RESEARCH ARTICLE

Synthesis and Identification of New (azo-heterocyclic) Derivatives and Study of their Biological Activity as Anti-bacteria and Fungi

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ABSTRACT

This research involved synthesis new heterocyclic compound such as tetrazole, β-lactam, oxazepine, imidazolidine-4-one, thiazolidine-4-one, quinazoline, thayazin-4-on, derivatives, this compound prepared from starting react 5-nitrothiazol-2-amine with 4-hydroxybenzoic acid to gate azo derivative (1), (1) interact with phosphoryl trichloride to produce thiadiazole compound (2), (2) interact with vanillin to produce Schiff base (3), after that (3) react with (sodium azide, chloroacetyl chloride, phthalic anhydride, glycine, alanine, Tryptophan, 2-mercaptobenzoic) to get heterocyclic derivatives All these compound characterized by ^{13}C-NMR, fourier-transform infrared spectroscopy (FT-IR), ^{1}HMNR. We then study the biological properties for all heterocyclic derivatives to ward two different kinds of bacteria and two different kinds of funguses.

Keywords: β-lactam, Azo, Imidazolidine, Oxazepine, Quinazoline, Schiff bases, Tetrazole, Thayazine, Thiazolidine.

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INTRODUCTION

Heterocyclic compounds that have O, N, S as hetero atoms are very important because of the applications.[1,2] In this research, we prepare many kinds of heterocyclic derivatives such as β-lactam using as antimicrobial agents such as cephalosporin and penicillin's[3,4] Imidazolidin-one and thiazolidine and tetrazole are five-membered with a good stability and using in biological activities such as anticancer, antidiabetic, antibacterial, antioxidant, and anti-hyperglycemic.[5,6]

Quinazolines and thiazine derivatives have six-membered containing (N and S) respectively, such as antitubercular, anti-inflammatory, antimicrobial, antipyretic, anti-HIV, analgesic, antitumor, and calcium channel modulatory activities.[7,8]

Oxazepine derivatives have some important pharmacological, biological properties, such as enzyme inhibitors, analgesic etc.[9,10]

Materials

" (FTIR) Spectra (400 -4000 cm-1) in KBr disk were recorded on SHIMADZU FTIR-8400S Fourier transform. ^{13}C-NMR and ^{1}HNMR were recorded on Varian Agilent USA at (500MHz) with (DMSO-d6) measurements were made at Department of Chemistry, Tehran University, Iran."

Methods

Preparation of compound (1):- 4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl) benzoic acid[11]

(0.01) (1.45 g) of 5-nitro-2-amino thiazole was dissolved in a solution consisting of (8 mL) hydrochloric acid with the mixture cooled to 0-5°C and then added sodium nitrite (0.8 g) $NaNO_2$ (0.01 mol) Dissolved in (10 mL) distilled water afterward (with 20 minutes). Then add the solution with a brown color drop as a drop to a solution consisting of (1.38 g) (0.01 mol) of parar hydroxybenzoic acid and (2 g) of NaOH dissolved in (70 mL) distilled and cooled water to (20°C) and (10 mL) ethanol was observed The Azo composite deposit is the dark brown color after completing the addition process. This process was carried out in PH = 5 and the solution is left for (24 hours) after which the precipitate was filtered and then the precipitate was collected after filtering and washed with distilled water and dried and recrystallized with ethanol.

Preparation of compound (2):- 4-(5-amino-1,3,4-thiadiazol-2-yl)-2-((5-nitrothiazol-2-yl)diazenyl)phenol

In a dual nozzle flask with a magnetic stirrer and condensate (1.73 g) (0.005 mol) of thiosemicarbazide was dissolved in (8ml) of phosphorous-oxychloride ($POCl_3$) with stirring for (3 hours) after that the mixture was left to cool and then added (40 mL) of Slowly distilled water and after completing the addition process, the mixture is reflexed of (4 hours), then filter the mixture and treat the filtrate with a potassium hydroxide solution until the solution becomes neutral, then collect the precipitate after its filtering and wash it with distilled water, dry it and recrystallize it with absolute ethanol.

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Preparation of compound (3):- 4-(((5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl) imino)methyl)-2-methoxyphenol[12]

In a double-beaker flask, (0.33 g) (0.001) of derivative (2) was mixed with (0.1521 g) (0.001 mol) of vanillin compound with 20 mL of ethyl alcohol added to it (three drops) of glacial acetic acid and the mixture up and left for 2 hours at a 78°C temperature and then cool the mixture and leave it for 24 hours and then recrystallize it with absolute ethyl alcohol.

