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Synthesis, spectral characterization and biological activity of some novel quinoline substituted Thiazolo [4,5-e] azepines derivatives

Sharma Ravi*and Dharam Kishore
Department of Chemistry, Banasthali University, Banasthali-304022, Rajasthan, India
ravi.sharma8278@yahoo.com

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Abstract

A novel series of Quinoline substituted thiazolo fused azepines (3a1-3c3) were synthesized via condensation of N-(5-arylidene- substituted-2-benzylthiazolidin-4-oxo-1,3- thiazolidine-3-yl)-(8-quinolin-yl oxy)-acetamide series (2a-2c) with O-phenyldiamine, O-aminophenol, O-aminothiophenol respectively in the presence of glacial acetic acid and methanol. Compound (2a-2c) were synthesized by condensation of key starting compound N-(4-keto-2-arylthiazolidin-3-yl)-2-(benzazine-8yloxy)ethanamide (1a) with various types of aromatic aldehydes. All these novel compounds were characterized by spectroscopic interpretation methods (i.e. MASS, IR, 1H NMR) and elemental analysis. For all these compounds we have used the micro dilution format to check the amount of antimicrobial agents that is needed to inhibit growth of specific microorganisms.

Keywords: Aminophenol, antimicrobial activity, diazepines, oxazepines, phenylamine, quinoline, thiazepines, 4-thiazolidinone.

Introduction

Quinoline moiety generally occur in various natural complexes (cinchona alkaloids). Quinoline pharmacological studies explain, that several of its subordinated compounds show extraordinary biological activity[1], they are anti-cancer[2], anti-inflammatory[3], anti-allergic[4], anti-microbeal[5], anti-malarial[6] and many subordinates consider as medication for diabetes, depression and obesity etc.

4-Thiazolidinones or Thiazolidine-4-ones are the derived of thiazolidine. They are five membered sulphur, nitrogen and oxygen containing heterocycles. Where second and fifth position are occupied with two methylene groups and a carbonyl (ketone) group situated on fourth position. Literature reveals that Joining of 4-Thiazolidinones skeleton with various heterocycles increase the biological action so many times of various types of pharmacological products. Application of 4-Thiazolidinone are describes as antimicrobial[7], antiviral[8], anti-inflammatory[9], anti-cancer[10], anti-convulsant[11], anti-hyperglycemic in activity[12] and many more useful therapeutic motif.

Benzo-1,5-substituted azepines moieties were present along with thiazolidin moiety in a single molecular framework to provide an additive effect on the overall biological efficiency of the molecules. [1,5]-benzodiazepines are widely used as sedatives, sleep inducers, anesthetics, anticonvulsants, muscle relaxants and also as tranquilizers since 1960 when chlordiazepoxide was introduced as a tranquilizer. Diazepam, a non-nucleoside reverse transcriptase inhibitor (NNRTI) has also been evaluated for the treatment of kidney disease such as chronic nephritis and its tablets (containing dilazep HCl, lactose, starch and cellulose-20:20:50:5) are used for improving hematologists. Some arylpyridodiazepine and thidiazepine derivatives are highly selective HIV-1 inhibitors[13]

Materials and methods

All chemicals and solvents were used of AR-grade. The melting points of all the novel compounds were determined in one end open capillary tubes. The IR spectra were recorded on Bruker FT-IR Spectrometer using KBr pellets in the range 4000-500 cm-1. 1H-NMR spectra were recorded on Bruker 400 NMR spectrometer. Chemical shifts are reported in parts per million (ppm) using tetra methyl silane (TMS) as an internal standard. Mass spectra recorded a waters mass spectrometer. IR, NMR and MS were consistent with assigned structure. Element analysis (CHN) was undertaken with Thermo Scientific analyzer. The completion of reaction and purity of compounds were checked on thin layer chromatography (TLC) on silica gel-G (Merck) coated aluminum plates, visualized by ultra violet light 254 nm and developing solvents were n-hexane: ethylacetate.

General procedure for Preparation of N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3 thiazolidine-3-yl)-(8-quinolin-yl oxy)-acetamide series (2a-2c): N-(4-keto-2-arylthiazolidin-3-yl)-2-(benzazine-8yloxy)ethanamide (1a) (0.01 mol) and different aromatic aldehydes (0.02mol) suspended in dry toluene were taken in a flask equipped with a dean-Stark apparatus fitted with calcium guard tube. catalytic amount of piperidine (0.5mL) was added and the mixture was refluxed with stirring for 10-12 hours. After completion of reaction on

(TLC), cooling the reaction mass, product was precipitated, filtered and washed with cold ethanol (95%) to give compound yield: 60-65% (2a – 2c).

N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3 thi azolidine-3-yl)-(8-quinolin-yloxy)-acetamide (2a): Yield: 60.52%; m.p.:178-180°C; Anal. calcd. for $C_{27}H_{21}N_3O_3S$: C, 69.36; H, 4.53; N, 8.99; Found: C, 69.45; H, 4.44; N, 8.90%. IR (cm-1, KBr): 3310 (N-H stretching, -CONH), 3078 (C-H stretching, aromatic ring), 1690 (>C=O stretching, cyclic amide), 1664 (>C=O stretching, -CONH-), 1330 (>C-N stretching), 1181 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.56 (s, 2H, -OCH_2), 5.94 (s, 1H, -S-CH-N<), 7.30-8.10 (m, 16H, Ar), 8.20 (d, 1H, –CONH). MS: m/z- 467 (M+)

N-(5-(3-Hydroxybenzilidene-substituted-2-benzylthiazolidin -4-oxo-1,3-thiazolidine-3-yl)-(8-quinolin-yloxy) acetamide (2b): Yield: 62.40%; m.p.:158-160°C; Anal. calcd. for $C_{27}H_{21}N_3O_4S$: C, 67.07; H, 4.38; N, 8.69; Found: C, 67.00; H, 4.46; N, 8.77%. IR (cm-1, KBr): 3312 (N-H stretching, -CONH), 3076 (C-H stretching, aromatic ring), 1689 (>C=O stretching, cyclic amide), 1669 (>C=O stretching, -CONH-), 1332 (>C-N stretching), 1182 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.58 (s, 2H, -OCH_2), 5.94 (s, 1H, -S-CH-N<), 7.30-8.10 (m, 16H, Ar), 8.10 (d, 1H, –CONH). MS: m/z- 483 (M+).

N-(5-(3-Chlorobenzilidene-substituted-2-benzylthiazolidin-4-oxo-1,3-thiazolidine-3-yl)-(8-quinolin-yloxy)acetamide (2c): Yield: 60.52%; m.p.:178-180°C; Anal. calcd. for $C_{27}H_{21}N_3O_3S$: C, 69.36; H, 4.53; N, 8.99; Found: C, 69.45; H, 4.44; N, 8.90%. IR (cm-1, KBr): 3310 (N-H stretching, -CONH), 3078 (C-H stretching, aromatic ring), 1690 (>C=O stretching, cyclic amide), 1664 (>C=O stretching, -CONH-), 1330 (>C-N stretching), 1181 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.56 (s, 2H, -OCH2), 5.94 (s, 1H, -S-CH-N<), 7.30-8.10 (m, 16H, Ar), 8.20 (d, 1H, –CONH). MS: m/z- 467 (M+).

