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SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL EVALUATION OF *N*-(4-MORPHOLIN-3-FLUOROPHENYL)-*N*-(FURAN-2-YLMETHYL)-2-SUPSTITUTED PHENOXYPROPANAMIDE DERIVATIVES

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ABSTRACT

A novel series of eight novels *N*-(4-Morpholin-3-fluorophenyl)-*N*-(furan-2-ylmethyl)-2-substituted phenoxypropanamide derivatives (8 E – 8 L) have been synthesized from commercially available 3,4-Difluoronirobenzene as a starting material. High yield and high purity indicates lack of side reaction and by product. The chemical structures of the synthesized compounds were confirmed by means of ^{1}HNMR and mass spectral data. The synthesized compounds were then examined for their antibacterial and antifungal activities. Some of them were found to possess good activity.

KEYWORDS: **Morpholine, Furan, Monofluoroaniline, Antibacterial, Antifungal Activity.**

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INTRODUCTION

Nitrogen and oxygen containing heterocyclic compounds like morpholine[1] and fused ring morphline[2-5] are very important building blocks in medicinal chemistry[6] field. So the morpholine derivatives are extensively very essential in the drug discovery research, which stimulate research activity in the field of the broad spectrum of biological activity[7] study. After the literature survey that many morpholine derivative molecule are shows very good biological activity in different therapeutic area such as antibacterial[8], antiviral, anticancer, antimicrobial, antidiabetic, anti-Inflammatory, antimalarial, antifungal[9], Antiemetic etc.

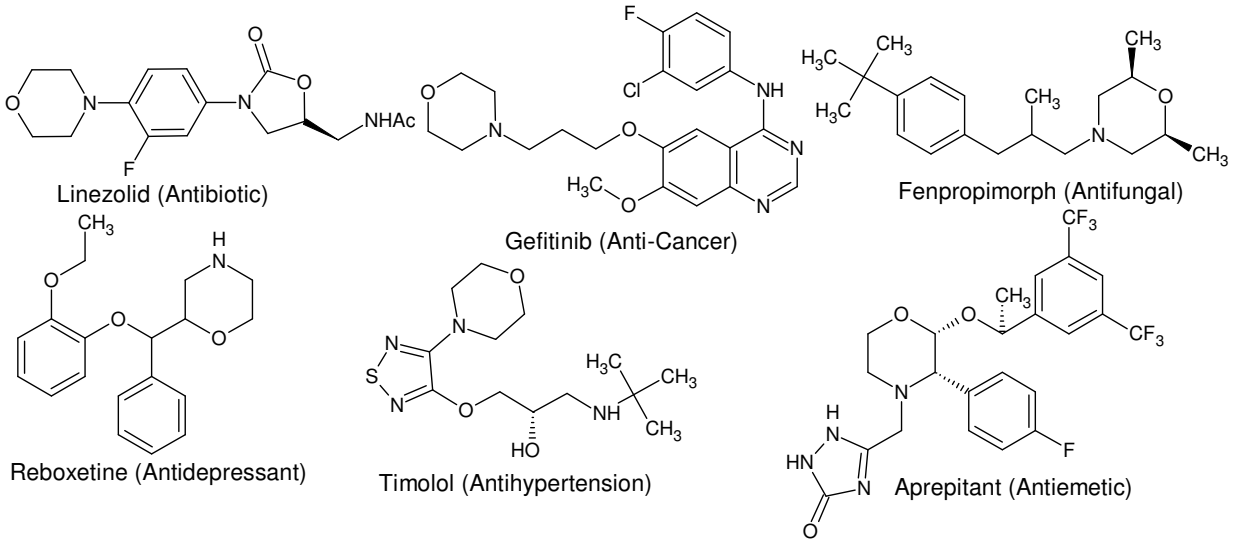


Figure 1
Marketed drugs containing a morpholine ring

It is well known that the introduction of fluorine[10-13] atom into organic molecule causes dramatic changes in its biological profile, mainly due to high electro negativity of fluorine causes increase lipid solubility. The Furan[14-19] was introduced in our moiety considering the better biological activity in a vaster range of therapeutic field. The biological activity of phenoxy derivatives were reported by Crowther, et al[20]. They showed that compounds bearing substituent's on the benzene nucleus, such as alkyl, alkoxy, aryloxy[21-23], were highly active. These findings prompted us to synthesize some derivatives bearing substituent's on the benzene nucleus. Hence, in the present study, some new phenoxy derivatives have been synthesized. Their characterization was done by spectroscopic methods like ^{1}HNMR and mass spectral data. Further, antibacterial and antifungal activities of these derivatives have been studied.

