

Natural Source Paradigm: Potential Chemotherapeutic Agents for Cancer Treatment

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Abstract: Chemotherapy was first developed at the beginning of 20th century, although it was not originally intended as cancer treatment. Due to several drawbacks like harmful side effects, advances in chemotherapy i.e. combined chemotherapy along with use of naturally derived anticancer agents becomes one of the best available methods of cancer treatment. Some of the important natural products derived anticancer agents are discussed in this review. The main objective of using natural product derived anticancer agents is to diminish the harmful side effects of the synthetic chemotherapeutic agents. These naturally derived agents can be used either alone or in combination with synthetic anticancer agents. As compared to chemically derived agents for cancer treatment, naturally derived agents show minimum side effects and results in maximum possible efficacy to treat cancer. These naturally derived anticancer agents are also very cost effective as compared to the chemically derived anticancer agents. Hence, we can conclude that anticancer agents derived from natural sources result in highly effective treatment of cancer.

Key words: Chemotherapy • Natural sources • Microbes • Dietary sources • Marine sources.

INTRODUCTION

Cancer can be defined as undisciplined growing group of cells without following normal mechanism of cell division. Cancer can also be defined as multi-gene, multi-step disease arises from an individual cell which shows DNA mutation. Cells in our body undergo mitosis and lead to form another cell by cell division. Sometimes, cell division got affected and results in formation of abnormal cell and these cells split in another part of body. These abnormal cells are usually known as cancer [1]. Repetition of mutation and expansion leads to tumor growth and leads to metastasis. Metastasis is a process in which cancer cells break away from primary site of cancer and with the help of body transport system i.e. lymph or blood form new tumors by reaching other parts in the body [2]. This leads to 90% of cancer related deaths, it is also known as tumor spreading. Lifestyle, environment and age are the main causes that lead to cancer. After heart diseases, cancer is the second leading cause of death. The mechanism that limit DNA damage and show DNA repairing more frequently and satisfactorily lead to decrease cancer incidence [3]. The six hallmarks of cancer

are illustrated in Fig. 1. [4]. All cancer cells express aerobic glycolysis. It involves elevated glucose uptake with lactic acid production aerobically. The invasion of tumor cells leads to mortality and morbidity for cancer patients [5]. The treatment for advance stage cancer includes surgery, radiation and drugs or medicines i.e. chemotherapy [6]. An ideal anticancer drug should have the ability to kill cancer cells without any effect on other normal cells but it seems probably impossible so that's why cancer patients suffer side effects. Most common types of cancer includes the following: anal cancer, breast cancer, bladder cancer, bone marrow cancer, colon cancer, cervical cancer, eye cancer, gynecological cancer, lung cancer, osteosarcoma, Wilms cancer, leukemia, larynx cancer, testicular cancer and rectal cancer [7]. The common symptoms which are visible in a patient suffering from cancer are as follows persistent cough or blood-tinged saliva, change in bowel habits, blood in the stools, unexplained anemia, breast lump or breast discharge, lumps in the testicle, change in the urination, blood in the urine, hoarseness, persistent lump or swollen glands, indigestion or difficulty in swallowing, unusual vaginal bleeding or discharge unexpected, weight loss, night

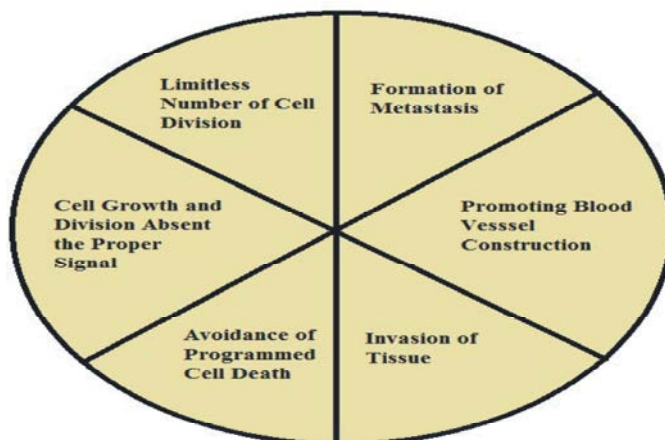


Fig. 1: Six Hallmarks of Cancer [4].