General procedure for Preparation of N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin/oxazepin/thiazepine-3 (9H)-yl)-2-(benzazine-8-yl-oxy)ethanamide (3a1-3c3): N-(5-arylidene- substituted-2-benzylthiazolidin-4-oxo-1,3thiazolidine -3-yl)-(8-quinolin-yl oxy)-acetamide (2a-2c) (0.01mole) and O-phenylinediamine/O-aminophenol/O-aminothiophenol (0.02 mole) in methyl alcohol followed by ethanoic acid (0.01mole) at reflux for 10-12 hrs. After completion progress of reacted mass on TLC poured mass into chilled ice water followed by ethyl acetate wash and evaporation to get crude solid and was purified in ethyl alcohol (99%) to give pure compound yield: 60.2-65.3% (3a1-3c3).

N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin-3 (9H)-yl)-2-(benzazine-8-yloxy)ethanamide (3a1): Yield: 60.22%; m.p.:160-162°C; Anal. calcd. for $C_{33}H_{25}N_5O_2S$ C, 71.33; H, 4.53; N, 12.60; Found: C, 71.44; H, 4.62; N, 12.68%. IR (cm-1, KBr): 3362 (N-H stretching, -CONH), 3190 (C-H stretching, aromatic ring), 1688 (>C=O stretching, cyclic amide), 1468 (>C-N stretching), 1236 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.0 (s, 1H, -NH cyclic), 4.49 (s, 2H, -OCH2), 4.92 (s, 1H, -S-CH-N<), 6.60-8.40 (m, 20H, Ar), 8.90 (d, 1H, –CONH). MS: m/z- 557 (M+1).

N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]oxazepin-3 (9H)-yl)-2-(benzazine-8-yloxy)ethanamide (3a2): Yield: 61.80%; m.p.:172-173°C; Anal. calcd. for $C_{33}H_{24}N_4O_3S$ C, 71.21; H, 4.35; N, 10.07; Found: C, 71.32; H, 4.25; N, 10.15%. IR (cm-1, KBr): 3360 (N-H stretching, -CONH), 3180 (C-H stretching, aromatic ring), 1696 (>C=O stretching, cyclic amide), 1472 (>C-N stretching), 1158 (C-S stretching). NMR (400MHz, DMSO-d6): δ=4.62 (s, 2H, -OCH_2), 4.89 (s, 1H, -S-CH-N<), 6.92-8.30 (m, 20H, Ar), 8.84 (s, 1H, –CONH). MS: m/z- 557 (M+1).

N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]thiazepin-3(9H)-yl)-2-(benzazine-8-yloxy)ethanamide (3a3): Yield: 64.20%; m.p.:156-158°C; Anal. calcd. for $C_{33}H_{24}N_4O_2S_2$ C, 69.21; H, 4.22; N, 9.78; Found: C, 69.08; H, 4.29; N, 9.90%. IR (cm-1, KBr): 3341 (N-H stretching, -CONH), 3048 (C-H stretching, aromatic ring), 1692 (>C=O stretching, cyclic amide), 1467 (>C-N stretching), 1232 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.55 (s, 2H, -OCH_2), 4.94 (s, 1H, -S-CH-N<), 7.30-8.30 (m, 20H, Ar), 8.80 (s, 1H, –CONH). MS: m/z- 574 (M+1).

N-10-(3-Phenolic)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e][1,4] diazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)- ethanamide (3b1) Yield: 62.7%; m.p.:188°C; Anal. calcd. for $C_{33}H_{25}N_5O_3S$ C, 69.34; H, 4.41; N, 12.25; Found: C, 69.40; H, 4.50; N, 12.35%. IR (cm-1, KBr): 3342 (N-H stretching, -CONH), 3108 (O-H stretching, aromatic), 3060 (C-H stretching, aromatic ring), 1689 (>C=O stretching, cyclic amide), 1472 (>C-N stretching), 1212 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.0 (s, 1H, -NH cyclic), 4.65 (s, 2H, -OCH_2), 5.30 (s, 1H, -OH cyclic), 6.90-8.36 (m, 20H, Ar), 8.69 (s, 1H, –CONH). MS: m/z- 572 (M+1).

N-10-(3-Phenolic)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e][1,4] oxaazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)- ethanamide (3b2): Yield: 61.7%; m.p.:170°C; Anal. calcd. for $C_{33}H_{24}N_4O_4S$ C, 69.22; H, 4.22; N, 9.78; Found: C, 69.30; H, 4.30; N, 9.87%. IR (cm-1, KBr): 3320 (N-H stretching, -CONH), 2986 (O-H stretching, aromatic), 3080 (C-H stretching, aromatic ring), 1682 (>C=O stretching, cyclic amide), 1452 (>C-N stretching), 1192 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.0 (s, 1H, -NH cyclic), 4.70 (s, 2H, -OCH_2), 5.35 (s, 1H, -OH cyclic), 6.65-8.30 (m, 20H, Ar), 8.86 (s, 1H, –CONH). MS: m/z- 573 (M+1).

N-10-(3-Phenolic)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e][1,4] thiazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3b3): Yield: 65.3%; m.p.:158°C; Anal. calcd. for

$C_{33}H_{24}N_4O_3S_2$ C, 67.33; H, 4.11; N, 9.52; Found: C, 67.40; H, 4.01; N, 9.60%. IR (cm-1, KBr): 3336 (N-H stretching, -CONH), 3010 (O-H stretching, aromatic), 2996 (C-H stretching, aromatic ring), 1672 (>C=O stretching, cyclic amide), 1441 (>C-N stretching), 1186 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.68 (s, 2H, -OCH_2), 5.29 (s, 1H, -OH cyclic), 6.78-8.39 (m, 20H, Ar), 8.72 (s, 1H, –CONH). MS: m/z-588 (M+).

N-10-(3-Chlorobenzyl)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e] [1,4] diazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3c1): Yield: 62.3%; m.p.:190°C; Anal. calcd. for $C_{33}H_{24}ClN_5O_2S$ C, 67.17; H, 4.10; N, 11.87; Found: C, 67.20; H, 4.18; N, 11.78%. IR (cm-1, KBr): 3358 (N-H stretching, -CONH), 3180 (C-H stretching, aromatic ring), 1668 (>C=O stretching, cyclic amide), 1486 (>C-N stretching), 1232 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.2 (s, 1H, -NH cyclic), 4.63 (s, 2H, -OCH2), 4.95 (s, 1H, -S-CH-N<), 6.81-8.86 (m, 19H, Ar), 8.78 (d, 1H, –CONH). MS: m/z- 591 (M+1).

***N*-10-(3-Chlorobenzyl)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e] [1,4]oxazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3c2):** Yield: 64.3%; m.p.:182°C; Anal. calcd. for $C_{33}H_{23}ClN_4O_3S$ C, 67.06; H, 3.92; N, 9.48; Found: C, 66.90; H, 3.99; N, 9.56%. IR (cm-1, KBr): 3372 (N-H stretching, -CONH), 3176 (C-H stretching, aromatic ring), 1674 (>C=O stretching, cyclic amide), 1476 (>C-N stretching), 1220 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.51 (s, 2H, -OCH2), 4.86 (s, 1H, -S-CH-N<), 6.75-8.76 (m, 19H, Ar), 8.68 (d, 1H, –CONH). MS: m/z- 591 (M+).

