doi.org/10.36721/PJPS.2025.38.4.REG.14078.1

Exploring *Eichhornia crassipes* pharmacological potential: Muscle relaxant and sedative activities, molecular docking and molecular dynamics simulations

Fayaz Asad[1]*, Mamoona Bibi[2, 3], Vasila Sharipova[4], Nodira Rakhimova[4], Sarir Ahmad[5,6], Imtiaz Ahamd[1] and Sajid Ali[7]*

[1]Department of Botany, Bacha Khan University Charsadda-24420, Kpk, Pakistan.
[2]Department of Botany, Islamia College Peshawar, Pakistan.
[3]Department of Botany, Abdul Wali Khan University Mardan, Kpk, Pakistan
[4]Institute of Botany, Academy of Sciences the Republic of Uzbekistan, Tashkent, Durmon Yuli – Uzbekistan
[5]Department of Forestry, University of Agriculture Dera Ismail Khan, 29111, Pakistan
[6]College of Life and Environmental Sciences, Central South University of Forestry and Technology, Changsha 410004, China
[7]Department of Horticulture and Life Science, Yeungnam University, Republic of Korea.

Abstract: This study aims to investigate the therapeutic properties of *Eichhornia crassipes* (Mart.) Solms, demonstrating its sedative and muscle relaxant capabilities. It examines molecular dynamics simulations, docking investigations, *in silico* screening *and* molecular interactions. The study revealed that there are differences in the responses of muscle relaxant activity to several extracts, highlighting the intricate connection between dose and effects. The *E. crassipes* did not exhibit considerable muscle relaxant action. Additionally, the study showed that *E. crassipes* had dose-dependent sedative effects, underscoring the plant's potential for targeted sedative uses and the management of stress-induced sleep disturbances. According computational studies, *E. crassipes* interacts with the COX-1 and COX-2 proteins. Orientin is a promising chemical since it has strong docking scores against both proteins. The possible sedative properties of *E. crassipes* compounds are further explained by intricate amino acid interactions. The constant B-factor and RMS scores, together with the examination of eigenvalues and covariance matrices, validate the simulations' dependability in confirming the binding stability found in docking experiments. Further research is needed to explore the potential muscle relaxant properties and this could lead to new opportunities for investigating herbal medicine in the future.

Keywords: *Eichhornia crassipes*, molecular docking, molecular dynamics simulations, pharmacological potential, muscle relaxant, sedative activities.

Submitted on 03-02-2025 – Revised on 22-04-2025 – Accepted on 14-05-2025

INTRODUCTION

Developing novel pharmaceuticals is a major problem for the medical and pharmacological fields. Conventional techniques that depend on a target-based methodology are frequently sluggish and ineffective (Le and Le 2016). The pursuit of therapeutic improvement has led to a dramatic shift in drug discovery at the nexus of biological computation and pharmacology (Zhang *et al*. 2022). Natural substances made from plants and herbal medicine are becoming more and more popular than synthetic medications since they are less expensive and have fewer negative effects (Sam 2019; Umaru *et al*. 2020). In addition to being more costly and having unfavorable side effects, synthetic medications can encourage the growth of bacterial resistance (Johann *et al*. 2007). Ethnomedicinal research is vital to the continuous process of searching for new medications by means of medicinal plants (Gao *et al*. 2019). The creation of many medications has been greatly influenced by the traditional usage of medicinal herbs. The pharmaceutical sector has benefited greatly from pharmacological testing, biological and phytochemical screening *and* other methods (Srinivasan *et al*. 2007).

Numerous plant species with medicinal significance have been investigated (Kunwar *et al*. 2023; Karahan 2023; Mentreddy 2007), but there remain numerous higher plant species that have not yet been explored (Srinivasan *et al*. 2007). The goal of the current study is to conduct a scientific investigation of the *E. crassipes*is species. It is a member of the Pontederiaceae family and is distributed throughout Southeast Asia and Amazon basin in South America (Patel 2012; Zhao *et al*. 2017). Another name for this plant is the water hyacinth. As an antipyretic, anti-inflammatory *and* antispasmodic drug, *E. crassipes* has long been utilized therapeutically in traditional healthcare systems for a range of medical ailments, including digestive problems (Kumar *et al*. 2018). *E. crassipes* contains a variety of phytochemicals such as alkaloids, flavonoids, tannins, saponins, terpenoids, phenolic compounds *and* lignans (Bibi *et al*. 2023; Tyagi and Agarwal 2017; Ben Bakrim *et al*. 2022), which have been

**Corresponding author:* e-mail: fayaz.asad79@gmail.com; drsajid@yu.ac.kr

documented to have a wide variety of biological activities, including antioxidant and anti-inflammatory, antifungal and antimicrobial potential can be used in the industry (Haggag *et al*. 2017; Ahmad *et al*. 2024; Begum *et al*. 2021). The current study was designed to investigate plants with sedative and muscle relaxant effects for treating muscle-related illnesses and conditions linked to nervous system hyperactivity. Traditional research has discovered several muscle relaxants with unique modes of action (Kruidering-Hall and Campbell 2015), but finding drugs with a well-balanced blend of muscle relaxant effectiveness is challenging. Sedative activities provide comfort to individuals suffering from anxiety and insomnia by reorienting the emphasis from the physical to the neurological (Grounds *et al*. 2014). In silico screening, a cutting-edge computer method, accelerates the search for compounds with both sedative and muscle-relaxing properties by predicting compound effects and modeling molecular interactions (Myrianthopoulos and Mikros 2019; Akash *et al*. 2023). Based on the ethnomedicinal importance of the plant, the study was designed to investigate the muscle relaxant and sedative potentials of the plant using in vivo models. Furthermore, the study aims to identify potential phytoconstituents using in silico approaches.

