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Synthesis, DFT Studies, Molecular Docking, and In Vitro Cytotoxic Evaluation of Schiff Bases as Potential Anti-Breast Cancer Agents

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ABSTRACT

In this study, three benzothiazole derived Schiff bases were prepared in good yield. The ^{1}HNMR, ^{13}CNMR, 2DNMR, mass and FTIR spectroscopy were used to characterize the suggested structures. Molecular docking studies of the prepared Schiff bases 1-3 against two aromatase inhibitor receptors, 5JL6 and 5JL7, were conducted. Binding energies were calculated, within the range -8.6 to -9.3 kcal/mol. Schiff bases 1 exhibited the best binding energies against receptors 5JL6 and 5JL7, at -8.9 and -9.3 kcal/mol respectively. The results of the in vitro cytotoxicity assay using the MTT against the MCF7 breast cancer cell line at various concentrations of the prepared compounds were consistent with the molecular docking results. The IC50 value of compound 1 was 33.96 µM against MCF-7, which is the lowest and closest to that of cisplatin 27.0 µM, which served as a reference. The DFT calculations showed that compound 1 had the lowest energy gap compared to the other prepared compounds. The theoretical polarizability calculations also revealed that compound 1 exhibited the highest polarizability value at 2.024 x10^{-24} esu, while compounds 2 and 3 had values at 1.933 x10^{-24} and 1.845 x10^{-24} esu, respectively.

1. Introduction

To date, breast cancer has been directly linked to one of the leading causes of cancer-related deaths among women. It has been observed that hormone-dependent types constitute a large proportion of diagnosed cases [1-3]. Overexpression of estrogen from androgen precursors has been shown to be directly associated with the development of estrogen receptor-positive breast cancers, and the aromatase enzyme plays a crucial role in the biosynthesis of estrogens from androgen precursors [4]. Consequently, aromatase inhibitors have become one of the established therapeutic strategies for managing postmenopausal breast cancer [5]. However, studies have shown that long-term use of present aromatase inhibitors, like letrozole and anastrozole, can lead to side effects, resistance, or incomplete inhibition of estrogen synthesis. These limitations have prompted the search for new, effective aromatase inhibitors with minimal side effects [6,7].

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In a related context, Schiff bases are among the important classes of chemical compounds known for their broad biological activity, and have proven effective as antioxidant, antibacterial, and anticancer agents [8-11]. Many Schiff base derivatives have received considerable attention, as the structural diversity of Schiff base, along with their ability to form coordinate bonds with metals and form various conformation, are unique properties that make them promising candidates in medicinal chemistry and docking studies targeting enzyme inhibitions such as aromatase [12,13]

In a related, Schiff bases a type of imine or azomethine compounds synthesis by condensation of primary amines with carbonyl compounds, have attracted increasing attention due to their wide range of biological activities, including antioxidant, antimicrobial, and anticancer properties[8-11]. The structural versatility of Schiff bases, along with their ability to coordinate metals and form varied tautomeric forms, construct them interesting candidates for medicinal chemistry and molecular docking studies pointed at enzyme inhibition [12,13].

The concept of polarizability has become increasingly important in the investigation and design of anticancer agents. It is believed that the ability of electrons to be distributed under the influence of external fields may enhance their interaction with targets receptors. Some recent studies have confirmed that polarizability, in conjunction with spatial parameters, has stronger influence on anticancer potency than lipophilicity. These findings underscore the importance of incorporating polarizability computation into predictive drug discovery models, as it provides mechanistic insights into docking and affinity, which are key to anticancer design [14-16].

In this study consider the electronic structure investigation of a series of Schiff bases using spectroscopic and computational methods, integrated by molecular docking study against two aromatase inhibitor receptor (5JL6, 5JL7) models related with breast cancer. The aim is to illustrate how structural features influence binding efficiency to aromatase active sites. This study may contribute provide a promotion for the design of novel Schiff base derived aromatase inhibitors with improved pharmacological profiles.

2. Experimental

2.1. Instrumentation and Materials

Infrared spectra were recorded as KBr spheres on a Buck-M500 spectrometer (Buck Scientific, USA). ^{1}H-NMR spectra were recorded on a Bruker-400 using DMSO-d_6 as a solvent and Tetramethylsilane (TMS) as an internal standard. Mass spectra were recorded on Electron Impact Mass Spectrometry (EIMS) an Agilent Technologies 5957C spectrometer.

All chemicals and solvents used were used without purification. Aromatic 2-amines- benzothiaol derivatives, and aldehydes were purchased from Sigma-Aldrich and AK scie. (USA) Solvents were dried and distilled prior to use according to standard procedures. Thin-layer chromatography (TLC) was performed on silica gel plates to monitor the reaction. Melting points were determined digitally and are uncorrected.

2.2. General procedure for prepared Schiff bases 1-3

Three benzothiazole derived Schiff bases 1-3 were prepared by protonating 2-hydroxy-1-naphthaldehyde dissolved in ethanol using glacial acetic acid, followed by mixing with an amine (2-amino-6-ethoxy benzothiazole, 2-amino-6-methoxy benzothiazole, and 2-amino benzothiazole) solution in ethanol .The procedure can be summarized as follows:

1mmol of 2-hydroxy-1-naphthaldehyde was dissolved in 10 mL of absolute ethanol with three drops of glacial acetic acid. In a 50 mL round bottom flask this was then gradually mixed with 1mmol of aminobenzothiazol derivatives in 15 mL of absolute ethanol, and allow the mixture to reflux for 3-26 hours with continuous stirring [16]. The reaction was monitored using TLC. After cooling, the product was filtered and recrystallized from a mixture of ethyl acetate and hexane (v/v3:2). Scheme 1. Display the pathway of synthesis of benzothiazole Schiff bases derivatives **1-3**.

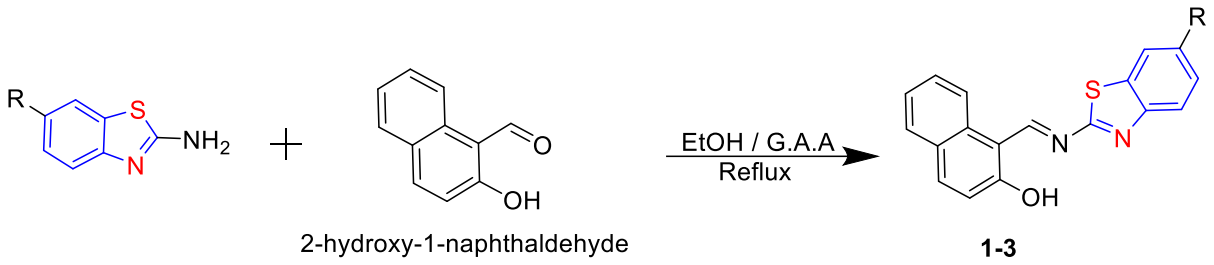

Fig. 1. Routs of prepared the benzothiazole derived Schiff bases 1-3.

