oldest ancient (4500 BCE) still living traditions are Traditional Chinese Medicine, Traditional Indian Medicine, Ayurveda, and. The information of selecting the proper plants, a precise collection time and the method of medication production with their detailed usage was passed down from one generation to the next verbally. In the later 18th to early 19th centuries, with advancement in organic chemistry and proper chemical investigation, a systematic investigation of mechanisms of bioactive principles of medicinal plants was done for purification and characterization after isolation of many herbal bioactive principles. The initial separation of analgesic medications like morphine from *Papaver somniferum* followed by salicylic acid from Salix sp. as the prodrug of aspirin, quinine from *Cinchona officinalis*, cocaine from *Erythroxylum coca*, digitoxin from *Digitalis lanata* and *Digitalis purpurea* etc. had great pharmaceutical and clinical potentials. Various small pharmaceuticals molecule created from natural compounds were approved in between 1981 and 2014 as templates for synthetic alteration, pharmacological probes and drug precursors.

3.2. Medicinal plants and cancer

Plants' anticancerous powers is known for millennia. The separation of podophyllotoxin and chemicals like lignans from common mayapple (*Podophyllum peltatum*) created medications for treatment of small cell lung and testicular cancer. Roughly 36,000 species of plant are investigated for anticancerous properties by the National Cancer Institute. Approximately 3500 plant species have shown repeatable anticancer action (Fig. 1). The plants like *Abrus precatorius* in fibrosarcoma in mice, ascites tumour cells and *Albizzia lebbeck* in mice sarcoma, *Asparagus racemosa* in human epidermoid carcinoma, *Euphorbia hirta* in Freund virus leukaemia, *Anacardium occidentale* in hepatoma, *Erthyrina suberosa* in sarcoma has shown anticarcinogenic properties and encouraging results (Pooja, 2017).

3.2.1. Acorus calamus

Acorus calamus (bauj) (Bisht et al., 2011) belongs to the Acorus genus, Acoraceae family. A phytochemical study of A. calamus rhizomes resulted in separation of newer compounds like zingiberene and safrol. The cytotoxic action of these bioactive compounds was shown by 3-(4, 5-dimethylthiazol-2-yl)−2, 5-diphenyltetrazolium bromide [MTT] assay in different human cancer cell lines (Bisht et al., 2011; Samaneh Rahamooz Haghighi et al., 2017; S. Sarla & Subhash, 2011).

3.2.2. Ajuga parviflora

Ajuga parviflora (neelkanthi) is a flowering plant belonging to Lamiaceae family. Conventionally being used as a medicine for curing malaria, oedema, fungal, and other microbes (Revathi & Lukmanul, 2019; Ankit et al., 2019; Xia et al., 2017). The cytotoxicity action of aqueous and methanol extracts from A. parviflora leaves was explored against leukaemia murine [L-1210] and human chronic myelogenous leukaemia [K-562] cell lines.

3.2.3. Aloe vera

Aloe vera (Ghrit kumara) belonging to Asphodelaceae family posseses wide range of pharmaceutical activities (Pooja, 2017; Bisht et al., 2011). The leaves of A. vera showed presence of secondary metabolites like doxorubicin, butyl-p-tolyl sulphide, lupeol isobarbaloin, 6-methyl-4-chromanone, barbaloin, lectin, emodin, aloe-emodin, aloesin, acemannan, anthrone-C-glycosides, sitasterol alexin-B, campesterol and butylated hydroxyanisole. Other isolated compounds from A. vera leaves were examined against ovarian cancer [OVCAR-3], human colon cancer [HCT-116 and IGROV-1], and breast cancer [MCF-7] cell lines through MTT assay to assess in vitro cytotoxic activity (Karpagam et al., 2019).

3.2.4. Asparagus racemosus

Asparagus racemosus (satavari) belongs to Asparagus genus (Pooja, 2017; Bisht et al., 2011). The kaempferol of *A. racemosus* displays encouraging actions in the experimental HT-29 and HCT-116 colon cancer cells along with regular immortalized intestinal cells [IEC-6 and INT-407]. The root extract of *A. racemosus* helped in tyrosin, histone arginine and shatawarine isolation. The chloroform, methanol, ethyl acetate, DMSO, and water extracts of *A. racemosus* tuber, root and leaves showed antitumor growth hangup of human colon cancer cells through MTT test (Verma et al., 2014).

3.2.5. Artemisia herba-alba

Artemisia herba-alba (white wormwood) belongs to family Asteraceae, genus Artemisia. The whole plant and specially leaf extract of *A. herba-alba* showed high anticancerous activity against 3 human tumour cell lines like human bladder carcinoma, human laryngeal carcinoma, human myelogenous leukaemia (K-562) cells. The phenol complexes

Table 1
Medicinal plants having efficacy against cancer.

