



(REVIEW ARTICLE)



Anticancer effects of herbal medicine compounds and novel formulations: A literature review

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Abstract

Cancer remains a global health challenge, necessitating continuous exploration of novel therapeutic strategies. Herbal medicine compounds have garnered significant attention due to their potential anticancer effects. This review summarizes the current state of research on various herbal compounds and their formulations, highlighting their mechanisms of action and potential applications in cancer treatment. Prominent compounds such as curcumin, green tea extract (EGCG), artemisinin, ginsenosides, vinca alkaloids, and quercetin exhibit promising anticancer properties, demonstrating inhibitory effects on cancer cell growth, induction of apoptosis, and modulation of cellular signaling pathways. Additionally, novel formulations, including nanoparticle-based drug delivery systems, are discussed for their potential to enhance the bioavailability and targeted delivery of herbal compounds. While preclinical studies show encouraging results, the translation of these findings into effective clinical therapies requires further investigation. Moreover, considerations of safety, potential drug interactions, and standardization of herbal preparations are crucial for advancing these compounds toward clinical application. This review underscores the importance of a comprehensive and evidence-based approach, integrating herbal medicine compounds and novel formulations into the evolving landscape of cancer treatment.

Keywords: Herbal medicine; Anticancer effects; Novel formulations; Cancer treatment; Curcumin; Green tea extract; Artemisinin; Ginsenosides; Vinca alkaloids; Quercetin; Nanoparticle-based drug delivery; Apoptosis; Cellular signaling pathways; Bioavailability; Safety considerations; Drug interactions; Evidence-based approach

1. Introduction

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells in the body. These abnormal cells can form a mass of tissue called a tumor. Not all tumors are cancerous; benign tumors do not spread to other parts of the body, while malignant tumors have the potential to invade nearby tissues and metastasize to other organs(1).

2. Physiology of cancer

The physiology of cancer involves complex changes in the regulation of cell growth, survival, and behavior. Below is a brief overview of key aspects of cancer physiology, and include general aspects of cancer physiology -

- **Cell Cycle Dysregulation-** The cell cycle is tightly regulated, ensuring proper cell growth and division. Dysregulation of cell cycle control is a hallmark of cancer(2).

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- **Genetic and Epigenetic Changes-** Genetic mutations and epigenetic alterations play a crucial role in cancer development. These changes can affect key genes involved in cell cycle control, DNA repair, and apoptosis(3).
- **Tumor Microenvironment-** The microenvironment surrounding tumors, including blood vessels, immune cells, and extracellular matrix, influences cancer progression(4).
- **Angiogenesis-** Tumors induce the formation of new blood vessels (angiogenesis) to supply nutrients and oxygen(5).
- **Invasion and Metastasis-** Cancer cells acquire the ability to invade surrounding tissues and spread to distant organs(6).
- **Cancer Immunology-** The interaction between cancer cells and the immune system is a dynamic process(7). Some key features of cancer cells are as follows:
- **Uncontrolled Cell Growth:** Cancer begins when the normal control mechanisms that regulate cell growth and division malfunction. This leads to the formation of abnormal cells that can rapidly multiply and form a tumor(8).
- **Invasion and Metastasis:** Malignant tumors can invade nearby tissues and spread to other parts of the body through the bloodstream or lymphatic system. This process is known as metastasis and is a hallmark of cancer.
- **Genetic Changes:** Cancer often involves genetic mutations that can be inherited or acquired during a person's lifetime. These mutations may affect the normal functioning of genes involved in cell cycle regulation, DNA repair, and apoptosis (programmed cell death)(9).
- **Types of Cancer:** There are numerous types of cancer, each classified based on the type of cells or tissues in which it originates. Common types include breast cancer, lung cancer, colorectal cancer, prostate cancer, and leukemia, among others.
- **Risk Factors:** Various factors can increase the risk of developing cancer, including age, genetic predisposition, exposure to carcinogens (cancer-causing substances), certain infections, lifestyle factors (such as smoking, diet, and physical activity), and exposure to ionizing radiation(10).
- **Diagnosis and Treatment:** Cancer is diagnosed through imaging tests, biopsies, and other diagnostic procedures. Treatment options depend on the type and stage of cancer but may include surgery, chemotherapy, radiation therapy, immunotherapy, targeted therapy, and hormone therapy(3).
- **EPIDEMIOLOGY-** Cancer is the study of the distribution, causes, and patterns of cancer occurrence in populations. Epidemiological research provides essential insights into understanding the risk factors, incidence, prevalence, and mortality associated with various types of cancer(11). Here are some key aspects of cancer epidemiology:
 - **Incidence and Mortality Rates:** Epidemiologists study the rates at which new cases of cancer are diagnosed (incidence) and the rates at which people die from cancer (mortality). These rates can vary across populations, regions, and demographic groups.
 - **Prevalence and Survival Rates:** Prevalence refers to the total number of individuals with cancer in a population at a specific time. Survival rates provide insights into the proportion of individuals who survive for a certain period after a cancer diagnosis. Both prevalence and survival rates contribute to understanding the overall burden of cancer(12).
 - **Screening and Early Detection:** Epidemiological studies assess the effectiveness of cancer screening programs and early detection efforts. These studies help evaluate the impact of screening on reducing cancer mortality and improving outcomes.
 - **Geographical and Temporal Trends:** Cancer epidemiology explores geographical and temporal trends in cancer incidence and mortality. These trends may highlight variations in cancer rates over time and across different regions(13).
 - **Cancer Clusters:** Epidemiologists investigate cancer clusters, which are higher-than-expected numbers of cancer cases in a specific geographic area or community. Identifying clusters can lead to further investigations into potential environmental or occupational causes.
 - **Cancer Health Disparities:** Understanding disparities in cancer incidence, access to healthcare, and outcomes among different populations is a key focus of cancer epidemiology. This includes disparities based on race, ethnicity, socioeconomic status, and geographical location.
 - **Occupational and Environmental Exposures:** Certain occupations and environmental exposures are associated with an increased risk of cancer. Epidemiological studies examine these associations to inform preventive measures(14).

