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Antibacterial Efficacy of *Thymus vulgaris* Essential Oil Against Extended-Spectrum Beta-Lactamase-Producing *Escherichia coli* in Urinary Tract Infections

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Abstract

The rate at which the extended-spectrum β -lactamase (ESBL) is being disseminated among bacteria have become a serious issue of health concern globally due to the resistance it confers to most of the classes of antimicrobial which makes treatment options increasingly difficult. This study evaluated the antibacterial efficacy of *Thymus vulgaris* (thyme) essential oil against extended-spectrum beta-lactamase-producing *Escherichia coli* isolated from urinary tract infections (UTIs) at the state hospital Ijaiye and Federal Medical Center Idi-aba, both in Abeokuta, Ogun State. A total of 229 urine isolates were collected and cultured on eosin methylene blue (EMB) agar, identified biochemically according standard procedures. Ten antibiotics belonging to five classes of antibacterial agents including 4 fluoroquinolones, 3 beta-lactam, sulfonamide, chloramphenicol, and aminoglycoside were tested on the isolates. ESBLs were determined using double-disk synergy method. Essential oil from *T. vulgaris* was obtained by hydrodistillation using Clevenger apparatus and dehydrated with anhydrous sodium sulfate salt. Antibacterial effect of the oil was determined using agar well diffusion. Minimum inhibitory concentration (MIC) and minimum bactericidal concentrations (MBC) were also determined following the double fold dilution method. The rate of kill by the oil on isolates was also determined. The physicochemical property of the oil was evaluated using gas chromatography-mass spectrometry (GC-MS), while molecular docking was carried out on the components of the oil. One hundred and fifty-nine isolates were positive for *E.*

coli; high resistance was recorded against ceftazidime (92.4%), amoxicillin (84.9%), ampicillin (76.7%), gentamicin (74.2%), and Septrin (61.6%) and least resistance was recorded against chloramphenicol (16.4%). Out of 109 isolates, 30 were identified as ESBL producers. The zones of inhibition of the essential oil *T. vulgaris* was 16.0 ± 0.0 to 26.0 ± 0.0 mm. MIC and MBC values ranged from 0.0024 to 0.195 mg/ml and 0.42 to 0.375 mg/ml, respectively. Time-kill kinetics showed a continuous decrease in cell number as the time of exposure of the oil to the organism increases. GC-MS analysis of the oil showed high concentration thymol (41.33%) and p-cymene (18.08%). Molecular docking revealed that T-cadinol, gamma-terpinene, and β -terpene are druggable. The study suggests that *Thymus vulgaris* essential oil used has promising antibacterial activity against the extended-spectrum beta-lactamase-producing *E. coli* from UTI.

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