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Acorus calamus	Sweet flag /Bauj	*Acoraceae*	Rhizomes and roots	Ethanolic and methanolic	Zingiberene, cyclohexanemethanol, calacorene, valencene, isocalamendiol, α-gurgujene, aristolene, naphthalene, eugenol, limonene, camphene, α-asarone, β-asarone, caryophyllene, methyl isoeugenol and safrol.	MTT assay, acetic acid induced writhing method and brine shrimp lethality assay.	Antimicrobial, anticellular, antioxidant, antifungal, antibacterial, anaesthetic and allelopathic.	(Pooja, 2017; Bisht et al., 2011; Samaneh Rahamooz Haghighi et al., 2017)
Aegle marmelos	Bael	*Rutaceae*	Leaves, stems, barks and fruits	Hexane, acetone, chloroform, methanolic, water and ethanolic	Lupeol, acetamide, benzoic acid, pyranocoumarin, scopoletin, marmesin, psoralen, skimmianine, eugenol, 6-methly-4-chromanone, butyl p-tolyl sulfide, citral, cineol and limonene.	MDA-MB-231 HEp-2 and vero cells method, MTT assay and apoptotic assay.	Antiviral, antianalgesic, antidiabetic, hepatoprotective, anti-inflammatory, antifungal, radioprotective, antiulcer, antispermatogenic and antipyretic.	(Pooja, 2017; S. Sarla & Subhash, 2011; Bisht et al., 2011; Revathi & Lukmanul, 2019)
Ajuga parviflora	Neelkanthi	Lamiaceae	Leaves	Water and Methanolic	Withanolides-I & II, pyrrolizidine alkaloids, senecionine, integerrimine and clerodinin-A.	MTT assay and EBV activation induced methods.	Antimalarial, antitumor, hypertension, anthelmintic, pneumonia, hypoglycaemia, antitussive, oedema, antifungal, anti-inflammatory and antimicrobial.	(Ankit et al., 2019; Xia et al., 2017)
Allium cepa	Pyaj	Amaryllidaceae	Roots, bulbs and flowers	Aqueous, n-hexane, methanolic and n-butenol: water (1:1v/v)	Cepa-2, myricetin, delphinidin-3-glucoside, quercetin-3–4-diglucoside, peonidin-3-glucoside, malvidin-3-glucoside, furfuraldehyde, dipropyl disulfide, isorhamnetin and butyrolactone.	MTT assay.	Antitumor, antidibetic, antioxidant, antibacterial, anti-allergic, antimicrobial, molluscicidal activity, antiproliferative and antimutagenic.	(Ankit et al., 2019; Zeljana et al., 2017)
Allium wallichii	Lainka	Amaryllidaceae	Flowers, tubers, leaves and whole plant	Aqueous and ethanol	Allixin, vinyldithiins, β-chlorogenin, ajoene, organo-selenium, cysteine sulphoxides, S-allylcysteine, arginine, glutamic acid, allicin, diallyl trisulfide, methionine and threonine.	Cell viability assay and MTT assay.	Antidibetic, antihypertensive, anti-microbial, anti-inflammatory, antifungal, analgesic, hepatoprotective, anti-oxidant, antibacterial, antithrombotic and hypocholesterolemic.	(Ankit et al., 2019; Jaya & Muhammad, 2017; Seied & Afra, 2018)
Aloe vera	Ghrit Kumari	*Asphodelaceae*	Leaves	Methanolic, ethanolic, water and dimethyl sulfoxide(DMSO)	Doxorubicin, lectin, barbaloin, aloe-emodin, aloesin, acemannan, anthrone-C-glycosides, β-sitasterol, emodin, butyl-p-tolyl sulphide, alexin-B, campesterol, 6-mrthyl-4-chromanone and lupeol.	MTT assay.	Haemostatic, astringent, arthritis, anti-inflammatory, antiseptic, antioxidant, antibacterial and treat or prevent vitamin deficiency.	(Pooja, 2017; Bisht et al., 2011; Karpagam et al., 2019)
Andrographis paniculata	Kalmegh /Chiretta	*Acanthaceae*	Leaves and aerials	Methanolic, aqueous, acetone, ethanolic and hydro alcohol	Stigmasterol, andrographolide and 14-deoxyandrographolide.	Sulphorhodamine B (SRB) assay and MTT assay.	Antifertility, antidiabetic, hypertension, antityphoid, antivenom, anti-HIV, antifungal, hepatoprotective, antimalarial, anti-inflammatory and immunostimualant.	(Pooja, 2017; Bisht et al., 2011; Avni et al., 2008; Rajeshkumar1 et al., 2015)
Asparagus racemosus	Satavari	*Liliaceae*	Roots, tubers and leaves	Chloroform, methanol, DMSO, ethyl acetate and water	Rutin, quercetin, glutathione, kaempferol, phytoestrogens, asparagines and arginine.	MTT assay	Antibacterial, gastroduodenal ulcer protective, antidiabetic, antiestrogen, anticarcinogenic, antihepatoprotective, antioxidant and immunostimulant.	(Pooja, 2017; Bisht et al., 2011; Verma et al., 2014)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Annona atemoya /muricata	Mamaphal	Annonaceae	Leaves, stems, seeds and fruits	Ethyl acetate, methanolic, ethanol, water, n-hexane and chloroform	Chlorogenic acid, ledol, ferulic acid, vanillic acid, myricetin, cleistopholine, anonaine, myrcene, α-β-pinene, asimilobine, lanuginosine, catechin, epicatechin, stepharine, bullatacin, acetogenin and apoptosis.	MTT assay, HaCaT, WRL-68, MDA-MB-435S cell lines.	Antiparasitic, antioxidant, antileishmanial, antidepressant, antidibetic, antimalarial, antimutagenic, anticonvulsant, antiviral, cardiotonic, nerviness, febrifuge, vermifuge, pediculocide, urine stimulant, analgesic and cytotoxic activities.	(Avni et al., 2008; Saranya et al., 2019; S.M. Bassam et al., 2020; Amudha & Vanitha, 2017; S.M. Bassam et al., 2020; Joseph et al., 2019)
Annona squamosa	Sugar/Custard apple	Annonaceae	Leaves, aerials, seeds, peel, pulp and barks	Ethanol, pet. ether, chloroform, ethyl acetate, methanol and water	Limonene, anonaine, aporphine, isocorydine, norcorydine, glaucine, carvone, linalool, eugenol, bisabolene, borneol, β-caryophyllene, γ-cadinene, geraniol, germacrene-D, β-cedrene, α-pinene, α,β-unsaturated γ-lactone and aromadendrene.	MTT assay, flow cytometry analysis and fluorescence phase-contrast microscope.	Antifertility, anthelmintic, antiviral, anti-atherogenic, anti-platelet, antidibetic, antiplasmodial, anti-genotoxic, anti-inflammatory, antithyroidic, anti-ulcer, antiobesity, antihyperlipidemic, antihistaminic, hepatoprotective, antihypertensive, antiparasitic, antimalarial, mosquitocidal and molluscicidal activities.	(Saranya et al., 2019; Manoj et al., 2021; Gajalakshmi et al., 2011)
Artocarpus obtusus	Sabah/Sarawak	*Moraceae*	Stems and barks	n-hexane, chloroform and methanol	Pyranocycloartobiloxanthone-B, pyranocycloartobiloxanthone-A and dihydroartoindonesianin-C.	MTT assay	Antioxidant, antimicrobial, antiproliferative, tyrosinase inhibitory and antibacterial.	(Pooja, 2017; M.H. Najihah et al., 2012; M. Najihah et al., 2012)
Arbutus andrachne/unedo	Strawberry	Ericaceae	Leaves, barks and stems	Chloroform, methanol and ethanolic	Myricetin, betulin, kaempferol, proanthocyanidins-B_1,B_2,B_3,B_7, betulinic acid, quercetin, vanillic acid, flavan-3-ols, gallic acid, gentisic acid, catechins, procyanidins, galloylquinic acid, gallotannin, α-linolenic, linoleic, oleic acids, α-β-γ-δ-tocopherols, lupeol and β-sitosterol.	XTT method, MTT assay and A-375, A-431, HeLa and HEK-293 cellas.	Antioxidant, anti-diabetic, antiproliferative, anti-aggregant, cardiovascular, anti-diarrhoeal, antiseptic, anti-hypertension, astringent, anti-diarrhoeal, human platelet, antibacterial, anti-inflammatory, neurological and antimicrobial.	(Saranya et al., 2019; A. Emna et al., 2016; A. Emna et al., 2016; Eman et al., 2016; Maria et al., 2014)
Aristolochia ringens	Ako-igun	Aristolochiaceae	Roots	Ethanolic, dichloromethane, methanol and water	Aristolactams, aporphines, isoquinolines, *p*-cymen-8-ol, limonene, β-caryophyllene, benzyl isoquinoline, isocaryophyllene, coumarins, tetralones and benzenoids.	A-549, HCT-116, PC-3, and THP-1 human cancer cell lines and semiautomated assay.	Anti-fertility, emmenagogues, abortifacient, anti-inflammatory, antipyretic, antimicrobial, antiseptic, anti-fungal, anti-venom, antispermatogenic, anti-hypertensive, storage stability as preservative, foaming as lather, curative, and nephrotoxic.	(Saranya et al., 2019; Taiye et al., 2015; Latha et al., 2015; Tian-Shung et al., 2004)
Aristolochia bracteolata	Worm killer	Aristolochiaceae	Leaves	Ethyl acetate, methanol and ethanol	Aristolochic acids-I & II, betulin ester, aristolactams, aporphines, protoberberines, isoquinolines, benzyl isoquinolines, coumarins, tetralones and benzenoids.	MTT assay	Antipyretic, antiscorpion, antisnake, analgesic, antihelminthic, antiallergic, anti-inflammatory, anti-arthritis, antiulcer, antibacterial, antioxidant, antifungal, antiplasmodial, antimicrobial, wound healing, anti-angiogenetic, trypansocidal, anti implantation and abortifaciant activity.	(Latha et al., 2015; Tian-Shung et al., 2004; Abdelgadir et al., 2011)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Artemisia nilagirica	Wormwood/Kunja	Asteraceae	Leaves and stems	n-hexane, butenol, ethyl acetate, ethanol and water	Borneol, terpinene-4-ol, 1,8-cineole, *β*-caryophyllene, L-linalool, *β*-thujone, azulene, lactones, coumarins, acetylenes, *β*-eudesmol, *α*-gurjunene, para-cymene, *α*-pinene and stigmasterol.	SRB and MTT assay.	Antimicrobial, nervous disorders, antifilarial, epilepsy, anti-asthmatic, antiparasitic, antifungal, antiulcer, antibacterial, insecticidal, antioxidant, diuretic, anti-inflammatory and skin diseases.	(Ankit et al., 2019; Suresh et al., 2011; Pandey & Singh, 2017)
Artemisia herba-alba	Desert wormwood	Asteraceae	Whole plant, leaves, flower, stems and aerial	Methanolic, ethanolic and water	Chlorogenic acid, rutin, vicenin-2, dihydrocostunolide and piperitone.	Human cell lines (RT-112, Hep-2 & K-562), Q-RT-PCR, P-815 & BSR cancer cells and MTT assay.	Antihelminthic, antidiabetic, anti-venom, antioxidant, antileishmanial, analgesic, antibacterial, pesticidal, antispasmodic, antimalarial and as antibiotic resistant inhibitor.	(Pandey & Singh, 2017; Mohamed et al., 2010)
Beberis aristata	Barberry	Berberidaceae	Bark and stems	Water, methanolic and ethanolic	Berberine, *β*-sitosterol, palmatine, aromoline, berbamine, jatorrhizine, quercetin, columbamine, caffeic acid, chlorogenic acid and rutin.	MTT assay	Anti-parasitic, anti-amoebic, anti-platelet, anti-secretory, antidibetic, osteoporosis, antiproliferative, antihypertensive, anti-inflammatory, anti-pyretic, anti-ulcer, anti-arthritic, anti-diarrhoeal, antihepatotoxic, antimalarial, immunomodulatory, HIV-AIDS and tuberculostatic activity.	(Saranya et al., 2019; S. Sarla & Subhash, 2011; Deepti et al., 2014; Sharma et al., 2011; Ibrahim et al., 2016)
Bergenia ciliata	Syalphadi	Saxifragaceae	Rhizome,	n-hexane, chloroform, methanol, ethanol and water	Benzenoids, ellagitannins, gallic acid, monogalloylquinic acid, benzaldehyde, benzeneacetaldehyde, decadienal, catechin-7-*O*-glucoside, *p*-hydroxybenzoic acid, afzelechin, catechin, arbutin, bergenin and protocatechuic acid.	XTT assay and brine shrimps cytotoxicity assay.	Antimalarial, anti-ulcer, anti-diabetic, antioxidant, antidotary, antiasthma, anti-inflammatory, antiurolithic, antiarrhythmic, antiwrinkle, antidiarrheal, antiepileptic, antiflatulent, anti-haemorrhoidal, antiviral, antilithiatic, antimenorrhagic, antiobesity, antiophthalmia, antipyretic, antispasmodic, antiulcer, burn wound healing, immunomodulatory and pulmonary action.	(Ankit et al., 2019; Mohammad & Vimal, 2016; Ruby et al., 2012; Vinesh & Devendra, 2013; Farman et al., 2016; Roheena et al., 2019; Bhupendra et al., 2020)
Betula utilis	Bhojpatra /Himalayan birch	*Betulaceae*	Barks	Ethyl acetate, chloroform, methanol and water	Triterpenes, *β*-sitosterol, lupeol, betulinic acid, oleanolic acid, myristic, linalool, palmitic, lupenone, oleic, linoleic, geranic acid, methyl betulonate, *β*-amyrin, betulin, sesquiphellendrene, ursolic acid, karachic acid, 1,8-cineol and champacol.	SRB and MTT assay.	Antiseptic, contraceptive, antibacterial, carminative and antifungal.	(Pooja, 2017; Bisht et al., 2011; Tripti et al., 2016)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Bidens bipinnata	Marigold /Kumur	*Asteraceae*	Leaves	Ethanol and water	Aurons, polyacetylenes, phenylpropanoid, polyacetylenic glycosides, sesquiterpenes, aurons glycosides, acetylacetone and cardiac glucosides.	MTT assay	Antioxidative, antimalarial, antiallergic, antipyretic, antimicrobial, antidibetic, antibacterial and IFN-a promoter.	(Bisht et al., 2011; Parimalakrishnan et al., 2006)
Bidens pilosa	Ottrancedi	Asteraceae	Aerial, whole plant and leaves	n-hexane, ethyl acetate, methanol, ethanol, hydro alcoholic, acetone, chloroform, and water	Friedelan-3-beta-ol, linolenic acid, phenylheptatriyne and friedelin.	Brine shrimp & haemolytic, MTT and NRU assay.	Antioxidant, antipyretic, antimicrobial, anti-inflammatory and antimicrobial.	(Parimalakrishnan et al., 2006)
Boswellia serrata	Salai guggul	Burseraceae	Oleo gum resins	Pet. ether, methanol, ethanolic and water	Boswellic acid, arabinose, galactose, xylose, α-β-pinene, borneol, myrcene, 3α−24-dihydroxyurs-12-ene, phallendrene, cadinene, verbenone, limonene, verbenol, *p*-cymene, α-thujene, α-copaene, α-terpinyl acetate, methyl chavicol, linalool and α-terpineol.	SRB and MTT assay.	Antiviral, analgesic, anti-complementary, antifungal, anti-hyperlipidmic, anti-asthmatic, antitumor, anti-neurotic, anti-artherosclerotic, hepatoprotective, antidiuretic, antidepressant, antidiarrhoeal, anti-obesity, antiseptic, anti-inflammatory, anticonvulsant, asthma, anti-arthritic, antioxidant and anti-Alzheimer's.	(Avni et al., 2008; Sudhanshu et al., 2020; Aman & Balu, 2009; Mahe et al., 2012; Nand et al., 2019)
Centella asiatica	Brahmi	*Apiaceae*	Leaves	Aqueous, ethyl acetate, acetone and methanol	Vallarine, sistosterol, asiaticoside, oxyasiaticoside and madecassoside.	MTT assay	Antiulcer, antimicrobial, leprosy, eczema, antioxidant, lupus, antidiarrheal, analgesic, antibacterial, psoriasis and amenorrhoea.	(Bisht et al., 2011; Avni et al., 2008; Iwan et al., 2016)
