ABSTRACT

Hanif Putra Kusuma, 24020222130036. ***The Potential of Astaxanthin-Cu^{2+} and Astaxanthin-Zn^{2+} Complexes as Candidate Multi-Target Agents for Metabolic Syndrome through In silico Studies and Their Characterization Using UV-Vis Spectrophotometry****, Under the guidance of Nurhayati and Syahputra Wibowo.*

Metabolic syndrome (MetS) is a cluster of concurrent health conditions—comprising hypertension, central obesity, insulin resistance, dyslipidemia, and hyperuricemia—that poses a major global health threat and demands a multi-target therapeutic approach. Astaxanthin (Asx), a marine carotenoid pigment with potent antioxidant activity, holds considerable promise as a therapeutic agent against MetS. Complexation of Asx with transition metal ions copper (Cu^{2+}) and zinc (Zn^{2+}) is theoretically expected to enhance its stability and binding affinity; however, a comprehensive computational evaluation of these complexes as multi-target agents has not previously been reported. This study employed a mixed-method approach comprising: (1) UV-Vis spectrophotometry (190–690 nm) to confirm the formation of Asx–Cu^{2+} and Asx–Zn^{2+} complexes; (2) molecular docking simulations to evaluate binding affinity against ten key MetS receptors; and (3) molecular dynamics (MD) simulations over 10 ns at 300 K using CABS-flex 3.0 to assess the stability of each ligand–receptor complex. Spectrophotometric results confirmed complex formation through a bathochromic shift in λmax (an increase of 1–2 nm), the emergence of a charge transfer band at 263 nm (Asx-Cu) and 256 nm (Asx-Zn), and a pronounced hypochromic effect. Molecular docking simulations demonstrated that free Asx and its complexes exhibited more negative binding free energies (ΔG) than the reference drugs across the majority of target receptors. MD simulations confirmed ligand–receptor complex stability, evidenced by an overall mean RMSD of 2.41–2.51 Å, RMSF profiles indicative of dampened fluctuations at active-site residues, and well-maintained protein geometric compactness throughout the simulation period. Collectively, these findings support the potential of Astaxanthin and its bioinorganic complexes as viable multi-target agent candidates for MetS, warranting further evaluation through in vitro and in vivo studies.

Key words: *Astaxanthin (Asx), metabolic syndrome (MetS), multi-target agent, receptors, transition metal ions*