2.2.1. Prepared of (E)-1-(((6-ethoxybenzo-thiazol-2-yl)imino)methyl)naphthalen-2-ol (1)

Orange solid. Yield: 76%, reaction time 16h, m.p: 229-232°C, FT-IR (KBr, cm^{-1}): O-H (3433), C–H aromatic (3064), C–H aliphatic (2924), CH=N (1599), C=C (1451), C–O (1264), C-N (1326), C-S (665) (supplementary materials: Fig S1). ^{1}H-NMR: (400MHz-DMSO-d_6) δ 13.76 (s, 1H), 9.94 (s, 1H), 8.79 (d, *J* = 8.5 Hz, 1H), 8.12 (d, *J* = 9.0 Hz, 1H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.86 (d, *J* = 8.9 Hz, 1H), 7.66 (t, *J* = 5.0 Hz, 2H), 7.47 (t, *J* = 7.5 Hz, 1H), 7.25 (d, *J* = 9.0 Hz, 1H), 7.12 (dd, *J* = 8.8, 2.6 Hz, 1H), 4.13 (q, *J* = 6.9 Hz, 2H), 1.39 (t, *J* = 6.9 Hz, 3H) .(supplementary materials: Fig S4). ^{13}C NMR (101 MHz, DMSO-d6) δ 169.76 (C=N), 135.24 (C-OH), 133.01 (Ar-C), 132.08 (Ar-C), 129.86 (Ar-C), 129.55 (Ar-C), 123.97 (Ar-C), (supplementary materials: Fig S7). MS m/z for $C_{20}H_{16}N_2O_2S$: 348 [M^+] (supplementary materials: Fig S10).

2.2.2. Prepared of (E)-1-((5-methoxybenzo-thiazol-2-yl)imino)methyl)naphthalen-2-ol (2)

Golden orang solid. Yield: 77%, reaction time 3h, m.p: 198-202°C, FT-IR (KBr, cm^{-1}): O-H (3432), C–H aromatic (3040), C–H aliphatic (2923), CH=N (1600), C=C (1552,1460), C–O (1264),C-N (1319), C-S (655 supplementary materials: Fig S2) . ^{1}H-NMR: (400MHz-DMSO-d6) δ 13.77 (s, 1H), 9.94 (s, 1H), 8.75 (d, *J* = 8.5 Hz, 1H), 8.12 (d, *J* = 9.0 Hz, 1H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.87 (d, *J* = 8.9 Hz, 1H), 7.71 – 7.62 (m, 2H), 7.47 (t, *J* = 7.4 Hz, 1H), 7.25 (d, *J* = 9.0 Hz, 1H), 7.13 (dd, *J* = 8.9, 2.6 Hz, 1H), 3.85 (s, 3H). (supplementary materials: Fig S5). ^{13}C NMR (101 MHz, DMSO-d6) δ 167.13(C=N), 164.82(C-O), 162.91(C-O), 157.80(C-S), 145.93 (N-C), 135.43 (Ar-C), 138.22 (N-C), 135.71 (Ar-C), 132.76 (Ar-C), 129.69 (Ar-C), 128.20(Ar-C), 124.81 (Ar-C), 124.16 (Ar-C), 123.23 (Ar-C), 122.28 (Ar-C), 116.34(Ar-C),110.24 (Ar-C). (supplementary materials: Fig S8). MS m/z for $C_{19}H_{14}N_2O_2S$: 334 [M^+] (supplementary materials: Fig S11).

2.2.3. Prepared of (E)-4-(((6-methoxybenzo-thiazol-2-yl)imino)methyl) benzonitrile (3)

Orange solid. Yield: 86%, reaction time 5h, m.p: 212-213°C, FT-IR (KBr, cm^{-1}): O-H (3433), C–H aromatic (3050), C–H aliphatic (2918), CH=N (1593), C=C (1550, 1420), C–O (1207), C-N (1316), C-S (662) (supplementary materials: Fig S3). ^{1}H-NMR: (400MHz-DMSO-d6) δ 13.74 (s, 1H), 9.98 (s, 1H), 8.76 (d, *J* = 8.5 Hz, 1H), 8.10 (dd, *J* = 14.0, 8.4 Hz, 2H), 7.97 (d, *J* = 8.1 Hz, 1H), 7.91 (d, *J* = 8.0 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.53 (t, *J* = 7.7 Hz, 1H), 7.45 (q, *J* = 8.5 Hz, 2H), 7.24 (d, *J* = 9.1 Hz, 1H). (supplementary materials: Fig S6). ^{13}C NMR (101 MHz, DMSO-d6) δ 167.31(C=N), 163.67(C-O), 151.71(C-S), 138.81(C-N), 134.29 (Ar-C), 132.81 (Ar-C), 129.74 (Ar-C), 129.49 (Ar-C), 128.21 (Ar-C), 127.23 (Ar-C), 125.68 (Ar-C), 124.90 (Ar-C), 122.93 (Ar-C), 122.89 (Ar-C), 122.41 (Ar-C), 119.85 (Ar-C), 110.27 (Ar-C). (supplementary materials: Fig S9).MS m/z for $C_{18}H_{12}N_2OS$: 304 [M^+] (supplementary materials: Fig S12).

2.3. Computational detail

2.3.1. Density functional theory

Density Functional Theory (DFT) calculations were performed to optimize the geometries of the prepared compound using the Gaussian 09 software package. The widely adopted hybrid function B3LYP was employed in conjunction with Pople's split-valence basis set 6-311(d,p) as a theoretical level. The highest occupied molecular orbital (HOMO) energy, lowest unoccupied molecular orbital (LUMO) energy, energy gap, and polarizability (α) of the optimized compounds were calculated.

2.3.2. Molecular docking

Molecular docking studies were conducted against aromatase inhibitors (PDB IDs: 6JL6 and 5JL7). AutoDock Tools 1.5.7-vina and Discovery Studio 2021 Client software were employed to performed a molecular docking studies. The binding energy between the studied compounds and their target receptors was calculated. The types of interactions that occurred to form the complex were also analysed.

The receptors were obtained from the Research Collaboratory for Structural Bioinformastics Protein Data Bank RCSB PDP website. The proteins (receptors) were prepared using a protein preparation steps by adding polar hydrogen atoms only and removing all the solvent, further improving performance.

3. Results and discussion

3.1. Chemistry

This study involved the prepared of three Schiff bases derived **1-3** from 2-amino-6-ethoxy benzothiazole, 2-amino-6-methoxy benzothiazole, and 2-amino benzothiazole reacting (each separately) with 2-hydroxy-1-naphthaldehyde. The FTIR, ^{1}HNMR, ^{13}CNMR, 2DNMR, and mass spectroscopy were used to characterize the suggested structures.

