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Natural resources as cancer-treating material

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ABSTRACT

This review study investigates conventional anticancer treatments derived from the world's different parts as a wonderful substitute for pharmaceuticals since they have fewer or no side effects and can fix the disease at its source. This study provides thorough information regarding physiologically active substances derived from various parts of the plant for cancer treatment such as Alkaloids (ervine, methylervine, ervolanine, and aervolanine), Terpenoids, Vitamins, Coumarins, Tannins, Carbohydrates, Flavonoids (kaempferol, quercetin, isorhamnetin, persinol, persinosides A and B), Fatty Acids, and Essential Oils). This technique is beneficial in clinical studies for breast, prostate, and colon cancer. The ongoing rise in cancer incidence, the inability of traditional chemotherapies to manage cancer, and the excessive toxicity of chemotherapies all call for a new strategy. The first trial to establish the effectiveness of chemoprevention was conducted in breast cancer patients using tamoxifen, which indicated a substantial reduction in invasive breast cancer. The effectiveness of utilizing chemopreventive drugs to protect high-risk people from cancer suggests that the technique is sound and promising. Dietary components such as capsaicin, cucurbitacin B, isoflavones, catechins, lycopene, benzyl isothiocyanate, phenethyl isothiocyanate, and piperlongumine have been shown to suppress cancer cell growth, indicating that they might be used as chemopreventive agents.

1. Introductions

Cancer has long been regarded as one of the leading causes of mortality, causing widespread suffering. Chemotherapy, radiation treatment, surgery, hormone therapy, and other conventional therapies are accessible. Yet, these medications have a variety of undesirable side effects that have hampered conventional therapy's efficacy. Many phytochemicals found in plants have been studied extensively for their anticancer properties (Groelly et al., 2023 Siegel et al., 2023; Tzenios 2023).

As a result, researchers have several potentials to develop effective anticancer medications using medicinal plants grown in various nations. The current study thoroughly examined the anticancer effects of many phytochemical substances to develop more effective anticancer medications (Khatun et al., 2011; Yalçın et al., 2021; Bagci et al., 2010). Plants are incredibly significant to humans because they contain a wide range of active compounds used in the creation of a wide range of medications (Ahmed et al., 2022; Khan et al., 2022; Mazumder et al., 2022). As such, they might be used to improve cancer therapeutic procedures. Yet, there are significant barriers to modifying extraction system for therapeutic benefit (G. P. Gupta and Massagué 2006; Kojima et al., 2013; Lu et al., 2016; Sahai et al., 2020). Waldenstrom's maladies, Multiple myeloma, Lymphomas, Leukemias, Hodgkin's maladies, malignant growth of different organs, and Choriocarcinoma (Fig 1), Plants have been used to treat a variety of human illnesses since antiquity, and not just as a source of food. Many plants and plant components are utilized to treat a variety of physical and mental illnesses, as well as to help in human survival. Some medicinal herbs can act as anticancer experts in cases of malignant development (Bose et al., 2022; Pascual et al., 2022; Govind 2011b; Sulaiman et al., 2022). Because of their adaptive immune-modulatory and cell-reinforcing properties, medicinal herbs have been demonstrated to have anticancer properties. They may help the host's immunological response by re-establishing biological balance and sculpting body tissues (AlQathama et al. 2022; Pascual et al., 2022; Kaplan 2022; Kola et al., 2022; Umashanker and Shruti 2011).

Abbreviations: $CD8^+$ T cells, Limphocytes; DWD, Human Oral Cancer; DU-145, Human Prostrate Cancer; COLO-205, Human Colon Cancer; HepG2, Human liver cancer cell lines; CAS, *Cassia Auriculata* saponin; DLA, Dalton's lymphoma ascites; EAC, Ehrlich ascites carcinoma; MLL, Purified mulberry leaf lectin; MLB, mulberry bark lectin; OPCs, Oligomeric Proanthocyanidins; PTOX, Plastid Terminal Oxidase; HL-60, Human leukemia cancer cells; A549, Human lung epithelial carcinoma cells; ACOX1, Acyl-CoA oxidase 1; TER, Therapeutic enhancement ratio; Hep2c, laryngeal cancer cells; RD, Rhabdomysarcom; L2OB, Mice intestine carcinoma cell line; RG_2, INS_{-1}, Rat cancer cell lines; HT29, Human colorectal adenocarcinoma cell line; MCF7, Human breast cancer cell line; L929, Mouse fibroblast cell line; HeLa, Henrietta Lacks; MAPK1, Mitogen-activated protein kinase 1; AKT, Ak strain transforming; UPR, unfolded protein response; LAEF, Left atrial emptying fraction; A375, Human Melanoma Reporter Gene Cell Lines; MTT, 3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide; MDA-MB-231, Human breast cancer cell line; COLO-320DM, colorectal adenocarcinoma cancer; Vero, Verda reno, which means 'green kidney'; Bax, Bcl-2, and PARP-1, Core regulators of the intrinsic pathway of apoptosis; AU565, AU565 breast cancer cells; p-Akt, Phospho-Akt

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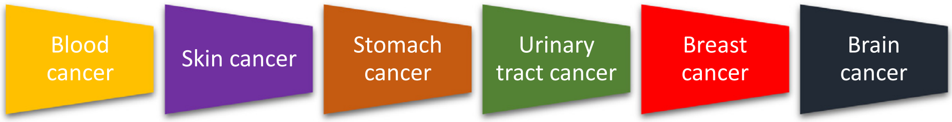


Fig. 1. Type of cancer.

The presence of visible phytochemicals that control solid cancer prevention agents is directly responsible for the anticancer movement of medicinal plants. Vitamins A, C, E, and K, carotenoids or carotene, polyphenols, proteins like superoxide dismutase and catalase, minerals including selenium, copper, manganese, zinc, chromium, and iodine, and polysaccharides are all anticancer nutrients. Plants and herbs can aid in the prevention and treatment of illness (S. He et al. 2022; Ishwarya et al., 2022; Kousar et al., 2022).

According to the World Health Organization, 80% of the general population living in rural regions uses medicinal plants as the major foundation for human services. Substantial pharmaceutical research has been conducted, resulting in a marked increase in the quality of domestic medications used to treat malignant growth. Certain herbs (Fig 2) can help prevent cancer by boosting the detoxifying components of the body, while others can help reduce the harmful side effects of chemotherapy and radiation. (AlQathama et al. 2022; A. Chaudhary 2020; Pascual et al., 2022; Kaplan 2022; Kola et al., 2022; Nagaraja et al., 2022). Researchers from all over the world are attempting to target malignant growth cells while avoiding harming healthy body cells. Malignant growth cell proliferation is selectively inhibited by imitating macrophage phagocytosis, augmenting typical executioner cell function. Apoptosis of malignant growth cells is promoted by increasing the production of interferon-I, interleukin-2, immunoglobulin, and supplements in blood serum. By restricting the blood supply of tumor tissue, you can force the tumor to decay and prevent its transfer and spread (Ouyang et al., 2012).

2. Active components with its properties: sources and methodology

A thorough search of the electronic databases Web of Science, Scopus, PubMed, and Google Scholar yielded the most relevant material. The search terms were "Medicinal plants," "Anticancer activity," "Anticancer herbs," "Anticancer plants," "phytochemicals for cancer treatment," and " The number of relevant articles identified after extraction and analysis using the aforementioned keywords/phrases (Khatun et al., 2011; Yalçın et al., 2021; Bagci et al., 2010; Satil and Selvi, 2020; Selvi et al., 2022). Two sets of criteria were used to determine inclusion. Articles considered for this publication had reported on the traditional anticancer action of plants and their components, and (ii) reported on the anticancer role of plant extracts or pure chemicals. The second set of criteria was utilized to choose specific anticancer plants whose phytochemicals are discussed in detail. Fifty plants were chosen for this purpose from the available literature. The

Fig. 2. Pictorial presentation of different plants containing antitumoural activities.

data was compiled into a table, and the phytochemicals and other facts were explained in relevant subheadings and shown with various charts. The plant contains about 85 potentially active components are discussed, including vitamins, enzymes, minerals, carbohydrates, lignin, saponins, salicylic acids, and amino acids. Antioxidants include vitamins A (beta-carotene), C, and E. There is also B12, folic acid, and choline. Free radicals are neutralized by antioxidants such as aliases, alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. Bradykinase is a kind of enzyme. Calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium, and zinc are all present. It has both monosaccharides (glucose and fructose) and polysaccharides (glucomannans and polymannose). mucopolysaccharides. The most common polysaccharides are mannose-6-phosphate and glucomannans. Acemannan, a well-known glucomannan, was found as well. Alprogen, a glycoprotein with antiallergic properties, and a novel anti-inflammatory chemical, C-glucosyl chromone, Anthraquinones, were recently discovered. other Components included for anticancerous activity are cholesterol, campesterol, and lupeol (Mohd et al., 2022; Tibolla et al., 2018).

3. Table list of plants having anti-cancer activity- Detail of plants having anticancer activity is given in Table 1

Table 1

Table 1
Pants having anticancer activity.

S. No.	Family	Common Name	Botanical Name,	Places where plants found	Part Used	Anticancer constituent	References
1	Combertacae	Arjuna Bark	*Terminalia arjuna*	Indian Subcontinent	Bark	Gallic acid. Ellagic acid Flavone Phytosterol Tannins OPCs Triterpenoid saponin	(Bradford and Awad, 2007; Chahar et al., 2011; Kahkeshani et al., 2019; Netala et al., 2015; Rauf et al., 2019; Mohanty and Jena, 2021; Bodiga et al., 2022)
2	Acanthacae	Kalmegh,	*Andrographis Paniculata*	Peninsular India and Srilanka and is also distributed in different regions of Southeast Asia, China, America, West Indies, and Christmas Island.	Dried leaves	Polyphenols Benzylidene derivative SRJ09 5, 7, 2`, 3`- Tetramethoxyflavanone. 14- Deoxyandrographolide. Lactones. Lactose Saponin(Solanine). Alkaloids(Nicotine)	(Chao and Lin, 2010; Deshmukh et al., 2023; Fresco et al., 2006; Jada et al., 2008)
3	Apocynacae	Vinca,	*Catharanthus Roseus*	Native and endemic to Madagascar	Whole plant	Vincamine, Vindoline, Coumarins, Terpenoid	(Saha et al., 2022; Kumar et al., 2022)
4	Apocynacae	Ochrosia	*Ochrosia Elliptica*	North-eastern Australia, Lord Howe Island, and New Caledonia	Trunk bark	Lupeol acetate Lupeol Uvaol Ursolic acid Beta-sitosterol glucoside Rutin 8- methoxy ellipticine 9- methoxy ellipticine	(Elshimy et al., 2023; Fua, 2017)
5	Berberidacae	May Apple	*Podophyllum Peltatum*	Native to eastern North America, most commonly in shady areas on moist, rich soil.	Dried rhizome	Podophyllotoxin 5- Methoxypodophyllotoxin	(Choudhari et al., 2020; Wichers et al., 1990)
6	Zingibaracae	Ginger	*Zingiber Officinalis*	Native to southeastern Asia	Rhizome	6- gingerol 6- shogaol 6- paradol	(Ali et al., 2022; Hendra et al., 2022)
7	Zingibaracae	Turmeric,	*Curcuma Longa*	Native to tropical South Asia	Rhizome	Curcumin ar-turmerone alpha- turmerone Beta- turmerone Demethoxycurcumin Bis- Demethoxycurcumin Tetrahydrocurcumin Hexahydrocurcumin 1,7-bis- (4-hydroxy-3-methoxyphenyl)- hepta-1,6- diene- 3,5 – dione.	(Chanda and Ramachandra, 2019; Sabir et al., 2020)
8	Ericaceae	Deerberry,	*Vaccinium Stamineum*	North America, including Ontario, the eastern and central United States, and parts of Mexico	Fruit	12-O-tetradecanoylphorbol-13- acetate	(Sater et al., 2020; Wang et al., 2007)