Cassia fistula	Amaltas /Cassia	Leguminosae	Whole plant, fruits (pulp & seed) and flowers	Methanolic, n-butenol and ethyl acetate	Rhein, fistucacidin, β-sitosterol, hexacosanol, lupeol, caprylic, myristic acids, lecithin phospholipids, epiafzelechin, proanthocyanidins, procyanidin B-2 and epicatechin.	MTT assay	Antiulcer, antidiabetic, purgative, antipyretic, hypoglycaemic, analgesic, anti-inflammatory, antioxidant, antipruritus, antirheumatic, anti-tissive, antileucoderm, antiseptic and antifertility.	(Bisht et al., 2011; Duraipandiyan et al., 2012)
Catharanthus roseus	Sadabahar	*Apocynaceae*	Seeds, stems, leaves, flowers and roots	Methanolic and ethanolic	Vinorelbine, vinblastine, vincristine and vindesine.	MTT assay	Antimicrobial, anti-mitotic, rhabdomysacroma, anti-microtubule, leukaemia and neuroblastoma.	(Pooja, 2017; Bisht et al., 2011; Harshini et al., 2020)
Centella asiatica	Brahmi /Penny wort	*Apiaceae*	Leaves	Methanolic, ethanolic, ethyl acetate, DCM and water	Madecassoside, vallarine, asiatic acid, hydrocotylin, brahmoside, madecassic acid, asiaticosides, centelloside, β-sitosterol and brahminoside.	MTT and SRB assay.	Antiinfertility, antimicrobial, anxiety, blood pressure, anti-ulcer, antibacterial and antidiabetic.	(Bisht et al., 2011; Iwan et al., 2016)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Cedrus deodara	Deodar	*Pinaceae*	Pine needle, barks and stems	Ethanolic, water and hydro-alcoholic	Dihydromyricetin, oleoresin, dibenzylbutyrolactol, α-β-himachalene, β-sitosterol, ethyl stearate, isocentdarol, 3-beta-hydroxy-oleanolic acid, shikimic acid and ferulic acid.	MTT, DMH and SRB assay.	Antifungal, anti-ulcer, antioxidant, antiapoptotic, anti-malarial, antihyperlipidemic, analgesic, anti-ulcer, anti-allergic, anti-diabetic, antibacterial, anticonvulsant, antispasmodic, insecticidal, anticonvulsant, antitubercular, antiproliferative, antisarcoptic mange, anti-arthritic, anti-urolithiatic, antiurolithiatic, anti-inflammatory and anthelmintic activity.	(Avni et al., 2008; Sumeet et al., 2011; Dwaipayan, 2019; Chandur et al., 2011; Amit et al., 2018)
Cleome viscosa	Jakhiya	*Cleomaceae*	Barks, whole plant, fruits, seeds and leaves	Methanolic, ethanolic and aqueous	3-glucuronide, lupeol, arginine, aspartic acid, ursolic acid, chrysosplenetin, macrocyclic diterpene, glutamic acid and anthroquinones.	MTT, SRB assay and Brine shrimp lethality method.	Antinociceptive, nematicidal, insecticidal, antimalarial, hepatoprotective, analgesic, anti-inflammatory, antiemetic, antiseptic, antiulcer, anti-convulsants, anti-arthritic, antihelmintic, rheumatic arthritis, hypertension, antimicrobial, antimalarial, antioxidant, antipyretic, anti-diarrhoeal, antidibetic, antiplasmodial, antiemetic and antioxidant.	(Bisht et al., 2011; Anuj et al., 2018; Ravi, 2015; Subhash et al., 2021)
Curcuma longa	Haldi	*Zingiberaceae*	Rhizomes	Heptanes, chloroform, methanol, ethanolic and water	Curcumin, glucuronide, demethoxycurcumin and bisdemethoxycurcumin.	MTT and SRB assay.	Anti-HIV, antiseptic, anti-inflammatory, antibacterial, antioxidant, antifungal, antiviral, antitumor and antimicrobial.	(Bisht et al., 2011; Ankit et al., 2019; Avni et al., 2008; Antonio & Giuseppina, 2019)
Dioscorea bulbifera	Tairu	Dioscoreaceae	Roots, rhizomes, tubers, stems, leaves and bulbs	Pet. ether, chloroform, ethyl acetate, n-hexane, methanol, ethanol, benzene, acetone and water	Diosgenin, kaempferol, lutein, zeaxanthin, diosbulbin-B-D-F, tristin, protocatechuic acid, adenosine, stigmasterol, azelaic acid, caryatin and catechin.	MTT assay	Anti-diabetic, antifungal, antidyslipidemic, antituberculosis, anorexiant, anti-inflammatory, antihyperlipidemic, antihelminthic, sore throat, analgesic, contraceptive, antitumor, antiHIV, antihyperglycemic, antioxidant and plasmid curing.	(Ankit et al., 2019; Gang et al., 2009; Jin-Song et al., 2017; Hilda et al., 2019; S. Sarla & Subhash, 2012)
Hippophae salicifolia	Amesh	Elaeagnaceae	Barks	Methanolic and ethanolic	Kaempferol, myricetin, β-sitosterol, vitamins A, B_1–$_{12}$, C, E (β, α, γ), K, isorhamnetin, quercetin, δ-β-carotene, lycopene, violaxanthin, β-cryptoxanthin and neoxanthin.	Trypan blue exclusion and MTT assay.	Anti-sterility, antifertility, antiviral, antibacterial, anti-atherosclerosis, antifungal, antioxidant, anti-inflammatory, radio-protective, immunomodulatory, adaptogenic and currently more than 150 pharmaceuticals/nutraceuticals companies around the world are used.	(Ankit et al., 2019; Manu et al., 2014; Tanurajvir et al., 2017)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Mappia foetida	Amruta	*Icacinaceae*	Barks, roots, stems, leaves and seeds	Methanolic	p-Hydroxybenzaldehyde, thymine, oleic acid, scopoletin, linolenic acid, camptothecin, scopoletin, linoleic acid, β-sitosterol, uracil, palmitic acid, stearic acid, trigonelline, 9-methoxy-camptothecin and 3-ketooctadec-cis-15-enoic acid.	MTT assay	Anti-HIV, antimicrobial, anti-inflammatory, antimalarial, anti-fungal, antibacterial, anti-anaemic, anti-oxidant and immunomodulatory activity.	(Avni et al., 2008; Nazeerullah et al., 2013)
Nelumbo nucifera	Kamal /Lotus	*Nelumbonaceae*	Leaves, flowers, stamen and embryos	Methanol, acetone, n-hexane, ethanol and water	Liensinine, isoliensinine, roemerine, neferine and procyanidins.	MTT assay	Antidiarrheal, anti-obesity, anti-angiogenic, hepatoprotective, immunomodulatory, anti-inflammatory, antispasmodic, anti-diabetic, sedative, anti-pyretic, menorrhagia, anti-steroidogenic, halitosis, antifertility, antimicrobial, antioxidant, dermatopathy, antiviral and anti-hyperdipsia.	(Bisht et al., 2011; Xin et al., 2017)
Ocimum tanuiflorum	Tulsi /Holy basil	*Lamiaceae*	Leaves and roots	Water and methanol	Oleanolic acid, ursolic acid, eugenal, camphene, oleic, pinenes, linoleic, linolenic acid, selinene, apigenin, luteolin, methyl ester, cerebrosides, 12-dimethylbenz-(a)-anthracene, palmitic, eugenol and stearic acid.	MTT assay	Antifungal, antidiabetic, antimicrobial, antifertility, anti-inflammatory, immunomodulatory, anti-asthmatic, hypotensive, antioxidant, analgesic, antipyretic and antibacterial.	(Bisht et al., 2011; Lam et al., 2018)
Phyllanthus amarus	Bhui-aonla	*Euphorbiaceae*	Whole plant and leaves	Water, methanolic and dimethylformamide	Quercetin, phyltetralin, phyllanthin, lignans niranthin, hypophyllanthin and nirtetralin.	Trypan blue exclusion and MTT assay.	Antistomachic, antiviral, antispasmodic, antibacterial, antianalgesic, antidiabetic and hypertension.	(Bisht et al., 2011; Avni et al., 2008; Rajeshkumar et al., 2002)
Piper longum	Pipalli /Long pepper	*Piperaceae*	Fruits and seeds	Chloroform, benzene, ethyl acetate, acetone, methanol, ethanolic and aqueous	piperine, β-sitosterol, piperlongumine, sylvatine, guineensine and piperlongumine.	SRB and MTT assay	Immunostimulatory, antiamoebic, anti-inflammatory, antimicrobial, anti-giardial, antioxidant and antiulcer.	(Bisht et al., 2011; Saranya et al., 2019; Amit et al., 2014)
Plumbago zeylanica	Chitrak	*Plumbaginaceae*	Flowers, roots, leaves and stems	Pet. ether, ethanolic, hydro-alcoholic and aqueous	Trilinolein, β-sitosterol, plumbagin, lupenone, cyanidin-3-O-β-glucopyranoside and lupeol.	SRB, MTT assay and Ehrlich Ascites Carcinma animal model.	Antioxidant, anti-inflammatory, antimicrobial, antiseptic and abortifacient.	(Pooja, 2017; Bisht et al., 2011; Hema & Jayachitra, 2019)
Podophyllum hexandrum	Ban kakri /May apple	*Berberidaceae*	Rhizomes, roots, fruits, whole plant and leaves	Aqueous, ethanolic, methanolic, n-hexane, benzene and chloroform	podophyllotoxin, lipopolysaccharide, berberine, interleukin-1-β, podophyllum and phorbol-12-myristate-13-acetate.	MTT assay	Antioxidant, vermicidal, liver tonic, immunostimulatory, antimicrobial and antimalarial.	(Bisht et al., 2011; Semwal et al., 2010)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Punica granatum	Anar	Lythraceae	Fruits, Leaves, seeds and peels	Aqueous, ethanolic and methanolic	Punicic acid, myricetin, kaempferol, luteolin, brevifolin, isolariciresinol, maslinic acid, α-conidendrin, pelletierine, ursolic acid, asiatic acid, phloretin, isopelletierine, coumestrol, matairesinol, hovetrichoside-C, betulinic acid, pseudopelletierine, methionine, vanillic acid, corilagin, chlorogenic acid, sinapic acid, neochlorogenic acid, castalagin, pedunculagin-I-II, isocorilagin, hippomanin-A and oenothein-B.	MTT assay and Trypan blue exclusion method.	Antiviral, antimalarial, antiobesity, antialzheimer's, antiparasitic, antidiarrheal, antibacterial, antifungal, analgesic, antiaging, antiplasmodium, male infertility, anti-diabetic, antihypertension, anticarcinogenic, osteoarthritis, antimicrobial, anti-inflammatory, antiatherogenic, antioxidant, obesity, immune suppressive activity and nephrotoxicity protection.	(Ankit et al., 2019; Sharrif & Hamed, 2012; Sheng & Li, 2017; Arshad et al., 2017)
Rubia Cordifolia /manjith	Manjith /madder	*Rubiaceae*	Roots and aerial	Aqueous, pet. ether, methanolic, Ethanolic, dichloromethane and cyclophosphamide	Alizarin, rubiadin, purpurin, munjistin and rubierythrinic acid.	XTT method, MTT and SRB assay.	Antivenom, antimicrobial, immunomodulatory and antioxidant.	(Bisht et al., 2011; Patel et al., 2011)
Rumex nepalensis	Khuldya	Polygonaceae	Roots	Methanolic and ethanolic	Chrysophanol, physcion, emodin, aloesin, catechin, resveratrol, orcinol glucoside, ferulic acid, linoleic acid, palmitic acid, stearic acids, methylorsellinate, isovanillin, pulmatin, pentadecanoic acid, neopodin, 1-octadecene, orcinol glucoside and citreoresin.	MTT assay and SKBR-3, H-522, MCF-10A, MCF-7 & A549 cell lines.	Antipyretic, antidiabetic, antidiarrheal, anti-malarial, antiviral, antiproliferative, antifungal, antibacterial, anti-inflammatory, antitumor, antihypertension, anti-suppressive, antioxidant, anti-ageing, analgesic, anti-mutagenic, antimicrobial, wound healing, anti-plasmodial, purgative, anti-algal, insecticidal and CNS depressant.	(Ankit et al., 2019; Yilma et al., 2021; Samrin et al., 2018; Nusrat et al., 2017)
Saussurea costus	Kuth	Asteraceae	Leave and roots	Methanolic, n-hexane, ethyl acetate, chloroform and ethanolic	Naringenin, kaempferol,ferulic acid, malic acid, ellagic acid, gallic acid, cinnamic acid chlorogenic acid, vanillin, coffeic acid, taxifolin, catechin, syringic acid, methyl gallate and rutin.	SRB, MTT assay.	Anti-inflammatory, antibacterial, antifungal, antioxidant, hepatoprotective and antimicrobial.	(Ankit et al., 2019; Mohamed et al., 2021)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Saussurea lappa	Costus	Asteraceae	Roots and fruits	Methanolic and aqueous	Costunolide, β-pinene, linalool, α-pinene, myrcene, γ-terpinene, isodihydrocostunolide, sabinene, phellandrene, anethole, limonene, thymol, α-thujene, estragole, camphene, p-cymene, α-terpinolene, menthone, terpinen-4-ol, cryptone, α-terpineol, ocimene, isozaluzanin, zaluzanin-C, cynaropicrin, lappalone, reynosin, magnolialide, isocostic acid, β-sitosterol, daucosterol and pregnenolone.	MTT assay	Anti-viral, anti-epileptic, antiarthritic, antidiarrheal, anti-inflammatory, anticonvulsant, anti-hyperlipidemic, antibacterial, anti-hepatotoxic, angiogenesis, antibacterial, anti-ulcer, antimicrobial, hepatoprotective, antioxidant, neuroprotective, cardiovascular and immunomodulatory activity.	(Ravinder et al., 2017; Mohammad et al., 2013)
Taxus baccata	Thuner /Yew tree	*Taxaceae*	Needles, leaves and seeds	Aqueous and methanolic	Paclitaxel, taxodione, gibberellin A-12, carnosol, sugiol, ferruginol, phenylbutyl, isolariciresinol, taxiresinol, lariciresinol and baccatin III.	MTT assay	Immunomodulatory, antifungal, analgesic, antibacterial, anti-inflammatory, sedative, antimicrobial, anti-nocieptive, aphrodisiac, antimalarial, antipyretic, antirheumatic, anti-spasmodic, antioxidant, anticonvulsance and emmenagoque.	(Bisht et al., 2011; Ankit et al., 2019; Milena et al., 2015)
Terminalia arjuna	*Arjun kowa /Arjun*	*Combretaceae*	Barks and leaves	Ethanolic, pet. ether, DMSO and methanolic	Casuarinin, arjunetin, luteolin, arjunone, friedlin, β-sitosterol, gallic acid and ellagic acid.	SRB, MTT assay, Trypan blue exclusion method and LDH assay.	Antioxidant, anti-anaemiac, alexiteric, anti-leucodermatic, styptic, anti-asthmatic, antimicrobial and anthelmintic.	(Bisht et al., 2011)
Tinospora cordifolia	Giloe /Guduchi	*Menispermaceae*	Stems	Methanolic, acetone, aqueous, DMSO and ethanolic	Palmatine, columbin, phenylpropanoids, β-sitosterol, tinosporide, phytoecdysones, giloin, giloinin, isocolumbin, tetrahydropalmatine, magnoflorine, tinosporidine, berberine and tinosporic acid.	Trypan blue exclusion method and MTT assay.	Antileprotic, immunostimulatory, antitoxicity, antimalarial, antidiabetic, antispasmodic, spleenic disorder, antipyretic, nervine tonic, anti-inflammatory, antiarthritic, antimicrobial, antiallergic, anthelmintic and antioxidant.	(Pooja, 2017; Bisht et al., 2011; Ankit et al., 2019; Avni et al., 2008; Rumana & Srivastava, 2015)
Trigonella foenum-graecum	Methi /Fenugreek	*Papilionaceae*	Leaves, seeds and whole plant	Aqueous, ethanolic, methanolic, ethyl acetate and pet. Ether	Diosgenin, cyclophosphamide and gitogenin.	MTT and SRB assay.	Immunomodulatory, antimicrobial, antioxidant, antiseptic, antidiabetic, antibacterial, aphrodisiac, antiparasitic, carminative, hypocholesterolaemic, anthelmentic, lactation stimulant, antipyretic and anti-inflammatory.	(Bisht et al., 2011; Faris et al., 2021)

