RSC Advances

ROYAL SOCIETY OF CHEMISTRY

www.rsc.org/advances

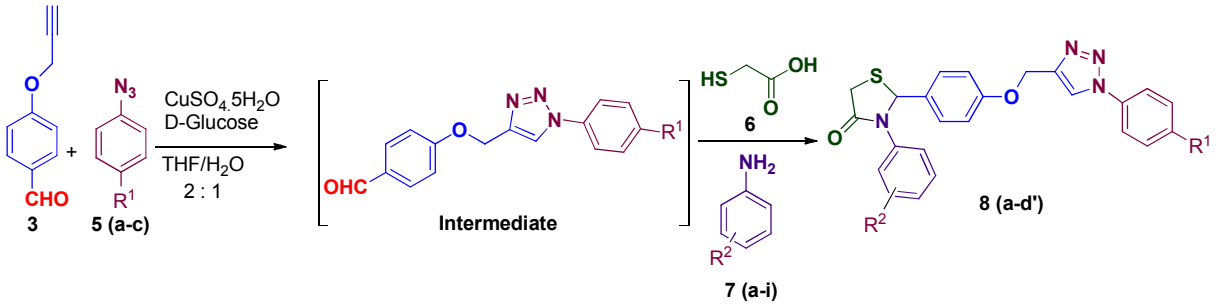
Cu(I)-Catalyzed Microwave-Assisted Synthesis of 1,2,3-triazole linked with 4-thiazolidinones *:* A one-pot sequential approach

Yogesh Kumar,[a, b] Akanksha Matta,[a] Prashant Kumar,[a] Virinder S. Parmar,[a, b] Erik V. Van der Eycken[b] and Brajendra K. Singh*[, a]

[a] Bioorganic Laboratory, Department of Chemistry, University of Delhi, Delhi 110 007, India
E-mail: *singhbk@chemistry.du.ac.in*

[b] Laboratory for Organic & Microwave-Assisted Chemistry (LOMAC), Department of Chemistry, University of Leuven (KU Leuven), Celestijnenlaan 200F, B-3001 Leuven, Belgium

Abstract:



A novel copper (I) catalyzed, microwave-assisted one-pot, four-component sequential reaction between a propargyloxybenzaldehyde, a substituted phenyl azide, a substituted aniline and thioglycolic acid has been developed for the synthesis of 3-phenyl-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl]thiazolidin-4-ones.

Keywords: Thiazolidinones / Triazoles / Microwave-assisted synthesis / Cu(I) catalysis / One-pot sequential synthesis

Introduction

Thiazolidinones and 1,2,3-triazoles represent important classes of drugs in medicinal chemistry. They are among the most extensively investigated compounds by biochemists and medicinal chemists.[1] Thiazolidinones in particular show interesting anticancer,[2] anti-HIV,[3] antimalarial,[4] tuberculostatic,[5] antihistaminic,[6] anticonvulsant,[7] antibacterial[8] and antiarrythmic[9] activities. Similarly, various triazole derivatives possess antifungal,[10] anticancer,[11] antituberculosis[12] and antimicrobial[13] activities.

So called hybrid molecules have been shown to be highly active and effective in medicinal chemistry. Synergistic effects are obtained *via* hybridization of two different bioactive moieties with complementary pharmacophoric functions, or with different modes of action.[14] The confirmation of this hypothesis has been well established in previous studies of 4-thiazolidinones coupled with other heterocyclic fragments,[15] i. e. resulting in high antitumor activity. As a result, we have planned the synthesis of linked thiazolidinone-triazole hybrid molecules. 4-Thiazolidinones have been conveniently synthesized by a three-component condensation of a primary amine, an aldehyde, and either a mercaptoacetic or mercaptopropanoic acid.[15] This cyclocondensation could be accelerated with N,N'- dicyclohexylcarbodiimide (DCC),[16] 2-(1H-benzotriazole-1-yl)-1,1,3,3-tetramethyluronium hexafluorophosphate (HBTU),[17] γ-ferrite,[18] $ZnCl_2$,[19] sodium sulfate,[20] [bmim][PF_6],[21] and activated fly ash.[22] The use of microwave irradiation[23] and polymer supported systems[24] has also been reported. However, the main bottleneck of these protocols is mostly harsh reaction conditions, prolonged heating, and the need for simultaneous removal of water to accelerate the cyclocondensation. On the other hand, the synthesis of 1,2,3-triazoles has been reported by various methods,[25] like copper-catalyzed azide-alkyne cycloaddition (CuAAC) reaction[26] and microwave-assisted one-pot reaction of an alkyl halide, sodium azide and an alkyne.[27] We have recently reported the formation of 1,2,3-

triazoles using D-glucose as a reducing agent for the copper catalyst.[28] Very recently, metal free synthesis of 1,2,3-triazoles has been also developed.[29]

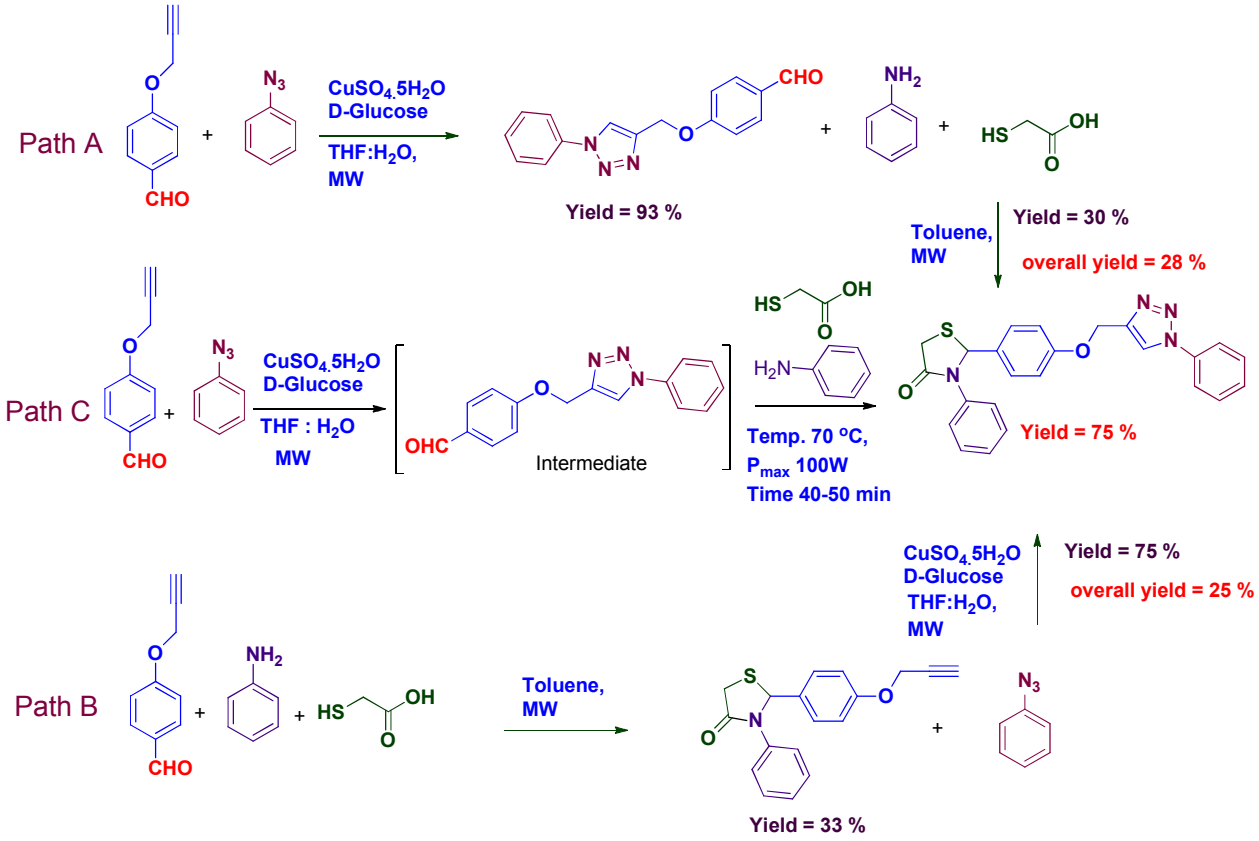
Microwave irradiation is an alternative heating technique based on the transformation of electromagnetic energy into heat. Often this method increases the rate of chemical reactions [30] and results in higher yields.

In recent years, multicomponent reactions (MCRs)[28b, 31] have received increasing attention due to their simplicity, efficiency, atom economy, shortened reaction times, and the possibility for diversity-oriented synthesis. The combination of MCRs with transition metal-catalysis gives access to complex molecules in few steps as compared to traditional multistep processes. We have investigated the application of microwave irradiation for the synthesis of our hybrid molecules.

Results and Discussion

In view of the useful applications of 4-thiazolidinones and 1,2,3-triazoles, we have developed a new microwave-assisted Cu(I)-catalyzed one-pot, two step sequential synthesis *via* reaction of an propargyloxybenzaldehyde, an aryl azide, an aniline and thioglycolic acid under microwave irradiation. This synthesis could be achieved by three different pathways A, B and C (Scheme 1). The simple one could be a two-step synthesis where either triazole ring formation takes place, followed by the thiazolidinone ring (Path A) or *vice versa, i.e.* formation of the thiazolidinone ring followed by the triazole ring (Path B). However, alternatively, one-pot, two-step synthesis could be employed, where initially 4-(prop-2-yn-1-yloxy)benzaldehyde and an aryl azide are reacted followed by addition of the aniline and thioglycolic acid, to form the desired hybrid molecule (Path C). Interesting to mention here that the second step where aniline and

thioglycolic acid react with triazolyated intermediate didn't proceed under conventional heating. Moreover, attempt to succeed this reaction in a single step, one-pot manner was not feasible even under microwave irradiation in contrast to the sequential addition of the reactants as shown in Path C (Scheme 1).