(*continued*)

Table 1 (*Continued*)

S. No.	Family	Common Name	Botanical Name,	Places where plants found	Part Used	Anticancer constituent	References
9	Rubiaceae	Indian Mulberry,	*Morinda Citrifolia,*	Southeast Asia and Australasia, and was spread across the Pacific by Polynesian sailors	Fruit	Scopoletin Aspartic acid Glutamic acid Isoleucine Glucuronic acid Galactose D-Arabinose L- Rhamnose	(Elvis et al., 2023; Sina et al., 2021)
10	Anacardiaceae	Bhilwa	*Semecarpus Anacardium*	The outer Himalayas to the Coromandel Coast.	Fruit	Phenolics Garcinia biflavonoid Bhilawanol B Anacardic acid Steroids Glycoside	(Nair et al., 2009; Bhola, 2020)
11	Asclepiadaceae	Madar	*Calotrophis gigantea*	Wastelands of Africa and Asia	Whole plant	Cardiac glycoside Beta- carotene Alpha-carotene Lutein, Pregnanes, terols, flavonol Usharin, Gigantin, Giganteol	(Wadhwani et al., 2021; Mutiah et al., 2021)
12	Fabaceae	Arhar Dal	*Cajanus cajan*	Origin is most likely Asia, from where it traveled to East Africa and used the slave trade to the American continent	Leaves	Quercetin Luteolin Apigenin Isorhamnetin Cajaninstilbene acid Pinostrobin Cajanol Cajanuslactone	(Lakshmi et al., 2022; Imran et al., 2019; Jadaun et al., 2019; Kong et al., 2010)
13	Fabaceae	Palash	*Butea monosperma*	The tropical and subtropical climates and found throughout the drier parts of India	Bark	Leucocyanidin Procyanidin Butrin, isobutrin, isocoreopsin	(Zhang et al. 2019)
14	Liliaceae	Onion	*Alium cepa*	Various regions of Europe, America, Asia, and Africa	Bulb	Quercetin Flavonols Flavanone Anthocyanins Diallyl disulfide S- Allylcysteine S- methyl cysteine	(Robert et al., 2001; Zamri and Hamid, 2019; Zhao et al., 2021)
15	Liliaceae	Indian Aloe	*Aloe barbadensis*	Dry regions of Africa, Asia, Europe, and America. In India	Leaves	Beta-D-Mannose Cellulose Xylose Pectic acid(alpha-1,4-galacturonic acid)	(Majumder et al., 2019; Sebastian and Mary Samuel, 2023)
16	Caesalpinaceae	Tarwar	*Cassia auriculata*	Dry regions of India and Sri Lanka.	Root	3-O-Methyl-D-Glucose Alpha-tocopherol Methyl palmitate	(Nawaz et al., 2020; Seshadri, 2021; Thorat and Nimbalkar, 2021)
17	Caesalpinaceae	Senna	*Cassia senna*	Egypt, Sudan, and Nigeria	Leaves	Anthraquinone glycosides Sennoside A&B	(Kumar et al., 2010; Rizwan et al., 2011)
18	Rutaceae	Lemon	*Citrus medica*	Asia, primarily Northeast India (Assam), Northern Myanmar, or China	Root	Tangeritin Ascorbic acid Rutin Lycopene Lutein Canthaxanthin	(Bhowal et al., 2022; Dadwal et al., 2022)
19	Apiaceae	Carrot	*Daucus carota*	Eurasia and is thought to have been domesticated in Central Asia	Root	2-Hydroxycinnamic acid 4-Hydroxybenzoic acid Zeaxanthin	(Singh et al., 2022; Zaib et al., 2022)
20	Euphorbiaceae	Danti	*Jatropha curcas*	Native to the American tropics, most likely Mexico and Central America.	Leaves, seeds, oils	p-Coumaric acid	(Saleh et al., 2023; Felix et al., 2022)
21	Mimosaceae	Mint	*Mimosa pudica,*	Native to the Caribbean and South and Central America	Whole plant	Saponins Cardiac glycoside	(Rizwan et al., 2022)

(*continued*)

Table 1 (*Continued*)

S. No.	Family	Common Name	Botanical Name,	Places where plants found	Part Used	Anticancer constituent	References
22	Theaceae	Green tea	*Camellia sinensis*	East Asia, the Indian subcontinent, and Southeast Asia.	Leaves	Epigallocatechin-3-gallate, epigallocatechin, epicatechin-3- gallate, epicatechin	(Chaudhary et al., 2023; Manikandan et al., 2012; Zhao et al., 2022)
23.	Meliaceae	Neem	*Azadirachta indica*	Indian subcontinent.	leaves, flowers, seeds, fruits, roots, and bark	Terpenoid-Thymol, Menthol Auraptene D-limonene	(Akinloye et al., 2021; Ansari and Akhtar 2019; Fan et al., 2023; Kamran et al., 2022)
24.	Hammameli daceae	Sweet gum	*Liquidambar orientalis*	East to central Florida and eastern Texas	Fruit	Protocathecuic acid, Liquidambaric acid, Combretastatin, Atractyloside A.	(Pozzobon et al., 2023)
25.	Amaranthaceae	Mountain knotgrass	*Aerva lanata*	Native to Asia, Africa	Root	Aervitrin, Aervolanine, Campesterol, Kaempferol	(Singh et al., 2020)
26.	Solanaceae	Bell pepper	*Capsicum annuum*	Native to southern North America, the Caribbean, and northern South America	Fruit	Capsaicin	(Sukmanadi et al., 2020)
27.	Lamiaceae	Spiked Mint	*Elsholtzia stachyodes*	The Himalayas, from Kashmir to Nepal (India), Burma, and China	Leaves	Apigenin	(Chen et al. 2019; Rahmani et al., 2022)
28.	Euphorbiaceae	Indian Copperleaf	*Acalypha indica L.*	Throughout Asia and Africa	Leaves	Isorhamnetin	(Kalaivani D Arun, 2022)
29.	Zingiberaceae	Fingerroot	*Kaempferia pandurata*	Southeast Asia and Indo-China.	Roor	Pinostrobin	(Jadaun et al., 2019; Kong et al., 2010)
30.	Vitaceae	European wine grape	*Vitis vinifera*,	Mediterranean region, Central Europe, and southwestern Asia, from Morocco and Portugal north to southern Germany and east to northern Iran.	Leaves	Leucocyanidin	(Zhang et al. 2019)
31.	Annonaceae	Soursop	*Annona muricata* L.,	Tropical areas in South and North America and is now widely distributed throughout tropical and subtropical parts of the world, including India, Malaysia, and Nigeria	Leaves	Procyanidin	(Llorent-martinez et al. 2019; Yang et al., 2021)
32.	Euphorbiaceae	Dyer's croton	*Croton celtifolius*,	The south and southwest areas of China, such as Guangxi, Guangdong, and Hainan provinces	Root	Flavonols	(Biscaro et al., 2013)
33.	Apiaceae, or Umbelliferae	Asiatic pennywort	*Centella asiatica*	Tropical regions of Africa, Asia, Australia, and islands in the western Pacific Ocean	Whole plant	Asiatic acid, Kaempferol, Asiaticosside	(Kunjumon et al., 2022; Swargiary and Mani 2022)
34.	Fabaceae, or Leguminosae	Golden Shower Tree	*Cassia fistula*	Indian Subcontinent and adjacent regions of Southeast Asia.	Leaves	Rhein, Emodine Physion Chrysophanol Obtusin Chrysoobtusin	(Upadhyay 2020)
35.	Rutaceae	Bel	Aegle *marmelos*	Dry forests on hills and plains of central and southern India and Burma, Pakistan, and Bangladesh	Fruit	Lupeol	(Parveen et al., 2022)

(*continued*)

Table 1 (*Continued*)

S. No.	Family	Common Name	Botanical Name,	Places where plants found	Part Used	Anticancer constituent	References
36.	Amaryllidaceae	Garlic	*Allium sativum*	Central Asia, is widely grown in many countries, but China produces 80% of the world's supply	bulb	Diallyl disulfide, S- Allylcysteine	(Orozco-Ibarra et al., 2016; Robert et al., 2001; Ruiz-Sánchez et al., 2020)
37.	Zingiberaceae	Barakulanjan	*Alpinia galanga*	Arab cuisine and Southeast Asian	Root	Combretastatin	(El-Hadidy et al., 2020; Indrayah et al., 2009; Rouf et al., 2021)
38.	Phyllanthaceae	Amla	*Phyllanthus emblica* L.	Pakistan, Uzbekistan, Sri Lanka, Southeast Asia, China, and Malaysia.	Fruit	Gallic Flavonoids Glycosides Ellagic	(Golechha et al., 2014; A. Sharma et al., 2009)
39.	Liliaceae	Yellow colchicum	*Colchicum luteum*	Native to Central Asia, Afghanistan, Pakistan, the western Himalayas, and Tibet	Seed	Vinca alkaloids	(Dhyani et al., 2022)
40.	Fabaceae, or Leguminosae	Gum arabic tree	*Acacia nilotica*	Native to Africa, the Middle East, and the Indian subcontinent.	Fresh pods	Ellagic acid	(Al-Nour et al., 2019; P. Gupta et al. 2019)
41.	Moraceae	Himalayan Mulberry	*Morus laevigata*	Temperate Asia and North America	Fruits, roots, and leaves	Ursolic acid	(Janakirama et al., 2021; Zafar et al. 2022)
42.	Asteraceae	Fever or stomach bush	*Dicoma anomala*	Sub-Saharan Africa	Roots and leaves	Sesquiterpene Lactones.	(Mangisa et al., 2021)
43.	Solanaceae	Garden Huckleberry	*Solanum nigram*	Africa, but it also occurs in North America,	Leaf	Saponin (Solanine).	(Ukwubile et al., 2022)
44.	acanthaceae	gray mangrove, api-api jambu	*Avicennia marina*	Mainland coast of Australia. South Australia and Victoria.	Leaves and aerial parts	Lupeol acetate	(Elumalai et al., 2022)
45.	Rosaceae	Common plum	*Prunus domestica*	Kashmir	Fruit	Rutin	(Prasad and Prasad 2019; Satari et al., 2021)
46.	Grossulariaceae	Black currant	*Ribes nigrum*	It is native to temperate parts of central and northern Europe and northern Asia	Seed	Gamma-linolenic acid	(Ginovyan et al. 2022)
47.	Anacardiaceae	Red currant	*Rhus* chinensis	China, Japan, Malaysia, Taiwan, and India	Stem-bark	Triterpenoids	(G. Wang et al., 2021)
48.	Ginkgoaceae	Maidenhair tree	*Ginkgo biloba*	Chinese and Japanese temple gardens	Leaves	Glutamic acid	(Qanash et al., 2022)
49.	Lamiaceae, or Labiatae	Rosemary	*Rosmarinus officinalis*	The hills along the Mediterranean, Portugal, and northwestern Spain	leaf and its oil	Alpha-carotene	(Chaudhary et al., 2020)
50.	Apiaceae or Umbelliferae	Cumin	*cuminum cyminum*	southwest asia and the eastern mediterranean region.	Fruit or seed	Luteolin	(Goodarzi et al., 2018; Imran et al., 2019)

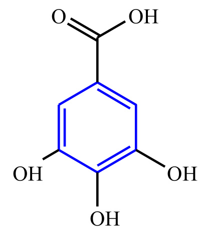
4. Discussion and structure of anticancer constituents in different family

4.1. Terminalia arjuna, *Combertacae*

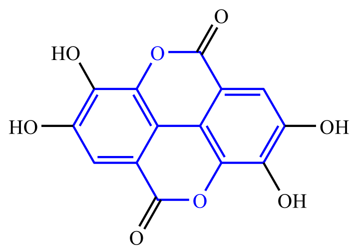
T. arjuna, commonly known as arjuna, belongs to the family of Combretaceae (Dwivedi and Chopra 2014; Moulisha et al., 2010; Pettit et al., 1996) with it contains gallic acid, ellagic acid, and flavone which have anticancerous activities (Chart 1) (Mahajan and Haswani 2018; Singh et al., 2016). Researchers devised a study to test *T. arjuna* petroleum-ether bark extract's anticancer efficacy against cancer cell lines. An in vitro screening was performed using two human cancer cell lines, HEP2 and HT29. Proliferation was reduced by 78% and 79.33%, respectively (Shivsharan Singh et al., 2017).