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Table 1 (*continued*)

Plant Name	Common Name	Family	Plant parts used	Extracts	Anticancer compounds	Anticancer methods	Biological activities	References
Urtica dioica	Kandali	Urticaceae	Leaves, aerial, stems and roots	Aqueous, methanolic, ethanolic and dichloromethane	Kaempferol, isorhamnetin, secoisolariciresinol, gentisic acid, amentoflavone, ferulic acid, quercitrin, catechin, esculetin, protocatechuic acid, scopoletin, chrysoeriol, acetylcholine, moroidin, carvacrol, carvone, E-anethol, hexa-hydrofarnesyl acetone, E-β-ionone and phytol.	MTT assay and TUNEL method.	Antiviral, antidiabetic, anti-ulcer, anti-alzheimer, antimicrobial, anti-androgenic, analgesic, antioxidant, anti-inflammatory, antibacterial, antifungal, anti-colitis, anti-androgenic, anti-hyperglycaemia, anti-hyperlipidaemia and immunomodulatory.	(Ankit et al., 2019; S. Sarla & Subhash, 2012; Jinous & Razieh, 2012; Dorota et al., 2018)
Withania somnifera	Ashwagandha /Ginseng	*Solanaceae*	Roots, stems, leaves and whole plant	Ethanolic, aqueous and hydro-alcoholic	Withanolides, anahygrine, anaferine, withanine, β-sitosterol, chlorogenic acid, somniferine, cysteine and scopoletin.	Trypan blue exclusion method and MTT assay.	Antimicrobial, cardiotonic, antitumor, anti-ageing, immunomodulatory, antistress, diuretic, hypothyroid, hypoglycaemic, antioxidant, anti-inflammatory, antiseptic, aphrodisiac, thyro-regulatory, hemopoietic, anti-peroxidative and rejuvenating properties.	(Bisht et al., 2011; Avni et al., 2008; Saranya et al., 2019)
Ziziphus nummularia	Bhukamtaka /Sidr	Rhamnaceae	Leaves, barks and fruits	n-hexane, chloroform, methanolic, ethanolic and water	Betulin, betulinic acid, campesterol, stearic acid, linoleic acid, palmitic acid, squalene, trans-geranylgeraniol, lupeol, stigmasterol, vitamin-E, benzoic acid, γ-sitosterol, oleic acid, squalene, tetratetracontane, tricosane, tetradecane, lapachol, 2-methoxy-4-vinyl phenol and ethyl alpha-D-glucopyranoside.	MTT assay	Anthelmintic, anti-migratory, anti-secretory, anti-invasive, antidiarrheal, anti-ulcer, anti-inflammatory, anti-spasmodic, antifungal, anti-proliferative, anti-teratogenicity, anti-allergic, antiprotozoal, antihyperlipidemic, anticonvulsant, anxiolytic, antidepressant, hair fall defence, antidandruff, antimicrobial, anti-angiogenic, anti-proliferative, antipyretic, antifertility, anti-androgenic, antidiabetic, anti-stiffness and anti-hypercholestrolemic.	(Avni et al., 2008; Joelle et al., 2021; Sayed et al., 2017; Sonia & Sumitra, 2019)

