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A review on anti-cancer plants of India

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Abstract

India has a high level of endemism and a diverse range of floral species. Cancer is one of the most significant challenges facing global health today. The indigenous peoples and residents who live in India have, for a very long time, made use of specific medicinal plants to fight cancer. This practice is still prevalent today. Several different drugs may be utilized in the treatment of cancer. Because of the potential drawbacks associated with such treatments and the development of drug resistance, the quest for new therapies that are both safer and much more effective is still the most challenging field of study. Several cancer medicines used today come from natural sources. We're returning to our old ways because medicinal plants are a good, natural way to make medicines that prevent cancer without causing major side effects. Within the scope of this study, a few herbs traditionally used to treat cancer are looked at to see what they might be good for. The cytotoxicity of these plants, the processes that lead to them, and the different compounds they make were looked into. This study has tried to focus on how these plants fight cancer.

Keywords

Cancer; medicinal plants; *Zingiber officinale*; *Catharanthus roseus*; *Phyllanthus emblica*; *Curcuma longa*

Introduction

One of the significant mortality and morbidity causes in the world today is still cancer, accounting for 10 million deaths in 2020 (1). Cancer is considered to cause one in eight fatalities (1). It is estimated that 13, 92,179 people were diagnosed with cancer in India in 2020 (2). Cancer is India's second-leading cause of mortality after cardiovascular diseases among non-communicable diseases in India (2). Research into the literature revealed that the usage of medicinal plants by cancer patients has positive outcomes, such as the inhibition of cancer development (3), progression (3), and metastasis (4). These medicinal plants, such as *Zingiber officinale*, *Curcuma longa*, *Phyllanthus emblica*, and *Catharanthus roseus,* exhibit cytotoxic (5), antioxidant (6), anti-inflammatory (5), immunomodulatory (7), and antiproliferative properties (6), according to studies conducted primarily *in vitro* and in animals. According to several studies, using herbal supplements in the treatment of cancer increased patient survival rates (6), enhanced patient quality of life (6), and had disease-preventive or chemo-toxic effects (5). Additionally, a literature review of population studies revealed that plant-based diets lower cancer risk (6, 8). Many herbs are used by locals to

treat or prevent cancer in India (9). Many of these herbs are used to cure several diseases, such as insomnia (9), arthritis (9), urinary tract infection (10), and some plants are primarily used to treat cancer (9,10). The following description includes information about commonly used plants in the treatment of cancer, such as *Z. officinale*, *C. longa*, *P. emblica*, and *C. roseus* (5,7).

The aim of this article is to discuss the plants that have been traditionally used in India, such as *Z. officinale*, *C. longa*, *P. emblica*, and *C. roseus* to treat cancer and see whether they have been evaluated scientifically for their ability to do so, as well as to see if any interesting secondary metabolites have been found in these plants. The goal was also to bring attention to some plant species that can fight cancer and show how important it is to do more research on these plants.

Articles from various sources, such as Google Scholar, including a few Scopus and Web of Science indexed journals, were selected and studied. Articles based on the traditionally used Ayurveda plants of India, ancient anticancer treatments, plants with bioactive compounds that prevent cancer, phytochemicals present in various plants, and pathways involved in the anti-cancer property of various plants were studied. Based on the readings in this article, four plants such as *Zingiber officinale, Phyllanthus emblica, Curcuma longa,* and *Catharanthus roseus,* were selected, and an explanation based on their bioactive compound and anti-cancer properties has been given. The other plant species with anti-cancer property studied is formulated into tables that explain the traditional use of plants as anti-cancer agent in India (Table 1) and the anti-cancer property of these plants that have been scientifically validated (Table 2).