4.2. Andrographis paniculata, *Acanthaceae*

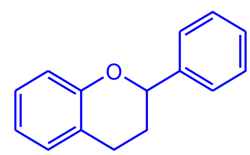
APE is a well-known medicinal plant that is also referred to as "Kalmegh" or "King of Bitters." Since it contains anticancer polyphenols, lactones, and lactose, it is a bitter plant utilized in Siddha, Ayurveda, and homeopathic medicine, as well as tribal medicines in India and other nations. The structure is shown in Chart 2 (Sidda and Mani, 2021; Malik et al., 2021; T. Paul, Basu, and Saha 2019). It investigated the anticancer properties of *A. paniculata* leaf extract using the



Gallic acid 1

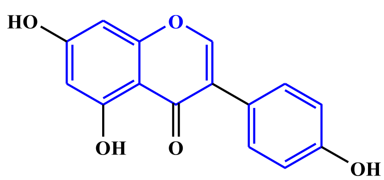


Ellagic acid 2



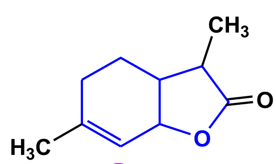
Flavone 3

Chart 1. Selected example of an anticancer constituent of the Combertacae family.



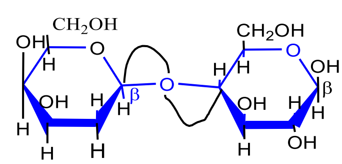
Polyphenols

4
4



Lactones

5



Lactose

6

Chart 2. Selected example of an anticancer constituent of the Acanthaceae family.

Spectrophotometric MTT test technique. The results indicated that ethanol extract inhibited around 50% of IMR-32 and HT-29 cell lines at 200 g/ml, whereas other extracts inhibited 50% of HT-29 cell lines at 250 g/ml (Shanmugam et al., 2015; Pandian et al., 2020).

4.3. Catharanthus roseus, *Apocynacae*

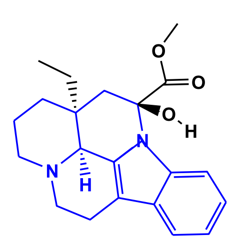
C. roseus are evergreen perennial plants belonging to the family Apocynaceae is well known as a medicinal and ornamental plant around the world (Chen et al. 2017; Deore et al., 2019; González-Burgos and Gómez-Serranillos 2021; Javaid et al., 2021; Villalobos et al., 2019). C. roseus was previously mentioned in terms of the use of plant material as an anticancer agent (Moon et al., 2018). They were the first professionals to take part in clinical studies for cancer. Among the 70 vinca alkaloids identified in this plant are vinblastine, vincristine, and its derivatives. The major components of the plant include alkaloids like vincristine and vinblastine, flavonoids, and phenolic acids (Mishra et al., 2022; Nayak et al., 2017; Prabha et al., 2020). Vincamine and vindoline have anticancer activities their structure is shown in Chart 3.

4.4. Ochrosia elliptica, *Apocynaceae*

O. elliptica is a tiny shrub in the Apocynaceae family that is well-known as a potential anti-cancer agent. The plant's juvenile and old stems, stem bark, and leaves were studied botanically (El-Shiekh et al. 2017; Yeshi et al., 2022). All of the organs investigated included carbohydrates, sterols, catechol tannins, flavonoids, and alkaloids (Chart 4). This study might help with plant quality management (El-shiekh et al., 2019; Ryan, Cooper, and Tauer 2013; Yeshi et al., 2022).

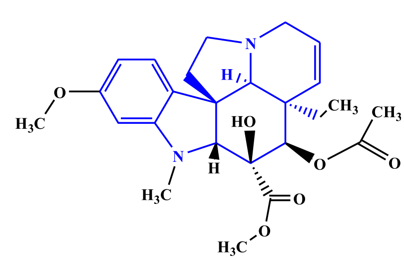
4.5. Podophyllum peltatum, *Berberidaceae*

A member of the Berberidaceae family, aryltetralin lignan, is the principal natural component of Podophyllum peltatum. Moreover, aryltetralin lignan has been found to reduce the risk of breast and prostate cancer by altering steroidal hormone production. PTOX, an aryltetralin lignin, has been extensively explored for its anticancer



Vincamine

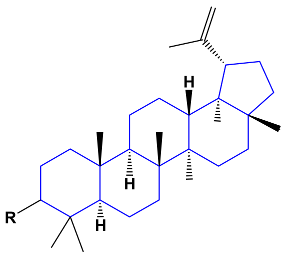
7

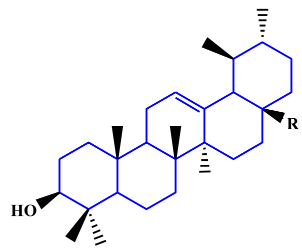


Vindoline

8

Chart 3. Selected example of an anticancer constituent of the Apocynacae family.

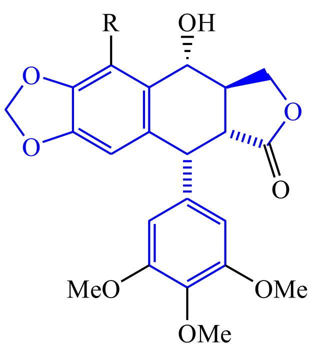




R=$COOCH_3$ Lupeol acetate, 9
R= OH Lupeol, 10

R= CH_2OH Uvaol, 11
R= COOH Ursolic acid, 12

Chart 4. Selected example of an anticancer constituent of the Apocynacae family.



R= H: Podophyllotoxin, 13

R= OMe : 5- Methoxypodophyllotoxin, 14

Chart 5. Selected example of an anticancer constituent of the Berberidaceae family.

and antihyperlipidemic effects in vitro and animal experiments. PTOX is manufactured commercially from the rhizomes of Podophyllum species, and P. peltatum has a greater PTOX content (Chart 5) than other Podophyllum species or plant species (Ivanova et al., 2021; Motyka et al., 2023; Yin et al., 2021).

4.6. Zingiber officinalis, *Zingibaracae*

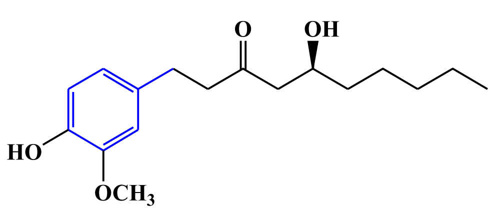
Ginger is a Southeast Asian plant of the Zingiberaceae family. Ginger has been used for centuries by Asia's indigenous peoples, mostly in China and India, as a spice and sweetener in local cuisine as well as herbal medicine to treat several ailments. It is used as a cough remedy because of its expectorant ability to loosen and expel phlegm. Ginger is also used to aid digestion as well as to alleviate pain, nausea, vomiting, and poisoning. It contain 6-gingerol and 6-paradol which have anticancerous activity (Chart 6) (Chen et al. 2022; Cui et al., 2019; Liao et al., 2020; Ozkur et al., 2022; Sathi and Sultana, 2022; Sharma 2017; Yang and Rahmawati 2022).

4.7. Curcuma longa, *Zingibaracae*

Turmeric, the rhizomes of the tuberous herbaceous perennial plant *C. longa*, has been used as a spice, color, medicinal, cosmetic, flavoring, and culinary component since ancient times (Ali et al., 2021; Zhoua et al., 2019). Their constituent curcumin, tetrahydrocurcumin, etc. (Chart 7) is responsible for its use as an anticancer drug.

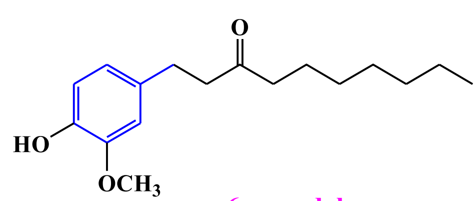
4.8. Vaccinium stamineum, *Ericaceae*

Vaccinium is a genus of around 500 berry-producing plants, some of which are commercially important. Attempts to improve the scent of diverse Vaccinium crops by breeding for preferred fruit volatiles. (Chart 8). Analytical procedures for obtaining volatile profiles of Vaccinium berries are also described. Further research directions for Vaccinium berry volatiles are also being investigated (Migicovsky et al., 2022; Sater et al., 2020). The anticancer effects of deerberry fruit were tested in JB6 *P*+ mouse epidermal cells, human lungs, and leukemia cells. Deerberries have strong free radical scavenging properties. Human leukemia HL-60 cancer cells and human lung epithelial carcinoma A549 cells were suppressed in growth by deerberry fruit extracts, and HL-60 cells were driven to apoptosis. Our findings imply that the ERKs and MEK 1/2 signaling pathways may be involved in the production of apoptosis in human leukemia HL-60 cancer cells (Wang et al., 2007).



6- gingerol

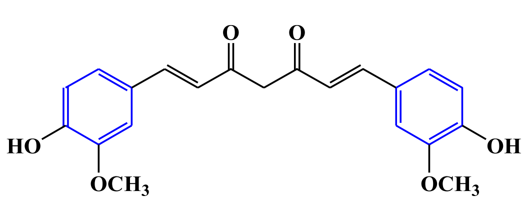
15



6- paradol

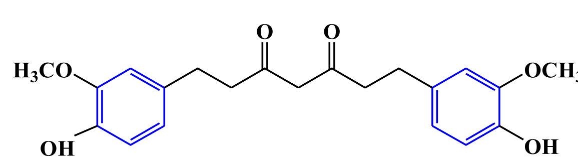
16

Chart 6. Selected example of an anticancer constituent of the Zingibaracae family.