N-10-(3-Chlorobenzyl)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e] [1,4]thiazepin-3(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3c3): Yield: 62.7%; m.p.:198°C; Anal. calcd. for $C_{33}H_{23}ClN_4O_2S$ C, 65.28; H, 3.82; N, 9.23; Found: C, 65.40; H, 3.92; N, 9.31%. IR (cm-1, KBr): 3360 (N-H stretching, -CONH), 3168 (C-H stretching, aromatic ring), 1665 (>C=O stretching, cyclic amide), 1462 (>C-N stretching), 1232 (C-S stretching). NMR (400MHz, DMSO-d6): δ= 4.64 (s, 2H, -OCH2), 4.76 (s, 1H, -S-CH-N<), 6.63-8.72 (m, 19H, Ar), 8.63 (d, 1H, –CONH). MS: m/z- 608 (M+1).

Results and discussion

In the present work, key starting compound N-(4-keto-2-arylthiazolidin-3-yl)-2-(benzazine-8-yloxy)ethanamide (1a) were as already synthesized and reported by S. Sangu et al[14] from 8-hydroxy quinoline .We have taken these starting compound (1a) and react it with different types of aromatic aldehyde to get novel series of N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3- thiazolidine-3-yl)-(8-quinolin-yl oxy)-acetamide compounds (2a-2c). These compounds (2a-2c) were reacted with O-phenyldiamine, O-aminophenol, O-aminothiophenol to give desire novel thiazolo azepines compounds N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin/oxazepine/thiazepine-3(9H)-yl)-2-(benzazine-8-yl-oxy)ethanamide(3a1-3a3),N--10-(3-Phenolic)2-benzyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin/ oxazepine/thiazepine-3-(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3b1-3b3) and N--10-(3-Chlorobenzyl)-2-benzyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin/oxazepine/thiazepine-3(4aH)-yl)-2-(benzazine-8-yloxy)-ethanamide (3c1-3c3).

The synthesis route is outline in Scheme-1. The chemical structures of the synthesized compounds (3a1-3c3) were characterized by FT-IR, 1H-NMR, MS and elements analysis. The FT-IR spectra of (3a1-3c3)) showed absorption band at 3300-3400cm-1 due to N-H stretching of -CONH, band at 1680-1710cm-1 due to >C=O stretching of -CONH- and band at 1230-1260cm-1 due to >C-S stretching of thiazolidine. The nuclear magnetic resonance (1H-NMR) of (3a1-3c3) showed multiple at δ 7.26-8.85 Ar-H (aromatic region proton) and a sharp singlet appear at δ 4.46-4.61 indicating presence of -OCH2 proton. At δ 4.90-5.02 singlet indicating presence of -S-CH-N< proton. In the mass spectrum, (3a1-3c3) showed a peak at m/z, that conforms its molecular formula. The characterization data of (3a1-3c3) provide strong evidence to proposed structures of all the synthesized compounds. The Physicochemical data, elemental analysis results and spectral data of all the compounds are given in experiment Section.

Antimicrobial activity: The anti-bacterial and antifungal activities of the novel synthesized compounds (3a1-3c3) were evaluated by cup-plate agar diffusion method[15]. All synthesized compounds (3a1-3c3) were screened against Escherichia coli (MTCC-443), Pseudomonas aeruginosa (MTCC-1688), Staphylococcus aureus (MTCC-96), Streptococcus pyogenes (MTCC-442), Candida albicans (MTCC-227), Aspergillus niger (MTCC-282) at 250µg/ml concentration. The solvent used for the preparation of compound solutions (DMF) did not show inhibition against the tested organisms. Ciprofloxacin and Griseofulvin were used as standard for comparisons antibacterial and antifungal activity.

The results of antimicrobial activity of all the Novel compounds were presented in Table-1. Most of synthesized compounds showed significant to moderate antimicrobial activity. Compounds 3a3, 3b3, 3c3 and 3c2 showed significant activity, suggestion that the substitutions of nitro were contribute to their increased antimicrobial activity. Whereas, other compounds showed moderate activity.

Conclusion

We planned and executed to achieve novel quinoline substituted thiazolo [4,5-e] azepines derivatives (3a1-3c3) through feasible methods. The formations of all compounds were confirmed on the basis of spectral data and evaluated antimicrobial activities against strains of bacteria and fungi. All novel compounds (3a1-3c3) showed significant activities for both gram-positive and gram-negative bacteria.

Table-1: Antimicrobial ctivity of the Novel synthesized Thiazolo [4,5-e] azepines compounds.

Compound	Minimum inhibitory concentration (MIC)					
	For bacteria (µg/mL)				For fungi (µg/mL)	
	E.c.	*P.a.*	*S.a.*	*S.p.*	*A.n.*	*C.a.*
$3a_1$	12	10	13	07	11	12
$3a_2$	14	09	11	13	09	11
$3a_3$	17	18	20	17	16	18
$3b_1$	11	13	10	14	12	09
$3b_2$	15	13	11	14	09	12
$3b_3$	20	19	21	18	19	21
$3c_1$	10	15	12	11	13	12
$3c_2$	16	13	14	11	14	13
$3c_3$	19	21	20	19	21	20
Ciprofloxacin	29	30	24	32	-	-
Griseofulvin	-	-		-	36	32

