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HERBAL DRUGS: ROLE IN THE TREATMENT OF CANCER

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ABSTRACT
Cancer encompasses a collection of diseases marked by the unrestrained growth and spread of abnormal cells. When this growth unchecked, it may lead to tumors, harm to bodily tissues, and the dissemination (metastasis) to various other areas of the body. There are numerous cancer types, such as breast cancer, lung cancer, prostate cancer, skin cancer, each different regions. Typically, cancer originates from genetic mutations that interfere with normal cellular regulation, prompting cells to multiply uncontrollably. These mutations may be inherited, triggered by environmental influences (including smoking, radiation, or exposure to cancer-causing agents), or they can occur spontaneously. Treatment alternatives vary based on the cancer type and stage, potentially involving surgery, chemotherapy, radiation therapy, immunotherapy, and targeted therapies. Detecting cancer early through screenings can significantly enhance the prospects for effective treatment. Synthetic drugs for cancer therapy aim to precisely focus on cancer cells, prevent tumor advancement, or enhance the body's immune system in combating the disease. Herbal medicines, sourced from natural plants, have been utilized in traditional medicine for centuries and are increasingly recognized in contemporary healthcare due to their potential healing properties. These natural substances provide a broad array of pharmacological advantages, such as antioxidant, anti-inflammatory, antimicrobial, and anticancer effects. Their capacity to influence various biological pathways makes them essential in managing intricate conditions, including cancer, heart diseases, and neurodegenerative disorders.
KEYWORDS: *Cancer, Herbal drugs, Treatment.*

INTRODUCTION

The growing burden of cancer globally underscores the need for novel, effective, and safer treatment options. Herbal drugs, derived from medicinal plants, have emerged as a valuable resource in cancer therapy due to their diverse bioactive compounds with anticancer, antioxidant, and anti-inflammatory properties. These natural agents act through mechanisms such as inducing apoptosis, inhibiting angiogenesis, modulating immune responses, and suppressing cancer cell proliferation. Unlike conventional therapies, herbal drugs often exhibit lower toxicity and fewer side effects, making them attractive as complementary or alternative treatments [1].

Medicinal plants have been essential to healthcare for centuries and have formed the basis of many contemporary pharmaceuticals. Recently, there has been a growing interest in plant-based treatments for cancer due to an increasing desire for alternative and complementary medicine options. Cancer, known for its complexity and varied nature, often necessitates treatments that are both effective and cause fewer side effects. Numerous medicinal plants possess bioactive compounds with properties that combat cancer, such as alkalo, flavonoids, and terpenoids, which have demonstrated effectiveness in slowing cancer cell proliferation, promoting apoptosis, and hindering metastasis. Ongoing research is investigating these natural compounds for their potential to improve standard cancer therapies or act as independent treatments. As the quest for safer and more effective cancer treatments progresses, medicinal plants continue to be a vital asset in oncology studies. This review intends to emphasize significant medicinal plants that are utilized in cancer treatment and the mechanisms through which they operate [2].

Current Approaches for the Treatment of Cancer

The treatment of cancer has evolved significantly over the years, with modern approaches focusing on improving efficacy, precision, and patient quality of life. Current strategies include:

Surgical removal of tumors is often the first step for localized cancers. Advances in minimally invasive and robotic-assisted surgeries have enhanced precision and recovery outcomes.

High-energy radiation, such as X-rays or protons, targets and destroys cancer cells by damaging their DNA. Techniques like intensity-modulated radiation therapy (IMRT) and proton beam therapy improve accuracy and reduce side effects.

Chemotherapy uses cytotoxic drugs to destroy rapidly dividing cancer cells. It is often used in combination with other treatments but can lead to side effects such as nausea, fatigue, and immune suppression.

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Targeted Therapy focuses on specific molecular targets involved in cancer cell growth and survival. Examples include monoclonal antibodies and small-molecule inhibitors, such as trastuzumab (for HER2-positive breast cancer) and imatinib (for chronic myeloid leukemia).