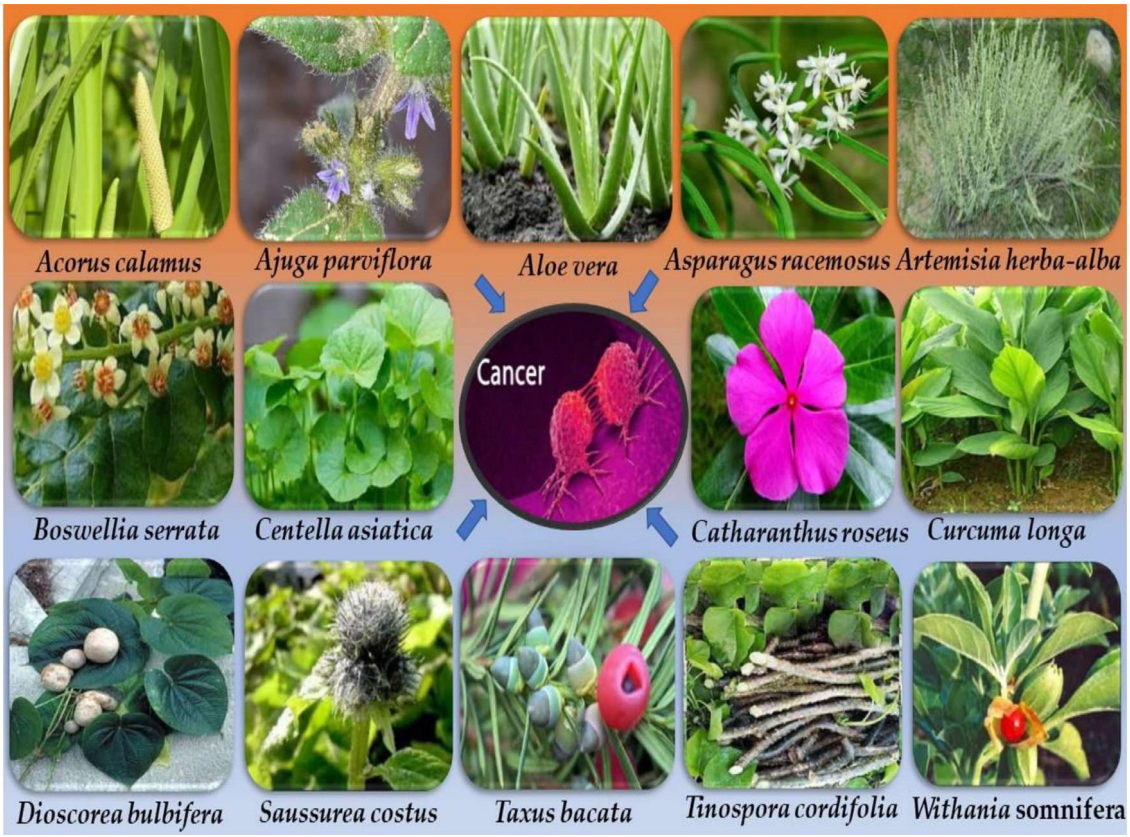

Fig. 1. Medicinal plants having efficacy against cancer.

perceived in Indian *A. herba-alba* are herbolide, torrentin, chlorogenic acid, dihydroreynosin, isophorone, rutin, schaftoside, isoschaftoside, vicenin-2, 11-epitaurin, vachanic acid, α,13-dihydrocostunolide, 3-Epi-erivanin, 1-b-hydroxy colartin, pinocarveol, artemisia ketone, deacetyl-torrentin, piperitone and herbalbin Mohamed et al. (2010); Sarla and Subhash (2011). The quercetin and apigenin administration in syngeneic mice repressed the development and metastatic budding of melanoma (B-16-BL-6) cells in vitro. The chemopreventive activities of chlorogenic acid indicated possible role of microsomal glucose-6-phosphate translocase in the brain tumours growth.

3.2.6. *Boswellia serrata*

Boswellia serrata (guggul) is a member of the family Burseraceae (Avni et al., 2008; Sudhanshu et al., 2020; Aman & Balu, 2009). *B. serrata* is frequently used to cure inflammatory diseases i.e., viral, fungal, asthma, etc. (Mahe et al., 2012; Nand et al., 2019). The oleo gum resin extract of *B. serrata* had more anticancer activity against 3 human cancer cell lines like human laryngeal carcinoma, bladder carcinoma, human myelogenous leukaemia cells.

3.2.7. *Centella asiatica*

Centella asiatica (brahmi) belonging to Apiaceae family is a traditional medicinal plant of India and China (Bisht et al., 2011; Avni et al., 2008). The ethyl acetate, aqueous, acetone and methanol extracts of *C. asiatica* leaves possesses alkaloids that were assessed for their cytotoxicity effect in human lung epithelial carcinoma (A-549) cell line with help of colorimetric MTT assay (Iwan et al., 2016). *C. asiatica* leaf was physiologically active and had a significant cytotoxic impact. After 48 h of incubation, the leaf ethyl acetate extract of C. asiatica displayed the maximum cytotoxic activity, with an IC50 of 82 g/mL.

