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Synthesis and Biological Evaluation of Triazole linked Thiazolidenone Glycosides

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Abstract

In a one pot procedure a series of novel triazole linked thiazolidinone derivatives **8a**–**g** and **9a**–**g** was prepared by condensation of (3a*R*,5*S*,6*R*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydro[2,3-*d*][1,3]dioxole-5-carbaldehyde **7** with mercapto acids and primary amines in the presence of $ZnCl_2$ under both microwave irradiation and conventional heating conditions. Compound **7** was prepared from diacetone D-glucose with oxidation followed by reduction, click reaction, primary acetonide deprotection and with oxidative cleavage. Characterization of new compounds has been done by means of IR, NMR, MS and elemental analysis. The nematicidal and antibacterial activity of the compounds has also been evaluated.

Keywords: Swern oxidation, click reaction, cyclisation, antibacterial and nematicidal activity.

1. Introduction

1,2,3-Triazoles are one of the most important classes of heterocyclic organic compounds, which are reported to be involved in a plethora of biological activities and important 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 heterocyclices rank as 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., becames 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.

Thiazolidenone and its derivatives are known to possess significant pharmacological[6] and biological activities,[7] like sedative,[8] anti inflammatory,[9] anti tubercular,[10] anticancer,[11] antitumor,[12] anti-HIV,[13] antibacterial,[14] antifungal,[15] analgesic, hypothermic,[16] anesthetic,[17] nematicidal[18] and CNS stimulant.[19] Furthermore, thiazolidenones have been used for the treatment of cardiac diseases,[20] diabetic complications, like cataract nephropathy, neuropathy,[21] and as selective anti platelet activating factor.[22]

Nematodes are tiny worms, some of them are plant parasites, and can play an important role in the predisposition of the host plant to the invansion by secondary pathogens.[23] Plants attacked by nematodes show retarded growth and development, as well as loss in the quality and quantity of the harvest. The use of nematicides is slated for reduction due to environmental problems, and human and animals health concerns. For example, effective namaticides such as dibromochloropropane (DBCD) and ethylene dibromide (EDB) have been withdrawn from the market due to their deleterious effects on humans and the environment. Methyl bromide, the most effective and widely used fumigant for soil borne pests including nematodes, has already been banned.

The use of nonfumigant nematicides, based on organophosphates and carbamates, is expected to increase after the withdrawal of methyl bromide, which will bring about new environmental concerns. In fact, the highly toxic Aldicarb used to control insects and nematodes has been already detected in ground water.[24] Therefore alternative nematode control methods or less toxic nematicides need to be developed. One way of searching for such nematicidal compounds is to screen naturally occurring compounds in plants. Several such compounds, *e.g*. alkaloids, phenols, sesquiterpenes, diterpenes, polyacetylenes, and thienyl derivatives have nematicidal activity.[25] For example, -terthienyl is a highly effective nematicidal compound.[26] Other compounds with nematicidal activity have been isolated from plants, mainly from the family *Asteraceae*.[25] However, compounds of plant origin and their analogs have not been developed into commercial nematicides; hence there is a need to develop commercial synthesis.

Following the successful introduction of antimicrobial and nematicidal agents, inspired by the biological profile of triazoles, thiazolidenones, and in the continuation of our work on biologically active heterocycles,[27–39] we have developed a series of novel triazole linked thiazolidenone derivatives, and evaluated their nematicidal activity along with antibacterial activity.

2. Result and Discussion

Diacetone D-glucose (**1**), prepared from D-(+)-glucose by treating with acetone in the presence of catalytic amount of sulphuric acid according to the literature procedure,[40] reduction of **2** (prepared by Swern oxidation of **1**) with $NaBH_4$ in aq. ethanol at 0 °C for 1 h gave **3** (77%), which on subsequent propargylation in DMF in the presence of NaH for 1 h afforded propargyl ether **4** (80%). Next, the propargyl ether **4** was converted into triazole **5** (82%) by using 1,3-dipolar cycloaddition with *p*-chlorophenyl azide carried out at ambient temperature in the presence of $CuSO_4$ and sodium ascorbate in a mixture of 1:1 *t*-BuOH–H_2O, as reported by Sharpless. Acid hydrolysis of 5,6-acetonide **5** in 60% AcOH furnished the diol **6** (85%), which on oxidative cleavage with $NaIO_4$ gave the aldehyde **7**. Subsequently, one pot synthesis of triazole linked thiazolidenone glycosides was carried out by the condensation reaction between **7**, primary aromatic amine and a thioglycolic acid in the presence of $ZnCl_2$ under microwave irradiation or conventional heating (Scheme 2). In classical method the reactions were performed in dry toluene at reflux for a long time (2–4 h), often leading to degradation processes and consequent low yields of isolated products, whereas with the application of microwave assisted technology, the reaction was completed in only 5–10 min and the compounds, isolated by conventional work-up, were obtained in satisfactory yields, often higher than those achieved by traditional methods (Table 1). The structures of synthesized compounds were confirmed by IR, NMR, MS and elemental analysis. Further the compounds were subject to nematicidal and antibacterial testing.

3. Antibacterial Activity

Compounds **8a**–**g** and **9a**–**g** were screened for their antibacterial activity using the tube dilution method[41] by measuring the minimum inhibitory concentration (MIC) in μg/mL against four representative organisms, *viz. Bacillus subtilis, Staphylococcus aureus, Escherichia coli* and *Staphylococcus pyogenus.* Standard antibacterial agents, such as streptomycin and Neomycin, were also screened under identical conditions for comparison. The minimum inhibitory concentrations are given in Table 2. However, it has been observed that the test compounds exhibited an interesting biological activity, with degree of variation.