MATERIALS AND METHODS

Collection of plant

In the month of April 2021, the fresh plants of *E. crassipes* was procured from Akbarpura District, Nowshehra KP, Pakistan. The leaves, roots and bulbs were separated from one another and washed with tap water for further processes. The plant material was identified by Dr. Imtiaz Ahmad, Department of Botany, Bacha Khan University Charsadda. The plant specimen was stored for reference in the Herbarium, Department of Bacha Khan University under Voucher No. HBKUC-2936. To prevent fungal growth and to store for future use, certain sections were shade dried at room temperature, individually pulverized by an electric grinder *and* kept in airtight bottles.

Plant Materials and Extract Preparation

E. crassipes root, leaves and bulb powder drug were soaked in methanol solvent in a closed container for two weeks. The mixture was violently shaken repeatedly throughout the soaking period. Whatman filter paper No. 1 was then used to filter the mixture. The solubilized solvent in the crude drugs was evaporated under pressure of 50°C using a rotating vacuum evaporator. The filtrate was then put into a China dish placed on a water bath for complete removal of solvent.

Muscle relaxant activity

In this activity, a total of thirty-three (n=33) Swiss albino mice were utilized in 11 groups, each with 3 animal each. The two groups received distilled water (10ml/kg) and Diazepam (1mg/kg) as negative and positive control respectively. while the remaining 9 groups received separately the selected doses (100, 150 and 200 mg/kg) of *Eichhornia* root extract (ERE), *Eichhornia* leaf extract (ELE) and *Eichhornia* bulb extract (EBE).

In the assay, an iron string coated with rubber was tightly stretched between two stands at the height of 60 cm from the ground. After the treatment the mice were exposed for muscle relaxant test. Each mouse was suspended from the wire by its hind legs and the hanging duration was recorded. The mice's inability to hang from a wire for five seconds was caused by the presence of muscle relaxants (Muhammad *et al*. 2013).

Sedative activity

Each extract (bulb, root *and* leaves) was administered to 15 mice of either sex, weighing 20–30g, with three replicates for each concentration (100, 150 *and* 200 mg/kg). These fifteen mice were divided into five groups. One group received an injection of saline water (5 milliliters per kilogram), another received an injection of bromazepam (5 milligrams per kilogram) *and* the remaining groups received injections of extract (100, 150 *and* 200 milligrams per kilogram). The grid chart that was used for this experiment has lines on it. After 30 minutes of treatment, the number of lines that the mice crossed in 10 minutes was counted (Ali *et al*. 2015).

STATISTICAL ANALYSIS

One-way ANOVA with multiple comparisons was used to analyze the outcomes of this activity. *p values of <0.05 and ** p <0.01 were considered statistically significant when the findings were compared to the control group.

In silico screening

Target protein receptor

For a subset of target proteins, the potential bioactivity of the discovered compounds-including possible sedative and muscle-relaxing effects was computed and assessed. The cyclo-oxygenases COX-1 (PDB ID 2OYE) and COX-2 (PDB ID 5F19) crystal structures, which are based on biological mechanisms and readily available data, are demonstrated in order to accomplish this. These three-dimensional structures were retrieved in PDB format from https://www.rcsb.org's RCSB Protein Data Bank.

Protein preparation for molecular docking

All non-protein molecules and any additional residues were taken out of proteins for molecular docking (PDB ID: 2OYE and PDBID: 5F19) using BIOVIA discovery studio visualizing b.21.1. 0.20298. The proteins were optimized and docked with ligands using Mestro 12.5.

Selection and preparation of phytochemicals

Known phytochemicals from the *E. crassipes* plant were used to create the lig and. From the PubChem database, each chemical's 3D structure was retrieved as a sdf file. The

Table 1: Muscle relaxant activities of methanol extracts of different parts of *Echhornia crassipes* in traction assay

Groups	Dose (mg/Kg)	Traction test (30.00 minutes)
Distilled water	10.00 ml/kg	0.00±0.00
Diazepam	01.00	99.66±0.57**
	100.00	01.33±0.57
ERE	150.00	02.33±0.57
	200.00	03.00±1.00
	100.00	02.0±0.00
EBE	150.00	01.33±0.57
	200.00	02.66±1.15
	100.00	01.66±0.57
ELE	150.00	02.33±0.57
	200.00	03.00±1.00

ERE stands for *E. crassipes* root extract, EBE = *E. crassipes* bulb extract and ELE = *E. crassipes* leaf extract. The data has been expressed in Mean ± SD, and * signify $p < 0.01$.