3.2.8. *Catharanthus roseus*

Catharanthus roseus (sadabahar) belongs to family Apocynaceae is native to India, China. Extracts from *C. roseus* are traditionally used to cure asthma, leukaemia, insomnia, cancer, and diabetes (Pooja, 2017; Bisht et al., 2011). The methanolic extracts of *C. roseus* exhibited noteworthy anticancer action on the (Hep-2) cell line. These extracts inhibited cells significantly, lowering viable cell count. The MTT assay was used to test the cytotoxicity effect of ethanolic extract of C. roseus flower in human epithelial cervical carcinoma cell line(HeLa) (Harshini et al., 2020).

3.2.9. *Curcuma longa*

Curcuma longa (turmeric, haldi) belonging to ginger family Zingiberaceae (Bisht et al., 2011) has wide range of pharmacological effects like anti-HIV, antiseptic, anti-inflammatory, antibacterial, antioxidant, antifungal, antiviral, antitumor, and antimicrobial activities (Ankit et al., 2019; Avni et al., 2008). Curcumin being the main constituent of *C. longa* is responsible for its beneficial activities. Curcumin displays anticancer, antidiabetic, and anti-inflammatory activities (Antonio & Giuseppina, 2019). Cyclooxygenase (C0X-2) has a vital role in initiation of colon cancer. The HT-29 colon cancer cells treated with different concentrations of curcumin decreased expression of (COX-2).

Curcumin aiding in prevention of colon cancer and breast cancer cell lines (MCF-7) was assessed through SRB and MTT assays for cytotoxicity and cell viability, respectively which exhibited augmented caspase 3/9 activity and initiation of apoptosis indicating downregulation of miR-21 the expression of miR-21 in MCF-7 cells by upregulation of PTEN/Akt signalling pathway (Antonio & Giuseppina, 2019).

3.2.10. *Dioscorea bulbifera*

Dioscorea bulbifera (Air Potato) belonging to family Dioscoreaceae has 13 species globally. It is mostly employed in India and China as traditional medicine for its anticancer and antidiabetic effects (Ankit et al.,

2019; Gang et al., 2009; Jin-Song et al., 2017). *D. bulbifera* possesses significant secondary metabolites such as diosgenin, kaempferol-3, 5-dimethyl ether, lutein, zeaxanthin, neoxanthins, mono-arachidin, behenic acid, demethyl batatasin-IV, diosbulbin-B-D-F, docosyl ferulate, tristin, protocatechuic acid, adenosine, stigmasterol, azelaic acid and caryatin Hilda et al. (2019); S. Sarla and Subhash (2012). Aqueous, methanolic and ethanolic extracts of *D. bulbifera* exhibited likely anticancer effect against human gastric (BGC-823), human liver carcinoma (HepG-2 and SMMC-7721), human oesophagus adenocarcinoma (CaEs-17) cell lines) and human colon adenocarcinoma (LoVo and SW-116).

3.2.11. *Saussurea costus*

Saussurea costus(kuth/ Indian costus) belonging to the family Asteraceae. The leaves and root of *S. costus* are poteintially used traditionally in North Korea, Japan, China and India for cancer, diabetes, fungal, microbial, sore throat, inflammation, cough, etc. (Ankit et al., 2019). *S. costus* possesses many biologically active isolated compounds like naringenin, vanillin, chlorogenic acid, kaempferol, ferulic acid, syringic acid, ellagic acid, taxifolin, methyl gallate, cinnamic acid, pyro-catechol, doconexent, butanedioic acid, etc. (Mohamed et al., 2021). The anticancer activity of *S. costus* reduced PKC improvement of matrix metallopeptidases (MmP-9 and MmP-2) causing death of HT-80 cells dose-dependently.

3.2.12. *Taxus bacata*

Taxus bacata (Thuner) belonging to family Taxaceae (Bisht et al., 2011) have anticancer, antimalarial, antiparasitic, antifungal, analgesic, antibacterial, anti-inflammatory, antimicrobial, anti-nocieptive, aphrodisiac, antipyretic, antirheumatic, anti-spasmodic, antioxidant, anticonvulsance effects (Ankit et al., 2019). In vitro and in vivo researches exposed that oridonin persuades apoptosis in a wide range of cancer, including hepatocellular, cutaneous, colorectal, gallbladder, breast, gastric, and pancreatic malignancies. The MTT test was used to assess the cytotoxicity of T. bacata aqueous and aqueous methanol extracts against human colon cancer (HCT-116) cell lines (Milena et al., 2015).

3.2.13. *Tinospora cordifolia*

Tinospora cordifolia (Giloe or Guduchi) belonging to family Menispermaceae is found in China, Japan, India, Europe, and East Asia (Pooja, 2017; Bisht et al., 2011; Ankit et al., 2019). *T. cordifolia* extract is used in brain, intestine, breast, head, vaginal, prostate & neck cancer. The methanolic, aqueous, and ethanolic extracts of stems caused programmed cell death inhibiting apoptosis. The in vitro cytotoxic effect of DMSO and ethanolic extract from *T. cordifolia* stems against murine monocyte/-macrophages (J-774-A-1), human melanoma (A-375) and human breast cancer (MCF-7) cell lines was determined by the colorimetric MTT assay and TBE method (Avni et al., 2008; Rumana & Srivastava, 2015).

3.2.14. Withania *somnifera*

Withanaia somnifera (ashwagandha) belonging to family Solanaceae is grown in India, China, Japan, Europe and Asia and frequently used in cancer and diabetes (Bisht et al., 2011). The presence of these substances (withanolides, anahygrine, withananine, anaferine, withanine, β-sisterol, tropanol, chlorogenic acid, somniferiene, cysteine, scopoletin and somniferimine) contributes to anticancer and antidiabetic actions. The hydro-alcoholic extract has the highest scavenging activity when compared to the ethanolic extract. The cytotoxicity of ethanolic, aqueous and hydro-alcoholic extracts of W. somnifera root, stem, and leaves on Hep-2 cells was examined with the MTT assay and the TBE method (Avni et al., 2008; Rajeshkumar1 et al., 2015; Verma et al., 2014; Saranya et al., 2019). Hydro alcoholic (IC50 = 55 g/mL) and ethanolic (IC50 = 69 g/mL) extracts were determined to be the most active.

3.3. Possible molecular mechanism of medicinal plants in cancer

A. paniculata is a robust chemoprotective drug showing effect against many viral and neoplastic agents as it can trigger both types of immune response. Andrographolide being cytotoxic to cancer cells like KB human epidermoid cancer cells, MCF-7 breast cancer cells, P388 lymphocytic leukaemia cells, and HCT-116 colon cancer cells. Andrographolide inhibits colon cancer cell line HT 29 growth, promotes human peripheral blood lymphocytes proliferation as well as division along with pro-differentiative actions in M1 murine myeloid leukaemia cell line (Oseni et al., 2021).

Betulin and betulinic acid extracted from *Z. nummularia* exhibit anticancer properties. The cancer cell lines being more susceptible than normal cells, betulinic acid glycosides create differential cytotoxicity. Betulinic acid is a natural pentacyclic triterpenoid having cytotoxicity against many tumours cell types. Betulinic acid causes apoptosis via activating the mitogen activated protein kinase cascade, inhibiting angiogenesis, and modulating pro-growth transcriptional activators and aminopeptidase-N activity. It also induces apoptosis through a p53- and CD95-independent pathways efficiently killing cancer cells resistant to conventional chemotherapeutic drugs (Sakna et al., 2022).

Some fractions of *C. asiatica* suppressed altered cell lines proliferation like Ehrlich ascites, Dalton's lymphoma and ascites tumour cells dose-dependently. In long-term culture, partially purified fractions of C. asiatica greatly inhibited the propagation of mouse lung fibroblast cells. The direct inhibition of DNA synthesis after oral intake of C. asiatica extracts decelerated solid and ascites tumours development to improve life time of tumour mice (Pundalik et al., 2022).

Curcumin's anticancer potential seen through decrease growth in numerous tumour cell types. Curcumin down-regulate the expression lysyl oxidase (LOX), epidermal growth receptor 1 (EGR-1), activator protein 1 (AP-1), NF-kappa B, cycloxygenase 2 (COX2), matrix metallopeptidase 9 (MMP- (HER2), nitric oxide synthase (NOS) genes, etc. Turmeric suppresses c-Jun N-terminal kinase, protein tyrosine kinases, and protein serine/threonine kinases activities along with its gene expression impact. Turmeric limited tumour cell raid and metastasis by suppressing MMP-2 activity and HEp2 (epidermoid carcinoma cell line) cell raid in vitro. The oral intake of *P. amarus* extract greatly improved life duration and decreased tumour size in Dalton's lymphoma ascites and Erlich ascites carcinoma affected mice. This plant's chemoprotective qualities may be connected to its capacity to suppress carcinogenic chemical metabolic activation, and interfere with DNA repair (Fatemizadeh et al., 2022).

Alpinumisoflavone, a pyranoisoflavone discovered in *Derris eriocarpa* inhibited proliferation and metastasis of 786-O human ccRCC cells in BALB/c nude mice xenografted with human clear cell renal cell cancer cell xenografts. The inhibitory impact was caused by increasing miR-101 expression via reducing Akt signalling.*T. cordifolia* slays HeLa cells in vitro effectively, implying its efficacy as effective anticancer drug (Basavaraj et al., 2022).

