Abstract

Extraction of terrestrial wood-derived cellulose poses environmental challenges, making fast-growing Indonesian marine macroalgae a sustainable, high-purity alternative for biomedical engineering. This study evaluated the wound dressing potential of novel cellulose biomembranes synthesized from *Chaetomorpha crassa*, *Sargassum ilicifolium*, and *Gracilaria arcuata*. Antibacterial efficacy against common wound pathogens was tested using Kirby-Bauer disk diffusion, while biocompatibility was assessed via MTS cytotoxicity assays on human skin keratinocytes (HaCaT cells). Additionally, compatibility with tissue repair signaling was evaluated through TGF-β1 gene expression (qRT-PCR) and matrix metalloproteinase enzymatic activity (gelatin zymography). The results demonstrated that all macroalgae-derived biomembranes were non-cytotoxic, maintaining HaCaT cell viability. Quantitative gene expression analysis showed no notable deviations in TGF-β1 regulation compared to untreated controls, and gelatin zymography showed that gelatinolytic activity of MMP-2 remained unaffected. While the purified biomembranes exhibited no intrinsic antibacterial activity, as evidenced by the lack of observable zones of inhibition, they successfully met all primary scaffolding safety criteria. In conclusion, these Indonesian macroalgae-derived cellulose biomembranes function as inert, non-interfering, biocompatible structural matrices, demonstrating promising potential for sustainable functional wound dressing applications.

Keywords: macroalgae, cellulose biomembrane, wound healing, biocompatibility, HaCaT cells