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ARTICLE

Design, synthesis, molecular docking, and biological evaluation of novel selenium containing lumefantrine analogues

Divyaraj Puthran[1,2] | **Boja Poojary**[1] | **Soukhyarani Gopal Nayak**[1] | **Nikil Purushotham**[1] | **Mohammed Shafeeulla Rasheed**[3] | **Hemant Hegde**[4]

[1]Department of Studies in Chemistry, Mangalore University, Mangalagangotri, Karnataka, India

[2]Process Development Laboratory, Solara Active Pharma Sciences, Ltd, Mangaluru, Karnataka, India

[3]Department of Chemistry, Sahyadri Science College, Shivamogga, Karnataka, India

[4]Department of Chemistry, Manipal Academy of Higher Education, Manipal, Karnataka, India

Correspondence
Boja Poojary, Department of Studies in Chemistry, Mangalore University, Mangalagangotri 574199, Karnataka, India.
Email: poojaryboja@gmail.com

Abstract

A new series of 1-(9-benzylidene-2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl) ethanol was synthesized by a simple Knoevenagel condensation of 1-(2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol with different substituted aromatic aldehydes in basic media. These synthesized compounds were confirmed on the basis of their elemental analyses, infrared (IR), ^{1}H NMR, ^{13}C NMR, and mass spectral data and screened for the antibacterial and antifungal activity. The preliminary antibacterial and antifungal screening revealed that the compounds **8c** (dichloro), **8d** (fluoro), **8e** (chloro), **8i** (methoxy), and **8l** (methyl) displayed moderate to good activity. The antibacterial results of these compounds were further supported by *in silico* molecular docking studies, for the inhibition of *Escherichia coli MurB* enzyme (PDB code: 2MBR), wherein they showed higher binding energy and good affinity towards the active pocket of the enzyme compared with that of the standard drug Ciprofloxacin. Thus, the plausible mechanism of their antibacterial activity was owed to their inhibitory action of the bacterial *MurB* enzyme.

1 | INTRODUCTION

The literature on organo-selenium compounds showed that their structures are similar to those of organo-sulfur compounds, but they vary significantly in their properties. Because of hazardous properties and tremendously nasty odor of organo-selenium compounds, they have not been well-explored. However, organo-selenium compounds have been reported as active antibacterial, antiviral, antifungal, antiparasitic, anti-inflammatory, antihistamine agents.[1–3]

In this perspective, an enormous variety of organo-selenium derivatives were studied for their *in vivo* and *in vitro* activity against a lane variety of microorganisms in the recent decades.[4,5] Since bacteria develop resistance to antibiotics, the study needs novel strategies and innovative drugs or known biologically active compounds on innovative targets.[6] Various diselenides, as well as selenium nanoparticles have shown extremely interesting antibiofilm activity, highlighting their potential in the medical application or in prolonging the shelf life of food products.[7] Some of the antimicrobial seleno-organic compounds known in the literature, such as 2-phenylbenzo[*d*][1,2]selenazol-3(2*H*)-one (1), 2-phenylbenzo[*d*][1,2]selenazol-3(1*H*)-one-1-oxide (2), (3*R*)-3,7-dimethyl-2-(phenylselanyl)oct-6-enal (3), (3*R*)-3,7-dimethyl-2-(phenylselanyl)oct-6-en-1-ol (4), 1-isopropyl-3-methyl-1*H*-benzo[*d*]imidazole-2(3*H*)-selanone (5) and 1,3-bis(4-methoxybenzyl)tetrahydropyrimidine-2(1*H*)-selanone (6) are represented in Figure 1.[6,8,9]

Lumefantrine was introduced in Nigeria in 2005 as the first-line antimalarial[10] drug for the treatment of

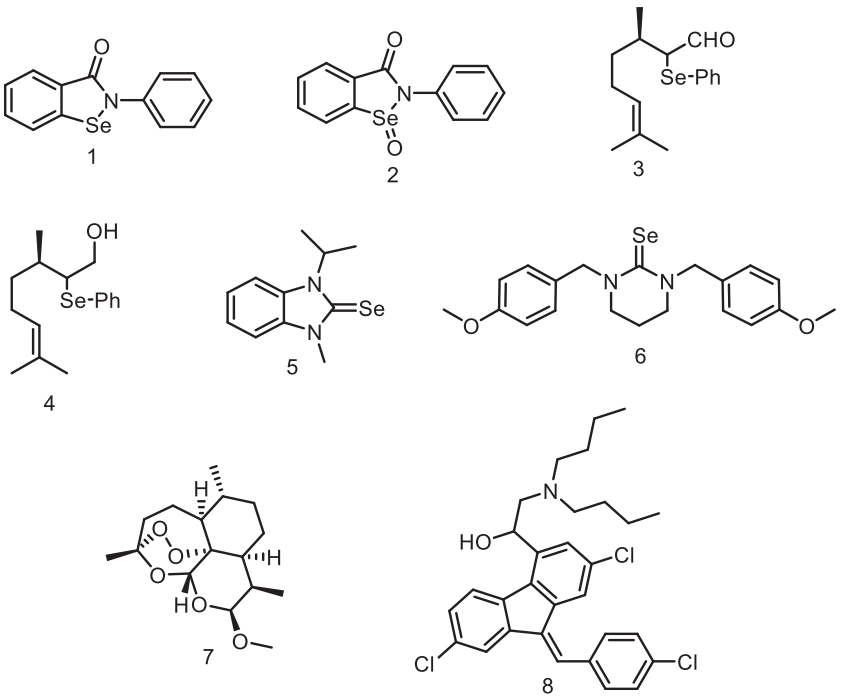


FIGURE 1 Structures of some antimicrobial organo-selenium compounds (**1**–**6**) and the antimalarial drugs Artemether (**7**) and Lumefantrine (**8**)

uncomplicated malaria. The drug was a fixed combination of Artemether and Lumefantrine in the ratio 1:6 (20 mg Artemether: 120 mg Lumefantrine). Artemether is chemically known as 3*R*, 5a*S*, 6*R*, 8a*S*, 9*R*, 10*S*, 12*R*, 12a*R*-decahydro-10-methoxy-3,6, 9-trimethyl-3,12-epoxy-12*H*-pyrano[4,3-j]-1,2-benzodioxepin (**7**). Lumefantrine is chemically known as (1*R*,*S*)-2-dibutylamino-1-{2,7-dichloro-9-[(*Z*) (4-chlorobenzylidene)-9*H*-fluoren-4-yl}-ethanol (**8**).[11–15] The above structures of seleno-organic compounds (**1**-**6**) and the structures of Artemether (**7**) and Lumefantrine (**8**) are shown below in Figure 1.

The foremost intention of this study is to invent new chemotherapeutic agents against bacterial strains using an array of substituted aromatic compounds which is an abridgment of selenium-containing Lumefantrine analogs based on the literature. Consequently, we hereby present the synthesis, spectral characterization, molecular docking studies, and antimicrobial evaluation of novel selenium-containing Lumefantrine skeletal-based polycyclic aromatic compounds.

