

Comparative Analysis of Inflammatory Capabilities of Combined Astaxanthin and Tocotrienols in A549 and CALU-3 Cells

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Structured Abstract

Background: Inflammation, while essential for the immune system, becomes pathological when unregulated, contributing to diseases such as rheumatoid arthritis, cardiovascular conditions, and cancers. Astaxanthin, a carotenoid with unique antioxidant and anti-inflammatory properties, and tocotrienols, a potent form of vitamin E, have demonstrated promise individually as anti-inflammatory agents. However, their combined effects remain underexplored. This study investigates the synergistic anti-inflammatory capabilities of astaxanthin and tocotrienols in A549 and Calu-3 lung epithelial cell lines, focusing on understanding their interaction and impact on inflammatory mediators such as nitric oxide (NO).

Methods: The study utilized A549 and Calu-3 cell lines cultured under standard conditions. Astaxanthin was extracted from *Haematococcus pluvialis*, while tocotrienols were derived from palm oil. Cells were treated with varying concentrations of astaxanthin, tocotrienols, and their combinations, followed by exposure to inflammatory stimuli. Nitric oxide production, cell viability, and the expression of inflammatory markers were analysed using RNA extraction, reverse transcription polymerase chain reaction (RT-PCR), and statistical methods. The compound interaction was assessed using combination index (CI) analysis to evaluate potential synergistic effects.

Results: Both compounds demonstrated strong anti-inflammatory properties individually. Combination treatments at optimal concentrations significantly enhanced nitric oxide inhibition, reaching up to 70% reduction in NO production in inflamed A549 and Calu-3 cells. Cell viability remained high (>95%) across all treatment groups, indicating minimal cytotoxic effects. ANOVA results confirmed that treatment concentration significantly influenced inflammation markers ($p < 0.05$), while time did not significantly affect outcomes, suggesting the stability of the compounds' effects over the observed duration. Combination index analysis revealed synergistic interactions at specific dosages, highlighting the potential for improved efficacy compared to individual treatments.

Conclusion: In conclusion, the findings establish the efficacy of combined astaxanthin and tocotrienols as a potent anti-inflammatory strategy. This study highlights their therapeutic potential in managing inflammation-related conditions and underscores the importance of dosage optimization. Future research should explore molecular pathways and in vivo models to elucidate their combined effects and therapeutic applications fully.

Keywords: Astaxanthin, tocotrienols, anti-inflammatory, A549 cells, Calu-3 cells

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