Immunotherapy enhances the body's immune system to recognize and attack cancer cells. Immune checkpoint inhibitors (e.g., pembrolizumab) and CAR-T cell therapy represent significant advances in treating certain cancers [3, 4].

Hormonal Therapy is used for cancers driven by hormones, such as breast and prostate cancer. Drugs like tamoxifen and aromatase inhibitors block or lower hormone levels to slow tumor growth.

Bone Marrow and Stem Cell Transplantation involves replacing damaged bone marrow with healthy stem cells, often after high-dose chemotherapy or radiation. This is used for blood cancers such as leukemia and lymphoma.

The integration of advanced technologies, such as artificial intelligence and genomics, continues to refine allopathic cancer treatments, making them more precise and patient-centric [5].

Limitations of Allopathic Approaches for the Treatment of Cancer
While allopathic treatments for cancer have significantly improved patient outcomes, they are associated with several limitations that can impact their effectiveness, safety, and accessibility:

Toxicity and Side Effects
Chemotherapy and Radiation Therapy: These treatments often damage healthy tissues alongside cancer cells, leading to side effects such as nausea, fatigue, immune suppression, hair loss, and long-term complications (e.g., secondary cancers).
Targeted and Immunotherapy: While more precise, they can still cause adverse reactions, such as immune-related side effects or organ inflammation.

Drug Resistance
Cancer cells can develop resistance to chemotherapy, targeted therapies, and immunotherapies, reducing their efficacy over time. This often necessitates a shift to alternative treatments, which may be less effective.

Incomplete Response
Not all patients respond adequately to standard treatments. Factors such as genetic heterogeneity of tumors and variations in individual biology can limit treatment success [6-8].

High Costs and Accessibility
Advanced therapies like CAR-T cell therapy, proton beam therapy, and precision medicine can be prohibitively expensive, limiting access for many patients, especially in low-resource settings.

Risk of Recurrence
Some treatments may not eliminate all cancer cells, leading to a risk of recurrence. This is particularly challenging in aggressive or metastatic cancers.

Limited Efficacy for Advanced or Metastatic Cancers
Allopathic treatments are often less effective for cancers that are advanced or have spread extensively, where options are limited to palliative care or experimental therapies.

Potential for Over-treatment
In some cases, aggressive treatments may be used even when the expected benefits are minimal, leading to unnecessary side effects and reduced quality of life.

Resistance to Immunotherapies
Some tumors evade immune system detection or create an immunosuppressive microenvironment, making immunotherapy less effective.

Long-term Health Risks
Treatments like radiation and chemotherapy can lead to chronic health problems, such as cardiovascular issues, infertility, or secondary malignancies, long after the treatment ends [9, 10].

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Importance of Herbal Drugs

Herbal medicines have garnered significant attention in the field of cancer, primarily due to their ability to offer therapeutic benefits with fewer adverse effects compared to standard chemotherapy and radiation therapies. The active compounds present in various herbs, including flavonoids, alkaloids, saponins, and terpenes, showcase a range of pharmacological properties, such as anti-inflammatory, antioxidant, and anti-tumor effects. These compounds can block cancer cell growth, trigger apoptosis (the process of programmed cell death), impede angiogenesis (the creation of new blood vessels that nourish tumors), and diminish metastasis (the distribution of cancer cells to other parts of the body).

Numerous herbal treatments function by influencing molecular pathways that play a role in cancer development. For instance, curcumin (derived from Curcuma longa), resveratrol (found in grapes), and epigallocatechin gallate (EGCG from green tea) have shown the capacity to disrupt cell signaling pathways that are essential for the survival and multiplication of cancer cells. Furthermore, particular herbal solutions can enhance immune system activity, aiding the body in identifying and eliminating cancer cells more efficiently.

Herbal drugs are often used in combination with conventional treatments to enhance efficacy, reduce toxicity, and improve the quality of life for cancer patients. While some herbs are being integrated into modern oncological practices, ongoing research and clinical trials are necessary to validate their effectiveness and ensure safety. In the future, herbal drugs may play an even more prominent role in integrative cancer therapy, offering new avenues for treatment and prevention [11].