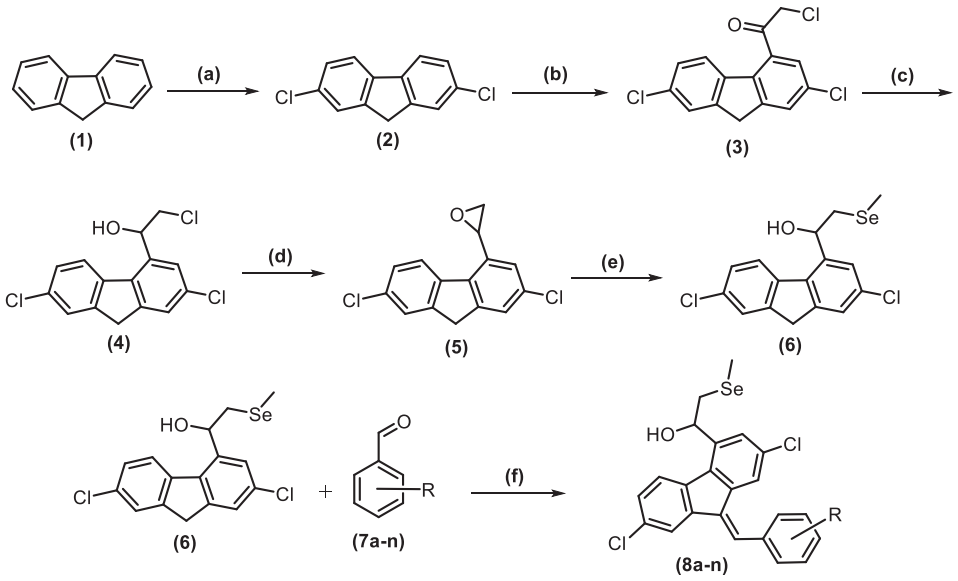
2 | RESULTS AND DISCUSSION

2.1 | Chemistry

The synthetic procedure for the aimed derivatives (**8a**-**n**) is represented in Scheme 1. The current way starts with the chlorination of 9*H*-fluorene in acetic acid at 40 °C to 42 °C. The process was not choosy. In addition to the required 2,7-isomer (**2**), large amounts of 2,5-dichloro-9*H*-fluorene with monochlorinated and trichlorinated compounds are also formed simultaneously. However, by applying controlled acetic acid crystallization conditions, compound (**2**) can be isolated in pure form. The Friedel-Craft chloroacylation of compound **2** was performed by adding a solution of compound **2** in dichloromethane at 0 °C to 5 °C to a suspension of aluminum chloride and chloroacetyl chloride in dichloromethane.[16] The reaction mixture was quenched with dilute hydrochloric acid, and after phase separation and washing, dichloromethane was distilled off and replaced by methanol. The reaction mass was chilled to 5 °C to 10 °C, and compound **3** was isolated in 94% yield by filtration and drying. In the conversion of compound **3** to compound **5**, the intermediate chlorohydrins **4** was not isolated but was transformed *in situ* to epoxide **5**. The reduction was carried at 0 °C to 5 °C by adding sodium borohydride to a suspension of compound **4** in methanol. Excess of sodium borohydride was then destroyed by heating the reaction mixture for 2 hours at 50 °C to 55 °C. Sodium hydroxide was added in portions, and continued stirring the reaction mixture for another 1 hour at 50 °C to 55 °C. Upon cooling the reaction mixture to 5 °C to 10 °C and the adjusting the pH using acetic acid, compound **5** was isolated in 86% yield by filtration and drying.[17]

The synthetic method involves convenient, commercial, and simple process for the ring opening of epoxides with nucleophilic selenium species. That is, 2-(2,7dichloro-9*H*-fluoren-4-yl)oxirane (**5**) was converted to 1-(2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)

SCHEME 1 Synthetic strategy for the formation of compounds (**8a-n**)



ethanol (**6**) in presence of dimethyl diselenide and sodium borohydride. Then, the target products (**8a-n**) were obtained in good yield by treating intermediate **6** with substituted aromatic aldehydes (**7a-n**) in presence of a base by Knoevenagel condensation.

The Fourier-transform infrared (FTIR) spectrum of compound **6** exhibited a broad band centered at 3447 cm^{-1} as a resultant to O—H functional group. Two sharp bands at 2920 and 1597 cm^{-1} were assigned to C—H and C═C stretchings correspondingly. Bands at 1051 and 767 cm^{-1} were assigned to C—O and C—Cl bonds in accordance with the functional groups of the structure. The ^{1}H NMR spectrum of compound **6** in DMSO-d_6 showed a singlet integrating to three protons of the —Se—CH_3 group at δ 1.95 ppm. A multiplet of two protons for the Se—CH_2 group was observed at δ 2.88 to 2.90 ppm. A singlet of two protons at δ 3.99 ppm was observed for the active methylene protons. A multiplet at δ 5.44 to 5.46 ppm was observed for the CH protons. A doublet centered at δ 5.88 ppm appeared for the OH proton. Multiplet in the range of δ 7.55 to 7.88 ppm were assigned for the five aromatic protons. Its mass spectrum showed a molecular ion peak at *m/z* 370.8 $[M-H]^-$, which in turn confirmed the formation of the compound having the molecular formula $C_{16}H_{14}Cl_2OSe$.

Formation of the compound **8e** was confirmed by recording their IR, ^{1}H NMR, ^{13}C NMR, and mass spectra. IR analysis of compound **8e** displayed a band at 3394 cm^{-1} because of the OH group. Presence of (Ar—H) and (C═C) groups were confirmed by the presence of sharp bands at 2922 and 2359 cm^{-1}, respectively. Finally, the presence of the (C—Cl) group was confirmed by a sharp band at 775 cm^{-1}. The ^{1}H NMR spectrum of compound **8e** in DMSO-d_6 showed singlet at δ 1.95 ppm corresponding to three protons of the —Se—CH_3 group. Multiplet recorded at δ 2.88 to 2.92 ppm was because of the three protons of the —CH_2 group. Multiplet observed at δ 5.44 to 5.48 ppm was assigned to one proton of the —CH group. Doublet showed at δ 5.94 to 5.95 ppm was because of one proton of the —OH group. The formation of compound **8e** was also confirmed by the presence of characteristic singlet at δ 7.31 ppm, corresponding to ═CH proton. Six aromatic protons appeared as a multiplet in the range of δ 7.53 to 7.62 ppm. Remaining aromatic protons appeared at δ 7.84, 8.12, and 8.17 ppm as a doublet, singlet, and singlet, respectively. The mass spectrum of compound **8e** showed a molecular ion peak at *m/z* 493.1 $[M-H]^-$. This, in turn, confirmed the formation of the compound **8e** having the molecular formula $C_{23}H_{17}Cl_3OSe$. The spectral data of other compounds (**8a-n**) are given in the Supplementary information. The physical properties of synthesized compounds are listed in Table 1.