Anti-cancer property of Zingiber officinale

Z. officinale (common name: ginger) (Fig. 1) is a member of the family Zingiberaceae and is frequently used in traditional cancer-fighting formulations for gastrointestinal (5), liver (5), and oesophageal malignancies (11). *Z. officinale* uses multiple modes of action to combat cancer (5,11). *Z. officinale* extract was proved to inhibit inflammatory TNFα in rats with liver cancer which in turn drastically lowered the expression of NF-B (5). NF-B is a transcription factor

Fig. 1. *Zingiber officinale*

Table 1. Anti-cancer plants mentioned in Indian text or used traditionally to cure cancer

Scientific name of the plant	Occurrence	Local name	Mentioning in ancient texts	Traditional uses	Reference
Tinospora cordifolia (Family: Menispermaceae)	Karnataka, Tamil Nadu, Kerala, Andra Pradesh	Amruthavalli	Charaka Samhita	The decoction of the plant is used to restore body equilibrium and boost immunity.	(25)
Carica papaya (Family: Caricaceae)	Maharashtra, Karnataka, Tamil Nadu, Kerala, Uttar Pradesh	Pappali, Papaya	Bhavaprakasha Nighantu	Detoxification of the body, anti-inflammatory, and immune stimulating properties.	(26)
Ocimum sanctum (Family: Lamiaceae)	Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Uttar Pradesh, Gujarat	Tulsi	Sushruta Samhita	Immune-enhancing, antioxidant, and adaptogenic properties	(27)
Citrus limon (Family: Rutaceae)	Gujarat, Maharashtra, Tamil Nadu, Karnataka, and Himachal Pradesh	Nimbu	------	Anti-cancer and antioxidant properties	(28)
Moringa oleifera (Family: Moringaceae)	Tamil Nadu, Andhra Pradesh, Kerala, Maharashtra, Uttar Pradesh and Karnataka	Drumstick tree, Murungai	Bhavaprakasha Nighantu	Antioxidant, anti-cancer, and anti-inflammatory properties	(29)
Azadirachta indica (Family: Meliaceae)	All over India.	Neem	Sushruta Samhita	Anti-inflammatory and immunomodulatory properties	(30)
Hemidesmus indicus (Family: Apocynaceae)	Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Karnataka	Ashwagandha, Indian sarsaparilla	Bhavaprakasha Nighantu	Adaptogenic properties.	(31)

Table 2. Anti-cancer properties of plants in India

Sl.No.	Name of the Plant	Common name	Compound isolated from the plant	Experimental system	Major results of the experiment/ study	Reference
1	*Tinospora cordifolia*	Amruthavalli (Tamil)	Palmatine, Magnoflorine, Jatrorrhizine, Tinocordiside	*In vitro* and *in vivo* experiments	Induction of apoptosis. Increases antioxidant level. Enhances oxidative damage to cancer cells.	(25)
2	*Carica papaya*	Pappali (Tamil), Papaya	Papain, Carpaine, Isothiocyanate	*In vitro* studies	Decrease cancer markers and prevent cancer progression. Reduces prostate cancer cell growth and proliferation	(32)
3	*Ocimum sanctum*	Tulsi (Kannada, Hindi, and various other regional languages)	Eugenol, Cirsilineol, Isothymusin, Apigenin, Rosmarinic acid.	*In vitro* and *in vivo* studies	Exhibits radioprotective effect against clastogenic effects of radiation. Exhibits anti-cancer activity against Human Fibrosarcoma cells	(27)
4	*Citrus limon*	Nimbu (Hindi)	Citral and limonene	*In vitro* and *in vivo* studies	Suppress Chronic Myeloid Leukemia tumor growth. Induces apoptosis in Human Breast Adenocarcinoma (MCF-7) cells.	(28)
5	*Moringa oleifera*	Drumstick tree, Murungai (Tamil), Munaga (Telugu)	*Isothiocyanate, Thiocarbamate*	*In vivo* study	Exhibits anti-tumor activity. Inhibits tumor promoter teleocidin B-4-induced Epstein-Barr virus	(29)
6	*Azadirachta indica*	Neem (Hindi)	Azadirachtin A, Nimbin, Nimbolide, Gedunin	*In vitro* and *in Vivo* studies	Decreases Proliferating Cell Nuclear Antigen. Exhibits cytotoxic and chemopreventive effects.	(33)
7	*Hemidesmus indicus*	Ashwagandha (Sanskrit and other regional languages)	Withanolides	*In vitro* and *in vivo* studies	Exhibits anti-tumor effects in mouse skin. Inhibits the development of liver tumors.	(31)