Curcumin

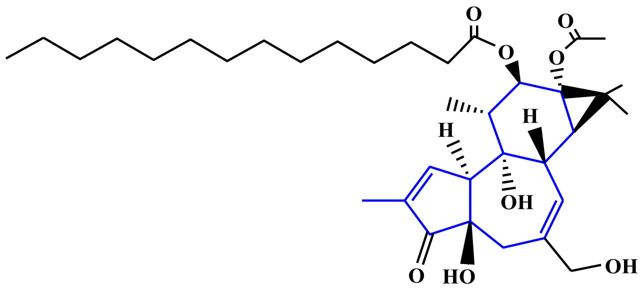
17



Tetrahydrocurcumin

18

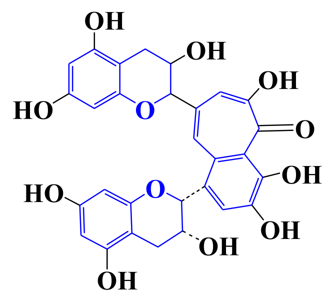
Chart 7. Selected example of an anticancer constituent of the Zingibaracae family.



12-O- tetradecanoylphorbol-13- acetate

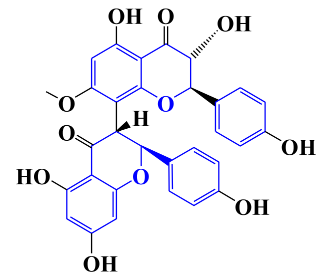
19

Chart 8. Selected example of an anticancer constituent of the Ericaceae family.



Phenolics

24



Garcinia biflavonoid

25

Chart 10. Selected example of an anticancer constituent of the Anacardiaceae family.

4.9. Morinda citrifolia, *Rubiaceae*

The Indian Mulberry is a Polynesian native with commercial potential in tropical and subtropical areas. According to Chart 9, there is growing interested in using the noni plant as a source of bioactive chemicals such as scopoletin, aspartic acid, glutamic acid, and isoleucine as an anticancer treatment. Bioactive chemicals, anti-nutrients, antioxidant activity, and IC_{50} values of noni seed. Bioactive substances with a wide variety of biological activities have been found in noni seed extracts. Noni fruit seed, which contains a lot of bioactive compounds, might be utilized to make functional meals.(Almeida et al., 2019; Jahurul et al., 2021; Lin et al., 2023).

4.10. Semecarpus anacardium, *Anacardiaceae*

Bhilwa is a tropical plant with several isolated and described metabolites. Furthermore, it aims to highlight and emphasize this plant's medicinal potential.(Gore and Umesh, 2020; Singh 2022) The major purpose of this research was to identify and characterize the anticancer component discovered in the kernel of the Semecarpus anacardium nut. Cytotoxicity, apoptosis, cell cycle arrest, and synergism between the new anticancer agent and doxorubicin were studied in human tumor cell lines. Catechol is more cytotoxic to tumor cell lines than doxorubicin. Other anticancer constituent such as phenolic and garcinia biflavanoid are also responsible for anticancerous activity (Chart 10). (Nair et al., 2009).

4.11. Calotrophis gigantea, *Asclepiadaceae*

C. gigantea is a well-known medicinal plant that has been used for millennia in the Unani, Ayurvedic, and Siddha medical systems (Jahan et al., 2016; Patial et al., 2023). The extracts were further tested for anticancer activity in three regularly used cell lines: DWD, DU-145, and COLO-205 using the SRB assay technique . *C. gigantea* produced non-classical cardenolides with particular cytotoxicity against cancer cell lines HCT116, HeLa, HepG2, A549, MCF-7, A2780, and MDA-MB-231. Furthermore, a detailed structure-activity correlation for these non-classical cardenolides as HIF-1 inhibitors were established, which may help with the rational design and development of cardenolide-based anticancer medicines (Chart 11) (Zheng et al., 2021).

4.12. Cajanus cajan, *Fabaceae*

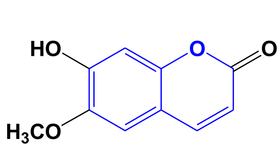
Cajanus (Fabaceae) has around 37 species, with *C. cajan* being a significant member of the genus (Gargi et al. 2022; Sarkar et al., 2020; Sharvani et al., 2022). Considering *C. cajan's* noteworthy nutraceutical and therapeutic properties, this review article focuses on essential elements such as ethnomedicinal usage, chemical composition, biological applications, and some other medical factors associated with C. cajan nutraceutical and pharmacological applications. It includes anticancer phytochemicals such as quercetin, luteolin, and apigenin (Beer 2022; Khanum et al., 2015), etc. as shown in Chart 12.

4.13. Butea monosperma, *Fabaceae*

Amalaki Rasayana is a popular rejuvenating rasayana used in ancient Indian ayurvedic medicine to promote healthy aging. It showed a stronger anticancer impact on HeLa cells, although Rasayana was shown to be less cytotoxic to normal cells. The cytotoxicity to HeLa cells enhanced when amla was processed vs AR in the heartwood of *B. monosperma*. (Kulkarni and Joshi, 1995; Neupane and Aryal 2022; Subramanyan et al., 2022; Tiwari et al., 2019) Leucocyanidin and procyanidin are anticancer agents responsible for the anticancerous activity of BM as shown in Chart 13.

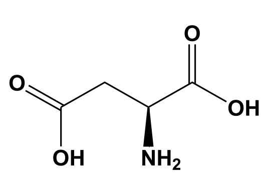
4.14. Alium cepa, *Liliaceae*

A. cepa is a kind of onion that is widely produced in northern China but has received little attention. Cell viability tests on human liver (HepG2) cancer cell lines revealed that aqueous extracts of story



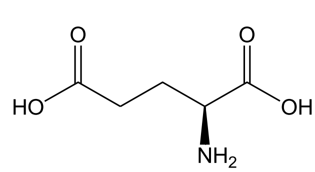
Scopoletin

20



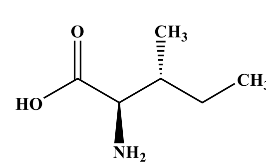
Aspartic acid

21



Glutamic acid

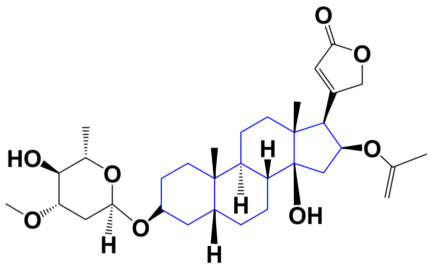
22



Isoleucine

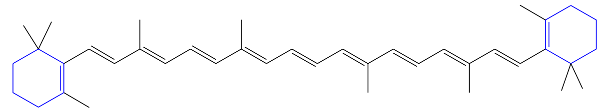
23

Chart 9. Selected example of an anticancer constituent of Rubiaceae family.



Cardiac glycoside

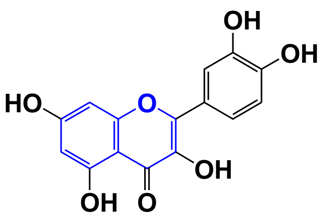
26



Beta- carotene

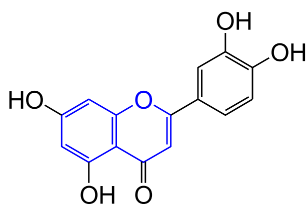
27

Chart 11. Selected example of an anticancer constituent of the Asclepiadaceae family.



Quercetin

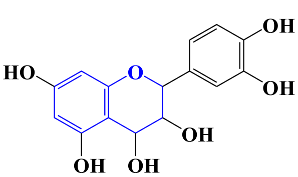
28



Luteolin

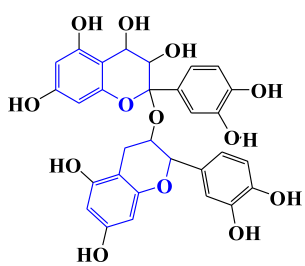
29

Chart 12. Selected example of an anticancer constituent of the Fabaceae family.



Leucocyanidin

30



Procyanidin

31

Chart 13. Selected example of the anticancer constituent of the Fabaceae family.

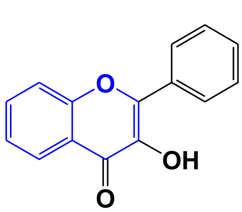
onion efficiently inhibited cell proliferation and increased cell death. Welsh onion and onion have the least effective antibacterial and anticancer properties (Chakraborty et al., 2022; Karavelioglu and Mustafa, 2022; Y. Zhou et al., 2020). Quercetin, di, trisulphides, folic acid, glycoside, alkaloid, saponin, tannin, and other compounds are found in A. cepa. There is diallyl disulfide, the flavonoid quercetin, allicin, allin, and nutrients. Diallyl disulfide may help prevent stomach cancer, but quercetin may assist cure lung and other diseases(Chart 14) (Dhankhar et al., 2011; A. K. Singh et al., 2019; Virendra et al., 2018).

4.15. Aloe barbadensis, *Liliaceae*

It contains cellulose and xylose as shown in Chart 15 which may be responsible for its anticancerous activity (Golmohammadi 2022; Kumar et al., 2022). Aloe vera includes aloe-emodin, which actuates the macrophages to attack disease. Aloe vera furthermore includes acemannan, which promotes the movement of insusceptible cells against malignancy. Aloe vera includes "super starches" that protect against a variety of cancers (P. H. Huang et al. 2013; Sajjad and Subhani Sajjad 2014).

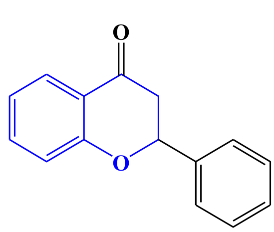
4.16. Cassia auriculata, *Caesalpinaceae*

C. auriculata has long been used to treat a variety of chronic diseases. *C. auriculata* plant pharmacological characteristics, safety/toxicity testing, pharmacognostic research, and phytochemical inquiry. It contains different phytochemicals such as tocopherol, 3-O-methyl-D-glucose, etc. (Chart 16) as an anticancer agent (Albrahim et al., 2021; Gowda et al., 2022; Nille et al., 2021; Nille and Reddy, 2015) .



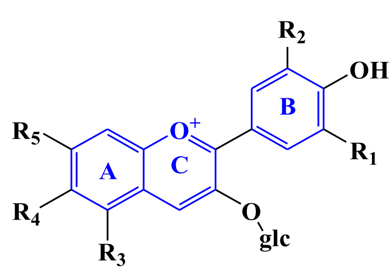
Flavonols

32



Flavanone

33

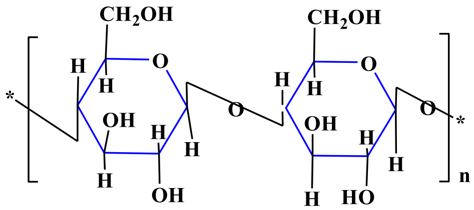


$R_1, R_2, R_3, R_4, R_5 = H, OH, OCH_3$

Anthocyanins

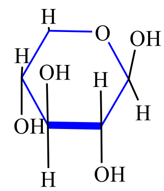
34

Chart 14. Selected example of an anticancer constituent of the Liliaceae family.



Cellulose

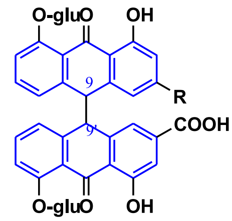
35



Xylose

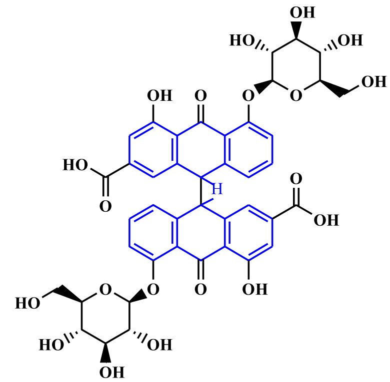
36

Chart 15. Selected example of an anticancer constituent of Liliaceae family.