Preparation of compound (4):- 4-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-3-(4-hydroxy-3-methoxyphenyl)-3,4-dihydrobenzo[e][1,3] oxazepine-1,5-dione[13]

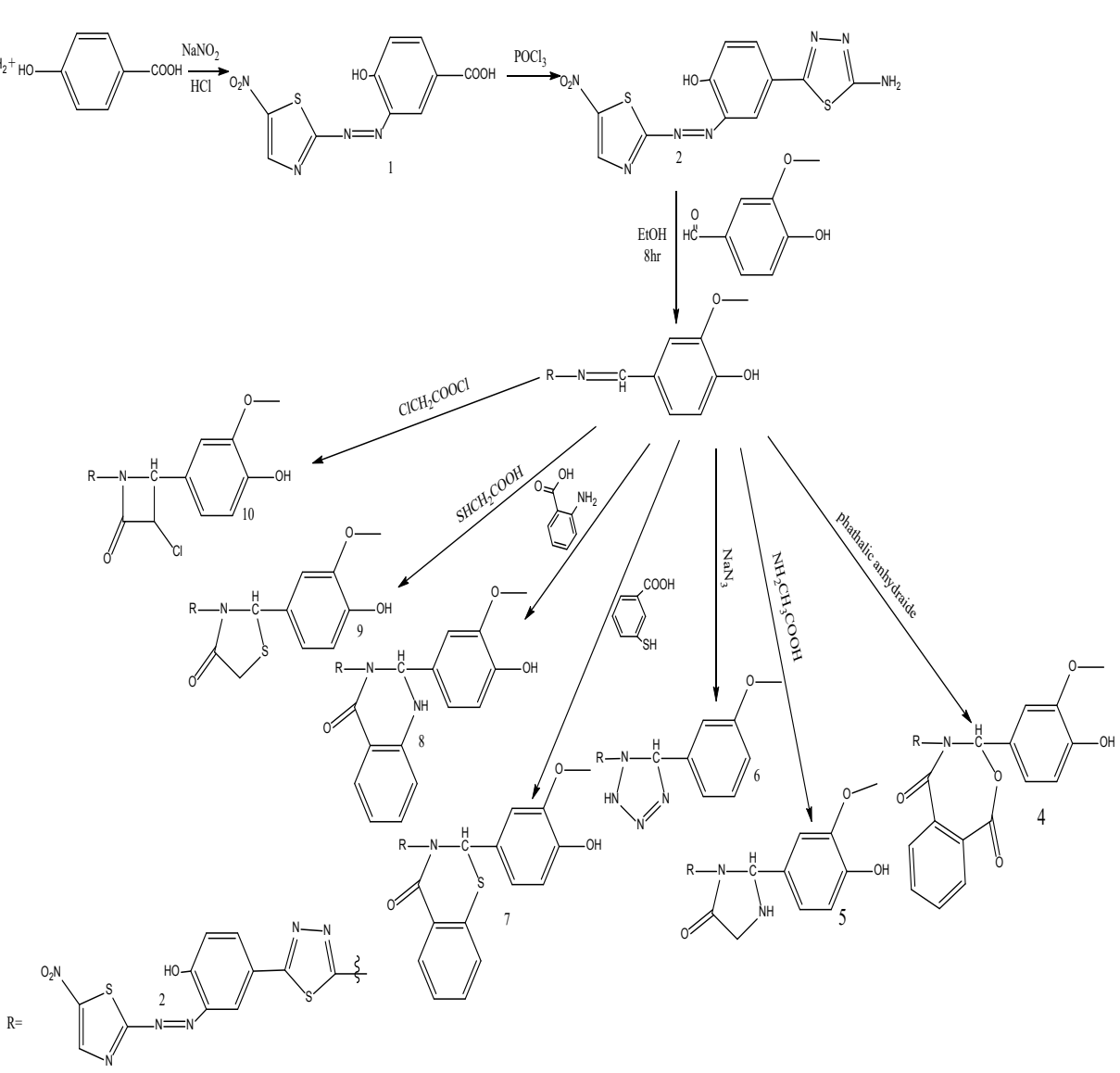
(0.59 g) (0.0017 mol) was dissolved from the dissolving Schiff base compound in (30 mL) of benzene with (0.1585 g) of phthalic anhydride. The mixture was raised at a temperature 50°C and for a period of 14 hours with follow-up of the reaction using TLC technology. Then the result was cooled, the precipitate was filtered, and it was recrystallized with absolute ethyl alcohol.

