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Microwave assisted synthesis of hybrid heterocyclics

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Treatment of 2-(2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro [3,4-d][1,3]dioxol-4-yl)-4-oxo-3-phenylthiazolidin-5-yl)acetic acid *o*-phenyl diamine in conventional and microwave irradiation gives 5-((1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-phenylthiazolidin-4-one. Characterization of new compounds has been done by means of IR, NMR, MS and elemental analysis.

Keywords: Hybrid heterocyclics, click reaction, Knovenagel condensation, microwave assisted synthesis, antibacterial activity

1,2,3-Triazoles are one of the most important classes of heterocyclic organic compounds, which are reported to present in a plethora of biological activities for diverse therapeutic areas[1]. The 1,2,3-triazole motif is associated with diverse pharmacological activities such as antibacterial, antifungal, hypoglycemic, antihypertensive and analgesic properties. Polysubstituted five-membered aza heterocyclic's rank the most potent glycosidase inhibitors[2]. Further, this nucleus in combination with or in linking with various other classes of compounds such as amino acids, steroids, aromatic compounds, carbohydrates *etc* became prominent in having various pharmacological properties[3]. 1,2,3-Triazole modified carbohydrates have became easily available after the discovery of the Cu(I) catalyzed azide-alkynes 1,3-dipolar cycloaddition reaction[4] and quickly became a prominent class of non-natural sugars. The chemistry and biology of triazole modified sugars is dominated by Triazole glycosides[5]. Therefore, the synthesis and investigation of biological activity of 1,2,3-triazole glycosides is an important objective, which also received the considerable attention by the medicinal chemists.

Thiazoles are familiar group of heterocyclic compounds possessing a wide variety of biological activities and their utility as medicine is very much estabilished[6]. Thiazole nucleus is also integral part of all the available pencillins which have revolutionized the therapy of bacterial diseases[7]. Furthur the chemistry of thiazolidenone ring system is one considerab interest as it core structure in various synthetic pharmaceuticals displaying a broad spectrum biological activities[8]. The thiazolidenone nucleus also appears frequently in the structure of various natural products notably thiamine, compounds possessing cardiac and glycemic benefits such as troglitazone[9] and many metabolic products of fungi and primitive marine animals, including 2-(aminoalyl) – thiazole – 4- carboxylic acids[10]. Numerous thiazolidenone derivatives have shown significant bio activities such as antidiarrhoeal[11], anticonvulsant[12], antimicrobial[13], antidiabetic[14], antihistaminic[15], anticancer[16], anti HIV[17], Ca^{+2} channel blocker[18], PAF antagonist[19], cardioprotective[20], antiischemic[21], COX inhibitory[22], antiplatelet activating factor[23], non- peptide thrombin receptor antagonist[24], tumor necrosis factor- α antagonist[25] and nematicidal activities. Natural biological substances such as purine bases and vitamin B^{12} include Benzimidazole moiety in their structure. Several Benzimidazole derivatives are reported to exhibit antimicrobial[26-28], anticancer[29,30], antifungal[31,32], antiparasitic[33], antiviral[34], anti-inflammatory[35], and antihistaminic[36] activities.

Microwave irradiation is an alternative heating technique based on the transformation of electromagnetic energy into heat. Often this method increases the rate of chemical reactions[37] and results in higher yields. Microwave energy couples directly with polar molecules or ions and leads to a rapid rise in the temperature of reaction medium[38,39]. Reactions that require hours or even days using conventional heating can usually be completed in minutes or seconds using

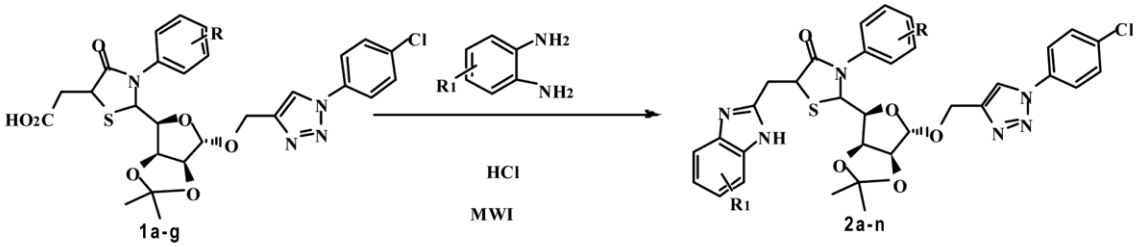
MWs. Several reactions have been performed under MW – assisted conditions with significant rate enhancements, improved yield, and selectivity[39].