In the FTIR spectra of the prepared compounds the appearance of a stretching vibrational absorption for the azomethine group C=N at 1599, 1600, and 1593 cm^{-1}, respectively, indicating Schiff base formation. Furthermore, the presence of a substituent hydroxyl group at the ortho position on naphthaldehyde. Their spectra exhibited a distinct broad absorption band at 3432, 3433, and 3433 cm^{-1}, respectively, attributed to the stretching vibrational of the (O-H) group. A bending absorption band was also observed for the O-H group of compounds 2 and 3 at 1319 and 1316 cm^{-1}, respectively. However, the absence of stretching vibrations 3100–3400 cm^{-1} and around 1700 cm^{-1} rules out the presence of the $–NH_2$ and C=O functional groups in the analogy amines and aldehydes, respectively, and is therefore attributed to the formation of an azomethine group (–CH=N-). The disappearance of the modulus frequency of the reactants (primary amine and carbonyl) in the spectrum of the prepared compounds further confirms the identification of the proposed compounds.

The ^{1}HNMR spectra of all the prepared compounds **1-3** showed the signatures of their protons at the predicted chemical shifts. A distinct single signal for the imine proton appeared at 9.95, 9.94 and 9.98 ppm, $^{-1}$, respectively, confirming the formation of azomethine group in the compounds. A single signal of the hydroxyl group proton also showed a very high chemical shift towards the downfield at 13.76, 13.77 and 13.74 ppm, respectively. This signal is attributed to a strong intrinsic hydrogen bond between the hydroxyl group and the imine nitrogen atom, which stabilizes the enol-imine formula characteristic of this type of Schiff base derived from o-hydroxynaphthaldehyde. This bond had a significant effect on the imine group proton of these compounds, which exhibited a small shift towards the downfield.

^{13}CNMR spectra of the prepared compounds showed the expected signals according to the suggested structure, within the range of chemical shifts appropriate to the environment of each carbon and for all the prepared compounds. The imine carbon signal appeared in the range of 167–169 ppm.

The hetropolymer bonding (HMBC) experiment, a two-dimensional nuclear magnetic resonance (NMR) technique designed to detect long-range coupling between protons and carbons, typically involving two or three bonds, was performed. This technique is particularly effective in confirming

the presence of conjugated systems, hetrocyclic aromatic bonds, and functional groups such as imines (Schiff bases).

The HMBC spectrum (Fig. 2) of compound **1** showed cross-peaks at (9.94, 163.06), (9.94, 135), and (9.94, 123.45), with the proton and carbon-13 signals representing the imine group and the imine carbon with the naphthalol ring, respectively. Meanwhile, the CH_2 and CH_3 groups showed cross-peaks at (4.13, 15.14) and (1.39, 64.19), respectively, confirming the suggested structure of the compound.

The HMBC spectra of compounds 2 and 3 (Figs. 3 and 4) also showed cross-peaks at (9.94, 167.3), (9.94, 135.71), (9.94,110.24) and (9.98, 167.31), (9.98, 163.67), (9.98,134.29) respectively, attributable to the correlation between the imine proton, the imine carbon-13, and the naphthanol ring.