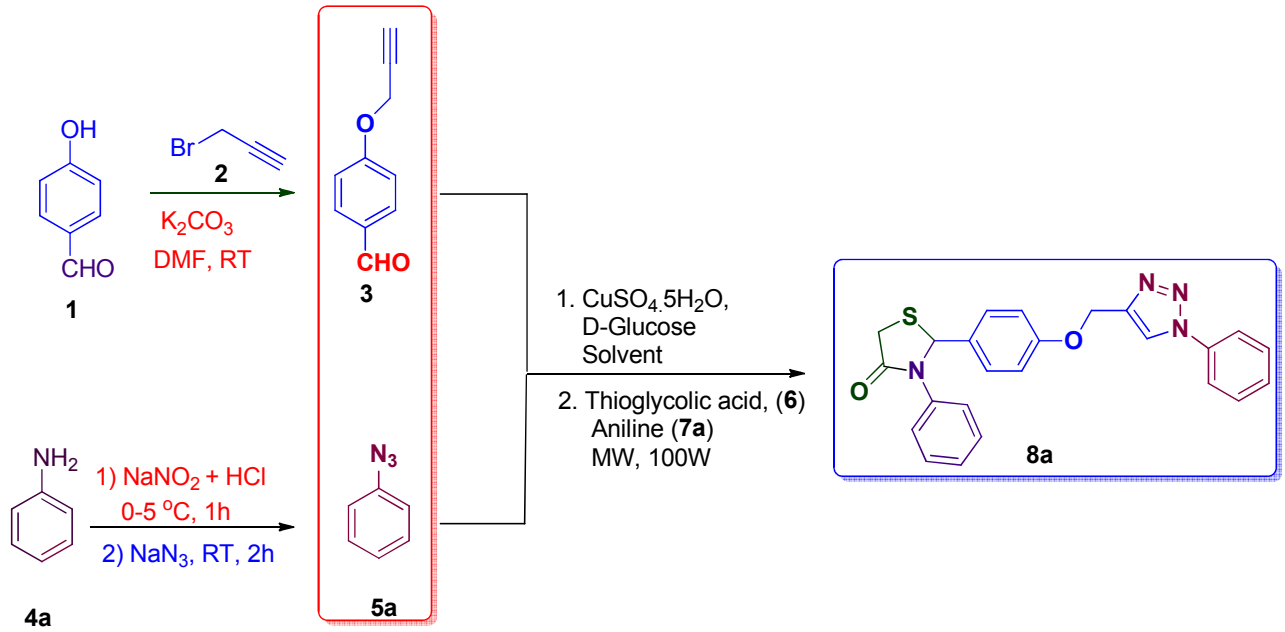


Scheme 1. Synthesis of thiazolidinone linked triazole

Our initial investigation was focused on the screening of various solvents to achieve the best yield under microwave irradiation (**Table 1)**. The reaction was unsuccessful when carried out in polar aprotic solvents like tetrahydrofuran (THF), acetonitrile (MeCN), 1,4-dioxane and non polar aprotic solvent like toluene, while the reaction went to completion when carried out in polar protic solvents, like ethanol (EtOH) and methanol (MeOH) resulting in the formation of the desired product in 33% and 29% yield, respectively (**Table 1, entries 5 and 6**). To our delight, when the reaction was carried out in an aqueous mixture of toluene or THF, decent

amounts of compound **8a** were obtained (**Table 1, entries 7 and 8**). The reaction did not run to completion when it was carried out in chloroform or dioxane mixed with water (**Table 1, entries 9 and 10**). Among the screened aqueous solvent, THF/H_2O (2:1) appeared to be the most effective (**Table 1, entry 8**).

Table 1: **Optimization of the solvent system.**[a]



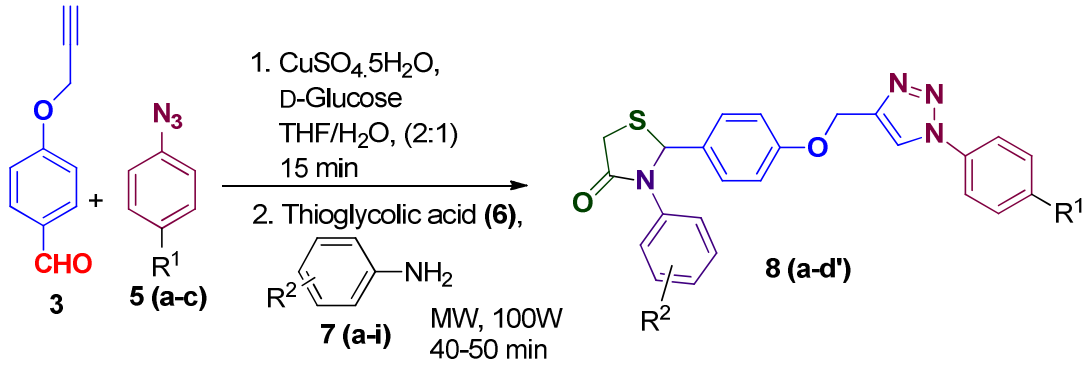
Entry	Solvent	Temp. (°C)	Time (min) Ist step + 2nd step	Yield (%)[b]
1	Toluene	110	20 + 35	c
2	THF	70	20 + 25	c
3	MeCN	100	20 + 30	c
4	1,4-dioxane	100	5 + 10	c

5	EtOH	85	15 + 55	33
6	MeOH	80	5 + 40	29
7	Toluene/H_2O, (2:1)	90	5 + 35	50
8	**THF/H_2O, (2:1)**	**70**	**15 + 40**	**75**
9	$CHCl_3$/H_2O, (2:1)	50	10 + 30	c
10	Dioxane/H_2O, (2:1)	100	10 + 30	c
11	MeCN/H_2O, (2:1)	75	15 + 70	17

[a]The first step involves the reaction of 4-(prop-2-yn-1-yloxy)benzaldehyde (**3**) (1.8 mmol), phenyl azide (**5a**) (2.2 mmol), $CuSO_4.5H_2O$ (0.35 mmol) and D-glucose (0.75 mmol) in different solvents under microwave irradiation for the indicated time and temperature at 100 W maximum power, followed by the addition of aniline (**7a**) (2.2 mmol) and thioglycolic acid (**6**) (2.2 mmol) in the second step; [b]isolated yields, c = no reaction

To investigate the scope and limitations, various phenyl azides **5a-c** and anilines **7a-i** were evaluated employing the optimized conditions. All the screened azides and anilines reacted smoothly with propargyloxybenzaldehyde (**3**) and thioglycolic acid (**6**) and afforded the expected desired products **8 (a-d')** (**Table 2**) in good yields. Anilines bearing either an electron donating group or electron withdrawing group were well tolerated.

Table 2: Scope and limitations of the protocol employing different phenyl azides 5a-c and anilines 7a-i.[a]



Entry	Compd.	R^1	R^2	Time (min) (I_{st} step)[b] + II^{nd} step	Yield (%)[c]
1	**8a**	H	H	40	75
2	**8b**	H	4-$COCH_3$	50	82
3	**8c**	H	3-$COCH_3$	45	76
4	**8d**	H	4-CH_3	40	75
5	**8e**	H	3-CH_3	40	84
6	**8f**	H	4-OCH_3	40	82
7	**8g**	H	2-OCH_3	40	76
8	**8h**	H	4-Br	45	62
9	**8i**	H	3-F	40	71
10	**8j**	CH_3	H	45	85
11	**8k**	CH_3	4-$COCH_3$	50	69
12	**8l**	CH_3	3-$COCH_3$	40	74

13	**8m**	CH_3	4-CH_3	40	87
14	**8n**	CH_3	3-CH_3	45	80
15	**8o**	CH_3	4-OCH_3	40	9
16	**8p**	CH_3	2-OCH_3	40	70
17	**8q**	CH_3	4-Br	40	68
18	**8r**	CH_3	3-F	40	76
19	**8s**	OCH_3	H	45	76
20	**8t**	OCH_3	4-$COCH_3$	40	76
21	**8u**	OCH_3	3-$COCH_3$	40	83
22	**8v**	OCH_3	4-CH_3	45	79
23	**8w**	OCH_3	3-CH_3	50	73
24	**8x**	OCH_3	4-OCH_3	40	87
25	**8y**	OCH_3	2-OCH_3	40	80
26	**8z**	OCH_3	4-Br	40	74
27	**8a'**	OCH_3	3-F	40	75
28	**8b'**	OCH_3	4-F	40	78
29	**8c'**	OCH_3	4-Cl	50	85
30	**8d'**	OCH_3	2-Cl	50	77

[a]The first step involves the reaction of 4-(prop-2-yn-1-yloxy)benzaldehyde (**3**) (1.8 mmol), phenyl azide (**5a-c**) (2.2 mmol), $CuSO_4.5H_2O$ (0.35 mmol) and D-glucose (0.75 mmol) in THF/H_2O solvent under microwave irradiation for the appropriate time and temperature at 100 W maximum power, followed by the addition of aniline (**7a-i**) (2.2 mmol) and thioglycollic acid (**6**) (2.2 mmol), [b]15 min; [c]isolated yields.

Conclusions

In summary, we have developed a convenient route for the synthesis of thaizolidinones linked triazoles through a Cu(I)-catalyzed one-pot sequential approach. The products could be isolated in good yields. Work is ongoing to investigate the biological properties of these novel heterocyclic compounds.

Experimental Section

General Information: All microwave assisted experiments were run in a closed vial applying a dedicated CEM-Discover monomode microwave apparatus operating at a frequency of 2.45 GHz with continuous irradiation power from 0 to 300 W (CEM Corporation, P.O. Box 200, Matthews, NC 28106). Analytical TLCs were performed on Merck silica gel 60_{F254} plates. All liquid column chromatographic separations were performed on column chromatography. IR spectra were recorded on a Perkin-Elmer 2000 FT-IR spectrometer at Department of Chemistry, University of Delhi. The ^1H and ^{13}C NMR spectra (in $CDCl_3$) were recorded on a JEOL ECX-400P NMR/Bruker Avance at 400 MHz/300 MHz and 100 MHz/75 MHz, respectively at USIC, University of Delhi/Katholiek University Leuven, TMS was used as internal standard. The NMR spectra were processed by JEOL Delta^{TM} NMR data processing software, the chemical shift values are on a δ scale and coupling constants (*J*) are in ppm and Hz respectively. Abbreviations used are: s (singlet), d (doublet), t (triplet), dd (double doublet) and m (multiplet). The high-resolution mass spectral

data was obtained using a JEOL JMS-SX-102A spectrometer at Institute for Chemistry and Biochemistry, Free University Berlin, Germany. Melting points were recorded on a Buchi M-560 melting point apparatus and are uncorrected. All the chemicals and reagents like phenol, aniline, thioglycolic acid and propargyl bromide were purchased from commercial sources and used as received unless otherwise indicated.

General procedure for the synthesis[32] of 4-(prop-2-yn-1-yloxy) benzaldehyde or propargyloxybenzaldehyde **(3):**

A mixture of 4-hydroxy benzaldehyde (1 mmol) and propargyl bromide (1.2 mmol) in DMF (2 mL) as solvent was stirred with K_2CO_3 at r. t. for 24 h. The progress of the reaction was monitored on TLC [ethyl acetate/petroleum ether (1:4)]. After completion of the reaction, the mixture was extracted with ethyl acetate (3 x 50 mL). The combined ethyl acetate layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was directly used in the next step without any further purification.