Table 2: Sedative activities of methanol extracts of different parts of *Eichhornia crassipes* in open field assay

Sample	Dose (mg/kg)	Crossed lines number	(%) activity
Control (Normal Saline)	5.00 ml/kg	128.00±01.00	
Bromazepam	05.00	09.00±10.00	92.96
	100.0	110.00±01.00	14.06
ERE	150.00	101.00±01.00	21.09
	200.00	92.00±02.00	28.12
	100.00	118.00±02.00	07.81
EBE	150.00	105.33±02.51	17.96
	200.00	92.33±02.51	28.12
	100.00	112.33±02.51	12.50
ELE	150.00	97.33±03.05	24.21
	200.00	78.66±01.52	39.06

* stands for the significant level at $p < 0.01$.

file was converted into a pdb file using BIOVIA Discovery Studio Visualizer (version 21.1.0.20298) (Srinivasan *et al*. 2007). By protonating the phytochemicals in 3D at 300°C and 7 PH with the default MOE 2015.10 setting, the energy was decreased.

Molecular docking analysis

Molecular docking was used to determine the optimal orientation of the ligand to the corresponding receptor and the binding affinity. The ligand atom was selected during molecular docking of the receptors *and* rescoring 1 and 2 were set up to capture the ligand-protein interaction in both situations. Using BIOVIA Discovery studio visualize b21.1.0.20298, the results were analyzed. The DSV also shows the binding site, or the site where the ligand binds to the protein.

Molecular dynamic stimulation

Since MD simulation offers a more comprehensive understanding of the physical underpinnings of the complexes under study, it was used to analyze the molecular activity and stability of protein-ligand complexes (Fu *et al*. 2022). The proposed protein's and its inter-ligand complexes' 3D structures will be analyzed in the current investigation using the Imods online server.

RESULTS

Effect of E. crassipes in Muscle Relaxant Activity

table 1 shows the results of the Traction Test, which evaluated the muscle relaxant effects in mice after 30 minutes of post-treatment. The muscle relaxant activity of *E. crassipes* demonstrated insignificant effects in all parts extracts. Notably, the most significant activity (03.00±1.00) was observed at 200 mg/kg for both *Eichhornia* Root Extract (ERE) and *Eichhornia* Leaf Extract (ELE), while the least impact (01.33 ± 0.57) was observed for 100 mg/kg (ERE and ELE). Similarly, the lowest activity was also observed at 01.33 ± 0.57 for 100 mg/kg *Eichhornia* Bulb Extract (EBE), showing a response that varies with the dosage. These findings illuminate the intricate correlation between dosage and response in *E. crassipes* extracts and offers important perspectives for future exploration of their muscle relaxant characteristics.

Sedative activity

The sedative effects of *E. crassipes* were systematically evaluated in its leaf, root *and* bulb components at different concentrations. Remarkably, the leaf extract (ERE) showed dose-dependent results with values of 110.00±01.00, 101.00±01.00 *and* 92.00±02.00 at 100, 150 and 200mg/kg, respectively. Similarly, the bulb extract (EBE) demonstrated varying effects at different concentrations,

producing results of 118.00±02.00, 105.33±02.51 *and* 92.33±02.51 at 100, 150 and 200mg/kg. The root extract (ELE) also exhibited concentration-dependent outcomes, with values of 112.33±02.51, 97.33±03.05 and 78.66±01.52 at 100, 150 *and* 200mg/kg, respectively, as shown in table 2. These results highlight the diverse sedative responses displayed by different parts of the *E. crassipes* plant. *E. crassipes* components show dose-dependent sedative effects, with leaf (ERE), bulb (EBE) *and* root (ELE) extracts demonstrating varied responses. This highlights the potential of the plant for targeted sedative applications, emphasizing the importance of understanding and utilizing its diverse sedative properties for future therapeutic developments.

In Silico screening

Molecular docking study

The plant components were analyzed for their optimal conformations when interacting with COX1 (PDB ID: 2OYE) and COX2 (PDB ID:5F19). The docking results revealed the binding affinity and amino acid interactions of the compounds; Orientin, Chrysoeroil, Azaleatin, Tricin, thebaine, Naringenin, 5F19-ccl *and* 2OYE_ccl (table 3). Orientin exhibited the highest docking score of -10.928 kcal/mol against COX-1, followed by Chrysoeroil (-7.170), Azaleatin (-8.095), Tricin (-7.360), Quinine (-4.570), thebaine (-4.850) and Naringenin (-6.289 kcal/mol) (table 3). The docked structure illustrated the interactions of Orientin with significant amino acids such as CYS-36, TYR-39, CYS-41, GLY-45, CYS-47, ARG-49, LEU-152, PRO-153 *and* PRO-156 of cyclooxygenases-1 (COX-1) through Vander Waal forces and hydrogen bonding. Orientin interacted with significant amino acids such as PRO-40, CYS-41, HIS-43, GLY-45, CYS-47, ASP-135, ARG-150, ILE-151, LEU-152, PRO-153, GLU-465 *and* ARG-469 with the COX-1 protein (fig. 1), whereas the 2D & 3D structure of Orientin shows in fig. 3. The best pose for each molecule was considered to investigate the intramolecular correlation conditions. The docking of the ligand Chrysoeroil with COX-1 indicated binding interactions with significant and functionally relevant amino acids such as GLN-44 forming hydrogen bonds, while ILE-46, CYS-47, TYR-130, ILE-137, LEU-152 *and* PRO-153 formed Pi-Pi, Pi-Alkyl *and* Pi-Cation bonds with cyclooxygenase-1 (COX-1) protein. The docking of the ligand Azaleatin with COX-1 indicated binding interactions with significant and functionally relevant amino acids such as GLN-44, TYR-130 *and* GLU-465 forming hydrogen bonds, while CYS-36, ILE-46, CYS-47, ASP-135, LEU-152 *and* PRO-153 formed Alkyl, Pi-Alkyl *and* Pi-Pi bonds with COX-1 (fig. 1).