Anthraquinone glycosides

40



Sennoside

41

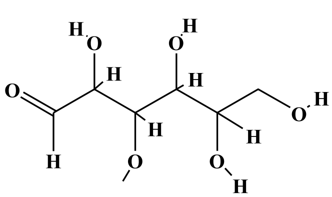
Chart 17. Selected example of the anticancer constituent of the Caesalpinaceae family.

4.17. Cassia senna, *Caesalpinaceae*

The chromosomal aberration test and the micronucleus assay were used to investigate the effects of CAS-rich fractions on mouse bone marrow cells. There were no significant changes in mitotic indices or chromosomal abnormalities after a single oral treatment of CAS fraction to mouse bone marrow cells (Ajayi et al., 2015; Singh et al., 2013). *C. Auriculata* components are not genotoxic or clastogenic. According to the findings of this investigation, CAS fraction, anthraquinone glycosides and senoside might be a viable anti-promotion agent for skin tumors (Chart 17) (Albrahim et al., 2021; Kewatkar et al., 2021; S et al. 2022).

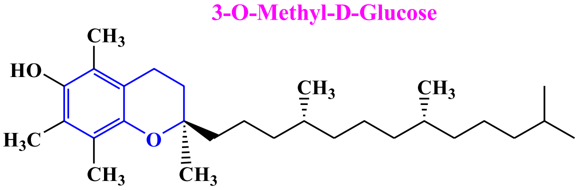
4.18. Citrus medica, *Rutaceae*

Oranges and lemons have been referred to as the genus Citrus since the time of Linnaeus, who combined orange, citron, and lemon under a classical name first applied to the coniferous tree Tetraclinis articulata (Vahl) Mast. (citron tree), known to the Ancient Greeks as thyon and to the Romans as citrus. In antiquity, it was prized for its sweet-scented timber (citrum), which was used for table tops (Kumar and Ashok, 2022; Mabberley 2004; Shi et al., 2023; Sofiyanti et al., 2022). It contains tangeritin, ascorbic acid, rutin, etc. which have anticancerous activities as their structure is shown in Chart 18 (Alam et al., 2022; He et al., 1997).



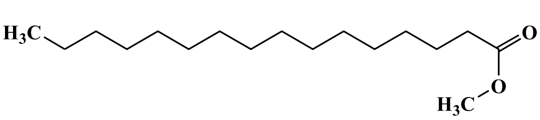
37

3-O-Methyl-D-Glucose



38

Alpha-tocopherol



39

Methyl palmitate

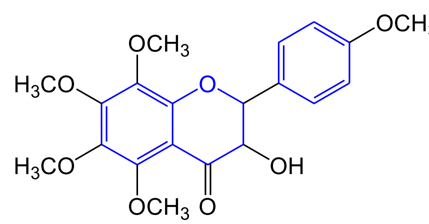
Chart 16. Selected example of an anticancer constituent of the Caesalpinaceae family.

4.19. Daucus carota, *Apiaceae*

Polyacetylenes (PAs) are a diverse group of bioactive phytochemicals mostly produced by higher plants in the Apiaceae and Araliaceae families. Especially aliphatic C17-polyacetylenes of the falcarinol type, such as falcarinol (FaOH) and falcarindiol (FaDOH), are known to have several biological activities, including favorable effects on human health. Other phytochemicals such as 2-hydroxycinnamic acid, 4-hydroxybenzoic acid, and zeaxanthin, etc. are found in *D. carota* which contain anticancerous activities (Chart 19). (Ademosun et al., 2021; Dunemann et al., 2022; Majdoub et al., 2019).

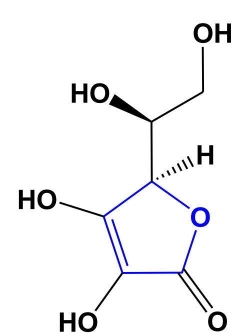
4.20. Jatropha curcas, *Euphorbiaceae*

J.curcas is well-known for its anti-inflammatory effects. It is well recognized for its antibacterial, anti-cancer, and anti-HIV effects (Sharma et al., 2012; Tekaya et al., 2014). The bioactive components in leaf extracts were identified using high-performance thin-layer chromatography, which revealed the presence of important phytochemicals such as flavonoids, saponins, and tannins. p-Coumaric acid is an anticancer agent in *J. curcus* (Chart 20). The cytotoxic concentration for aqueous and methanol extracts was estimated using the trypan blue dye exclusion experiment. (Dahake et al., 2013; Eusebio et al., 2020; Oyama et al., 2016; Patil et al., 2013)



Tangeritin

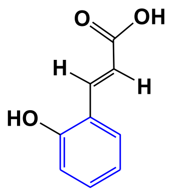
42



Ascorbic acid

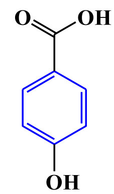
43

Chart 18. Selected example of an anticancer constituent of the Rutaceae family.



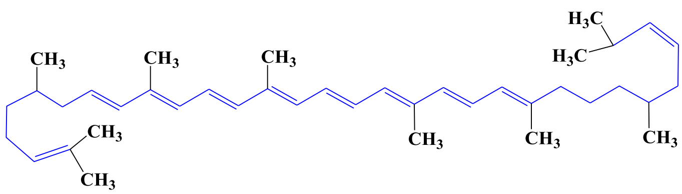
2-Hydroxycinnamic acid

44



4-Hydroxybenzoic acid

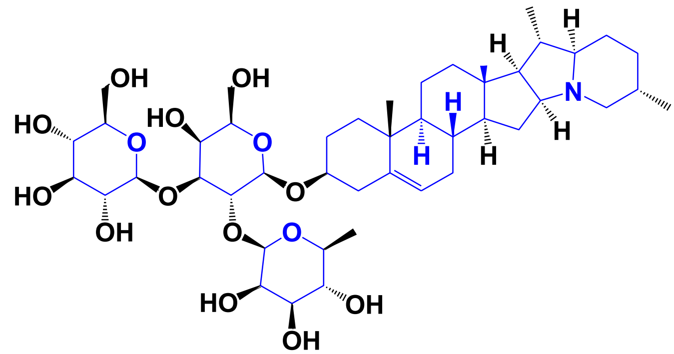
45



Zeaxanthin

46

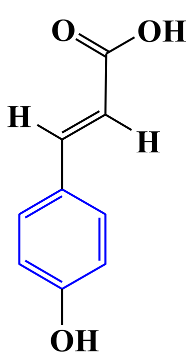
Chart 19. Selected example of an anticancer constituent of the Apiaceae family.



Saponins

48

Chart 21. Selected example of an anticancer constituent of the Mimosaceae family.



p-Coumaric acid

47

Chart 20. Selected example of an anticancer constituent of the Euphorbiaceae family.

4.21. Mimosa pudica, *Mimosaceae*

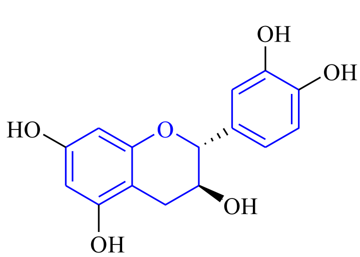
Mimosa is a Fabaceae family genus with around 400 species of plants, shrubs, and ornamental trees. Mimosa species are recognized as an important source of secondary metabolites with diverse biological activities. Pharmacological investigations revealed that isolated chemicals had strong antiprotozoal, antibacterial, antiviral, antioxidant, antiproliferative, and cytotoxic properties. This genus has yielded alkaloids, chalcones, flavonoids, indoles, terpenes, terpenoids, saponins, steroids, amino acids, glycosides, flavonols, phenols, lignoids, polysaccharides, lignins, salts, and fatty esters. saponin and cardiac glycoside are the anticancer agents (Chart 21) (Muhammad et al., 2016; Hafsa et al., 2012).

4.22. Camellia sinensis, *Theaceae*

Epigallocatechin-3-gallate, epigallocatechin, epicatechin-3-gallate, epicatechin catechin, etc. have anticancerous activity (Chart 22) (Chaudhary et al., 2023; Manikandan et al., 2012). Green tea is a kind of unfermented tea that retains the natural substance in fresh leaves to a great extent. It is regarded as the second most popular drink in the world besides water. In this paper, the phytochemistry, pharmacology, and toxicology of green tea are reviewed systematically and comprehensively (Zhao et al., 2022).

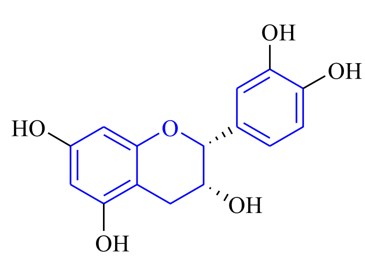
4.23. Azadirachta indica, *Meliaceae*

This plant has around 40 unique dynamic ingredients known as limonoids. Nimbolide, derived from neem leaves and blooms, prevents the development and spread of various tumours, including colon disease, dangerous lymphoma, harmful melanoma, and leukaemia, by inducing apoptosis (modified cell death), which instructs the body's safe cells to distinguish and destroy malignant cells (El-Hawary et al., 2013; Jeba et al., 2020; R. Paul, Prasad, and Sah 2011). Nimbolide, azadirachtins, nimocinol, isomeldenin, azadirachtol,



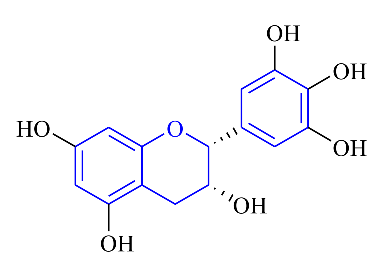
Catechin

49



Epi-Catechin

50



Epi-Gallocatechin

51

Chart 22. Selected examples of anticancer phytochemicals found in the family Theaceae.

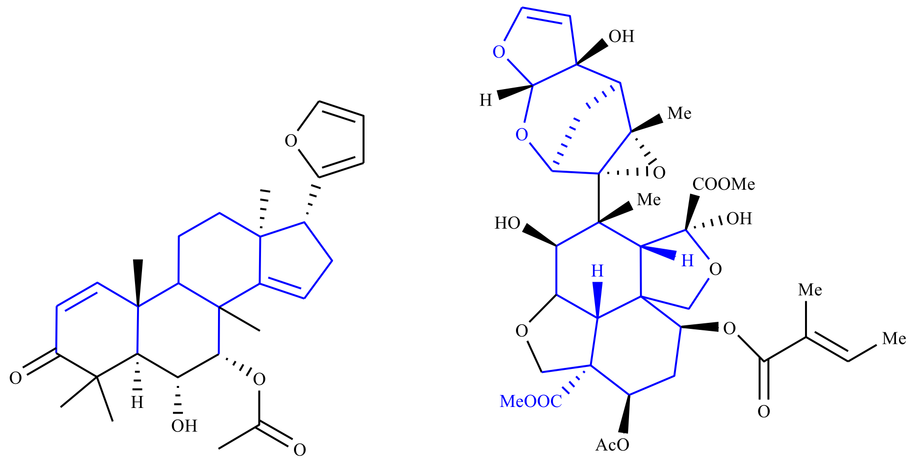


Chart 23. Selected examples of anticancer phytochemicals found in the family Meliaceae.

Terpenoid- Thymol, Menthol Auraptene D-limonene, etc. contain anticancerous activity (Chart 23) (Akinloye et al., 2021; Ansari and Akhtar 2019; Fan et al., 2023; Kamran et al., 2022).