8a: R = H; **8b**: 4-Br; **8c**: R = 2,3-$(Cl)_2$; **8d**: R = 4-F; **8e**: R = 4-Cl; **8f**: R = 4-C_6H_5; **8g**: R = 2,4-$(OH)_2$; R = 4-N$(CH_3)_2$; **8i**: R = 2,3,4-$(OCH_3)_3$; **8j**: R = 3,4-$(OCH_3)_2$; **8k**: R = 3-OH-4-OCH_3; **8l**: R = 3,4-$(CH_3)_2$; **8m**: R = 2,4,6-Cl_3; **8n**: 2-OH;

Reagents and conditions: (a) Chlorine gas in acetic acid at 40 °C to 42 °C (b) Aluminum chloride, chloroacetyl chloride, 0-5 °C (c) $NaBH_4$, methanol, 0 °C to rt (d) NaOH, methanol, reflux (e) Dimethyl diselenide, $NaBH_4$, MeOH (f) NaOH, MeOH, reflux.

2.2 | Antimicrobial studies

Zone of inhibition values (mm) of the compounds (**8a-n**) against the tested microorganisms are represented in

TABLE 1 Characteristic data of 1-[(9)-2,7-dichloro-9-(substitutedphenylmethylidene)-9*H*-fluoren-4-yl]-2-(methylselanyl)ethanol (**8a-n**)

Compound	R	% Yield	Melting Point, °C
8a	H	83	128-132
8b	4-Br	75	153-157
8c	2,3-$(Cl)_2$	86	182-184
8d	4-F	88	134-137
8e	4-Cl	79	178-179
8f	4-C_6H_5	92	185-188
8g	2,4-$(OH)_2$	88	151-153
8h	4-$N(CH_3)_2$	72	159-165
8i	2,3,4-$(OCH_3)_3$	71	193-196
8j	3,4-$(OCH_3)_2$	79	183-185
8k	3-OH-4-OMe	60	136-140
8l	3,4-$(CH_3)_2$	86	172-173
8m	2,4,6-$(Cl)_3$	80	195-197
8n	2-OH	70	135-138

Table 2. The antimicrobial property of the newly synthesized 1-(2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol derivatives (**8a-n**) were tested against bacterial and fungal strains, which were isolated from clinical specimens belonging to the following genera and species, *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, and *Candida albicans*, cultivated on liquid/solidified Muller Hinton (for bacterial strains) Media. Synthesized compounds were tested for the antimicrobial activity against Gram-positive (*S. aureus* and *B. subtilis*) and a Gram-negative (*E. coli*) bacteria along with a fungal strain (*C. albicans*) by the zone of inhibition (ZOI) method. The ZOI was found to be in the range of 12 to 41 mm. Compounds containing 2,3-$(Cl)_2$, 4-F, 4-Cl, 2,3,4-$(OCH_3)_2$, and 3,4-$(CH_3)_2$ substituents showed high antimicrobial activity with respect to the standard, Ciprofloxacin. Compounds **8c**, **8e**, **8i**, and **8l** showed a ZOI of 39, 39, 38, and 34 mm, respectively, against *E. coli*. Furthermore, compounds **8c**, **8e**, **8i**, and **8l** showed a ZOI of 40, 37, 34, and 41 mm, respectively, against *S. aureus*. The compounds **8d** and **8l** showed high microbial activity with ZOI values of 39 and 39 mm, respectively, against *B. subtilis*. In case of Gram-negative bacteria and fungal strain (*C. albicans*), compounds **8d** and **8h** exhibited high activity with a ZOI of 32 and 31 mm, respectively. Fluconazole was used as a standard drug for the antifungal activity evaluation.

Table 3 represents the results of the quantitative assay of the antimicrobial and antifungal activity of the newly synthesized compounds, being known that a concentration of 2 μg/mL represents a very strong effect and a 125-μg/mL concentration represents a moderate effect.

TABLE 2 Zone of inhibition (mm) of the compounds (**8a-n**) against the test microorganisms

Compound	*Escherichia coli*	*Staphylococcus aureus*	*Bacillus subtilis*	*Candida albicans*
8a	34	36	27	19
8b	31	35	23	16
8c	**39**	**40**	32	15
8d	29	12	**39**	**32**
8e	**39**	**37**	20	19
8f	35	14	32	28
8g	25	36	32	27
8h	26	24	34	**31**
8i	**38**	34	27	**29**
8j	28	21	27	19
8k	28	21	37	19
8l	34	**41**	**39**	15
8m	35	34	27	17
8n	28	11	27	19
Ciprofloxacin	41	44	42	-
Fluconazole	–	–	–	36

Note:The bold characters highlight the active molecules.

Few of the tested compounds exhibited antimicrobial activity against both Gram-positive, Gram-negative bacteria and fungal strains. It is important to notice the good antimicrobial activity of tested compounds **8c** and **8d** against *B. subtilis* (minimum inhibitory concentration [MIC] = 125 to 7.8 μg/mL) and *C. albicans* (MIC = 62.5 to 31.25 μg/mL), which symbolize the latest therapeutically options in the treatment of fungal infections. The activity against *S. aureus* was moderate, the tested compound **8c** exhibiting MIC values ranging from 500 to 125 μg/mL. The activity against *E. coli* was higher with the tested compounds **8c** and **8e**, exhibiting MIC values ranging from 31.5 to 125 μg/mL.

2.3 | *In silico* molecular docking studies

To determine and prop up the antibacterial activity, molecular docking of the synthesized compounds (**8a-n**) was conceded out using *E. coli* MurB enzyme (PDB code: 2MBR). MurB enzyme is crucial for the ability of bacterial cells. The enzymes concerned in peptidoglycan biosynthesis are along with the mainly admirable known targets for innovative antibiotics. Hence, *E. coli* MurB enzyme (PDB code: 2MBR) was selected as the target receptor.[18,19]

For the molecular docking studies, chemical structures of the synthesized ligands (**8a-n**), and standard

Ciprofloxacin were drawn using Chem Draw Ultra. 3D docking score can be interpreted as the interaction energy. An extra negative E-total energy value implies that a tough interaction exists between drug and receptor, which leads to the reticence of receptor activity. Molecular docking job was performed with the Hex molecular modeling package version 8.2. The ligands were transformed to 2D and 3D energy-minimized conformations using Hex 3D Ultra 8.2 and the conformation was visualized using Acceryl Discovery Studio 3.1 Client. Docking scores of the synthesized compounds (**8a-n**) were evaluated against *E. coli* MurB enzyme. Ciprofloxacin drug was used as the standard with docking score of −237.66 kcal mol^{-1}.[20,21]

TABLE 3 Minimum inhibitory concentration (MIC) determination

	MIC, μg/mL			
Compound	***Escherichia coli***	***Staphylococcus aureus***	***Bacillus subtilis***	***Candida albicans***
8c	31.25	31.25	>125	-
8d	-	-	125	31.25
8e	62.5	>125	-	-
8l	125	>125	-	-
Ciprofloxacin	3.95	2	2	-
Fluconazole	-	-	-	2