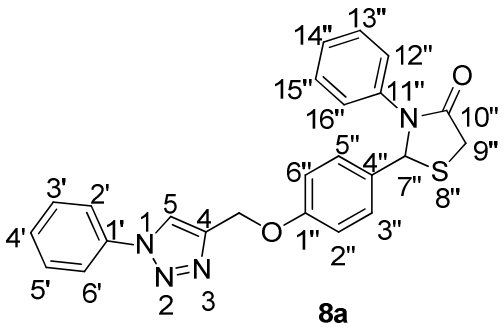
General procedure for the synthesis[33] of azidobenzene and its derivatives (5a-c)

A mixture of appropriate aniline **4 (a-c)** (1 mmol) in HCl (17 %, 5 mL) was stirred at 0 ^{o}C. Sodium nitrite (1.5 equiv., dissolved in 5 mL of water) was added dropwise and stirring continued at 0 ^{o}C. After 15 min, sodium azide (1.5 equiv., dissolved in 5 mL of water) was added dropwise at 0 ^{o}C and the mixture was stirred for 3-4 h. The progress of the reaction was monitored by TLC [ethyl acetate/petroleum ether (1:5)]. After completion of the reaction, the reaction mixture was extracted with ethyl acetate (3 x 50 mL). The combined ethyl acetate layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was directly used in the next step without any further purification.

Synthesis of 3-phenyl-2-(4-((1-phenyl-1H-1,2,3-triazol-4-yl)methoxy)phenyl)thiazolidin-4-one and its derivatives (8a-d')

A mixture of the alkyne (1 mmol), the appropriate azide (1.2 mmol), $CuSO_4 \cdot 5H_2O$ (0.2 equiv) and D-Glucose were taken in THF/H_2O (2:1) in microwave transparent glass vial equipped with a small magnetic stirring bar, and the vial was tightly sealed with a Teflon crimp cap. The mixture was then irradiated for 15 min at 70 ^oC and 100 W maximum power. The reaction mixture was cooled to r. t. and aniline (1.2 mmol) and thioglycolic acid (1.2 mmol) were added. The reaction mixture was irradiated again for appropriate time (40-50 min) at 70 ^oC and 100 W maximum power. The progress of the reaction was monitored by TLC [ethyl acetate/petroleum ether (1:2)]. After completion of the reaction, the mixture was extracted with ethyl acetate (3 x 50 mL). The combined ethyl acetate layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography over silica gel to yield the desired products **8a-d'**.

3-phenyl-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl]thiazolidin-4-one (8a)

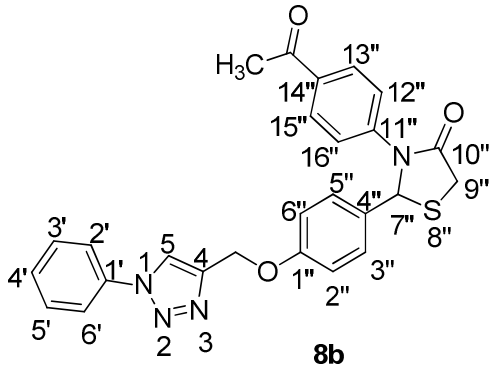


8a

It was obtained as white solid having m. p. 169-171 ^oC in 75% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2931 (C-H, Ar), 1689 (C=O), 1226 (C-O), 765 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 8.00 (s, 1H, H-5), 7.72 (dd, *J* = 1.5, 6.5 Hz, 2H, Ar), 7.53-7.45 (m, 3H, Ar), 7.29-7.23 (m, 4H, Ar), 7.176-7.12 (m, 3H, Ar), 6.92(dd, *J* = 2.1, 6.5 Hz, 2H, Ar), 6.07 (s, 1H, H-7"), 5.24 (s,

2H, -OCH_2), 3.98 (dd, *J* = 1.5, 16.1 Hz, 1H, H-9"), 3.87 (d, *J* = 16.0 Hz, 1H, H-9"); **^{13}C NMR (75 MHz, $CDCl_3$)** δ 170.918 (C=O), 158.51 (C-1"), 144.56, 137.45, 136.90, 131.89, 129.80, 129.09, 128.95, 128.64, 127.12, 125.89, 120.95, 120.61, 115.01, 65.31 (C-7"), 61.99 (–O<u>C</u>H_2), 33.58 (C-9"); **HRMS** calcd. for $C_{24}H_{20}N_4O_2SH$: 429.5141; found $[M+H]^+$: 429.5215.

3-(4-acetylphenyl)-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8b)

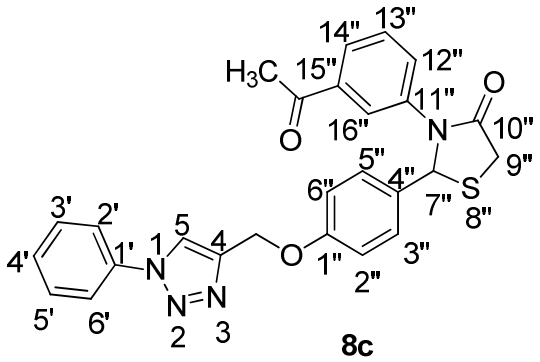


8b

It was obtained as a white solid with a m. p. of 123-125 ^oC in 82% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (-C-H, Ar), 1679 (C=O), 1599 (C=O), 1267 (C-O), 758 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 8.02 (s, 1H, H-5), 7.86 (d, *J* = 7.5 Hz, 2H, Ar), 7.72 (d, *J* = 7.32 Hz, 2H, Ar), 7.54-7.42 (m, 3H, Ar), 7.34-7.22 (m, 4H, Ar), 7.31 (d, *J* = 8.05 Hz, 2H, Ar), 7.25-7.21 (m, 2H, Ar), 6.93 (d, *J* = 8.02 Hz, 2H, Ar), 6.19 (s, 1H, H-7"), 5.27 (s, 2H, -OCH_2), 3.96 (d, *J* = 16.2 Hz, 1H, H-9"), 3.86 (d, *J* = 16.2 Hz, 1H, H-9"), 2.52 (s, 3H, -$COCH_3$); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 197.00 (-<u>C</u>OCH_3), 171.03 (C-10"), 158.59 (C-1"), 144.39, 141.70, 136.81, 134.80, 131.18, 129.78, 129.11, 128.98, 128.34, 124.63, 121.02, 120.56, 115.15, 64.67 (C-

7"), 61.90 (-O<u>C</u>H$_2$), 33.59 (C-9"), 26.49 (-CO<u>C</u>H$_3$); **HRMS** calcd. for $C_{26}H_{22}N_4O_3SH$: 471.5508; found $[M+H]^+$: 471.5514.

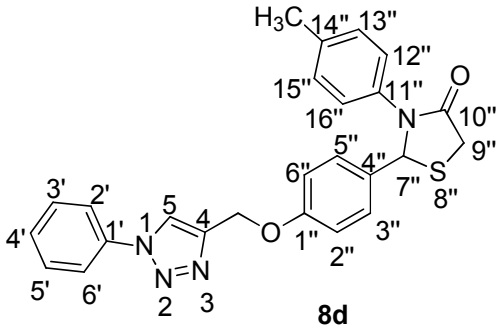
3-(3-acetylphenyl)-2--[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8c)



8c

It was obtained as a brown semi solid in 76% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1685 (C=O), 1598 (C=O), 1240 (C-O), 758 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 8.02 (s, 1H, H-5), 7.74-7.70 (m, 4H, Ar), 7.55-7.44 (m, 5H, Ar) 7.38-7.36 (m, 2H, Ar), 6.92 (dd, *J* = 2.2, 6.5 Hz, 2H, Ar), 6.14 (s, 1H, H-7"), 5.22 (s, 2H, -OCH$_2$), 3.98 (dd, *J* = 1.7, 14.6 Hz, 1H, H-9"), 3.88 (d, *J* = 15.6 Hz, 1H, H-9"), 2.50 (s, 3H, -COCH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 197.08 (-<u>C</u>OCH$_3$), 171.12 (C-10"), 158.59 (C-1"), 144.38, 137.84, 137.76, 136.89, 131.16, 130.47, 129.77, 129.32, 128.98, 128.73, 126.89, 125.23, 121.02, 120.56, 115.06, 65.06 (C-7"), 61.83 (-O<u>C</u>H$_2$), 33.54 (C-9"), 26.56 (-CO<u>C</u>H$_3$); **HRMS** calcd. for $C_{26}H_{22}N_4O_3SH$: 471.5508; found $[M+H]^+$: 471.5521.

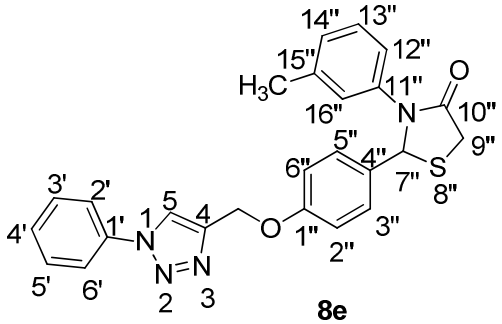
2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl]-3-(*p*-tolyl)thiazolidin-4-one (8d)



8d

It was obtained as a yellowish solid with a m. p. of 166.0-168.0 ^{o}C in 75% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2924 (C-H, Ar), 1681 (C=O), 1239 (C-O), 757 (C-S-C); **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.01 (s, 1H, H-5), 7.70 (d, *J* = 8.05 Hz, 2H, Ar), 7.49 (d, *J* = 7.32 Hz, 2H, Ar) 7.45-7.41 (m, 1H, Ar), 7.24-7.21 (m, 2H, Ar), 7.04 (d, *J* = 7.32 Hz, 2H, Ar), 6.97 (d, *J* = 8.05 Hz, 2H, Ar), 6.90 (d, *J* = 8.05 Hz, 2H, Ar), 6.00 (s, 1H, H-7"), 5.22 (s, 2H, -OCH$_2$), 3.95 (d, *J* = 16.1 Hz, 1H, H-9"), 3.85 (d, *J* = 16.1 Hz, 1H, H-9"), 2.22 (s, 3H, -CH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 170.12 (C-10"), 158.42 (C-1"), 144.45, 137.07, 136.78, 134.62, 131.92, 129.70, 128.89, 128.64, 125.84, 120.99, 120.52, 114.89, 65.35 (C-7"), 61.88 (-O<u>C</u>H$_2$), 33.46 (C-9"), 20.93 (-<u>C</u>H$_3$); **HRMS** calcd. for $C_{25}H_{22}N_4O_2SH$: 443.5407; found $[M+H]^+$: 443.5414.