4.24. Liquidambar orientalis, *Hammamelidaceae*

The medicinal plant *L.orientalis*, sometimes known as oriental sweet gum, This study will look at the cellular and molecular processes of L. orientalis in colorectal cancer cell lines. The results showed that L. *orientalis* leaf methanol extract (LM) had the maximum cytotoxic activity in HCT-116 (IC_{50} 27.80 g/mL) and HT-29 (IC_{50} 43.13 g/mL) cell lines. The principal phytochemical substances found were quercetin 3-glucoside, chlorogenic acid, pyrogallol, epigallocatechin gallate, apigenin 7-O-glucoside, gallic acid, genistin, Protocathecuic acid, Liquidambaric acid, Combretastatin, and Atractyloside A., luteolin, and kaempferol (Chart 24). According to our findings, LM extract has cytotoxic and apoptotic effects in vitro (Çetinkaya et al., 2022; Pozzobon et al., 2023).

4.25. Aerva lanata, *Amaranthaceae*

Ethanolic extract of the whole plant of *A. lanata* exhibited immunomodulatory and antitumor activity. The extract was 100% cytotoxic to Dalton's lymphoma ascites (DLA) and Ehrlich ascites carcinoma (EAC) cells at a concentration of 500 μg/mL. It was also found to be cytotoxic toward L929 and HELA cells at higher concentrations, whereas the nontoxic concentrations produced a reduction in the rate of proliferation (Siveen and Kuttan 2011). Aervitrin, aervolanine, campesterol, kaempferol, etc. have anticancerous activity (Chart 25). (Siveen and Kuttan 2011)

4.26. Capsicum annuum, *Solanaceae*

Capsaicin is a secondary metabolite of the *C. Annuum* plant and one of its most important constituents (Chart 26). Capsaicin in C. annuum has a high affinity for MAPK1 and AKT1 receptor/protein targets, with binding energies of -5.5 Kcal/mol and -6.7 Kcal/mol, and a Potential Activity Score (Pa) of 0.690 for preneoplastic treatment, 0.590 for apoptosis agonist, and 0.366 for antineoplastic activity, making it candidates for anticancer treatment (Al-Samydai et al., 2021).

4.27. Elsholtzia stachyodes, *Lamiaceae*

The cytotoxicity of ethanol extracts was determined using flow cytometry. The ethanolic extract of *E. stachyodes* had the most powerful anti-leukemic action. The primary components of the *E. stachyodes* fraction were identified to be lutein and apigenin. LAEF activated the UPR, enhanced autophagic flux, and promoted cell cycle arrest and apoptotic cell death. This is the first research to identify E. stachyodes as a novel source of luteolin and apigenin, which have both been associated with leukemic cell death (Chart 27) (X. Chen et al. 2019; Kulaphisit et al., 2023; Rahmani et al., 2022).

4.28. Acalypha indica, *Euphorbiaceae*

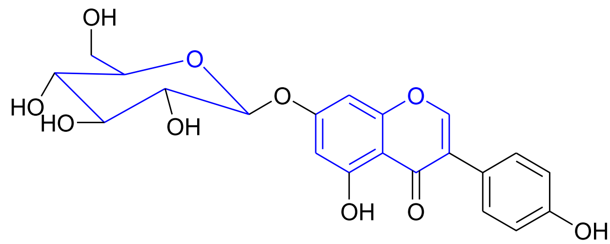
This study demonstrated the anti-cancer and anti-melanogenesis effects of isorhamnetin extracted from *A.indica* ethyl acetate fraction on the A375 cell line (Chart 28). The chemical inhibited melanin synthesis as well as tyrosinase activity. Likewise, the chemical inhibited anti-apoptotic genes while increasing proapoptotic genes, indicating anticancer activity (Chekuri et al., 2017).

4.29. *Kaempferia pandurata, zingiberaceae*

The rhizome of *K. pandurata* is dried and extracted via maseration with n-Hexane solvent. it contains anticancerous activity generally due to the presence of pinostrobin (Chart 29) (Jadaun et al., 2019; Kong et al., 2010; Wiyono et al., 2020). Pinostrobin and its nanoparticle show anticancer action, according to the MTT assay. MDA-MB-231 cells fared better than pinostrobin nanoparticles. MDAMB-231 cells surpassed MCF-7 cells in both samples. Pinostrobin has the potential to be effective in the treatment of breast cancer (Wiyono et al., 2020).

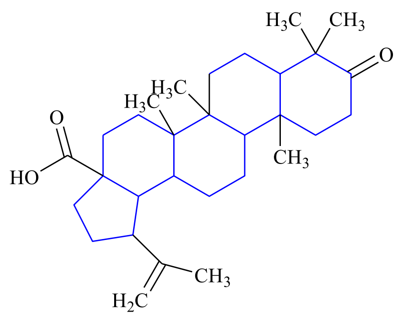
4.30. Vitis vinifera, *Vitaceae*

Synthesis of anthocyanins, and leucocyanidin (Chart 30) in *V. vinifera* appeared 10 weeks after blooming and continued to mature during fruit ripening. Our findings suggest that the commencement of anthocyanin production in ripening grape berry skins is accompanied by a coordinated rise in the expression of many genes involved in the anthocyanin biosynthetic pathway (Boss et al., 1996; Zhang et al. 2019).



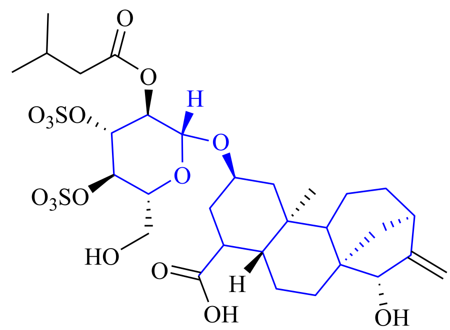
Genistin

54



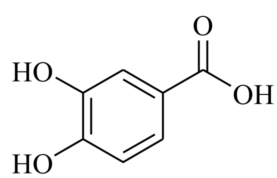
Protocathecuic acid

55



Liquidambaric acid

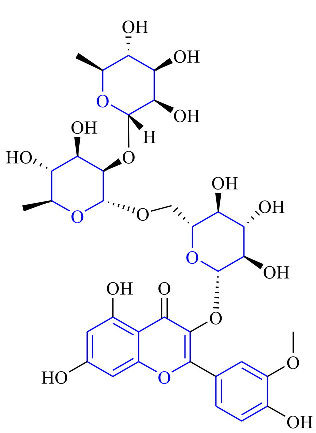
56



Atractyloside A

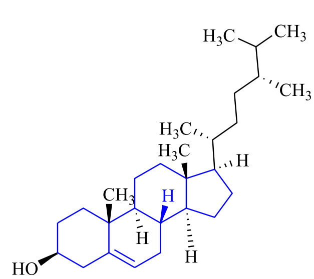
57

Chart 24. Selected examples of anticancer phytochemicals found in the family Hammamelidaceae.



Aervitrin

58



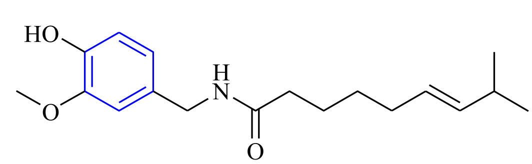
Campesterol

59

Chart 25. Selected examples of anticancer phytochemicals found in the family Amaranthaceae.

4.31. Annona muricata, *Annonaceae*

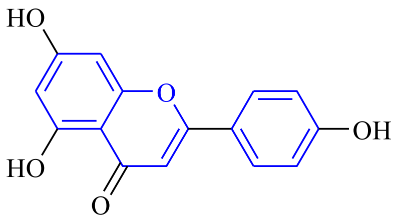
Graviola has been shown to have therapeutic properties against numerous human cancers in vitro culture and preclinical animal model systems. the existing understanding of the anticancer effects of *A. muricata* and its components on several cancer kinds and illness states, as well as efficacy and safety considerations. It also includes an assessment of our current understanding of potential mechanisms of



Capsaicin

60

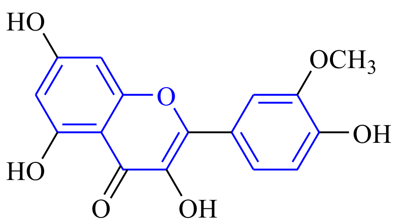
Chart 26. Selected examples of anticancer phytochemicals found in the family Solanaceae.



Apigenin

61

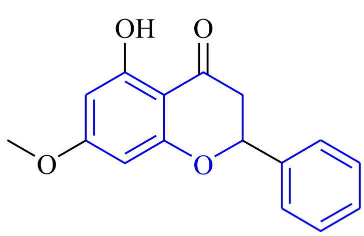
Chart 27. Selected examples of anticancer phytochemicals found in the family Lamiaceae.



Isorhamnetin

62

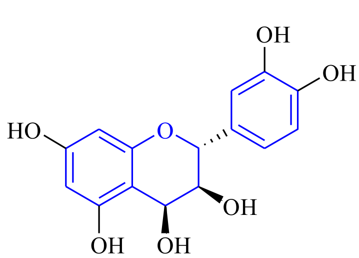
Chart 28. Selected examples of anticancer phytochemicals found in the family Euphorbiaceae.



Pinostrobin

63

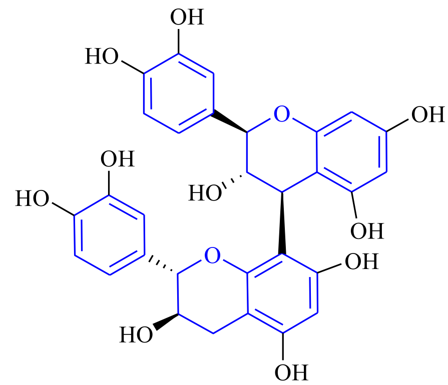
Chart 29. Selected examples of anticancer phytochemicals found in the family Zingiberaceae.



Leucocyanidin

64

Chart 30. Selected examples of anticancer phytochemicals found in the family Vitaceae.



Procyanidin

65

Chart 31. Selected examples of anticancer phytochemicals found in the family Annonaceae.

action, intending to encourage the creation of better and more cost-effective therapies for a variety of diseases. Procyanidin is present as an anticancer agent (Chart 31) (Llorent-martinez et al. 2019; Rady et al., 2018; H. Yang et al., 2021).

4.32. *Croton celtififolius, euphorbiaceae*

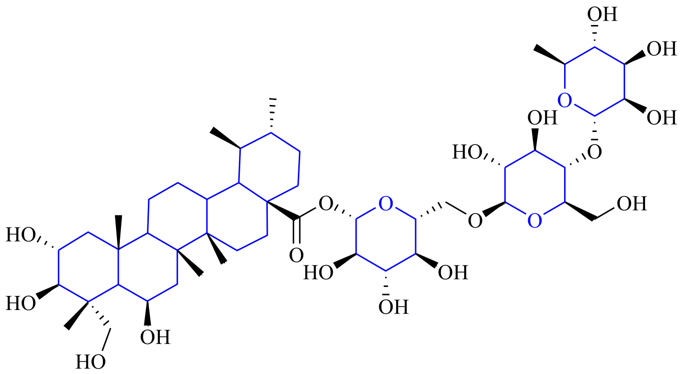
C. celtidifolius is a tree native to the Atlantic Forest in southern Brazil. Its crimson latex has historically been used to cure ulcers, diabetes, and cancer. In the MTT experiment, these chemicals decreased MCF-7 and EAC cell viability (IC_{50} 14169.0 and 187.0 mg/Ml). The EB/acridine orange experiment revealed that latex chemicals induced considerable DNA fragmentation and increased the frequency of apoptotic cells. The greatest dosage of latex decreased tumor development by 56%. These findings corroborate ethnopharmacological accounts of *C. celtidifolius* latex's cytotoxicity and anticancer potential. The anticancer mechanism may be connected to direct DNA fragmentation, which lowers survival and causes apoptosis (Biscaro et al., 2013).