3. Herbal formulations for the treatment of cancer

The potential anticancer effects of herbal medicine compounds have been a subject of interest in both traditional medicine and modern research. It's important to note that while some herbal compounds have demonstrated promising anticancer properties in laboratory studies, clinical evidence for their effectiveness in humans is often limited. Additionally, the safety and efficacy of these compounds may vary, and it is crucial to consult with healthcare

professionals before incorporating herbal remedies into cancer treatment or prevention strategies (15). Here are some herbal compounds that have been studied for their potential anticancer effects:

Table 1 Herbal compounds that have been studied for their potential anticancer effects

Herb	Active Compound	Physiology	Reference
Turmeric	Curcumin	It has been investigated for its potential to inhibit cancer cell growth and induce apoptosis (programmed cell death)	(16)
Green Tea	Polyphenols	Epigallocatechin gallate (EGCG) is a polyphenol found in green tea that has been studied for its potential anticancer effects. It may help inhibit the growth of cancer cells and promote apoptosis	(17)
Red Grapes and Berries	Resveratrol	has antioxidant properties and has been explored for its potential to inhibit cancer development. It may also have anti-inflammatory effects	(18)
Sweet Wormwood	Artemisinin	has been studied for its potential anticancer effects. Research has suggested that it may selectively target cancer cells	(19)
Panax Ginseng	Ginsenosides	have shown anti-cancer properties in preclinical studies. They may impact various signaling pathways involved in cancer development	(20)
Fruits and Vegetables	Quercetin	has antioxidant and anti-inflammatory properties. It has been studied for its potential to inhibit cancer cell growth	(20)
	Mistletoe Extracts	have been investigated for their potential anticancer effects. They may stimulate the immune system and induce apoptosis in cancer cells	(21)

4. Conclusion

In conclusion, the exploration of herbal medicine compounds and novel formulations for their anticancer effects presents a promising avenue in cancer research and treatment. The reviewed compounds, such as curcumin, green tea extract (EGCG), artemisinin, ginsenosides, vinca alkaloids, and quercetin, exhibit diverse mechanisms of action that show the potential to inhibit cancer cell growth and induce apoptosis. The incorporation of novel formulations, especially nanoparticle-based drug delivery systems, aims to address challenges related to bioavailability and targeted drug delivery, potentially enhancing the therapeutic efficacy of these herbal compounds.

While preclinical studies have provided encouraging evidence, the translation of these findings into clinically effective cancer therapies requires cautious consideration. Safety profiles, potential drug interactions, and standardization of herbal preparations are critical aspects that need careful attention as these compounds progress toward clinical application. Additionally, the complexity of cancer biology and the heterogeneity of tumors underscore the need for further research, including well-designed clinical trials, to validate the efficacy and safety of these herbal medicine compounds in diverse patient populations.

This comprehensive review emphasizes the importance of adopting an evidence-based approach that integrates herbal medicine into the broader landscape of cancer treatment. Collaborative efforts between traditional medicine and modern oncology can facilitate the development of effective and safe therapeutic interventions. As research progresses, continued exploration of the synergistic potential of herbal compounds in combination with conventional cancer therapies may open new avenues for personalized and integrated cancer treatment strategies.

In summary, the anticancer effects of herbal medicine compounds and novel formulations hold promise, but careful validation and further research are essential to harness their full therapeutic potential for the benefit of cancer patients.

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Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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