2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl]-3-(*m*-tolyl)thiazolidin-4-one (8e)

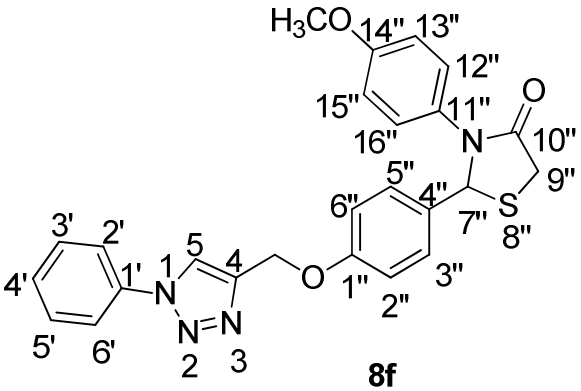


8e

It was obtained as a yellowish solid with a m. p. of 181-183 ^{o}C in 84% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2924 (C-H, Ar), 1681 (C=O), 1238 (C-O), 759 (C-S-C); **^{1}H NMR (400 MHz,**

$CDCl_3$) δ 8.01 (s, 1H, H-5), 7.70 (d, *J* = 7.32 Hz, 2H, Ar), 7.52-7.49 (m, 2H, Ar), 7.45-7.41 (m, 1H, Ar), 7.24-7.21 (m, 2H, Ar), 7.13-7.09 (m, 1H, Ar), 6.95-6.85 (m, 5H, Ar), 6.02 (s, 1H, H-7"), 5.23 (s, 2H, -OCH_2), 3.95 (d, *J* = 1.46, 16.11 Hz, 1H, H-9"), 3.84 (d, *J* = 16.11 Hz, 1H, H-9"), 2.23 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.96 (C-10"), 158.43 (C-1"), 144.50, 139.00, 137.24, 136.82, 131.96, 129.75, 128.93, 128.81, 128.60, 128.05, 126.66, 122.93, 120.96, 120.56, 114.91, 65.36 (C-7"), 61.90 (-O$\underline{C}H_2$), 33.52 (C-9"), 21.29 (-$\underline{C}H_3$); **HRMS** calcd. for $C_{25}H_{22}N_4O_2SH$: 443.5407; found $[M+H]^+$: 443.5419.

3-(4-methoxyphenyl)-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8f)

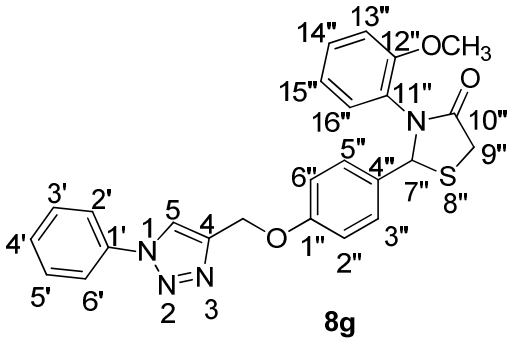


8f

It was obtained as a brown semi solid in 82% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2926 (C-H, Ar), 1676 (C=O), 1215 (C-O), 758 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 8.02 (s, 1H, H-5), 7.72 (dd, *J* = 2.0, 7.6 Hz, 2H, Ar), 7.55-7.44 (m, 3H, Ar), 7.26-7.22 (m, 2H, Ar), 7.00-6.91 (m, 4H, Ar), 6.79-6.76 (m, 2H, Ar), 5.96 (s, 1H, H-7"), 5.24 (s, 2H, -OCH_2), 3.97 (dd, *J* = 1.7, 16.11 Hz, 1H, H-9"), 3.86 (d, *J* = 16.0 Hz, 1H, H-9") 3.71 (s, 3H, -OCH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.14 (C-10"), 158.52 (C-1"), 144.51, 136.84, 131.91, 129.90, 129.77, 128.95, 128.83, 127.62, 120.97, 120.58, 114.91, 114.42, 65.67 (C-7"), 61.89 (-O$\underline{C}H_2$), 55.28

(-O<u>C</u>H$_3$), 33.40 (C-9"); **HRMS** calcd. for $C_{25}H_{22}N_4O_3SH$: 459.5401; found $[M+H]^+$: 459.5417.

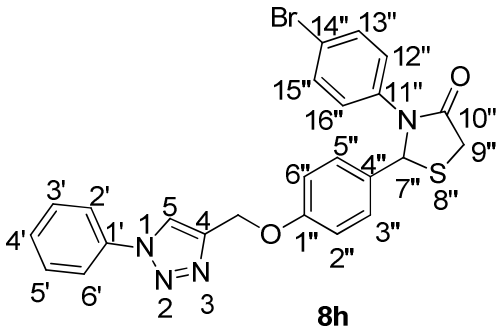
3-(2-methoxyphenyl)-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8g)



8g

It was obtained as a white solid with a m. p. of 168.0-170.0 ^oC in 76% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2926 (C-H, Ar), 1686 (C=O), 1236 (C-O), 761 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 8.00 (s, 1H, H-5), 7.69 (d, *J* = 8.79 Hz, 2H, Ar), 7.52-7.41 (m, 3H, Ar), 7.26-7.24 (m, 2H, Ar), 6.87-6.82 (m, 4H, Ar), 6.77-6.74 (m, 1H, Ar), 6.05 (s, 1H, H-7"), 5.20 (s, 2H, -OCH$_2$), 3.90-3.80 (m, 2H, H-9"), 3.79 (s, 3H, -OCH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 171.52 (C-10"), 158.45 (C-1"), 154.74, 144.50, 136.78, 131.32, 130.29, 129.74, 129.49, 129.39, 128.94, 125.24, 120.94, 120.71, 120.54, 114.53, 111.81, 64.35(C-7"), 61.79 (-O<u>C</u>H$_2$), 55.59 (-O<u>C</u>H$_3$), 33.24 (C-9"); **HRMS** calcd. for $C_{25}H_{22}N_4O_3SH$: 459.5401; found $[M+H]^+$: 459.5409.

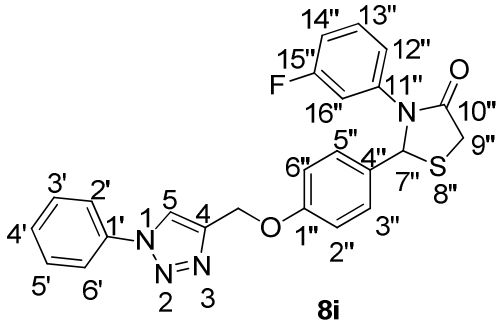
3-(4-bromophenyl)-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8h)



8h

It was obtained as a yellow solid with a m. p. of. 87.0-89.0 ^{o}C in 62% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1685 (C=O), 1216 (C-O), 758 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.03 (s, 1H, H-5), 7.72 (d, *J* = 8.05 Hz, 2H, Ar), 7.53-7.43 (m, 3H, Ar), 7.38 (d, *J* = 8.79 Hz, 2H, Ar), 7.22 (d, *J* = 8.05 Hz, 2H, Ar), 7.02 (d, *J* = 8.05 Hz, 2H, Ar), 6.93 (d, *J* = 8.05 Hz, 2H, Ar), 6.04 (s, 1H, H-7"), 5.25 (s, 2H, -OCH_2), 3.95 (d, *J* = 16.11 Hz, 1H, H-9"), 3.85 (d, *J* = 15.38 Hz, 1H, H-9"); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.90 (C-10"), 158.62 (C-1"), 144.49, 136.85, 136.45, 132.18, 131.32, 129.79, 128.99, 128.60, 127.23, 121.00, 120.59, 115.11, 65.05 (C-7"), 61.94 (-O<u>C</u>H_2), 33.48 (C-9"); **HRMS** calcd. for $C_{24}H_{19}BrN_4O_2SH$: 508.4102; found $[M+H]^+$: 508.4110.

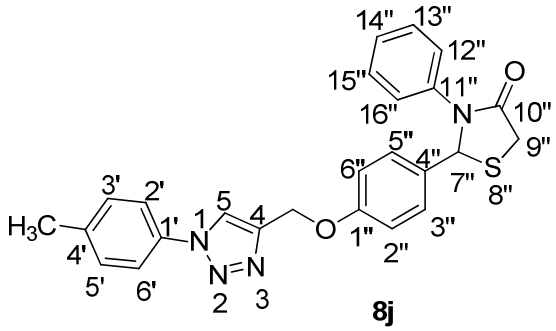
3-(3-fluorophenyl)-2-[4-{(1-phenyl-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8i)



8i

It was obtained as a white solid with a m. p. of 156.0-158.0 ^{o}C in 71% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2926 (C-H, Ar), 1675 (C=O), 1243 (C-O), 760 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.01 (s, 1H, H-5), 7.72 (dd, *J* = 1.09, 8.01 Hz, 2H, Ar), 7.54-7.51 (m, 2H, Ar), 7.47-7.43 (m, 1H, Ar), 7.25-7.19 (m, 3H, Ar), 6.98-6.82 (m, 5H, Ar), 6.07 (s, 1H, H-7"), 5.24 (s, 2H, -OCH_2), 3.95 (dd, *J* = 1.6, 16.1 Hz, 1H, H-9"), 3.85 (d, *J* = 16.1 Hz, 1H, H-9"); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.94 (C-10"), 158.60 (C-1"), 144.47, 131.44, 129.79, 128.96, 128.43, 120.93, 120.60, 115.12, 114.01, 113.84, 113.08, 112.85, 64.99 (C-7"), 61.97 (-O<u>C</u>H_2), 33.48 (C-9"); **HRMS** calcd. for $C_{24}H_{19}FN_4O_2SH$: 447.1291; found $[M+H]^+$: 447.1296.