that has a role in biological actions like cell growth, inflammation, and survival. Cancer formation and progression have been linked to abnormal NF-kB activation. TNFα, a cytokine, promotes NF-B to carry out its biological effects (12). According to a study, intestinal cancer caused by azoxymethane was considerably inhibited when gingerol, a substance found in ginger, was administered to rats for around three weeks at a dosage of 0.02% (11). According to research on gingerol, a chemotherapeutic or chemopreventive drug for colorectal cancer was successful (5). For instance, gingerol significantly reduced the size of tumors in mice when it was provided to the animals before and after the injection of tumor cells (5). Gingerol (Chemical structure: Fig. 2) has demonstrated anti-angiogenic effects *in vivo* and *in vitro*, suggesting that it may also aid in inhibiting metastasis. (5)

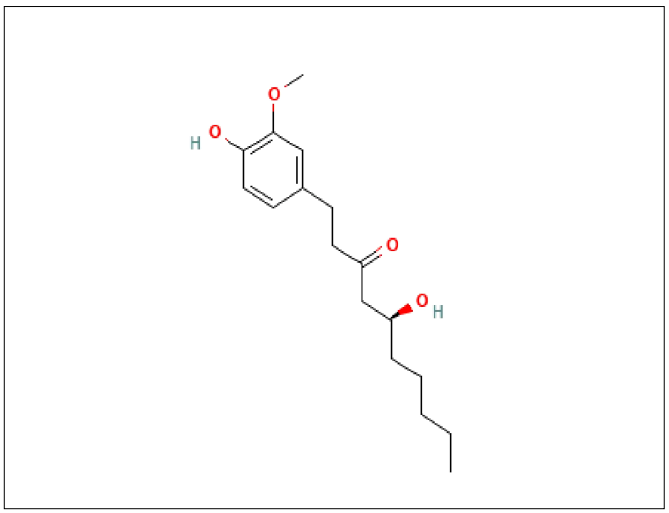

Fig. 2. Chemical Structure of Gingerol

Anti-cancer property of Catharanthus roseus

C. roseus (common name: periwinkle) (Fig. 3) is a member of the Apocynaceae family. Alkaloids present in *C. roseus* are the chemical components that have the most significant anti-cancer potential (13). This plant has been the source of more than 400 alkaloids (14). Vincristine and vinblastine are two of the principal alkaloids found in *C. roseus*, and they were the first plant compounds to be