Preparation of compound (5):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl) imidazolidin-4-one[14]

(0.59g) (0.0017 mL) of the base compound were mixed with (0.0985 g) of dissolved thioglycolic acid in (20 mL) from 1-4 dioxane was added to this mixture, at a temperature (0°C) and for a period (8 hours) with Follow the progress of the interaction with thin layer chromatography (TLC) technology, filter the precipitate and finance its crystallization with absolute alcohol.

Preparation of compound (6):- 4-(1-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2,5-dihydro-1H-tetrazol-5-yl)-2-methoxyphenol[15]

(0.59g) (0.0017mol) of the dissolved Schiff base compound was mixed in 20 mL 1-4 dioxane with continuous stirring until dissolution with 0.0695 g of sodium azide and reflexes for 24–48 hours with follow-up of the reaction using a technique



Scheme 1: prepare of some heterocyclic compounds

TLC then filter the precipitate and recrystallize it with absolute ethyl alcohol

Preparation of compound (7):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl)-2,3-dihydro-4H-benzo[e][1,3] thiazin-4-one[16]

(0.59g) (0.0017mol) of Schiff base compound was mixed in 22 mL of benzene with (0.1649g) of 2-mercapto benzoic acid 3 mL of DMF then add drops of triethylamine to the reaction mixture and from Then reflex for 4 hours, then the product was filtered and recrystallized with absolute ethanol.

Preparation of compound (8):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl)-2,3-dihydroquinazolin-4(1H)-one[1]

(0.59g) (0.0017mol) of dissolved schiff base compound was mixed in (1-4-dioxane 20 mL with 0.1469 g of (anthranilic acid) then add drops of DMF and reflex of 20 hours and then re-crystallized the product with absolute ethanol .

Preparation of compound (9):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl) thiazolidin-4-one[17]

(0.59g) (0.0017 mol) of the dissolved Schiff base compound was mixed in 15 mL THF with (0.0802g) of glycine dissolved in 15 mL THF and reflex of 24 hours and left for 24 hours the precipitate was filtered and recrystallized with absolute ethyl alcohol .

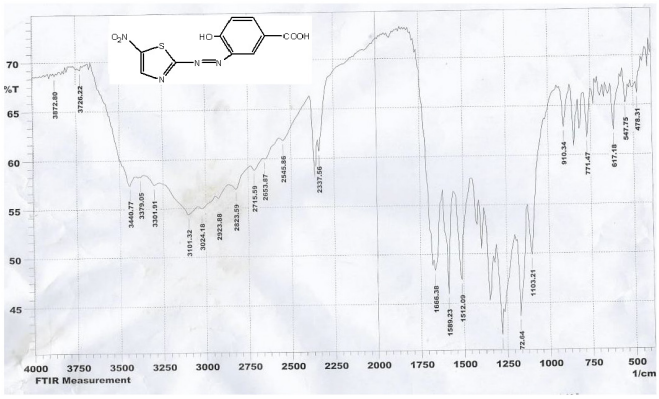


Figure 1: FTIR spectrum of compound 1

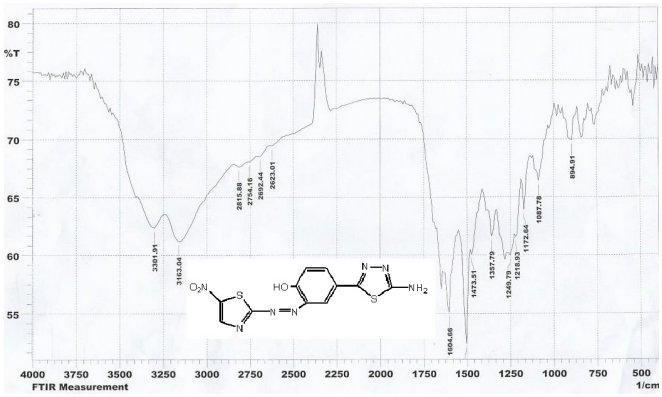


Figure 2: FTIR spectrum of compound (2)

Preparation of compound (10):- 3-chloro-1-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-4-(4-hydroxy-3-methoxyphenyl) azetidin-2-one[18]

(0.59g) (0.0017 mol) was mixed from the Schiff base with 0.440 mL of trimethylamine in 20 mL 1,4 dioxane was added to this cooled mixture with stirring 0.038 mL in the form of drops of chloracetyl chloride at temperature 10°C for 6 hours then the precipitate was filtered and recrystallized with absolute ethyl alcohol.