The compounds showed similar E-total values ranging from −273.78 to −312.42 kcal mol^{-1} when compared with the standard drug Ciprofloxacin (E-total ¼ −237.66 kcal mol^{-1}) (Table 4). In addition, it was recorded that all the compounds exhibited bonding with a variety of amino acid residues in the active pocket. The majority of the ligands exhibited interactions with Gly228, Ala227, Ser50, Ser116, Ser117, Ile122, Gly123, Arg159, Asn121, and Asn120, residues present in the active site of the enzyme. The compounds **8l**, **8m**, **8i**, and **8f** showed more negative E-total values of 318.22, 315.32, 318.78, and 330.42 kcal mol^{-1} when compared with the standard drug Ciprofloxacin (E-total value −237.66 kcal mol^{-1}). The respite of compounds showed sensible scores and the binding interactions with different amino acid residues on the

TABLE 4 Compound Interaction with different amino acids of 2MBR

Compound	Docking score(kcal mol^{-1})	Vander Waals (Green) and Halogen Interactions (Blue)	(Violet) Carbon Hydrogen Bond, Pi-Donor Hydrogen Bond, Alkyl and Pi-alkyl Interactions
8a	−291.47	Gly123	Ala 227, Val 326, Ile 119, Gly 325
8b	−304.42	Gly123	Ile 119, Phe 11, Val 326, Glu 325
8c	−312.09	Thr10, Gly123, Gln120, Val326	Pro118, Ala 227
8d	−273.78	Thr10, Gly123	Pro 118
8e	−290.09	Gly123	Pro 118, Val 326
8f	**−330.42**	Glu325	Val 326 Pro 118
8g	−293.57	Vala326, Gly228, Asn121	Pro 118, Ile 119
8h	−288-62	Ile119, Glu325	Pro 118
8i	**−318.78**	Ser 229, Thr10	Pro 118, Ile 119, Tyr 158
8j	−312.42	Ser229, Thr10, Glu325, Asn226, Tyr158	Pro 118, Ile 119
8k	−306.80	Asn226, Thr 10, Ile119, Asn 121	Pro 118
8l	**−318.22**	Thr 10	Val 326, Pro 118
8m	**−315.32**	Gly 123	Pro 118, Val 326
8n	−287.93	Val 326, Gly 123, Gln 120	Pro 118,Ile 119, Ala 227

Note: Bold characters highlight active or promising compounds.

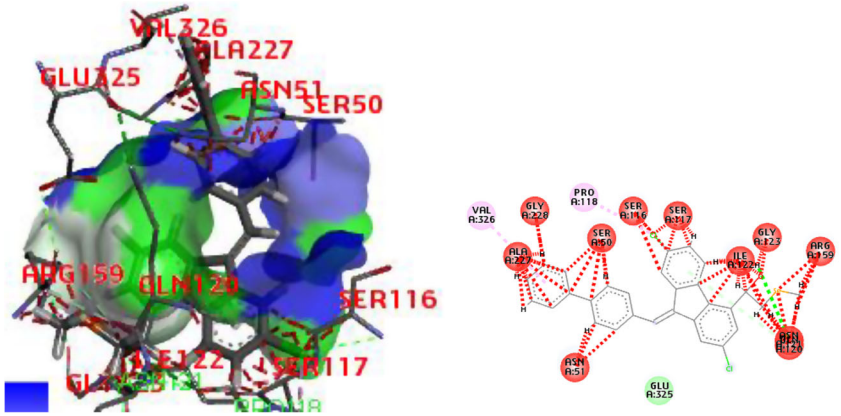


FIGURE 2 Interaction of compound **8f** with amino acids of 2MBR (A) 3D-structure compound (ball and stick model) protein receptor (stick model) (B) 2D-structure

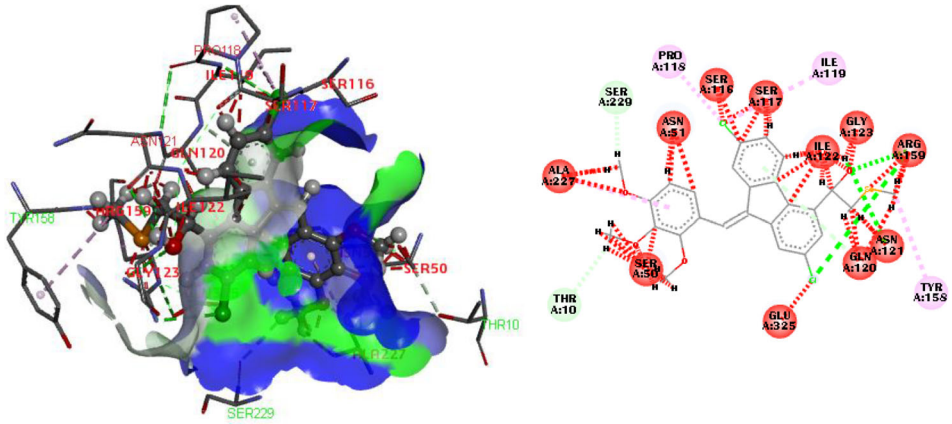


FIGURE 3 Interaction of compound **8i** with amino acids of 2MBR (A) 3D-structure compound (ball and stick model) protein receptor (stick model) (B) 2D-structure

binding pocket as represented in Table 4. Compound **8f**, which is a phenyl substituted derivative exhibited Van der Waals and halogen interactions with Glu325 and carbon hydrogen bond, pi-donor hydrogen bond, alkyl, and pi-alkyl interactions with Val 326 Pro 118 AMino acids. Trimethoxy substituted derivative **8i** also exhibited all the interactions with Ser 229, Thr10, Pro 118, Ile 119, Tyr 158. Besides these interactions, the dimethyl and trichloro derivatives (ie, compound **8l** and **8m**) also showed good interaction with the residues around the binding pocket, such as Thr 10, Val 326, Pro 118, Gly 123, Pro 118, and Val 326, respectively. Pharmacophore interaction of **8f**, **8i**, **8l**, and **8m** are shown in **Figures** 2–4, and 5 below, respectively.

3 | EXPERIMENTAL SECTION

3.1 | General

Solvents and reagents were obtained from commercial sources and used without purification. Recrystallization was used for purification instead of column chromatography. Melting points were determined by the open capillary method and were uncorrected. IR spectra were obtained in KBr discs on a Shimadzu FT-IR 157 spectrometer. NMR spectra were recorded on a Bruker WH-200 (400 MHz) in DMSO-d_6 as solvent and TMS as an internal standard. Chemical shifts and coupling constants were expressed as ppm (δ) and Hz (*J*) respectively. Mass spectra were recorded on a Jeolsx 102/Da-600 mass spectrometer/Data system using argon/xenon (6 kV, 10 mA) as the FAB gas. The accelerating voltage was 10 kV and spectra were recorded at room temperature. The elemental analyses (CHN) were performed using VARIO EL-III (Elemental Analyse system GmBH). The progress of the reactions was monitored by TLC on precoated silica gel G plates. All the spectral data of newly synthesized compounds were consistent with the proposed structure. Docking studies of the synthesized compounds was carried out against *E. coli* MurB enzyme (PDB code: 2MBR) using HEX 8.2 software.