3-phenyl-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl}methoxy]phenyl)thiazolidin-4-one (8j)

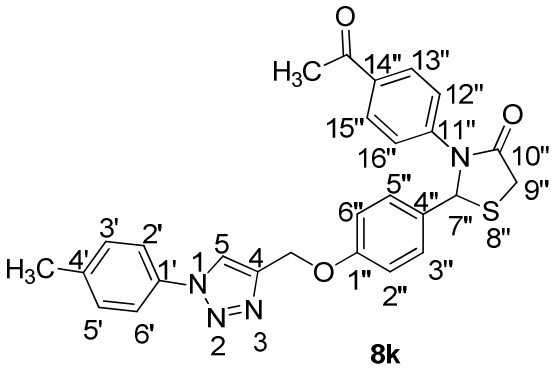


8j

It was obtained as a dark brown solid with a m. p. of 152.0-154.0 ^{o}C in 85% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1701 (C=O), 1228 (C-O), 826 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.05 (s, 1H, H-5), 7.72 (d, *J* = 8.05 Hz, 2H, Ar), 7.54-7.43 (m, 4H, Ar), 7.26-7.23 (m, 1H, Ar), 7.06 (d, *J* = 7.32 Hz, 2H, Ar), 6.99 (d, *J* = 8.05 Hz, 2H, Ar), 6.92 (d, *J* = 8.05 Hz, 2H, Ar), 6.02 (s, 1H, H-7"), 5.24 (s, 2H, -OCH_2), 3.97 (d, *J* = 15.38 Hz, 1H, H-9"), 3.87 (d, *J* = 16.11 Hz, 1H, H-9"), 2.24 (s, 2H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.48 (C-10"), 158.93 (C-1"), 144.97, 137.59, 137.29, 135.14, 132.44, 130.22, 129.41, 129.16, 126.35,

121.50, 121.03, 115.40, 65.87 (C-7"), 62.40 (-O<u>C</u>H$_2$), 33.97 (C-9"), 21.45 (-<u>C</u>H$_3$); **HRMS** calcd. for $C_{25}H_{22}N_4O_2SH$: 443.5407; found $[M+H]^+$: 443.5401.

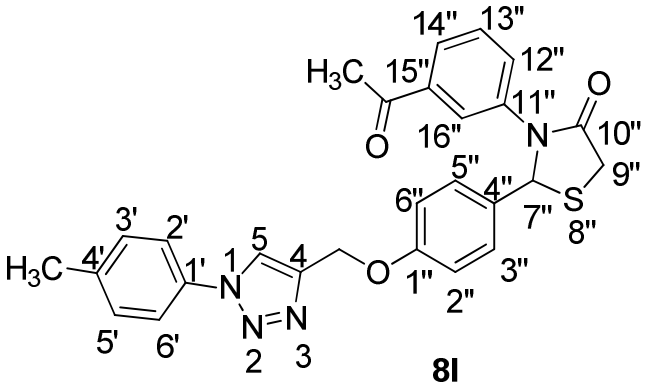
3-(4-acetylphenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8k)



8k

It was obtained as a white solid with a m. p. of 137.0-139.0 ^oC in 69 % yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2917 (C-H, Ar), 1683 (C=O), 1227 (C-O), 750 (C-S-C); **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.97 (s, 1H, H-5), 7.86 (d, *J* = 8.6 Hz, 2H, Ar), 7.58 (d, *J* = 8.6 Hz, 2H, Ar), 7.33-7.29 (m, 4H, Ar), 7.23 (d, *J* = 8.6 Hz Hz, 1H, Ar), 7.21 (m, 1H, Ar), 6.93 (d, *J* = 8.00 Hz, 2H, Ar), 6.18 (s, 1H, H-7), 5.22 (s, 2H, -OCH$_2$), 3.95 (d, *J* = 16.8 Hz, 1H, H-9"), 3.87 (d, *J* = 16.8 Hz, 1H, H-9"), 2.51 (s, 3H, -COCH$_3$), 2.41 (s, 3H, -CH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 197.05 (-<u>C</u>OCH$_3$), 170.97 (C-10"), 158.49 (C-1"), 144.31, 141.67, 139.21, 134.85, 134.57, 131.14, 130.26, 129.13, 128.32, 124.62, 120.98, 120.47, 115.17, 64.91 (C-7"), 61.69 (-O<u>C</u>H$_2$), 33.60 (C-9"), 26.53 (-CO<u>C</u>H$_3$), 21.08 (-<u>C</u>H$_3$); **HRMS** calcd. for $C_{27}H_{24}N_4O_3SH$: 485.5774; found $[M+H]^+$: 485.5770.

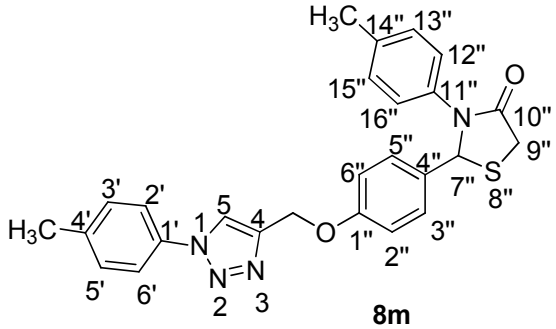
3-(3-acetylphenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8l)



8l

It was obtained as a dark brown semi solid in 74% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (C-H, Ar), 1682 (C=O), 1240 (C-O), 757 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.98 (s, 1H, H-5), 7.73-7.70 (m, 2H, Ar), 7.57 (d, *J* = 8.72 Hz, 2H, Ar), 7.36-7.35 (m, 2H, Ar), 7.30-7.26 (m, 4H, Ar), 6.91 (d, *J* = 8.70 Hz, 2H, Ar), 6.13 (s, 1H, H-7"), 5.20 (s, 2H, -OCH_2), 3.97 (d, *J* = 16.03 Hz, 1H, H-9"), 3.88 (d, *J* = 16.03 Hz, 1H, H-9"), 2.49 (s, 3H, -$COCH_3$), 2.40 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 197.01 (-$COCH_3$), 171.06 (C-10"), 158.55 (C-1"), 144.19, 138.89, 137.76, 134.48, 131.03, 130.44, 130.21, 129.28, 128.69, 126.84, 125.21, 120.98, 120.43, 115.03, 65.02 (C-7"), 61.84 (-O$\underline{C}H_2$), 33.52 (C-9"), 26.53 (-CO$\underline{C}H_3$), 21.04 (-$\underline{C}H_3$); **HRMS** calcd. for $C_{27}H_{24}N_4O_3SH$: 485.5774; found $[M+H]^+$: 485.5779.

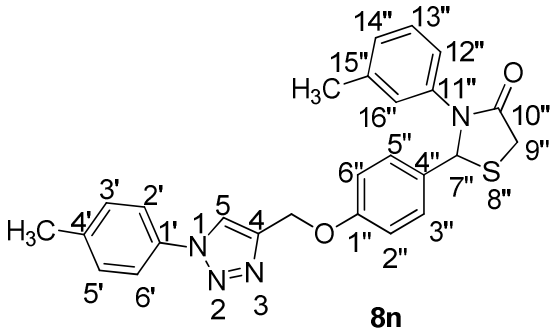
3-(*p*-tolyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]thiazolidin-4-one (8m)



8m

It was obtained as a white solid with a m. p. of 159.0-161.0 ^{o}C in 87% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1690 (C=O), 1232 (C-O), 819 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.97 (s, 1H, H-5), 7.59 (d, *J* = 2.48, 6.4 Hz, 2H, Ar), 7.31 (d, *J* = 8.4 Hz, 2H, Ar), 7.25-7.23 (m, 2H, Ar),7.06 (d, *J* = 8.4 Hz, 2H, Ar), 7.04-6.97 (m, 2H, Ar), 6.93 (dd, *J* = 2.4, 6.8 Hz, 2H, Ar), 6.01 (s, 1H, H-7"), 5.22 (s, 2H, -OCH_2), 3.97 (dd, *J* = 1.6, 15.6 Hz, 1H, H-9"), 3.86 (d, *J* = 15.6 Hz, 1H, H-9"), 2.42 (s, 3H, -CH_3), 2.24 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.02 (C-10"), 158.47 (C-1"), 144.30, 139.08, 137.12, 134.63, 134.53, 131.90, 130.22, 129.73, 128.66, 125.87, 120.94, 120.45, 114.90, 65.39 (C-7"), 61.87 (-O<u>C</u>H_2), 33.48 (C-9"), 21.05 (-CH_3), 20.96 (-CH_3); **HRMS** calcd. for $C_{26}H_{24}N_4O_2SH$: 457.5673; found $[M+H]^+$: 457.5679.

3-(*m*-tolyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]thiazolidin-4-one (8n)

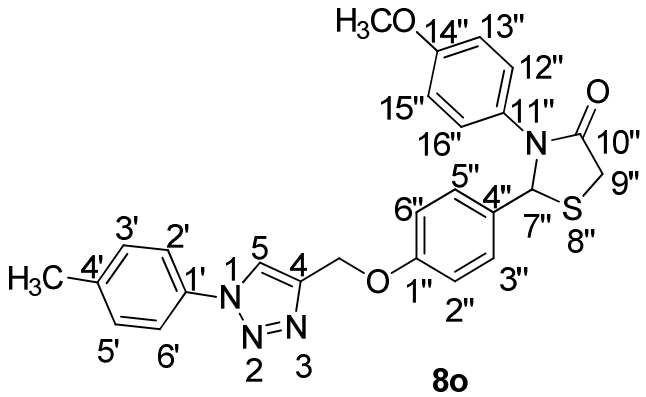


8n

It was obtained as a white solid with a m. p. of 227.0-229.0 ^{o}C in 80% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2926 (C-H, Ar), 1676 (C=O), 1237 (C-O), 824 (C-S-C); **NMR (300 MHz, $CDCl_3$)** δ 7.97 (s, 1H, H-5), 7.58 (dd, *J* = 2.4, 8.4 Hz, 2H, Ar), 7.32-7.21 (m, 4H, Ar), 7.16-7.1028 (m, 1H, Ar), 7.97-6.86 (m, 5H, Ar), 6.04 (s, 1H, H-7"), 5.22 (s, 2H, -OCH_2), 3.97 (dd, *J* = 2.4, 21.2 Hz, 2H, H-9"), 3.85 (d, *J* = 15.3 Hz, 1H, H-9"), 2.41 (s, 3H, -CH_3), 2.21 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.50 (C-10"), 158.95 (C-1"), 144.78, 139.57, 137.60, 135.12, 135.01, 132.38, 130.70, 130.22, 129.15, 126.35, 121.42, 120.94, 115.38, 65.88 (C-

7"), 62.36 (-O<u>C</u>H$_2$), 33.96 (C-9"), 21.53 (-CH$_3$), 21.44 (-CH$_3$); **HRMS** calcd. for $C_{26}H_{24}N_4O_2SH$: 457.5673; found $[M+H]^+$: 457.5670.