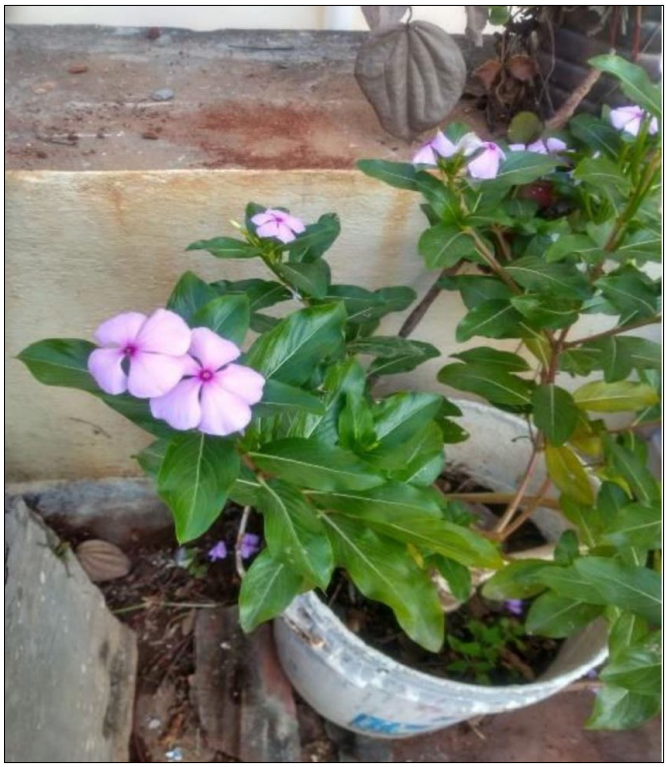

Fig. 3. *Catharanthus roseus*

therapeutically employed as anti-cancer drugs (14). Vincristine destroys acute lymphoblastic leukemia cells without significantly delaying mitosis. Vincristine is utilized to treat juvenile leukemia, as evidenced by *in vitro* research of the drug's cytotoxicity in CLL (Chronic Lymphocytic leukemia) cells and PBMC (peripheral blood mononuclear cells) (15). Multiple myeloma (13), metastatic melanoma (14), B-cell lymphoma (14), glioblastoma with a negative estrogen receptor (13), neuroblastoma (13), colorectal cancer (14), and Wilms' tumor (14) are among the carcinomas that are frequently treated with vincristine. Vinblastine mechanically promotes the removal of microtubule minus ends from their organization centers, which results in fragments of microtubule (16). Vinblastine is frequently used to treat several cancers, such as leukemia (16), breast cancer (14), lung cancer (14), lymphoma (14), Hodgkin's nephroblastoma, and germ cell tumors (16). The first anticancer medications that were plant-based were Vinblastine sulfate (Velban) and vincristine sulfate (Oncovin), which were approved by the US FDA (17).

Anti-cancer property of Phyllanthus emblica

The *P. emblica* plant (Fig. 4), which is a member of the family Phyllanthaceae, produces fruit that is frequently used with other herbs in preparations of medicines (5). Gooseberry is the popular name for this plant. *P. emblica* is commonly prescribed for lung and throat malignancies and is frequently ingested as fruit or fruit juice (18). The active

Fig. 4. *Phyllanthus emblica*

substances present in the plant's fruit are ellagic (18), tannic (5), ascorbic (18) (Chemical Structure: Fig. 5), and gallic acid (18) (Chemical structure: Fig. 6). An investigation discovered that the *P. emblica* fruit's aqueous decoction inhibited the lung cancer cell lines A549, Hela, SKOV-3, and SW620, with the Hela cell line showing the most significant activity (19). The aqueous decoction activated the death receptor apoptosis pathway, causing activation of caspase