Following the successful introduction of antimicrobial agents microwave assisted synthesis, inspired by the biological profile of triazoles, thiazolidinones, benzimidazoles and in the continuation of our work on biological active molecules[40-54] we have developed a series of novel hybrid heterocyclics (Scheme I, Table I) and investigated the application of microwave irradiation for the synthesis of our hybrid molecules and evaluated their antbacterial activity.

Antibacterial activity

The compounds **2a-n** were screened for their antibacterial activity using the tube-dilution method[55] by measuring the minimum inhibitory concentration (MIC) in μg/mL, against four representative organisms viz., *Bacillus subtilis. Staphylococcus aursus*, *Escherichia coli* and *Staphylococcus pyogenes*. Standard antibacterial agents, such as Streptomycin and Neomycin, were also screened under identical conditions for comparison. The minimum inhibitory concentrations are given in Table II. It has been observed that the test compounds exhibited an interesting biological activity however, with a degree of variation.

Compounds **2b**, **2f**, **2i**, **2m** were highly active against *B. subtilis*, *S. aureus* and *S. pyogenes*, the compound **2f** was highly active against *B. subtilis*, *S. aureus*, *E. coli* and the compound **2b** was highly active against *B. subtilis*, *E. coli*, *S. pyogenes*. The compounds **2a** and



R
(a) C_6H_5
(b) 4 – Cl- C_6H_5
(c) 4-NO_2- C_6H_5
(d) 2-Me – C_6H_5

R
(e) 4-Me - C_6H_5
(f) 3-OH- C_6H_5
(g) 4-OH- C_6H_5

R_1 = H,Cl

Scheme I

Table I — Synthesis of compounds **2a-n**

Compd	R	R^1	Mol. formula	ReactionTime (min)	Yield (%)
9a	C_6H_5	H	$C_{33}H_{31}ClN_6O_5S$	10	85
9b	C_6H_5	Cl	$C_{30}H_{30}Cl_2N_6O_5S$	3	76
9c	4-Cl-C_6H_4	H	$C_{33}H_{30}Cl_2N_6O_5S$	4	88
9d	4-Cl-C_6H_4	Cl	$C_{33}H_{29}Cl_3N_6O_5S$	3	81
9e	4-NO_2-C_6H_4	H	$C_{33}H_{30}ClN_7O_7S$	5	85
9f	4-NO_2-C_6H_4	Cl	$C_{33}H_{29}Cl_2N_7O_7S$	4	90
9g	2-CH_3-C_6H_4	H	$C_{34}H_{33}ClN_6O_5S$	8	87
9h	2-CH_3-C_6H_4	Cl	$C_{34}H_{32}Cl_2N_6O_5S$	12	85
9i	4-CH_3-C_6H_4	H	$C_{34}H_{33}ClN_6O_5S$	8	91
9j	4-CH_3-C_6H_4	Cl	$C_{34}H_{32}Cl_2N_6O_5S$	6	92
9k	3-OH	H	$C_{33}H_{31}ClN_6O_6S$	7	88
9l	3-OH	Cl	$C_{33}H_{30}Cl_2N_6O_6S$	5	89
9m	4-OH	H	$C_{33}H_{31}ClN_6O_6S$	8	85
9n	4-OH	Cl	$C_{33}H_{30}Cl_2N_6O_6S$	7	88

Table II — Antibacterial activity of **2a-m**

Compd	Minimum inhibition concentration (MIC, μg/mL)			
	B. subtilis	*S. aureus*	*E. coli*	*S. pyogenus*
2a	50	25	50	50
2b	12.5	12.5	25	12.5
2c	25	25	12.5	12.5
2d	25	50	25	25
2e	100	50	50	50
2f	12.5	12.5	12.5	25
2g	50	50	100	25
2h	50	50	-	25
2i	12.5	25	12.5	12.5
2j	25	25	25	12.5
2k	50	100	-	50
2l	50	50	50	50
2m	12.5	12.5	25	12.5
2n	50	25	50	50
Streptomycin	10	10	10	10
Neomycin	30	30	30	30

2d did not exhibit any activity against *E. coli* even at 100 μg/mL concentration (Table II).