3.1.1 | Procedure for of 1-(2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselenayl)ethanol

In a three-necked round bottom flask, five volumes of methanol were taken and 1 mol of dimethyl diselenide was added under nitrogen atmosphere. Reaction mass chilled to 5 °C to 10 °C. To this, 2 mol of sodium borohydride was added in four equal lots during 1 hour and it was stirred for

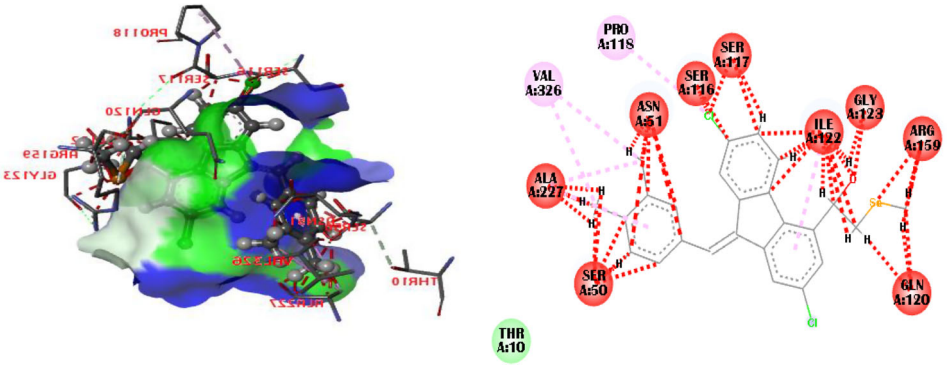


FIGURE 4 Interaction of compound **8l** with amino acids of 2MBR (A) 3D-structure compound (ball and stick model) protein receptor (stick model) (B) 2D-structure

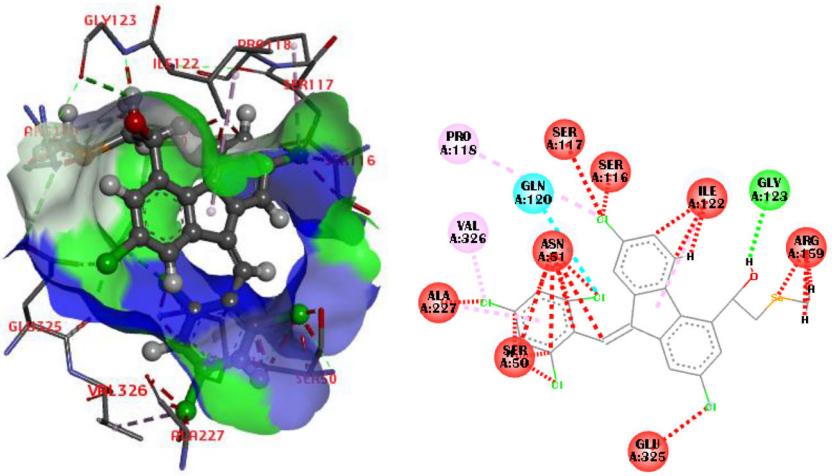


FIGURE 5 Interaction of compound **8m** with amino acids of 2MBR (A) 3D-structure compound (ball and stick model) protein receptor (stick model) (B) 2D-structure

3 to 4 hours. A color change was observed from dark yellow to pale yellow. The reaction mass was brought to room temperature and then cooled to 0 °C to 5 °C. To this reaction mass, 1 mol of 2-(2, 7-dichloro-9*H*-fluoren-4-yl)oxirane was added in four equal lots in 1 hour and stirred for 12 to 16 hours with TLC monitoring [Hexane:EtOAc, 4.5:0.5 (v/v)] followed by heating up to 40 °C to 45 °C for an hour. Then, methanol was distilled out to 2.0-2.5 residual volume under reduced pressure. The resulting reaction mass was then cooled to room temperature and cooled to 0 °C to 5 °C, followed by the addition of 10 volumes of water and stirred for 30 minutes, and pH of the reaction mass was adjusted to 4.0 to 5.0 using acetic acid to get white precipitate of the product. The reaction mass was filtered, washed with water, and dried. The crude material was recrystallized from ethyl acetate to obtain the pure material.

3.1.2 | Procedure for 1-[(9)-2,7-dichloro-9-(substitutedphenylmethylidene)-9*H*-fluoren-4-yl]-2-(methylselanyl)ethanol

In a three-necked round bottom flask, four volume of methanol with 1 mol of 1-(2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselenyl)ethanol was taken under nitrogen atmosphere. Substituted aromatic aldehydes of 1.35 mol were charged and heated up to 50 °C to 55 °C. Then, 1.25 mol of sodium hydroxide was added and was heated up to 65 °C to 70 °C. The reaction mass was maintained for 6-8 hours, with TLC monitoring [Hexane:EtOAc, 4.5:0.5 (v/v)]. Then the resulting reaction mass was cooled to 0-5 °C and stirred for 2 hours. The reaction mass was filtered, washed with 0.5 volume chilled methanol with 2.0 volume water, and drained. The crude material was recrystallized from ethyl acetate to obtain the pure material.

Safety notes: use protective equipment such as safety goggles, chemical splash eyewear, half face respirator with organic vapor cartridge, safety shoes, nitrile hand gloves, disposal head caps, apron, laboratory fume hoods containing 50% sodium hydroxide solution, local exhaust ventilation, fire extinguisher, smoke/heat detector, spill control kit containing sand, sodium bicarbonate, waste pan, and broom throughout the work.

3.1.3 | 1-(2,7-Dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethan-1-ol (6)

White crystalline solid; Yield: 73%; mp 118-119 °C; IR (KBr, υ_{max}, cm^{-1}): 3447 (O—H), 2920 (C—H), 1597 (C═C),

1051 (C—O), 767 (C—Cl) cm^{-1}; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.95 (s, 3H, —Se—CH_3), 2.89 (d, 2H, J = 8.0 Hz, —Se—CH_2), 3.99 (s, 2H, —CH_2), 5.46-5.44 (m, 1H, CH), 5.87 (d, 1H, —OH), 7.51 (d, 1H, J = 8.0 Hz, Ar—H), 7.57 (d, 2H, J = 4.0 Hz, Ar—H) 7.70 (s, 1H, Ar—H) 7.87(d, 1H, J = 8.0 Hz, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): δ: 5.3, 32.7, 37.0, 70.2, 124.3, 124.8, 125.3, 125.8, 127.5, 131.9, 132.0, 135.5, 139.0, 142.5, 146.5, 146.5; ESI-MS (m/z): 370.88 $[M - H]^-$; Anal. Calcd for $C_{16}H_{14}Cl_2OSe$: C, 51.64; H, 3.79. Found: C, 51.63; H, 3.78.

