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Review Article

Recent Advances in Polyphenolic Nutraceuticals for Management of Cancer

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ABSTRACT

Cancer is a prominent cause of death globally, having multiple pathologic components. Genetic abnormalities, infection or inflammation, bad dietary habits, radiation exposure, work stress, and toxin consumption can all contribute to the development and spread of cancer. Early cancer detection and treatment improve survival rates, however anticancer medications might have negative side effects that can outweigh the benefits in terms of hospitalization and survival. Natural bioactive substances have been shown to have anticancer capabilities, destroying malignant cells without harming healthy cells. Polyphenolic nutraceuticals are phytochemicals derived from food or natural sources. These drugs can induce apoptosis in cancer cells, making them suitable for use alongside chemotherapy. Polyphenolic nutraceuticals with strong anticancer properties include stilbenes, flavonoids, carotenoids, and sulfur-containing substances. This chapter discusses the clinical significance of nutraceuticals for several cancer types, including gastric, breast, ovarian, and skin cancers. Many cancer treatment strategies have historically produced outstanding results, eradicating tumors in patients. Unfortunately, nearly all of these tumors relapse (recur) and frequently kill the patients quickly. Metastasis, chemoresistance, and medication toxicity are among the most difficult issues confronting cancer researchers and patients today. Furthermore, the cost of cancer therapy is a financial strain. Polyphenols are natural compounds known for their beneficial properties in preventing epithelial-mesenchymal transition, scavenging reactive oxygen species, improving DNA repair processes, regulating epigenetic processes, and influencing cancer stem cells to overcome therapeutic challenges. Polyphenols have garnered a great deal of interest due to their anti-inflammatory, anticancer, and antioxidant properties. Many polyphenolic compounds, however, have limited therapeutic use due to their low oral bioavailability.

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INTRODUCTION

A huge variety of dietary elements have a positive impact on human health. Polyphenols and antioxidants have been widely studied for their therapeutic effects following intravenous treatment throughout the past decade. Natural polyphenols are organic compounds obtained from plants that differ structurally by having two or more phenol units [1]. Several research on polyphenols have been conducted to investigate their potential health advantages, including protection against oxidative stress, diabetes, cardiovascular disease, neurodegenerative disease, and aging. These polyphenols can kill cancer cells through a variety of processes, including signalling pathway alteration, cell cycle inhibition, and apoptosis induction. Polyphenols also affect the activity of enzymes involved in tumor cell growth. Recent research has linked natural polyphenols to anti-cancer activity via a variety of features, including antiangiogenicity, antimetastatic, DNA interaction, and others [1-2]. Polyphenols are classified based on the number of phenol rings and the structural components that hold them together. The groups are phenolic acids,

stilbenes, lignans, and flavonoids. Legumes, fruits, vegetables, green tea, and red wine all contain flavonoids, which have antioxidant and anti-inflammatory qualities. They are classified into six types: anthocyanins, flavanols, flavones, flavanones, isoflavones, and flavanols. Flavanols are the most common flavonoids, found in fruits and green vegetables. The main components are quercetin and kaempferol, which are plentiful in onions, curly kale, leeks, and broccoli [2]. The majority of flavones are luteolin and apigenin glycosides. The majority of flavones are luteolin and apigenin glycosides. Citrus fruits, tomatoes, and fragrant plants such as mint contain flavanones. Isoflavones are flavonoids that share structural similarities with estrogens and are found mostly in leguminous plants. Soya and its processed derivatives provide the majority of isoflavones in the human diet. Tea, cinnamon, coffee, kiwis, blueberries, apples, plums, and cherries all contain hydroxybenzoic acids. Stilbenes are present in small amounts in the human diet. Resveratrol is a well-studied polyphenol with anticarcinogenic properties in medicinal plants [2-3].



Fig.1 Polyphenolic nutraceuticals obtained from plant sources.

Cancer

Cancer is a broad category of disorders that can begin in practically any organ or tissue of the body when aberrant cells develop uncontrolled, cross their normal limits, invade adjacent regions of the body, and/or spread to other organs. The latter phase, known as metastasizing, is a primary cause of cancer-related mortality [3]. Cancer is also known as a neoplasm or malignant tumor. Cancer is the world's second biggest cause of mortality, accounting for an estimated 9.6 million deaths (or one in every six) in 2018. Men are most likely to get lung, prostate, colorectal, stomach, and liver cancer, whereas women are more likely to develop breast, colorectal, lung, cervical, and thyroid cancer [3-4].

The cancer burden continues to rise worldwide, putting enormous physical, emotional, and financial pressure on people, families, communities, and health-care systems. Many low-

and middle-income nations' health systems are unable to deal with this load, and a huge percentage of cancer patients worldwide lack access to prompt, high-quality diagnosis and treatment. Survival rates for many forms of cancer are improving in nations with strong health systems due to accessible early identification, quality treatment, and survivorship care [4].

Cancer is an umbrella word for a wide range of illnesses that may affect any region of the body. Other terminology used include malignant tumors and neoplasms. One distinguishing aspect of cancer is the fast formation of aberrant cells that expand past their normal borders and eventually infiltrate neighbouring sections of the body and migrate to other organs; this process is known as metastasis [5]. The leading cause of cancer-related mortality is widespread metastases.