MATERIALS AND METHODS

All the reagents and solvents were used as obtained from the supplier or recrystallized/redistilled as necessary. The moiety 3,4-Difluoronirobenzene[24-29] is commercially available and is also in Sigma Aldrich. This can be also synthesized as per reported literature. Melting points were recorded on open capillary melting point apparatus and are uncorrected. Mass spectra were recorded on 'LCMS-QP2010s' instrument by direct injection method. Nuclear Magnetic Resonance spectra (^{1}HNMR) were recorded in DMSO-d_6 & $CDCl_3$ on Bruker advance spectrometer at 400MHz using Tetramethylsilane (TMS) as internal standard and the chemical shift (δ) are reported in parts per million. The purity of the synthesized compounds was checked by Thin Layer Chromatography, Merck pre-coated plates (silica gel 60 F254) were visualized with UV

light. Fungus Culture: Candida sp. Gram-positive microorganisms: Staphylococcus aureus, Staphylococcus albus, Streptococcus faecalis, Bacillus sp and Gram-negative microorganisms: Klebsiella pnuemoniae, Escherichia coli, Pseudomonas sp, Proteus sp were used for biological activity.

Antimicrobial Activity

The antimicrobial activity of all synthesized compounds (8 E – 8 L) was examined by standard literature procedure using agar diffusion method by finding the zone of inhibition of the drug sample against the standard drugs. Compounds were taken as test samples along with a standard drug Ciprofloxacin sample. 10 mg of each test compound was dissolved in 1 ml of Dimethylsulphoxide for preparing stock solution of standard drugs. The organisms employed in the in vitro testing of the compounds were gram-positive and gram-negative. Procedure for the preparation of inoculum for all the organisms was same. The inoculum was prepared from a 24-hours old growth of organism on Nutrient agar slant. With the help of sterile nichrome wire loop, the growth of the organism on slant was aseptically transferred to a tube containing sterile distilled water. The contents of the tube were then shaken properly so as to get uniform cell suspension of the organism. Optical density the innoculum was adjusted to 0.6 on the photoelectric colorimeter by using sterile distilled water, before using it as an inoculum. The medium, 1.5 g of Nutrient agar (Microbiology grade, Hi Media) was dissolved in 100 ml of sterile distilled water. 3 g of Poloxomer 182 was added as a surfactant to the media to prevent the drug precipitation. 20 ml of this stock solution was transferred to each Petri plate. On to each Petri plate containing 20 ml of sterile Nutrient agar 0.1 ml of an authentic culture (corresponding to 5 X 10^{15} CFU/ml.) of test organisms was spread. Four bore wells were bored on each Petri plate and 5-20 µl of the stock solution was added to it. This corresponds to concentration range of 30 µg/ml of the test compound. The tests were carried out in duplicate. Apart from putting the controls of standard drug (Ciprofloxacin), controls with dimethylsulphoxide (positive control) and without dimethylsulphoxide (negative control) were also included in the test. The Petri plates were kept in the dark conditions at 37^0C for 24 hours. At the end of incubation period, the results were interpreted by finding the zone of inhibition.

Antifungal Activity

The antifungal activity of all synthesized compounds (8 E – 8 L) screened against Candida sp in dimethylsulfoxide. Fluconazole was employed as standard drug during the test procedures as references. 10 mg of each test compound was dissolved in 1 ml of Dimethylsulphoxide. 3 gm of Saboraud`s dextrose agar (microbiology grade, Hi Media LABORATORY) was dissolved in 100 ml of sterile distilled water. 3 g of Poloxomer 182 was added as a surfactant to the media to prevent the drug precipitation. On to each Petri plate containing 20 ml of sterile Saboraud`s dextrose agar (microbiology grade, Hi Media LABORATORY) 0.1 ml of an authentic culture (corresponding to 5 X 10^{15} CFU/ml.) of test organisms was spread. Four bore wells were bored on each Petri plate and 5-20 µl of the stock solution was added to it. This corresponds to a concentration range of 30 µg/ml of the test compound. The tests were carried out in duplicate. Apart from putting the controls of standard drug (Fuconazole), controls with dimethyl sulphoxide (positive control) and without dimethyl sulphoxide (negative control) were also included in the test. The test tubes were kept in the dark conditions at room temperature for 48 hours. At the end of incubation period, the results were interpreted by measuring the zone of inhibition.