RESULTS AND DISCUSSION

Derivative (1) 4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl) benzoic acid

FTIR spectrum data for derivative (1)show band at 3440 cm^{-1} for (O–H),3070 cm^{-1} for (Ar –H), 1720 cm^{-1} for (C=O), 1666 cm^{-1} for (C=N), 1512 cm^{-1} for (C=C) aromatic shown in the Figure 1.

Compound (2) 4-(5-amino-1,3,4-thiadiazol-2-yl)-2-((5-nitrothiazol-2-yl)diazenyl)phenol

FTIR spectrum data for derivative (2) show peak at 3301 cm^{-1} for (N – H), 3020 cm^{-1}(Ar – H), 1666 cm^{-1} for (C=N), 1604 cm^{-1} for (C=C) aromatic and absence two band at 3040 cm^{-1} for OH and band at 1720 cm^{-1} for C=O are shown in the Figure 2.

Compound (3) 4-(((5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)imino)methyl)-2-methoxyphenol

FTIR spectrum data for derivative (3) show band at 3163 cm^{-1} for (O – H) 3028 for (Ar – H), 2947cm^{-1} for (C- H) in CH_3, 1667 cm^{-1} for (C=N), 1609 cm^{-1} for (C=C) are shown in the Figure 3.

Derivative (4) 4-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-3-(4-hydroxy-3-methoxyphenyl)-3,4-dihydrobenzo[e][1,3]oxazepine-1,5-dione

FTIR spectrum data for derivative (4) show peak at 3390 cm^{-1} for (O – H), 3024 for (Ar – H), 2947cm^{-1} for (C- H) in CH_3, 1668 cm^{-1} for (C=O), 1690 cm^{-1}C=O lactam, 1589 cm^{-1} for (C=C) . ^{1}HMNR spectrum data of derivative (4) show 2.52ppm (DMSO), 9.7ppm (s, 2H, OH), 1.2ppm (S,3H,

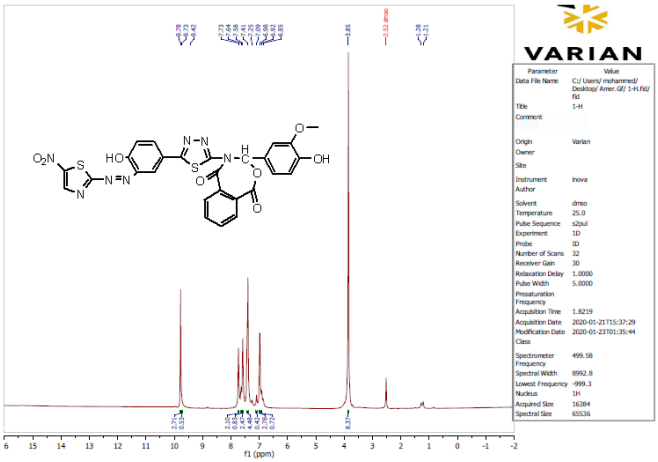


Figure 3: ^{1}H–NMR spectrum of compound (3)

OCH_3),3.8ppm (s, 1H, CH),6.8-7.7ppm (m, 11H, Ar-H), 9.4PPm (1H,C-H,thayazol). The C13–NMR spectrum data (DMSO) compound (4) show: 12 ppm (C_{28}), 56 ppm (C_{30}), 169 ppm (C_{31},C_{32}), 169 ppm (C_4,C_{14},C_{17}),153 ppm (C_{12}, C_{31}),148 ppm (C_{24}), 137 (C_1) 111-131 ppm (C_{Arom}) are shown in the Figure 4.