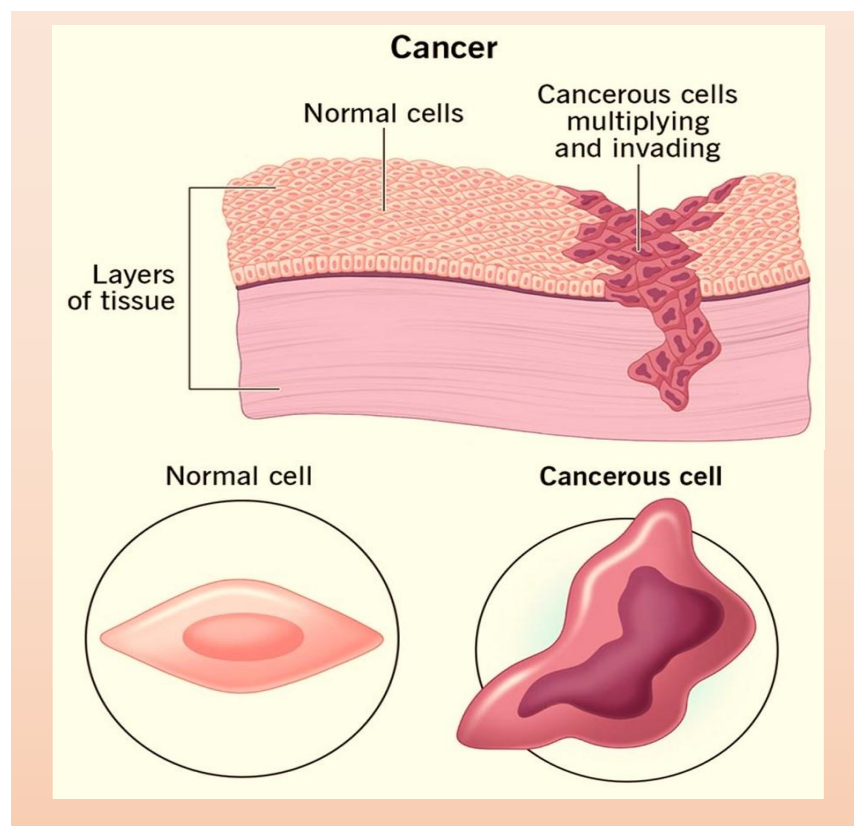


Fig.2 Difference between normal cell and cancer cell.

Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020 (1). The most common in 2020 (in terms of new cases of cancer) were:

- breast (2.26 million cases);
- lung (2.21 million cases);
- colon and rectum (1.93 million cases);
- prostate (1.41 million cases);
- skin (non-melanoma) (1.20 million cases); and
- stomach (1.09 million cases).

The most common causes of cancer death in 2020 were:

- lung (1.80 million deaths);
- colon and rectum (916 000 deaths);
- liver (830 000 deaths);
- stomach (769 000 deaths); and
- breast (685 000 deaths).

Each year, approximately 400 000 children develop cancer. The most common cancers vary between countries. Cervical cancer is the most common in 23 countries.

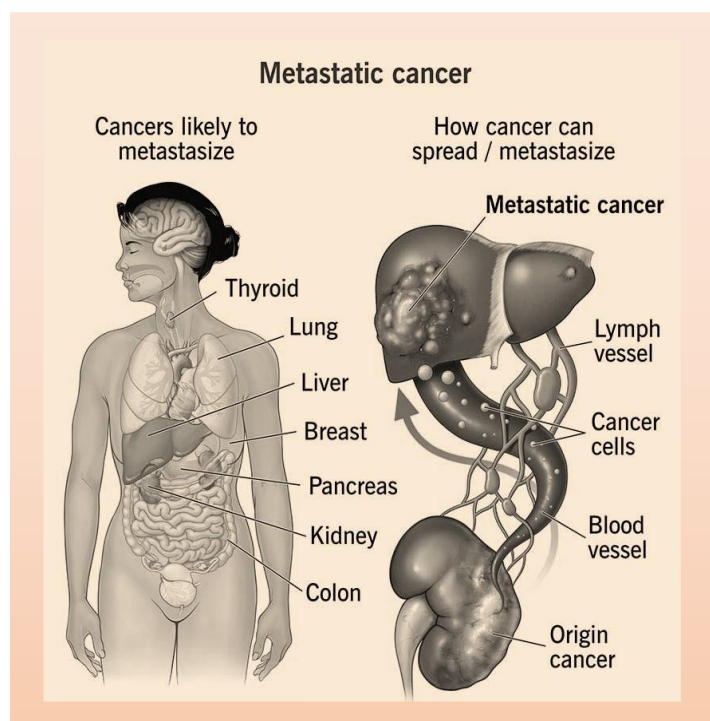


Fig.3 Cancer metastasis

Cancer is the second most common cause of death worldwide. Researchers estimate that in 2024, over 2 million people living in the U.S. will receive a cancer diagnosis, and over 611,000 people will die from the disease. About 1 in 4 people will develop cancer at some point during their lifetime.

The most common cancers in the U.S. are:

- Breast cancer.
- Lung cancer.
- Prostate cancer.

- Colorectal cancer.
- Blood cancers.