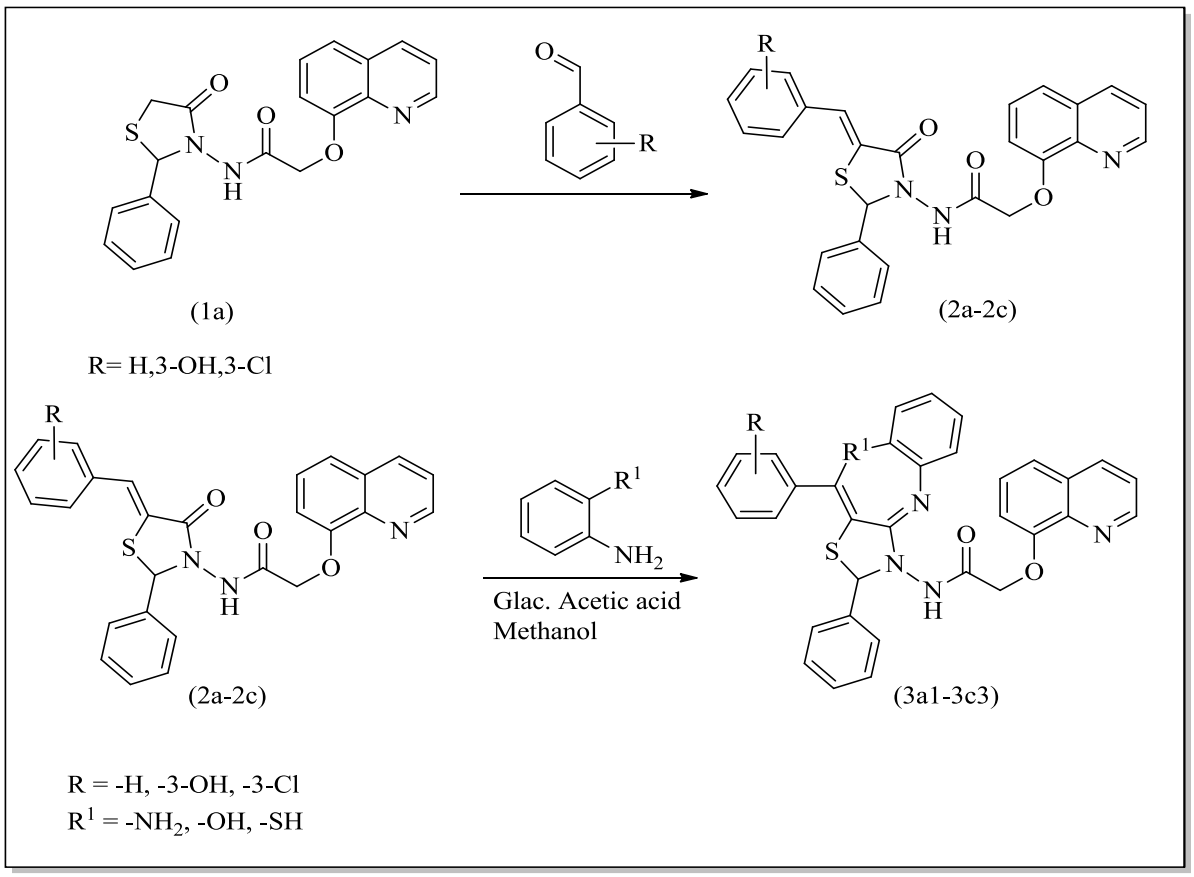

Figure-1: Reaction scheme of novel Thiazolo [4,5-e] azepines compound.

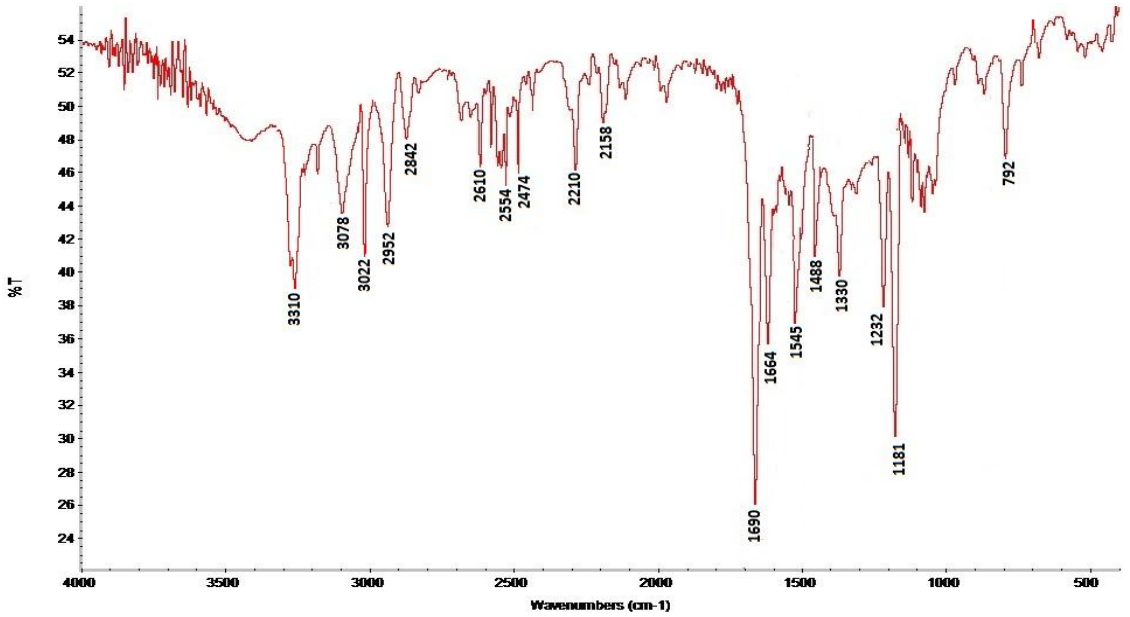

Figure-2: IR spectra of compound (N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3 thiazolidine-3-yl)-(8-quinolin-yl-oxy)-acetamide) (2a).

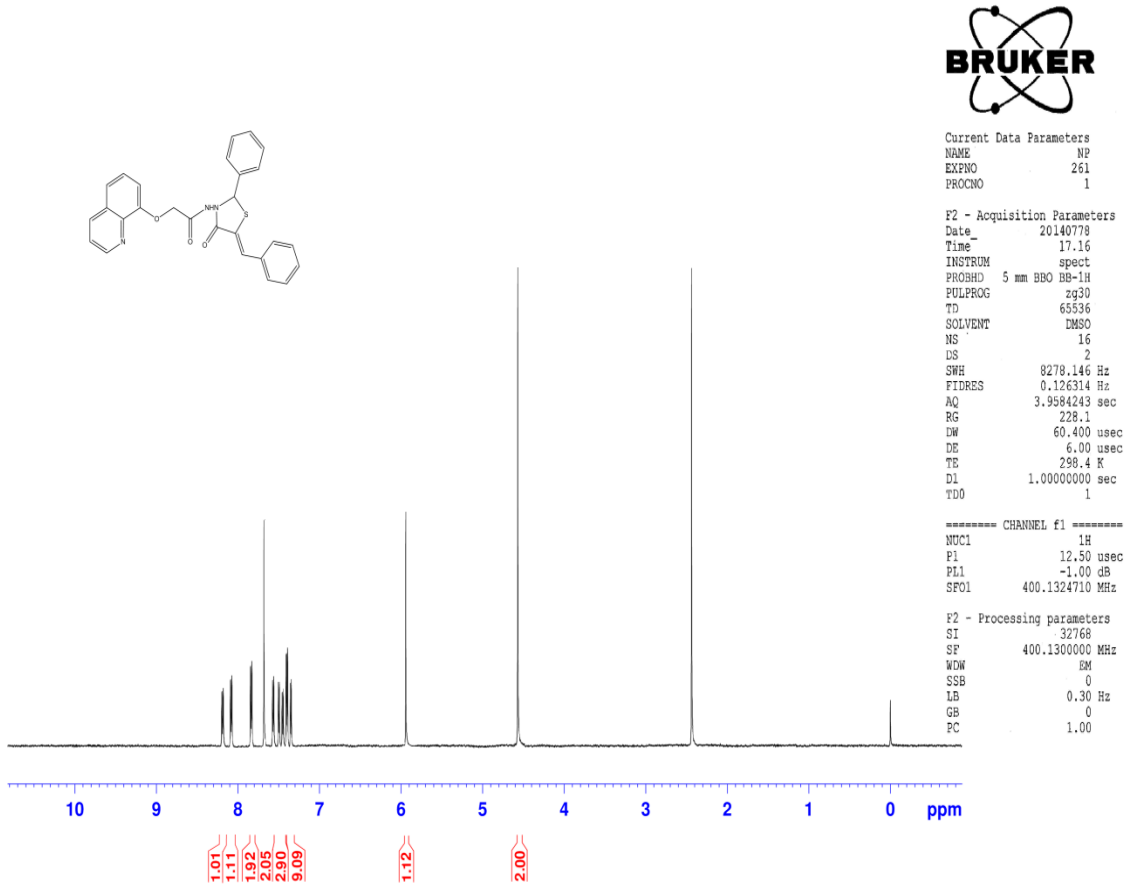

Figure-3: [1]H NMR spectra of compound (N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3-thiazolidine-3-yl)-(8-quinolin-yloxy)-acetamide) (2a).