Compound (5)3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl) imidazolidin-4-one

FT-IR spectrum data for derivative (5) show peak at 3340 cm^{-1} for (O – H), 3070 for (Ar – H), 2916cm^{-1} for (C- H) in CH_3, 1696 cm^{-1} for (C=O), 1512 cm^{-1} for (C=C) . ^{1}HMNR spectrum

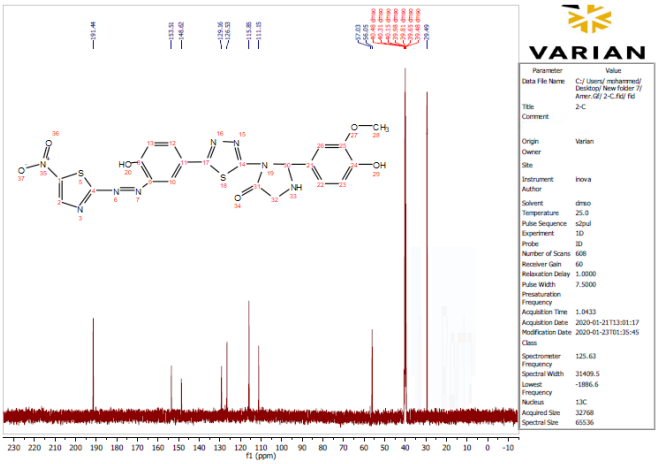


Figure 4: ^{13}C–NMR spectrum of compound (4)

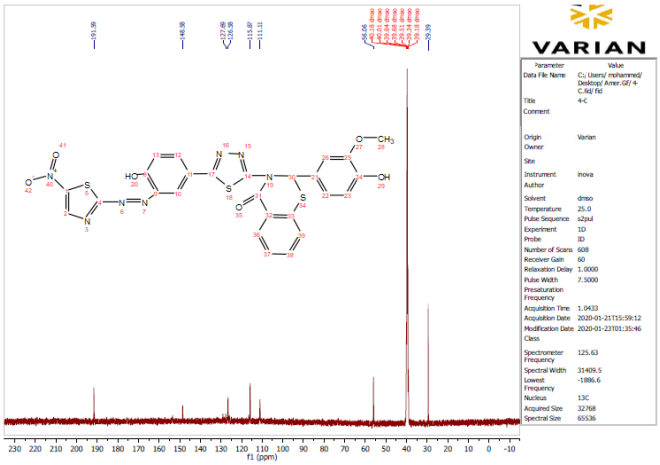


Figure 5: ^{13}C–NMR spectrum of compound (6)

data of derivative (5) show 10.27 ppm (s, 1H, NH), 1.4 ppm (S,3H, OCH_3),3.8ppm (s, 1H, CH), 1.8 ppm (s, 2H, CH_2), 6.8-7.8 ppm (m, 11H, Ar-H) 8.1 ppm (1H,C-H,thayazol), 9.7 (S,2H,OH). The C^{13}–NMR spectrum data (DMSO) compound (5) show :29 ppm (C_{28}), 56 ppm (C_{30}), 57 ppm (C_{32}), 153 ppm (C_4,C_{14},C_{17}) 148 ppm (C_{24}), 111-129 ppm (C_{Arom}).

Compound (6):-4-(1-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol -2 -yl) -2,5-dihydro-1H-tetrazol-5-yl)-2-methoxyphenol

FT-IR spectrum data for derivative (6) show peak at 3212 cm^{-1} for (O – H), 3097 for (Ar – H), 2925 cm^{-1} for (C- H) in CH_3, 1666 cm^{-1} for (C=O), 1512 cm^{-1} for (C=C). ^{1}HMNR spectrum data of compound (5) show 9.7ppm (s, 1H, OH), 2.1ppm (S,3H, OCH_3), 3.8 ppm (s, 1H, CH), 1.8 ppm (s, 2H, CH_2), 6.8-7.8 ppm (m, 7H, Ar-H) 8.81ppm (1H,C-H,thayazol) are shown in the Figure 5. The C^{13}–NMR spectrum data (DMSO) compound (6) show: 20 ppm (C_{28}), 56.01 ppm (C_{30}), 153 ppm (C_4,C_{14},C_{17}) 148 ppm (C_{24}), 111-129 ppm (C_{Arom}) .

Derivative (7):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl)-2,3-dihydro-4H-benzo[e][1,3]thiazin-4-one

FTIR spectrum data for derivative (7) show peak at 3332 cm^{-1} for (O – H), 3090 for (Ar – H), 2916 cm^{-1} for (C- H) in CH_3, 1681 cm^{-1} for (C=O), 1583 cm^{-1} for (C=N) 1512 cm^{-1} for (C=C). ^{1}HMNR spectrum data of compound (7) show 10.4 ppm (s, 1H, OH), 2.1ppm (S,3H, OCH_3) 6.8-8.1ppm (m, 11H, Ar-H) 8.4ppm (1H,C-H,thayazol). The C^{13}–NMR spectrum data (DMSO) compound (7) show :29.1 ppm (C_{28}), 56.05 ppm (C_{30}), 153 ppm (C_4,C_{14},C_{17}), 191 ppm (C_{31}), 111-127 ppm (C_{Arom}).