3.1.4 | 1-(9-Benzylidene-2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8a)

Yellow color solid; 83%; mp 128-132°C IR (KBr, υ_{max}, cm^{-1}) (O—H) 3394, (C—H) 2943, (C═C) 2258, (C—Cl) 761; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.93(s, 3H, CH_3) 2.92-2.86 (m, 2H, CH_2), —CH 5.46-5.42(t, 1H, J = 4.0 Hz), 5.95 (d, 1H, —OH), 6.95 (s, 1H, Ar—H, J = 4.0 Hz), 7.35-7.45 (m, 3H, Ar—H), 7.51-7.62 (m, 4H, Ar—H) 7.71-8.0 1 (m, 3H, Ar—H);^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.4, 122.4, 123.2, 123.5, 126.1, 126.8, 128.1, 129.5, 130.8, 130.8, 131.6, 132.9, 133.6, 134.5, 134.5, 135.6, 137.5, 137.4, 139.3, 141.5, 141.8, 161.1; ESI-MS (m/z): 457.88 $[M - H]^-$; Anal. Calcd for $C_{23}H_{18}Cl_2OSe$: C, 60.02; H, 3.94. Found: C, 60.05; H, 3.97.

3.1.5 | 1-(9-[4-Bromobenzylidene]-2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8b)

Yellow color solid; 75%; mp 153-157 °C. IR (KBr, υ_{max}, cm^{-1}) (O—H) 3394, (C—H) 2922, (C═C) 2359, (C—Cl) 743, (C—Br) 413; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.97(s, 3H, CH_3) 2.92-2.87 (m, 2H, CH_2) 5.45 (t,1H, —CH, J = 4.0 Hz), 5.94 (d,1H, —OH), 7.33 (s,1H, Ar—H), 7.55-7.68 (m, 5H, Ar—H), 7.88 (d,1H, Ar—H, J = 8.0 Hz) 8.15 (s,1H, Ar—H), 8.19 (d, 2H, Ar—H, J = 4.0 Hz); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 70.0, 121.7, 122.2, 122.4, 125.7, 126.4, 129.1, 129.4, 130.5, 131.6, 131.5, 132.1, 133.6, 134.2, 134.8, 135.9, 138.3, 138.5, 139.1, 141.9, 142.8, 150.3, 158.1.; ESI-MS (m/z): 535.56 $[M - H]^-$; Anal. Calcd for $C_{23}H_{17}BrCl_2OSe$: C, 51.24; H, 3.18. Found: C, 51.22; H, 3.17.

3.1.6 | 1-(2,7-Dichloro-9-[2,3-dichlorobenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8c)

Yellow color solid; 86%; mp 182-185 °C. IR (KBr, υ_{max}, cm^{-1}) (O—H) 3394, (C—H) 1402, (C═C) 1627, (C—Cl) 775; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.96 (s, 3H, CH_3) 2.94-2.91 (m, 2H, CH_2), 5.44 (t, 1H, —CH, J = 4.0 Hz, J = 8.0 Hz), 5.97 (s, 1H, —OH,), 6.97 (s, 1H, Ar—H), 7.52-7.66 (m, 4H, Ar—H), 7.82-7.90 (m, 2H, Ar—H), 8.06-8.19 (m, 2H, Ar—H) ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 31.9, 70.0, 120.2, 122.1, 124.2, 125.3, 128.1, 129.0, 129.2, 132.2, 132.6, 135.3, 136.9, 138.2, 141.6, 142.3, 149.8, 150.0; ESI-MS (m/z): 529.9 $[M - H]^-$; Anal. Calcd for $C_{23}H_{17}Cl_4OSe$: C, 52.21; H, 3.05. Found: C, 52.23; H, 3.07.

3.1.7 | 1-(2,7-Dichloro-9-[4-fluorobenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8d)

Yellow color solid; 88%; mp 134-137 °C. IR (KBr, υ_{max}, cm^{-1}) (O—H) 3373, (Ar—H) 1404 (C═C) 1595, (C—Cl) 775, (C—F) 1055; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.97 (s, 3H, CH_3), 2.93 (t, 2H, CH_2, J = 4.0 Hz) 5.46 (s, 1H, —CH, J = 4.0 Hz), 5.95 (d, 1H, —OH), 7.31 (s, 1H, Ar—H), 7.37-7.41 (m, 2H, Ar—H), 7.52-7.65 (m, 4H, Ar—H), 7.82-7.88 (m, 1H, Ar—H), 8.06-8.16 (m, 2H, Ar—H) ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 5.3, 32.5, 60.9, 70.0, 116.2, 116.4, 120.1, 121.1, 121.4, 122.2, 123.6, 125.3, 125.6, 126.3, 126.5, 128.8, 129.1, 130.9, 131.0, 131.7, 131.7, 131.8, 132.4, 132.4, 132.6, 132.7, 133.9, 134.8, 135.9, 138.4, 138.4, 141.8, 141.9, 142.5, 142.8, 161.4, 163.9; ESI-MS (m/z): 478.9 $[M - H]^-$; Anal. Calcd for $C_{23}H_{17}Cl_2FOSe$: C, 57.76; H, 3.58. Found: C, 57.78; H, 3.55.

3.1.8 | 1-(2,7-Dichloro-9-(4-chlorobenzylidene)-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8e)

Yellow color solid; 79%; mp 178-179 °C. IR (KBr, υ_{max}, cm^{-1}): (O-H) 3394, (Ar—H) 2922, (C═C) 2359, (C—Cl) 775; ^1H NMR (400 MHz; DMSO-d_6, δ ppm): 1.95 (s, 3H, CH_3), 2.90 (dd, 2H, CH_2, J = 8.0 Hz), 5.48-5.44 (m, 1H, —CH), 5.94 (d, 1H, —OH, J = 4.8 Hz), 7.31 (s, 1H, Ar—H), 7.53-7.62 (m, 6H, Ar—H), 7.84 (d, 1H, Ar—H, J = 8.0 Hz.), 8.12 (s, 1H, Ar—H), 8.17 (d, 1H, Ar—H, J = 4.0 Hz); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.8, 121.6, 122.1, 122.2, 125.4, 126.7, 129.0, 129.4, 130.6, 131.3, 131.8, 132.7, 133.9, 134.2, 134.99, 135.9, 138.3138.4, 139.2141.8, 142.8; ESI-MS (m/z): 493.1$[M - H]^-$; Anal. Calcd for $C_{23}H_{17}Cl_3OSe$: C, 55.84; H, 3.46. Found: C, 55.82; H, 3.47.

3.1.9 | 1-(9-([1,1′-Biphenyl]-4-ylmethylene)-2,7-dichloro-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8f)

Yellow color solid; 91%; mp 185-188 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3365, (Ar—H) 2867, (C═C) 2235, (C—Cl) 753; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.97 (s, 3H, CH_3) 2.91-2.89 (m, 2H, CH_2) 5.46 (t,1H, —CH J = 4.0 Hz), 5.94 (d,1H, —OH), 6.98 (d, 1H, Ar—H J = 4.0 Hz), 7.42-7.50 (m, 5H, Ar—H), 7.55-7.68 (m, 6H, Ar—H), 7.71-8.15 (m, 3H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.4, 69.4, 125.7, 126.3, 126.6, 126.3, 126.8, 126.9, 127.4, 127.4, 127.5, 127.8, 127.9, 128.9, 129.3, 129.5, 130.5, 130.9, 133.0, 133.4, 135.9, 138.1, 139.5, 136.7, 141.8, 140.5, 140.2, 150.5, 151.6; ESI-MS (*m/z*): 534.3 $[M - H]^-$; Anal. Calcd for $C_{29}H_{22}Cl_2OSe$: C, 64.94; H, 4.13. Found: C, 64.92; H, 4.17.

