UNIVERSITAS INDONESIA

PEMANFAATAN NADES SEBAGAI PELARUT EKSTRAKSI DAUN BELUNTAS (*Pluchea indica* L.) DAN PEMISAHAN ASAM DIKAFEOILQUINAT SERTA AKTIVITAS ANTIOKSIDAN DAN ANTIRETROVIRALNYA

DISERTASI

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FAKULTAS FARMASI
PROGRAM PASCASARJANA
DEPOK
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DISERTASI

Diajukan sebagai salah satu syarat untuk memperoleh gelar Doktor

NI PUTU ERMI HIKMAWANTI
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FAKULTAS FARMASI
PROGRAM STUDI DOKTOR ILMU FARMASI
DEPOK
JULI 2025

HALAMAN PERNYATAAN ORISINALITAS

Disertasi ini adalah hasil karya saya sendiri, dan semua sumber baik yang dikutip maupun dirujuk telah saya nyatakan dengan benar.

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NPM	**: 2006624381**
Tanda Tangan	**:**
Tanggal	**: 7 Juli 2025**

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Nama	: Ni Putu Ermi Hikmawanti
NPM	: 2006624381
Program Studi	: Doktor Ilmu Farmasi
Judul Disertasi	: Pemanfaatan NADES Sebagai Pelarut Ekstraksi Daun Beluntas (*Pluchea indica* L.) dan Pemisahan Asam Dikafeoilquinat serta Aktivitas Antioksidan dan Antiretroviralnya

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Tanggal : 7 Juli 2025

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Depok, 7 Juli 2025

Penulis

ABSTRAK

Nama	: Ni Putu Ermi Hikmawanti
Progam Studi	: Doktor Ilmu Farmasi
Judul	: Pemanfaatan NADES Sebagai Pelarut Ekstraksi Daun Beluntas (*Pluchea indica* L.) dan Pemisahan Asam Dikafeoilquinat serta Aktivitas Antioksidan dan Antiretroviralnya
Promotor	: Prof. Dr. apt. Abdul Mun'im, M.Si. Prof. Dr. apt. Arry Yanuar, M.Si. Prof. Dr. apt. Fadlina Chany Saputri, M.Si.

Beluntas (*Pluchea indica* L.) merupakan salah satu sumber fenolik alami, terutama asam kafeoilquinat (CQA). Senyawa ini pernah dilaporkan memiliki aktivitas antioksidan dan anti-HIV. Tujuan penelitian ini adalah meningkatkan perolehan senyawa fenol total pada ekstrak daun beluntas dengan memanfaatkan *natural deep eutectic solvent* (NADES) sebagai pelarut pengekstraksi, melakukan pemisahan senyawa CQA dari ekstrak NADES, serta menguji aktivitas antioksidan dan antiretroviral. Secara garis besar, tahapan penelitian meliputi: (1) tahap pra-ekstraksi, (2) tahap ekstraksi dan optimasi kondisi ekstraksi dibantu *Response Surface Methodology* (RSM), (3) tahap uji bioaktivitas, meliputi aktivitas antioksidan dan antiretroviral, (4) tahap pemisahan dengan teknik *anti-solvent*. Hasil pada tahapan pra-ekstraksi menunjukkan bahwa simplisia daun beluntas sebagai bahan uji telah memenuhi persyaratan mutu. Karakteristik pelarut NADES pada studi ini memiliki polaritas dan viskositas yang tinggi dengan pH dan berat jenis yang bervariasi. Pelarut Glisin-Asam laktat (Glis-AL) dengan rasio molar 1:3 dan penambahan air 50% menunjukkan perolehan kadar fenolik total yang tinggi dibandingkan etanol 50% (1,1 kali-nya) dan metanol (3,6 kali-nya) pada suhu ekstraksi 45 °C selama 15 menit. Kadar 3,5-DCQA ditemukan paling tinggi pada ekstrak UAE-Glis-AL dibandingkan CQA lainnya (3,5-DCQA>4,5-DCQA>3,4-DCQA>3-CQA>5-CQA) menggunakan analisis RP-UHPLC-UV secara simultan. Melalui studi *in silico*, prediksi aktivitas antioksidan terbaik ditunjukkan oleh senyawa 5-CQA terhadap reseptor NOX-2 dan CYP2E1, sedangkan aktivitas anti-HIV terbaik ditunjukkan oleh senyawa 3,4-DCQA dan 3,5-DCQA terhadap gp120 HIV-1. Senyawa 3,5-DCQA terdeteksi dan terkuantifikasi paling tinggi dibandingkan senyawa CQA lainnya pada fraksi metanol hasil pemisahan ekstrak UAE-Glis-AL dengan teknik *anti-solvent*. Terakhir, baik ekstrak UAE-Glis-AL maupun fraksi metanol memiliki aktivitas antioksidan dan antiretroviral yang baik. Pemanfaatan NADES pada ekstraksi daun beluntas dapat dijadikan alternatif pelarut ekstraksi CQA dengan aktivitas antioksidan dan antiretroviral.