EXPERIMENTAL

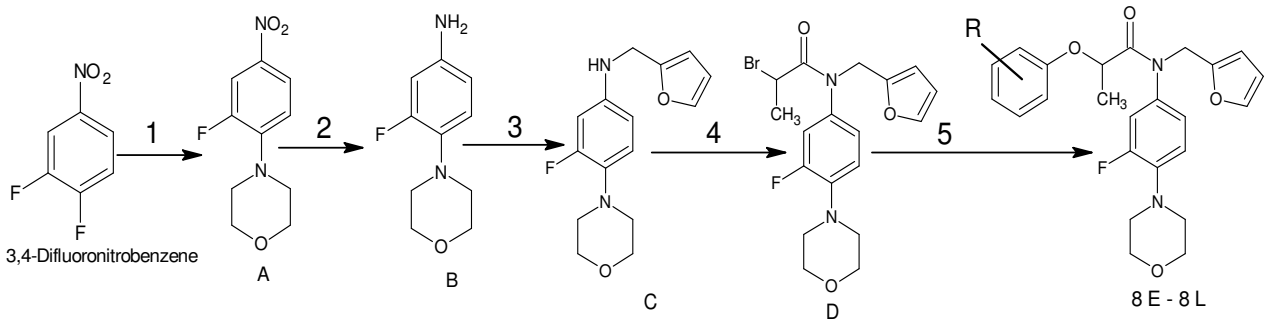
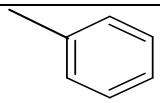
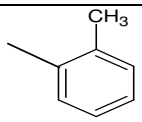
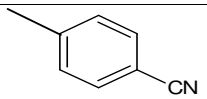
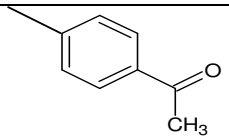
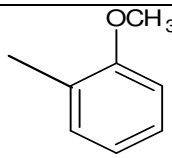
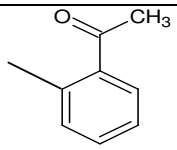
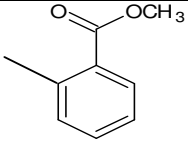
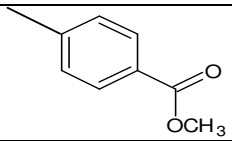


Figure 2
Synthesis of N-(4-Morpholin-3-fluorophenyl)-N-(furan-2-ylmethyl)-2-supstituted phenoxypropanamide derivatives derivatives

Table 1
Physical data of synthesized compounds (8 E – 8 L)

S.No	Code	-R	Molecular Formula	M.Wt	M.P (°C)	% Yield
1	8 E		$C_{24}H_{25}FN_2O_4$	424.46	89-92	82
2	8 F		$C_{25}H_{27}FN_2O_4$	438.49	101-104	88
3	8 G		$C_{25}H_{24}FN_3O_4$	449.47	117-120	93
4	8 H		$C_{26}H_{27}FN_2O_5$	466.50	132-135	87
5	8 I		$C_{25}H_{27}FN_2O_5$	454.49	106-109	96
6	8 J		$C_{26}H_{27}FN_2O_5$	466.50	141-144	88
7	8 K		$C_{26}H_{27}FN_2O_6$	482.50	129-133	91
8	8 L		$C_{26}H_{27}FN_2O_6$	482.50	142-146	78

Preparation of 4-(2-fluoro-4-nitrophenyl)morpholine (A)

The 3,4-Difluoronirobenzene (15g, 94mmol) was added to the solution of Morpholine (9.85g, 113mmol), potassium carbonate (19.54g, 141mmol) in N,N-Dimethylformamide (90ml) at room temperature. Then the reaction mixture heated to 80°C and maintained for 4h. After completion of reaction, the reaction was cooled to room temperature and slowly poured into cold water (540ml) and the suspension was stirred at room temperature for 2hr. Filtered and washed with water (30ml), after drying yielded the titled product (A) as yellow solid.

Preparation of 3-fluoro-4-(morpholin-4-yl) aniline (B)

The methanol (180ml), compound (A) (18g, 79mmole) and 10% palladium on carbon catalyst (1.8g) was added into the hydrogenation parr shaker reactor, 30 PSI hydrogen gas pressure applied and the mixture was stirred for 5 hr at room temperature. After completion of reaction, the reaction mass filtered through celited bed washed with methanol (40ml). The filtrate was evaporated under vacuum. Yielded the titled product (B) as brown solid.