4.33. Centella asiatica, *apiaceae, or umbelliferae*

The use of *C. asiatica* leaf extract to determine its activity became an option. Asiatic acid, madecassic acid, glicosides, asiaticoside, madecassoside, a Anthocyanins, Asiatic acid, kaempferol, asiaticosside nd other compounds are found in *C. asiatica* (Chart 32) (Ghasemzadeh et al., 2012; Kunjumon et al., 2022; Swargiary and Mani 2022). *C. asiatica* has the potential to be used in cancer treatment. this research finds out how C. asiatica leaf extract influences the amount of benzo(a)pyrene-induced lung tumor nodules (Hamid et al., 2016).

4.34. Cassia fistula, *Fabaceae or Leguminosae*

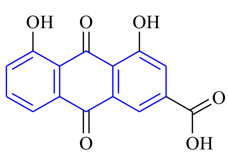
Rhein extracted from ethyl acetate extract of *C. fistula* flowers was tested for anticancer efficacy against colon cancer cell lines. Rhein was put to the test against the cell lines COLO 320 DM and VERO. Rhein had a low cytotoxic impact on VERO cells but was shown to be cytotoxic to COLO320 DM cells in a dose and time-dependent way. Rhein cytotoxicity was 40.59%, 58.26%, 65.40%, 77.92%, and 80.25% at 200 g/mL for 6, 12, 24, 48, and 72 h incubation periods. Rhein's IC50 values were 100, 25, 15, and 12.5 g/mL after 12, 24, 48, and 72 h of incubation, respectively. The COLO 320DM cells treated with Rhein demonstrated apoptosis after 24 h of treatment at 6.25 and 12.5 g/mL (Duraipandiyan et al. 2012). Rhein, emodine, physion, chrysophanol,



Asiaticosside

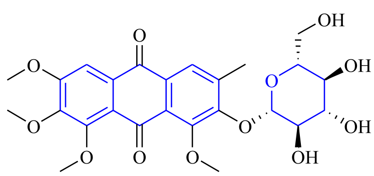
66

Chart 32. Selected examples of anticancer phytochemicals found in the family Apiaceae, or Umbelliferae.



Rhein

67



Chrysoobtusin

68

Chart 33. Selected examples of anticancer phytochemicals found in the family Fabaceae, or Leguminosae.

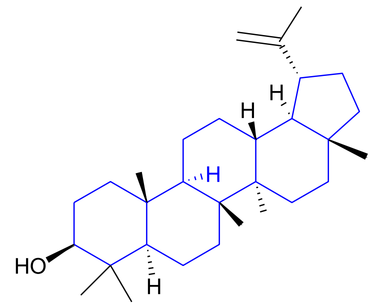
Obtusin, chrysoobtusin are all these phytochemical present in this plant that is responsible for anticancerous activity (Chart 33) (Upadhyay 2020).

4.35. Aegle marmelos, *Rutaceae*

Lupeol, extracted from the seeds and mash of the *A. marmelos*, has potent anticancer properties against bosom sickness, hazardous lymphoma, dangerous melanoma, harmful ascites, and leukaemia (Chart 34) (Rahman and Parvin 2014; Ruiz-Rodríguez et al., 2017).

4.36. Allium sativum*, Amaryllidaceae*

There are about 100 organically beneficial alternative metabolites in *A. sativum*, including alliin, alliinase, allicin, allyl-cysteine, diallyl disulphide, and methylallyl trisulphide. sulfur mixes (diallyl sulfide, diallyl disulphide, allyl propyl disulphide) and allicin are found in *A. sativum* (Chart 35) (Govind 2011; Isbilen and Volkan 2021; Regassa et al., 2022).



Lupeol

69

Chart 34. Selected examples of anticancer phytochemicals found in the family Rutaceae.

4.37. Alpinia galangal*, Zingiberaceae*

Combretastatin (Chart 36) is dynamic against colon, lung, and leukemia malignant growths and, normally, this atom is the most cytotoxic phyto molecule (Hura, 2018). Rhizomes of *A. officinarum, A. zerumbet*, and *A. calcarata* include a high iron level as well as a moderate and balanced carbohydrate, protein, fat, and crude fiber content. A. galanga rhizomes have the lowest fat content but the highest carbohydrate content (El-Hadidy et al., 2020; Indrayah et al., 2009; Rouf et al., 2021).

4.38. Phyllanthus emblica *L., Phyllanthaceae*

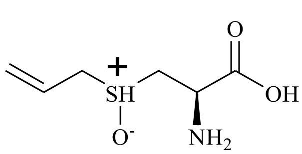
The product of Emblica Officinalis contains gallic corrosive, flavonoids and glycosides, ellagic corrosive, and so forth (Jain et al., 2015). Amla organic product contains 18 intensifies that repress the development of gastric, uterine, and bosom cancers (Golechha et al., 2014; Sharma et al., 2009).

4.39. Colchicum luteum*, Liliaceae*

Colchicine is a secondary metabolite derived from the genius colchicum plant. Colchicine is derived from the dried mature seeds of Colchicum autumnale Linn. It successfully serves as a mitotic toxin or spindle inhibitor, but its primary drawback is toxicity and non-target cell action (Balasubramanian, E. et al. 2013) Vinca alkaloids (Chart 37) are found in their seed part and have anticancerous activities too (Dhyani et al., 2022).

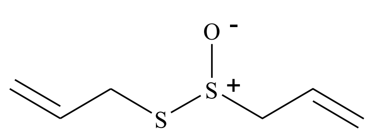
4.40. Acacia nilotica*, Fabaceae or Leguminosae*

Treatment with A. nilotica flower and leaf aqueous extracts by oral gavage for 15 days resulted in a highly significant decrease in the quantity of lipid peroxidation (LPO) in the liver, but this was less



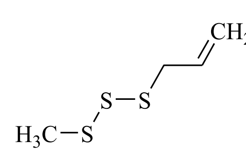
Alliin

70



Allicin

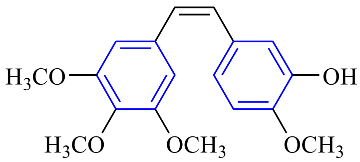
71



Methylallyltrisulphide

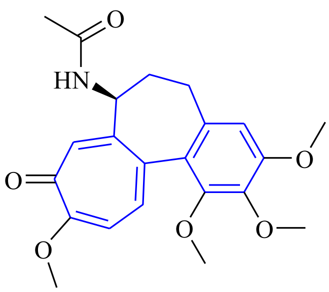
72

Chart 35. Selected examples of anticancer phytochemicals found in the family Amaryllidaceae.



Combretastatin
73

Chart 36. Selected example of anticancer phytochemicals of the family Zingiberaceae.



Vinca alkaloids(colchicine)
74

Chart 37. Selected example of anticancer phytochemicals of the family Liliaceae.

obvious with the gum extract. In contrast, reduced glutathione (GSH) concentration was observed to be significantly greater in comparison to the control group with leaves and flowers. The leaf extract of A. nilotica possesses the most chemopreventive and antimutagenic activity, followed by the flower extract, and finally by gum (Meena et al., 2006). Its fresh pods contain ellagic acid which has anticancerous potential (Al-Nour et al., 2019; Gupta et al. 2019)

4.41. Morus laevigata, *Moraceae*

It is critical to have a safer natural approach for treating neoplastic cells by inducing apoptosis. The antioxidant and cytotoxic activities of *M. laevigata* aqueous extracts were investigated, and Ursolic acid was revealed to be an anticancer agent (Chart 38) (Janakirama et al., 2021; Zafar et al. 2022). The reduction of cell growth in vivo was investigated on animals with EAC. Fluorescent microscopy and qPCR expression of PARP-1, Bax, and Bcl-2 were employed to determine apoptosis. MLL and MLB extracts inhibited cell growth by 68.33% and 48.66%, respectively. The activation of the intrinsic apoptotic pathway is supported by morphological alterations, DNA fragmentation, and differential expression of Bax, Bcl-2, and PARP-1(Rahi et al., 2020).

4.42. Dicoma anomala, *Asteraceae*

D. anomala is a perennial herb of the Asteraceae family that is widely used to treat cancer, malaria, fever, diabetes, ulcers, colds, and cough in Sub-Saharan Africa. It contains Sesquiterpene Lactones artesunate (Chart 38) which is responsible for their antitumor activity (Mangisa et al., 2021). The purpose of this study was to emphasize the benefits of D. anomala in a variety of therapeutic applications, with a particular emphasis on cancer treatment and the methods by which plant-derived medications promote cell death (Chota et al., 2020).

4.43. Solanum *nigrum*, *Solanaceae*

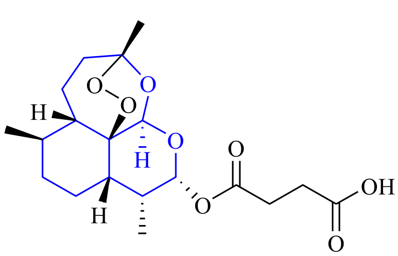
S. nigrum is a Solanaceae plant that grows abundantly in South Asia and has been utilized in traditional folk medicine. Gentisic acid, luteolin, apigenin, kaempferol, and m-coumaric acid were found in the greatest concentrations in *S. nigrum* leaves. Nevertheless, anthocyanidin was exclusively found in purple fruits. Also, the cytotoxicity of the leaf, stem, or fruit extract was assessed against cancer cell lines and normal cells. According to the findings, AU565 breast cancer cells were more susceptible to the extract. A modest dosage of SN leaf extract also activated autophagy but not apoptosis. Larger concentrations (>100 g/mL) of SN leaf extract might suppress p-Akt and induce cell death via autophagy and apoptosis activation (Huang et al., 2010). The Leaf part of it contains Saponin/Solanine (Chart 39) which has anticancerous activities (Ukwubile et al., 2022).

4.44. Avicennia marina, *Acanthaceae*

The antimutagenic and anticancer properties of A. marina leaf extract were investigated in this work. The extract increased cytotoxicity in HL-60 cells in a concentration and time-dependent manner, with IC_{50} values of 600, 400, and 280 g/ml after 24, 48, and 72 h, respectively, according to the MTT cell viability study (Karami et al., 2012). Lupeol acetate is the phytochemical found in their leaf extract which worked as an anticancer agent (Elumalai et al., 2022).

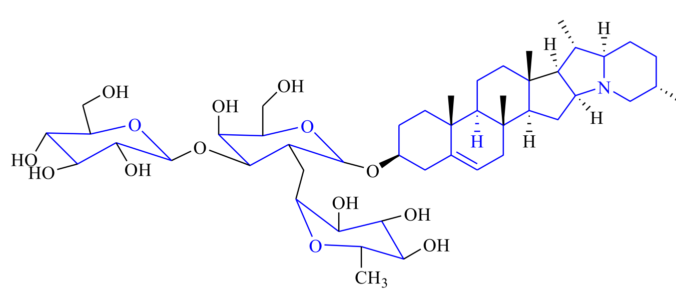
4.45. Prunus domestica, *Rosaceae*

Apart from antibacterial capabilities, plum wines were shown to have a significant cytotoxic effect (IC_{50}- 50 gmL^{-1}) on the growth of three cancer cell lines studied (Hep2c, RD, and L2OB). Anska rana plum wine achieved the best outcomes in terms of anticancerous activities as it contains Rutin (Chart 40). The findings might be seen as a step forward in the adoption of fruit wines as functional meals, with a focus on moderation. In terms of alcohol content, fruit wines have a major advantage over grape wines (Miljić et al., 2016; Prasad and Prasad 2019; Satari et al., 2021).



