

ABSTRAK

Pengaruh Nanopartikel PLGA Ekstrak Etanol Sambiloto (*Andrographis paniculata*) terhadap Ekspresi mRNA dan Kadar Protein IL-4, IL-10 pada Sel RAW 264.7 yang Diinduksi Lipopolisakarida

Latar Belakang: Inflamasi kronis berkontribusi terhadap berbagai penyakit degeneratif dan autoimun. Interleukin-4 (IL-4) dan Interleukin-10 (IL-10) merupakan sitokin antiinflamasi yang berperan penting dalam regulasi sistem imun. Efektivitas keduanya dapat menurun dalam kondisi inflamasi. *Andrographis paniculata* (sambiloto) diketahui memiliki aktivitas antiinflamasi, namun bioavailabilitas senyawa aktifnya, yaitu andrografolid, relatif rendah. Formulasi dalam bentuk nanopartikel berbasis *poly lactic-co-glycolic acid* (PLGA) berpotensi meningkatkan efektivitasnya. **Metode:** Penelitian ini merupakan studi *in vitro* menggunakan sel RAW 264.7 yang diinduksi lipopolisakarida (LPS) 100 ng/mL. Sel dibagi menjadi sembilan kelompok: kontrol media (A), kontrol sakit (B), nanopartikel sambiloto dosis 200 (C), 300 (D), 400 (E), 500 (F), dan 600 ppm (G), ekstrak etanol sambiloto 500ppm (H), serta nanopartikel kosong (I). Perlakuan dilakukan selama 24 jam. Kadar IL-4 dan IL-10 diukur menggunakan *enzyme-linked immunosorbent assay* (ELISA), sedangkan ekspresi mRNA dinilai melalui RT-qPCR. Uji normalitas dilakukan dengan *Shapiro-Wilk*. Data IL-4 yang tidak terdistribusi normal dianalisis menggunakan *Kruskal-Wallis* dilanjutkan *post hoc Dunn*. Data IL-10 yang terdistribusi normal dianalisis dengan ANOVA dan *post hoc Tukey*. **Hasil:** Nanopartikel PLGA ekstrak etanol sambiloto menunjukkan pengaruh signifikan terhadap peningkatan kadar dan ekspresi IL-4 dan IL-10 ($p < 0,05$). Pada sel yang diinduksi dosis 500 dan 600 ppm menunjukkan kadar IL-4 dan IL-10 tertinggi. Ekspresi mRNA IL-10 meningkat signifikan dibandingkan kelompok kontrol. Uji *post hoc* menunjukkan perbedaan bermakna antara kelompok perlakuan dengan kelompok kontrol negatif (media), kontrol sakit (LPS), dan nanopartikel kosong. **Kesimpulan:** Pemberian nanopartikel PLGA ekstrak etanol sambiloto mampu meningkatkan ekspresi mRNA dan kadar protein IL-4 serta IL-10 pada sel RAW 264.7 yang diinduksi LPS, dengan efek paling tinggi pada dosis 500 ppm. Hasil ini menunjukkan potensi nanopartikel sambiloto berbasis PLGA sebagai agen anti-inflamasi alami berbasis nanoteknologi.

Kata kunci:

Andrographis paniculata, nanopartikel PLGA, IL-4, IL-10, LPS, Raw 264.7

ABSTRACT

Effect of PLGA Nanoparticles of Ethanolic Extract of *Andrographis paniculata* on mRNA Expression and Protein Levels of IL-4 and IL-10 in LPS-Induced RAW 264.7 Cells

Background: Chronic inflammation contributes to various degenerative and autoimmune diseases. Interleukin-4 (IL-4) and Interleukin-10 (IL-10) are anti-inflammatory cytokines that play important roles in immune regulation, but their effectiveness may decrease under inflammatory conditions. *Andrographis paniculata* (sambiloto) is known for its anti-inflammatory activity; however, the bioavailability of its main active compound, andrographolide, is relatively low. Nanoparticle formulation using *poly lactic-co-glycolic acid* (PLGA) has the potential to enhance its effectiveness. **Methods:** This in vitro study used RAW 264.7 cells induced with lipopolysaccharide (LPS) at 100 ng/mL. Cells were divided into nine groups: media control (A), LPS control (B), sambiloto nanoparticles at 200 ppm (C), 300 ppm (D), 400 ppm (E), 500 ppm (F), and 600 ppm (G), ethanolic sambiloto extract 500 ppm (H), and blank nanoparticles (I). Treatments were administered for 24 hours. IL-4 and IL-10 protein levels were measured using enzyme-linked immunosorbent assay (ELISA), while mRNA expression was assessed using RT-qPCR. Normality was tested with Shapiro–Wilk. Non-normally distributed IL-4 data were analyzed using *Kruskal–Wallis* followed by *Dunn’s* post hoc test, while normally distributed IL-10 data were analyzed using ANOVA followed by *Tukey’s* post hoc test. **Results:** PLGA nanoparticles of sambiloto extract significantly increased both IL-4 and IL-10 levels and mRNA expression ($p < 0.05$). The highest IL-4 and IL-10 levels were observed at 500 and 600 ppm. IL-10 mRNA expression showed significant upregulation compared to controls. Post hoc analysis revealed significant differences between treatment groups and media control, LPS control, and blank nanoparticles. **Conclusion:** Administration of PLGA-encapsulated ethanolic extract of *Andrographis paniculata* nanoparticles enhanced the mRNA expression and protein levels of IL-4 and IL-10 in LPS-induced RAW 264.7 cells, with the strongest effect observed at 500 ppm. These results indicate the potential role of PLGA-based *Andrographis paniculata* nanoparticles in modulating inflammatory responses.

Keywords:

Andrographis paniculata, nanoparticle PLGA, IL-4, IL-10, LPS, RAW 264.7