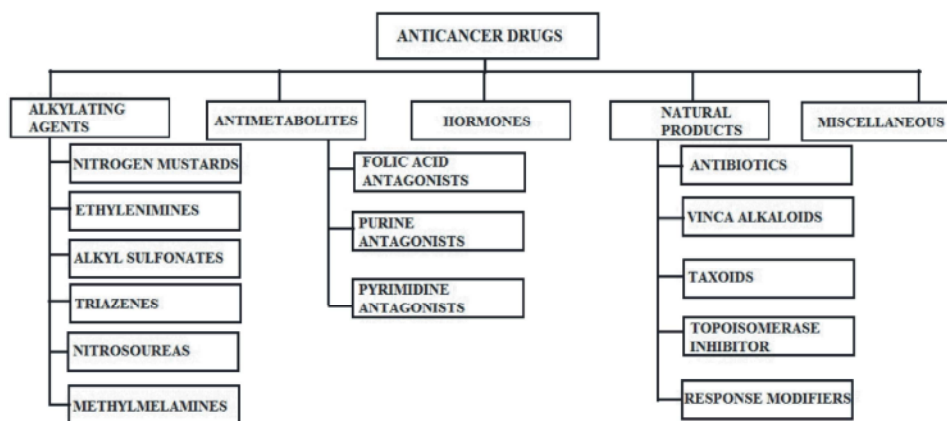


Fig. 2: Classification of Anticancer Agents [14].

sweats or fever, continued itching in genital area, non-healing sores, headache, back pain and pelvic pain [8-10]. The main aim of this review is to focus on availability and enhance the use of natural source based anticancer agents to treat various types of cancers.

Chemotherapy: It is category of cancer treatment that uses one or more anticancer drugs as a part of a standardized chemotherapy regimen. The ultimate objective of chemotherapy is to cure the disease. Chemotherapeutic drugs work by impairing mitosis (cell division) targeting fast dividing cells. These drugs are cytotoxic as they cause damage to the cells. Chemotherapeutic drugs impair mitosis either by damaging DNA or inhibition of the cellular machinery [11]. They induce apoptosis which is a programmed cell death that occur in multicellular organism [12]. It occurs normally during development and aging and acts as a homeostatic mechanism to maintain cell population in

tissues [13]. The various chemotherapeutic drugs can be classified as shown in Fig. 2.

Alkylating agents act by forming covalent bonds with nucleophilic groups of different cell constituents. The main target is the nitrogen at the N-7 position of guanine which results in DNA strand breakage and hence prevents DNA synthesis. Folate antagonists competitively inhibit dihydrofolate reductase and block the conversion of DHFA (dihydrofolic acid) to THFA (tetrahydrofolic acid). It is an essential coenzyme in synthesis of amino acid and nucleic acid. Purine antagonists inhibit specific enzyme, essential for nucleic acid synthesis. Pyrimidine antagonists inhibit thymidylate synthetase, while vinca alkaloids are well known to mitotic inhibitors activities. These all different agents are cytotoxic in nature i.e. harmful to cells but hormones are not cytotoxic in nature they modify the growth of hormone modify tumors [14]. The various mechanisms of action of all classes of anticancer agents are described in Fig. 3.