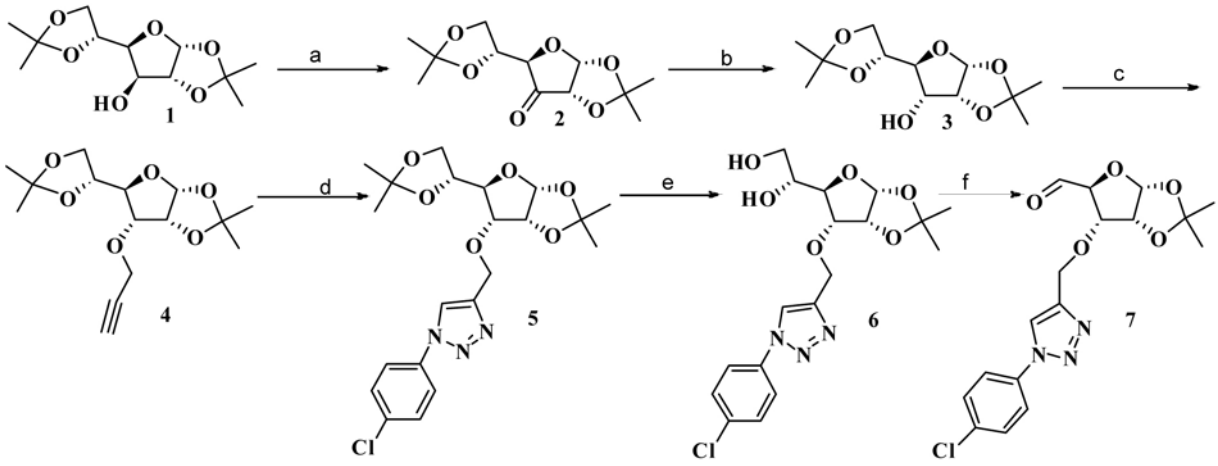
Compounds in series **8** and **9**, which contain 4-Cl or 3-OH groups, displayed good antibacterial activity against all the organisms. Compounds **8b** and **9f** were highly active against all the organisms. Compounds **8b** and **9f** were highly active against *B. subtilis*, *S. aureus* and *S. pyogenus,* compound **9f** was highly active against *B. subtilis*, *S. aureus*, *E. coli*, compound **9b** was highly active against *B. subtilis*, *E. coli* and *S. pyogenus* and the compound **8c** was highly active against *E. coli* and *S. pyogenus*. Compounds **9a** and **9d** did not exhibit any activity against *E. coli*, even at 100 μg/mL concentration. The alkyl substituted derivatives displayed moderate levels of antibacterial activity (Table 2).

4. Nematicidal Activity

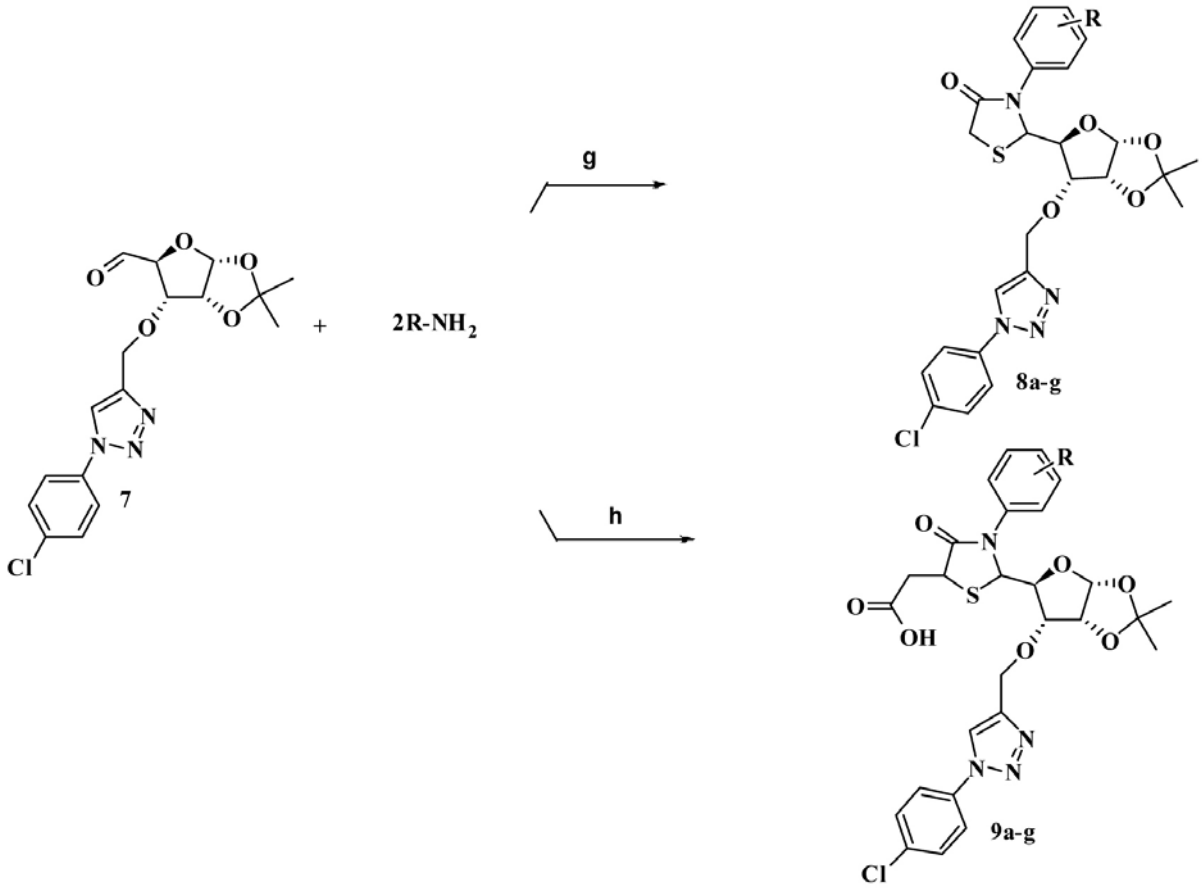
Compounds **8a**–**g** and **9a**–**g** were also screened for their nematicidal activity against *Ditylenchus myciophagus* and *Caenorhabditis elegans* by aqueous *in vitro* screening technique[42] at various concentrations. The results have been expressed in terms of LD_{50}, *i.e*. median lethal dose at which 50% of nematodes became immobile. The screened data reveal that compound **8f** and **9f** are the most effective against *D. myceliophagus* and *C. elegans* with LD_{50} values of 210 and 240 ppm, respectively.