Compound (8):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl)-2,3-dihydroquinazolin-4(1H)-one

The FTIR spectrum data for derivative (8) show peak at 3292 cm^{-1} for (O – H), 3070 for (Ar – H), 2908 cm^{-1} for (C- H) in CH_3, 1666 cm^{-1} for (C=O), 1604 cm^{-1} for (C=N), 1580 cm^{-1} for (C=C. ^{1}HMNR spectrum data of compound (8) show 10.3 ppm (s, 1H, NH), 2.7ppm (S,3H, OCH_3),3.4ppm (s, 1H, CH), 6.5-7.9 ppm (m, 11H, Ar-H) 8.81ppm (1H,C-H,thaiazol), 9.8, 9.4 (S,2H,OH). The C^{13}–NMR spectrum data (DMSO) compound (8) show: 16.6 ppm (C_{28}), 56 ppm (C_{30}), 153 ppm

Table 1: Results of the antibacterial activity for 1-7 derivatives

Comp No	*Staph aureus*	*mm*	*E. Coli*	*mm*
1	++	15	++	15
2	+++	32	+++	25
3	+++	30	+++	22
4	+++	25	+++	25
5	+++	35	+++	35
6	+++	25	+++	35
7	+++	30	+++	25

"+= (5-10)mm =slightly active, ++= 11–20 mm moderately +++ = more than 20, good active"

Table 2: Results of the anti against activity for 1-7 derivatives

Comp No	*asper gillus*	*mm*	*Pencellium*	*mm*
1	+	5	++	10
2	+	7	+	5
3	++	10	+	7
4	+	7	-	3
5	++	13	++	10
6	+	5	++	15
7	+	9	++	10

Table 3: Physical and analytical data of compounds 1-10

Comp	*M.F M.wat*	*mp*	*Rf*	*Colour*	*%*
1	$C_{10}H_6N_4O_5S$ 294.24	190	0.34	Black	72
2	$C_{11}H_7N_7O_3S_2$ 349.34	123	0.16	Brown	86
3	$C_{19}H_{13}N_7O_5S_2$ 483.48	178	0.19	Black	93
4	$C_{27}H_{17}N_7O_8S_2$ 631.59	134	0.13	Brown	86
5	$C_{21}H_{16}N_8O_6S_2$ 540.53	126	0.27	Brown	73
6	$C_{19}H_{14}N_{10}O_5S_2$ 526.51	158	0.21	Brown	87
7	$C_{26}H_{17}N_7O_6S_3$ 619.65	Serum	0.18	Black	82
8	$C_{26}H_{18}N_8O_6S_2$ 602.60	Serum	0.13	Black	79
9	$C_{21}H_{15}N_7O_6S_3$ 557.57	119	0.27	Black	75
10	$C_{21}H_{14}ClN_7O_6S_2$ 559.96	Serum	0.12	Brown	78

(C_4,C_{14},C_{17}) 191 ppm (C_{31}), 111-134ppm (C_{Arom}) .

Compound (9):- 3-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl) diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-2-(4-hydroxy-3-methoxyphenyl) thiazolidin-4-one

FT-IR spectrum data for derivative (9) show band at 3425 cm^{-1} for (O – H), 3016 for (Ar – H), 2978 cm^{-1} for (C- H) in CH_3, 1666 cm^{-1} for (C=O), 1589 cm^{-1} for (C=N), 1512 cm^{-1} for (C=C). 1HMNR spectrum data of compound (9) show 10.27 ppm (s, 2H, OH), 0.8 ppm (S,3H, OCH_3),1.19ppm (s, ^{1}H, CH), 1.18 ppm (s, 2H, CH_2), 6.9-8 ppm (m, 11H, Ar-H) 8. 1 ppm (1H,C-H,thayazol). The C^{13}–NMR spectrum data (DMSO) compound (9) show :29.1 ppm (C_{28}), 56.05 ppm (C_{30}), 153 ppm (C_4,C_{14},C_{17}), 111-129 ppm (C_{Arom}) .