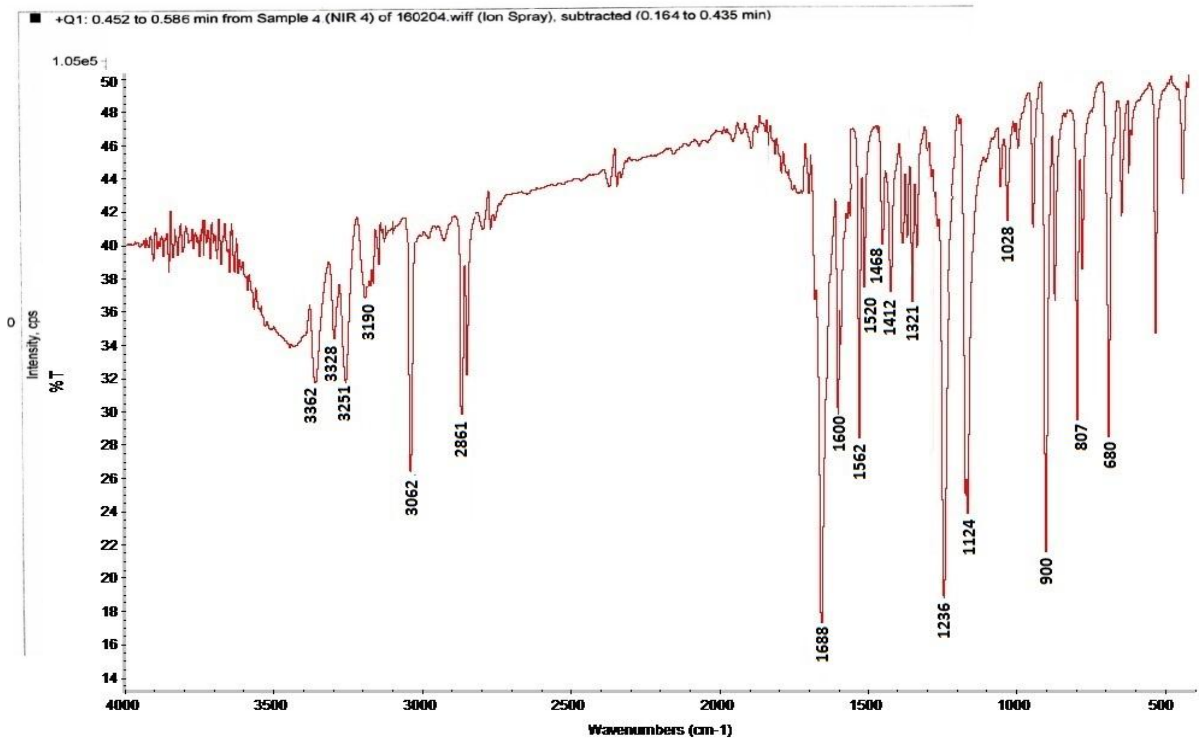

Figure-4: Mass spectra of compound (N-(5-arylidene-substituted-2-benzylthiazolidin-4-oxo-1,3 thiazolidine-3-yl)-(8-quinolin-yloxy)-acetamide) (2a).

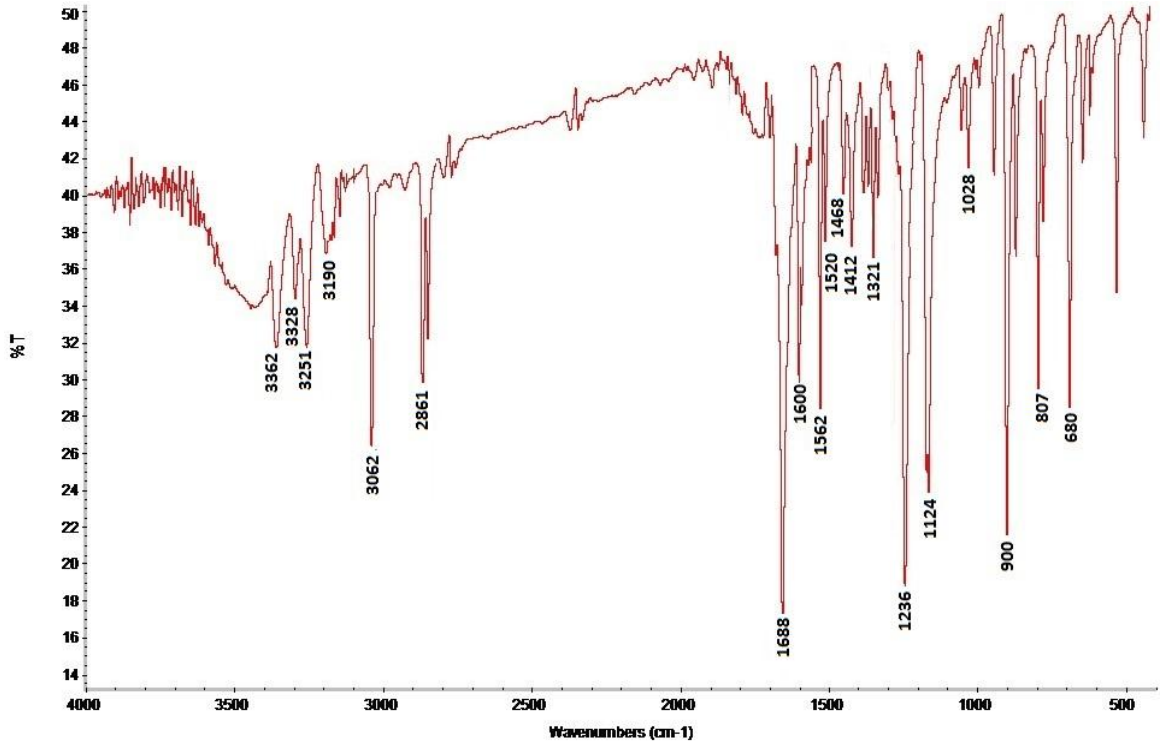

Figure-5: IR spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin-3(9H)yl)-2-(benzazine-8-yl-oxyethanamide) ($3a_1$).

