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ABSTRAK

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Formulasi Gel Topikal Berbasis *Nanostructured Lipid Carrier* (NLC) Ekstrak Kulit Nanas (*Ananas comosus* L. Merr) sebagai Antibakteri terhadap *Staphylococcus aureus* dan *Staphylococcus epidermidis*

Kulit nanas (*Ananas comosus* L. Merr.) mengandung senyawa bioaktif yang berpotensi sebagai antibakteri, namun pemanfaatannya dalam sediaan topikal masih terbatas akibat rendahnya stabilitas zat aktif dan distribusi yang kurang optimal. Penelitian ini bertujuan memformulasikan ekstrak kulit nanas ke dalam sediaan gel berbasis *Nanostructured Lipid Carrier* (NLC) serta mengevaluasi karakteristik dan aktivitas antibakterinya terhadap *Staphylococcus aureus* dan *Staphylococcus epidermidis*. Ekstrak kulit nanas diperoleh dengan metode maserasi menggunakan etanol 96%. Aktivitas antibakteri ekstrak diuji untuk menentukan konsentrasi yang akan digunakan dalam formulasi NLC. Selanjutnya, NLC dikarakterisasi berdasarkan ukuran partikel, indeks polidispersitas, dan zeta potensial. Basis gel dengan variasi Carbopol 940 sebesar 1%, 1,5%, dan 2% dievaluasi untuk memperoleh formula yang paling sesuai sebagai pembawa NLC. Formula II yang mengandung Carbopol 940 1,5% dipilih sebagai basis gel terpilih, kemudian diinkorporasikan dengan NLC dan dievaluasi aktivitas antibakterinya. Hasil penelitian menunjukkan bahwa ekstrak kulit nanas mengandung metabolit sekunder, dengan konsentrasi 3% dipilih sebagai konsentrasi formulasi karena menghasilkan aktivitas antibakteri yang baik terhadap *Staphylococcus aureus* dan *Staphylococcus epidermidis*. Karakterisasi NLC menghasilkan ukuran partikel 735,9 nm, indeks polidispersitas 0,730, dan zeta potensial -22,28 mV. Formula II (Carbopol 940 1,5%) memenuhi karakteristik fisik dan stabilitas sebagai basis gel. Sediaan NLC gel menunjukkan aktivitas antibakteri kategori kuat dengan diameter zona hambat terhadap *Staphylococcus aureus* sebesar $14,61 \pm 2,74$ mm dan *Staphylococcus epidermidis* sebesar $13,96 \pm 1,81$ mm. Berdasarkan hasil penelitian, sediaan NLC gel ekstrak kulit nanas berhasil dibuat, memenuhi karakteristik fisik sediaan topikal, dan menunjukkan aktivitas antibakteri kategori kuat. Namun, karakteristik NLC yang diperoleh masih memerlukan optimasi lebih lanjut.

Kata Kunci: antibakteri, gel topikal, kulit nanas, *Nanostructured Lipid Carrier* (NLC), *Staphylococcus*

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ABSTRACT

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The Formulation of a Nanostructured Lipid Carrier (NLC)-Based Topical Gel of Pineapple Peel Extract (*Ananas comosus L. Merr.*) as an Antibacterial Agent against *Staphylococcus aureus* and *Staphylococcus epidermidis*

Pineapple peel or *Ananas comosus L. Merr.* contains bioactive compounds with potential antibacterial activity; however, its utilisation in topical preparations remains limited due to the low stability of active compounds and suboptimal distribution. This study aimed to formulate pineapple peel extract into a Nanostructured Lipid Carrier (NLC)-based gel preparation and evaluate its characteristics and antibacterial activity against *Staphylococcus aureus* and *Staphylococcus epidermidis*. Pineapple peel extract was obtained by maceration using 96% ethanol. The antibacterial activity of the extract was tested to determine the concentration to be used in the NLC formulation. Subsequently, the NLC was characterised based on particle size, polydispersity index, and zeta potential. Gel bases with variations in Carbopol 940 concentrations of 1%, 1.5%, and 2% were evaluated to obtain the most suitable formula as an NLC carrier. Formula II containing 1.5% Carbopol 940 was selected as the gel base and subsequently incorporated with NLC and evaluated for its antibacterial activity. The results showed that pineapple peel extract contained secondary metabolites, with a concentration of 3% selected for the formulation because it produced good antibacterial activity against *Staphylococcus aureus* and *Staphylococcus epidermidis*. NLC characterisation resulted in a particle size of 735.9 nm, a polydispersity index of 0.730, and a zeta potential of -22.28 mV. Formula II containing 1.5% Carbopol 940 met the physical characteristics and stability requirements as a gel base. The NLC gel preparation showed strong antibacterial activity, with inhibition zone diameters of 14.61 ± 2.74 mm against *Staphylococcus aureus* and 13.96 ± 1.81 mm against *Staphylococcus epidermidis*. Based on the results, the NLC gel preparation of pineapple peel extract was successfully formulated, met the physical characteristics of a topical preparation, and showed strong antibacterial activity. However, the characteristics of the obtained NLC still require further optimisation.

Keywords: *antibacterial, Nanostructured Lipid Carrier (NLC), pineapple peel, Staphylococcus, topical gel*