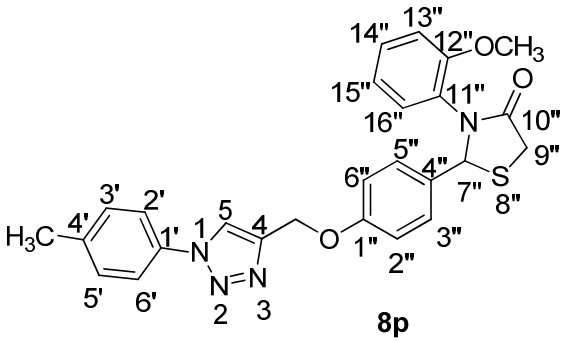
3-(4-methoxyphenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-5-one (8o)



8o

It was obtained as a yellowish solid with a m. p. of 123.0-125.0 ^oC in 69% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (C-H, Ar), 1678 (C=O), 1246 (C-O), 757 (C-S-C); **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.98 (s, 1H, H-5), 7.60 (d, *J* = 8.4 Hz, 2H, Ar), 7.32 (d, *J* = 8.0 Hz, 2H, Ar), 7.26-7.23 (m, 2H, Ar), 7.00 (dd, *J* = 2.0, 6.8 Hz, 2H, Ar), 6.94 (d, *J* = 8.4 Hz, 2H, Ar), 6.79 (dd, *J* = 2.7, 7.3 Hz, 2H, Ar), 5.96 (s, 1H, H-7"), 5.24 (s, 2H, -OCH$_2$), 3.98 (dd, *J* = 1.6, 15.6 Hz, 1H, H-9"), 3.87 (d, *J* = 16.0 Hz, 1H, H-9"), 3.73 (s, 3H, -OCH$_3$), 2.43 (s, 3H, -CH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 171.04 (C-10"), 158.53 (C-1"), 144.30, 139.12, 134.50, 131.90, 130.26, 129.93, 128.82, 127.62, 120.98, 120.48, 114.90, 114.41, 65.62 (C-7"), 61.90 (-O<u>C</u>H$_2$), 55.28 (-OCH$_3$), 33.40 (C-9"), 21.07 (-<u>C</u>H$_3$); **HRMS** calcd. for $C_{26}H_{24}N_4O_3SH$: 473.5667; found $[M+H]^+$: 473.5660.

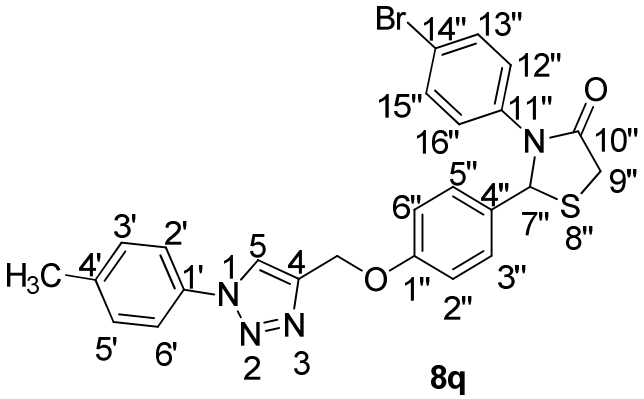
3-(2-methoxyphenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]thiazolidin-4-one (8p)



8p

It was obtained as a white solid with a m. p. of 237.0-239.0 ^{o}C in 70% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2922 (C-H, Ar), 1672 (C=O), 1271 (C-O), 757 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.95 (s, 1H, H-5), 7.59 (d, *J* = 8.8 Hz, 2H, Ar), 7.32-7.14 (m, 5H, Ar), 6.90-6.75-7.20 (m, 5H, Ar), 6.06 (s, 1H, H-7"), 5.21 (s, 2H, -OCH_2), 3.90 (s, 2H, H-9"), 3.82 (s, 3H, -OCH_3), 2.42 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.10 (C-10"), 159.99 (C-12"), 158.45 (C-1"), 141.18, 137.18, 134.58, 131.92, 129.76, 128.69, 125.90, 122.25, 121.22, 120.03, 114.91, 114.78, 65.44 (C-7"), 61.82 (-O<u>C</u>H_2), 55.61 (-O<u>C</u>H_3), 33.50 (C-9"), 20.99 (-<u>C</u>H_3); **HRMS** calcd. for $C_{26}H_{24}N_4O_3SH$: 473.5667; found $[M+H]^+$: 473.5662.

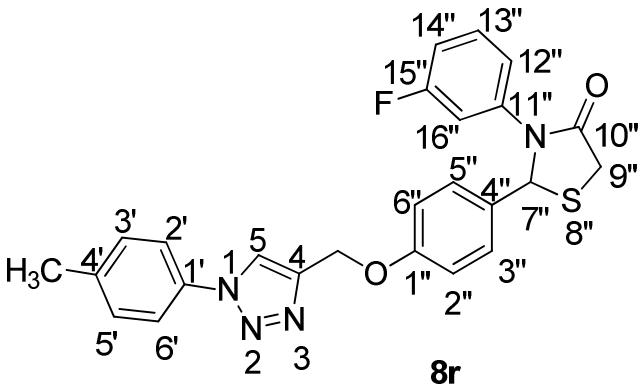
3-(4-bromophenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8q)



8q

It was obtained as a white solid with a m. p. of 180.0-182.0 ^{o}C in 68% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2926 (C-H, Ar), 1684 (C=O), 1231 (C-O), 823 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.98 (s, 1H, H-5), 7.59 (d, *J* = 8.4 Hz, 2H, Ar), 7.40-7.36 (m, 2H, Ar), 7.31 (d, *J* = 8.4 Hz, 2H, Ar), 7.24-7.20 (m, 2H, Ar), 7.03 (d, *J* = 8.8 Hz, 2H, Ar), 6.94 (d, *J* = 8.8 Hz, 2H, Ar), 6.04 (s, 1H, H-7"), 5.23 (s, 2H, -OCH_2), 3.95 (dd, *J* = 1.2, 15.6 Hz, 1H, H-9"), 3.85 (d, *J* = 15.6 Hz, 1H, H-9"), 2.42 (s, 3H, -CH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.87 (C-10"), 158.64 (C-1"), 144.26, 139.10, 136.44, 134.55, 132.17, 131.26, 130.26, 128.57, 127.22, 120.97, 120.58, 120.46, 115.09, 64.98 (C-7"), 61.95 (-O<u>C</u>H_2), 33.47 (C-9"), 21.07 (-<u>C</u>H_3); **HRMS** calcd. for $C_{25}H_{21}BrN_4O_2SH$: 522.4368; found $[M+H]^+$: 522.4360.

3-(3-fluorophenyl)-2-[4-{(1-(*p*-tolyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one(8r)

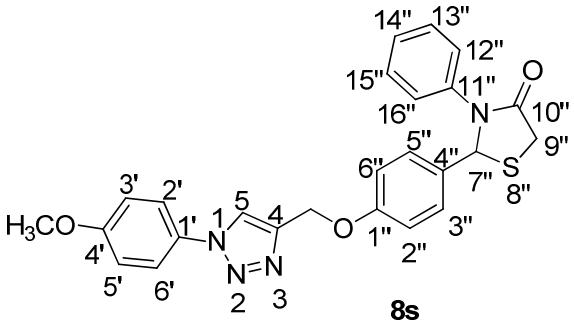


8r

It was obtained as a white solid with a m. p. of 276-278 ^{o}C in 76% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2928 (C-H, Ar), 1638 (C=O), 1255 (C-O), 825 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.05 (s, 1H, H-5), 7.41 (d, *J* = 8.05 Hz, 2H, Ar), 7.54 (t, *J* = 7.32 Hz, 2H, Ar), 7.49-7.45 (m, 1H, Ar), 7.26 (d, *J* = 8.05 Hz, 2H, Ar), 7.08 (d, *J* = 7.32 Hz, 2H, Ar), 7.01 (d, *J* = 8.05 Hz, 2H, Ar), 6.94 (d, *J* = 8.05 Hz, 1H, Ar), 6.04 (s, 1H, H-7"), 5.26 (s, 2H, -OCH_2), 3.98 (d, *J* = 16.11 Hz, 1H, H-9"), 3.88 (d, *J* = 16.11 Hz, 1H, H-9"), 2.26 (s, 3H, -CH_3); **^{13}C NMR (100**

MHz, $CDCl_3$) δ 170.04 (C-10"), 157.66 (C-1"), 143.11, 138.07, 133.64, 130.45, 129.37, 127.69, 120.84, 120.19, 119.47, 114.14, 112.86, 112.66, 112.19, 111.95, 63.74 (C-7"), 60.75 (-O<u>C</u>H_2), 32.56 (C-9"), 20.17 (-<u>C</u>H_3); **HRMS** calcd. for $C_{25}H_{21}FN_4O_2SH$: 461.5312; found $[M+H]^+$: 461.5318.

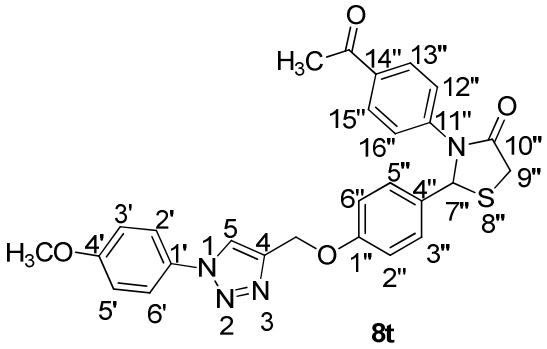
2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]-3-phenylthiazolidin-4-one (8s)



8s

It was obtained as a yellowish solid with a m. p. of 170.0-172.0 ^oC in 76 % yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2924 (C-H, Ar), 1683 (C=O), 1248 (C-O), 757 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (s, 1H, H-5), 7.64-7.60 (m, 2H, Ar), 7.29-7.23 (m, 4H, Ar), 7.18-7.12 (m, 2H, Ar),7.04-7.01 (m, 2H, Ar), 6.92 (d, *J* = 8.05 Hz, 2H, Ar), 6.07 (s, 1H, H-7"), 5.22 (s, 2H, -OCH_2), 4.00-3.85 (m, 5H, H-9" & -OCH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.93 (C-10"), 159.88 (C-4'), 158.49 (C-1"), 144.23, 137.36, 131.75, 130.26, 129.04, 128.59, 127.09, 125.85, 122.20, 121.11, 114.93, 114.73, 65.28 (C-7"), 61.91 (-O<u>C</u>H_2), 55.58 (-O<u>C</u>H_3), 33.52 (C-9"); **HRMS** calcd. for $C_{25}H_{22}N_4O_3SH$: 459.5401; found $[M+H]^+$: 459.5407.