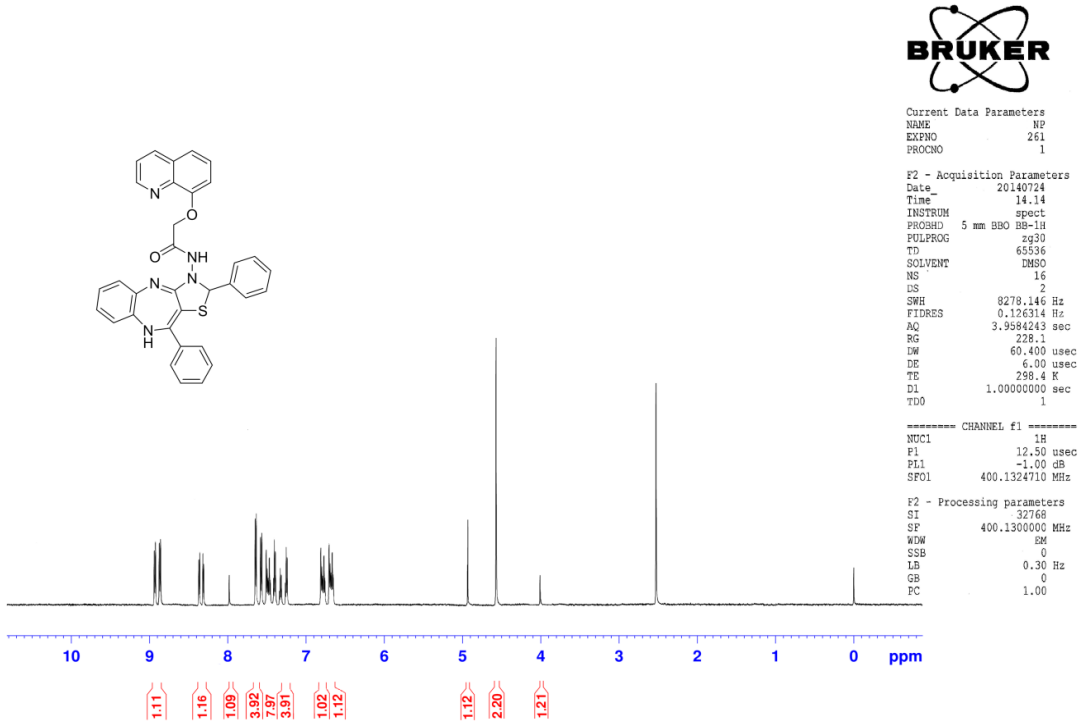

Figure-6: ^{1}H NMR spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin3(9H)yl)-2-(benzazine-8-yloxy)ethanamide) ($3a_1$).

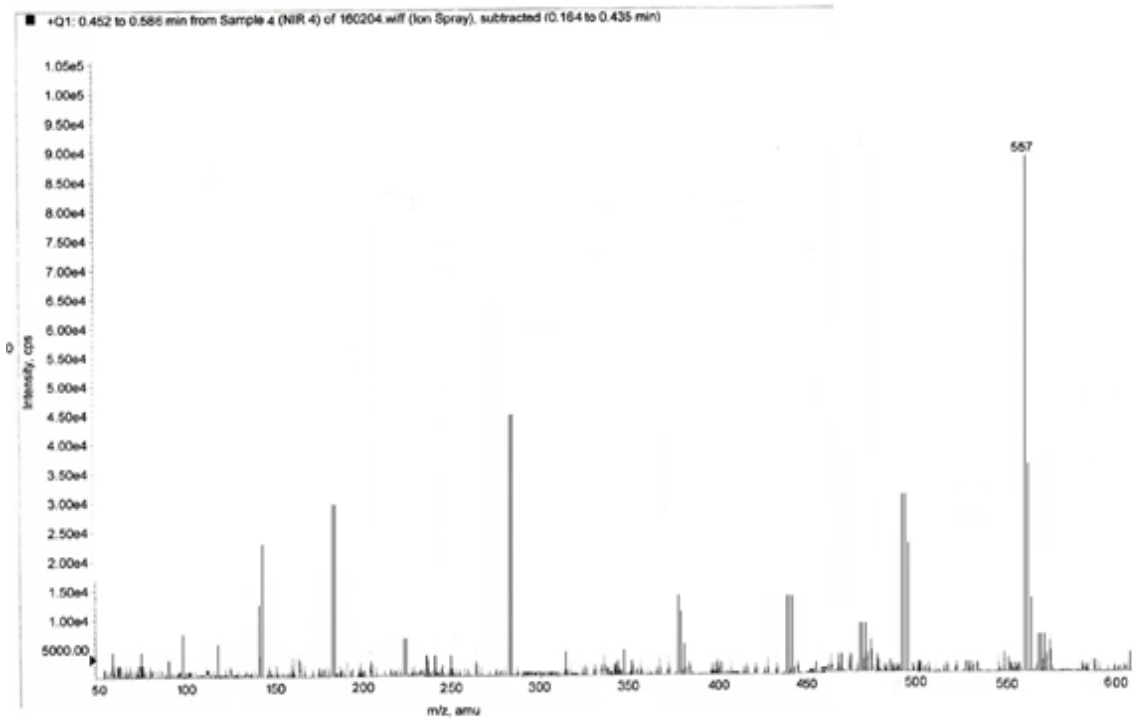

Figure-7: Mass spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]diazepin-3(9H)yl)-2-(benzazine-8-yloxy) ethanamide) ($3a_1$).

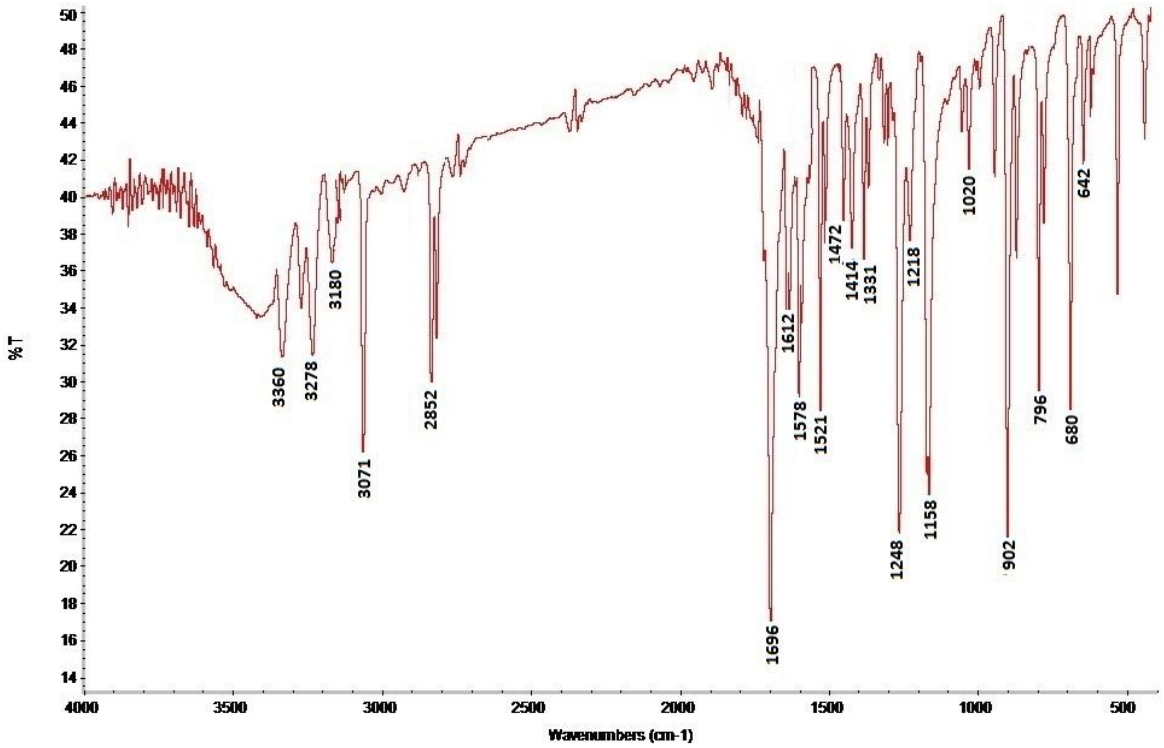

Figure-8: IR spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]oxazepin-3(9H)-yl)-2-(benzazine-8- yloxy) ethanamide) ($3a_2$).