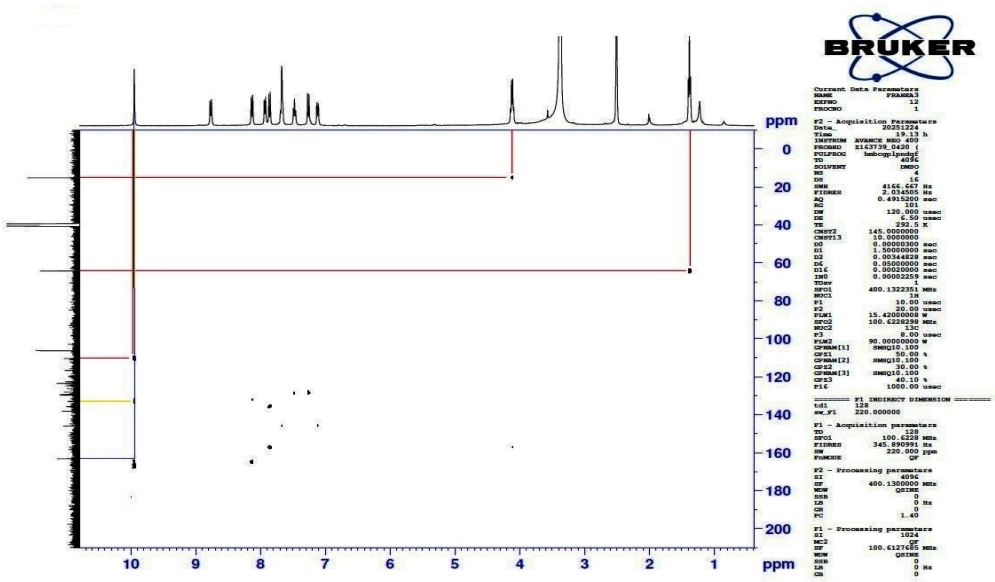

Fig. 1. HMBC spectrum of the prepared compound 1

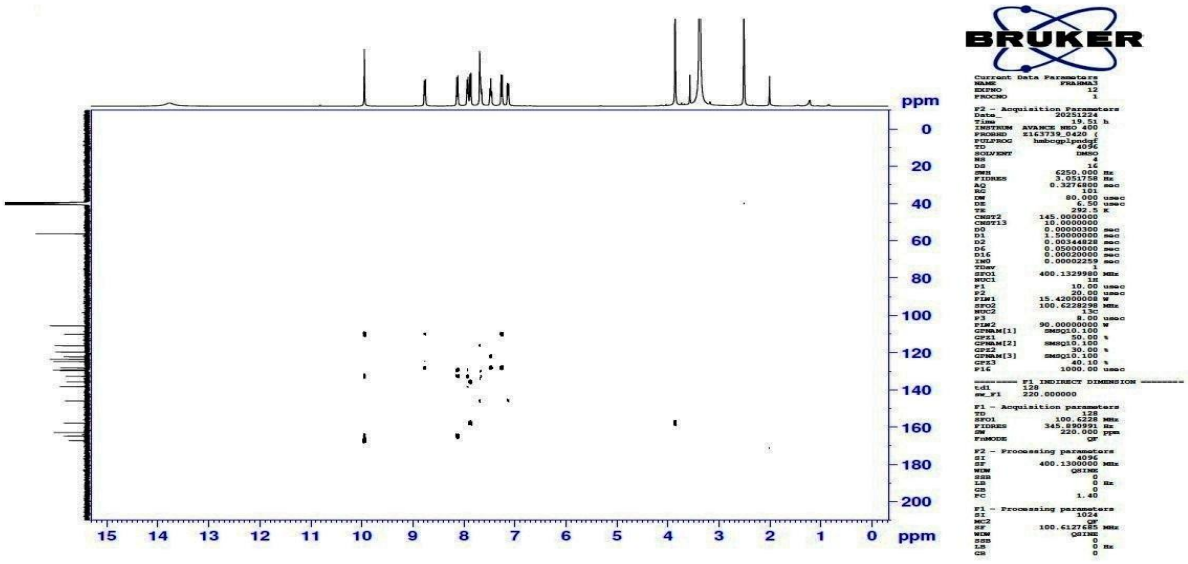

Fig. 2. HMBC spectrum of the prepared compound 2

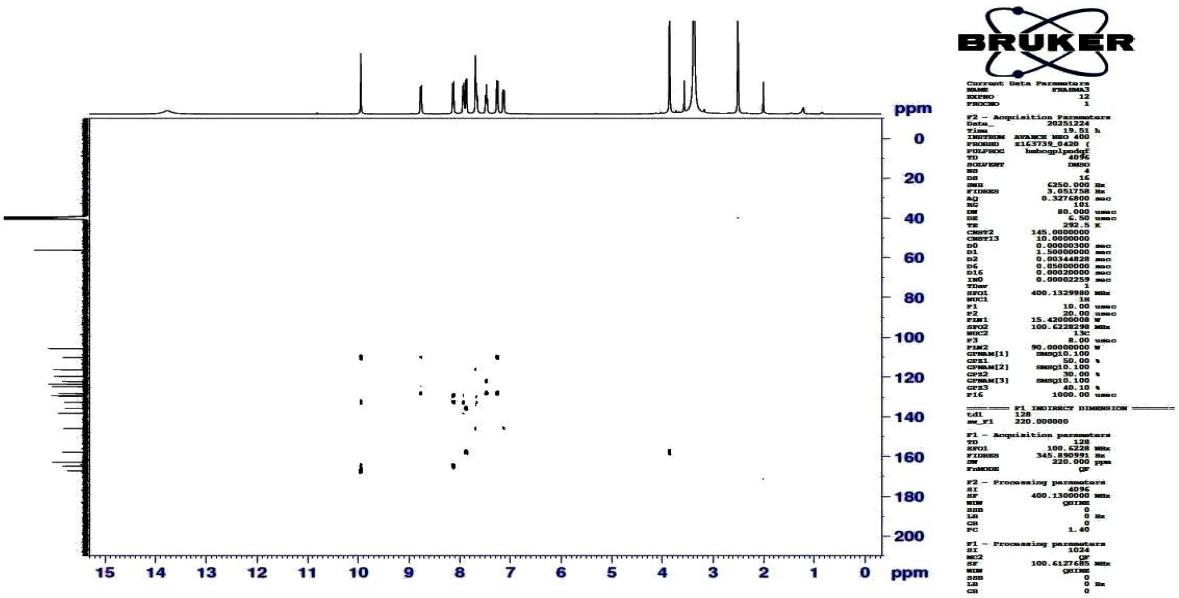

Fig. 3. HMBC spectrum of the prepared compound 3

3.2. Density Functional Theory DFT

All computational chemistry calculations were performed using density functional theory (DFT) with Pople's split-valence basis set 6-311(d,p) at the B3LYP level of theory. Geometric optimization was carried out for all prepared compounds, and the energies of the frontier molecular orbitals (HOMO and LUMO) were calculated to determine the energy gap (ΔE). The HOMO–LUMO analysis revealed that compound 1 possessed the lowest energy gap compared to compounds 2 and 3.

The biological activity of chemical compounds is directly related to their energy gap; a small value of the energy gap indicates high activity. The computational results show that the HOMO of prepared compound 1 is primarily located on the benzothiazole, indicating a high electron-donating ability, while the LUMO is distributed across the imine bond and the aromatic ring, suggesting potential sites of electrophilic attack.

The HOMO of compound 1 was localized primarily on the benzothiazole moiety, suggesting strong electron-donating capacity, while the LUMO was distributed over the imine linkage and aromatic ring system, indicating potential sites for electrophilic attack. This orbital distribution supports that compound 1 has a higher interaction activity with the active site of target receptors (aromatase) through π-π and hydrogen bonding interactions [17]. Furthermore, higher polarizability is often associated with increased biological activity, as it reflects the molecule's ability to adapt its electrons in response to the binding environment [18]. This was obtained from polarizability calculations that supported this hypothesis. The calculation results are listed in Table 1, while Fig. 4 show the HOMO, LUMO and energy gap, Fig. 5 represented the polarizability of compounds 1-3. Compound 1 show the highest polarizability at 2.024 x 10^{-24} esu, while compounds 2 and 3 at 1.933 x 10^{-24} and 1.845 x 10^{-24} esu, respectively.

Table 1. Calculation energy, HOMO, LUMO and polarizability of compounds 1-3

Comp.	Energ (a.u.)				μ(Debye)	polarizability (esu)
	Total energy	HOMO	LUMO	E_{gap}		
1	-1430.197	-0.20717	-0.09246	0.11471	2.073	2.024 x10^{-24}
2	-1390.87	-0.20840	-0.09306	0.11534	1.9602	1.933 x10^{-24}
3	-1276.317	-0.21857	-0.09735	0.12122	3.0879	1.845 x10^{-24}