Results and Discussion

Compounds **1a-g** on condensation with o-phenylenediamine under microwave irradiation in presence of HCl yielded compounds **2a-n**. The reaction is completed in only 5-10 min and the compounds, isolated by conventional work - up, are obtained in satisfactory yields, often higher than those achieved by traditional methods. The structures of synthesized compounds have been confirmed by IR, NMR, MS and elemental analysis.

Experimental Section

Commercial grade reagents were used as received. Solvents except analytical reagent grade were dried and purified according to literature when necessary. Reaction progress and purity of the compounds were checked by thin-layer chromatography (TLC) on pre-coated silica gel F254 plates from Merck and compounds visualized either by exposure to UV light or dipping in 1% aqueous potassium permanganate solution. Silica gel chromatographic columns (60–120 mesh) were used for separations. Optical rotations were measured on an Perkin – Elmer 141 polarimeter by using a 2 mL cell with a path length of 1 dm with $CHCl_3$ or $CDCl_3$ as solvent. Microwave reactions are carried out in mini lab microwave catalytic reactor (ZZKD, WBFY-201). All melting points are uncorrected and measured using Fisher–Johns apparatus. IR spectra were recorded as KBr disks on a Perkin–Elmer FT IR spectrometer. The ^1H and ^{13}C NMR spectra were recorded on a Varian Gemini spectrometer (300 MHz for ^1H and 75 MHz for^{13}C). Chemical shifts are reported as δ (ppm) against TMS as internal reference and coupling constants *(J)* are reported in Hz. Mass spectra were recorded on a VG micro mass 7070H spectrometer. Elemental analyses (CHN) were determined by a Perkin–Elmer 240 CHN elemental analyzer, and were within ± 0.4% of theoretical.

Triazol-4-yl)methoxy)tetrahydrofuro[2,3-d][1,3]dioxol-5-yl)-3-phenylthiazolidin-4-one, 2(a-n)

A mixture of **1** (0.01mol) and substituted *o*-phenylenediamine (2mmol) catalytic amount of HCl were ground thoroughly and transferred to a 50 mL flask. After adding a few drops of DMF, the mixture was irradiated in a microwave oven at 180 W. The progress of reaction was monitored by TLC, with a mixture of ethanol and water (9:1) as the eluent. On completion, the reaction mixture was cooled, ice cold distilled H_2O was added, and stirred for a while wherein a precipitate was observed. The precipitate was collected by filtration, washed with water, dried, and recrystallized from ethanol-water mixture.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-phenylthiazolidin-4-one, 2a: m.p.221-223°C; IR (KBr): 3414, 3223, 2981, 2970, 2944, 2830, 1610, 1542, 1514, 1416, 1224, 687 cm^{-1}; ^1H-NMR (500 MHz,DMSO-d_6): δ 9.32 (s, 1H, -NH), 8.06 (s, 1H, Ar-H), 7.52 (d, *J* = 9.2Hz, 4H, Ar-H), 7.44 (d, J = 8.9 Hz, 2H,Ar-H), 7.21(d, 2H, Ar-H), 6.73- 7.35 (m, 5H,Ar –H),) 6.15 (s,1H, CHS), 5.73 (d, *J* = 4.2 Hz,1H, CH), 4.69 (t, *J* = 3.9 Hz,1H, CH),4.65 (t, 1H,CH), 4.52(s, 2H, OCH_2), 3.92 – 3.89 (m, 1H,CH), 3.31 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.38 (d, 2H,CH_2), 1.53 (s, 3H,CH_3), 1.30 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 151.4,143.8, 141.2, 134.2, 128.2, 126.8, 122.1,118.8, 104.2, 80.4, 77.9, 73.8, 66.1, 53.0, 37.2, 33.9, 25.9; MS: m/z (M^++H) 545. Anal. Calcd for $C_{33}H_{31}ClN_6O_5S$: C, 60.13; H, 4.74; N, 12.75. Found: C, 60.01; H, 4.54; N, 12.55.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-phenylthiazolidin-4-one, 2b: m.p.227-229°C; IR(KBr): 3410, 3213, 2977, 2960, 2942, 2820, 1614,

