

POTENSI SENYAWA BIOAKTIF
EKSTRAK BUNGA CENGKEH (*Syzygium aromaticum* L.)
SEBAGAI AGEN ANTIBAKTERI TERHADAP ISOLAT
KLINIK *Escherichia coli* UROPATOGENIK
MULTI-DRUG RESISTANT

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INTISARI

Infeksi saluran kemih (ISK) menjadi semakin sulit ditangani akibat munculnya strain *multi-drug-resistant* (MDR), termasuk bakteri uropatogenik *Escherichia coli* (UPEC). Cengkeh (*Syzygium aromaticum* L.) diketahui memiliki aktivitas antimikrobia, yang mampu mengubah morfologi UPEC dan menunjukkan efek penghambatan. Namun, senyawa aktif spesifik dan target penghambatan belum banyak diketahui. Penelitian ini bertujuan untuk mengeksplorasi senyawa bioaktif dalam ekstrak bunga cengkeh sebagai kandidat anti-MDR UPEC melalui pendekatan *in vitro* dan *in silico*. Ekstraksi dilakukan dengan pelarut etanol dan n-heksana, menghasilkan nilai rendemen 27,44% dan 9,96%. Ekstrak etanol menunjukkan inhibisi terhadap bakteri MDR-UPEC dengan membentuk zona bening $11,07 \pm 0,32$ (250 mg/mL) hingga $16,77 \pm 1,36$ (1.000 mg/mL) melalui uji aktivitas antibakteri dengan difusi cakram. Kombinasi ekstrak etanol dan antibiotik *ciprofloxacin* menunjukkan antagonisme ketika diaplikasikan bersama. Hasil GC-MS ekstrak etanol mengidentifikasi 29 senyawa bioaktif yang selanjutnya dianalisis dengan *PASS Online*, *Lipinski's Rule of Five* dan *molecular docking* terhadap protein target PBP2 dan AcrB. Tiga senyawa bioaktif menunjukkan potensi menghambat PBP2 dan sepuluh terhadap AcrB. 8,14-Seco-3,19-epoxyandrostane-8,14-dione, 17-acetoxy-3 β -methoxy-4,4-dimethyl-, Ethyl iso-allocholate dan Estra-1,3,5(10)-trien-17 β -ol secara berturut-turut, menunjukkan nilai binding affinity sebesar -7,9; -7,6; dan -8,0 kkal/mol terhadap protein PBP2, serta -9,3; -8,5; dan -8,6 kkal/mol terhadap protein AcrB. Ketiga senyawa bioaktif tersebut menjadi kandidat potensial sebagai agen anti-MDR UPEC dan dapat dikembangkan lebih lanjut dalam formulasi antibakteri berbasis tumbuhan.

KATA KUNCI: cengkeh, MDR, UPEC, PBP2, AcrB, *molecular docking*.

**POTENTIAL OF BIOACTIVE COMPOUNDS
FROM CLOVE BUD EXTRACT (*Syzygium aromaticum* L.)
AS AN ANTIBACTERIAL AGENT AGAINST MULTI-DRUG
RESISTANT UROPATHOGENIC *Escherichia coli*
CLINICAL ISOLATES**

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ABSTRACT

Urinary Tract Infections (UTIs) are becoming increasingly challenging to treat due to the emergence of multi-drug-resistant (MDR) strain, including uropathogenic *Escherichia coli* (UPEC). Clove (*Syzygium aromaticum* L.) is known to possess antimicrobial activity, capable of altering UPEC morphology and exhibiting inhibitory effects. However, the specific bioactive compounds and their mechanisms of inhibition remain largely unknown. This study aimed to explore the bioactive compounds in clove flower extract as potential anti-MDR UPEC agents through in vitro and in silico approaches. Extraction was performed using ethanol and n-hexane, yielding 27,44% and 9,9% respectively. The ethanol extract exhibited inhibitory activity against MDR-UPEC, forming clear zones ranging from $11,07 \pm 0,32$ (250 mg/mL) to $16,77 \pm 1,36$ (1.000 mg/mL) in a disk diffusion assay. However, combining ethanol extract with ciprofloxacin resulted in antagonistic effects. GC-MS analysis of the ethanol extract identified 29 bioactive compounds, which were subsequently analyzed using PASS Online, Lipinski's Rule of Five, and molecular docking against the target proteins PBP2 and AcrB. Three bioactive compounds showed potential to inhibit PBP2 and ten bioactive compounds targeting AcrB. Specifically, 8,14-Seco-3,19-epoxyandrostane-8,14-dione, 17-acetoxy-3 β -methoxy-4,4-dimethyl-, Ethyl iso-allocholate and Estra-1,3,5(10)-trien-17 β -ol show binding affinities of -7,9; -7,6; and -8,0 kcal/mol to PBP2, and -9,3; -8,5; and -8,6 kcal/mol to AcrB, respectively. These three bioactive compounds represent promising candidates for development as plant-based antibacterial agents against MDR UPEC.

KEY WORDS: clove, MDR, UPEC, PBP2, AcrB, molecular docking.