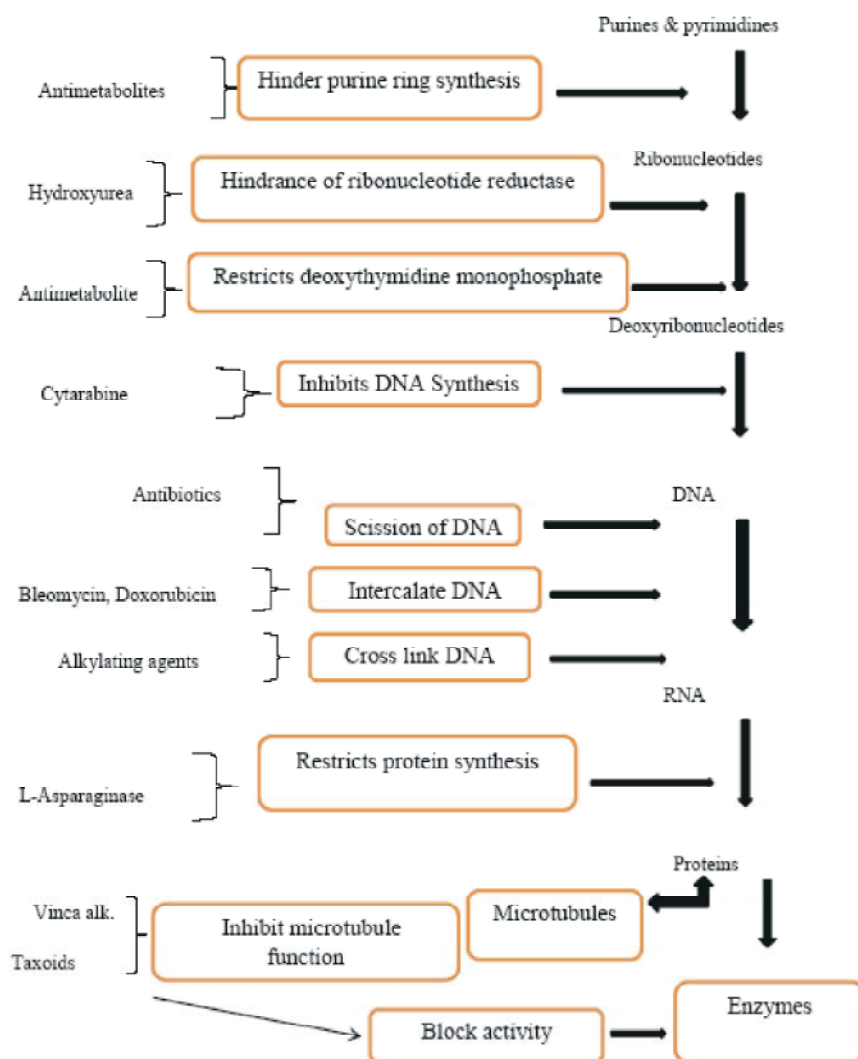


Fig. 3: Schematic Representation of Mechanism of Action of Chemotherapeutic Agents [14].

Chemotherapy can also lead to various harmful side effects. The most common side effects of chemotherapy are nausea and vomiting [15]. These may be controlled by using antiemetic drugs e.g. metoclopramide, dexamethasone. Mucositis (mouth ulceration) is another side effect and is due to direct effect of cytotoxic drugs on mucosal membrane [16]. The other severe side effects of chemotherapy include bone marrow suppression (myelosuppression), alopecia (reversible hair loss), teratogenicity and infertility, cystitis (inflammation of urinary bladder), neurotoxicity common with vinca alkaloids and hepatotoxicity [17]. These are the serious side effects of chemotherapy. As a result of prolonged chemotherapy the cancerous cells may develop resistance towards the anticancer drugs, resistance may be of any type either primary or acquired. Primary resistance can be

defined as the absence of response by the tumor cell when the drug is first given e.g. in lung cancer and colon cancer while acquired resistance can be defined as the resistance which is developed during treatment with drug [18]. When the resistance is developed by a tumor cell, the drug is not able to treat that tumor cell. The industrialization and modification of the said chemistry result in the use of synthetic product which minimizes the use of natural products [19]. As we know, chemotherapy is used to treat cancer, but there are various consequences related to these chemically modified drugs. Recently, different natural sources added drugs are available as anticancer agents which can be used to treat various types of cancers. The use of natural products revolutionized the medicine industry, till now about a million of natural products are known which can be used

as therapeutic agents. 75% of anticancer compounds used in the medicine are either natural products or related to them [20]. Since last 40 years, naturally occurring sources shows a very important role as anticancer agents either in their naturally occurring form or modified form [21]. The anticancer agents are derived from herbs or phytochemicals; these can be defined as plants which are administered as whole plant or by extraction of one or more ingredient. The most important criteria for a medicine's use are safety, effectiveness, quality, identity, purity, potency and stability [22]. Natural products have various advantages over synthetic drugs. The natural products are less expensive than synthetic agents. It results in a tremendous and big success and lead to reduction in pain and suffering [23]. The natural source based antitumor agents belong to several class, these are anthracyclines, enediyne, indolocarbazoles, isoprenoids, polyketide macrolides, non-ribosomal peptides and others. On the basis of a report of WHO, probably 80% of world's population uses traditional medicines for their primary health needs [24]. Nature itself acts as a wide source of new pharmacological active candidate as chemical diversity is found in various species of all living beings present in nature. A survey shows that over 60% of available drugs are derived from natural sources [25]. Natural products having therapeutic characters are applicable in various types of disease over a very long period of time [19].