Types of cancer

There are over 100 types of cancer. Healthcare providers categorize them according to where they start in your body and the type of tissue they affect. There are three broad cancer classifications:

- **Solid cancers:** This is the most common type of cancer, making up about 80% to 90% of all cases. This includes carcinoma that forms in epithelial tissue (like your skin, breast, colon and lungs) and sarcoma that forms in bone and connective tissues.
- **Blood cancers:** These are cancers that start in your blood cells or lymphatic system. Examples include leukemia, lymphoma and multiple myeloma.
- **Mixed:** Cancers that involve two classifications or subtypes. Examples include carcinosarcoma and adenosquamous carcinoma.

Symptoms

Symptoms of cancer vary from person to person. They depend on what type of cancer you have and how advanced it is.

General cancer symptoms may include:

- Fatigue.
- Fever that occurs mostly at night.
- Loss of appetite.
- Night sweats.

- Persistent pain.
- Skin changes, particularly moles that change shape and size or new moles.
- Unexplained weight loss.

In some cases, cancer may cause additional organ-specific symptoms. These may include:

- Blood in your pee or in your stool.
- Changes in the shape, color or size of a skin mole.
- Coughing up blood.
- New lumps or bumps.

This isn't an exhaustive list. And having these symptoms doesn't necessarily mean you have cancer. Cancer is a complicated disease. Different types cause different symptoms. It's also possible to have cancer for years without knowing it. Other times, it can cause obvious symptoms that get worse very quickly. A good rule of thumb is to let a healthcare provider know any time there's a change in your body that lasts for more than two weeks.

Causes

Cancer is a genetic disorder. But that doesn't necessarily mean it's inherited. It happens when genes that manage cell activity mutate (change). They create abnormal cells that divide and multiply, eventually disrupting how your body works. These cells create cancer clusters, or tumors. Cancerous cells may break away from tumors and travel to other areas of your body through your lymphatic system or bloodstream. (Healthcare providers call this metastasis.) For example, a tumor in your breast may spread to your lungs, making it hard for you to breathe. In



some types of blood cancer, your bone marrow makes abnormal blood cells that multiply uncontrollably. Eventually, the abnormal cells crowd out normal blood cells. According to medical researchers, inherited genetic mutations (changes you can't control) cause about 5% to 10% of all cancers. More often, cancer occurs as an acquired genetic mutation (change). That means it happens over the course of your life. Medical researchers have identified several risk factors that increase your chance of developing cancer.

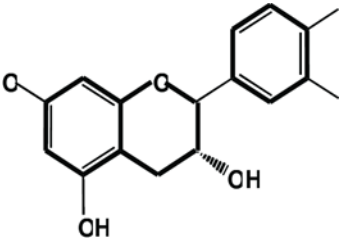
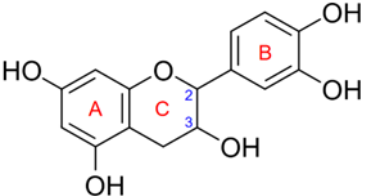
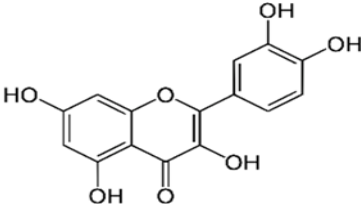
Diagnosis of cancer

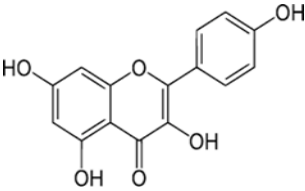
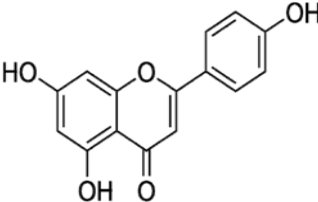
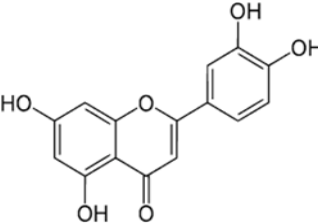
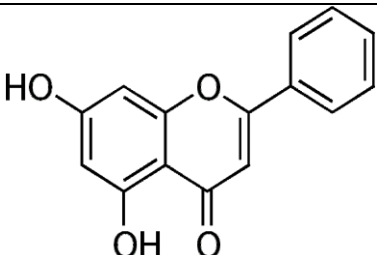
Healthcare providers begin a cancer diagnosis by doing a complete physical examination. They'll

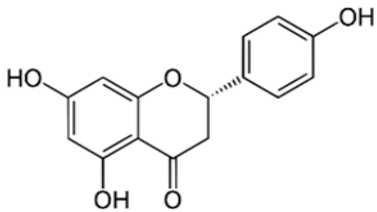
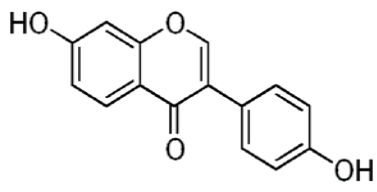
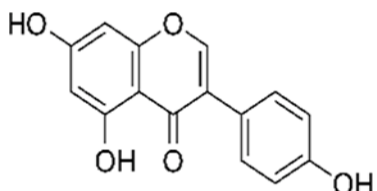
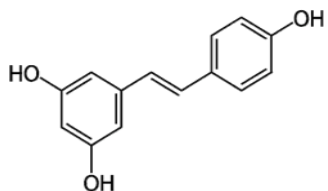
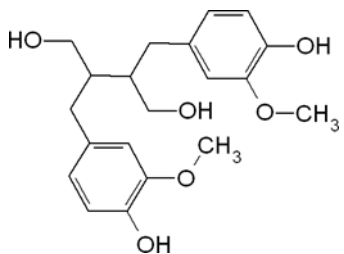
ask you to describe your symptoms and your family medical history. They may also need to do:

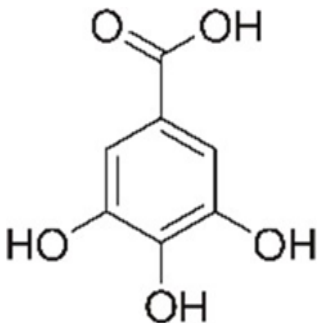
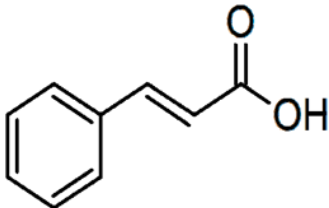
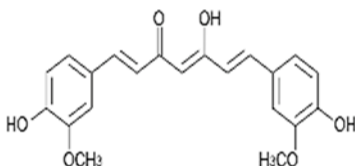
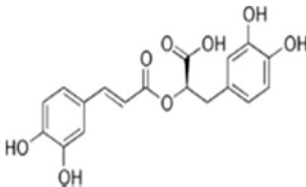
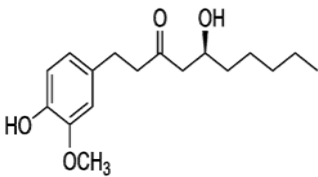
- Blood tests for cancer, which may include complete blood count (CBC), blood protein tests and tumor marker tests.
- Imaging tests like CT scans, MRI, ultrasound or iodine metaiodobenzylguanidine (MIGB).
- Biopsies, which could be surgical (with an incision) or nonsurgical (with a needle).
- Genetic testing for cancer to diagnose and plan treatment for inherited forms of cancer.

Classification of Polyphenolic Nutraceuticals

Sr. No.	Name of Polyphenolic Nutraceuticals	Chemical Structure	Dietary Source	Biological Effect
Flavanols				
1.	Epicatechin		Apple, berries, grapes, red wine, green and black tea, chocolate	Antioxidative, anti-proliferative, pro-apoptotic, antiangiogenic, suppression of growth and invasion, anti-inflammatory, antimetastatic, antimutagenic, inhibition of telomerase activity and lipid peroxidation, modulation of estrogen activity, modulation and reversal of epigenetic changes
2.	Catechin		Red wine, broad beans, black grapes, apricots, tea, strawberries	Inhibition of tumor growth, anti-inflammatory, suppression of growth and invasion, pro-oxidative
3.	Quercetin		Onions, broccoli, apples, apricots, berries, nuts, seeds, tea, wine, cocoa	Antioxidative; pro-oxidative, antiviral, inhibition of tumor formation and migration, pro-apoptotic, anti-proliferative, antimetastatic, anti-angiogenic, inhibition of lipid peroxidation, reduction of tumor incidence and

				multiplicity, prevention of GJIC inhibition, modulation of epigenetic changes
4.	Kaempferol		Apples, grapes, tomatoes, green tea, potatoes, onions, broccoli, Brussels sprouts, squash, cucumbers, lettuce, green beans, peaches, blackberries, raspberries, and spinach	Antioxidant, anti-viral, antibacterial, antiproliferative, anti-inflammatory
Flavones				
5.	Apigenin		Parsley, Celery, celeriac, and chamomile tea	Antioxidative, anti-mutagenic, anti-inflammatory, anti-viral, inhibition of tumor growth, pro-apoptotic, suppression of tumor progression, anti-invasive, antiangiogenic, antimetastatic, anti-proliferative, modulation of epigenetic changes
6.	Luteolin		Celery, broccoli, green pepper, parsley, thyme, dandelion, chamomile tea, carrots, olive oil, peppermint, rosemary, navel oranges, and oregano	Anti-inflammatory, anti-mutagenic, anti-carcinogenic
7.	Chrysin		Passion flowers, chamomile, honeycomb	Anti-proliferative, anti-anxiety, anticonvulsant, antioxidant, anti-inflammatory
Flavanones				

8.	Naringenin		Grapefruit, oranges, and tomatoes	Anti-oxidative, anti-inflammatory, anti-metastatic, delayed tumor development, reduction of tumor incidence, anticarcinogenic, lipid-lowering, superoxide scavenging, anti-apoptotic, metal chelating
Isoflavones				
9.	Daidzein		Kwao Krua, Kudzu, Maackia amurensis cell cultures, tofu	Antioxidant, estrogenic and anti-estrogenic effects
10.	Genistein		Lupin, fava beans, soybeans, kudzu, psoralea, coffee	Antioxidative, anti-invasive, anti-inflammatory, anti-metastatic, delay/repression of tumor development/growth, reduction of tumor multiplicity and volume, pro-apoptotic, antiproliferative, estrogenic activity, prevention of GJC inhibition, modulation of epigenetic changes
Stilbenes				
11.	Resveratrol		Skin of grapes, blueberries, raspberries, mulberries	Antioxidative, anti-inflammatory, anti-cyclooxygenase, antiproliferative, proapoptotic, antiestrogenic, modulation of lipid metabolism, inhibition of platelet aggregation
Lignans				
12.	Secoisolariciresinol		Flax, sunflower, sesame, pumpkin seeds	Antioxidant, anti-inflammatory, antiproliferative, anticarcinogenic
Phenolic Acids				

