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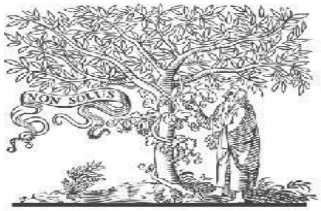

ELSEVIER SSRN

IJIEMR Transactions, online available on 26th Nov 2021. Link :http://www.ijiemr.org/downloads.php?vol=Volume-10&issue=Issue 11

10.48047/IJIEMR/V10/ISSUE 11/91

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Volume 10, ISSUE 11, Pages: 561-565

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MECHANISMS OF ACTION OF PLANT BIOACTIVE COMPOUNDS IN LUNG CANCER CELLS

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ABSTRACT
Lung cancer remains a global health concern with limited treatment options and high mortality rates. The emergence of plant bioactive compounds as potential anti-cancer agents has garnered substantial interest due to their diverse mechanisms of action and minimal adverse effects. This research paper aims to comprehensively review the current understanding of the mechanisms underlying the anti-cancer effects of various plant bioactive compounds on lung cancer cells. By elucidating these mechanisms, this paper contributes to the growing body of knowledge surrounding alternative therapeutic strategies for lung cancer treatment.

Keywords: - Alternative therapies, lung Cancer, Health, Plant.

I. INTRODUCTION

Lung cancer continues to be a leading cause of cancer-related mortality globally, presenting a substantial burden on healthcare systems and public health. The intricate nature of this disease, characterized by its heterogeneity and limited treatment options, necessitates innovative therapeutic approaches. Plant bioactive compounds have emerged as a promising avenue for lung cancer treatment due to their diverse mechanisms of action and potential to target multiple aspects of cancer progression. This introduction section provides an overview of the current landscape of lung cancer, introduces the concept of plant bioactive compounds as potential anti-cancer agents, and outlines the objectives and structure of the research paper.

Lung cancer ranks as one of the most prevalent cancers worldwide, accounting for a significant portion of cancer-related deaths. Its two main subtypes, non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC), present distinct challenges in terms of treatment response and prognosis.

Despite advancements in conventional therapies such as surgery, chemotherapy, and radiation, the overall survival rates remain relatively low, underscoring the need for novel therapeutic strategies that can overcome treatment resistance and improve patient outcomes. Plant bioactive compounds, often derived from various parts of plants, including leaves, fruits, and roots, have gained attention as potential anti-cancer agents. These compounds are known for their diverse biological activities, ranging from antioxidant and anti-inflammatory effects to modulation of cellular signaling pathways. Their natural origin and relatively low toxicity make them attractive candidates for cancer treatment,

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addressing concerns associated with conventional therapies. By targeting multiple pathways implicated in cancer development and progression, plant bioactive compounds hold promise as multitargeted therapeutic agents.

II. MECHANISMS OF ACTION OF PLANT BIOACTIVE COMPOUNDS

Plant bioactive compounds exhibit a remarkable array of mechanisms through which they exert their anti-cancer effects on lung cancer cells. These mechanisms target key cellular processes, including apoptosis, inflammation, angiogenesis, cell signaling pathways, and epigenetic modifications. Understanding these mechanisms is essential for unlocking the full therapeutic potential of plant bioactive compounds in lung cancer treatment.

1. Induction of Apoptosis:

Apoptosis, or programmed cell death, is a critical process for maintaining tissue homeostasis and preventing uncontrolled cell growth. Plant bioactive compounds have been shown to promote apoptosis in lung cancer cells through various pathways. For instance, curcumin, a compound found in turmeric, activates caspases and disrupts mitochondrial function, triggering apoptosis. Resveratrol, a polyphenol found in grapes, activates the p53 pathway, leading to cell cycle arrest and apoptosis. Quercetin, a flavonoid present in various fruits and vegetables, induces apoptosis by targeting multiple signaling pathways, including the PI3K/Akt pathway.

2. Anti-inflammatory Effects:

Chronic inflammation is closely linked to cancer development and progression. Plant bioactive compounds possess anti-inflammatory properties that can inhibit inflammatory signaling pathways in lung cancer cells. Epigallocatechin gallate (EGCG) from green tea has been shown to inhibit NF-κB, a key transcription factor involved in inflammation, thereby reducing cytokine production and inhibiting lung cancer cell growth. Luteolin, a flavonoid found in various plants, suppresses pro-inflammatory cytokines and inhibits COX-2 expression, mitigating inflammation-driven tumorigenesis.

3. Inhibition of Angiogenesis:

Angiogenesis, the formation of new blood vessels, is essential for tumor growth and metastasis. Plant bioactive compounds can disrupt this process by targeting angiogenic factors. Genistein, an isoflavone found in soy products, inhibits VEGF expression and suppresses endothelial cell proliferation, thereby impeding blood vessel formation. Silibinin, derived from milk thistle, inhibits multiple angiogenic pathways, including the PI3K/Akt/mTOR pathway, reducing blood supply to lung tumors.