Additionally, cyclooxygenase-2 (COX-2) protein was also docked with Orientin, Chrysoeroil, Azaleatin *and* Tricin *and* the binding affinity results. Orientin exhibited the highest binding affinity against the target protein with a docking score of -10.928 kcal/mol, followed by Azaleatin (-8.095 kcal/mol), Tricin (-7.360 kcal/mol) and Chrysoeroil (-7.170 kcal/mol) (table 4). The docking of Chrysoeroil with COX-2 showed hydrogen bond interactions with amino acids like ASN-382, HIS-386 and TRP-387 forming Pi-Pi bonds and Amide-Pi bonds and TYR-385 forming carbon hydrogen bonds. Tricin interacting with the target protein COX-2 showed hydrogen bond interactions with amino acids like ALA-199, ASN-382, HIS-386 *and* GLN-203, with TYR-385 forming carbon hydrogen bonds, while ALA-202, TRP-387, TYR-385 *and* LEU-391 formed alkyl and Pi-Alkyl bonds. The docking of Orientin with the target protein COX-2 showed various amino acids forming hydrogen bonds such as HIS-207, THR-212, ASN-382, TYR-385 *and* GLN-454, while IS-214 and HIS-388 formed carbon hydrogen bonds. The docking interaction of Azaleatin with COX-2 showed various amino acids forming hydrogen bonds such as SER-451 and HIS-207, HIS-386, HIS-214, THR-212, GLN-203, VAL-447 forming Pi-Pi, Pi-Alkyl *and* carbon hydrogen bonds. The HOMO-LUMO energy levels and molecular electrostatic potential (MEP) maps of multiple compounds (5F9X ccl, EC-3, EC-2 *and* EC-1). The color changes reveal electron-rich and electron-deficient areas, offering information on the stability and reactivity of these molecules (fig. 2).

DFT analysis

The ligands' DFT analysis reveals that their distinct electronic properties influence their stability and reactivity (table 5). The maximum dipole moment of EC-1 (7.0637 Debye) suggests strong intermolecular interactions, whereas the lowest dipole moment of CCL (5.2233 Debye) suggests decreased polarity. EC-1 has the largest gap (-0.1527 a.u.), indicating greater stability, whereas CCL has the smallest gap (-0.27076 a.u.), showing stronger reactivity. The HOMO-LUMO gap (ΔEGap) is a measure of electronic stability (Bendjeddou *et al*. 2016).

Ionization capability and electron attraction further demonstrate ligands' propensity to supply or accept electrons. For instance, CCL's reactivity is increased by its lower ionization energy (2.237 eV) whereas EC-1's reactivity is decreased by its higher ionization potential (5.76 eV) (table 5). With the highest electronegativity (3.543 eV), EC-3 exhibits a considerable propensity to remove electrons. Electron-attracting capacities are determined by electrochemical potential and electronegativity. The electrophilicity index (ω) indicates that CCL is the most electrophilic at 6.28 eV, compared to EC-1 at 1.04 eV (Giju *et al*. 2005). While CCL is the softest and makes it easier to engage in chemical reactions, EC-1 and EC-3 are tougher and more stable. A key determinant of ligand reactivity is harshness (η) and softness (S). These findings indicate that EC-1 is the most robust and less reactive ligand, which makes it a strong candidate for applications requiring stability, while CCL is better suited for enzymatic and redox-based activities because of its significant reactivity and electrophilia (Tokunaga *et al*. 2020).