3.4. Phytochemicals having anticancer properties can be used for anticancer drug discovery

The phytochemicals have powerful anticancer properties. From 1940 to 2014, more than half of all licenced anticancer medicines were produced directly or indirectly from natural sources. These phytochemicals are evaluated for anti-cancer activity in vitro and in vivo. They have complimentary and overlapping pathways that slow down carcinogenesis by altering free radicals, reducing malignant cell survival and proliferation, and decreasing tumour invasiveness and angiogenesis (Negri et al., 2018).

Plant phytochemicals and byproducts are promising alternatives to increase therapy efficacy and decreasing unwanted effects in cancer. Many phytochemicals mentioned here are naturally occurring physiologically active anticancer agents. The first step in developing effective

and side-effect-free phytochemical-based anticancer therapy is to test natural extracts for potential anticancer biological activity, followed by purification of active phytochemicals using bioassay-guided fractionation and testing for in vitro and in vivo effects (Solanki et al., 2022).

3.5. Phytochemicals used in current cancer therapy

Vinca alkaloids, camptothecin derivatives epipodophyllotoxin, and taxane diterpenoids are the four chief clinically effective plant-derivative anticancer agents. Additional plant-derived anticancer medicines utilised in addition to these phytochemicals are combretastatins, ingenol mebutate, etc. Less water solubility and considerable hazardous side effects continue to be a major problem; hence the present emphasis of research is on reducing the influence of these variables. Numerous analogues and prodrugs are produced in this regard, and techniques to improve aqueous solubility and tumour selectivity have been developed (Solanki et al., 2022; Mazumder et al., 2022).

Few phytochemicals that are used in cancer therapy are

3.5.1. Vinca alkaloids

Vinca alkaloids from *Catharanthus roseus* (pink periwinkle) of family Apocynaceae cause cytotoxicity by binding to beta-tubulin at a dissimilar spot than taxanes, blocking polymerization and microtubule assembly, ensuing in metaphase arrest and thus cell death. Since microtubules are involved in cell shape preservation, organelle transport, motility, like cell processes, vinca alkaloids impact both malignant and non-malignant cells in non-mitotic cell cycle. The semisynthetic equivalents of these two naturally isolated alkaloids, vinblastine and vincristine are used for 50 years for in vitro and in vivo actions. The only two clinically approved semisynthetic counterparts are vinorelbine and vindesine to be used in conjunction with chemotherapy for treatment of leukaemia, Kaposi's sarcoma, breast and lung cancers, testicular carcinoma, Hodgkin and non-Hodgkin lymphomas. Vinflunine is recently accepted for the second-line transitional cell carcinoma treatment (Mazumder et al., 2022).

3.5.2. Taxanes

Taxanes found in Yew tree bark are prospective anticancerous drugs. Taxanes suppress cancer growth by triggering aberrant mitosis and cell cycle detention by stabilising microtubules. Paclitaxel derived naturally from *Taxus brevifolia* bark and leaves and docetaxel semi-synthetically derived are commonly used to treat ovarian, prostate, pancreatic, lung, and breast cancer. Semisynthetic byproducts are created with augmented solubility, cytotoxicity in resistant tumours and reduced toxicity. A docetaxel derivative of second-generation, Cabazitaxel shows cytotoxic activity against numerous docetaxel-resistant malignancies while having lesser general toxicity. Unlike other taxanes, cabazitaxel passes the blood-brain barrier in vivo. Several paclitaxel analogues, including milataxel, tesetaxel, ortataxel, larotaxel, etc. are now in clinical trials (Sun et al., 2022).

3.5.3. Camptothecins

Camptothecin is a quinolone alkaloid derived from the Chinese tree *Camptotheca acuminata.* It attaches to type I DNA topoisomerase, stopping DNA cleavage, downgrading and thus producing DNA double strand break and cytotoxicity. Two FDA-permitted semi-synthetic camptothecin byproducts are irinotecan and topotecan are therapeutically active and lesser toxic. Irinotecan is used to treat advanced large intestine and rectum cancers. Topotecan can treat small cell lung, recurrent ovarian, and cervical cancer (Fan et al., 2022).

3.5.5. Podophyllotoxins

Podophyllotoxin is natural toxin found in *Podophyllum peltatum* and *Podophyllum emodi* of family Berberidaceae. It reversibly attaches to tubulin while its primary derivatives, etoposide as well as teniposide hinder topoisomerase II, ensuing in topoisomerase II-facilitated DNA cleavage. Furthermore, podophyllotoxin may be effective against a range of drug-resistant tumour cells in terms of anti-multidrug resistance (Kumar et al., 2022).

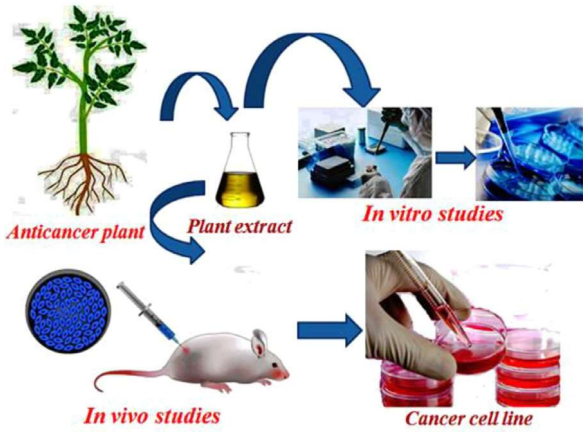

Fig. 2. Anticancer plant and their anticancer activity (in vitro and in vivo).

3.5.6. Some other plant-derived anticancer agents

Ingenol mebutate found in Australian shrub *Euphorbia peplus*, family Euphorbiaceae is can treat actinic keratosis topically caused by long-term UV exposure leading to squamous cell carcinoma if untreated. It causes rapid cell death at high concentrations and triggers an inflammatory response at low concentrations. Homoharringtonine is an alkaloid cephalotaxine from family Cephalotaxaceae *Cephalotaxus* genus. These are accepted for treating chronic myeloid leukaemia. Homoharringtonine attaches to the A-site cleft of the big ribosomal subunit, stopping chain extension along with protein synthesis (Ahmed et al., 2022).

3.6. Studies of anticancer herbal medicine: an overview

Many plant metabolites have been studied and reported to have anticancer characteristics, including isothiocyanate, resveratrol, genistein, soybean extract, vitamin A derivatives, luteolin, curcumin, green tea extract, and lycopene. The majority of plant extracts have been researched for cancer prevention rather than treatment, resulting in low efficacy and uptake in practise.These herbal medications were studied in both vivo and in vitro settings (Adetunji et al., 2021). Nutraceuticals are gaining popularity due to their low risk of adverse effects and overall health benefits. Acceptance has resulted in their use as a preferred choice in cancer prevention (Rudrapal et al., 2022). Diverse medicinal plants' anticancer properties have been evaluated in vivo using various animal models (Fig. 2). Many works on in vivo investigations of many anticancer plants in mouse models are available.

3.6.1. Preclinical anticancer potential of phytochemicals

A careful use of preclinical screening models in drug development process can result in probable lead compounds in anticancer drug progress with better initial efficacy, safety information, pharmacokinetic and toxicity data that aid in deciding if the molecule can be taken for clinical trials further (Wang et al., 2018).

6-Shogaol, bioactive from ginger (*Zingiber officinale)* condensed the development of NCI-H1650 lung cancer cells significantly through lowering cell proliferation and enhancing apoptosis. 6-shogaol reduced Akt signalling in vitro through direct targeting Akt1 and Akt2. Intraperitoneal 6-shogaol therapy reduced tumour weight in a syngeneic FVB/N mouse model of prostate cancer linked with decreased pSTAT3Y705, cyclin D1, and survivin levels (Dinda & Dinda, 2022).

Allicin (*Allium sativum*) of Amaryllidaceae family reduced human hepatic bile duct cancer growth in BALB/c nude mice. It inhibited the

STAT3 signalling pathway, which condensed the matrix metalloproteinase (MMP)−2 and −9 levels in HuCCT-1 cells in vitro, leading in decreased invasion, migration, and epithelial-mesenchymal transition. Allicin decreased proliferation by persuading apoptosis and lowering the expression of proteins downstream of STAT3, such as B-cell lymphoma 2 (Bcl-2) while boosting the expression of Bcl-2-associated X. Furthermore, allicin impacted TIMP/MMP balance by lowering lung cancer A549 and H1299 cell adhesion, invasion, and migration via the PI3K/AKT signalling pathway (Talib et al., 2022).

The bicyclic diterpenoid lactone andrographolide is obtained from the plant *Andrographis paniculata* (family Acanthaceae). Andrographolide was discovered to constrain tumour growth by hindering hypoxia variation. Andrographolide decreased the activity of hypoxia-inducible factor (HIF)−1a as well as its downstream PI3k/AKT/mTOR pathway. Apigenin (APG) is an anticancer flavonoid found naturally in fruits and vegetables. It controlled the expression of Bcl-2 family proteins and triggered the caspase cascade, resulting in G2/M phase seizure and apoptosis. It suppressed NSCLC xenograft development and metastasis by inhibiting the dipeptidyl peptidase IV enzyme. APG's efficacy is boosted when combined with other chemotherapeutic medicines or put in nanocarriers (Ma et al., 2022).

