

## Role of Herbal Medicines in Management of Cancer

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### ABSTRACT

Cancer remains a major global health burden with increasing incidence and mortality worldwide. Despite advances in conventional treatment modalities such as chemotherapy, radiotherapy, and surgery, cancer management continues to be challenged by treatment-related toxicity, reduced quality of life, and disease recurrence. This has led to growing interest in complementary and alternative systems of medicine, particularly herbal and natural compounds, for supportive and integrative cancer care. Natural products derived from plants, animals, and microorganisms have long been used for cancer prevention and therapy and form the basis of several modern anticancer drugs. These compounds exert anticancer effects through multiple mechanisms, including antioxidant activity, induction of apoptosis, inhibition of inflammation and angiogenesis, modulation of detoxification enzymes, and regulation of key molecular signaling pathways. The present review discusses the global burden of cancer, the limitations of conventional therapies, and the role of herbal medicines and natural compounds in cancer prevention and treatment, with emphasis on their mechanisms of action and evidence from experimental and clinical studies.

**Keywords:** Cancer; Herbal medicines; Natural compounds; Apoptosis; Antioxidants; Complementary therapy

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### 1. INTRODUCTION

Cancer remains a significant global health challenge, with an estimated 19.3 million new cases and nearly 10 million deaths reported worldwide in 2020 [1]. It is one of the leading causes of mortality globally, accounting for more than 20% of all deaths [2]. Over 100 distinct types of cancer have been identified. According to reports from the International Agency for Research on Cancer (IARC), the most commonly diagnosed cancers worldwide include lung cancer (1.8 million cases; 13.0%), breast cancer (1.7 million cases; 11.9%), and colorectal cancer (1.4 million cases; 9.7%) [3].

Conventional cancer treatment modalities such as chemotherapy, radiotherapy, and surgery are effective in disease management; however, they are frequently associated with adverse effects including immunosuppression, fatigue, and reduced quality of life [4]. These limitations have increased interest in complementary and alternative systems of medicine. Natural compounds play an important role in cancer prevention and treatment. Many of these agents have a long history of use and are studied for their pharmacognostic properties. They are used either as therapeutic agents or as chemopreventive substances. These compounds are obtained from plants, animals, and microorganisms, and several modern anticancer drugs are synthetic derivatives of natural compounds. Their anticancer effects occur through interactions with key cellular targets such as DNA and microtubules. Current cancer chemotherapy also emphasizes genetic and genomic factors, with growing evidence suggesting that aneuploidy may be a fundamental driving factor in cancer development [5].

Recent experimental and clinical studies highlight the benefits of herbal medicines in alleviating side effects, improving tolerance to chemotherapy, and producing synergistic effects when used alongside conventional treatments. For example, the herbal formulation SH003 has been found to be safe and potentially effective in the treatment of solid cancers, while fucoidan has shown anti-inflammatory properties beneficial for patients with advanced cancer.

### **Anticancer Mechanisms of Natural and Herbal Compounds**

Herbal medicines exert anticancer effects through multiple mechanisms. The major mechanisms include antioxidant activity, induction of apoptosis, inhibition of cyclooxygenase-2 (COX-2), and suppression of angiogenesis. Most natural products target multiple molecular pathways, making them suitable for the prevention and treatment of chronic diseases such as cancer, which involve dysregulation of several cellular signaling networks.

## **2. ROLE OF HERBAL MEDICINES AND NATURAL COMPOUNDS IN CANCER MANAGEMENT**

### **Mechanisms of Action**

Herbal medicines exert anticancer effects through multiple mechanisms. The major mechanisms include antioxidant activity, induction of apoptosis, inhibition of cyclooxygenase-2 (COX-2), and suppression of angiogenesis. Most natural products target multiple molecular pathways, making them suitable for the prevention and treatment of chronic diseases such as cancer, which involve dysregulation of several cellular signaling networks.