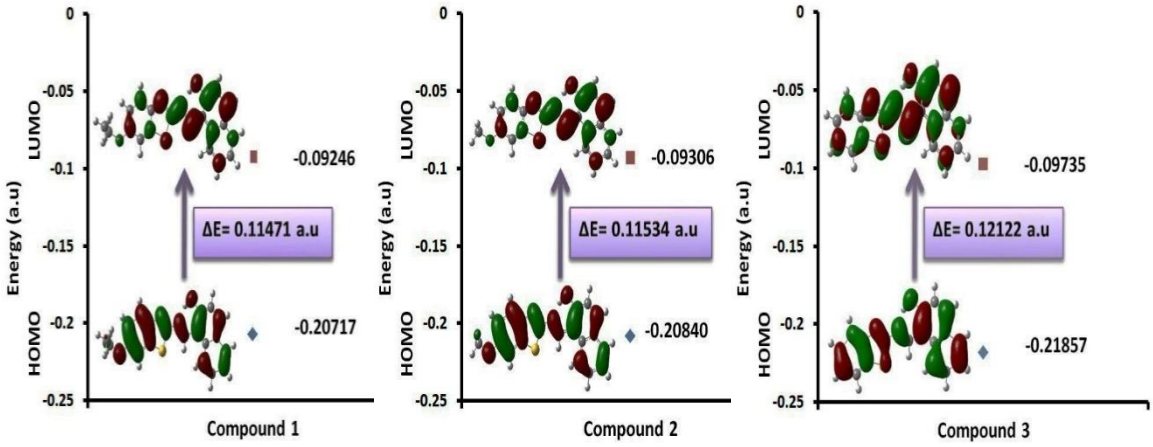

Fig. 4. Visual representation of the HOMO, LUMO and the energy gap

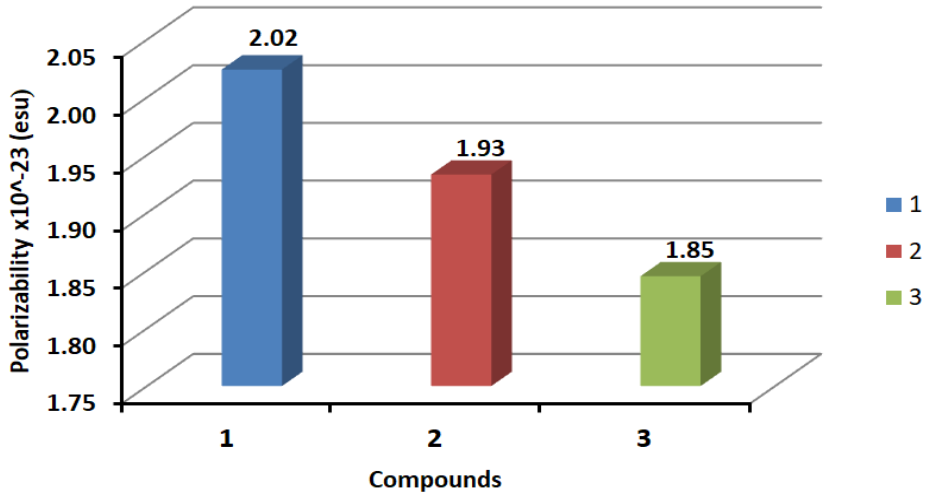

Fig. 5. The calculated polarizability value of compounds 1-3

3.3. Molecular docking study

Molecular docking is a computation technique that predicts the biological activity of chemical compounds via analysing there binding interaction between the studied compound (as a ligand) and its target receptor[19]. The inhibitory potential of a compound is determined by the nature and number of non-covalent interactions. Particularly hydrogen bond, van der Waals forces, electrostatic, hydrophobic, other non-covalent forces, and binding affinity, which collectively indicate its promise as a therapeutic candidate[20]. Re-docking of co-crystallized ligand into active sides of 5JL6 and 5JL7 receptors were performed in order to validate the molecular docking protocol. The values of RMSD (<2.0 Å) were within acceptable limits.

Molecular docking studies of the prepared compounds 1-3 against two aromatase inhibitor receptors, (PDB ID: 5JL6) and (PDB ID: 5JL7), were carried out. The binding affinity of the prepared compounds were calculated with two aromatase inhibitor protein receptors (5JL6 and 5JL7). Table 3 shows the molecular docking results, and Figures 6 and 7 illustrate the two and three-dimensional visual interactions of the prepared compounds with the target aromatase inhibitor receptors (5JL6 and 5JL7), respectively.

Binding energies were calculated, within the range -8.6 to -9.3 kcal/mol. Schiff bases 1 exhibited the best binding energies against receptors 5JL6 and 5JL7, at -8.9 and -9.3 kcal/mol respectively, supported by three hydrogen bonds with residues Cys437, Val370, and Thr310. Furthermore, 15 and

18 hydrophobic interaction with 5JL6 and 5JL7, respectively. These extensive interaction explain its superior docking score and correlate well with lowest IC50 value in MTT assays.
The combined results of the molecular docking confirm a clear structure-activity relationship: Compound 1 exhibits high binding strength, a well-established position in the simulations, and a wide range of non-covalent interactions, which explains its promising cytotoxic properties.

Table 2. Molecular docking results for the compounds 1-3 against the target aromatase inhibitors receptors 5JL6 and 5JL7

Comp.	5JL6						5JL7					
	AF kcal/mol	**No. HB**	**A.A**	**Å**	**Hyd**	**other**	**AF kcal/ mol**	**No. HB**	**A.A**	**Å**	**Hyd.**	**other**
1	-8.9	3	Cys437 Val370 Thr310	3.50 3.63 3.90	15	6 pi-S 5 vw	-9.3	3	Va;370 Cys437 Thr310	3.16 3.79 3.91	18	4 pi-S 7 vw
2	-8.7	3	Ser314 Cys437 Thr310	3.18 3.77 3.88	14	1 pi-S 1elec 6vw	-9.2	4	Val369 Val370 Met364 Thr310	3.21 3.19 3.75 3.97	12	4 pi-S 6 vw
3	-8.6	2	Thr310 Thr310	3.36 3.71	9	1 pi-S	-8.7	2	Phe427 Val422	2.96 4.16	6	1 elect 4vw

3.4. In vitro anti-cancer activity

The MTT method was tested in vitro at various concentrations (0.03, 0.1, 0.3, 1, 3, 10,30 and 100 µM) of prepared compounds **1-3** and cisplatin against the MCF-7 breast cancer cell line. The results of the IC_{50} calculation are listed in Table 3. Figure 8 show the results of the cytotoxicity test using the MTT method against the MCF-7 breast cancer cell line. The results indicate that compound **1** is a promising candidate as a breast cancer inhibitor, with an IC_{50} value of 33.96 µM, which is close to that of cisplatin 27 µM, which served as a reference. The in vitro cytotoxicity test results were consistent with the theoretical results and the molecular docking results. The theoretical results, molecular docking, and cytotoxicity tests provide strong agreement regarding a correlation between polarizability and the anticancer activity of the prepared compounds.
This variation in response is consistent with molecular docking findings with aromatase inhibitory receptors (5JL6 and 5JL7), suggesting that the compound's mechanism of action may be linked to hormone-dependent pathways and highlighting its potential as a candidate for targeted therapy in estrogen receptor-positive breast cancer[21-23].