Kata Kunci: Antioksidan, *Anti-solvent*, Antivirus, Asam kafeoilquinat, Fenolik, Pelarut hijau, *Pluchea indica*

ABSTRACT

Name	: Ni Putu Ermi Hikmawanti
Study Program	: Doktor Ilmu Farmasi
Title	: Utilization of NADES as a Solvent for Extraction of Beluntas (*Pluchea indica* L.) Leaves and Separation of Dicaffeoylquinic Acid and Its Antioxidant and Antiretroviral Activities
Counselor	: Prof. Dr. apt. Abdul Mun'im, M.Si. Prof. Dr. apt. Arry Yanuar, M.Si. Prof. Dr. apt. Fadlina Chany Saputri, M.Si.

Beluntas (*Pluchea indica* L.) is a source of natural phenolics, especially caffeoylquinic acid (CQA), which has been reported to have antioxidant and anti-HIV activity. This research aims to increase the yield of total phenolic compounds in beluntas leaf extract by using natural deep eutectic solvent (NADES) as an extraction solvent, separating CQA compounds from NADES extract, and testing antioxidant and antiretroviral activity. In general, the research stages include: (1) pre-extraction stage, (2) extraction stage and optimization of extraction conditions assisted by response surface methodology (RSM), (3) bioactivity test stage, including antioxidant and antiretroviral activity, (4) separation stage using an anti-solvent technique. The pre-extraction stage results showed that beluntas dried leaf as a test material met the quality requirements. The characteristics of the NADES solvent in this study had high polarity and tended to be viscous with varying pH and specific gravity. The Glycine-Lactic Acid (Glis-AL) solvent with a molar ratio of 1:3 and the addition of 50% water shows a high total phenolic content compared to 50% ethanol (1.1 times) and methanol (3.6 times) at an extraction temperature of 45 °C for 15 min. The 3,5-DCQA levels were found to be the highest in the UAE-Glis-AL extract compared to other CQAs (3,5-DCQA>4,5-DCQA>3,4-DCQA>3-CQA>5-CQA) using RP-UHPLC-UV simultaneously. Through *in silico* studies, the best prediction of antioxidant activity was shown by compound 5-CQA against NOX-2 and CYP2E1 receptors, while the best anti-HIV activity was shown by compounds 3,4-DCQA and 3,5-DCQA against HIV-1 gp120. The compounds 3,5-DCQA were detected and quantified in the methanol fraction obtaining from the separation of the UAE-Glis-AL extract using anti-solvent techniques. Finally, both UAE-Glis-AL extract and methanol fraction have good antioxidant and antiretroviral activities. The use of NADES in beluntas leaf extraction can be used as an alternative solvent for CQA extraction with antioxidant and antiretroviral activity.

Key words: Antioxidant, Anti-solvent, Antivirus, Caffeoylquinic acid, Green solvent, Phenolic, *Pluchea indica*

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