5. Experimental

Commercial grade reagents were used as supplied. 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



Sheme 1



Sheme 2

Reagents and conditions: (a) $COCl_2$, CH_2Cl_2, Et_3N, –78 °C ≥ rt, 1.5 h; (b) $NaBH_4$, EtOH, H_2O (19:1), 0 °C ≥ rt; (c) propargyl bromide, NaH, DMF, 0 °C ≥ rt; (d) *p*-chlorophenyl azide, sodium ascorbate, $CuSO_4 \cdot 5H_2O$, *t*-BuOH/H_2O; (e) 60%, AcOH; (f) $NaIO_4$, CH_2Cl_2; (g) Ar-NH_2, $SHCH_2COOH$, $ZnCl_2$, toluene , 80 °C; (h) Ar-NH_2, thiomalic acid, $ZnCl_2$, toluene, 80 °C.

silica gel F254 plates from Merck and compounds were 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

Table 1: Synthesis of Compounds **8a–g** and **9a–g**

Compound	R	Mol. Formula	Reaction time		Yield	
			A (h)	B (min)	A	B
8a	C_6H_5	$C_{25}H_{25}ClN_4O_5S$	3.5	5	62	80
8b	4-Cl-C_6H_4	$C_{25}H_{24}Cl_2N_4O_5S$	2.5	6	71	89
8c	4-NO_2-C_6H_4	$C_{25}H_{24}ClN_5O_7S$	3.0	6	69	82
8d	2-CH_3-C_6H_4	$C_{26}H_{27}ClN_4O_5S$	2.0	5	63	86
8e	4-CH_3-C_6H_4	$C_{26}H_{27}ClN_4O_5S$	2.5	5	68	88
8f	3-OH-C_6H_4	$C_{25}H_{25}ClN_4O_6S$	3.0	5	79	86
8g	4-OH-C_6H_4	$C_{25}H_{25}ClN_4O_6S$	2.0	3	80	91
9a	C_6H_5	$C_{27}H_{27}ClN_4O_7S$	3.5	5	63	79
9b	4-Cl-C_6H_4	$C_{27}H_{26}Cl_2N_4O_7S$	2.5	6	65	82
9c	4-NO_2-C_6H_4	$C_{27}H_{26}Cl_2N_5O_9S$	3.0	7	61	79
9d	2-CH_3-C_6H_4	$C_{28}H_{29}ClN_4O_7S$	2.5	5	70	81
9e	4-CH_3-C_6H_4	$C_{28}H_{29}ClN_4O_7S$	2.0	5	67	82
9f	3-OH-C_6H_4	$C_{27}H_{27}ClN_4O_8S$	3.0	5	77	87
9g	4-OH-C_6H_4	$C_{27}H_{27}ClN_4O_8S$	2.5	4	79	90

A: conventional heating, B: microwave irradiation

Table 2. Antibacterial and nematicidal activity of **8a–g** and **9a–g**

Compound	Anti bacterial activity Minimum inihibitory concentration (MIC, µg/mL)				Nematicidal activity	
	B. subtilis	*S. aureus*	*E. coli*	*S. pyogenes*	*D. myceliophagus*	*C. elegans*
8a	50	25	50	50	940	960
8b	12.5	12.5	25	12.5	360	400
8c	25	25	12.5	12.5	440	390
8d	25	50	25	25	610	650
8e	100	50	50	50	1070	1010
8f	12.5	12.5	12.5	50	210	320
8g	50	50	100	25	420	670
9a	50	50	–	25	710	650
9b	12.5	25	12.5	12.5	400	350
9c	25	25	25	12.5	490	510
9d	50	100	–	50	1030	1050
9e	50	50	50	50	910	970
9f	12.5	12.5	25	12.5	360	240
9g	50	25	50	50	660	540
Streptomycin 10	10	10	10	–	–	
Neomycin 30	30	30	30	–	–	

a path length of 1 dm with $CHCl_3$ or $CDCl_3$ as solvent. Microwave reactions are carried out in a 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 NMR 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 in ppm against TMS as internal reference and coupling constants *J* are reported in Hz units. Mass spectra were recorded on a VG micro mass 7070H spectrometer. Elemental analyses (C, H, N) were determined by a Perkin–Elmer 240 CHN elemental analyzer and were within ±0.4% of theoretical values.

(3a*R*,5*R*,6a*S*)-5-((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyldihydrofuro[3,2-*d*][1,3]dioxol-6(3a*H*)-one (2). Dissolved 8.5 mL of oxalylchloride in 20 mL of dry CH_2Cl_2. Stirred, cooled to –78 °C. Added 14 mL of DMSO. Added a solution of 5 g of alcohol in 30 mL of CH_2Cl_2. Stirred for 45 min. Added 40 mL Et_3N. After 15 min, warmed to 0 °C. After 10 min TLC showed complet reaction. The reaction mixture was placed on silica gel column and the product was purified column chromatography (Silica gel 60–120 mesh, 10% ethyl

acetate in hexane) gave **3** quantitative yield (4.5 g) as a yellow syrup, which was used as such for the next reaction.