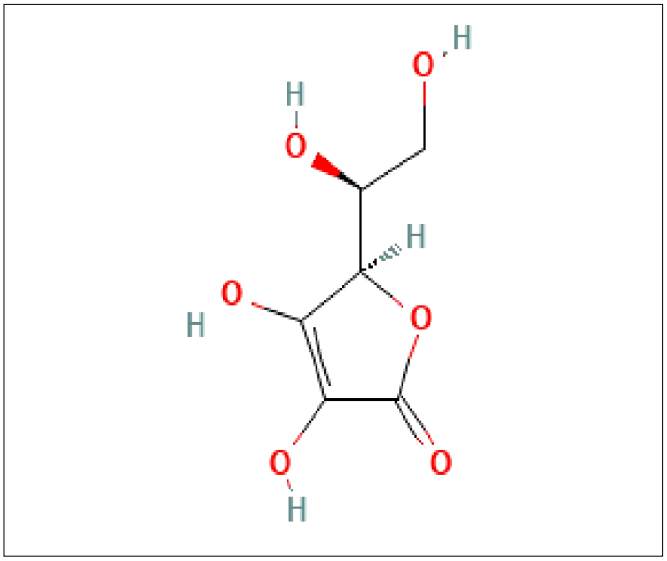

Fig. 5. Chemical Structure of Ascorbic acid

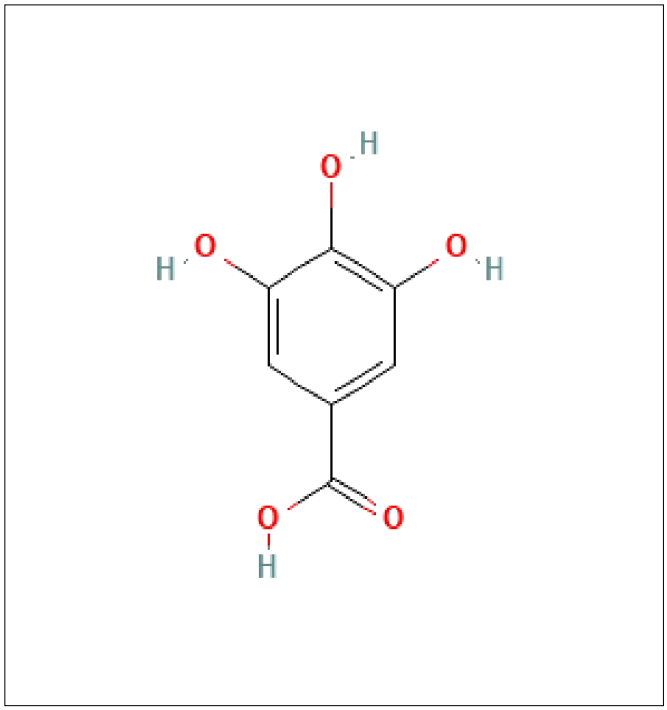

Fig. 6. Chemical Structure of Gallic acid

-8 as well as the expression of the Fas protein present in the Hela cells. This had the effect of suppressing the biological processes of NF-B (19). A mouse model of cutaneous tumorigenesis generated by DMBA (7, 12-dimethylbenzanthracene) and TPA (12-otetradecanoylphorbol-13-acetate) was used to examine the fruit extract's anti-tumor promoting effect. DMBA and TPA mouse models, when treated with the extraction, had significantly fewer tumors overall during a 20-week period. Through the use of substances like ellagic acid, tannic acid, and gallic acid, this plant has demonstrated antioxidant activity (5). It was discovered that the aqueous solution of *P. emblica* inhibited the development of ovarian cancer (5).

Anti-cancer property of Curcuma longa

Numerous malignancies are treated with the rhizome of the plant *C. longa* (Fig. 7) (Zingiberaceae) (20,21). Curcumin (Chemical structure: Fig. 8) is the primary chemically active component (7). There is scientific research that has