Table 3. MTT assay results (IC_{50} in µM) of prepared compounds 1-3

Comps.	**IC_{50} (µM) MCF7**
1	33.96
2	35.32
3	41.26
Cisplatin	27.00

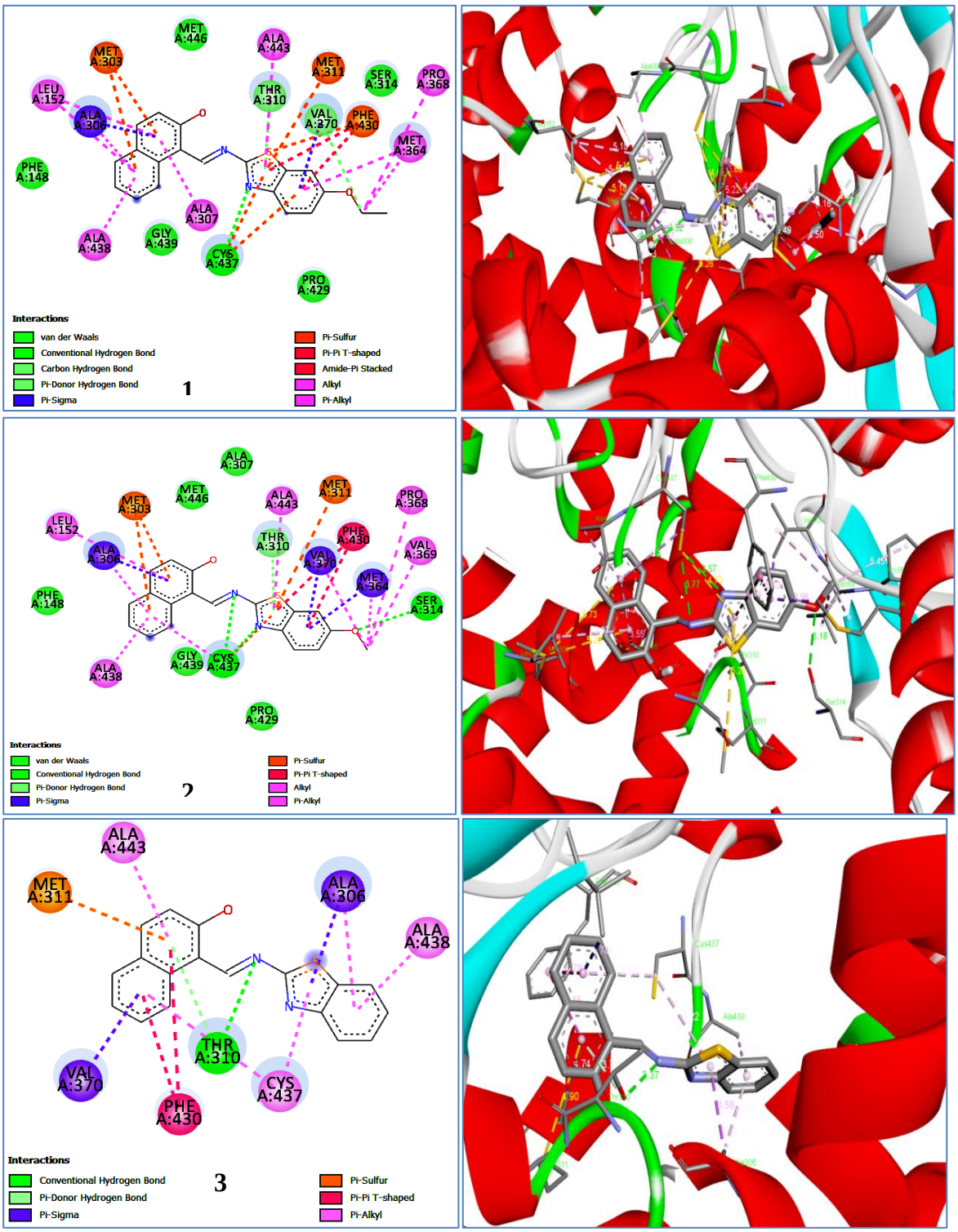

Fig. 6. 2D and 3D visual docking results of prepared compounds 1-3 against the target aromatase inhibitors receptor 5JL6

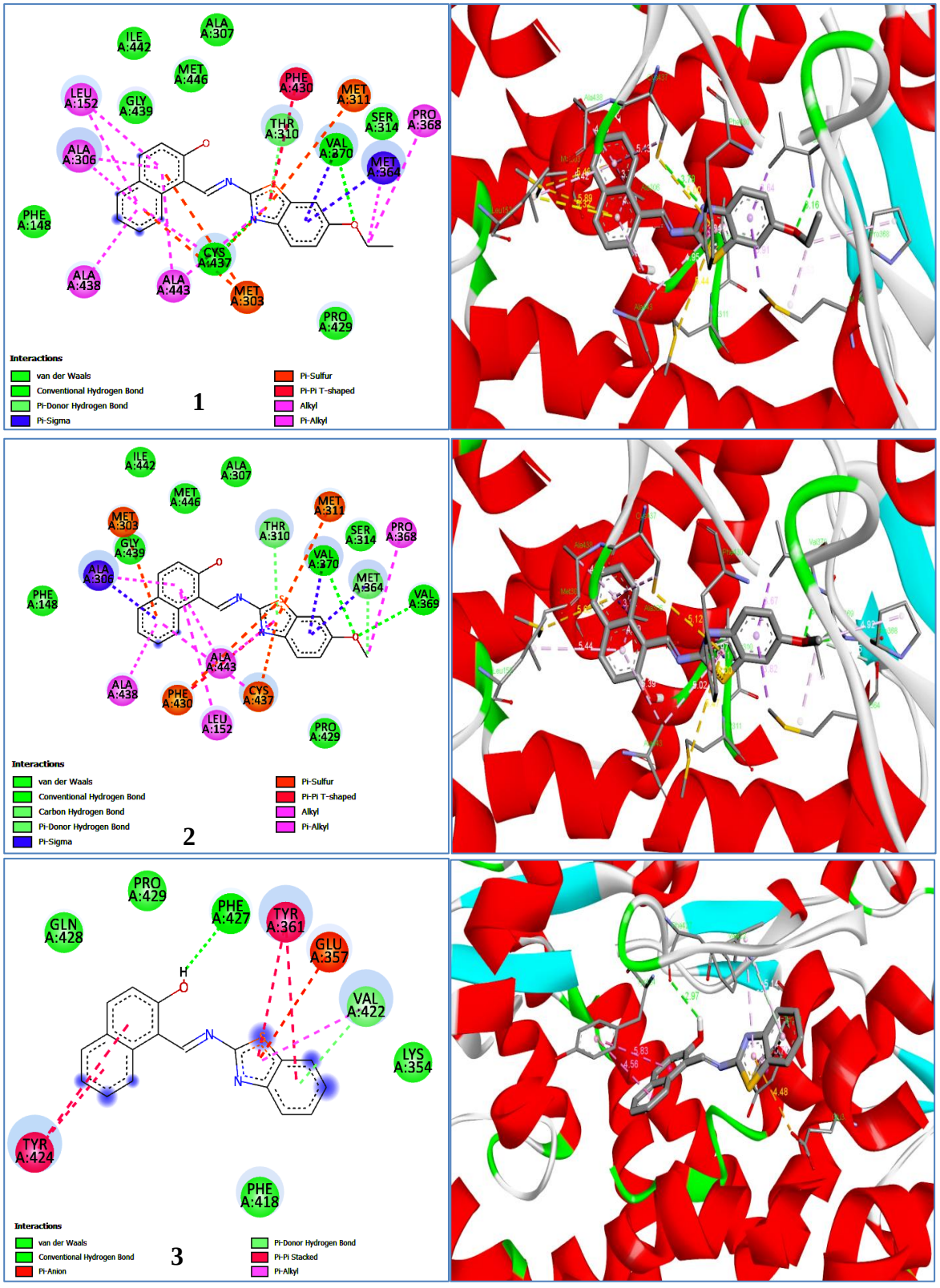

Fig. 7. 2D and 3D visual docking results of prepared compounds 1-3 against the target aromatase inhibitors receptor 5JL7

