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Short communication

Anticancer potential of xanthatin, a prominent bioactive compound derived from *Xanthium strumarium L.*

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Introduction

The global burden of cancer continues to escalate, with statistical analyses estimating that incidence and mortality rates will significantly increase in the next years. While traditional treatments like surgery are effective for localized disease, systemic drug treatment is often unavoidable (Chabner & Roberts, 2005). The evolution of neoplastic drugs has moved from general cytotoxic agents toward molecularly targeted therapies, which aim to increase effectiveness while minimizing adverse effects (Pérez-Herrero & Fernández-Medarde, 2015). Natural products have historically provided a vital reservoir for such bioactive molecules, with many current anticancer drugs being derived from plant sources. *Xanthium strumarium L.*, a medicinal plant native to many dry tropical climates, has emerged as a scientifically credible source of such agents. While the plant contains over 170 identified compounds, its most distinctive pharmacological activity is attributed to its sesquiterpene lactones, which are mediators of both plant defense and human therapeutic potential (Fan et al., 2019).

The role of Xanthatin in cancer

Xanthatin is a sesquiterpene lactone that serves as a cornerstone of the biological activity found in *Xanthium strumarium L.* The anticancer potential of xanthatin is characterized by its ability to induce apoptosis and cell-cycle arrest through the targeted modulation of several oncogenic signaling networks, rather than through non-specific cellular damage. Research across various cancer models has demonstrated that xanthatin exerts a multifaceted effect by acting at multiple regulatory nodes within the cell (Jiang et al., 2022).

In the specific context of colorectal cancer (CRC), xanthatin has been shown to inhibit tumor progression by significantly altering cellular energy metabolism. It suppresses aerobic glycolysis, a process essential for the rapid growth of tumor cells, by downregulating the mRNA levels of Glut1 and MCT4 genes. Furthermore, xanthatin inhibits the phosphorylation of the mTOR signaling pathway and its downstream targets, which are critical drivers of tumor metabolic reprogramming (Li et al., 2022;). Beyond these metabolic interventions, xanthatin effectively halts the migration and invasion of colon cancer cells in a dose-dependent manner, suggesting a role in limiting the metastatic potential of the disease (Xu et al., 2022).

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The efficacy of xanthatin extends to non-small cell lung cancer (NSCLC), where it acts by disrupting intracellular redox homeostasis. Cancer cells typically possess a disrupted redox balance, and xanthatin exploits this vulnerability by inducing mitochondrial damage, leading to oxidative stress-mediated apoptosis (Perillo et al., 2020). Additionally, xanthatin contributes to growth inhibition in lung cancer cell lines by suppressing GSK3β signaling pathways (Tao et al., 2013). Its activity also involves inducing cell-cycle arrest at the G2/M checkpoint, thereby preventing the uncontrolled division characteristic of malignant tissues (Galluzzi et al., 2017). These diverse mechanisms ranging from metabolic suppression to the destruction of redox balance underscore xanthatin's role as a sophisticated agent capable of targeting the fundamental survival frameworks of diverse cancer types

Conclusion

In summary, xanthatin is a promising natural compound with potential for targeted cancer therapy. However, important challenges remain, including toxicity associated with *Xanthium strumarium* L., which requires careful phytochemical standardization and dose optimization to ensure safety. Since most current evidence comes from *in vitro* studies, further *in vivo* and pharmacokinetic research are needed to confirm efficacy and bioavailability in humans. Future studies should also explore xanthatin's synergistic effects with chemotherapy and the development of semi-synthetic derivatives, which may enhance its role in cancer treatment and help overcome drug resistance.

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