Table 3: 2D, 3D structures and SMILES of the selected ligands from *Eichhornia crassipes.*

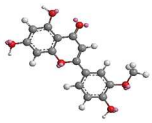
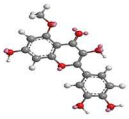
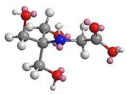
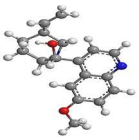
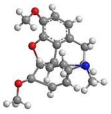
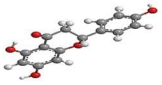
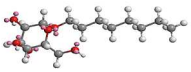
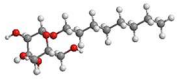
Code	Comp Name	2D structure	3D structure	Smiles
1	Orientin			O=C(C1=C(C([C@H]2[C@H](O)[C@@H](O)[C@H](O)[C@@H](CO)O2)=C(O)C=C1O)O3)C=C3C4=CC(O)=C(O)C=C4
2	Chrysoeroil			COC1=C(O)C=CC(C2=CC(C3=C(O)C=C(O)C=C3O2)=O)=C1
3	Azaleatin			COC1=CC(O)=CC2=C1C(C(O)=C(C3=CC(O)=C(O)C=C3)O2)=O
4	Tricin			OCC(CO)(NCC(O)=O)CO
5	Quinine			O[C@@H]([C@H]1C[C@H]2[C@H](C[N@@]1CC2)C=C)C3=CC=NC4=CC=C(OC)C=C34
6	thebaine			COC1=CC=C2C[C@@H](N(CC3)C)C4=CC=C(OC)C5[C@]43C2=C1O5
7	Naringenin			O=C1CC(C2=CC=C(O)C=C2)OC3=C1C(O)=CC(O)=C3
8	5F19-ccl			CC1=C(CCC(O)=O)C2=Cc3c(CCC(O)=O)c(C)c4n3[Co]56[N]2=C1C=C(C(C)=C7C=C)N5C7=CC(C(C)=C8C=C)=[N]6C8=C4
9	2OYE_ccl			O[C@H]([C@H]([C@@H]([C@@H](CO)O1)O)O)[C@@H]1OCCCCCCCC

Table 4: Docking Scores of the selected ligands against the targeted protein 5F19 and 2OYE.

NO	Compounds	Docking Scores (5F19)	Docking Scores (2OYE)
1	Orientin	-10.928	-11.021
2	Chrysoeroil	-7.170	-10.085
3	Azaleatin	-8.095	-7.379
4	Tricin	-7.360	-6.460
5	Quinine	-4.570	-4.728
6	thebaine	-4.850	-3.057
7	Naringenin	-6.289	-7.368
5F19-ccl	Octyl beta-D-glucopyranoside	-8.219	Octyl beta-D-glucopyranoside -9.261