1532, 1510, 1416, 1214, 677 cm^{-1}; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.27 (s, 1H, -NH), 8.20 (s, 1H, Ar-H), 8.04(s, 1H, Ar-H), 7.51 (d, *J* = 9.2Hz, 2H, Ar-H), 7.44 (d, J = 8.9 Hz, 2H,Ar-H), 7.21(d, 2H, Ar-H), 6.73- 7.35 (m, 5H,Ar –H),) 6.15 (s,1H, CHS),5.73 (d, *J* = 4.2 Hz,1H, CH), 4.69 (t, *J* = 3.9 Hz,1H, CH),4.65 (t, 1H,CH), 4.52(s, 2H, OCH_2), 3.92 – 3.89 (m, 1H,CH), 3.31 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.38 (d, 2H,CH_2), 1.53 (s, 3H,CH_3), 1.30 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 151.4,143.8, 141.2, 134.2, 128.2, 126.8, 122.1,118.8, 104.2, 80.4, 77.9, 73.8, 66.1, 53.0, 37.2, 33.9, 25.9; MS: m/z (M^++H) 694. Anal. Calcd for $C_{30}H_{30}Cl_2N_6O_5S$: C, 57.14; H, 4.36; N, 12.12. Found: C, 56.98; H, 4.14; N, 12.01.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-3-(4-chlorophenyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)thiazolidin-4-one, 2c: m.p.248-250°C; IR(KBr): 3411, 3220, 2981, 2970, 2944, 2830, 1610, 1542, 1514, 1416, 1224, 720 cm^{-1}; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.17 (s, 1H, -NH), 8.05 (s, 1H, Ar-H), 7.50 (d, *J* = 9.2Hz, 4H, Ar-H), 7.42 (d, J = 8.9 Hz, 2H,Ar-H), 7.20(d, 2H, Ar-H), 7.10- 6.95 (m, 4H, Ar –H), 6.13 (s,1H, CHS),5.71 (d, *J* = 4.2 Hz,1H, CH), 4.66 (t, *J* = 3.9 Hz,1H, CH),4.60 (t, 1H,CH), 4.50(s, 2H, OCH_2), 3.92 – 3.89 (m, 1H,CH), 3.31 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.38 (d, 2H,CH_2), 1.53 (s, 3H,CH_3), 1.30 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 151.1,143.8, 141.2, 138.9, 134.2, 128.2, 126.8, 122.1,118.8, 104.2, 80.4, 77.9, 73.8, 66.1, 53.0, 37.2, 33.9, 25.9; MS: m/z (M^++H) 693. Anal. Calcd for $C_{33}H_{30}Cl_2N_6O_5S$: C, 57.13; H, 4.36; N, 12.12. Found: C, 56.81; H, 4.14; N, 12.01.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-3-(4-chlorophenyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)thiazolidin-4-one, 2d: m.p.232-234°C; IR(KBr): 3397, 3211, 2972, 2950, 2932, 2810, 1612, 1532, 1512, 1413, 1212, 735 cm^{-1}; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.27 (s, 1H, -NH), 8.26 (s, 1H, Ar-H), 8.04(s, 1H, Ar-H), 7.51 (d, *J* = 9.2Hz, 4H, Ar-H), 7.44 (d, J = 8.9 Hz, 4H,Ar-H), 7.21(d, 1H, Ar-H),7.11(d, 1H, Ar-H), 6.15 (s,1H, CHS),5.73 (d, *J* = 4.2 Hz,1H, CH), 4.69 (t, *J* = 3.9 Hz,1H, CH),4.65 (t, 1H,CH), 4.52(s, 2H, OCH_2), 3.92 – 3.89 (m, 1H,CH), 3.31 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.38 (d, 2H,CH_2), 1.53 (s, 3H,CH_3), 1.30 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 151.1,143.5, 141.0, 134.1, 128.4, 126.2, 122.0,116.8, 102.2, 80.1, 77.6, 73.2, 66.0, 53.0, 37.6, 33.1; MS: m/z (M^++Na) 749. Anal. Calcd for $C_{33}H_{29}Cl_3N_6O_5S$: C, 54.14; H, 4.01; N, 11.54. Found: C, 53.98; H, 3.94; N, 11.31.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-(4-nitrophenyl)thiazolidin-4-one, 2e: m.p.256-258°C; IR(KBr): 3395, 3330, 3220, 2971, 2964, 2819, 1604, 1539, 1518, 1416, 1378, 1210, 863, 732 cm^{-1}; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.17 (s, 1H, -NH), 8.21 (d, J= 8.4 Hz, 2H), 8.01 (s, 1H, Ar-H), 7.49 (d, *J* = 9.1Hz, 2H, Ar-H), 7.41 (d, J = 8.5 Hz, 2H, Ar-H), 7.30- 7.34(m, 4H, Ar-H), 6.79 (d, J = 9.6 Hz, 2H,Ar-H), 6.14 (s,1H, CHS), 5.69 (d, *J* = 4.2 Hz,1H, CH), 4.65 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.52 (s, 2H, OCH_2), 3.90 – 3.86 (m, 1H,CH), 3.19 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.30 (d, 2H,CH_2), 1.49 (s, 3H,CH_3), 1.25 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 190.2, 173.2, 143.6, 141.9, 134.5, 128.2, 126.5, 122.2,118.2, 104.3, 80.4, 77.2, 73.1, 66.2, 52.1, 36.4, 33.1, 25.4; MS: m/z (M^++H) 704 Anal. Calcd for $C_{33}H_{30}ClN_7O_7S$: C, 56.70; H, 4.29; N, 13.92.Found: C, 56.49; H, 4.09; N, 13.75.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-(4-nitrophenyl)thiazolidin-4-one, 2f: m.p.247-248 °C; IR(KBr): 3392, 3333, 3221, 2961, 2950, 2815, 1601, 1529, 1510, 1406, 1378, 1209, 861, 722 cm−1; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.14(s, 1H, -NH), 8.36 (s, 1H, Ar-H), 8.19 (d, J= 8.4 Hz, 2H), 8.01 (s, 1H, Ar-H), 7.49 (d, *J* = 9.1Hz, 2H, Ar-H), 7.41 (d, J = 8.5 Hz, 2H,Ar-H), 7.34(d, *J*= 9.3Hz, 2H, Ar-H), 6.79 (d, J = 9.6 Hz, 2H,Ar-H), 6.14 (s,1H, CHS), 5.69 (d, *J* = 4.2 Hz,1H, CH), 4.65 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.52(s, 2H, OCH_2), 3.90– 3.86 (m, 1H,CH), 3.19 (dd, *J* = 9.1,4.2 Hz, 1H, C_3H), 2.30 (d, 2H,CH_2), 1.49 (s, 3H,CH_3), 1.25 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 190.2, 173.2, 143.6, 141.9, 134.5, 128.2, 126.5, 122.2,118.2, 104.3, 80.4, 77.2, 73.1, 66.2, 52.1, 36.4, 33.1; MS: m/z (M^++H) 739 Anal. Calcd for $C_{33}H_{29}Cl_2N_7O_7S$: C, 53.60; H, 3.96; N, 13.27.Found: C, 53.49; H, 3.79; N, 12.95.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro

[3,4-d][1,3]dioxol-4-yl)-3-o-tolylthiazolidin-4-one, 2g: m.p.247-249°C; IR(KBr): 3331, 3219, 2968, 2824, 1610, 1550, 1516, 1418, 1264, 753 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 9.19(s, 1H, -NH), 8.06 (s, 1H, Ar-H), 7.50 (d, *J* = 9.1Hz, 2H, Ar-H), 7.42(d, 2H, Ar-H), 7.38 (d, J = 8.5 Hz, 2H,Ar-H), 7.34(d, 2H, Ar-H), 7.29- 7.32(m, 4H, Ar-H), 6.14 (s,1H, CHS),5.65 (d, *J* = 4.2 Hz,1H, CH), 4.60 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.54 (s, 2H, OCH_2), 3.92 – 3.86 (m, 1H,CH), 3.22 (dd, *J* = 9.1,4.2 Hz, 1H, C_3H), 2.34 (d, 2H,CH_2),2.21 (s, 3H,CH_3), 1.51 (s, 3H,CH_3), 1.29 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 191.4, 173.4, 144.6, 142.9, 133.9, 125.4, 122.2,119.2, 105.6, 80.6, 77.4, 73.4, 66.5, 53.1, 36.3, 33.2; MS: m/z (M^++H) 674. Anal. Calcd for $C_{34}H_{33}ClN_6O_5S$: C, 60.66; H, 4.94; N, 12.48. Found: C, 60.26.; H, 4.62; N, 12.15.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-o-tolylthiazolidin-4-one, 2h: m.p.257-258°C;IR(KBr): 3338, 3217, 2964, 2827, 1614, 1549, 1512, 1410, 1264, 763 cm^{-1}; ^{1}H-NMR (500 MHz, DMSO-d_6): δ 9.17(s, 1H, -NH), 8.29 (s, 1H, Ar-H), 8.06 (s, 1H, Ar-H), 7.50 (d, *J* = 9.1Hz, 2H, Ar-H), 7.42(d, *J* = 8.1Hz, 2H,Ar-H), 7.38 (d, J = 8.5 Hz, 2H,Ar-H), 7.34(d, 2H, Ar-H), 7.29 (d,*J* = 9.2Hz, 1H, Ar-H), 7.14 (d, *J* = 8.6Hz, 1H, Ar-H), 6.14 (s,1H, CHS),5.65 (d, *J* = 4.2 Hz,1H, CH), 4.60 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.54 (s, 2H, OCH_2), 3.92 – 3.86 (m, 1H,CH), 3.22 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.34 (d, 2H,CH_2),2.21 (s, 3H,CH_3), 1.51 (s, 3H,CH_3), 1.29 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 191.4, 173.4, 144.6, 142.9, 133.9, 125.4, 122.2,119.2, 105.6, 80.6, 77.4, 73.4, 66.5, 53.1, 36.3, 33.2; MS: m/z (M^++H) 708. Anal. Calcd for $C_{34}H_{32}Cl_2N_6O_5S$: C, 57.71; H, 4.56; N, 11.88. Found: C, 57.26.; H, 4.22; N, 11.45.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-*p*-tolylthiazolidin-4-one, 2i: m.p.207-209°C IR(KBr): 3445, 3249, 2971, 2830, 1712, 1615, 1540, 1510, 1428, 1254, 743 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 9.12(s, 1H, -NH), 8.20 (d, *J*= 8.4 Hz, 2H, Ar-H), 8.04 (s, 1H, Ar-H),7.59 (d, *J* = 9.4Hz, 2H, Ar-H) 7.44 (d, *J* = 9.1Hz, 2H, Ar-H), 7.32(d, *J*= 8.9Hz, 2H, Ar-H), 7.21 (d, *J*= 8.3Hz, 2H, Ar-H), 7.12 (d, *J* = 8.3 Hz, 2H, Ar-H), 6.14 (s,1H, CHS),5.65 (d, *J* = 4.2 Hz,1H, CH), 4.60 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.54 (s, 2H, OCH_2), 3.92 – 3.86 (m, 1H,CH), 3.22 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.34 (d, 2H,CH_2),2.21 (s, 3H,CH_3), 1.51 (s, 3H,CH_3), 1.29 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 192.4, 175.4, 142.6, 139.9, 136.7,132.9, 124.4, 121.2,117.2, 104.6, 82.6, 78.4, 73.1, 64.5, 52.1, 35.3, 31.2, 25.2,21.4,16.2; MS: m/z (M^++H) 673. Anal. Calcd for $C_{34}H_{33}ClN_6O_5S$: C, 60.66; H, 4.94; N, 5.27. Found: C, 60.49; H, 4.62; N, 5.15.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-p-tolylthiazolidin-4-one, 2j: m.p.217-219°C. IR(KBr): 3435, 3242, 2961, 2820, 1711, 1616, 1542, 1515, 1428, 1244, 753 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 9.12(s, 1H, -NH), 8.22 (d, *J*= 8.4 Hz, 2H, Ar-H), 8.02 (s, 1H, Ar-H),7.56 (d, *J* = 9.4Hz, 2H, Ar-H) 7.42 (d, *J* = 9.1Hz, 2H, Ar-H), 7.31(d, *J*= 8.9Hz, 2H, Ar-H), 7.20 (d, *J*= 8.3Hz, 1H, Ar-H), 7.12 (d, *J* = 8.3 Hz, 2H, Ar-H), 6.15 (s,1H, CHS),5.63 (d, *J* = 4.2 Hz,1H, CH), 4.61 (t, 1H,CH), 4.53 (t, *J* = 3.9 Hz,1H, CH), 4.51 (s, 2H, OCH_2), 3.92 – 3.89 (m, 1H,CH), 3.23 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.35 (d, 2H,CH_2),2.20 (s, 3H,CH_3), 1.50 (s, 3H,CH_3), 1.25 (m, 3H,CH_3) ^{13}C NMR (75 MHz, DMSO-d_6): δ 192.4, 171.4, 142.6, 140.9, 131.9, 125.4,123.8, 121.2,118.2, 102.6, 81.6, 76.4, 72.4, 61.5, 52.1, 33.3, 25.2,23.2,16.2; MS: m/z (M^++H) 707. Anal. Calcd for $C_{34}H_{32}Cl_2N_6O_5S$: C, 57.71; H, 4.56; N, 4.88. Found: C, 57.59; H, 4.42; N, 4.75.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-(3-hydroxyphenyl) thiazolidin-4-one, 2k: m.p.237-239°C; IR (KBr): 3525, 3426, 3216, 2975, 2832, 1645, 1524, 1506, 1438, 1241, 834 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 9.09 (s,1H,NH), 8.21 (d, *J* = 8.7Hz, 2H, Ar-H), 8.03 (s,1H,Ar-H), 7.52 (d, *J* = 9.2Hz, 2H, Ar-H), 7.14 - 7.10 (m, 4H,Ar-H), 6.12 (s,1H, CHS), 5.74 (d, *J* = 3.6 Hz,1H, CH), 5.40 (s, 1H, OH), 4.96 (d, *J* = 5.2 Hz,1H, CH) 4.49 (t, *J* = 3.9 Hz,1H, CH), 4.50 (s, 2H, OCH_2), 3.93 – 3.90 (m, 1H,CH), 3.21 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.31 (d, 2H,CH_2), 1.51 (s, 3H,CH_3), 1.35 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 173.6, 158.1, 142.2, 140.2, 133.6, 131.4, 130.1, 125.6, 121.2, 120.1, 116.4, 114.1, 111.8, 105.6,106.2, 80.8, 76.6,