Preparation of 3-fluoro-N-(furan-2-ylmethyl)-4-(morpholin-4-yl)aniline (C)

The 2-Furaldehyde (6.85g, 71mmol) was added to the solution of compound (B) (14g, 71mmol), Molecular sieve (14g) in Tetrahydrofuran (140ml) and the mixture was stirred for 16hr at room temperature. After completion of reaction of reaction, the molecular sieve removed by filtration and the filtrate was evaporated under vacuum. The residue was suspended in Methanol (140ml) then Sodiumborohydride (2.7g, 71mmol) was added slowly and the mixture was stirred for 1 hr at room temperature. After completion of reaction, the reaction mass was evaporated under vacuum. The residue was suspended in ethyl acetate (70ml) and washed with 2×35ml of water. The organic layer dried with sodium sulfate and slowly poured into n-hexane (140ml) at room temperature. Stirred for 3hr at room temperature. Filtered and washed with hexane (20ml), after drying the yield product was titled as product (C) which is light brown color solid.

Preparation of 2-bromo-N-[3-fluoro-4-(morpholin-4-yl)phenyl]-N-(furan-2-ylmethyl)propanamide (D)

The 2-Bromopropionyl Bromide (12g, 55mmol) was added to the solution of compound (C) (14g, 50mmol), Triethylamine (6.7g, 66mmol) in Dichloromethane (140ml) at 0°C and the mixture was stirred for 15minute at 0°C. After completion of reaction of reaction, the solution was evaporated in vacuum and the residue was suspended in ethyl acetate (70ml) and washed with 2×35ml 10% ammonium chloride solution. The organic layer dried with sodium sulfate and slowly poured into hexane (140ml) at room temperature. Stirred for 2hr at room temperature. Filtered and washed with hexane (20ml), after drying the yield product was titled as product (D) which is light brown color solid.

General method for the synthesis of compounds (8 E – 8 L)

The compound (D) (1mol.Eq) was added to the solution of phenol/substituted phenol (1.1mol.Eq) and potassium tert butoxide (1.5mol.Eq) in N,N-Dimethylforamide (10 volume) and the mixture was stirred for 2hr at room temperature. After completion of reaction, the reaction mass slowly poured into 40 volume of cold water and stirred for 2 hr at room temperature. Filtered and washed with water to get pure crystalline product (8 E – 8 L).

RESULTS AND DISCUSSION

The results are obtained from various spectral data are results discussed below.

4-(2-fluoro-4-nitrophenyl)morpholine (A)
Off-white solid; Yield 87%; M.W: 226.2; Mol. For: $C_{10}H_{11}FN_2O_3$; ^{1}HNMR (400MHz, DMSO-d_6); δ 8.05-8.01 (1H, m), 7.18 (1H, t, J=8.8 Hz), 3.75 (4H, t, J=5.2 Hz), 3.27 (4H, t, J=4.8 Hz).

3-fluoro-4-(morpholin-4-yl) aniline (B)
Off-white solid; Yield 98%; M.W: 196.22; Mol. For: $C_{10}H_{13}FN_2O$; LC-MS (m/z): 197.2 (M+1); ^{1}HNMR (400MHz, DMSO-d_6); δ 6.76 (1H, t, J= 9.6 Hz), 6.36-6.29 (2H, m), 5.01 (2H, s), 3.68 (4H, t, J=4.4 Hz), 2.80 (4H, t, J=3.6 Hz).

3-fluoro-N-(furan-2-ylmethyl)-4-(morpholin-4-yl)aniline (C)
Light brown solid; Yield 76%; M.W: 276.30; Mol. For: $C_{15}H_{17}FN_2O_2$; LC-MS (m/z): 277.2 (M+1); ^{1}HNMR (400MHz, $CDCl_3$); δ 7.36 (1H, s), 6.83 (1H, t, J=11.6 Hz), 6.22-6.45 (4H, m), 4.25 (2H, d, J=4.8 Hz), 3.93 (1H, s), 3.85 (4H, t, J=4.8 Hz), 2.96 (4H, t, J=5.2 Hz.