Anticancer Agents Derived from Various Natural Sources

Plants: There are various anticancer drugs which are derived from the plant sources. Plant extracts shows the ability to produce response in humans and animals over a long period of time [26].

Vinca Alkaloids: First type of natural drugs which is introduced as antitumor agent [6]. This class includes vincristine and vinblastine, obtained from plant *Catharanthus roseus* belonging to family Apocynaceae. The commercial used drug is obtained from Africa, India, Thailand, Taiwan, Eastern Europe, Spain, USA and Australia [27]. Approximately, 150 alkaloids are present in *Catharanthus roseus* including ajmalicine, locherine, serpentine, tetrahydroalstonine along with vincristine and vinblastine [28]. In recent days, vinorelbine and vindesine, the semi-synthetic derivative of vincristine and vinblastine are available which can be used as anticancer agents either individually or in combination of other. Vinblastine is used mainly in treatment of Hodgkin's disease i.e. a type of blood cancer. Vincristine is primarily used for the treatment of lymphocytic leukaemia.

Podophyllum: Podophyllum is derived from the dried rhizomes and roots of *Podophyllum peltatum* belonging to family Berberidaceae [29]. The drug is collected in the eastern part of Canada, USA, Virginia, North Carolina and Indiana. The rhizome of about 10 cm in length is dug up cut into pieces of 10 cm in length, dried and stored. The main constituent obtained from podophyllum is podophyllin which is prepared by alcoholic extraction of the dried rhizomes and roots of the plant [30]. The other constituents are demethyl podophyllotoxin, peltatin and etoposide. It is used by Native Americans for the treatment of cancer [31]. It has long been used as a purgative but also used in the treatment of small cell lung cancer and testicular cancer [32].

Monoterpenes: Monoterpene compound active as antitumor agent is allamandin. It is obtained from the plant *Allamanda cathartica* belonging to family Apocynaceae [33]. The main constituents of the plant include lactones such as allamandin, plumericin and plumierides. Allamandin has been used to treat liver tumors and other uses of the plant include treatment of jaundice, splenomegaly and malaria [34].

Taxol: The name, Taxol was given to a diterpene ester with anticancer property obtained from the parts of the plant *Taxus brevifolia* belonging to family Taxaceae [35]. Initially, paclitaxel was the name given to the compound later followed by name taxol. Maximum parts of the plant *Taxus brevifolia* contain a wide range of diterpenoids named taxanes and having constituents comprise of Deacetyl baccatin and Docetaxel. Taxol is used in the treatment of ovarian cancers, breast cancers and non-small cell lung cancers and also shows potential value against other cancers [36].

Sesquiterpenes: This class of natural antitumor drugs includes compound baccharin, elephantopin, helenalin obtained from plant *Baccharis megapotamica*, *Elephantopus elatus* and *Helenium autumnale* respectively belonging to family Compositae and derivatives of these plants are used in the treatment of various cancers [37].

Quassanoids: This class includes compound like bruceatin which is obtained from the plant *Brucea antidysenterica* belonging to family Simorouibaceae. It is used in the treatment of skin cancer either alone or in combination with other drugs [38].

Garlic: *Allium sativum* commonly named as garlic belongs to the family Liliaceae. The main constituents having therapeutic activity are allicin along with allin and allose [39]. The composition of various constituents of garlic provides some protection against cancer.

Annona Muricata: The anticancer drug is obtained from the fruit of plant *Annona muricata* belonging to family Annonaceae [40]. This plant has a long history of its traditional use. Annona consists mainly of alkaloids, megastigmanes, flavanol triglycosides, phenolics, cyclopeptides and essential oils. It is used in the treatment of colon cancer, lung cancer etc. besides its anticancer activity. *Annona muricata* also have anti-arthritis activity, anticonvulsant activity, antidiabetic activity, anti-inflammatory and antihypertensive activities. It is one of the most traditionally used plants for its therapeutic activities [41].