3.1.10 | 4-((2,7-Dichloro-4-(1-hydroxy-2-(methylselanyl)ethyl)-9*H*-fluoren-9-ylidene)methyl)benzene-1,3-diol (8g)

Yellow color solid; 87%; mp 151-153 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3388, (Ar—H) 2934, (C═C) 2365, (C—Cl) 765; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.97 (s, 3H, CH_3), 2.92-2.88 (m, 2H, CH_2), 5.46 (t, 1H, —CH, J = 4.0 Hz), 5.94 (d, 1H, δ —OH), 5.53 (d, 2H, —OH), 6.95 (d, 2H, Ar—H, J = 4.0 Hz), 7.11 (s, 1H, Ar—H) 7.41-7.55 (m, 4H, Ar—H) 7.81-8.18 (m, 2H, Ar—H);^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.8, 121.6, 122.1, 122.2, 125.4, 126.6, 129.2, 129.4, 130.6, 131.3, 131.7, 132.7, 133.9, 134.2, 135.9, 136.9, 138.2, 138.4, 139.2, 141.6, 142.3, 151.6; ESI-MS (*m/z*): 490.32 $[M - H]^-$; Anal. Calcd for $C_{23}H_{19}Cl_2O_3Se$: C, 56.12; H, 3.69. Found: C, 56.10; H, 3.67.

3.1.11 | 1-(2,7-Dichloro-9-(4-[dimethylamino]benzylidene)-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8h)

Yellow color solid; 71%; mp 159-165 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3394, (Ar—H) 1429, (C═C) 1521, (C—Cl) 813; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): δ: 1.97 (t, 3H CH_3, J = 8.0 Hz), 2.89-2.93 (m, 2H, CH_2), 3.05 (s, 6H, —N—CH_3), 5.51-5.49 (t,1H, J = 8.0 Hz, —CH), 5.94 (s, 1H, —OH), 6.85-6.87 (d, 2H, Ar—H), 7.47-7.60 (m, 3H, Ar—H), 7.70-7.71 (m, 2H, Ar—H), 7.82-7.92 (m, 1H, Ar—H), 8.01-8.03 (m, 1H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): δ: 5.3, 32.6, 39.5, 70.2, 112.0, 124.2, 125.8, 127.5, 129.4, 131.9, 132.0, 135.1, 136.8, 138.3, 141.1, 142.2, 149.7, 150.1; ESI-MS (*m/z*): 480.9 $[M + H]^+$; Anal. Calcd for $C_{25}H_{23}Cl_2NOSe$: C, 59.66; H, 4.61; N, 2.78. Found: C, 59.62; H, 4.66; N, 2.76.

3.1.12 | 1-(2,7-Dichloro-9-[2,3,4-trimethoxybenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8i)

Yellow color solid; 70%; mp 143-146 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3374, (Ar—H) 2832, (C═C) 2269, (C—Cl) 731; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): δ: 1.92 (s, 3H, CH_3), 2.90-2.86 (m, 2H, CH_2), 3.85 (s, 9H, —OCH_3), 5.45 (t, 1H, —CH, J = 4.0 Hz), 5.94 (d,1H, —OH), 6.78 (s, 1H, Ar—H), 7.21 (d, 1H, Ar—H, J = 4.0 Hz), 7.43-7.51 (m, 4H, Ar—H), 7.75-8.17 (m, 2H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.6, 56.8, 69.9, 123.6, 123.7124.2, 126.8, 128.7, 130.1, 131.4, 132.7, 133.3, 133.8, 134.7, 135.6, 135.2, 136.6, 137.9, 139.3139.4, 141.2, 143.8, 145.8, 150.1, 160.3; ESI-MS (*m/z*): 548.1 $[M - H]^-$; Anal. Calcd for $C_{26}H_{24}Cl_2O_4Se$: C, 56.74; H 4.40. Found: C, 56.71; H, 4.39.

3.1.13 | 1-(2,7-Dichloro-9-[3,4-dimethoxybenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8j)

Yellow color solid; 78%; mp 133-135 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3298, (Ar—H) 2843, (C═C)2388, (C—Cl) 748; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.96 (s, 3H, CH_3), 2.92-2.89 (dd, 2H, CH_2), 3.78 (s, 6H, —OCH_3), 5.46-5.48 (t, 1H, —CH, J = 4.0 Hz), 5.94-5.95 (d, 1H, —OH), 6.99 (s, 1H, Ar—H), 6.98 (d, 1H, Ar—H, J = 4.0 Hz), 7.35-7.46 (m, 2H, Ar—H), 7.51-7.87 (m, 4H, Ar—H), 7.98-8.17 (m, 1H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 56.3, 69.9, 123.1, 123.4, 124.1, 125.8, 127.7, 130.1, 131.2, 132.3, 133.1, 133.4, 133.7, 134.6, 134.8, 135.9, 136.9, 138.3, 139.1, 140.2, 142.8, 144.9, 149.1, 155.1; ESI-MS (*m/z*): 518.01 $[M - H]^-$; Anal. Calcd for $C_{25}H_{22}Cl_2O_3Se$: C, 57.71; H, 4.26. Found: C, 57.72; H, 4.27.

3.1.14 | 5-((2,7-Dichloro-4-(1-hydroxy-2-(methylselanyl)ethyl)-9*H*-fluoren-9-ylidene)methyl)-2-methoxyphenol (8k)

Brown color solid; 60%; mp 136-140 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3294, (Ar—H) 2821, (C═C) 2401, (C—Cl) 776; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.96 (s, 3H, CH_3), 2.93-2.89 (m, 2H, CH_2), 3.85 (s, 3H, —OCH_3), 5.47 (t, 1H, —CH J = 4.0 Hz), 5.95 (d, 1H, —OH), 5.51 (s broad,1H, —OH), 7.01 (s, 2H, Ar—H), 7.39 (d, 2H,

Ar—H, J = 8.0 Hz), 7.45-7.76 (m, 4H, Ar—H), 7.91-8.06 (m, 1H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.8, 121.6, 122.1, 122.2, 125.4, 126.7, 129.0, 129.4, 130.6, 131.3, 131.8, 132.7, 133.9, 134.2, 13.9, 135.9, 138.3138.4, 139.2, 141.8, 142.8, 148.4, 156.1; ESI-MS (*m/z*): 503.88 $[M - H]^-$; Anal. Calcd for $C_{24}H_{20}Cl_2O_3Se$: C, 56.94; H, 3.98. Found: C, 56.92; H, 3.97.