13.	Benzoic acids (Gallic acid)		Gallnuts, sumac, witch hazel, tea leaves, oak bark	Antioxidative, pro-oxidative, anti-inflammatory, antibacterial, antiviral, anti-melanogenic, antimutagenic, suppression of tumor growth, anti-invasive, antiproliferative, inhibition of tumorigenesis, anti-angiogenic, modulation of androgen receptor
14.	Cinnamic acids		Oil of cinnamon, balsams such as storax, shea butter	Antioxidative, antimicrobial, anti-inflammatory, antiproliferative
Other Polyphenols				
15.	Curcumin		Turmeric	Antioxidative, anti-angiogenic, anti-adhesive, tumor growth suppressive, antiproliferative, proapoptotic, antimetastatic, anti-inflammatory, modulation and reversal of epigenetic changes
16.	Rosmarinic acid		Basil, lemon balm, rosemary, marjoram, sage, thyme, peppermint	Antioxidative, reduction of HCA formation, modulation of epigenetic changes
17.	6-Gingerol		Fresh ginger	Antioxidative, anti-inflammatory

Anticancer Effect of Polyphenolic Nutraceuticals

Polyphenols influence all three phases of carcinogenesis. They impact the initiation process by removing reactive oxygen species and inhibiting their interaction with DNA.

Additionally, they improve the efficacy of DNA repair once damage occurs [6]. The anti-promoting and anti-progressive function involves stimulating cell differentiation, inhibiting proliferation, inducing apoptosis, inhibiting angiogenesis, affecting the tumor microenvironment, and reducing invasive potential. These actions affect

metabolic pathways, including nuclear factor-kappa β , mitogen activated protein kinases (MAPK), Wnt/ β -catenin, phosphatidylinositol 3-

kinase, and protein kinase B, through selective actions on network components [7].

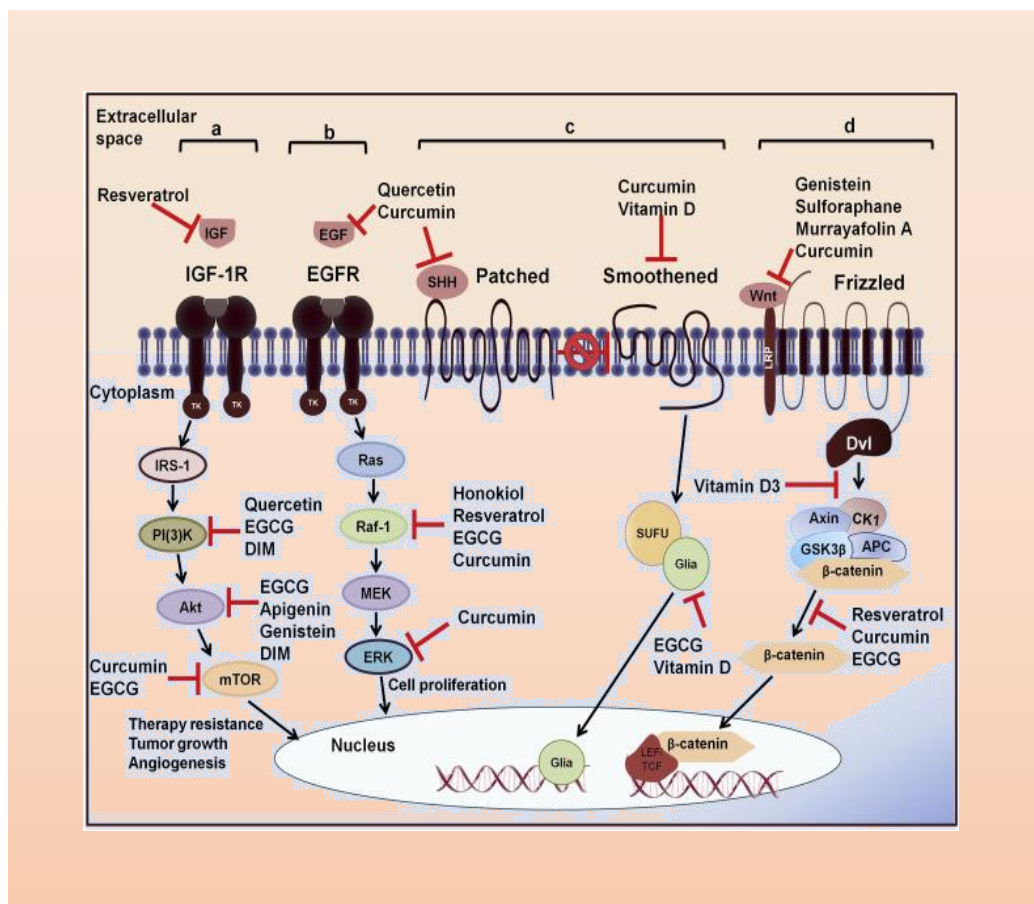


Fig.4 Anticancer effect of polyphenolic nutraceuticals.

