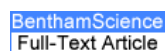


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Anticancer Agents Med Chem. 2026;26(3):302-312. doi: 10.2174/0118715206376021250506104129.

Precision-engineered Carrageenan Gels: Boosting the Efficacy, Selectivity, and Release of Celecoxib for Lung Cancer Therapy

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PMID: 40357790 DOI: [10.2174/0118715206376021250506104129](https://doi.org/10.2174/0118715206376021250506104129)

Abstract

Background: Lung cancer is one of the most widespread malignancies among all types of cancers. There is uncertainty in its treatment because of the selectivity. The investigation is aimed to enhance therapeutic efficacy through targeted improvements in drug selectivity and reduced toxicity by analyzing well-accepted cyclooxygenase (COX)-2, which is an enzyme target and a known therapeutic target for anti-inflammatory and antitumor agents.

Objective: The objective of the present research was to identify the most suitable counterpart for celecoxib, which would produce synergistic effects and improve the selectivity index, safety, and efficacy of targeting cancer cells.

Methods: The HOPE-62 cancer cell line and noncancerous LLC-MK2 cell line were used to analyze the activity of the prepared formulations. The effectiveness was compared by calculating the half-maximal inhibitory concentration (IC₅₀) values of carrageenan, celecoxib, and celecoxib embedded with carrageenan. The release pattern of celecoxib from the carrageenan matrix was also determined by using a trans-diffusion cell; moreover, the binding sites of carrageenan and celecoxib were also evaluated through *in silico* molecular docking studies.

Results: Carrageenan showed promising anticancer activity, with an IC₅₀ value of 17.3±2 µM against the HOPE- 62 cell line. When blended with celecoxib (15.6±2 µM), the combination achieved enhanced efficacy and improved selectivity over celecoxib alone (IC₅₀ of 10.3±1.5 µM). In noncancerous LLC-MK2 cells, the IC₅₀ values were observed to be significantly higher: 1484 ±6 µM in the combined formulation and with IC₅₀ values of 559±3 µM and 878±4 µM, respectively, in celecoxib and carrageenan alone.

Conclusion: The carrageenan-embedded celecoxib exhibited a significant increase in the selectivity index from 32 to 144, which suggests enhanced anticancer activity with a favorable safety profile. Initially, sustained release of celecoxib from the blend was at a higher rate, but steadily maintained rates were. The *In-silico* docking studies also supported the synergistic activity of the combined form through separate interaction patterns without interfering with others. These findings underscore the therapeutic potential of excipient-drug blending strategies to achieve synergistic effects, excellent selectivity, and reduced toxicity in cancer treatments.

Keywords: Carrageenan; celecoxib; drug delivery; encapsulation; lung cancer; therapeutic efficacy..

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