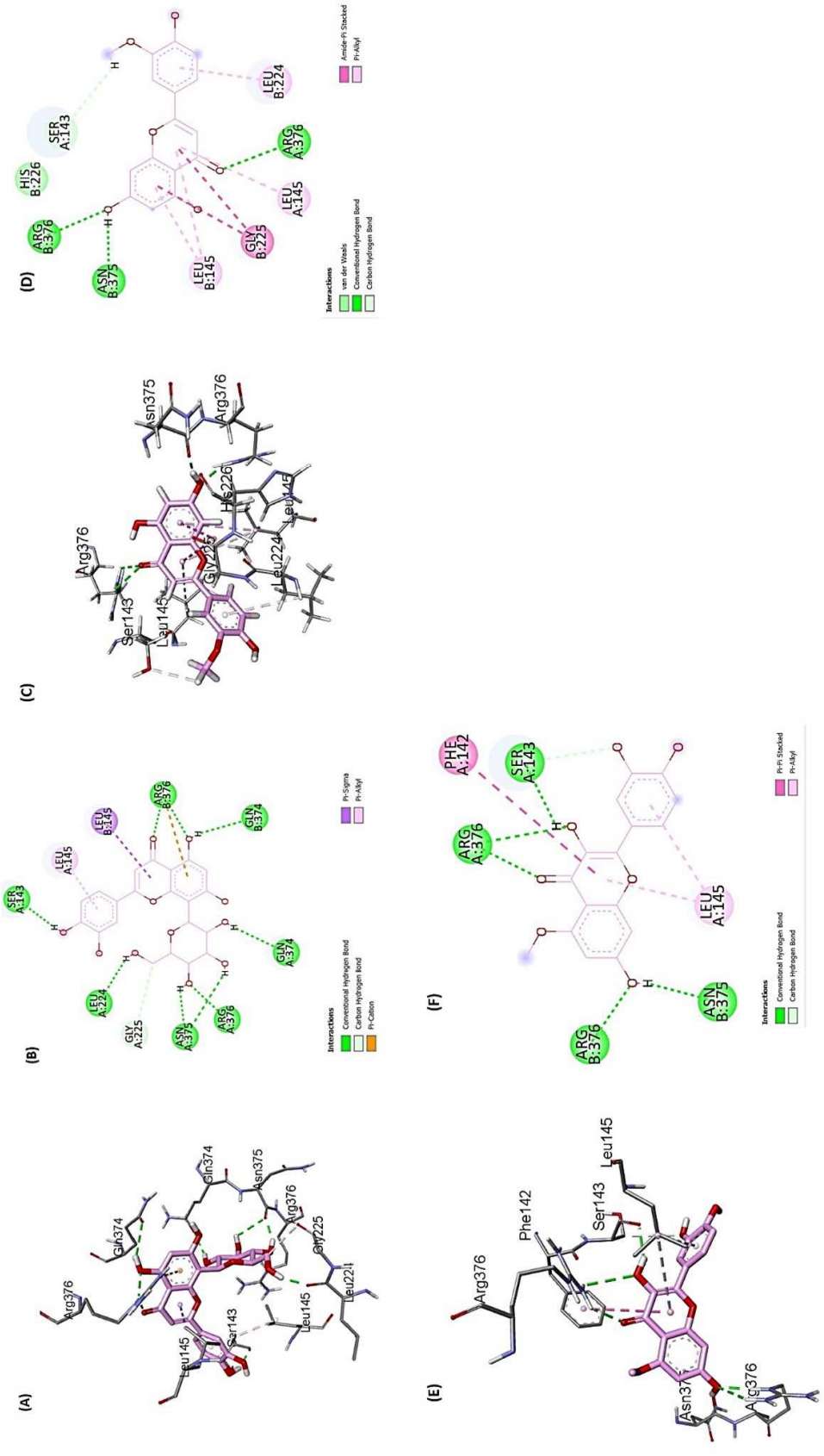


Fig. 1: 2D and 3D structure of Orientin (A & B) Chrysoeroil (C & D) Azaleatin (E & F)

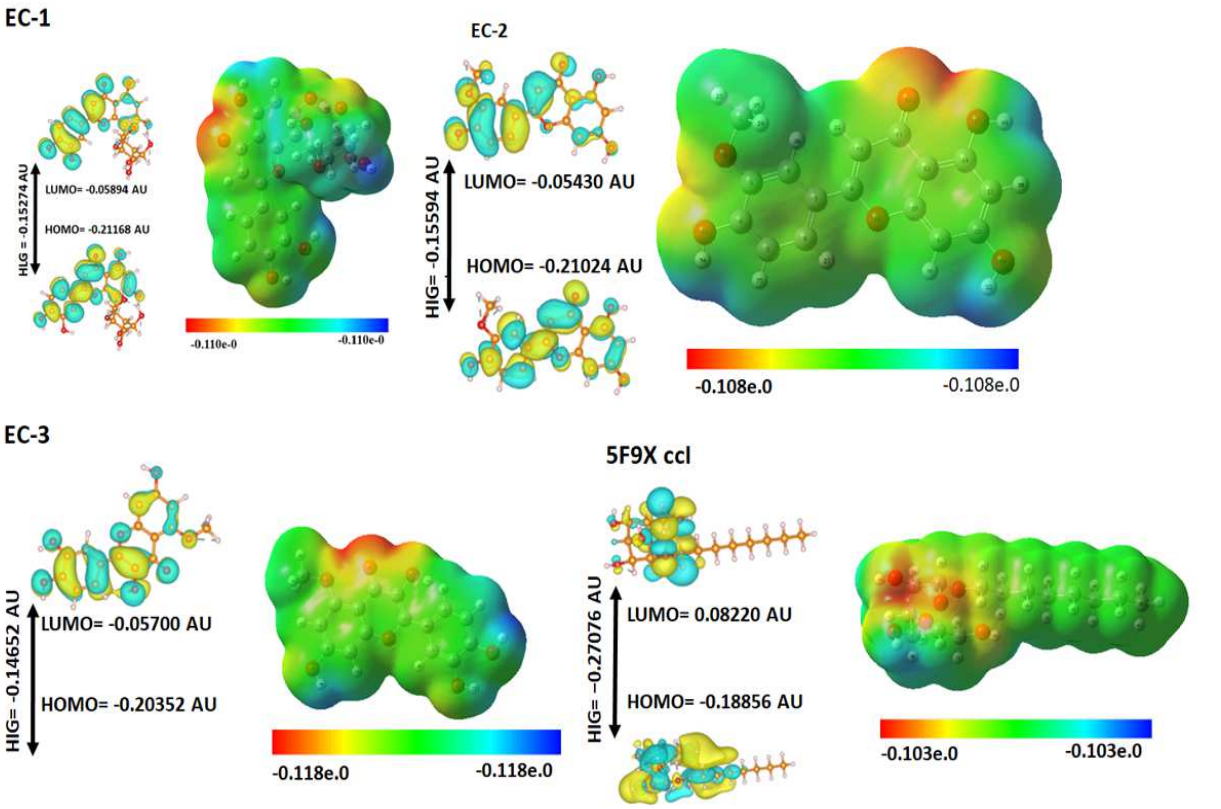


Fig. 2: EC-1, HOMO-LUMO, and bandgap; (EC-2) HOMO-LUMO, and bandgap; (EC-3) HOMO-LUMO, and bandgap; (5F19-Ccl) HOMO-LUMO, and bandgap.

