Abstract (język angielski)

Drug resistance, various side effects, long treatment time increasing the risk of metastasis represent just a few examples of the limitations imposed by traditional anticancer therapies. Despite the rapid development of science and technology in the field of pharmacy and medicine, many malignancies remain a huge problem for humanity, and at the same time, a challenge prompting the development of modern approaches, such as photodynamic therapy (PDT) combined with nanomedicine. Moreover, in the current climate crisis, there is an increasing search for sustainable solutions based on the principles of *Green Chemistry*. As an alternative to standard chemical syntheses, a potential source of drugs is a widely available biomass of marine algae, rich in a whole range of valuable bioactive compounds. Modern green extraction techniques, such as microwave-assisted extraction (MAE), allow for highly efficient isolation of natural products with low energy and solvent input, supporting their environmental friendliness. The management of invasive species biomass constitutes an additional advantage, since it helps to stabilize and protect the marine environment. Nevertheless, many of the natural compounds, such as pigments being the subject of this thesis, have certain limitations due to their hydrophobicity, thermo- or photosensitivity. Hence, the instability in aqueous cellular environments may lead to degradation or aggregation before reaching the target, which hinders their therapeutic application. Furthermore, addressing tumors' highly complex and heterogeneous microenvironment remains a major obstacle for effective drug delivery. Intending to find a solution for these problems, the thesis presents an approach based on non-lamellar lyotropic liquid crystalline nanoparticles (LLCNPs), specifically cubosomes, as nanocarriers suitable for encapsulation of the extracted algal pigments to improve their solubility, stability, and delivery to pancreatic cancer cells, thus enhancing their anticancer efficiency. It highlights the benefits of novel biocompatible Pluronic-free cubosomes (TS-CUB) compared to the standard Pluronic-based ones (CUB), focusing on their physicochemical characteristics through scattering and microscopic techniques, along with the biocompatibility and anticancer activity evaluation in a series of *in vitro* assays upon human pancreatic cancer BxPC-3 cells. Combined with the TS-CUB, the cytotoxicity, photocytotoxicity, cellular uptake, or morphological analysis via the chosen cell line bioimaging have proved promising anticancer effects of the potential drugs derived from marine algae. Namely, the natural photosensitizers – chlorophylls, and a bisindole alkaloid, caulerpin, characteristic of *Caulerpa* species. The provided investigation indicated that the sustainable nanoplatforms represent a promising step toward advanced nanomedicine applications combined with the valorization of marine biomass.