73.8, 63.9, 52.9, 40.1, 36.9,32.3, 28.1; MS: m/z (M^++H) 675. Anal. Calcd for $C_{33}H_{31}ClN_6O_6S$: C, 58.71; H, 4.63; N, 5.25. Found: C, 58.62; H, 4.55; N, 5.19.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-3-(3-hydroxyphenyl)thiazolidin-4-one, 2l: m.p.247-249°C; IR (KBr) ν 3525, 3426, 3216, 2975, 2832, 1645, 1524,1506, 1438, 1241, 834 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 9.09 (s,1H,NH), 8.21 (d, *J* = 8.7Hz, 2H, Ar-H), 8.03 (s,1H,Ar-H), 7.52 (d, *J* = 8.2 Hz, 1H, Ar-H), 7.14 - 7.10 (m, 4H,Ar-H), 6.12 (s,1H, CHS), 5.74 (d, *J* = 3.6 Hz,1H, CH), 5.40 (s, 1H, OH), 4.96 (d, *J* = 5.2 Hz,1H, CH) 4.49 (t, *J* = 3.9 Hz,1H, CH), 4.50 (s, 2H, OCH_2), 3.93 – 3.90 (m, 1H,CH), 3.21 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.31 (d, 2H,CH_2), 1.51 (s, 3H,CH_3), 1.35 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 172.6, 156.1, 141.2, 140.2, 131.6, 130.4, 129.1, 124.6, 123.2, 121.1, 115.4, 113.1, 112.8, 104.6,103.2, 82.8, 75.6, 72.8, 62.9, 53.9, 41.1, 37.9,33.3, 26.1; MS: m/z (M^++Na) 729. Anal. Calcd for $C_{33}H_{30}Cl_2N_6O_6S$: C, 55.86; H, 4.26; N, 5.25. Found: C, 55.62; H, 4.15; N, 5.09.