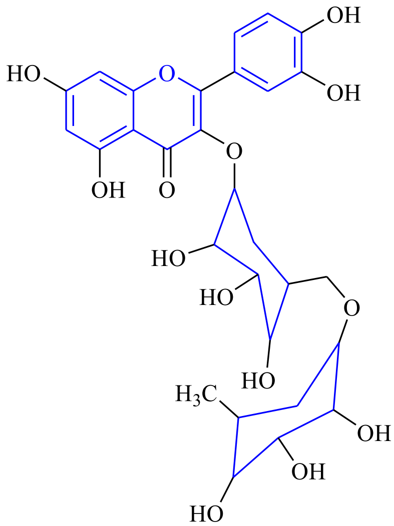
Sesquiterpene Lactones artesunate
75

Chart 38. Selected example of anticancer phytochemicals of the family Asteraceae.



Solanine
76

Chart 39. Selected example of anticancer phytochemicals of the family Solanaceae.

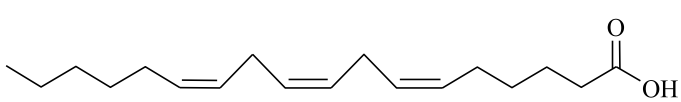


Rutin
77

Chart 40. Selected example of anticancer phytochemicals of the family Rosaceae.

4.46. Ribes nigrum, *Grossulariaceae*

The current study looks at the potential selective cytotoxicity of a *R. nigrum* extract grown in Armenia's mountainous setting. Non-cancer ACOX1 defective, and cancer (HT29 and MCF7) cell lines were used for this purpose. At a concentration of 0.5 mg/mL DW, an ethanol extract of *R. nigrum* leaf decreased the proliferation of HT29 and MCF7 cells after 6 h of treatment. After 72 h of treatment with cancer cells, the lowest dosage (0.125 mg/mL DW) of the studied extract showed cytotoxicity. In contrast to the cancer cells, the non-cancer cells tested had no detrimental impact at the doses used (Ginovyan et al. 2022). Its seed contains gamma-linolenic acid (Chart 41) which has anticancer activity.



Gamma-linolenic acid
78

Chart 41. Selected example of anticancer phytochemicals of the family Grossulariaceae.

4.47. Rhus *chinensis*, *Anacardiaceae*

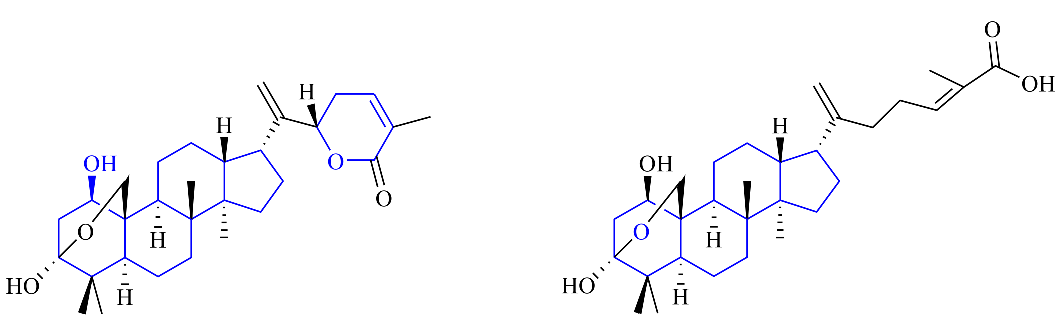
R. chinensis is a traditional Chinese medicine (TCM) that is commonly used for cancer treatments. Our previous work had proven that triterpenoids of *R. chinensis* could effectively regulate glycolysis involved in colorectal cancer and play an important role in the prevention of T-cells dysfunction. The extract of triterpenoids (Chart 42) from *R. chinensis* was obtained, and the production of lactic acid and glucose uptake was assayed. Also, the expression of CD8+ T-cells surface markers, cytokines secreted by $CD8^+$ T cells, and the expression of key glycolytic enzymes and glucose deprivation-induced by tumor cells were further examined. Notably, results showed that TER prevented the dysfunction in $CD8^+$ T cells by enhancing mTOR activity and subsequent cellular metabolism (Wang et al., 2021).

4.48. Ginkgo biloba, *Ginkgoaceae*

G. biloba is now grown all over the world for both cosmetic and medical purposes. The anti-proliferative characteristics of several cancer lines were studied (Qanash et al., 2022). Bilobetin and isoginkgetin had stronger anti-proliferative efficacy in several cancer lines (Chart 43). Their effects on the most sensitive HeLa cells were found to be cell-specific, dose and time-dependent. The significant morphological changes confirmed their anticancer activities in a dose-dependent manner. They could halt the cell cycle in the G2/M phase, induce apoptosis in HeLa cells, and activate the proapoptotic protein Bax and the executor caspase-3. Bilobetin can inhibit the antiapoptotic protein Bcl-2. These might be the processes that underlie their anti-proliferation properties. In conclusion, bilobetin and isoginkgetin have the potential to be the initial lead compounds for innovative anticancer medicines (Male et al., 2019).

4.49. Rosmarinus officinalis, *Lamiaceae or Labiatae*

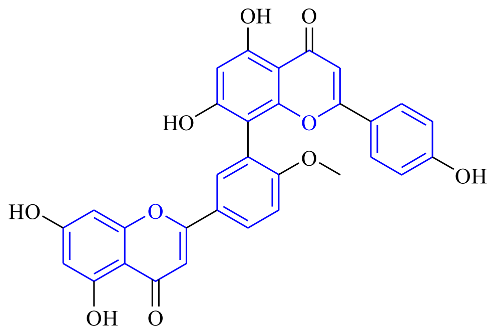
The addition of rosemary to our food chain, as well as dietary choices, has enhanced the chance of exposure to diterpenes in rosemary. Three compounds, in particular, have gotten the greatest interest, including carnosic acid, Alpha-carotene, and rosmanol, which have shown potential anti-cancer efficacy (Chart 44) (Chaudhary et al., 2020) diterpenes can modify aberrant signaling pathways in several solid and blood malignancies. Rosemary extracts and the phytochemicals included in them appear to be well tolerated in various animal models, as indicated by comprehensive studies conducted for approval as an antioxidant food preservative by the EU and the FDA (Petiwala et al., 2015).



Triterpenoids of Rhus chinensis

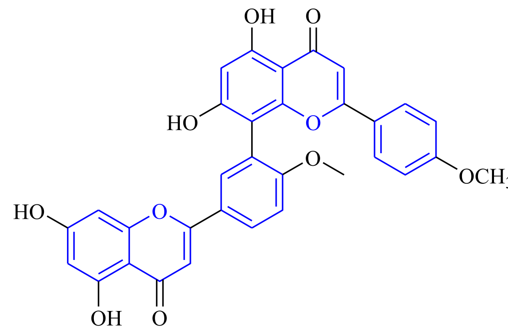
79 **80**

Chart 42. Selected example of anticancer phytochemicals of the family Anacardiaceae.



Bilobetin

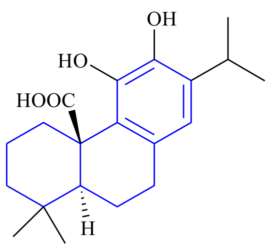
81



Isoginkgetin

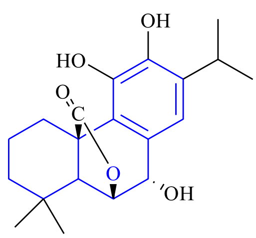
82

Chart 43. Selected example of anticancer phytochemicals of the family Ginkgoaceae.



Carsonic acid

83



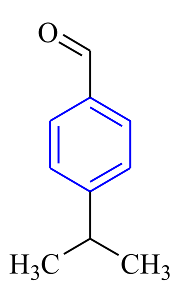
Rosmnol

84

Chart 44. Selected example of anticancer phytochemicals of the family Lamiaceae or Labiatae.

4.50. Cuminum cyminum, *Apiaceae or Umbelliferae*

C. cyminum is generally luteolin which is responsible for its anticancer activity and is found in the Fruit or seed part of it (Goodarzi et al., 2018; Imran et al., 2019). The cytotoxic activity of *C. cyminum* ethanolic extract in vitro is studied and cumin has anticancerous activities (Chart 45). The SRB test was used to investigate the anticancer effects of cumin seed. SF-295, Colon 502713, Colo-205, Hep-2, A-549, OVCAR-5, and PC-5 human cancer cell lines were reported to have 25%, 61%, 40%, 31%, 31%, 28%, and 27% activity, respectively. The greatest activity of *C. cyminum* extract against the Colon 502713 cell line was 61% (Prakash and Dwijendra, 2014).



Cumin

85

Chart 45. Selected example of anticancer phytochemicals of the family Apiaceae or Umbelliferae.

5. Side effects-

The applications listed below are based on folklore or scientific assumptions. They are generally not examined sufficiently in humans, and their safety and utility are not always established. Autoimmune illnesses include alopecia, bacterial and fungal skin infections, chronic leg wounds, parasitic infections, systemic lupus erythematosus, arthritis, and tic douloureux (Han et al. 2022; Ohnishi and Takeda 2015). It can cause redness, burning, stinging, and, in rare situations, extensive dermatitis in sensitive persons. The most prevalent cause of allergic reactions is anthraquinones, such as aloin and barbaloin. Cramps in the belly, diarrhea, red urine, hepatitis, dependency, or worsening constipation are all symptoms of hepatitis (Alkhamaiseh and Aljofan 2020; Fraunfelder 2004). Long-term use has been related to an increased risk of colorectal cancer. As a result of the laxative effect, electrolyte imbalances may occur. Due to the likelihood of uterine contraction stimulation, oral administration is not recommended during pregnancy, and it may occasionally induce gastrointestinal distress in nursing mothers (Desai 2016; Ernst 2006; Staines et al. 2011; Williamson 2005).

6. Conclusions

Chemoprevention of cancer with plant-based chemicals has become a popular strategy in cancer treatment. The discovery of novel chemopreventive phytocompounds has become a fundamental focus of anticancer research, and it also aids in the discovery of new therapeutic targets. Because oxidative stress is involved in the development of many malignancies, the antioxidant action of dietary phenolic substances may be a viable cancer prevention method. Plants are abundant in dietary antioxidant phytochemicals, which constitute several families of molecules with varied modes of action on cancers. Thus, chemoprevention by diets high in plant-based antioxidants shows tremendous potential in lowering the risk factors linked with cancer progression. Finally, this study provides information on a large spectrum of anticancer phytochemicals having anticancer properties. This broad investigation of a variety of plants revealed that medicinal herbs have significant anticancer potential. This article fully explains the antitumor processes of numerous major plants. This is frequently achieved by altering signaling pathways. Inhibiting enzymes that restrict tumor formation has been shown in several trials to be successful.

Declaration of Competing Interest

No Conflict of interest.

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