Polyphenolic Nutraceuticals and breast cancer

Clinical factors have a significant role in selecting the appropriate therapy option for patients. Factors to consider include patient age, tumor size, involvement of axillary lymph nodes, histological type, and molecular status (progesterone, estrogen, and HER2 receptor expression). Triple negative cancers lack all of the aforementioned receptors [8].

Conventional breast cancer treatments, including chemotherapy, hormone therapy, radiation, and surgery, have severe adverse effects. Resistance to traditional chemotherapeutics used in breast cancer therapy is limiting their effectiveness [9].

Research is needed to create novel therapeutic procedures that improve treatment efficacy and minimize negative effects on receptors.

Phytochemicals, including polyphenols, have garnered interest for their potential application in cancer because to their multidirectional biological activity. Polyphenols have been found to have both chemopreventive and chemotherapeutic effects on breast cancer cells through several molecular pathways, according to in vitro studies [10]. These inhibitors target DNA-methyltransferase (DNMT) and histone deacetylase (HDAC), leading to enhanced acetylation and demethylation of suppressor genes, preventing breast cancer cell proliferation and migration. Polyphenols suppress

STAT3, a signal inducer and activator of transcription [11]. This inhibits gene expression in cell proliferation, angiogenesis, and metastasis. Overexpression of PD-L1 (programmed death ligand 1) is linked to carcinogenesis, metastasis, and treatment resistance. Polyphenols inhibit the expression of PD-L1 in breast cancer. Several studies show they can inhibit aromatase, which converts androgens to estrogens [12].

Polyphenolic Nutraceuticals and colorectal cancer

Research indicates that poor eating habits and lifestyle might increase the risk of chronic inflammation-related intestinal disorders including colorectal cancer [13]. Chronic inflammation in inflammatory bowel disorders (IBD) damages the mucosa and increases the formation of reactive oxygen species (ROS), which can lead to tumor growth and metastasis [14].

Polyphenols have immunomodulatory, pro-apoptotic, anti-proliferative, and anti-inflammatory actions. They also affect the makeup of the gut microbiota, which is relevant to colorectal cancer. The gut microbiome has a crucial role in immune system development, maturation, and function, as evidenced by recent research [15]. The gut microbiome interacts with innate and adaptive immunity to maintain the homeostasis of epithelial cells. Dysbiosis and lack of control over the process can cause inflammatory diseases, potentially leading to carcinogenesis. Polyphenols have a prebiotic impact, stimulating normal gut microbiota and reducing harmful germs, which helps prevent inflammation [16].

Curcumin, found naturally in the rhizomes of turmeric (also known as turmeric longa), was found to have a resistance-reversing impact among studied polyphenols [17]. Curcumin inhibits

epithelial-mesenchymal transition (EMT), a process that reduces cell communication, increases mobility, and enables migration [18]. Additionally, it reduces overexpression of P-gp and HSP-27, which are linked to drug resistance processes. Resveratrol, found mostly in grapes, strengthens intercellular connections in model cell lines [19], making them more sensitive to 5-fluorouracil. Resveratrol may overcome oxaliplatin resistance by enhancing drug accumulation in cells. Research indicates that using polyphenols alone may be less successful than combining them with traditional chemotherapies. Curcumin and 5-fluorouracil, as well as resveratrol metabolites and oxaliplatin, have shown synergistic benefits [20].

Polyphenolic Nutraceuticals and prostate cancer

Polyphenols have anticancer properties in prostate cancer by influencing gene expression, regulating cell cycle, apoptosis, and angiogenesis, as well as metabolizing carcinogenic xenobiotics [21]. Polyphenols have anti-androgenic properties, making them effective in treating hormone-dependent prostate cancer. This impact is likely caused by one of three mechanisms: direct competition between androgens and polyphenols, inactivation of androgen receptors, or inhibition of androgen receptor transactivators.

Green tea extract contains epigallocatechin gallate (EGCG), which affects various molecular pathways involved in carcinogenesis. These include the MAPK (mitogen-activated protein kinase) pathway, which regulates cell proliferation and death, and the NF-kappaB pathway, which regulates inflammation, immune response, and cancer cell growth. IGF (insulin-like growth factor) also influences cancer cell growth and development. EGCG and green tea extract inhibit 5-alpha reductase activity and regulate androgen



receptor gene and protein expression in cancer cells [22].

Polyphenolic Nutraceuticals and lung cancer

Green tea catechins, including epigallocatechin gallate (EGCG), epicatechin gallate, epigallocatechin, and epicatechin, have been extensively studied for their potential utility in lung cancer chemoprevention and treatment. Epigallocatechin gallate inhibits the expression of PD-L1, which is triggered by both interferon-gamma and epidermal growth factor [23]. Using epigallocatechin gallate lowered the invasive potential of non-small cell lung cancer cells by lowering MMP-2 and uPA levels. ECOG combined with cisplatin increased cytotoxicity and cell death by apoptosis, disruption of mitochondrial membrane potential, and activation of caspases 3 and 9.