5-((1*H*-Benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro [3,4-d][1,3]dioxol-4-yl)-3-(4-hydroxyphenyl) thiazolidin-4-one, 2m: m.p.266-268°C; IR (KBr) ν 3542, 3330, 3216, 2933, 2850, 1718, 1612, 1524,1501, 1431, 1238, 834 $cm^{-1;}$ ^{1}H-NMR (300 MHz, DMSO-d_6): δ 8.20 (d, *J* = 8.7Hz, 2H, Ar-H), 8.02 (s,1H,Ar-H), 7.49 (d, *J* = 9.2Hz, 2H, Ar-H), 7.14 – 7.09 (m, 4H,Ar-H), 6.16 (s,1H, CHS), 5.73 (d, *J* = 3.6 Hz,1H, CH), 5.41 (s, 1H, OH), 4.94 (d, *J* = 5.2 Hz,1H, CH) 4.51 (t, *J* = 3.9 Hz,1H, CH), 4.54 (s, 2H, OCH_2), 3.96 – 3.92 (m, 1H,CH), 3.24 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.33 (d, 2H,CH_2), 1.53 (s, 3H,CH_3), 1.38 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 171.2, 153.1, 142.2, 141.1, 136.6, 134.4, 129.6, 128.4, 122.2, 120.1, 114.4, 112.2, 111.3, 105.6,103.8, 80.8, 76.6, 74.8, 65.3, 57.0, 42.5, 36.4, 34.1; MS: m/z (M^++H) 675. Anal. Calcd for $C_{33}H_{31}ClN_6O_6S$: C, 58.72; H, 4.62; N, 5.28. Found: C, 58.52; H, 4.39; N, 5.19.