2-bromo-N-[3-fluoro-4-(morpholin-4-yl)phenyl]-N-(furan-2-ylmethyl)propanamide (D)
Light brown solid; Yield 92%; M.W: 411.26; Mol. For: $C_{18}H_{20}BrFN_2O_3$; LC-MS (m/z): 412.2 (M+1); ^{1}HNMR (400MHz, $CDCl_3$); δ 7.33 (1H, s), 6.82-6.86 (3H, m), 6.28 (1H, s), 6.18 (1H, d, J=2.8 Hz), 4.74-4.89 (2H, m), 4.18-4.23 (1H, m), 3.87 (4H, t, J=4.4 Hz), 3.12 (4H, t, J=4.4 Hz), 1.74 (3H, d, J=6.4 Hz).

N-(4-Morpholin-3-fluorophenyl)-N-(furan-2-ylmethyl)-2-phenoxypropanamide (8 E)
A white crystalline solid; Yield 82%; M.W: 424.4; Mol.For: $C_{24}H_{25}FN_2O_4$; LC-MS(m/z): 425.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.32 (1H, s), 7.19 (2H, t, J=8.0 Hz), 6.92 (1H, t, J=7.2 Hz), 6.65-6.81 (5H, m), 6.27 (1H, s), 6.14 (1H, s), 4.81 (2H, s), 4.62-4.64 (1H, m), 3.85 (4H, t, J=4.4 Hz), 3.04 (4H, t, J=3.6 Hz), 1.45 (3H, d, J=6.8 Hz).

N-(4-Morpholin-3-fluorophenyl)-N-(furan-2-ylmethyl)-2-(2-methylphenoxy) propanamide (8 F)
A white crystalline solid; Yield 88%; M.W: 438.4; Mol.For: $C_{25}H_{27}FN_2O_4$; LC-MS(m/z): 439.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.32 (1H, s), 6.98-7.09 (2H, m), 6.46-6.85 (4H, m), 6.27 (1H, s), 6.14 (1H, s), 4.80 (2H, s), 4.62-4.64 (1H, m), 3.85 (4H, t, J=4.4 Hz), 3.04 (4H, t, J=2.8 Hz), 2.11 (3H, s), 1.47 (3H, d, J=6.4 Hz).

N-(4-Morpholin-3-fluorophenyl)-2-(4-cyanophenoxy)-N-(furan-2-ylmethyl) propanamide (8 G)
A white crystalline solid; Yield 93%; M.W: 449.4; Mol.For: $C_{25}H_{24}FN_3O_4$; LC-MS(m/z): 450.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.49 (2H, d, J=8.8 Hz), 7.34 (1H, s), 6.70-6.83 (6H, m), 6.29 (1H, s), 6.15 (1H, s), 4.69-4.87 (4H, m), 3.86 (4H, t, J=4.4 Hz), 3.05 (4H, t, J=4.0 Hz), 1.49 (3H, d, J=6.8 Hz).

2-(4-acetylphenoxy)-N-(4-morpholine-3-fluorophenyl)-N-(furan-2-ylmethyl)propanamide (8 H)
A white crystalline solid; Yield 87%; M.W: 466.5; Mol.For: $C_{26}H_{27}FN_2O_5$; LC-MS(m/z): 467.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.84 (2H, d, J=9.2 Hz), 7.33 (1H, s), 6.71-6.84 (5H, m), 6.27 (1H, s), 6.14 (1H, s), 4.72-4.82 (3H, m), 3.84 (4H, t, J=4.4 Hz), 3.04 (4H, t, J=3.6 Hz), 2.53 (3H, s), 1.49 (3H, d, J=6.4 Hz).

N-(4-Morpholine-3-fluorophenyl)-N-(furan-2-ylmethyl)-2-(2-methoxyphenoxy) propanamide (8 I)
A white crystalline solid; Yield 96%; M.W: 454.4; Mol.For: $C_{25}H_{27}FN_2O_5$; LC-MS(m/z): 455.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.30 (1H, s), 6.93 (1H, d, J=7.2 Hz), 6.72-6.81 (3H, m), 6.59 (1H, d, J=8.4 Hz), 6.48 (1H, d, J=12 Hz), 6.26 (1H, s), 6.12 (1H, s), 4.78 (2H, s), 4.64 (1H, m, J=6.8 Hz), 3.85 (4H, t, J=4.8 Hz), 3.03 (4H, t, J=3.6 Hz), 1.46 (3H, d, J=6.4 Hz).

