

Enhanced antimicrobial and anti-inflammatory properties of PCL metal-turmeric oleoresin and metal-curcumin nanohybrids

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The concern about microbial infections and antimicrobial resistance has now shifted towards designing sustainable biomaterials with greater therapeutic efficacy for hospitals and several biomedical applications, which involve the use of modern multifunctional nanomaterials that are currently being studied. This blend is incorporated into an electrospun mat of biodegradable polycaprolactone (PCL). This developed antimicrobial electrospun PCL membrane by incorporating curcuminoids and trimetallic nanoparticles (Ag, Cu, Ni), exhibited strong antibacterial, anti-inflammatory, and antioxidant activity against a range of microorganisms. The nanohybrids were synthesized and characterized using Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, X-ray diffraction (XRD), scanning electron microscope (SEM), and UV diffuse reflectance spectrometry. The synergistic antimicrobial effect of the electrospun membranes containing a curcuminoid coupled trimetallic nanohybrid was demonstrated by the inhibition zones from 29.67 ± 0.24 to 33.17 ± 0.24 mm against several strains of bacteria and fungi. The evidence for the primary antibacterial action is the radical scavenging activity (RSA) that reached a high value of $76.14 \pm 0.99\%$ in the PCL mat with trimetallic and curcuminoid incorporated nanohybrid. Moreover, curcuminoids showed impressive anti-inflammatory effects, with a peak value of $72.81 \pm 0.33\%$ reduction at 5000 ppm. The electrospun membranes have

strong inhibiting activity against microbial growth and are non-toxic, environmentally friendly, and biodegradable. These membranes play a role in acting as a physical and biological barrier, a cost-effective, and environmentally safe substitute for conventional antimicrobial techniques. This research shows that trimetallic-curcuminoid nanohybrid electrospun membranes are viable as sustainable biomaterials for next-generation antimicrobial therapies that make biomedical applications safer and more effective while being environmentally friendly and biocompatible. It serves as an example of how creative approaches can address issues related to sustainability and health.

Keywords:

Antimicrobial; Anti-inflammatory; Electrospun membranes; Metal- turmeric oleoresin; Metal-curcuminoids.

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