

ABSTRAK

PENGARUH *NANOSTRUCTURED LIPID CARRIERS* (NLC) EKSTRAK ETANOL SAMBILOTO (*Andrographis paniculata*) TERHADAP EKSPRESI mRNA IL-4 PADA HATI MENCIT YANG DIINDUKSI CCl₄

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Latar Belakang: Inflamasi berperan penting dalam patogenesis berbagai penyakit hati, termasuk hepatitis, fibrosis, sirosis, dan karsinoma hepatoseluler. Interleukin-4 (IL-4) merupakan salah satu sitokin antiinflamasi yang berperan dalam regulasi sistem imun dan perbaikan jaringan hati, namun efektivitasnya menurun pada kondisi inflamasi. Sambiloto (*Andrographis paniculata*) diketahui memiliki aktivitas antiinflamasi dan hepatoprotektif, tetapi pemanfaatannya masih terbatas karena rendahnya kelarutan dan bioavailabilitas andrografolida. Formulasi *Nanostructured Lipid Carriers* (NLC) berpotensi meningkatkan bioavailabilitas dan efektivitas senyawa tersebut. Penelitian ini bertujuan untuk mengevaluasi efek pemberian NLC-EES terhadap ekspresi mRNA IL-4 pada jaringan hati mencit yang diinduksi CCl₄.

Metodologi: Sediaan NLC-EES dikarakterisasi berdasarkan ukuran partikel, *polydispersity index* (PDI), zeta potensial, serta stabilitas fisik *real-time*. Penelitian ini dilakukan terhadap 35 ekor mencit jantan BALB/c yang dibagi secara acak menjadi 5 kelompok: kontrol sehat, kontrol sakit (1 mL/kgBB CCl₄), perlakuan 1 (70 mg/kgBB NLC-EES), perlakuan 2 (70 mg/kgBB EES *only*), dan perlakuan 3 (0,14 mL *empty* NLC). Ekspresi mRNA IL-4 pada hati dianalisis menggunakan metode qRT-PCR.

Hasil Penelitian: NLC-EES memiliki ukuran partikel $11,38 \pm 0,08$ nm, PDI $0,1287 \pm 0,0039$, dan zeta potensial $-8,159 \pm 0,109$ mV. Perubahan warna dan pemisahan fase terjadi pada pekan ke-10 yang menunjukkan sediaan kurang stabil pada penyimpanan suhu ruang. Pemberian NLC-EES meningkatkan ekspresi mRNA IL-4 dibandingkan kontrol sakit dan kelompok EES *only*.

Kesimpulan: NLC-EES berhasil memenuhi karakteristik ukuran partikel dan PDI nanopartikel, namun nilai zeta potensial dan stabilitas fisik masih belum optimal. NLC-EES meningkatkan ekspresi mRNA IL-4 pada hati mencit, sehingga berpotensi dikembangkan sebagai sistem penghantaran obat antiinflamasi berbasis bahan alam yang lebih efektif.

Kata Kunci: *Nanostructured Lipid Carriers*, *Andrographis paniculata*, IL-4, inflamasi hati, CCl₄.

ABSTRACT

THE EFFECT OF NANOSTRUCTURED LIPID CARRIERS (NLC) LOADED WITH ETHANOLIC EXTRACT OF SAMBILOTO (*Andrographis paniculata*) ON IL-4 mRNA EXPRESSION IN THE LIVER OF CCl₄-INDUCED MICE

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Background: Inflammation plays a crucial role in the pathogenesis of various liver diseases, including hepatitis, fibrosis, cirrhosis, and hepatocellular carcinoma. Interleukin-4 (IL-4) is an anti-inflammatory cytokine involved in immune regulation and liver tissue repair, but its effectiveness decreases under inflammatory conditions. Sambiloto (*Andrographis paniculata*) is known for its anti-inflammatory and hepatoprotective activities, however its application is limited by the low solubility and bioavailability of andrographolide. Nanostructured Lipid Carriers (NLC) have the potential to enhance the bioavailability and therapeutic effectiveness of such compounds. This study aimed to evaluate the effect of NLC-EES on hepatic IL-4 mRNA expression in CCl₄-induced mice.

Methods: NLC-EES was characterized based on particle size, polydispersity index (PDI), zeta potential, and real-time physical stability. The study was conducted on 35 male BALB/c mice randomly divided into five groups: a healthy control, a disease control (1 mL/kgBW CCl₄), treatment 1 (70 mg/kgBW NLC-EES), treatment 2 (70 mg/kgBW EES only), and treatment 3 (0,14 mL empty NLC). Hepatic IL-4 mRNA expression was analyzed using qRT-PCR.

Results: NLC-EES showed a particle size of 11.38 ± 0.08 nm, a PDI of 0.1287 ± 0.0039 , and a zeta potential of -8.159 ± 0.109 mV. Colour changes and phase separation were observed at week 10, indicating limited physical stability during room temperature storage. Administration of NLC-EES increased hepatic IL-4 mRNA expression compared with the disease control and ethanolic extract-only groups.

Conclusion: NLC-EES met the nanoparticle criteria in terms of particle size and PDI, although its zeta potential and physical stability were not yet optimal. NLC-EES enhanced IL-4 mRNA expression in mice liver tissue, suggesting its potential as a natural product-based anti-inflammatory drug delivery system.

Keywords: *Nanostructured Lipid Carriers, Andrographis paniculata, IL-4, liver inflammation, CCl₄.*