ABSTRAK

Akbar Maulana Yuwandika Putra. 2026. Mekanisme Kerja Anti-Osteoartritis *in Silico* dari Tanaman Tepung Otot (*Borreria laevis*). Skripsi. Program Studi Farmasi, Fakultas Ilmu Kesehatan dan Sains, Universitas PGRI Madiun. Pembimbing (I) Apt. Weka Sidha Bhagawan, M. Farm. Pembi,bimg (II) Dra. Arum Suproborini, M.Si.

Osteoartritis merupakan penyakit sendi degeneratif kronis yang ditandai oleh kerusakan progresif tulang rawan artikular, perubahan struktur tulang subkondral, pembentukan osteofit, serta proses inflamasi kronis pada jaringan sendi. Penyakit ini menjadi salah satu penyebab utama nyeri kronis, kekakuan sendi, dan keterbatasan fungsi gerak, terutama pada populasi usia lanjut, meskipun dalam beberapa dekade terakhir prevalensinya juga meningkat pada kelompok usia produktif akibat obesitas, cedera sendi, dan gaya hidup sedentary. Tujuan penelitian ini adalah memvalidasi potensi anti-osteoartritis ekstrak herba Tepung Otot (*Borreria laevis*) melalui pendekatan fitokimia dan *in silico* sebagai dasar ilmiah pengembangan Obat Herbal Terstandar (OHT) berbasis bahan alam lokal. Penelitian ini mengadopsi kerangka berpikir deduktif yang komprehensif untuk mengelaborasi aktivitas bioprospeksi herba Tepung Otot (*Borreria laevis*) sebagai agen terapeutik anti-osteoartritis. Berangkat dari signifikansi etnomedisin dengan nilai *Species Use Value* (SUV) sebesar 0,57, eksplorasi molekuler diawali dengan karakterisasi profil metabolomik menggunakan instrumen *Liquid Chromatography–High Resolution Mass Spectrometry* (LC-HRMS) guna memetakan konstituen kimia secara presisi berdasarkan massa akurat dan pola fragmentasi ion. Berdasarkan analisis pengayaan KEGG Pathway, senyawa aktif dalam tanaman ini secara masif memodulasi jalur biologis spesifik, terutama kaskade pensinyalan *Mitogen-Activated Protein Kinases* (MAPKs) yang bertanggung jawab langsung dalam meregulasi respon stres seluler, supresi sitokin pro-inflamasi, dan pencegahan apoptosis kondrosit pada jaringan sendi. Di samping itu, simulasi molecular docking menggunakan AutoDock Vina berhasil memvalidasi afinitas pengikatan (*binding affinity*) dan stabilitas termodinamika yang kuat antara ligan aktif *Borreria laevis* terhadap panel reseptor kunci osteoartritis, yang meliputi COX-2, TNF-α, IL-6, dan keluarga enzim degradasi matriks seperti MMP-1, MMP-3, MMP-9, serta MMP-13. Penapisan farmakokinetika dan keamanan *in silico* berbasis parameter SwissADME dan ProTox-II yang mengonfirmasi bahwa mayoritas senyawa bioaktif terpilih memenuhi kriteria kelayakan sebagai obat (drug-likeness) berdasarkan Hukum Lima Lipinski, memiliki profil absorpsi oral optimal, serta tingkat toksisitas teoretis yang aman sehingga meminimalkan risiko efek samping sistemik dibandingkan terapi NSAID standar seperti Meloxicam.

Kata Kunci : Osteoartitris, *in silico*, tumbuhan obat, *Borreria laevis,* Suku Tengger

ABSTRACT

Akbar Maulana Yuwandika Putra. 2026. In Silico Mechanism of Action of Anti-Osteoarthritis Compounds from the Muscle Flour Plant (*Borreria laevis*). Undergraduate thesis. Pharmacy Programme, Faculty of Health and Science, PGRI University of Madiun. Supervisor (I) Apt. Weka Sidha Bhagawan, M. Farm. Supervisor (II) Dra. Arum Suproborini, M.Si.

Osteoarthritis is a chronic degenerative joint disease characterised by progressive damage to articular cartilage, structural changes in the subchondral bone, the formation of osteophytes, and chronic inflammation of the joint tissues. This condition is one of the leading causes of chronic pain, joint stiffness and limited range of motion, particularly amongst the elderly; however, in recent decades its prevalence has also risen amongst people of working age due to obesity, joint injuries and a sedentary lifestyle. The aim of this study is to validate the anti-osteoarthritis potential of the Tepung Otot herb (*Borreria laevis*) herbal extract through phytochemical and *in silico* approaches, as a scientific basis for the development of Standardised Herbal Medicines (SHMs) based on local natural ingredients. This study adopts a comprehensive deductive framework to explore the bioprospecting activity of the Tepung Otot herb (*Borreria laevis*) as an anti-osteoarthritis therapeutic agent. Building on its ethnomedical significance, with a *Species Use Value (SUV*) of 0.57, the molecular exploration began with the characterisation of the metabolomic profile using *Liquid Chromatography–High Resolution Mass Spectrometry (LC-HRMS)* to precisely map chemical constituents based on accurate mass and ion fragmentation patterns. Based on KEGG Pathway enrichment analysis, the active compounds in this plant extensively modulate specific biological pathways, particularly the *Mitogen-Activated Protein Kinases (MAPKs)* signalling cascade, which is directly responsible for regulating cellular stress responses, suppressing pro-inflammatory cytokines, and preventing chondrocyte apoptosis in joint tissue. Furthermore, molecular docking simulations using AutoDock Vina successfully validated the strong *binding affinity* and thermodynamic stability between the active ligand of *Borreria laevis* and a panel of key osteoarthritis receptors, including COX-2, TNF-α, IL-6, and the matrix-degrading enzyme family such as MMP-1, MMP-3, MMP-9, and MMP-13. *In silico* pharmacokinetic and safety screening based on SwissADME and ProTox-II parameters confirmed that the majority of the selected bioactive compounds meet the criteria for drug-likeness according to Lipinski's Five Rules, have an optimal oral absorption profile, and exhibit a safe theoretical toxicity level, thereby minimising the risk of systemic side effects compared with standard NSAID therapies such as meloxicam.

Keywords: Osteoarthritis, *in silico*, medicinal plants, *Borreria laevis*, Tengger tribe