Marijuana: *Cannabis sativa* is commonly known as marijuana belonging to family Cannabinaceae [42]. Marijuana consists of mainly cannabinoids which are responsible for its activity. It is used in the treatment of brain tumor and also used to reduce the side effects of chemotherapy i.e. nausea and vomiting [43].

Ginger: It is obtained from the roots and rhizomes of plant *Zingiber officinalis* belonging to family Zingiberaceae [44]. The alcoholic extract of this plant found activity in the treatment of mainly skin cancer. The main constituent of this plant is aristocholic acid [45]. Ginger shows potency to inhibit cell damage induced by carcinogen [46].

Some of the important anticancer compounds which are derived from the plants are discussed in Table 1 [32-62].

Table 1: Anticancer Compounds Derived from Plant Sources.

S. No.	Compound	Plant Source	Family	Uses	References
1.	Allamandin	<i>Allamanda cathartica</i>	Apocynaceae	Liver tumors, Jaundice	[32, 33& 34]
2.	Taxol	<i>Taxus brevifolia</i>	Taxaceae	Ovarian cancer, Breast cancer	[35, 36]
3.	Baccharin	<i>Baccharis megapotamica</i>			
	Compositae	Liver tumor	[37]		
4.	Soulameanone	<i>Brucea antidysenterica</i>	Simaroubaceae	Various carcinomas	[38]
5.	Allicin	<i>Allium sativum</i>	Liliaceae	Skin Cancer	[39]
6.	Alkaloids	<i>Annona muricata</i>	Annonaceae	Colon cancer, Lung cancer	[40, 41]
7.	Cannabinoids	<i>Cannabis sativa</i>	Cannabinaceae	Brain tumors	[42, 43]
8.	Aristocholic acid	<i>Zingiber officinalis</i>	Zingiberaceae	Skin cancer	[44, 45& 46]
9.	Vincristine, Vinblastine	<i>Catharanthus roseus</i>	Apocynaceae	Lymphoma, Leukemia	[47]
10.	Podophyllin	<i>Podophyllum peltatum</i>	Berberidiaceae	Small cell lung cancer, testicular cancer	[48]
11.	Colchicine	<i>Colchicum speciosum</i>	Colchicaceae	Skin cancer	[49]
12.	Camptothecin	<i>Camptotheca acuminata</i>	Nyssaceae	Breast cancer	[50]
13.	Baccharin	<i>Baccharis megapotamica</i>			
	Compositae	Liver tumor	[51]		
14.	Apigenin	<i>Salvia officinalis</i>	Labiatae	Breast cancer	[52]
15.	Stilbenoids	<i>Combretum caffrum</i>	Myrtaceae	Skin cancer	[53]
16.	Viscotoxins	<i>Viscum album</i>	Loranthaceae	Reduce side effects of cancer chemotherapy	[54]
17.	Terpenes	<i>Melaleuca alternifolia</i>	Labiatae	Skin cancer	[55]
18.	Terpene Bisabolel	<i>Matricaria chamomilla</i>	Asteraceae	Clinical trials	[55]
19.	Silvestrol	<i>Aglaia foveolata</i>	Meliaceae	Cytotoxic activity	[56]
20.	Capacitol	<i>Tabebuia rosea</i>	Bignoniaceae	Skin cancer	[57]
21.	Coumarin	<i>Dipteryx odorata</i>	Bignoniaceae	Used to treat various types of cancer	[58]
22.	Thapsigargin	<i>Thapsia garganica</i>	Apiaceae	Clinical trials for cancer treatment	[59]
23.	Pectin	<i>Physalis peruviana</i>	Solanaceae	Various types of cancer	[60]
24.	Casticin	<i>Vitex negundo</i>	Lamiaceae	Dalton's lymphoma	[61]
25.	Apocynin	<i>Picrorhiza kurroa</i>	Plantaginaceae	Hepatocarcinoma effect on mammalian cell lines	[61]
26.	Taxifolin	<i>Cedrus deodara</i>	Pinaceae	Lung, pancreas, colon cancer	[61]
27.	Longumine	<i>Peper longum</i>	Pepareaceae	Lung cancer	[61]
28.	Berberine	<i>Berberis aristata</i>	Berberidiaceae	Various types of cancer	[61]
29.	Galacromannan	<i>Glycine max</i>	Fabaceae	Various types of cancer	[62]

Table 2: Anticancer Compounds Derived from Marine Sources.