Scutellaria baicalensis contains flavonoids and active components that occur naturally, such as baicalein and baicalin (Lamiaceae). Both baicalein and baicalin inhibited tumour formation and triggered apoptosis in a NOD-scid IL2Rg null (NSG) mice xenograft with human colon cancer HCT116 cells. It effectively delayed tumour incidence and reduced tumour burden in a nude mouse model by persuading apoptosis and hindering propagation of human breast cancer MDA-MB-231 cells and disabling the mitogen-activated protein kinase (MAPK), extracellular receptor kinase and p38 signalling path (Tao et al., 2018).

To reduce nitrosamine-induced lung carcinogenesis, EGCG decreased the growth of oxidative stress-derived DNA damage marker 8-hydroxydeoxyguanosine levels in mouse lung DNA.

Emodin is an anthraquinone derivative derived from *Rheum palmatum* L's root and rhizome (Polygonaceae). In BALB/c nude mice, emodin reduced development of human lung epithelial (A549) cells via triggering endoplasmic reticulum (ER) stress-dependant apoptosis. Emodin stimulated ER stress and TRIB3/nuclear factor-kB signalling in vitro, according to the molecular mechanism. It repressed IRF4, STAT6, and C/EBPb signalling in tumour-associated macrophages and dramatically enhanced inhibitory histone H3 lysine 27 tri-methylation (H3K27m3) on the organizers of M2-related genes. Emodin inhibited tumour growth and caused apoptosis in BALB/c nude mice xenografted with human hepatocellular carcinoma SMMC-7721 cells, with upsurges in ERK and p38 phosphorylation and decrease of p-JNK expression (Goel et al., 2020).

Genistein is an oestrogen-like isoflavone found naturally in soy beans. By blocking unusual nuclear accretion of b-catenin and suppressing WNT signalling genes, genistein therapy reduced aberrant crypts in the azoxymethane- persuaded rat colon cancer. In HL60 cells, genistein triggered G2/M phase arrest and death via ROS-mediated endoplasmic reticulum stress, resulting in augmented Ca2+ production and reduced mitochondrial membrane potential. Augmented expression of endoplasmic reticulum stress-related proteins (calpain 1, IRE1a, GRP78, caspase 7, caspase 4 and GADD153, ATF6a) and apoptosis-associated proteins was responsible for the observed effect (Bax, PARP cleavage, caspase9, caspase3, Bcl2 and Bid) (Sharifi-Rad et al., 2021).

Gingerol found in ginger rhizomes is a phenolic compound. In mouse model of spontaneous breast cancer metastasis, gingerol therapy enhanced caspase-3 activation and decreased orthotopic tumour formation and metastasis of 4T1Br4 mammary tumour cells to numerous lung, bone, and brain. Similarly, Glycyrrhizin being the most abundant bioactive in roots of *Glycyrrhiza glabra* L condensed thromboxane synthase and multiplying cell nuclear antigen expression in athymic BALB/c nude mice xenografted with human lung adenocarcinoma (Zadorozhna & Mangieri, 2021).

A flavonoid phenol hispidulin found in plants like *Saussurea involucrata* Kar of Asteraceae family. Hispidulin therapy intra-peritoneally repressed tumour growth and lung metastasis in an athymic BALB/c nu/nu mouse model by growing cleaved caspase-3 expression and lessening Sphk1 activity, thus controlling ceramide-S1P balance. Hispidulin also significantly decreased human hepatocellular carcinoma Bel7402 cell xenograft tumour formation and lung metastasis via growing PPARg expression and AMPK, JNK, and ERK protein phosphorylation (Patel & Patel, 2017).

3.6.2. Clinical anticancer potential of phytochemicals

Clinical trials with phytochemicals in cancer are in their beginning, despite the fact that an enormous number of anti-cancer substances are now in research. Clinical studies including phytochemicals are focusing on three crucial aspects of cancer research: improving cancer cell responses to standard chemo- and radiation, reducing the severe adverse effects of standard anticancer therapy, and looking for unwanted interactions with standard therapy.

The preclinical studies showed numerous phytochemicals efficacy including lycopene, quercetin, resveratrol, curcumin, berberine, sulforaphane, and green tea catechins like EGCG.

The phytochemicals ongoing clinical trials against cancers are:

Berberine, a benzyl-tetra isoquinoline alkaloid discovered in Berberis sp. of family Berberidaceae is used in traditional Chinese and Ayurvedic medicine since many years. Berberine is effective in preclinical studies in numerous malignancies, including colon, breast, gastrointestinal, oral, liver, pancreas, prostate. Despite considerable preclinical efficacy findings, clinical trials evaluating berberine genuine potential as anticancerous drug are scarce. Berberine was proven to be harmless in type 2 diabetes individuals with dyslipidemia in a double-blind, randomised, placebo-controlled phase 3 clinical trial. A randomised, double-blind, placebo-controlled phase 2/3 trial is ongoing for assessment of berberine efficacy against the new colorectal adenoma's development in colorectal cancer history patients (Neag et al., 2018).

Curcumin, a yellow polyphenolic pigment found in *Curcuma longa* is a promising chemopreventive drug. Curcumin is chemopreventive and chemotherapeutic in numerous cancer cells like blood, breast, head and neck, liver, prostate, ovary. This has prompted clinical investigations to investigate the pharmacokinetics, safety, and efficacy of curcumin in people. Curcumin was found to be safe, tolerable, and nontoxic in phase I clinical studies, even at large doses however it had limited absorption in humans. Despite bioavailability issues, clinical trials with curcumin as an anticancer agent, either alone or in combination showed efficacy against pancreatic, breast, colorectal, prostate cancers. The most recent preclinical and clinical anticancer therapies including curcumin. More than 18 other active oncology-based trials with curcumin are listed in clinicaltrials.gov. A double-blind, randomised, placebo-controlled phase 2/3 trial is currently underway for investigating curcumin efficacy with paclitaxel given weekly for 12 weeks against patients with progressive and metastatic breast cancer (Kunnumakkara et al., 2019).

Green tea contains a significant amount of epigallocatechin gallate (EGCG) (*Camellia sinensis*; family Theaceae). EGCG's anticancer efficacy is verified in numerous research using animal models and cell lines. Clinical trial data show that a catechin mixture comprising EGCG is safe when given to high-grade prostatic intraepithelial neoplasia males. Polyphenon E (green tea polyphenol formulation mainly EGCG) gathered in cancer tissue and reduced proliferation and apoptosis in a randomised, placebo-controlled phase II pilot study before surgery in bladder cancer (Kumar et al., 2016).

3.7. Regulatory aspect of herbal anticancer drugs

Every proven medicine or its active ingredients (anticancer chemicals or isolated compounds) requires phase III clinical trials before it can be marketed. The rules of the "Food and Drug Administration" (FDA) and the "European Medicines Agency" (EMA) need at least one controlled

trial in phase III with statistically significant outcomes before they can be marketed. Plant-based isolated chemicals have been demonstrated to be less hazardous than laboratory manufactured compounds in previous studies and research. The problem is that there is insufficient information on the safety, quality, and efficacy of herbal drugs (Oyedepo & Palai, 2021). The debate remains, however, because there have only been a few research on the plant's anticancer effects. Oncology drug development and marketing are governed globally by specialists and an advisory process mediated by regulatory organisations. Numerous regulatory agencies are available to aid in the development and discovery of new drugs. The FDA recently approved the International Council for Harmonization's questions and answers guidelines on the nonclinical evaluation of cancer-cure medications (Boyle et al., 2021).

3.8. Modern era harvesting anticancer potential of plant

Along with the growing need for herbal goods and information technology, some databases, such as SymMap, Chinese Medicine Integrated Database (TCMID) (Huang et al., 2018), Collective Molecular Activities of Useful Plants (CMAUP), encyclopedia of Traditional Chinese Medicine (ETCM) (Xu et al., 2018) are increasingly widely used. The current work encourages further investigation of anticancer active components for in-silico screening and pharmacokinetic activities. The key difficulty with this technique is estimating the role of phytochemicals other than active compounds seen in traditional therapy.

4. Conclusions

All of the fundamental medicines are found in plants. Plant bioactive compounds have been shown to suppress cancer. The current study aims to compile a list of plants containing active phytochemicals with anticancer potential, as well as data supporting their use in cancer therapy, animal models, and their pharmacological properties. The chosen plants with anticancer properties showed essential role in battling oral, breast, colon, lung, stomach, cervical, hepatic, and blood cancer malignancies. The secondary metabolites present in the plant extracts inhibited cancer cells by causing DNA damage and activating apoptosis-inducing enzymes in vitro. Also, in vivo studies of these plants and their phytochemical actions revealed significant outcomes in cancer suppression in animal models.

Author contributions

Subhash Chandra, MG and ANC outlined the review. SC Drafted the manuscript. SC and SP edited and reviewed the article. SC, MG, ANC, SP and RA reviewed and edit it and all authors approved it.

Consent for publication

Not applicable.

Funding

None.

Declaration of Competing Interest

The authors declare that they have no known competing financial-interestsor personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

Declared none.

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