5-((6-Chloro-1*H*-benzo[d]imidazol-2-yl)methyl)-2-((3aR,4S,6S,6aS)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyl–tetrahydrofuro [3,4-d][1,3]dioxol-4-yl)-3-(4-hydroxyphenyl) thiazolidin-4-one, 2n: m.p.246-248°C; IR (KBr) ν 3342, 3320, 3206, 2953, 2840, 1716, 1614, 1534,1508, 1421, 1228, 814 $cm^{-1;}$ ^{1}H-NMR (300 MHz, DMSO-d_6): δ 8.19 (d, *J* = 8.3Hz, 2H, Ar-H), 8.02 (s,1H,Ar-H), 7.38 (d, *J* = 9.2Hz, 1H, Ar-H), 7.11 – 7.09 (m, 4H,Ar-H), 6.12 (s,1H, CHS), 5.70 (d, *J* = 3.4 Hz,1H, CH), 5.40 (s, 1H, OH), 4.83 (d, *J* = 5.1 Hz,1H, CH) 4.50 (t, *J* = 3.5 Hz,1H, CH), 4.52 (s, 2H, OCH_2), 3.94 – 3.92 (m, 1H,CH), 3.22 (dd, *J* = 9.1,4.2 Hz, 1H, CH), 2.30 (d, 2H,CH_2), 1.51 (s, 3H,CH_3), 1.34 (m, 3H,CH_3); ^{13}C NMR (75 MHz, DMSO-d_6): δ 154.1, 141.2, 140.1, 134.6, 132.4, 128.6, 126.4, 121.2, 120.8, 113.4, 112.6, 110.3, 105.2,103.2, 80.2, 76.2, 74.2, 65.1, 57.0, 42.1, 36.2, 34.1; MS: m/z (M^++H) 709. Anal. Calcd for $C_{33}H_{30}Cl_2N_6O_6S$: C, 55.85; H, 4.24; N, 9.88. Found: C, 55.72; H, 4.19; N, 9.69.

Conclusion

In conclusion, a series of a new class of hybrid heterocyclics **2a-n** have been synthesized, and evaluated for their antibacterial activity, most of the compounds showed appreciable antibacterial activity.

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