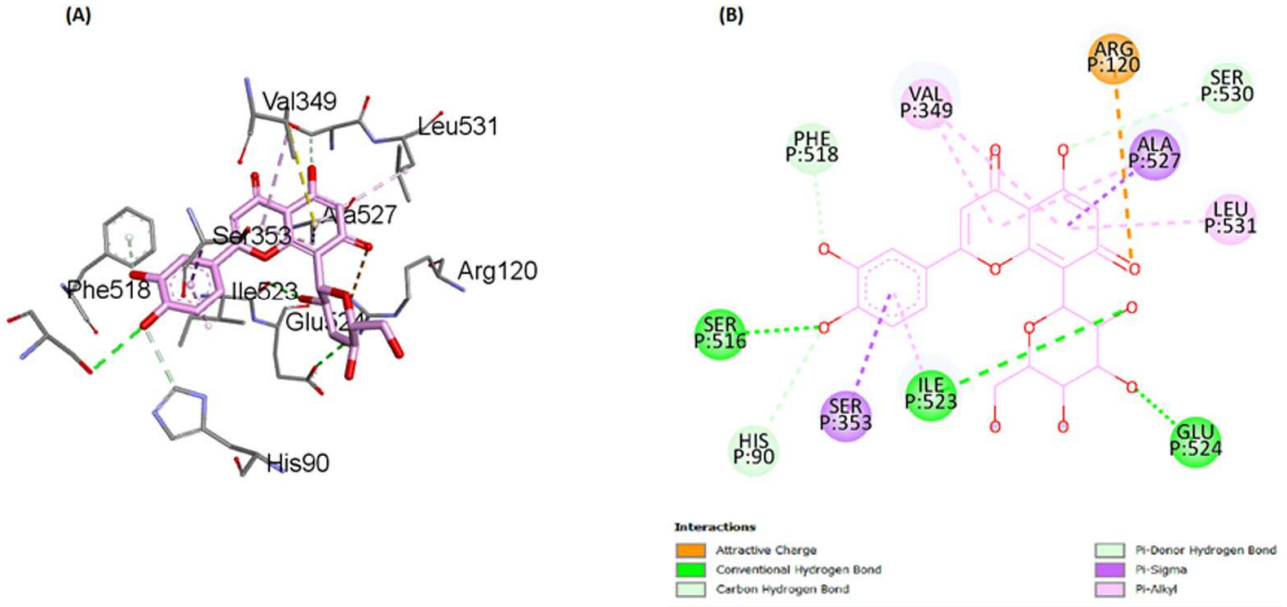


Fig. 3: 2D & 3D structure of Orientin (A & B)

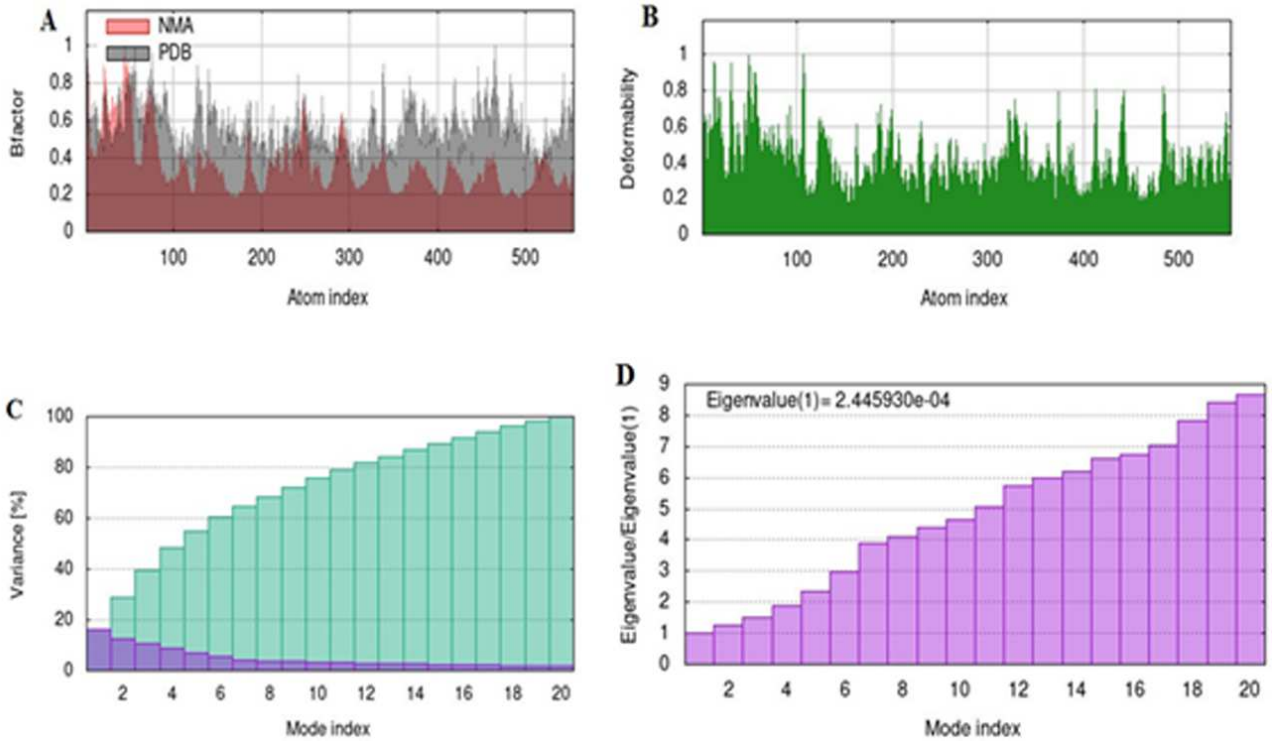


Fig. 4: The results from the NMA analysis conducted using the iMODs server. The outputs include A-B Factor, B-Deformation plot, C-Variance Plot, and D-Eigenvalue.