(3a*R*,5*S*,6*R*,6a*R*)-5-((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[3,2-*d*][1,3]dioxol-6-ol (3). To a stirred solution of **2** (4.5 g, 19 mmol) in aq. ethanol (EtOH–H_2O 19 : 1; 100 mL), $NaBH_4$ (0.37 g, 9.7 mmol) was added at 0 °C and then reaction mixture was stirred for 1 h. Solvent was evaporated in vaccuo, residue treated with saturated NH_4Cl solution (10 mL) and stirred at room temperature for additional 10 min. The reaction mixture was extracted with EtOAc (2 × 50 mL) and organic layer separated was washed with water (50 mL), brine (50 mL), dried (Na_2SO_4) and evaporated. Residue obtained was purified by column chromatography (60–120 mesh silica gel , 60% ethyl acetate in pethrol ether) to afford **3** (3.8g , 80%) as a white solid; mp 82 °C; $[\alpha]^{20}_D$ = +82.49 (*c* 1.62, $CHCl_3$); IR (KBr): ν 3413, 2994, 2927, 1632, 1375, 1220, 1162, 1072, 1010 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$, 298 K): δ 5.75 (d, 1H, *J* = 3.7 Hz, C_1H), 4.56 (d, 1H, *J* = 4.2 Hz, C_2H), 4.23 (m, 1H, C_5H), 4.07–3.91 (m, 3H, C_4H, 2 × C_6H), 3.74 (dd, 1H, *J* = 8.0, 4.3 Hz, C_3H), 2.44 (d, 1H, *J* = 8.4 Hz, OH), 1.56 (s, 3H, CH_3), 1.44 (s, 3H, CH_3), 1.36 (s, 6H, 2 × CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 112.8, 109.8, 103.9, 79.7, 79.0, 75.5, 72.5, 65.8, 26.6, 26.5, 26.3, 25.3; MS: *m/z* (M^++Na) 283.1171.

(3a*R*,5*R*,6*R*,6a*R*)-5-((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyl-6-(prop-2-ynyloxy)tetrahydrofuro[3,2-*d*][1,3]dioxole (4). Sodium hydride (60% in mineral oil, 0.64 g) was added to a stirred solution of **3** (3.6 g, 13.84 mmol) in DMF (80 mL) at 0 °C and allowed to stir for 30 min. This yellow mixture was cooled to 0 °C and treated with propargyl bromide (4.2 g) in DMF (20 mL). The dark brown reaction mixture was allowed to stir for an hour at room temperature and quenched (at 5–10 °C) with saturated aqueous ammonium chloride (20 mL). The crude product was extracted with methylene chloride (3 × 30 mL), dried (Na_2SO_4) and concentrated. The residue was purified by column chromatography on silica gel (5% ethyl acetate–hexane) to afford **4** (3.1 g, 75%) as viscous oil. $[\alpha]^{20}_D$ = -6.3 (*c* 1.7, $CHCl_3$). IR (KBr): ν 3310, 2995, 2928, 2268, 1634, 1379, 1224, 1164, 1075, 1018 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 5.62 (d, *J* = 3.7 Hz, 1H, C_1H), 4.69 (t, *J* = 3.9 Hz, 1H, C_2H), 4.36 (dt, *J* = 3.1, 7.3 Hz, 1H, C_5H), 4.21 (s, 2H, CH_2), 4.09–3.96 (m, 3H, C_4H, 2 × C_6H), 3.68 (dd, *J* = 8.9, 4.1 Hz, 1H, C_3H), 3.19 (s, 1H, CH), 1.56 (s, 3H, CH_3), 1.42 (s, 3H, CH_3), 1.36 (s, 6H, 2 × CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 112.7, 109.5, 103.8, 80.2, 77.6, 77.2, 74.6, 66.2, 57.2, 26.6, 26.2. MS: *m/z* (M^++Na) 321.10.

1-(4-Chlorophenyl)-4-(((3a*R*,5*R*,6*R*,6a*R*)-5-((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[3,2-*d*][1,3]dioxol-6-yloxy)methyl)-1*H*-1,2,3-triazole (5). To a solution containing alkyne **4** (3 g, 10.06 mmol), *p*-chlorophenyl azide (1.8 g, 11.76 mmol) in dichloro methane (30 mL) and water (30 mL) were added $CuSO_4 \cdot 5H_2O$ (1.8 g, 8.15 mmol) and sodium ascorbate (1.2 g). The resulting suspension was stirred at room temperature for 4–6 h. After this time, the mixture was diluted with 20 mL dichloromethane and 20 mL water. The organic phase was separated, dried with sodium sulfate and concentrated at reduced pressure, the crude residue was purified by column chromatography on silica gel (60–120 mesh, 35% EtOAc–hexane) to afford **5** (3.2 g, 75%) as a white powder. mp 159–161°C. $[\alpha]^{20}_D$ = -91.3 (*c* 1.7, $CHCl_3$). IR (KBr): ν 3250, 2975, 2928, 1634, 1554, 1512, 1376, 1220, 1168, 1072, 1020, 736 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.05 (s, 1H, Ar-H), 7.56 (d, *J* = 9.2 Hz, 2H, ArH), 7.45 (d, *J* = 8.9 Hz, 2H, Ar-H), 5.59 (d, *J* = 3.7 Hz, 1H, C_1H), 4.65 (t, *J* = 3.9 Hz, 1H, C_2H), 4.59 (s, 2H, CH_2), 4.39 (dt, *J* = 3.1, 7.3 Hz, 1H, C_5H), 4.09–3.96 (m, 3H, C_4H, 2 × C_6H), 3.71 (dd, *J* = 8.9, 4.1 Hz, 1H, C_3H), 1.54 (s, 3H, CH_3), 1.40 (s, 3H, CH_3), 1.34 (s, 6H, 2 × CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 144.1, 134.5, 122.4, 119.5, 112.5, 109.6, 103.6, 80.0, 77.4, 74.2, 67.5, 66.2, 26.6, 26.2, 24.9. MS: *m/z* (M^++H) 452.10. Anal. Calcd for $C_{21}H_{26}ClN_3O_6$: C, 55.81; H, 5.80; N, 9.30. Found: C, 55.75; H, 5.75; N, 9.21.