3.1.15 | 1-(2,7-Dichloro-9-[3,4-dimethylbenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8l)

Yellow color solid; 86%; mp 132-133 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3400, (Ar—H) 2920, (C═C) 1410, (C—Cl) 754; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.98 (s, 3H, —Se—CH_3), 2.51(s, 6H, —$(CH_3)_2$, 2.91 (t, 2H, —CH_2 J = 8.0 Hz), 5.48-5.46 (t,1H, —CH J = 4.0 Hz), 5.94 (t, 1H, J = 8.0 Hz, J = 4.0 Hz —OH), 7.31-7.40 (m, 3H, Ar—H), 7.49-7.60 (m,3H, Ar—H), 7.83-7.89 (m,1H, Ar—H), 8.08-8.11 (d, 2H, J = 4.0 Hz, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.8, 121.6, 122.1, 122.2, 125.4, 126.7, 129.0, 129.4, 130.6, 131.3, 131.8, 132.7, 133.9, 134.2, 134.9, 135.9, 138.3138.4, 139.2141.8, 142.8; ESI-MS (*m/z*): 489.2 $[M + H]^+$; Anal. Calcd for $C_{25}H_{22}Cl_2OSe$: C, 61.49; H, 4.54. Found: C, 61.52; H, 4.57.

3.1.16 | (2,7-Dichloro-9-[2,4,6-trichlorobenzylidene]-9*H*-fluoren-4-yl)-2-(methylselanyl)ethanol (8m)

Yellow color solid; 80%; mp 195-197 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3378, (Ar—H) 2852, (C═C) 2389, (C—Cl) 763; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.97 (s, 3H, CH_3), 2.88-2.86 (m, 2H, CH_2), 5.43 (t, 1H, —CH J = 4.0 Hz), 5.93 (s, 1H, —OH), 7.38 (s,1H, Ar—H), 7.64-7.75 (m, 4H, Ar—H), 7.88 (d, 2H, Ar—H, J = 8.0 Hz.), 8.27 (d, 1H, Ar—H, J = 4.0 Hz.); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.4, 69.2, 121.6, 122.5, 123.9, 125.8, 126.7, 129.1, 130.1, 131.6, 131.1, 131.6, 132.6, 133.6, 134.6, 134.9, 136.8, 137.3, 138.2, 138.9, 141.5, 143.9, 151.1; ESI-MS (*m/z*): 561.1 $[M - H]^-$; Anal. Calcd for $C_{23}H_{15}Cl_5OSe$: C, 49.02; H, 2.68. Found: C, 49.03; H, 2.67.

3.1.17 | 2-((2,7-Dichloro-4-(1-hydroxy-2-(methylselanyl)ethyl)-9*H*-fluoren-9-ylidene)methyl)phenol (8n)

Yellow color solid; 70%; mp 135-138 °C. IR (KBr, υ_{max}, cm^{-1}): (O—H) 3298, (Ar—H) 2872, (C═C) 2349, (C—Cl) 734; ^{1}H NMR (400 MHz; DMSO-d_6, δ ppm): 1.96 (s, 3H, CH_3), 2.88-2. 92 (m, 2H, CH_2), 5.47 (t, 1H, —CH, J = 4.0 Hz), 5.94 (d, 1H, —OH), 5.55 (d,1H,—OH), 6.81 (d, 1H, Ar—H, J = 4.0 Hz), 7.01-7.19 (m, 3H, Ar—H), 7.31-7.48 (m, 3H, Ar—H), 7.71-8.05 (m, 2H, Ar—H), 7.31-8.18 (m, 1H, Ar—H); ^{13}C NMR (100 MHz; DMSO-d_6, δ ppm): 5.3, 32.5, 69.8, 121.6, 122.1122.2, 125.4, 126.7, 129.0, 129.4, 130.6, 131.3, 131.8, 132.7, 133.9, 134.2, 134.9, 135.9, 138.3, 138.4, 139.2, 141.8, 142.8, 148.3, 151.2, 158.5; ESI-MS (*m/z*): 473.71 $[M - H]^-$; Anal. Calcd for $C_{23}H_{18}Cl_2O_2Se$: C, 58.00; H, 3.81. Found: C, 58.02; H, 3.84.

3.2 | Antimicrobial activity

Well diffusion method under NCCLS document M62-A7 protocol was followed for the antimicrobial assay.[22] Three bacterial strains chosen for the study were *E. coli*, *S. aureus*, and *B. subtilis*. The bacterial strains are maintained on Muller-Hinton (MH) agar medium. Ciprofloxacin was used as standard antibacterial drug. *C. albicans* was considered for the antifungal study and Fluconazole was used as standard drug for antifungal studies. Solutions of 10 mg/mL of the target compounds were prepared in dimethyl sulfoxide for the screening. The isolates were inoculated in saline solution and incubated at 37 °C for 4 hours. The inoculum was adjusted to 0.5 McFarland standards (1.5 × 108 CFU/mL). Sterile swabs were used in the process. The bacteria were seeded on Mulleur Hinton Agar plates performing lawn culture. Wells were punched in the agar plate using a sterile borer; 50 μL of each 3% stock solution the compound was dispensed in the wells. Culture plates were incubated, and inhibition zones were measured.

3.3 | MIC determination

MIC was determined by performing serial dilutions. Each compound suspension was prepared by dissolving 0.1 g of the compound in 10 mL of DMSO. This represents 10 mg/mL and was then serially diluted. Tube containing only growth medium and inoculated organism was considered as control without any compound in it. The tubes were incubated at 37 °C for 24 hours. Subculture was done from each tube on nutrient agar (including the control) and incubated at 37 °C for 24 hours.

3.4 | Molecular docking using HEX 8.2

Docking studies of the synthesized compounds were evaluated against *E. coli* MurB enzyme (PDB code: 2MBR)

which is known to be responsible for causing antimicrobial infections. Ciproflaxin was used as the standard for the docking studies. The protein structure was retrieved from protein data bank for docking study of synthesized compounds using HEX 8.2 software.

4 | CONCLUSION

A series of 1-[(9)-2,7-dichloro-9-(substitutedphenylmethylidene)-9*H*-fluoren-4-yl]-2-(methylselanyl)ethanol was synthesized using high selectivity, low cost, safe, and mild reaction conditions. The heterocyclic compounds were screened for antimicrobial activity against *E. coli* (NCIM 2574), *S. aureus* (NCIM 5021), *B. subtilis* (NCIM 2063), and *C. albicans* (NCIM 3100) by disc diffusion (mm) and minimum inhibitory concentration (μg/mL) method. The result of the antimicrobial activity suggested that many synthesized analogs served as excellent anti-microbial agents because of the presence of various functional groups. Within the series, compounds **8c** (dichloro), **8e** (chloro), and **8l** (methyl) were found to be potent and good antibacterial agents when compared with respect to the standard drug Ciprofloxacin. Meanwhile, the compound **8d** (fluoro) was found to be excellent antifungal agents against the *C. albicans*. Hence, there is a strong need to explore the molecular aspects of the mechanism of actions of various pharmacological mediated affected by the introduction of novel selenium-containing Lumefantrine skeletal-based polycyclic aromatic compounds so that we can use a huge range of antimicrobial agents. The antibacterial grades were more supported by *in silico* molecular docking studies of these compounds for the reticence of *E. coli MurB* enzyme (PDB code: 2MBR) and exhibited least binding energy and excellent affinity towards the active pocket analogous with the standard drug Ciprofloxacin.

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ORCID

Boja Poojary https://orcid.org/0000-0001-6725-3289

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SUPPORTING INFORMATION

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