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Codelivery of Raloxifene and Rutin as PEGylated Nanoliposomes: Formulation, Characterization, and Prophylactic Activity Against Breast Cancer

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Purpose: Breast cancer is the leading cause of cancer-related deaths among women. Chemotherapy faces challenges such as systemic toxicity and multidrug resistance. Advances in nanotechnology have led researchers to develop safer and more efficient cancer treatment methods.

Methods: The thin-film hydration method was employed to synthesize PEGylated nanoliposomes (NLs) loaded with raloxifene (RLX) and a combination of RLX and rutin. The NLs were characterized using a ZetaSizer® instrument, transmission electron microscopy (TEM), and high-performance liquid chromatography (HPLC) analysis. The encapsulation of RLX and rutin was confirmed, and cell viability assays were conducted against breast cancer and normal endothelial cell lines.

Results: The encapsulation efficiency significantly increased in the mixed formulation, with RLX reaching 91.28% and rutin 78.12%, indicating successful encapsulation. These NLs remained stable for up to two months at room temperature and one month at 4°C, demonstrating a biphasic release pattern. After 24 hours, approximately 17% of RLX was released from the NLs and 25% from the mixed NLs. In contrast, 55% of rutin was released from the NLs and 70.4% from the mixed NLs within 72 hours. The inclusion of rutin or RLX in the liposomal formulation reduced cytotoxicity against breast cancer cell lines, as indicated by the 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. However, it improved safety in normal human cells and tissues.

Conclusion: PEGylated NLs loaded with RLX and rutin demonstrated safe anti-breast cancer effects, outperforming mixed NLs, suggesting the potential for a safer and more targeted treatment. Further investigations are needed into clinical translation.