(*R*)-1-((3a*R*,5*R*,6*R*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[3,2-*d*][1,3]dioxol-5-yl)ethane-1,2-diol (6). A mixture of **5** (3 g, 6.65 mmol) in 60% aq. AcOH (25 mL) was stirred at room temperature for 12 h. Reaction mixture was neutralized with anhy. $NaHCO_3$ (15 g) and extracted with EtOAc (3 × 41 mL). The combined organic layers were dried (Na_2SO_4), evaporated and residue purified by column chromatography (60–120 mesh silica gel, 41% EtOAc–pethroleum ether) to afford **6** (2.6 g, 82%) as a pale yellow solid. mp 168–171°C IR. (KBr): ν 3228, 3486, 3372, 2994, 2975, 2946, 2928, 1634, 1554, 1512, 1217, 1164, 1020, 736 cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ 8.03 (s, 1H, Ar-H), 7.54 (d, *J* = 9.2 Hz, 2H, ArH), 7.43 (d, *J* = 8.9 Hz, 2H, Ar-H), 5.51 (d, *J* = 3.7 Hz, 1H, C_1H), 4.56 (t, *J* = 3.9 Hz, 1H, C_2H), 4.59 (s, 2H, OCH_2), 3.98–3.93 (m, 2H, C_4H, C_5H), 4.01–3.92 (m, 3H, C_3H, 2 × C_6H), 2.44 (bs, 1H, OH), 1.54 (s, 3H, CH_3), 1.50 (bs, 1H, OH), 1.34 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 144.2, 134.2, 122.1, 119.2, 112.2, 109.2, 103.1, 79.8, 77.1, 74.1, 67.2, 66.2, 64.2, 70.6, 26.6, 26.2, 24.9. MS: *m/z* (M^++H) 412.10. Anal. Calcd for $C_{18}H_{22}ClN_3O_6$: C, 52.49; H, 5.38; N, 10.21. Found: C, 52.35; H, 5.25; N, 10.211.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-phenylthiazolidin-4-one (8a–g). To a solution of diol **6** (0.200 g, 0.48 mmol) in CH_2Cl_2 (5 mL), $NaIO_4$ (0.130 g, 0.61 mmol) was added at 0 °C and

stirred at room temperature for 6 h. The reaction mixture was filtered and washed with CH_2Cl_2 (2 × 10 mL). It was dried (Na_2SO_4) and evaporated to give aldehyde **7** (0.150 g) in quantitative yield as a yellow liquid, which was used as such for the next reaction.

To a stirred mixture of **7** (0.150 g, 0.395 mmol), aromatic amine (0.395 mmol) and anhydrous thioglycolic acid (0.160 g, 0.211 mmol) in dry toluene (5 mL), $ZnCl_2$ (0.100 g, 0.751 mmol) was added after 2 min and irradiated in microwave bath reactor at 280 W for 4–7 minutes at 110°C. After cooling, the filtrate was concentrated to dryness under reduced pressure and the residue was taken up in ethyl acetate. The ethyl acetate layer was washed with 5% sodium bicarbonate solution and finally with brine. The organic layer was dried over Na_2SO_4 and evaporated to dryness at reduced pressure. The crude product thus obtained was purified by column chromatography on silica gel (60–120 mesh) with hexane–ethyl acetate as eluent. Under conventional method the reaction mixture in toluene (10 mL) was refluxed at 110 °C for the appropriate time (Table 1).

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-phenylthiazolidin-4-one (8a). mp 147–149°C; IR (KBr) ν 3432, 3230, 2986, 2975, 2944, 2836, 1716, 1612, 1551, 1512, 1416, 1221, 687 cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ 8.06 (s, 1H, Ar-H), 7.52 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.42 (d, *J* = 8.9 Hz, 2H, Ar-H), 7.52–6.90 (5H, m, Ar-H), 5.75 (d, *J* = 3.6 Hz, 1H, C_1H), 4.93 (d, *J* = 5.2 Hz, CH-S), 4.62 (t, *J* = 3.9 Hz, 1H, C_2H), 4.52 (s, 2H, OCH_2), 3.98–3.95 (m, 1H, C_4H), 3.75 (s, 2H, CH_2), 3.31 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 1.55 (s, 3H, CH_3), 1.32 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 171.6, 144.2, 141.2, 134.8, 134.2, 128.9, 128.2, 127.4, 122.2, 119.6, 119.2, 104.8, 81.2, 78.5, 74.4, 66.9, 52.0, 34.6, 26.5; MS: *m/z* (M^++Na) 552.10. Anal. Calcd for $C_{25}H_{25}ClN_4O_5S$: C, 56.76; H, 4.76; N, 10.59. Found: C, 56.53; H, 4.55; N, 10.43.