Gu's study found that combining resveratrol from grapes and red wine with arsenic trioxide (As₂O₃) led to increased cytotoxicity and apoptosis at the measured dose [24]. Resveratrol combined with cisplatin enhanced its antiproliferative action. Resveratrol can cause apoptosis by depolarizing the mitochondrial membrane potential, releasing cytochrome c into the cytosol, and altering the expression of Bcl-2 and Bax proteins, all of which are linked to programmed cell death.

Future Prospectives

The future of nutraceuticals in cancer treatment seems hopeful, with research focused on their use as complimentary therapies to traditional treatments such as chemotherapy and radiation. They are being investigated for their ability to decrease side effects, improve patient quality of life, and even increase therapy effectiveness. Key areas of development include employing particular

chemicals like curcumin and resveratrol in standardized formulations, co-delivering them with pharmaceuticals via nanocarriers, and undertaking more rigorous, large-scale clinical studies to evaluate their safety and efficacy.

The fingerprints of phytochemical substances, particularly nutraceuticals, have been extensively proven in the treatment of colon cancer. Dietary phytochemicals are frequently employed as medications that benefit human health and other commercial items. However, the methods of action of nutritional databases require more investigation and improved molecular identification in colon cancer treatment. Furthermore, the *in vivo* evidence for many powerful dietary phytochemical activity has not yet been examined. Nonetheless, the scientific community will concentrate on naturally occurring nutraceuticals and their usage in colon cancer therapies in depth. Secondary metabolites in the natural diet include flavonoids, steroids, sulfur-containing chemicals, alkaloids, saponins, phenolic acids, vitamins, minerals, and antioxidant enzymes. These nutraceutical ingredients may boost protection against a variety of variables, including red meat, excessive alcohol intake, and other substances. Research has shown that a high intake of nutraceuticals is useful in the prevention of colon cancer development. Finally, it should be noted that single or clustered dietary nutraceutical compounds contribute to therapeutic activity and will be crucial for future evaluation.

SUMMARY AND CONCLUSION

The significance and relevance of nutraceuticals to the prevention and treatment of breast cancer cannot be overstated. Natural food ingredients have several applications and have been utilized in traditional medicine for a long time. However, further study should be conducted to optimize the activity of these compounds and promote them as



a treatment for breast cancer patients. Following a cancer diagnosis, many people seek out nutraceuticals in the hope that they can give nutritional relief. Certain herbal supplements may inhibit or modify the metabolism of prescription medicines. Some natural chemicals may be effective for chemoprevention on their own or in conjunction with a balanced diet. These natural compounds have been shown in the laboratory to suppress the early phases of carcinogenesis, cancer spread, and metastasis; however, more research is needed in this area. Incorporating prooxidant-active nutraceuticals into the diet, which may have the opposite effect, may also help with cancer prevention by reducing the efficacy of chemotherapy. This is one of the reasons why chemotherapy patients should consider the benefits and downsides of supplementing. Significant advances have recently been achieved in our knowledge of the cellular, molecular, and genetic changes that drive cancer formation and progression. Significant breakthroughs have also been made in understanding the molecular processes that underlie the chemopreventive characteristics of certain polyphenols. Nonetheless, data from human research is insufficient, with trials frequently yielding unclear or contradictory results. The primary limitations of previous research have been the inaccurate concentration of polyphenols in the examined meals or drinks, as well as a lack of understanding of their kinetics and the real contribution of particular compounds to their effect. As a result, further clinical trials are needed to validate the use of polyphenols in cancer prevention and therapy.

REFERENCES

1. Maiuolo J, Gliozzi M, Carresi C, Musolino V, Oppedisano F, Scarano F, Nucera S, Scicchitano M, Bosco F, Macri R, Ruga S. Nutraceuticals and cancer: Potential for natural polyphenols. *Nutrients*. 2021 Oct 27;13(11):3834.
2. Nwanodi OB. Nutraceuticals: curative integrative cancer treatment. *Alternative and integrative medicine*. 2017;6(2):240.
3. Roomi MW, Kalinovskiy T, Rath M, Niedzwiecki A. Nutraceuticals in Cancer Prevention. In *Nutraceuticals 2016* Jan 1 (pp. 135-144). Academic Press.
4. Khan H, Labanca F, Ullah H, Hussain Y, Tzvetkov NT, Akkol EK, Milella L. Advances and challenges in cancer treatment and nutraceutical prevention: the possible role of dietary phenols in BRCA regulation. *Phytochemistry Reviews*. 2022 Apr;21(2):385-400.
5. Alharbi KS, Almalki WH, Makeen HA, Albratty M, Meraya AM, Nagraik R, Sharma A, Kumar D, Chellappan DK, Singh SK, Dua K. Role of Medicinal plant - derived Nutraceuticals as a potential target for the treatment of breast cancer. *Journal of Food Biochemistry*. 2022 Dec;46(12):e14387.
6. Sajilata MG, Bajaj PR, Singhal RS. Tea polyphenols as nutraceuticals. *Comprehensive reviews in food science and food safety*. 2008 Jun;7(3):229-54.
7. Babich H, Schuck AG, Weisburg JH, Zuckerbraun HL. Research strategies in the study of the pro - oxidant nature of polyphenol nutraceuticals. *Journal of toxicology*. 2011;2011(1):467305.
8. Mustafa YF. Nutraceutical-based telomerase inhibitors: renewed hope for cancer therapy. *Phytomedicine Plus*. 2024 May 1;4(2):100537.
9. Moga MA, Dimienescu OG, Arvatescu CA, Mironescu A, Dracea L, Ples L. The role of natural polyphenols in the prevention and treatment of cervical cancer—An overview. *Molecules*. 2016 Aug 17;21(8):1055.