Molecular dynamic stimulation

MD simulations model was used to assess alterations in protein structure and confirm the findings from docking investigations (fig. 4). The stability of ligand-receptor complexes was examined through MD simulations conducted on the iMODS server. In the analysis of normality, the B-factor scores from the iMODS servers were consistent with the RMS scores (fig. 4A). The strain of each residue is depicted by the chain's hinge, which also governs the deformation of the complex (fig. 4B). Consequently, we determined that the estimated eigenvalue of the mixed field was 2.4459 (fig. 4D). The variances and eigenvalues of each normal state were frequently inversely correlated (fig. 4C). The covariance matrix's red, blue *and* white colors indicate different pairs of residues correlated, anti-correlated, or correlated movements, illustrating the relationship between these residue pairs.

DISCUSSION

Muscle relaxant medications are essential for achieving the relaxation of skeletal muscles (Beebe *et al*. 2005) *and* D-tubocurarine is recognized as a safe option used in surgical procedures for this purpose, as documented by Neubig and Cohen (1979). The use of different medications is common for easing spastic conditions in skeletal muscles. Prior studies by Rauf *et al*. (2022), Yamashita *et al*. (2022) and Malik *et al*. (2023) have highlighted the muscle relaxant properties of medicinal plants. However, it is important to note that our current research did not find significant muscle relaxant activity in the specific context we investigated. This difference emphasizes the need for ongoing exploration and comprehension of various medicinal plant sources for their muscle relaxant effects, recognizing the complex nature of these pharmacological interactions.

A drug that is known for its capacity to cause serenity by lowering irritability is called a sedative or tranquilizer. Stress, a strong environmental effect commonly disrupts sleep habits (Meerlo *et al*. 2008). Zhang (2004) asserts that herbal therapy has acquired acceptance as a depression treatment technique. Yaseen and Ibrar (2013) found significant sedative effects in the ethanolic extract from *Wathinia coagulans* leaves. Rauf *et al*. (2013) explored the sedative activity of crude and various fraction extracts of *Caralluma tuberculata* in albino mice. The collective findings emphasize the broad spectrum of sedative potentials present in different plant extracts, highlighting their therapeutic relevance. *E. crassipes* also showed noteworthy sedative results. This indicates that people from different backgrounds and communities may benefit from herbal remedies in managing the difficulties caused by stress and its effects on sleep disruption. The investigation of natural treatments highlights the potential of herbal medicine in promoting calmness and addressing mental health.

Table 5: DFT analysis parameters of the top hit ligands of *Eichhornia crassipes.*

Ligand	Parameters for DFT analysis									
	Dipole moment (Debye)	HOMO (a.u.)	LUMO (a.u.)	Energy Gap (ΔE_{Gap})	Ionization Potential (eV)	Electron affinity (eV)	Electronegativity χ (eV)	Electrochemical potential μ (eV)	Hardness η (eV)	Softness S (eV)	Electrophilicity ω (eV)
EC-1	7.0637	0.21168	-0.05894	-0.1527	5.76	1.60	3.18	2.08	2.08	0.48	1.04
EC-2	6.2886	-0.05430	-0.15594	-0.15594	1.478	1.478	3.599	3.599	-2.12	0.472	3.06
EC-3	6.6935	-0.05700	-0.20352	-0.14652	1.549	5.537	3.543	-3.547	1.994	0.502	3.16
CCL	5.2233	0.08220	-0.18856	−0.27076	2.237	5.126	3.682	−3.682	−1.4445	−0.693	6.28

CONCLUSION

Our investigation into the muscle relaxant and sedative effects of *E. crassipes* extracts has provided valuable insights into the complex relationship between dosage and response. While our study found that the muscle relaxant effects were not significant, the dose-dependent sedative responses shown by leaf (ERE), bulb (EBE) *and* root (ELE) extracts highlight the diverse therapeutic potential of different parts of the plant. Importantly, the recognition of *E. crassipes* as having sedative effects contributes to the wider range of herbal remedies for addressing stress-related conditions and sleep disturbances. Additionally, our computer-based screening, molecular docking studies *and* simulations have shed light on the potential interactions of *E. crassipes* compounds with COX-1 and COX-2 proteins. Orientin, in particular, has shown promising binding affinity, suggesting its role in modulating these enzymes. These findings collectively provide a comprehensive understanding of the pharmacological properties of *E. crassipes* and pave the way for further exploration of its therapeutic uses as muscle relaxants, sedatives *and* anti-inflammatory agents. The complex interaction between plant extracts and molecular targets forms a basis for ongoing research into harnessing the potential of herbal medicine for various health benefits.

Author contributions

All the authors actively participated in finalizing the manuscript. All authors reviewed and approved the final version of the manuscript for publication.

Conflicts of interest

Authors confirm that they have no conflict of interest

Data availability

Available upon request to corresponding author.

Ethical approval and consent to participate

The ethical committee of biological sciences of botany department, Islamia college Peshawar, Pakistan, granted authorization for the current work, which includes in vivo experiments using mouse models, under approval number 2014/ICP-1180.

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