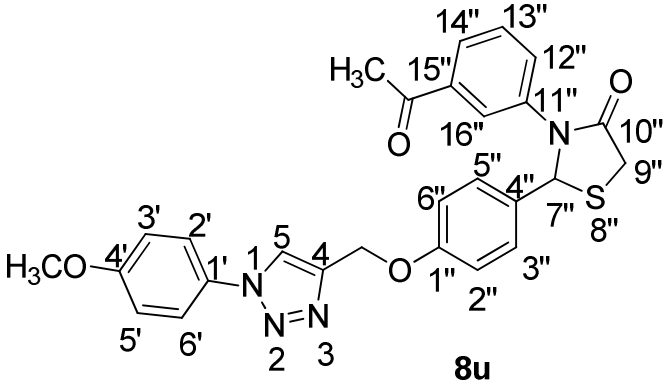
3-(4-acetylphenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8t)



8t

It was obtained as a yellow solid with a m. p. of 131.0-133.0 ^{o}C in 76% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1685 (C=O), 1230 (C-O), 837 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.93 (s, 1H, H-5), 7.86 (dd, *J* = 2.8, 8.8 Hz, 2H, Ar), 7.60 (dd, *J* = 2.8, 8.8 Hz, 2H, Ar), 7.32 (dd, *J* = 2.8, 8.8 Hz, 2H, Ar), 7.26-7.22 (m, 2H, Ar), 7.03-6.99 (m, 2H, Ar), 6.94-6.91 (m, 2H, Ar), 6.18 (s, 1H, H-7"), 5.21 (s, 2H, -OCH_2), 3.99-3,83 (m, 5H, H-9" & -OCH_3), 2.52 (s, 3H, -$COCH_3$); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 197.37 (-$\underline{C}OCH_3$), 176.27 (C-10"), 171.16, 159.61 (C-4'), 158.57 (C-1"), 141.78, 134.72, 131.13, 129.14, 128.35, 124.68, 122.24, 115.15, 114.80, 64.70 (C-7"), 61.80 (-O$\underline{C}H_2$), 55.61 (-O$\underline{C}H_3$), 33.60 (C-9"), 26.50 (-CO$\underline{C}H_3$); **HRMS** calcd. for $C_{27}H_{24}N_4O_4SH$: 501.5768; found $[M+H]^+$: 501.5760.

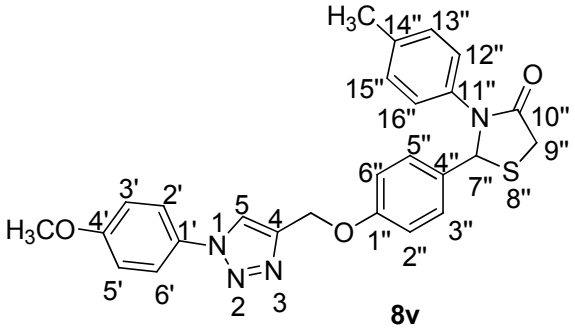
3-(3-acetylphenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8u)



8u

It was obtained as a brown semi solid in 83% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2922 (C-H, Ar), 1683 (C=O), 1247 (C-O), 759 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.93 (s, 1H, H-5), 7.74-7.71 (m, 2H, Ar), 7.62-7.58 (m, 2H, Ar), 7.38-7.36 (m, 1H, Ar), 7.27-7.24 (m, 2H, Ar), 7.02-6.99 (m, 2H, Ar), 6.93-6.90 (m, 2H, Ar), 6.11 (s, 1H, H-7"), 5.20 (s, 2H, -OCH_2), 4.01-3.86 (m, 5H, H-9" & -OCH_3), 2.50 (s, 3H, -$COCH_3$); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 197.12 (-$\underline{C}OCH_3$), 171.17 (C-10"), 159.94 (C-4'), 159.60 (C-1"), 144.09, 131.08, 130.48, 130.15, 129.31, 128.72, 126.91, 125.25, 122.21, 121.22, 115.04, 114.75, 65.08 (C-7"), 61,79 (-$O\underline{C}H_2$), 55.59 (-OCH_3), 33.54 (C-9"), 26.55 (-$CO\underline{C}H_3$); **HRMS** calcd. for $C_{27}H_{24}N_4O_4SH$: 501.5768; found $[M+H]^+$: 501.5762.

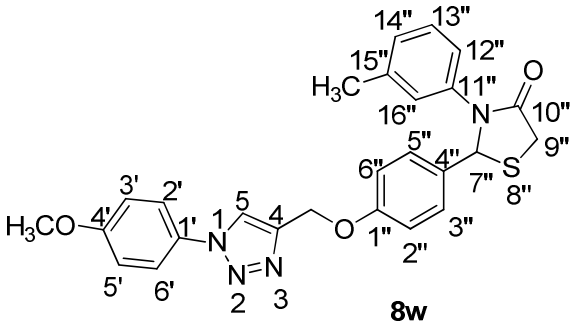
2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]-3-(*p*-tolyl) thiazolidin-4-one (8v)



8v

It was obtained as a white solid with a m. p. of 100-102 ^{o}C in 79% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (C-H, Ar), 1683 (C=O), 1238 (C-O), 758 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 7.93 (s, 1H, H-5), 7.61 (dd, *J* = 2.8, 8.8 Hz, 2H, Ar), 7.26-7.22 (m, 2H, Ar), 7.07-6.97 (m, 6H, Ar), 6.92 (dd, *J* = 2.8, 8.8 Hz, 2H, Ar), 6.02 (s, 1H, H-7"), 5.21 (s, 2H, -OCH$_2$), 3.99-3.83 (m, 5H, H-9" & -OCH$_3$), 2.24 (s, 3H, -CH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 171.10 (C-10"), 159.98 (C-4') , 158.45 (C-1"), 144.18, 137.18, 134.45, 131.92, 129.76, 128.69, 125.90, 122.25, 121.22, 114.91, 114.78, 65.44 (C-7"), 61.82 (-O<u>C</u>H$_2$), 55.61 (-O<u>C</u>H$_3$), 33.50 (C-9"), 20.99 (-CH$_3$); **HRMS** calcd. for $C_{26}H_{24}N_4O_3SH$: 473.5667; found $[M+H]^+$: 473.5662.

2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl]-3-(*m*-tolyl) thiazolidin-4-one (8w)

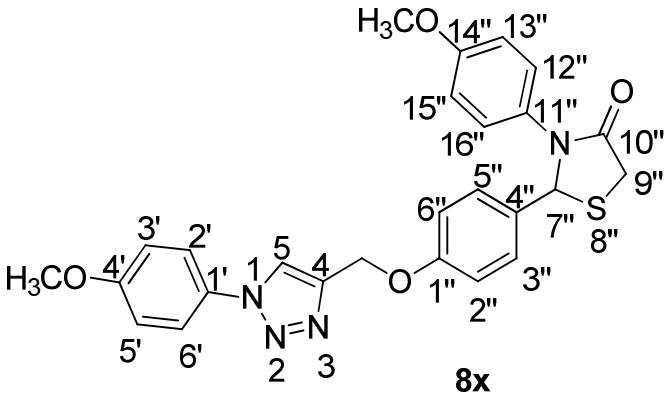


8w

It was obtained as a white solid with a m. p. of 158.0-160.0 ^{o}C in 73 % yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1677 (C=O), 1241 (C-O), 833 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 7.93 (s, 1H, H-5), 7.60 (dd, *J* = 3.2, 8.8 Hz, 2H, Ar), 7.26-7.22 (m, 2H, Ar), 7.16-7.10 (m, 1H, Ar), 7.02-6.86 (m, 7H, Ar), 6.04 (s, 1H, H-7"), 5.21 (s, 2H, -OCH$_2$), 3.99-3.82 (m, 5H, H-9" & -OCH$_3$), 2.25 (s, 3H, -CH$_3$); **^{13}C NMR (100 MHz, CDCl$_3$)** δ 173.56 (C-10"), 171.09, 159.92 (C-4'), 158.40 (C-1"), 144.15, 138.98, 137.13, 131.83, 130.13, 128.78, 128.59, 128.07, 126.65, 122.93, 122.18, 121.20, 114.88, 114.72, 65.39 (C-7"), 61.79 (-

O<u>C</u>H$_2$), 55.56 (-O<u>C</u>H$_3$), 33.49 (C-9"), 21.25 (-<u>C</u>H$_3$); **HRMS** calcd. for $C_{26}H_{24}N_4O_3SH$: 473.5667; found $[M+H]^+$: 473.5665.

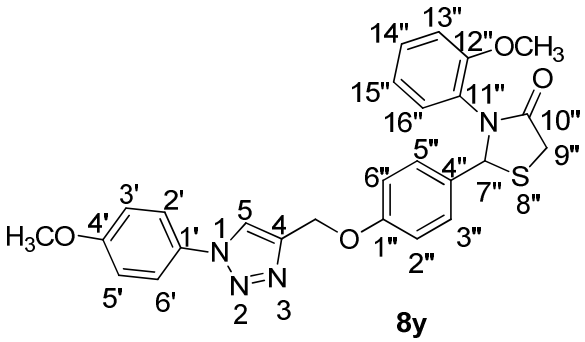
3-(4-methoxyphenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8x)



8x

It was obtained as a white solid with a m. p. of 164.0-166.0 ^oC in 87% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (C-H, Ar), 1681 (C=O), 1248 (C-O), 759 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 7.93 (s, 1H, H-5), 7.61 (d, *J* = 8.8 Hz, 2H, Ar), 7.24 (d, *J* = 8.8 Hz, 2H, Ar), 7.02-6.96 (m, 4H, Ar), 6.92 (d, *J* = 8.4 Hz, 2H, Ar), 6.77 (d, *J* = 8.8 Hz, 2H, Ar), 5.95 (s, 1H, H-7"), 5.22 (s, 2H, -O<u>C</u>H$_2$), 3.98-3.84 (m, 5H, H-9" & -OCH$_3$), 3.71 (s, 3H, -OCH$_3$), ; **^{13}C NMR (100 MHz, CDCl$_3$)** δ 171.00 (C-10"), 159.98, 158.41 (C-1"), 144.17, 131.95, 130.17, 129.94, 128.81, 127.60, 122.25, 121.28, 114.91, 114.78, 114.40, 65.58 (C-7"), 61.89 (-O<u>C</u>H$_2$), 55.60 (-O<u>C</u>H$_3$), 55.28 (-O<u>C</u>H$_3$), 33.39 (C-9"); **HRMS** calcd. for $C_{26}H_{24}N_4O_4SH$: 489.5661; found $[M+H]^+$: 489.5658.