4. Modulation of Cell Signaling Pathways:

Plant bioactive compounds can modulate key cell signaling pathways implicated in cancer development. Resveratrol inhibits the PI3K/Akt pathway, reducing cell survival and proliferation in lung cancer cells. Curcumin suppresses the MAPK and Wnt/β-catenin pathways, inhibiting cell growth and inducing apoptosis. These compounds often

target multiple pathways simultaneously, enhancing their effectiveness against lung cancer.

5. Regulation of Epigenetic Modifications: Epigenetic alterations play a significant role in cancer progression by influencing gene expression patterns. Plant bioactive compounds can regulate these modifications, offering potential for targeted therapy. Sulforaphane, found in cruciferous vegetables, inhibits histone deacetylases (HDACs) and DNA methyltransferases, leading to altered gene expression patterns in lung cancer cells. Curcumin modulates microRNA expression and DNA methylation, affecting various oncogenic pathways.

Understanding the intricate mechanisms of action of plant bioactive compounds provides insights into their potential as effective therapeutic agents for lung cancer treatment. By targeting multiple aspects of cancer development and progression, these compounds offer a multifaceted approach that may overcome resistance commonly associated with single-target therapies.

III. PRECLINICAL AND CLINICAL STUDIES

The efficacy and safety of plant bioactive compounds in lung cancer treatment have been extensively studied in preclinical models and, to a limited extent, in clinical trials. These studies provide valuable insights into the potential of these compounds as therapeutic agents, as well as the challenges that need to be addressed for successful translation into clinical practice.

1. Preclinical Studies:

- **In vitro Studies:** In vitro studies utilizing lung cancer cell lines have demonstrated the anti-cancer effects of various plant bioactive compounds. These studies often involve assessing cell viability, apoptosis induction, and inhibition of metastatic potential. For instance, curcumin treatment has been shown to reduce cell proliferation and induce apoptosis in NSCLC cell lines through activation of the intrinsic apoptotic pathway. Similarly, EGCG treatment suppresses invasion and migration of lung cancer cells by downregulating matrix metalloproteinases.
- **In vivo Studies:** Preclinical in vivo studies using animal models provide insights into the effects of plant bioactive compounds on tumor growth and metastasis. These studies often demonstrate the compounds' ability to inhibit tumor progression, reduce tumor size, and increase survival rates. Resveratrol administration in mouse xenograft models of lung cancer has been shown to suppress tumor growth by targeting angiogenesis and inducing apoptosis. Furthermore, genistein treatment has been associated with reduced tumor growth and angiogenesis in SCLC mouse models.

2. Clinical Studies:

- **Early-Phase Trials:** Clinical trials evaluating the effects of plant bioactive compounds on lung cancer

patients are relatively limited but show promising results. Early-phase trials focus on determining the safety, tolerability, and preliminary efficacy of these compounds. For example, a phase I trial investigating the administration of curcumin in combination with chemotherapy in advanced NSCLC patients demonstrated safety and potential benefits in terms of tumor response and patient quality of life.

- **Challenges in Clinical Trials:** Clinical trials involving plant bioactive compounds face challenges related to bioavailability, standardized dosing, and patient selection. The bioavailability of these compounds can vary significantly, affecting their therapeutic potential. Ensuring consistent and effective dosing is crucial for reproducible outcomes. Additionally, patient selection criteria and the identification of biomarkers to predict response to treatment remain areas of active research.
- **Future Prospects:** Despite these challenges, clinical trials assessing plant bioactive compounds in lung cancer treatment are ongoing. Further investigation is needed to establish optimal dosing regimens, evaluate long-term safety, and explore potential synergies with conventional therapies or other targeted agents.

The preclinical and limited clinical evidence underscores the potential of plant bioactive compounds as effective anti-cancer agents for lung cancer treatment. While promising, more rigorous and comprehensive clinical trials are required to establish their efficacy, safety, and potential integration into standard treatment protocols.

IV. CONCLUSION

Lung cancer remains a significant global health concern with limited treatment options and high mortality rates. The exploration of alternative therapeutic strategies is crucial to improve patient outcomes. This research paper delved into the mechanisms of action of plant bioactive compounds in lung cancer cells, shedding light on their potential as innovative anti-cancer agents.

Plant bioactive compounds exhibit a diverse array of mechanisms that contribute to their anti-cancer effects. Through apoptosis induction, anti-inflammatory activity, angiogenesis inhibition, modulation of cell signaling pathways, and epigenetic modifications, these compounds target critical processes involved in cancer initiation and progression. Their ability to impact multiple pathways presents a unique advantage in overcoming the complexity of lung cancer biology.

Preclinical studies have demonstrated the efficacy of plant bioactive compounds in curtailing lung cancer growth and metastasis. In vitro experiments using lung cancer cell lines and in vivo studies utilizing animal models have consistently shown promising results, supporting the compounds' potential as effective

therapeutic agents. These studies provide a foundation for further research and clinical exploration.

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