

# Pharmacognosy of Plant Based Cancer Therapies: Unlocking the Mechanisms behind Natural Anticancer Agents

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## Commentary

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## DESCRIPTION

Cancer remains one of the most significant global health challenges, leading to millions of deaths annually. While modern medicine including chemotherapy, radiation and immunotherapy has made strides in cancer treatment these methods often come with severe side effects and limitations in efficacy. In recent years plant-based therapies have acquired considerable attention for their potential anticancer properties, offering a promising alternative or adjunct to conventional treatments. The field of pharmacognosy, which is the study of natural products particularly those derived from plants, plays a vital role in uncovering the mechanisms behind these therapeutic agents.

The use of plants for medicinal purposes dates back centuries. Many ancient civilizations including the Egyptians, Chinese and Indians relied on plant based remedies to treat various diseases including cancer like symptoms. Today this tradition is being revisited with a modern understanding of the biological mechanisms underlying cancer. Approximately 60%-70% of all anticancer drugs are derived from natural sources with plant based compounds being among the most widely studied. These natural compounds are often less toxic than synthetic drugs and many exhibit a multi-target mechanism of action which could make them more effective in treating complex diseases like cancer.

The mechanisms by which plant based compounds exhibit anticancer effects are diverse and multifaceted. These compounds can target multiple pathways involved in cancer initiation, progression and metastasis. Some of the major mechanisms include the induction of apoptosis, inhibition of angiogenesis, cell cycle arrest and modulation of various signalling pathways.

Apoptosis or programmed cell death is a natural process that eliminates damaged or abnormal cells including cancerous ones. Many plant derived compounds have been shown to trigger apoptosis in cancer cells. Curcumin a polyphenolic compound found in turmeric induces apoptosis by activating caspases and inhibiting anti-apoptotic proteins like Bcl-2. Similarly, compounds like flavonoids and alkaloids from plants such as green tea and the Himalayan herb *Andrographis paniculata* have been reported to promote apoptosis in various cancer cell lines.

Angiogenesis the formation of new blood vessels is a vital process for tumor growth and metastasis. Tumors require a blood supply to deliver nutrients, oxygen and without angiogenesis their growth is limited. Several plant derived compounds have shown the ability to inhibit angiogenesis, thereby starving the tumor of essential resources. Resveratrol a polyphenol found in grapes has been shown to suppress angiogenesis by inhibiting the activity of Vascular Endothelial Growth Factor (VEGF) a key player in blood vessel formation. Additionally, flavonoids such as quercetin from apples and onions exhibit similar anti-angiogenic properties.

Cancer is often driven by signaling pathways that promote uncontrolled growth, survival and metastasis. Many plant derived compounds have been shown to modulate these pathways restoring normal cell function. Curcumin has been reported to inhibit the nuclear factor-kappa B pathway, which is involved in inflammation and cancer cell survival. Curcumin has been widely studied for its anticancer properties. It has been shown to inhibit cancer cell proliferation, induce apoptosis and suppress metastasis in various types of cancer including breast, colon and liver cancer. A major component of green tea, EGCG has demonstrated anticancer effects in a wide range of cancers. It inhibits cell proliferation, induces apoptosis and suppresses angiogenesis making it a potential candidate for cancer prevention and therapy.

Despite the promising potential of plant based anticancer agents, several challenges remain. The bioavailability of many plant derived compounds is often low, large doses are required to achieve therapeutic effects. This can result in undesirable side effects. Additionally the complex nature of plant extracts, which contain a multitude of compounds, makes it difficult to pinpoint the exact mechanisms of action and to develop standardized treatments. Future research should focus on improving the bioavailability of these compounds either through formulation techniques or by identifying more potent and bioavailable derivatives.