S. No.	Compounds	Source	Family	Mechanism of action	Use	References
1.	Trabectedin	<i>Ecteinascidia turbinata</i>	Perophoridae	Inhibition of activated transcription	Ewing sarcoma	[63]
2.	Aplidine	<i>Aplidium albicans</i>	Tubulin binding agents	Blocks cell cycle progression	Ewing's tumor	[64]
3.	Bryostatin	<i>Bugula neritina</i>	Bugulidae	Interfering with mitotic spindle	Esophageal cancer	[65]
4.	Kahalalide F	<i>Hawaiian mollusc</i> <i>E. Rufencens</i>	Mytilidae	Variable cell permeability in human hepatoma cell lines	Prostate cancer	[66]
5.	Aaptamine	<i>Aaptosuberi--toides</i>	Demspongiae	Induction of P21 gene	Breast cancer	[67]
6.	Bastodine-6	Sponge	Demspongiae	Induction of p21 gene	Breast cancer	[68]
7.	Bromovulone III	<i>Alcyonacea/ Soft coral</i>	Alcyoniidae	Activation of caspase-12	Prostate cancer	[69]
8.	Cephalostatin- I	<i>Riftia pachyptila</i>	Sibuglinidae	M-phase arrest and DNA damage	Chemo resistant cancer	[70]
9.	Onnamide-A	Sponge	Demspongiae	Protein synthesis inhibition	Breast cancer	[71]
10.	Peloruside-A	Sponge	Demspongiae	Synergistic effect with taxoid site drug	Lung cancer	[72]
11.	Cortistatin A	<i>Cortidium simplex</i>	Plankinidae	Selective inhibition of angiogenesis	Lung cancer	[73]
12.	Fucoxanthinol	<i>Undaria pinnatifida</i> , <i>Laminaria japonica</i>	Alariaceae, Laminariaceae	Induction of apoptosis	Breast cancer	[74, 75]
13.	Clavulone II	<i>Clavularia virdis</i>	Clavulariidae	G1 cell cycle arrest and apoptosis	Lung and Tonsil cancer	[76]
14.	Phalinopside A	<i>Pentacta quadrangulari</i>	Cucumariidae	Inhibition of angiogenesis and receptor tyrosine kinase	Breast cancer	[77]
15.	Variolon B	<i>Kirkpatrickia variolosa</i>	Hymedesmiidae	Inhibition of cyclin dependent kinase and apoptosis induction	Leukemia	[78]
16.	Dolostatin 10	<i>Cyanobacteri---um symploca</i>	Oscillatoriaceae	Binds to amino terminal peptide of Beta tubulin containing cysteine	Colon cancer	[79]

Table 3: Anticancer Compounds Derived from Microbes.

S. No.	Compound	Source	Family	Uses	References
1.	Actinomycin	<i>Streptomyces griseoruber</i>	Streptomycetaceae	Sarcoma & germ cell tumors	[81]
2.	Bleomycin	<i>Streptomyces verticillus</i>	Streptomycetaceae	Germ cell, head & neck tumor	[82]
3.	Daunomycin	Bacteria of <i>Streptomyces</i> type	Streptomycetaceae	Leukemia	[83]
4.	Doxorubicin	<i>Streptomyces peucetius</i>	Streptomycetaceae	Lymphoma, Breast, ovary, lung & sarcomas	[83]
5.	Rapamycin	<i>Streptomyces hygroscopicus</i>	Streptomycetaceae	Lung cancer	[83]
6.	Mitomycin	<i>Streptomyces caespitosus</i>	Streptomycetaceae	Gastric, rectal, anal, & lung cancer	[83]
7.	Idarubicin	<i>Streptomyces peucetius</i>	Streptomycetaceae	Breast cancer & leukemia	[84]

Marine Sources: In past 3-4 decades, the marine environment shows its own importance in the field of medicines. There are various marine source derived products which can be used in the treatment of various diseases. A limited number of marine plants and organisms lead to the development of various medicinal sources which can be used to treat disease. Some of the important anticancer compounds which are derived from marine sources are tabulated in Table 2 [63-79].