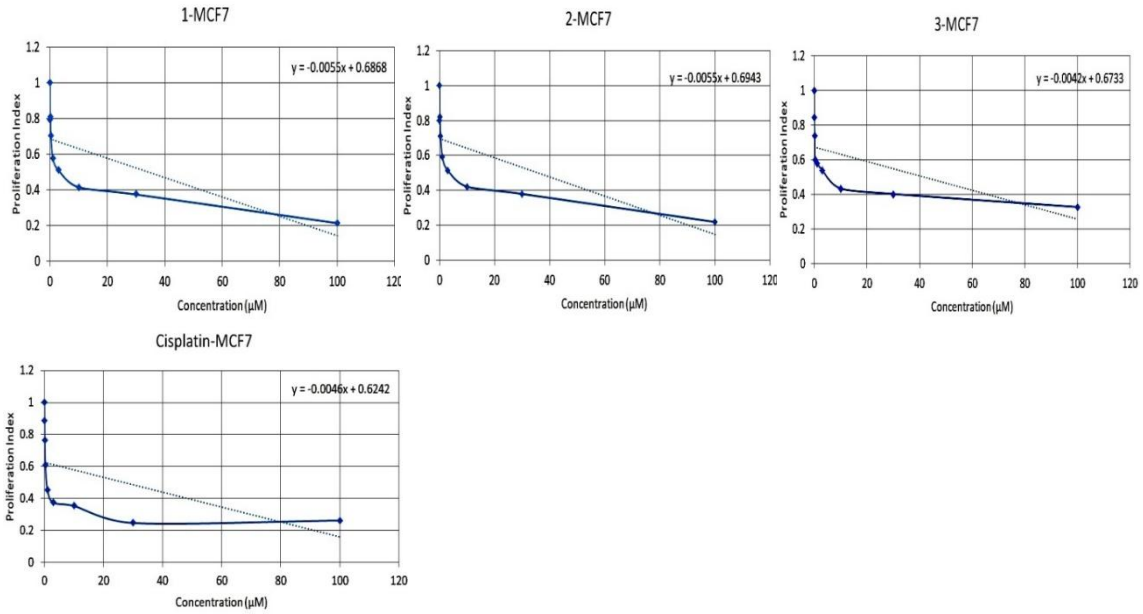

Fig. 8. MTT assay results of prepared compounds 1-3 and cisplatin against MCF-7 cell line

4. Conclusion

Three Schiff bases were synthesized and characterized using spectroscopic techniques, then evaluated through molecular docking and in vitro cytotoxicity assays. Compound 1 show the best binding affinity against receptors 5JL6 and 5JL7, at -8.9 and -9.3 kcal/mol respectively, supported by three hydrogen bonds with residues Cys437, Val370, and Thr310. Furthermore, 15 and 18 hydrophobic interaction with 5JL6 and 5JL7, respectively. These extensive interaction explain its superior docking score and correlate well with lowest IC_{50} value in MTT assay against MCF-7 cell line at 33.96 µM, which is very close to cisplatin. The theoretical results, molecular docking, and cytotoxicity tests provide strong agreement regarding a correlation between polarizability and the anticancer activity of the prepared compounds. The results indicate that compound 1 is a promising candidate as a breast cancer inhibitor.

Acknowledgement

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Appendix A.

Supplementary data

References

[1] F. Laversanne, M. Sung, H. Ferlay, J. Siegel, R. L. Soerjomataram, I., and A. Jemal, "Global cancer statistics : GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries", *CA: A Cancer Journal for Clinicians*, vol. 74, issue 3, pp. 229–263, 2022.DOI: https://doi.org/10.3322/caac.21834Digital Object Identifier (DOI)

[2] N. Harbeck, F. Penault-Llorca, J. Cortes, M. Gnant, N. Houssami, P. Poortmans, K. Ruddy, J. Tsang, and F. Cardoso, "Breast cancer," *Nature Reviews Disease Primers*, vol. *5*, issue 1, Article 66, 2019. DOI: https://doi.org/10.1038/s41572-019-0111-2.

[3] A. M. Dhumad, A. M. Jassim, R. A. Alharis, F. A. Almashal, "Design, cytotoxic effects on breast cancer cell line (MDA-MB 231), and molecular docking of some maleimide-benzenesulfonamide derivatives," *Journal of the Indian Chemical Society*, vol. 98, issue 4, pp. 100055, 2021. DOI: https://doi.org/10.1016/j.jics.2021.100055.

[4] A. Subramanian, M. Salhab, K. Mokbel, "Oestrogen producing enzymes and mammary carcinogenesis: a review," *Breast Cancer Res Treat*, vol. 111, pp.191–202 2008. DOI: https://doi.org/10.1007/s10549-007-9788-0

[5] S. Patel "Disruption of aromatase homeostasis as the cause of a multiplicity of ailments: a comprehensive review," *J Steroid Biochem Mol Biol*, vol. 168, pp. 19–25, 2017. DOI:https://doi.org/10.1016/j.jsbmb.2017.01.009

[6] S. Zhang Q., S. Jia, X. Li, R. Hu, Z. Luo, J. Wang and H. Xi, "Adverse events associated with aromatase inhibitors: an analysis of real-world datasets and drug-gene interaction network," *Expert Opinion on Drug Safety*, vol. 24, issue 3, pp. 315–324, 2025. DOI: https://doi.org/10.1080/14740338.2024.2424443

[7] A. Edith Perez, "The balance between risks and benefits: Long-term use of aromatase inhibitors," *European Journal of Cancer Supplements*,Vol. 4, Issue 9, pp. 16-25, 2006. DOI: https://doi.org/10.1016/j.ejcsup.2006.06.003.

[8] M. Shahzad Lodhi, M. Bibi, G. Kök, H. Muzzammel Rehman, S. Sharif, Y. Salman, M. Sajjad, E. Ali, R. Ullah, G. Ali, A. Alotaibi, E. Halay, "Synthesis, characterization, and In vitro Anti-cancer Studies of Triazine Core Schiff Base against Breast Cancer," *Journal of Molecular Structure*, vol. 1339, pp. 142343, 2025.DOI: https://doi.org/10.1016/j.molstruc.2025.142343.

[9] P. Kalaria, S.Karad, D.Raval, "A review on diverse heterocyclic compounds as the privileged scaffolds in antimalarial drug discovery," *European Journal of Medicinal Chemistry*, vol. 158, pp. 917-936, 2018. DOI: https://doi.org/10.1016/j.ejmech.2018.08.040.