Compound (10):- 3-chloro-1-(5-(4-hydroxy-3-((5-nitrothiazol-2-yl)diazenyl)phenyl)-1,3,4-thiadiazol-2-yl)-4-(4-hydroxy-3-methoxyphenyl) azetidin-2-one

FT-IR spectrum data for derivative (10) show band at 3178 cm^{-1} for (O – H), 3000 for (Ar – H), 2916 cm^{-1} for (C- H) in CH_3, 1666 cm^{-1} for (C=O), 1560 cm^{-1} for (C=O), 1514 cm^{-1} for (C=C). ^{1}HMNR spectrum data of derivative (10) show 9.9 ppm (s, 1H, OH), 1.4 ppm (S, 3H, OCH_3),3.6 ppm (d, 1H, CH-Cl), 3,6 ppm (d, 1H, NC-H), 6.5-7.6 ppm (m, 7H, Ar-H) 9.7 ppm

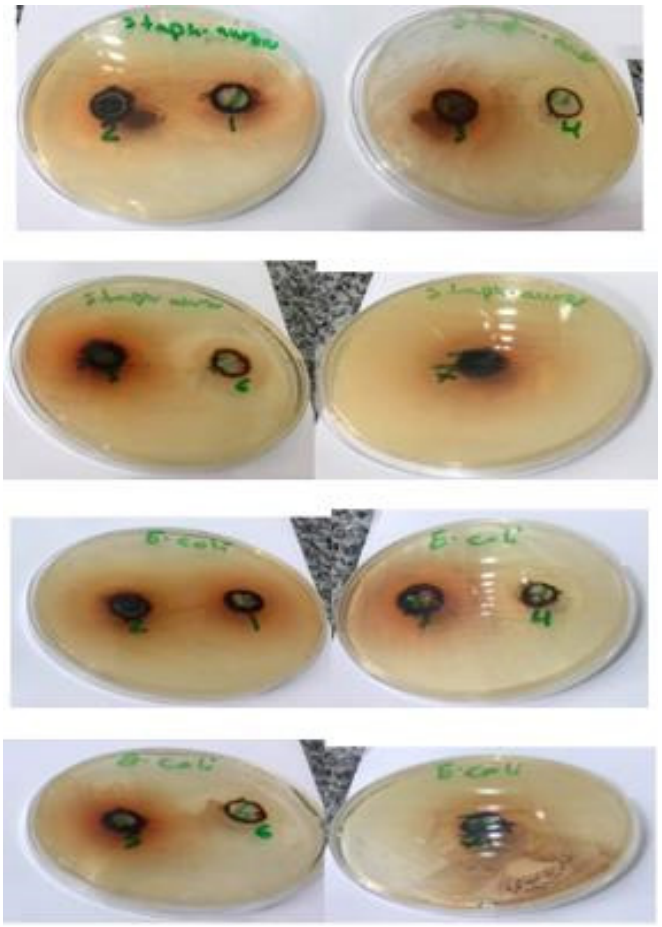


Figure 6: Effect componds (Staph Aureus) aginst and (*E.Coli*) aginst

(1H,C-H,thayazol). The C^{13}–NMR spectrum data (DMSO) compound (10) show :8.7 ppm (C_{28}), 56 ppm (C_{30}), 45ppm (C_{32}), 1991.44 ppm (C_{31}), 153ppm (C_4,C_{14},C_{17}) 148 ppm (C_{24}), 111-129 ppm (C_{Arom}) .

Biological Activity

1- antibacterial

The results show that derivatives reduce significant antibacterial effectiveness against bacteria "staphylococcus aurous and Escherichia coli." the compounds that show good activity are (1,3,4,5,6,7) against (staphylococcus aurous), and compound that show very good activity are (1-7) against (*Escherichia coli*), results of the antibacterial activity shown in the Figure 6 and Tables 1 and 2.

1- antifungal

In the above studies, the prepared derivatives reduce significant antifungal effectiveness against funguses aspergillus and penicillium. the compounds that show good activity are (3,5,7) against (aspergillus), and the compound that shows good activity is (1,5,7) against (penicillium) are shown in the Table 3.

REFERENCE

1. Alrecabi ZG, Alfraiji RA, Al-Majidi SM. Synthesis, Identification of Some New Derivatives of Oxazpine, Thiazinone and Hydroquinazoline and Evaluation of Antibacterial Activity. Iraqi Journal of Science. (2017);58(3C):1565-1579.