These are the compounds derived from the marine source which are used to treat various types of cancers. In future marine sources are as important as various natural source derived drugs, marine derived anticancer drugs provides perfect result in the treatment of various types of cancer.

Microbes: Microbes are also used as a source of anticancer agents nowadays. Microbial antibiotics are the leading type of anticancer agents which provide best therapeutic efficacy against cancerous cells.

Asparaginase shows anticancer activity and produced from several micro-organisms. *Streptomyces* are responsible for various compounds having antitumour and antimicrobial activity [80]. These antibiotics mainly include the members of anthracyclines, bleomycin, actinomycin, mitomycin and aureolic acid families. Table 3 consists of the compounds which are derived from microbial sources [81 - 84].

These followings are the some of the best therapeutic available drugs to treat cancer, derived from the microbial sources. As we all know microbes show their importance in proper body functioning and antibiotics are one of the frequently used anticancer agents. These antibiotics are derived from various types of microbes.

Dietary Source as Anticancer Agents: There are various dietary sources from which anticancer compounds are derived and used alone or in combination to treat various types of cancer. Some of them are discussed as follows in Table 4 [85 - 99].

Table 4: Anticancer Compounds Derived from Dietary Sources.

S. No.	Compound	Biological Source	Family	Part	References
1.	β -Cryptoxanthin	<i>Carica papaya</i>	Caricaceae	Berries	[85]
2.	Glycyrrhizin	<i>Glycyrrhiza glabra</i> , <i>Glycyrrhiza uralensis</i>	Leguminosae	Root	[86]
3.	Cannabinol	<i>Cannabis sativa</i>	Cannabiaceae	Hemp	[87]
4.	Carnosol	<i>Rosmarinus officinalis</i>	Lamiaceae	Flower	[88]
5.	Gingerol	<i>Zingiber officinalis</i>	Zingiberaceae	Tuber	[89]
6.	Lycopene, Lutein	<i>Lycopersicon esculentum</i>	Solanaceae	Tomato fruit	[89]
7.	Purpurogallin, Piperine	<i>Piper nigrum</i> , <i>Piper longum</i>	Piperaceae	Black pepper	[90]
8.	Carotenoids	<i>Crocus sativus</i>	Iridaceae	Saffron	[91]
9.	Capsaicinoids, Capsaicin	<i>Capsicum annum</i>	Solanaceae	Red Chilli	[92]
10.	Resveratrol	<i>Vitisvinifera</i>	Vitaceae	Grapes	[93]
11.	β -Carotene	<i>Baucus carotasativus</i>	Apiaceae/ Umbelliferae	Root	[94]
12.	Hesperidin	<i>Citrus aurantium</i>	Rutaceae	Peel	[95]
13.	Morin	<i>Prunus dulcis</i>	Rosaceae	Almond	[96, 97]
14.	Emodin	<i>Aloe arborescens</i>	Asphodelaceae	Aloe vera	[98]
15.	Polyphenolia	<i>Azadirachata indica</i>	Meliaceae	Neem bark and leaves	[99]

Table 5: Natural Source Based Marketed Anticancer Formulations.