## **3. IMPORTANT NATURAL COMPOUNDS AND MEDICINAL PLANTS**

### **Resveratrol**

**Resveratrol, a stilbene found in grapes and other plants, exhibits pro-apoptotic effects in breast, prostate, and leukemia cancer cell lines. It induces apoptosis by modulating Bcl-2 family proteins, activating caspases, disrupting mitochondrial function, and inhibiting the PI3K/Akt signaling pathway.**<sup>[6][7][8][9]</sup>

### **Quercetin and Its Derivatives**

Quercetin is a flavonoid widely distributed in plants such as dill (*Shatapushpa*) and fennel (*Foeniculum vulgare*). Quercetin-3,4'-di-O-glucoside, found in onions (*Allium cepa*) and horse chestnut (*Aesculus hippocastanum*), demonstrates antiproliferative, antioxidant, anti-inflammatory, antiviral, and anticancer activities. Rutin (quercetin rutinoside), a glycoside of quercetin present in *Ruta graveolens*, possesses antioxidant, anti-inflammatory, antiproliferative, and anticarcinogenic properties and is clinically used to manage capillary fragility and prevent bleeding.<sup>[10][11][12][13][14]</sup>

### **Ashwagandha (*Withania somnifera*)**

Aqueous root extracts of *Withania somnifera* have demonstrated immunomodulatory and anticancer effects, including increased oxidant scavenging, caspase activation, and modulation of pro-apoptotic and tumor-promoting proteins such as NF-κB, phospho-Akt, VEGF, and matrix metalloproteinases. Antineoplastic activity has been reported in lung, breast, prostate, colorectal, pancreatic, ovarian, renal, and brain cancers in both in vitro and animal models.<sup>[15][16][17][18][19][20][21]</sup>

### **Triphala**

Triphala, a classical Ayurvedic formulation, exhibits antioxidant, antibacterial, cardioprotective, anti-mutagenic, and anticancer properties. Studies have demonstrated its effectiveness in reversing precancerous lesions, attributed to the synergistic antioxidant activity of its three constituent fruits. Triphala acts as a potent free-radical scavenger and detoxifying agent.<sup>[22][23][24][25][26][27][28][29][30][31][32]</sup>

### **Guduchi (*Tinospora cordifolia*)**

Extracts of *Tinospora cordifolia* have been shown to inhibit proliferation and migration of cancer cells, induce differentiation and senescence, and modulate multiple cellular pathways. These effects have been demonstrated in glioblastoma and neuroblastoma cell lines, suggesting its potential role in neural cancer therapy.<sup>[32]</sup>

### **Tulsi (*Ocimum sanctum*) and Eugenol**

Eugenol has demonstrated anticancer activity against osteosarcoma cells by inducing apoptosis through caspase activation, mitochondrial pathway modulation, increased Bax and cytochrome C expression, and cleavage of PARP proteins.<sup>[33]</sup>

### **Haritaki (*Terminalia chebula*)**

Haritaki churna exhibits consistent anticancer activity across multiple cancer cell lines. Its polyphenolic compounds, including gallic acid, chebulinic acid, and ellagic acid, induce apoptosis and cell cycle arrest via the mitochondrial pathway, contributing to reduced cancer cell viability.<sup>[34]</sup>

### **Use of herbal medicines across cancer stages**

Herbal medicines have been explored in cancer care mainly as supportive or complementary approaches rather than primary curative treatments. Modern research in integrative oncology suggests that plant-based compounds may play different roles depending on the stage of cancer. Their usefulness ranges from prevention in very early disease to supportive and palliative care in advanced stages. Scientific literature increasingly examines these roles, although such therapies are generally recommended alongside conventional cancer treatment and under medical supervision.

In the earliest stage of cancer, known as carcinoma in situ or the pre-cancerous phase, herbal medicines are largely studied for their preventive potential. At this stage, abnormal cells are present but have not spread into surrounding tissues. Many herbal compounds demonstrate antioxidant, anti-inflammatory, and immune-modulating properties, which are believed to help reduce the progression of abnormal cellular changes. Curcumin, the active compound found in turmeric, has received considerable attention because of its ability to regulate multiple molecular pathways involved in cell proliferation and inflammation. Studies have shown that curcumin can suppress tumor initiation and early growth by influencing inflammatory mediators and cellular signaling pathways<sup>[35]</sup>. Similarly, green tea contains catechins, particularly epigallocatechin gallate (EGCG), which have been shown to inhibit carcinogenic pathways and promote apoptosis of abnormal cells.<sup>[36]</sup> Ashwagandha has also been studied for its immunomodulatory and potential anti-tumor properties, suggesting a supportive role in strengthening host defense mechanisms during early disease development.