[10] D. Qassim Kamil, A. Hussein Wasmi, W. Abed AL Hassan Alhaidry, M. Kassim Al-Hussainawy, H. Ali Kadhim Kyhoiesh, "Synthesis, molecular docking, ADMET profiling, and anti-PC3 activity of new Schiff base derivatives," *Results in Chemistry*, vol. 12, pp.101916, 2024. DOI:https://doi.org/10.1016/j.rechem.2024.101916

[11] K. Gupta, A. Kumar Sirbaiya, V. Kumar, M. Azizur Rahman, "Current Perspective of Synthesis of Medicinally Relevant Benzothiazole based Molecules: Potential for Antimicrobial and Anti-InflammatoryActivities," *Mini-Reviews in Medicinal Chemistry*; Vol. 22, Issue 14, 2022. DOI: https://doi.org/10.2174/1389557522666220217101805.

[12] F. Abdulkareem Almashal, M. Qasim Mohammed, Q. M. Ali Hassan, C.A. Emshary, H.A. Sultan, A. Muala Dhumad, "Spectroscopic and thermal nonlinearity study of a Schiff base compound," *Optical Materials*, Vol. 100, pp. 109703, 2020. DOI: https://doi.org/10.1016/j.optmat.2020.109703.

[13] P. Marinova, P. Tamahkyarova, "Synthesis, Investigation, Biological Evaluation, and Application of Coordination Compounds with Schiff Base—A Review" *Compounds*., vol. 5, issue 2, pp.14, 2025. DOI: https://doi.org/10.3390/compounds5020014

[14] K. Francis, K. Mawa, L. Ekossias, B. Digre, N. Camille, and G. Stephane, "Quantitative Structure Activity Relationship (QSAR) Anticancer Modeling of the MCF-7 Cell Line of Phthalocyanine Derivatives," *International Research Journal of Pure and Applied Chemistry*, vol. 26, issue 6, pp. 98-109, 2025. DOI: https://doi.org/10.9734/irjpac/2025/v26i6962.

[15] R. Verma and C. Hansch, "Cytotoxicity of Organic Compounds against Ovarian Cancer Cells: A Quantitative Structure−Activity Relationship Study," *Molecular Pharmaceutics* vol. 3, issue 4, pp. 441-450, 2006. DOI: https://doi.org/10.1021/mp050110i

[16] P. Duan, Sh. Li, N. Ai, L. Hu, W. Welsh, and G. You, "Potent Inhibitors of Human Organic Anion Transporters 1 and 3 from Clinical Drug Libraries: Discovery and Molecular Characterization," *Molecular Pharmaceutics*, vol. 9, issue 11, pp. 3340-3346, 2012. DOI: https://doi.org/10.1021/mp300365t

[17] A. Majeed Jassem, A. Muala Dhumad, J. Khudhair Salim, H.Abdalsamad Jabir, "An alternative technique for cyclization synthesis, in vitro anti-esophageal cancer evaluation, and molecular docking of novel thiazolidin-4-one derivatives," *Journal of Molecular Structure*, vol. 1280, pp. 135079, 2023. DOI: https://doi.org/10.1016/j.molstruc.2023.135079.

[18] H. Tandon, P. Ranjan, T. Chakraborty, and V. Suhag, " Polarizability: a promising descriptor to study chemical–biological interactions," *Mol Divers*, vol. 25, pp. 249–262, 2021. DOI: https://doi.org/10.1007/s11030-020-10062-w.

[19] A. M. Jassem, and A. M. Dhumad, "Synthesis, Antimicrobial Activity, Anti-HIV Activity, and Molecular Docking of Novel 5-, 6- and 7-Membered Ring (1 H -Pyrrol-2-yl)aminolactams," *Chemistry Select*, vol. 6, issue 10, pp. 2641-2647, 2021. DOI: https://doi.org/10.1002/slct.202004755

[20] R. Jerome de, B. Guillaume, B. Ralf, L. Marc, "Molecular docking as a popular tool in drug design, an in silico travel," *Advances and Applications in Bioinformatics and Chemistry*, vol. 9, pp. 1-11, 2016. DOI: https://doi.org/10.2147/AABC.S105289.

[21] Z. K. Shaheen, A. A. Al-Ali, S. A. Al-Asadi, "Anti-cancer activity of lavender oil and Newcastle disease virus on human glioblastoma: an in vitro study," Journal of Basrah Researches (Sciences), vol. 49, issue 1, pp.1-12, 2023. DOI: https://doi.org/10.56714/bjrs.49.1.1

[22] Fatima A. Ahmed and Dakhil Mutlaq, "Synthesis and anti-breast cancer activity of some succinimide derivatives via Michael addition reaction: arylhydrazide to maleimides," Journal of Basrah Researches (Sciences), vol. 50, issue 2, pp.28-197, 2024. DOI: https://doi.org/10.56714/bjrs.50.2.24.

[23] Z. Saleem Zami, M. Mohammed Nasri, A. Abd-Aljaleel Nsaif, N. AL-Huda Salah AL-Zuhairy , Kh. Fahim Muhsin, Sh. Mazin Abdulsahib Al-khafaji, "Therapeutic Role of Coenzyme Q10 in Male Infertility: A Semen Analysis-Based Study," Journal of Basrah Researches (Sciences), vol. 50, issue 2, pp.141, 2025. DOI: https://doi.org/10.56714/bjrs.51.2.11.

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تحضير، ودراسات دالية الكثافة والارساء الجزيئي ، وتقييم السمية الخلوية في المختبر لقواعد شيف كعوامل محتملة مضادة لسرطان الثدي

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الملخص

في هذه الدراسة حضرت ثلاث قواعد شف مشتقة من البنزوثايوزول بحصيلة جيدة. شخصت المركبات المحضرة بالطرق الطيفية ^{1}HNMR, ^{13}CNMR, 2DNMR, FTIR ومطيافية الكتلة. اجريت دراسة الارساء الجزيئي للمركبات المحضرة مع مستقبلين مثبط الاروماتيز. حسبت قيم طاقات الارتباط حيث كانت بين 9.3- و 8.6- كيلوسعرة لكل مول. اعطى المركب 1 اقل قيمة لطاقة الارتباط عند 9.3- و 8.6- كيلوسعرة لكل مول. تطابقت نتائج السمية الخلوية المقاسة مقابل خلايا سرطان الثدي مع نتائج الارساء الجزيئي, اذ اعطى المركب 1 اقل قيمة لل IC50 عند 33.96 µM وهي قريبة من قيمتها للسسزبلاتين المركب المعروف باستخدامه في علاج السرطان. كما اظهرت نتائج الحسابات النظرية باستخدام دالية الكثافة ان المركب 1 لديه اقل فجوة طاقة مقارنة بالمركبين الاخرين ما يؤشر فعالية عالية قياساً مع المركبات الاخرى. كذلك كانت قيمة قابلية الاستقطاب للمركب 1 هي الاعلى عند 10-24 x 2.024 . تدعم نتائج الحسابات النظرية نتائج الارساء الجزيئي و اختبارات السمية الخلوية وهذا ما يجعل المركب 1 مرشح واعد لتثبيط سرطان الثدي.

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