S. No.	Drug Name	Trade Name	Mechanism of Action	Manufacturer
1.	Paclitaxel	ABRAXANE®	Mitotic inhibitor	Celgene
2.	Everolimus	AFINITOR®	Mammalian target of rapamycin	Novartis
3.	Axitinib	INLYTA®	Tyrosine kinase inhibitor	Pfizer
4.	Vismodegib	ERIVEDGE®	Cyclopamine antagonist	Genentech
5.	Pertozumib	PERJETA®	Inhibits the dimerization of HER ₂	Genentech
6.	Vincristine liposome injection	MARQIBO®	Microtubule inhibitor	Talon Pharmaceuticals
7.	Carfilzomib	KYPROLIS®	Proteasome inhibitor	Onyx Pharmaceuticals
8.	Basutinib	BOSULIF®	Tyrosine kinase inhibitor	Pfizer
9.	Fentanyl sublingual spray	SUBSYS®	Opioid agonist	INSYS Therapeutics
10.	Pozopanib	VOTRIENT®	Tyrosine kinase inhibitor	GlaxoSmithKline
11.	Fentanyl citrate	LAZANDA®	μ -opioid agonist	Archimedes
12.	Crizatinib	XALKORI®	Protein kinase inhibitor	Pfizer
13.	Vemurafenib	ZELFORAF®	B-Raf enzyme inhibitor	Roche
14.	Abiraterone acetate	ZYTIGA®	Inhibits 17-hydroxylase	Centocor Ortho
15.	Sunitinib malate	SUTENT®	Receptor tyrosine kinase inhibitor	Pfizer
16.	Peg interferon alpha-2b	PEGINTERON®	Binds to interferon alpha receptor 1& 2	Merck
17.	Vandetanib	CAPRELSA®	Kinase inhibitor	Astra Zeneca
18.	Erwinia L-Asparaginase	ERWINASE®	Breaking down of asparaginase	Jazz Pharmaceuticals
19.	Brentoximab vedatin	ADCETRIS®	Antibody part attaches to CD30	Seattle Genetics
20.	Ingenol mebutate gel	PICATO®	Protein kinase C-inhibitor	Leo Pharmaceuticals

Marketed Formulations of Natural Source Based

Anticancer Agents: The advancements in pharmaceutical field lead to the formation of various new types of formulations to treat disorders. There are various types of natural source based formulations available in market in recent years. Some of them are describes in Table 5.

Recent Developments in Natural Source Based

Anticancer Agents: Natural products and their derivatives have been used in new drug discovery because of their diversity and highly selective activity [100]. Natural plants are the reservoirs of the curative

elements used by a large number of patients [101]. Recently scientific world experienced a huge growth in the development of new drugs from natural source having anticancer activity. These anticancer drugs have less toxicity compared to conventional synthetic anticancer agents [102]. The use of natural product based anticancer agents is one of the most trending topics nowadays in therapeutic field. Recently there has been a huge success in the natural product research due to the failure of alternative new drug discovery methods that leads to a revolution in the field of natural product based drug delivery. The use on natural products in anticancer

therapy leads to a cost- versus- benefit assessments of natural drug therapies and leads to improved efficiency [103]. The patients of all ages relied on the use of traditional herbal agents to fulfill their health care requirements, nowadays herbal medicine is used in the treatment in spite of presence of conventional drugs in the market [104]. One can also use nanoparticles to achieve targeted drug delivery for better result in the treatment of cancer. Nanotechnology is helpful in oncology because of small size of particles [105].

Future Prespectives: The traditional use of natural sources in medicinal purposes has been taken in account from the time of human civilization. At the time of development of organic chemistry, the use of natural source was diminished but from past 3-4 decades the use of naturally derived compounds in medicinal way increases due to the harmful side effects of synthetic compounds to the body. So we can say that natural source derived medicine have a golden future. Many of the different types of medicinal drugs have been developed from the natural sources mainly, plants in last 30-40 years and also marketed in the combinations with synthetic ones. Nature will continue to provide best of it in coming years also. Natural source derived anticancer agents with their use has been discussed above. Hence we can say that natural products as the source of various medicines provides best of it in coming years. As we all know nature is non-renewable source hence we have to protect it also from extinction of the important natural sources.

CONCLUSIONS

As we all know, Cancer is one of the most lethal disease of this time. The development of various anticancer drugs for cancer chemotherapy leads to the best treatment for cancer in last 2 decades. The use of natural sources i.e. plants, marine, microbes, etc. either alone or in combination with synthetic drugs leads to a revolution in cancer chemotherapy, the use of natural sources lead to the reduced side effects of chemotherapy. The various natural source derived compounds possess good anticancer activity. Recent studies about the anticancer activity possessed by natural sources leads to the treatment of different types of cancer. This review provides the best knowledge of some naturally derived compounds having anticancer property. Natural products provide an opportunity to introduce a new category of drugs and also a novel mechanism of action to treat cancer.

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