10. Lotha RO, Sivasubramanian AR. Flavonoids nutraceuticals in prevention and treatment of cancer: A review. *Asian J. Pharm. Clin. Res.* 2018;11(1):42-7.
11. Adedokun KA, Imodoye SO, Yahaya ZS, Oyeyemi IT, Bello IO, Adeyemo - Imodoye MT, Sanusi MA, Kamorudeen RT. Nanodelivery of polyphenols as nutraceuticals in anticancer interventions. *Polyphenols: food, nutraceutical, and nanotherapeutic applications.* 2023 Oct 26:188-224.
12. Adedokun KA, Imodoye SO, Yahaya ZS, Oyeyemi IT, Bello IO, Adeyemo - Imodoye MT, Sanusi MA, Kamorudeen RT. Nanodelivery of polyphenols as nutraceuticals in anticancer interventions. *Polyphenols: food, nutraceutical, and nanotherapeutic applications.* 2023 Oct 26:188-224.
13. Briguglio G, Costa C, Pollicino M, Giambò F, Catania S, Fenga C. Polyphenols in cancer prevention: New insights. *International Journal of Functional Nutrition.* 2020 Nov;1(2):9.
14. Gossiau A, Chen KY. Nutraceuticals, apoptosis, and disease prevention. *Nutrition.* 2004;20(1):95.
15. Shukla Y, George J. Combinatorial strategies employing nutraceuticals for cancer development. *Annals of the New York Academy of Sciences.* 2011 Jul;1229(1):162-75.
16. Zhang Z, Li X, Sang S, McClements DJ, Chen L, Long J, Jiao A, Jin Z, Qiu C. Polyphenols as plant-based nutraceuticals: health effects, encapsulation, nano-delivery, and application. *Foods.* 2022 Jul 23;11(15):2189.
17. Lall RK, Syed DN, Adhami VM, Khan MI, Mukhtar H. Dietary polyphenols in prevention and treatment of prostate cancer. *International journal of molecular sciences.* 2015 Feb 3;16(2):3350-76.
18. Ranzato E, Martinotti S, Calabrese CM, Calabrese G. Role of nutraceuticals in cancer therapy. *Journal of Food Research.* 2014 Aug 1;3(4):18.
19. Mileo AM, Nisticò P, Miccadei S. Polyphenols: immunomodulatory and therapeutic implication in colorectal cancer. *Frontiers in immunology.* 2019 Apr 11;10:729.
20. Caponio GR, Lippolis T, Tutino V, Gigante I, De Nunzio V, Milella RA, Gasparro M, Notarnicola M. Nutraceuticals: Focus on anti-inflammatory, anti-cancer, antioxidant properties in gastrointestinal tract. *Antioxidants.* 2022 Jun 28;11(7):1274.
21. Divella R, Daniele A, Savino E, Paradiso A. Anticancer effects of nutraceuticals in the Mediterranean diet: an epigenetic diet model. *Cancer Genomics & Proteomics.* 2020 Jul 1;17(4):335-50.
22. Asensi M, Ortega A, Mena S, Feddi F, Estrela JM. Natural polyphenols in cancer therapy. *Critical reviews in clinical laboratory sciences.* 2011 Dec 1;48(5-6):197-216.
23. Nair HB, Sung B, Yadav VR, Kannappan R, Chaturvedi MM, Aggarwal BB. Delivery of antiinflammatory nutraceuticals by nanoparticles for the prevention and treatment of cancer. *Biochemical pharmacology.* 2010 Dec 15;80(12):1833-43.
24. Nema N, Rajan N, Babu M, Sabu S, Khamborkar S, Sarojam S, Sajan L, Peter A, Chacko B, Jacob V. Plant Polyphenols as Nutraceuticals and Their Antioxidant Potentials. *Polyphenols: Food, Nutraceutical, and Nanotherapeutic Applications.* 2023 Oct 26:21-44.
25. PB Gollucke A, C. Peres R, A. Jr O, A. Ribeiro D. Polyphenols: A nutraceutical approach against diseases. *Recent patents on food, nutrition & agriculture.* 2013 Dec 1;5(3):214-9.

26. Prakash D, Gupta C, Sharma G. Importance of phytochemicals in nutraceuticals. *Journal of Chinese Medicine Research and Development*. 2012 Oct;1(3):70-8.
27. Montané X, Kowalczyk O, Reig-Vano B, Bajek A, Roszkowski K, Tomczyk R, Pawliszak W, Giamberini M, Mocek-Płóćiniak A, Tylkowski B. Current perspectives of the applications of polyphenols and flavonoids in cancer therapy. *Molecules*. 2020 Jul 23;25(15):3342.
28. Mohan A, Narayanan S, Sethuraman S, Maheswari Krishnan U. Combinations of plant polyphenols & anti-cancer molecules: A novel treatment strategy for cancer chemotherapy. *Anti-Cancer Agents in Medicinal Chemistry-Anti-Cancer Agents*. 2013 Feb 1;13(2):281-95.

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