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Synergistic Effect of Plasma Modified Curcumin and Nano-Doxorubicin in Breast Cancer Cells

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ABSTRACT

Introduction: Doxorubicin (DOX) is a widely used chemotherapeutic agent for breast cancer. However, its clinical utility is often limited due to severe side effects and the development of resistance. Curcumin (CUR), a natural polyphenol, has demonstrated anticancer activities. This study aimed to inhibit breast cancer (BC) cell growth using a combination therapy of cold plasma-modified nano-CUR and nano-DOX in BC cells.

Materials and Methods: To enhance the hydrophilicity of CUR, cold atmospheric plasma (CAP) modification was performed. The cytotoxic effects of carboxymethyl chitosan (CMC) nanoparticles loaded with plasma-modified CUR and DOX were evaluated on MCF-7 BC cells and L929 fibroblast cells using the MTT assay. Apoptosis was assessed through the Annexin V assay, and real-time PCR was employed to analyze the expression levels of the *TP53* and *BAX* genes.

Results and Discussion: CAP significantly increased the solubility of CUR ($p < 0.05$). The combination therapy of nano-CUR and nano-DOX significantly inhibited cell proliferation ($p < 0.05$). The effective dose of plasma-treated nano-CUR in combination with nano-DOX was lower than that of free CUR and free DOX ($p < 0.05$). This combination therapy resulted in a marked increase in the level of apoptosis (up to 61%) and significantly upregulated the expression of the *P53* and *BAX* genes in MCF-7 cells ($p < 0.05$), indicating an enhanced induction of programmed cell death.

Conclusion: The CMC-based co-delivery system of plasma-treated nano-CUR and nano-DOX demonstrated synergistic anticancer activity at reduced effective doses. This combined nanotherapeutic system could serve as a promising candidate for the treatment of BC.

Keywords: Breast cancer, Carboxymethyl chitosan, Cold atmospheric plasma, Nano-doxorubicin

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