Merits of Herbal Drugs

Herbal drugs are rich in bioactive compounds such as alkaloids, flavonoids, terpenoids, and polyphenols, which have been shown to possess anti-cancer properties. These compounds can inhibit cancer cell growth, induce apoptosis (cell death), and prevent the spread (metastasis) of tumors.

Compared to conventional chemotherapy and radiation, herbal drugs tend to have lower toxicity. Many cancer treatments cause severe side effects such as nausea, fatigue, and organ damage. Herbal drugs often provide a gentler alternative or complement by targeting cancer cells while sparing healthy tissue [11].

Herbal drugs often act on multiple biological pathways simultaneously, which can be beneficial in treating cancer, a disease known for its complex mechanisms. For example, they can inhibit tumor growth, reduce inflammation, suppress angiogenesis (formation of blood vessels in tumors), and boost immune response [12].

Herbal compounds can work synergistically, meaning that when combined, their therapeutic effects are enhanced. This property is often used to develop multi-component herbal formulations that may be more effective than single-compound treatments.

Many herbs have been found to have chemo preventive properties, meaning they can help in preventing the initiation, promotion, and progression of cancer. By neutralizing free radicals and reducing oxidative stress, herbal drugs can minimize DNA damage and the risk of mutations that lead to cancer [13].

Herbal drugs are also used in palliative care to improve the quality of life for cancer patients. They can alleviate side effects of conventional treatments (such as nausea, pain, and fatigue), enhance physical well-being, and support emotional health.

Herbal drugs are often more affordable compared to modern pharmaceutical treatments, making them accessible to a broader range of patients, especially in developing countries where traditional medicine is more prevalent.

Some cancer cells develop resistance to conventional chemotherapy drugs. Certain herbal compounds have been found to help overcome this resistance by altering cellular mechanisms, potentially making cancer treatments more effective over time.
Herbal drugs offer a promising and holistic approach to cancer treatment by providing natural compounds with therapeutic effects, fewer side effects, and the ability to target multiple mechanisms involved in cancer progression. Their integrative use alongside conventional treatments continue to be an area of active research [14-16].

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Table no.1: List of medicinal plants used for the treatment mitigation and prevention of cancer

Sr. no.	Plant	Phytochemical	Anticancer activity into the chemical compound
1	Adiantum venustrum	Terpenoids, Flavonoid	Reduction in lipid peroxidation
2	Aloe vera	Aloin	Inhibition of human neuroectodermal tumors
3	Heart-leaved moonseed	alkaloids, glycosides, steroids,	antiproliferative
4	Zingiber officinale	6-gingerol and 6-shogaol	inhibit the activation of NF-κB and MAPK signalling
5	Turmeric	Curcuminoids	inhibiting cell proliferation promoting cell apoptosis

DETAILS REGARDING THE HERBAL PLANTS

Adiantum Venustrum

Kingdom	Plantae
Family	Pteridaceae
Subfamily	Vittarioideae
Class	Polypodiopsida
Division	Tracheophyta
Species	Venustum
Order	Polypodiales
Genus	Adiantum

Anti-Cancer Activity

Induction of Apoptosis: Certain compounds may trigger programmed cell death in cancer cells while sparing normal cells.
Anti-inflammatory Effects: Reducing inflammation can lower the risk of cancer progression, and compounds in the fern may contribute to this effect.

While preliminary findings are promising, more extensive studies, including clinical trials, are needed to fully understand the anticancer potential of Adiantum venustrum. Investigating its active compounds and mechanisms will be crucial for validating its use in cancer therapy [17].