2-(2-acetylphenoxy)-N-(4-morpholine-3-fluorophenyl)-N-(furan-2-ylmethyl) propanamide (8 J)
A white crystalline solid; Yield 88%; M.W: 466.5; Mol.For: $C_{26}H_{27}FN_2O_5$; LC-MS(m/z): 467.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.72 (1H, d, J=1.6 Hz), 7.32 (2H, s), 6.99 (1H, t, J=7.6 Hz), 6.80(1H, t, J=9.6 Hz), 6.58-6.69 (3H, m), 6.27 (1H, s), 6.14 (1H, s), 4.79-4.81 (3H, m), 3.86 (4H, t, J=4.4 Hz), 3.07 (4H, t, J=4.4 Hz), 2.57 (3H, s), 1.56 (3H, d, J=4 Hz).

Methyl2-({1-[(4-morpholin-3-fluorophenyl)(furan-2-ylmethyl)amino]-1-oxopropan-2-yl}oxy)benzoate (8 K)
A white crystalline solid; Yield 91%; M.W: 482.5; Mol.For: $C_{26}H_{27}FN_2O_6$; LC-MS(m/z): 483.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.72 (1H, d, J=7.6 Hz), 7.31 (2H, s), 6.99 (1H, t, J=7.6 Hz), 6.71(1H, t, J=10.8 Hz), 6.54-6.73 (4H, m), 6.27 (1H, s), 6.15 (1H, s), 4.65-4.85 (3H, m), 3.83 (4H, t, J=4.4 Hz), 3.81 (3H, s), 3.01 (4H, t, J=4 Hz), 1.50 (3H, d, J=6.4 Hz).

Methyl 4-({1-[(4-morpholin-3-fluorophenyl) (furan-2-ylmethyl)amino]-1-oxopropan-2-yl}oxy)benzoate (8 L)
A white crystalline solid; Yield 78%; M.W: 482.5; Mol.For: $C_{26}H_{27}FN_2O_6$; LC-MS(m/z): 483.3 (M+1); ^{1}HNMR (400MHz, $CDCl_3$): δ 7.91 (1H, d, J=8.8 Hz), 7.33 (1H, s), 6.68-6.77 (5H, m), 6.28 (1H, s), 6.14 (1H, s), 4.71-4.82 (3H, m), 3.88 (1H, s), 3.84 (4H, t, J=4.8 Hz), 3.03 (4H, t, J=4 Hz), 1.49 (3H, d, J=6.8 Hz).

BIOLOGICAL EVALUATION

Some of the synthesized compounds showed good antimicrobial activity inhibition. Antimicrobial screening results of the tested compounds are shown in Table 2. All the synthesized compounds showed moderate inhibitory activity and some compound showed good antifungal activity inhibition compared to other compound. Antifungal screening results of the tested compounds are shown in Table 2.

Table 2
Antibacterial and Antifungal activity data of compounds (8 E – 8 L).

Compound No.	Inhibition Zone Diameter (mm)								
	I	II	III	IV	V	VI	VII	VIII	IX
8 E	14	16	18	15	12	16	16	19	20
8 F	13	23	27	20	21	19	22	24	29
8 G	12	19	22	24	25	29	26	21	19
8 H	16	26	29	22	23	19	21	28	25
8 I	15	22	19	29	24	27	26	16	18
8 J	18	18	19	14	16	16	17	22	25
8 K	16	23	23	21	20	19	19	22	21
8 L	14	17	20	22	21	23	20	24	22
Control (Solvent)	10	12	13	12	12	13	10	13	14
Ciprofloxacin	---	21	22	15	14	16	17	22	23
Fluconazole	15	---	---	---	---	---	---	---	---

Microbial Cultures Used to test antimicrobial Activity, *Fungus Culture:* I-Candida sp. *Gram Positive Bacteria:* II-Staphylococcus aureus, III-Staphylococcus albus, VIII-Streptococcus faecalis, IX- Bacillus sp. *Gram Negative Bacteria :* IV-Klebsiella pnuemoniae, V-Escherichia coli, VI- Pseudomonas sp, VII-Proteus s.

CONCLUSION

In this study, the synthesis of some fused ring benzomorpholine derivatives (8 E – 8 L) was performed and their structures were confirmed

by ^{1}HNMR, Mass spectroscopy techniques. In addition, the newly synthesized compounds were screened for their antibacterial and antifungal activities. Some of them were found to possess good antifungal and antibacterial activity.

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