

ABSTRACT

FORMULATION AND CHARACTERIZATION OF SELF-NANOEMULSIFYING DRUG DELIVERY SYSTEM (SNEDDS) FROM KALAMANSI ORANGE PEEL ESSENTIAL OIL (*Citrus x microcarpa* Bunge) AND ANTIBACTERIAL ACTIVITY TEST AGAINST *Staphylococcus aureus* IN VITRO

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Background: Calamansi peel essential oil (*Citrus x microcarpa* Bunge) contains monoterpene and sesquiterpene compounds which have antibacterial activity against *Staphylococcus aureus*. However, essential oil compounds have volatile properties, so that it will affect their antibacterial activity. Self-Nanoemulsifying Drug Delivery System (SNEDDS) was chosen as a delivery system to increase the stability of essential oils.

Objective: To discover the optimum SNEDDS formula, SNEDDS characteristics, and test of SNEDDS antibacterial activity against *Staphylococcus aureus*.

Methods: This research is an experimental study to find out the optimum SNEDDS formula, SNEDDS characteristics, and antibacterial activity test of SNEDDS Calamansi peel essential oil (*Citrus x microcarpa* Bunge) at concentrations of 4% against *Staphylococcus aureus*.

Results: The results showed that the optimum SNEDDS formula consists of tween 80 with a concentration of 78%, 9% propylene glycol, 9% olive oil, and 4% essential oil. Prediction software Design Expert Stat-Ease 22.0.3 showed optimum formula with a clear yellow color appearance and the distinctive odor of orange oil. An average emulsification time of SNEDDS in distilled water was $95 \pm 0,26$, artificial gastric fluid (AGF) media was $93 \pm 0,36$, artificial intestinal fluid (AIF) was $90 \pm 0,13$; an average particle size was $174,3 \pm 35,99$ nm; an average polydisperse index values was $0,56 \pm 0,04$; an average zeta potential was $-25,13 \pm 0,40$; SEM morphological visualization showed no particle aggregation occurred, and was physically stable at $37 \pm 0,5^{\circ}\text{C}$ and 25°C with no separation or agglomeration. The optimum formula with a concentration of 50 μl has activity against *Staphylococcus aureus* with an average inhibition zone diameter of $12,10 \pm 0,10$ mm.

Conclusion: Calamansi peel essential oil (*Citrus x microcarpa* Bunge) can be formulated into SNEDDS, meet the characteristic criteria of SNEDDS, and has antibacterial activity against *Staphylococcus aureus*.

Keywords: citrus peel calamansi, SNEDDS, antibacterial, *Staphylococcus aureus*.

ABSTRAK

FORMULASI DAN KARAKTERISASI *SELF-NANOEMULSIFYING DRUG DELIVERY SYSTEM* (SNEDDS) DARI MINYAK ATSIRI KULIT JERUK KALAMANSI (*Citrus x microcarpa* Bunge) SERTA UJI AKTIVITAS ANTIBAKTERI TERHADAP *Staphylococcus aureus* SECARA *IN VITRO*

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Latar Belakang: Minyak atsiri kulit jeruk kalamansi (*Citrus x microcarpa* Bunge) mengandung senyawa monoterpen dan seskuiterpen yang memiliki aktivitas antibakteri terhadap *Staphylococcus aureus*. Namun, senyawa minyak atsiri memiliki sifat mudah menguap, sehingga akan mempengaruhi aktivitas antibakterinya. *Self-Nanoemulsifying Drug Delivery System* (SNEDDS) dipilih sebagai sistem penghantaran untuk meningkatkan stabilitas minyak atsiri.

Tujuan: Mengetahui formula SNEDDS yang optimum, karakteristik SNEDDS, dan uji aktivitas antibakteri SNEDDS terhadap *Staphylococcus aureus*.

Metode: Penelitian ini merupakan penelitian eksperimental untuk mengetahui formula optimum SNEDDS, karakteristik SNEDDS, dan uji aktivitas antibakteri minyak atsiri kulit SNEDDS kalamansi (*Citrus x microcarpa* Bunge) konsentrasi 4% terhadap *Staphylococcus aureus*.

Hasil: Hasil penelitian menunjukkan bahwa formula SNEDDS optimum terdiri dari tween 80 dengan konsentrasi 78%, propilen glikol 9%, *olive oil* 9%, dan minyak esensial 4%. Prediksi *software Design Expert Stat-Ease 22.0.3* menunjukkan formula optimum dengan tampilan warna kuning jernih dan bau khas minyak jeruk. Rata-rata waktu emulsifikasi SNEDDS dalam aquades sebesar $95 \pm 0,26$, media *artificial gastric fluid* (AGF) sebesar $93 \pm 0,36$, *artificial intestinal fluid* (AIF) sebesar $90 \pm 0,13$; ukuran partikel rata-rata $174,3 \pm 35,99$ nm; nilai indeks polidispersitas rata-rata $0,56 \pm 0,04$; nilai potensial zeta rata-rata $-25,13 \pm 0,40$. Visualisasi morfologi SEM menunjukkan tidak terjadi agregasi partikel, dan stabil secara fisik pada suhu $37 \pm 0,5^\circ\text{C}$ dan 25°C tanpa pemisahan atau aglomerasi. Formula optimum dengan konsentrasi 50 μl memiliki aktivitas terhadap *Staphylococcus aureus* dengan diameter zona hambat rata-rata $12,10 \pm 0,10$ mm.

Kesimpulan: Minyak atsiri kulit kalamansi (*Citrus x microcarpa* Bunge) dapat diformulasikan menjadi SNEDDS, memenuhi kriteria karakteristik SNEDDS, dan memiliki aktivitas antibakteri terhadap *Staphylococcus aureus*.

Kata Kunci: kulit jeruk kalamansi, SNEDDS, antibakteri, *Staphylococcus aureus*.