Aloe Vera

Kingdom	Plantae
Family	Asphodelaceae
Subfamily	Asphodeloideae
Class	Liliopsida
Division	Magnoliophyta - Flowering plants
Species	Succulen
Order	Asparagales
Genus	Aloe

Anti-Cancer Activity

Aloe-emodin inhibited the proliferation of Merkel Cells Carcinoma to a significant degree and has also anti-neuroectodermal tumour activity in vitro and in vivo. Anthraquinones are involved in induction of death of human cancer cells in many studies. In Egypt, it was demonstrated that the extracts of *Aloe Vera* could have anti-hepatocarcinogenic effect through modulation of apoptosis [18, 19].

Heart-Leaved Moonseed

Kingdom	Plantae
Family	Menispermaceae
Class	Magnoliopsida
Species	Cordifolia
Order	Ranunculales

Anti-Cancer Activity

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Cancer is one of the main reasons for death among women all around the world. In a study, HCl extract of T. cordifolia roots was exposed to liver and extra hepatic organs of rats, at concentration levels of 50 and 100mg/kg of body weight. A significant increase in Glutathione and other metabolizing enzymes levels was observed. Furthermore, malonaldehyde (MLD) level was decreased. In another study, the effect of T. cordifolia hexane extract on rats having Ehrlich ascites tumor was examined. Inhibition of proliferation of tumor cell (G1 phase) was observed and at the same time the 'Bax' gene expression was enhanced. The anticancer properties of secondary metabolites including yangambin, palmatine and magnoflorine extracted from T. cordifolia were tested tested in different types of tumor cells. Palmatine and yangambin were highly effective against oral cancerous cells, while others were effective against colon cancer cells. Synthetic chemotherapeutic agents have adverse effects on health, which is not the case with T. cordifolia. Therefore, it can be used as a safe drug to cure cancer disease [20, 21].

Zingiber Officinale

Kingdom	Plantae
Family	Zingiberaceae
Subfamily	Zingiberoideae
Division	Magnoliophyta
Order	Zingiberales
Genus	Zingiber

Anti-Cancer Activity

Activation of Caspases

Ginger compounds can activate caspases, a family of proteases that play essential roles in programmed cell death. This activation leads to a cascade of reactions that ultimately result in cellular apoptosis.

Modulation of Bcl-2 Family Proteins

Ginger influences the expression of proteins in the Bcl-2 family, which regulate apoptosis. For example, it may downregulate anti-apoptotic proteins like Bcl-2 and upregulate pro-apoptotic proteins like Bax, promoting the release of cytochrome c from the mitochondria and triggering the apoptotic pathway.

Inhibition of NF-κB Pathway

Ginger can inhibit the nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB) pathway, which is often activated in cancer cells and promotes cell survival. By suppressing this pathway, ginger can enhance apoptosis.

Reactive Oxygen Species (ROS) Generation

Some studies suggest that ginger induces ROS production, which can lead to oxidative stress and damage cellular components, pushing the cells towards apoptosis.

Cell Cycle Arrest

Ginger can cause cell cycle arrest at various phases (often at the G0/G1 phase), which can lead to apoptosis. This arrest prevents cancer cells from proliferating and allows time for damaged cells to undergo programmed cell death.

Death Receptor Pathway Activation

Ginger may enhance the expression of death receptors (such as Fas) on the surface of cancer cells, facilitating the extrinsic apoptotic pathway that is triggered by ligands binding to these receptors [22-24].

Turmeric

Kingdom	Plantae
Family	Zingiberaceae
Subfamily	Zingiberoideae
Class	Liliopsida
Division	Angiosperm
Order	Zingiberales
Genus	Curcuma

Anti-Cancer Activity

Inhibition of Cancer Cell Proliferation

Cell Cycle Regulation: Curcumin has been shown to arrest the cell cycle at different phases (G1, S, or G2/M) in cancer cells. By preventing cancer cells from dividing, curcumin can reduce tumor growth. This action is believed to occur through modulation of key regulatory proteins such as cyclins and cyclin-dependent kinases (CDKs), which control the progression of the cell cycle.

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Downregulation of Oncogenes: Curcumin can suppress the expression of genes involved in the proliferation of cancer cells, such as Myc, K-ras, and EGFR (epidermal growth factor receptor) [25-27].

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