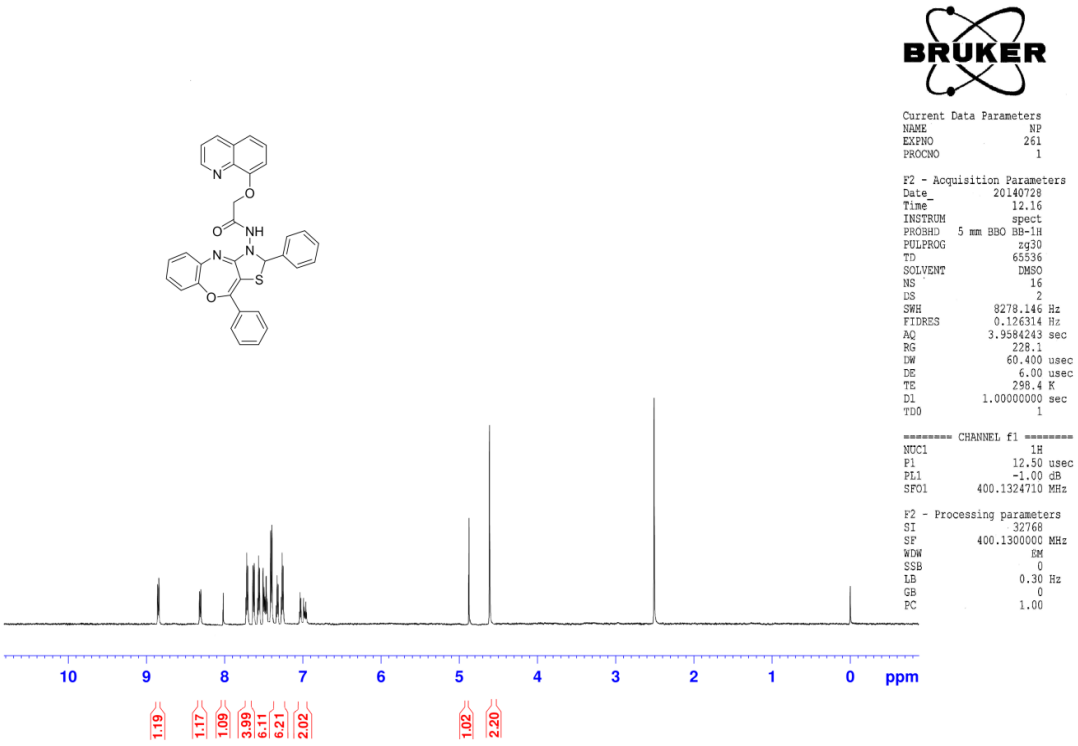

Figure-9: ^{1}H NMR spectra of (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]oxazepin-3(9H)-yl)-2-(benzazine-8-yloxy) ethanamide) ($3a_2$).

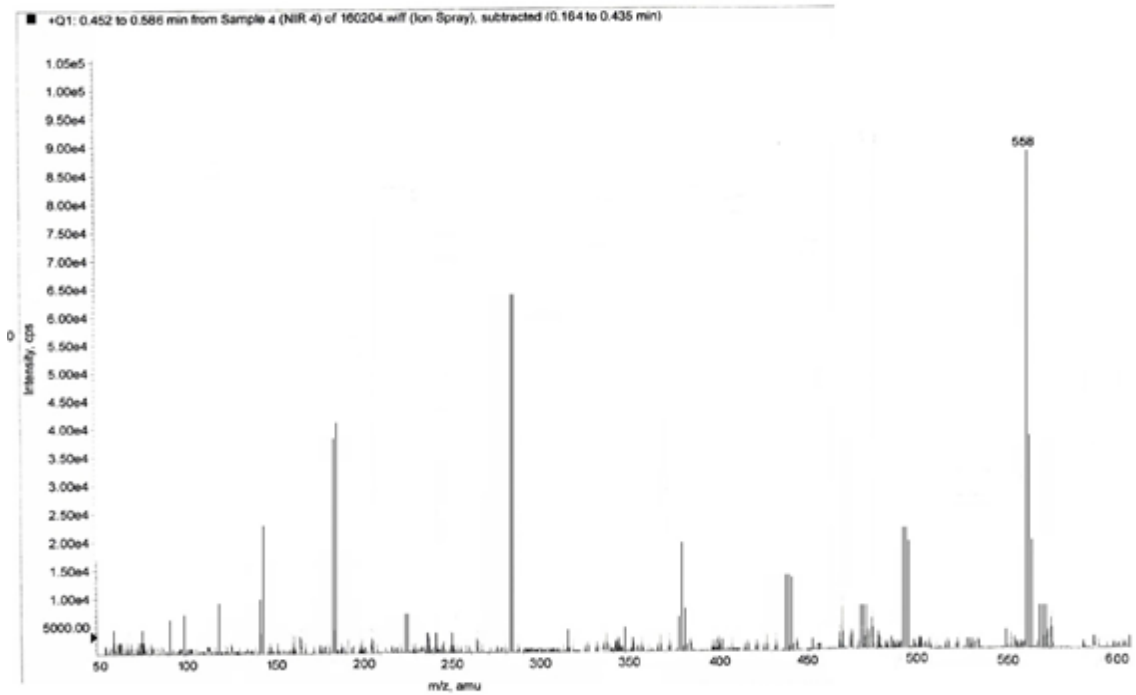

Figure-10: Mass spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]oxazepin-3(9H)-yl)-2-(benzazine-8 yloxy) ethanamide) ($3a_2$).