When cancer progresses to localized stages such as Stage I and Stage II, treatment typically focuses on surgical removal or localized therapy. During this period, herbal medicines are often considered as adjuncts to conventional treatment. Their primary purpose is not to replace surgery, chemotherapy, or radiotherapy but to help reduce treatment-related side effects and improve overall quality of life. Ashwagandha has been investigated for its role in reducing fatigue, stress, and treatment-related exhaustion, which are common challenges faced by patients undergoing cancer therapy<sup>[38]</sup>. Guduchi is frequently explored for its immune-enhancing properties, while turmeric extracts continue to be studied for their anti-inflammatory effects and potential to enhance sensitivity to chemotherapy. Integrative oncology research suggests that carefully monitored herbal supplementation may support symptom management and improve patient well-being during active treatment.<sup>[37]</sup>

In more advanced localized disease, such as Stage III cancer, patients often undergo aggressive combined therapies including chemotherapy and radiotherapy. During this phase, herbal medicines are mainly evaluated for supportive care benefits. They may help in managing symptoms like fatigue, nausea, mucositis, and immune suppression that frequently accompany intensive treatment protocols. Panax ginseng has shown promise in reducing cancer-related fatigue and improving energy levels in clinical investigations. Curcumin continues to be researched for its anti-inflammatory properties and its experimental potential as a radiosensitizer, meaning it may enhance the effectiveness of radiation therapy<sup>[40]</sup>. Mistletoe therapy, widely used in parts of Europe, has been examined in clinical studies for its potential role in improving quality of life and reducing side effects of conventional treatment, although the evidence remains variable.<sup>[39]</sup>

In Stage IV or metastatic cancer, the focus of care often shifts toward palliation and maintaining quality of life. At this stage, herbal medicines are primarily used to help manage symptoms such as chronic pain, loss of appetite, nausea, fatigue, and emotional distress. Plant-derived cannabinoids, where legally permitted, have been studied for their role in reducing cancer-related pain and chemotherapy-induced nausea.<sup>[41]</sup> Adaptogenic herbs such as Ashwagandha and ginseng may support stress reduction and energy maintenance. Ginger has also demonstrated effectiveness in controlling nausea, particularly that associated with chemotherapy, as supported by clinical studies<sup>[42]</sup>. In advanced disease, the primary goal of herbal therapy is not disease reversal but rather comfort, symptom relief, and psychological support.

Overall, scientific and clinical literature suggests that herbal medicines may play meaningful supportive roles across different stages of cancer when used responsibly and alongside standard oncological care. While laboratory and clinical studies demonstrate promising biological effects, the strength of evidence varies widely among different herbs and cancer types. Therefore, integrative treatment approaches emphasize collaboration between oncologists and practitioners of traditional or herbal medicine to ensure safety, effectiveness, and patient-centered care.

#### 4. DISCUSSION

The evidence presented in this review highlights the significant potential of herbal medicines and natural compounds as complementary agents in cancer management. Their multi-targeted mechanisms, including antioxidant, immunomodulatory, pro-apoptotic, anti-angiogenic, and detoxifying actions, align well with the complex and multifactorial nature of cancer. Unlike conventional chemotherapeutic agents that often act on single targets and are associated with considerable toxicity, natural compounds tend to exert broader biological effects with comparatively lower adverse outcomes. The integration of herbal medicines with standard cancer therapies may help reduce treatment-related side effects, enhance therapeutic efficacy, and improve patient quality of life. However, further well-designed clinical trials and standardization studies are essential to establish safety, efficacy, and optimal dosing protocols.

#### 5. CONCLUSION

Herbal medicines and natural compounds play an important role in cancer prevention and treatment due to their diverse pharmacological properties and multi-pathway mechanisms of action. Accumulating experimental and clinical evidence supports their use as complementary agents alongside conventional cancer therapies. A better understanding of their

molecular targets, supported by rigorous clinical validation, may facilitate their integration into evidence-based cancer care and contribute to the development of safer and more effective therapeutic strategies.

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