3-(4-Chlorophenyl)-2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-imidazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)thiazolidin-4-one (8b). mp 216–218 °C; IR (KBr) ν 3430, 3229, 2984, 2972, 2832, 1712, 1610, 1549, 1510, 1412, 1219, 682 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.02 (s, 1H, Ar-H), 7.50 (d, *J* = 9.2 Hz, 4H, Ar-H), 7.41 (d, *J* = 8.9 Hz, 4H, Ar-H), 5.72 (d, *J* = 3.6 Hz, 1H, C_1H), 4.94 (d, *J* = 5.2 Hz, CH-S), 4.60 (t, *J* = 3.9 Hz, 1H, C_2H), 4.51 (s, 2H, OCH_2), 3.96–3.91 (m, 1H, C_4H), 3.76 (s, 2H, CH_2), 3.31 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 1.55 (s, 3H, CH_3), 1.32 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.6, 139.4, 134.8, 133.2, 129.4, 128.6, 125.6, 122.2, 119.4, 111.2, 104.9, 81.5, 74.5, 66.3, 52.6, 34.6, 26.5; MS: *m/z* (M^++H) 563.10. Anal. Calcd for $C_{25}H_{24}Cl_2N_4O_5S$: C, 53.29; H, 4.29; N, 9.94. Found: C, 53.21; H, 4.16; N, 9.83.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(4-nitrophenyl)thiazolidin-4-one (8c). mp 201–205°C; IR (KBr) ν 3432, 3226, 2982, 2971, 2830, 1710, 1608, 1546, 1512, 1414, 1374, 1216, 865, 632 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.26 (d, *J* = 8.7 Hz, 2H), 8.04 (s, 1H, Ar-H), 7.51 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.42 (d, *J* = 8.5 Hz, 2H, Ar-H), 6.82 (d, *J* = 9.8 Hz, 2H, Ar-H), 5.71 (d, *J* = 3.6 Hz, 1H, C_1H), 4.96 (d, *J* = 5.2 Hz, CH-S), 4.62 (t, *J* = 3.9 Hz, 1H, C_2H), 4.53 (s, 2H, OCH_2), 3.96–3.91 (m, 1H, C_4H), 3.76 (s, 2H, CH_2), 3.28 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 1.52 (s, 3H, CH_3), 1.34 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.6, 147.5, 144.4, 143.2, 134.8, 131.2, 128.6, 124.6, 122.4, 119.8, 111.8, 104.9, 81.5, 78.2, 74.8, 66.9, 52.4, 34.6, 26.8; MS: *m/z* (M^++H) 574.10. Anal. Calcd for $C_{25}H_{24}ClN_5O_7S$: C, 52.31; H, 4.21; N, 12.20. Found: C, 52.26; H, 4.19; N, 12.11.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-*o*-tolylthiazolidin-4-one (8d). mp 181–183°C; IR (KBr) ν 3436, 3234, 2986, 2976, 2834, 1710, 1705, 1610, 1549, 1516, 1418, 1262, 865 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.23 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.04 (s, 1H, Ar-H), 7.54 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.45–6.82 (m, 5H, Ar-H), 5.74 (d, *J* = 3.6 Hz, 1H, C_1H), 4.94 (d, *J* = 5.2 Hz, 1H, CH-S), 4.62 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.96–3.91 (m, 1H, C_4H), 3.76 (s, 2H, CH_2), 3.26 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.1 (s, 3H, CH_3), 1.53 (s, 3H, CH_3), 1.36 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.6, 144.6, 138.7, 134.8, 134.3, 130.6, 129.4, 128.6, 125.8, 122.6, 119.8, 111.6, 104.8, 81.7, 78.6, 74.7, 66.5, 52.4, 26.6, 16.5; MS: *m/z* (M^++H) 545.10. Anal. Calcd for $C_{26}H_{27}ClN_4O_5S$: C, 57.51; H, 5.51; N, 10.32. Found: C, 56.86; H, 5.39; N, 10.11.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-*p*-tolylthiazolidin-4-one (8e). mp 191–193°C; IR (KBr) ν 3428, 3230, 2986, 2976, 2832, 1708, 1698, 1608, 1546, 1514, 1416, 1261, 859 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.26 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.04 (s, 1H, Ar-H), 7.54 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.39 (d, *J* = 8.3 Hz, 2H, Ar-H), 7.15 (d, *J* = 8.3 Hz, 2H, Ar-H), 5.76 (d, *J* = 3.6 Hz, 1H, C_1H), 4.96 (d, *J* = 5.2 Hz, 1H, CH-S), 4.66 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.96–3.91 (m, 1H, C_4H), 3.76 (s, 2H, CH_2), 3.26 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.30 (s, 3H, CH_3), 1.53 (s, 3H, CH_3), 1.36 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 172.6, 143.2, 137.4, 133.6, 132.3, 131.2, 128.4, 127.9, 124.8, 122.9, 119.2, 111.2, 103.8, 81.2, 78.1, 74.1, 65.9, 51.4, 26.1, 16.1; MS: *m/z* (M^++Na) 565.10. Anal. Calcd for $C_{26}H_{27}ClN_4O_5S$: C, 57.51; H, 5.51; N, 10.32. Found: C, 56.82; H, 5.35; N, 10.09.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(3-hydroxyphenyl)thiazolidin-4-one (8f). mp 208–209°C; IR (KBr) ν 3535, 3426, 3231, 2985, 2974, 2832, 1710, 1610, 1549, 1516, 1418, 1261, 864 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.26 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.03 (s, 1H, Ar-H), 7.56 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.14–6.70 (m, 4H, Ar-H), 5.76 (d, *J* = 3.6 Hz, 1H, C_1H), 5.40 (s, 1H, OH), 4.96 (d, *J* = 5.2 Hz, 1H, CH-S), 4.66 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.93–3.96 (m, 1H, C_4H), 3.74 (s, 2H, CH_2), 3.26 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 1.53 (s, 3H, CH_3), 1.38 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 171.6, 158.3, 144.2, 143.2, 134.6, 134.4, 130.6, 128.6, 122.2, 120.1, 119.4, 114.6, 111.8, 107.6, 106.8, 81.8, 78.6, 74.8, 64.9, 54.9, 41.1, 35.3; MS: *m/z* (M^++H) 545.20. Anal. Calcd for $C_{25}H_{25}ClN_4O_6S$: C, 55.09; H, 4.62; N, 10.28. Found: C, 54.82; H, 4.55; N, 10.19.

2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(4-hydroxyphenyl)thiazolidin-4-one (8g). mp 263–265°C; IR (KBr) ν 3541, 3425, 3232, 2987, 2980, 2834, 1710, 1612, 1546, 1519, 1416, 1258, 862 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 8.22 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.06 (s, 1H, Ar-H), 7.54 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.10–6.70 (m, 4H, Ar-H), 5.76 (d, *J* = 3.6 Hz, 1H, C_1H), 5.28 (s, 1H, OH), 4.92 (d, *J* = 5.2 Hz, 1H, CH-S), 4.65 (t, *J* = 3.9 Hz, 1H, C_2H), 4.52 (s, 2H, OCH_2), 3.91–3.94 (m, 1H, C_4H), 3.79 (s, 2H, CH_2), 3.34 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 1.52 (s, 3H, CH_3), 1.36 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 171.2, 157.8, 143.8, 143.2, 133.9, 133.4, 130.2, 127.6, 121.9, 120.5, 1198.8, 114.2, 111.2, 106.8, 81.4, 78.2, 73.8, 62.9, 54.2, 40.9, 34.9; MS: *m/z* (M^++H) 545.20. Anal. Calcd for $C_{25}H_{25}ClN_4O_6S$: C, 55.09; H, 4.62; N, 10.28. Found: C, 54.92; H, 4.59; N, 10.22.