Fig. 7. *Curcuma longa*

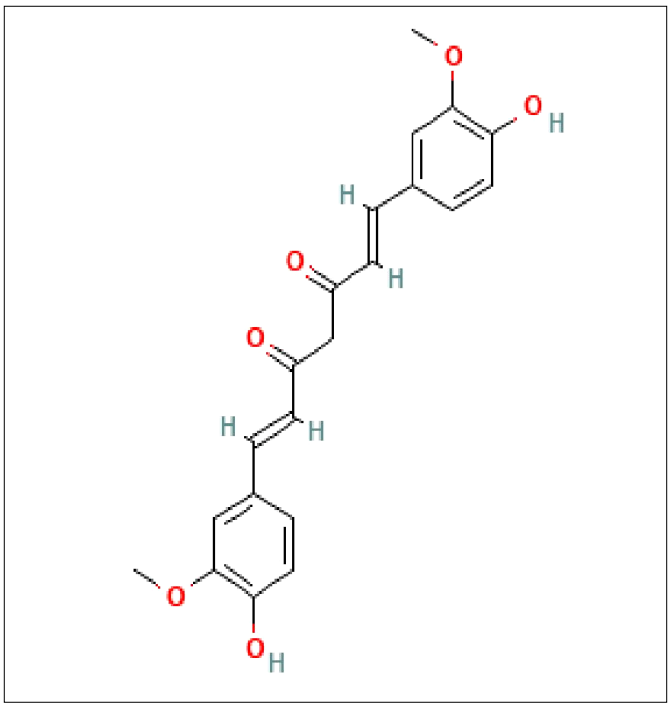

Fig. 8. Chemical Structure of Curcumin

supported the therapeutic and chemopreventive potential of curcumin (7,20,21). Multiple studies have shown that curcumin can prevent prostate cancer from developing, growing, and metastasizing (7,22,23). The reduced expression of the COX-2 enzyme, anti-oxidation, and a reduction in DNA adduct levels are said to be the processes through which curcumin exhibits its bioactivity. Curcumin is used for the treatment of prostate cancer by inhibiting prostate cancer cell growth (5). In one of the studies, inhibiting COL-205 adenocarcinoma cells of colon cancer and inducing cancer cell death through caspase-3 activity were proved as the two anti-cancer effects of curcumin (5). The same study demonstrated that curcumin was capable of raising levels of Ca2+, which causes cell death (5). The potential of Curcuma longa to outperform aryl hydrocarbons at both CYP1A1 and AhR sites has also led to clinical trials of this plant as a chemo-preventative drug, particularly against colorectal cancer. When AhR is activated, it induces the CYP1A1 gene, which causes the activation of human carcinogens and causes the beginning of cancer (8). In a different study, the daily administration of curcumin to patients for three months resulted in histological improvements of premalignant lesions of several malignancies, including superficial bladder carcinoma, intestinal metaplasia of the stomach, and uterine cervical intraepithelial neoplasm (8).

The plants such as *Zingiber officinale, Phyllanthus emblica, Curcuma longa,* and *Catharanthus roseus* have a lot of anti-cancer properties and are frequently combined with other medicinal plants in herbal preparations in the traditional medicinal practices of India to cure cancer (5). In order to increase the effectiveness of existing chemotherapy and lessen drug-induced toxicity, these medicinal plants may also contain potent anti-cancer chemicals that can be used as adjuvants (24). In this article, the various active compounds present in each plant and the anti-cancer pathway it uses to inhibit cancer have been explained. The extract of *Z. officinale* proved to lower the expression of NF-kB, which inhibited cancer growth (12). Vincristine and vinblastine present in C. roseus killed acute lymphoblastic leukemia cells (15) and caused microtubule fragmentation (16). *P. emblica* contains active compounds such as tannic (5), ellagic (18), and gallic acid (18), which help in preventing cancer. Curcumin, an antioxidant present in *C. longa,* exhibits its anti-cancer property by reduced expression of COX-2 enzyme and reduction in DNA adduct levels (5). It is important to find new therapeutic leads for cancer using traditional medical knowledge about these plants. Some of the plant species used for medicinal purposes, including *C. roseus,* are not scientifically proven (5) hence using cell line, animal, and clinical trial studies, more research needs to be done to find out if these medicinal plant preparations and active components could be used in chemotherapeutic or chemopreventive therapies.

Conclusion

The plants mentioned in this article, such as *Zingiber officinale, Phyllanthus emblica, Curcuma longa,* and *Catharanthus roseus*, offer a wide spectrum of therapeutic qualities, including anti-cancer capabilities. The vast biodiversity of India helps in providing a potential source of natural substances with anti-cancer abilities. By increasing the synthesis of anti-cancer compounds in these plants using genetic engineering and biotechnology techniques, its potential as an anti-cancer agent can be discovered on a larger scale. These novel approaches may result in higher yields and better quality phytochemicals, increasing their suitability for therapeutic uses. Furthermore, the affordability and convenience of these plants and the subsequent extraction of phytochemicals must be taken into account.

The availability of these crucial resources for cancer therapy should be guaranteed through the use of sustainable and financially viable techniques. Overall, Indian plants have considerable potential for bioprospecting and use in the creation of innovative anti-cancer treatments.

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Authors contributions

CCM idea, literature search, design and draft; RCS methodology; KP literature search and draft; MP coordination; AC design and drafting; AM design and drafting; AVA literature search; BB literature search.

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