2. Az Ad I, Hassan F, SAqUIb M, AHMA N, Khan AR, Al-Sehemi AG, et al. A Critical Review on Advances in the Multicomponent Synthesis of Pyrroles. Oriental Journal of Chemistry. (2018);34(4):1670-1700.
3. Li Z, Sharma UK, Liu Z, Sharma N, Harvey JN, Van der Eycken EV. Diversity-Oriented Synthesis of β-Lactams and γ-Lactams by Post-Ugi Nucleophilic Cyclization: Lewis Acids as Regioselective Switch. European Journal of Organic Chemistry. (2015);2015(18):3957-3962.
4. Rad JA, Jarrahpour A, Latour C, Sinou V, Brunel JM, Zgou H, et al. Synthesis and antimicrobial/antimalarial activities of novel naphthalimido trans-β-lactam derivatives. Medicinal Chemistry Research. (2017);26(10):2235-2242.
5. Abood ZH, Ali HR, Qabel HA, editors. Microwave synthesis of 2, 3, 5-trisubstituted-1, 3-imidazolidin-4-ones bearing 1, 3, 4-oxadiazole moiety and preliminary evaluation of their antibacterial activity. AIP Conference Proceedings; (2019): AIP Publishing LLC.
6. Abood Zh, Ali Hr, Qabel Ha, Rasheed Oh. Microwave Synthesis and Antibacterial Activities of Some Imidazolidine Derivatives Containing 1, 3, 4-Oxadiazole Moiety. Asian Journal of Chemistry. (2018);30(3): 21-24.
7. Begum S, Begum A, Sujatha D. Therapeutic utility of 1, 3-thiazines-mini review. Saudi J Med Pharm Sci. (2016);2:326-338.
8. Abbas SE, Barsoum FF, Georgey HH, Mohammed ER. Synthesis and antitumor activity of certain 2, 3, 6-trisubstituted quinazolin-4 (3H)-one derivatives. Bulletin of Faculty of Pharmacy, Cairo University. (2013);51(2):273-282.
9. Sallal ZA, Ghanem HT. Synthesis and Identification of New Oxazepine Derivatives bearing Azo group in their structures. Iraqi Journal of Science. (2018); 1-8.
10. Shen J, Xue L, Lin X, Cheng G, Cui X. The base-promoted synthesis of multisubstituted benzo [b][1, 4] oxazepines. Chemical communications. (2016) ;52(16):3292-3295.
11. Yahyazadeh A, Azimi V. Synthesis of some unsymmetrical new Schiff bases from azo dyes. European Chemical Bulletin. (2013);2(7):453-455.
12. Kumar A, Verma S, Mishra AK, Kumar S. Synthesis of some new Schiff bases of Pharmaceutical Interest. Ann Adv Chem. (2017);1: 53-56.
13. Kareem A, Ghanim H. Synthesis and Identification Some of 1, 3-Oxazepine Derivatives. Journal of Applied, Physical and Biochemistry Research. (2015);5(1):45-56.
14. Ramachandran S, Bharathi B, Lavanya R, Nandhini R, Sivaranjani R, Sundhararajan R. Synthesis, characterisation, antimicrobial evaluation of 2-hydroxy phenyl thiazolidine-4-one derivative. Int J Pharm Pharm Sci. (2017);6:278-283.
15. Al-Majidi SM, Rasheed HAM, Al-Mugdadi SFH. Synthesis, Identification and Evaluation of Antimicrobial Activities of some New N-substituted 2-azetidinone, Imidazolidinone and tetrazole derivatives of 2-(methylthio) benzimidazole. International Journal of Science and Research. (2015);78-76.
16. Tony G, Chandran M, Bhat A, Krishnakumar K. Molecular docking studies: 1, 3-thiazine and 1, 3-oxazine derivatives. J Pharm Res. (2014);8(2):136-138.
17. Gupta V, Pandurangan A. Synthesis and Antimicrobial Activity of Some New 5-Oxo-Imidazolidine Derivatives. American Journal of Advanced Drug Delivery. (2013);1(4):413-21.
18. Indrani B, Fredrick F, Bimal K. Microwave-Induced Synthesis of Enantiopure β-Lactams. Mod Chem appl 5: 228. DOI: 10.4172/2329-6798.1000228 Page 2 of 3 Scheme 1: Highly stereospecific synthesis of optically active β-lactam 4. Scheme. (2017);2:3.