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-4-oxo-3-phenylthiazolidin-5-yl)acetic acid (9 a–g). To a solution of diol **6** (0.200 g, 0.48 mmol) in CH_2Cl_2 (5 mL), $NaIO_4$ (0.130 g, 0.61 mmol) was added at 0 °C and stirred at room temperature for 6 h. The reaction mixture was filtered and washed with CH_2Cl_2 (2 × 10 mL). It was dried (Na_2SO_4) and evaporated to give aldehyde **7** (0.150 g) in quantitative yield as a yellow liquid, which was used as such for the next reaction.

To a stirred mixture of **7** (0.150 g, 0.395 mmol), aromatic amine (0.395 mmol) and thiomalic acid (0.125 g, 0.86 mmol) in dry toluene (5 mL), anhydrous $ZnCl_2$ (0.100 g, 0.751 mmol) was added after 2 min and irradiated in microwave bath reactor at 280 W for 4–7 min at 110 °C. After cooling, the filtrate was concentrated to dryness under reduced pressure and the residue was taken up in ethyl acetate. The ethyl acetate layer was washed with 5% sodium bicarbonate solution and finally with brine. The organic layer was dried over Na_2SO_4 and evaporated to dryness at reduced pressure. The crude product thus obtained was purified by column chromatography on silica gel (60–120 mesh) with hexane–ethyl acetate as the eluent. Under conventional method the reaction mixture in toluene (10 mL) was refluxed at 110 °C for the appropriate time (Table 1).

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-4-oxo-3-phenylthiazolidin-5-yl)acetic acid (9a). mp 211–214°C; IR (KBr) ν 3436, 3226, 2984, 2973, 2942, 2832, 1724, 1614, 1549, 1510, 1412, 1224, 685 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 11.44 (s, 1H, CO_2H), 8.09 (s, 1H, Ar-H), 7.55 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.48 (d, *J* = 8.9 Hz, 2H, Ar-H), 6.73–7.35 (m, 5H, Ar-H), 6.15 (s, 1H, CHS), 5.73 (d, *J* = 4.2 Hz, 1H, C_1H), 4.69 (t, *J* = 3.9 Hz, 1H, C_2H), 4.65 (t, 1H, CH), 4.52 (s, 2H, OCH_2), 3.92–3.89 (m, 1H, C_4H), 3.31 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.38 (d, 2H, CH_2), 1.53 (s, 3H, CH_3), 1.30 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.9, 143.8, 141.2, 134.2, 128.2, 126.8, 122.1, 118.8, 104.2, 80.4, 77.9, 73.8, 66.1, 52.0, 37.2, 33.9, 25.9; MS: *m/z* (M^++H) 545.20. Anal. Calcd for $C_{27}H_{27}ClN_4O_7S$: C, 55.24; H, 4.64; N, 9.54. Found: C, 55.12; H, 4.59; N, 9.39.

2-(3-(4-Chlorophenyl)-2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-4-oxothiazolidin-5-yl)acetic acid (9b). mp 259–261 °C; IR (KBr) ν 3438, 3431, 2982, 2829, 1724, 1716, 1608, 1539, 1509, 1410, 1216, 689 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 11.44 (s, 1H, CO_2H), 7.98 (s, 1H, Ar-H), 7.45 (d, *J* = 9.2 Hz, 4H, Ar-H), 7.39 (d, *J* = 8.9 Hz, 4H, Ar-H), 6.14 (s, 1H, CHS), 5.73 (d, *J* = 4.2 Hz, 1H, C_1H), 4.69 (t, *J* = 3.9 Hz, 1H, C_2H), 4.65 (t, 1H, CH), 4.52 (s, 2H, OCH_2), 3.92–3.89 (m, 1H, C_4H), 3.20 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.34 (d, 2H, CH_2), 1.53 (s, 3H, CH_3), 1.30 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.6, 143.2, 141.6, 134.6, 128.8, 126.9, 122.2, 118.4, 104.5, 80.6, 77.6, 73.2, 66.4, 52.3, 36.9, 33.2, 25.6; MS: *m/z* (M^++H) 621.13. Anal. Calcd for $C_{27}H_{26}Cl_2N_4O_7S$: C, 52.18; H, 4.22; N, 9.01. Found: C, 52.02; H, 4.09; N, 8.95

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(4-nitrophenyl)-4-oxothiazolidin-5-yl)aceticacid (9c). mp 256–258 °C; IR (KBr) ν 3428, 3434, 3225, 2981, 2966, 2820, 1725, 1710, 1609, 1536, 1510, 1412, 1373, 1210, 863, 639 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 11.45 (s, 1H, CO_2H), 8.21 (d, *J* = 8.4 Hz, 2H), 8.01 (s, 1H, Ar-H), 7.49 (d, *J* = 9.1 Hz, 2H, Ar-H), 7.41 (d, *J* = 8.5 Hz, 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, C_1H), 4.65 (t, 1H, CH), 4.53 (t, *J* = 3.9 Hz, 1H, C_2H), 4.52 (s, 2H, OCH_2), 3.90–3.86 (m, 1H, C_4H), 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, $CDCl_3$): 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) 632.13. Anal. Calcd for $C_{27}H_{26}Cl_2N_5O_9S$: C, 51.31; H, 4.15; N, 11.08. Found: C, 51.19; H, 4.09; N, 10.95.

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-5-yl)-4-oxo-3-*o*-tolylthiazolidin-5-yl)acetic acid (9d). mp 247–249 °C; IR (KBr) ν 3431, 3229, 2978, 2834, 1709, 1699, 1610, 1550, 1516, 1418, 1264, 853 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ 11.45 (s, 1H, CO_2H), 8.22 (d, *J* = 8.4 Hz, 2H, Ar-H), 8.06 (s, 1H, Ar-H), 7.50 (d, *J* = 9.1 Hz, 2H, Ar-H), 7.42–6.85 (m, 4H, Ar-H), 6.14 (s, 1H, CHS), 5.65 (d, *J* = 4.2 Hz, 1H, C_1H), 4.60 (t, 1H, CH), 4.53 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.92–3.86 (m, 1H, C_4H), 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, $CDCl_3$): 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, 25.2, 16.2; MS: *m/z* (M^++H) 600.13. Anal. Calcd for $C_{28}H_{29}ClN_4O_7S$: C, 55.95; H, 4.86; N, 9.32. Found: C, 54.19; H, 4.62; N, 9.15.