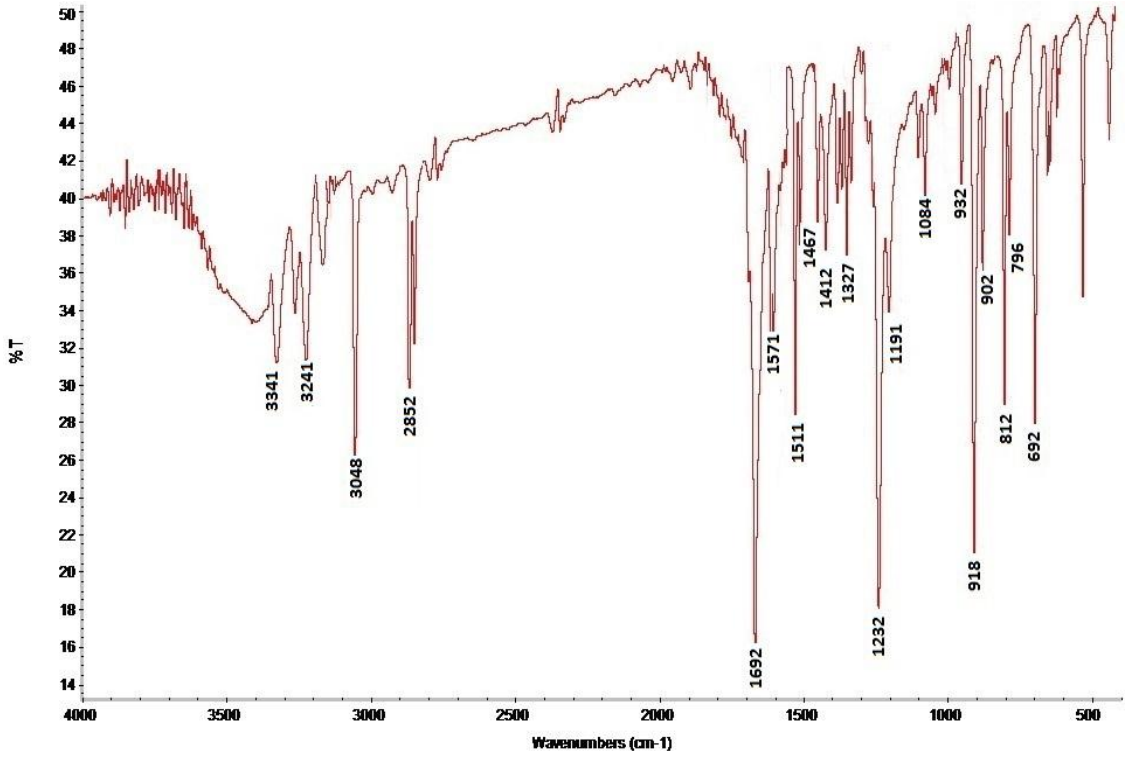

Figure-11: IR spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]thiazepin-3(9H)-yl)-2-(benzazine-8-yloxy)ethanamide) ($3a_3$).

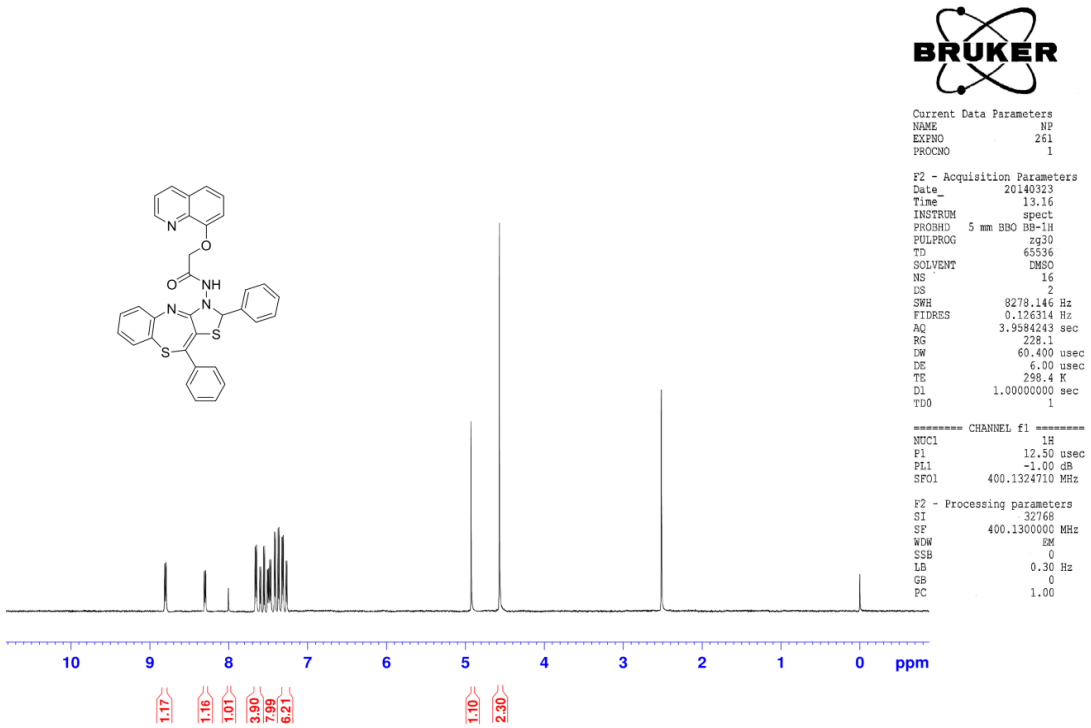

Figure-12: ^{1}H NMR spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]thiazepin-3(9H)-yl)-2-(benzazine-8-yloxy)ethanamide) ($3a_3$).

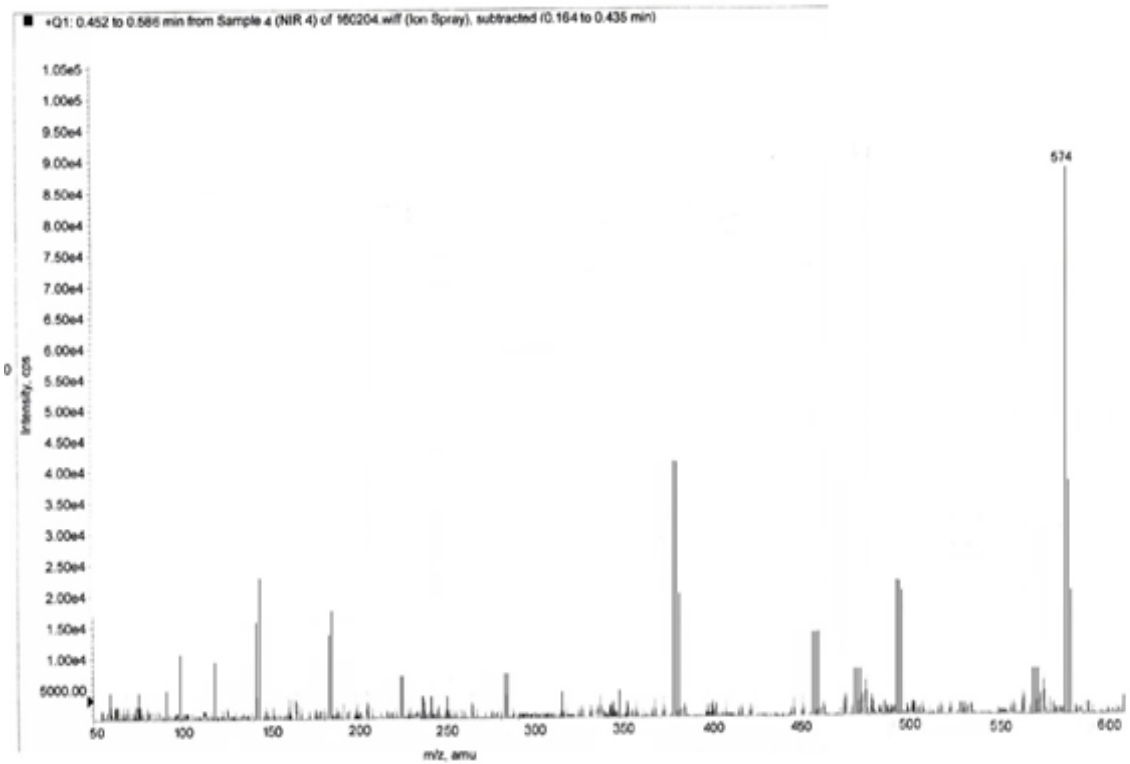

Figure-13: Mass spectra of compound (N-(2,10-biphenyl-2H-aryl[b]thiazolyl[4,5-e][1,4]thiazepin-3(9H)-yl)-2-(benzazine-8-yloxy)ethanamide) ($3a_3$).

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