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-4-oxo-3-*p*-tolylthiazolidin-5-yl)aceticacid (9e). mp 197–199 °C; IR (KBr) ν 3435, 3239, 2971, 2830, 1710, 1696, 1615, 1540, 1510, 1428, 1254, 843 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ 11.45 (s, 1H, CO_2H), 8.20 (d, *J* = 8.4 Hz, 2H, Ar-H), 8.04 (s, 1H, Ar-H), 7.54 (d, *J* = 9.1 Hz, 2H, Ar-H), 7.36 (d, *J* = 8.3 Hz, 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, C_1H), 4.60 (t, 1H, CH), 4.53 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.92–3.86 (m, 1H, C_4H), 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, $CDCl_3$): 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, 25.2, 16.2; MS: *m/z* (M^++H) 600.13. Anal. Calcd for $C_{28}H_{29}ClN_4O_7S$: C, 55.95; H, 4.86; N, 9.32. Found: C, 54.19; H, 4.62; N, 9.15.

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(3-hydroxyphenyl)-4-oxothiazolidin-5-yl)acetic acid (9f). mp 227–229 °C; IR (KBr) ν 3535, 3436, 3236, 2975, 2832, 1710, 1610, 1544, 1516, 1418, 1261, 864 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ 11.42 (s, 1H, CO_2H), 8.24 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.03 (s, 1H, Ar-H), 7.56 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.14–6.70 (m, 4H, Ar-H), 6.14 (s, 1H, CHS), 5.76 (d, *J* = 3.6 Hz, 1H, C_1H), 5.42 (s, 1H, OH), 4.96 (d, *J* = 5.2 Hz, 1H, CH), 4.51 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.93–3.96 (m, 1H, C_4H), 3.26 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.34 (d, 2H, CH_2), 1.53 (s, 3H, CH_3), 1.38 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 175.6, 171.6, 158.3, 144.2, 143.2, 134.6, 134.4, 130.6, 128.6, 122.2, 120.1, 119.4, 114.6, 111.8, 107.6, 106.8, 81.8, 78.6, 74.8, 64.9, 54.9, 41.1, 38.9, 35.3; MS: *m/z* (M^++H) 545.20. Anal. Calcd for $C_{27}H_{27}ClN_4O_8S$: C, 53.78; H, 4.52; N, 9.29. Found: C, 53.52; H, 4.35; N, 8.99.

2-(2-((3a*R*,5*S*,6*S*,6a*R*)-6-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)-3-(4-hydroxyphenyl)-4-oxothiazolidin-5-yl)acetic acid (9g). mp 256–258 °C; IR (KBr) ν 3532, 3430, 3226, 2973, 2830, 1710, 1616, 1534, 1506, 1411, 1258, 854 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ 11.39 (s, 1H, CO_2H), 8.22 (d, *J* = 8.7 Hz, 2H, Ar-H), 8.06 (s, 1H, Ar-H), 7.52 (d, *J* = 9.2 Hz, 2H, Ar-H), 7.14–6.87 (m, 4H, Ar-H), 6.14 (s, 1H, CHS), 5.76 (d, *J* = 3.6 Hz, 1H, C_1H), 5.42 (s, 1H, OH), 4.96 (d, *J* = 5.2 Hz, 1H, CH), 4.51 (t, *J* = 3.9 Hz, 1H, C_2H), 4.54 (s, 2H, OCH_2), 3.93–3.96 (m, 1H, C_4H), 3.26 (dd, *J* = 9.1, 4.2 Hz, 1H, C_3H), 2.34 (d, 2H, CH_2), 1.53 (s, 3H, CH_3), 1.38 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ 173.6, 171.6, 154.1, 143.2, 142.1, 133.6, 131.4, 129.6, 128.1, 122.6, 120.5, 115.4, 112.6, 111.8, 107.6, 106.8, 81.8, 78.6, 76.8, 65.9, 56.9, 42.1, 36.9, 34.3; MS: *m/z* (M^++H) 545.20. Anal. Calcd for $C_{27}H_{27}ClN_4O_8S$: C, 53.78; H, 4.52; N, 9.29. Found: C, 53.42; H, 4.25; N, 8.79.

6. Conclusions

A series of novel triazole linked thiazolidenone derivatives **8a**–**g** and **9a**–**g** was prepared and evaluated for their antibacterial and nematicidal activity against various bacterias and nematodes. The screened compounds **8b**, **9f** exhibited potent antibacterial activity compared to standard drugs at the tested concentrations and **8f**, **9f** exhibited potent nematicidal activity compared to standard drugs at the tested concentrations.

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8. References

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Povzetek

S pomočjo kondenzacije (3a*R*,5*S*,6*R*,6a*R*)-6-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2,2-dimethyltetrahydro[2,3-*d*][1,3]dioxole-5-carbaldehyde **7** z merkapto kislinami in primarnimi amini v prisotnosti $ZnCl_2$ smo pod pogoji obsevanja z mikrovalovi in s klasičnim segrevanjem s pomočjo enolončnega postopka pripravili serijo novih derivatov **8a**–**g** in **9a**–**g**, ki vsebujejo povezana triazolski in tiazolidinonski obroč. Spojino 7 smo pripravili iz diaceton D-glukoze s pomočjo oksidacije, ki ji je sledila redukcija, klik reakcija, odščita primarnega acetonida in oksidativni razcep. Karakterizacijo novih spojin smo izvedli z IR, NMR, MS in elementno analizo. Raziskali smo tudi aktivnost novih spojin proti nematodam in bakterijam.