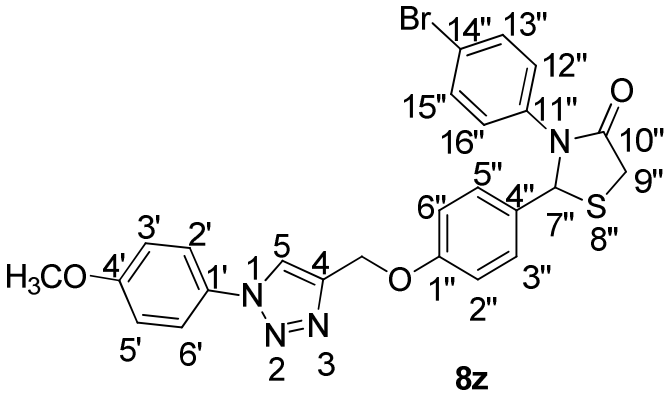
3-(2-methoxyphenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8y)



8y

It was obtained as a yellow solid with a m. p. of 156.0-158.0 ^{o}C in 80% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2929 (C-H, Ar), 1682 (C=O), 1255 (C-O), 753 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.91 (s, 1H, H-5), 7.61 (dd, *J* = 3.2, 8.8 Hz, 2H, Ar), 7.28-7.25 (m, 2H, Ar), 7.20-7.14 (m, 1H, Ar), 7.03-6.99 (m, 2H, Ar), 6.90-6.78 (m, 5H, Ar), 6.06 (s, 1H, H-7"), 5.21 (s, 2H, -OCH_2), 3.91-3.82 (m, 8H, H-9", 2 x –OCH_3); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.32 (C-10"), 159.86 (C-4'), 158.48 (C-12"), 154.76 (C-1"), 144.22, 131.34, 130.32, 130.23, 129.44, 129.35, 125.32, 122.17, 121.10, 120.70, 114.71, 114.51, 111.80, 64.27 (C-7"), 61.84 (-O$\underline{C}H_2$), 55.58 (-OCH_3), 33.22 (C-9"); **HRMS** calcd. for $C_{26}H_{24}N_4O_4SH$: 489.5661; found $[M+H]^+$: 489.5665.

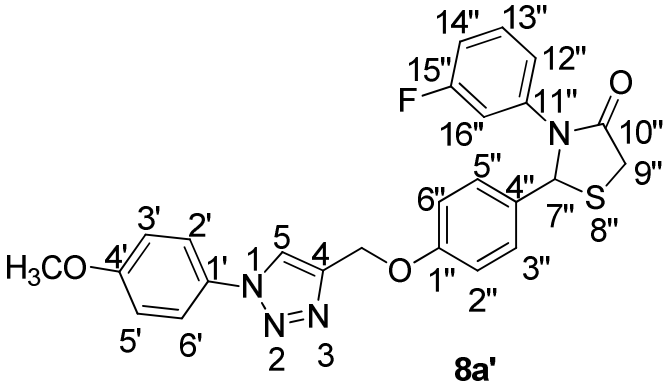
3-(4-bromophenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8z)



8z

It was obtained as a yellow solid with a m. p. of 104.0-106.0 ^{o}C in 74% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2957 (C-H, Ar), 1637 (C=O), 1249 (C-O), 756 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.95 (s, 1H, H-5), 7.59 (d, *J* = 8.79 Hz, 2H, Ar), 7.36 (d, *J* = 8.79 Hz, 2H, Ar), 7.20 (d, *J* = 9.15 Hz, 2H, Ar), 7.00 (d, *J* = 8.79 Hz, 4H, Ar), 6.91 (d, *J* = 8.05 Hz, 2H, Ar), 6.02 (s, 1H, H-7"), 5.23 (s, 2H, -OCH_2), 3.95-3.82 (m, 5H, H-9" & -OCH_3),; **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.11 (C-10"), 160.05 (C-4'), 158.59 (C-1"), 136.67, 132.19, 131.33, 130.17, 128.61, 127.24, 122.27, 121.26, 120.60, 115.10, 114.83, 65.00 (C-7"), 61.82 (O$\underline{C}H_2$), 55.64 (-OCH_3), 33.49 (C-9"); **HRMS** calcd. for $C_{25}H_{21}BrN_4O_3SH$: 538.4362; found $[M+H]^+$: 538.4368.

3-(3-fluorophenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8a')

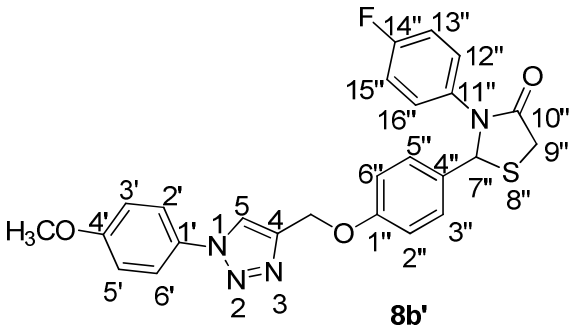


8a'

It was obtained as a yellowish solid with a m. p. of 167.0-169.0 ^{o}C in 75% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2922 (C-H, Ar), 1689 (C=O), 1255 (C-O), 756 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.92 (s, 1H, H-5), 6.97 (d, *J* = 8.8 Hz, 2H, Ar), 6.62-6.52 (m, 3H, Ar), 6.39-6.28 (m, 6H, Ar), 6.24-6.19 (m, 1H, Ar), 5.43 (s, 1H, H-7"), 4.59 (s, 2H, -OCH_2), 3.33-3.19 (m, 5H, H-9" & -OCH_3),; **^{13}C NMR (100 MHz, $CDCl_3$)** δ 170.95 (C-10"), 160.02 (C-4'), 158.56 (C-1"), 144.09, 139.04, 131.44, 130.21, 128.43, 122.30, 115.15, 114.81, 114.06, 113.09,

65.01 (C-7"), 62.02 (-O<u>C</u>H$_2$), 55.63 (-O<u>C</u>H$_3$), 33.49 (C-9"); **HRMS** calcd. for $C_{25}H_{21}FN_4O_3SH$: 477.5306; found $[M+H]^+$: 477.5300.

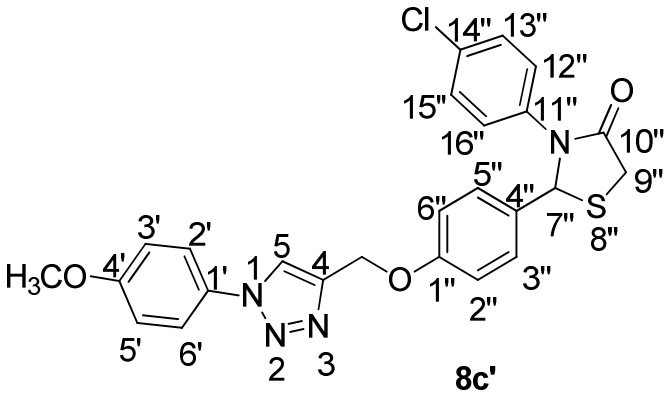
3-(4-fluorophenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8b')



8b'

It was obtained as a brown solid with a m. p. of 76.0-78.0 ^oC in 78% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2925 (C-H, Ar), 1682 (C=O), 1237 (C-O), 757 (C-S-C); **^{1}H NMR (300 MHz, CDCl$_3$)** δ 7.93 (s, 1H, H-5), 7.61 (dd, *J* = 2.4, 8.8 Hz, 2H, Ar), 7.24-7.21 (m, 1H, Ar), 7.10-6.92 (m, 8H, Ar), 6.00 (s, 1H, H-7"), 5.23 (s, 2H, -OCH$_2$), 3.99-3.84 (m, 5H, H-9" & -OCH$_3$),; **^{13}C NMR (100 MHz, CDCl$_3$)** δ 170.01 (C-10"), 160.03 (C-4'), 158.47 (C-1"), 144.23, 131.42, 128.86, 128.03, 122.24, 121.13, 116.20, 115.98, 115.04, 114.79, 65.38 (C-7"), 61.89 (-O<u>C</u>H$_2$), 55.68 (-O<u>C</u>H$_3$), 33.42; **HRMS** calcd. for $C_{25}H_{21}FN_4O_3SH$: 477.5306; found $[M+H]^+$: 477.5302.

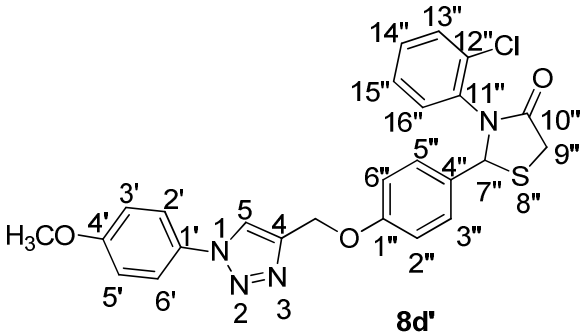
3-(4-chlorophenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8c')



8c'

It was obtained as a yellowish solid with a m. p. of. 84.0-86.0 ^{o}C in 85% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2923 (C-H, Ar), 1688 (C=O), 1249 (C-O), 757 (C-S-C); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.98 (s, 1H, H-5), 7.61 (d, *J* = 8.79 Hz, 2H, Ar), 7.26-7.21 (m, 4H, Ar), 7.07 (d, *J* = 8.79 Hz, 2H, Ar), 7.02 (d, *J* = 8.79 Hz, 2H, Ar), 6.93 (d, *J* = 8.05 Hz, 2H, Ar), 6.03 (s, 1H, H-7"), 5.25 (s, 2H, -OCH_2), 3.97-3.84 (m, 5H, H-9" & -OCH_3),; **^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.01 (C-10"), 160.13 (C-4'), 158.59 (C-1"), 135.92, 132.65, 132.04, 131.37, 129.24, 128.63, 126.99, 122.28, 115.10, 114.85, 65.09 (C-7"), 61.83 (-O<u>C</u>H_2), 55.63 (-O<u>C</u>H_3), 33.47 (C-9"); **HRMS** calcd. for $C_{25}H_{21}ClN_4O_3SH$: 493.1101; found $[M+H]^+$: 493.1107.

3-(2-chlorophenyl)-2-[4-{(1-(4-methoxyphenyl)-1H-1,2,3-triazol-4-yl)methoxy}phenyl] thiazolidin-4-one (8d')



8d'

It was obtained as a light brown solid with a m. p. of 103.0-105.0 ^{o}C in 77% yield. **IR** (KBr) ν_{max} (cm^{-1}) = 2930 (C-H, Ar), 1702 (C=O), 1256 (C-O), 830 (C-S-C); **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.93 (s, 1H, H-5), 7.61 (d, *J* = 8.79 Hz, 2H, Ar), 7.42-7.38 (m, 1H, Ar), 7.32-7.29 (m, 2H, Ar), 7.23-7.07 (m, 3H, Ar), 7.03-7.00 (m, 2H, Ar), 6.93-6.90 (m, 2H, Ar), 6.04 (s, 1H, H-7"), 5.23 (s, 2H, -OCH_2), 3.94-3.81 (m, 5H, H-9" & -OCH_3),; **^{13}C NMR (100 MHz, $CDCl_3$)** δ 176.47 (C-10"), 159.98 (C-4'), 158.33 (C-1"), 144.37, 130.69, 130.28, 129.52, 122.28, 121.24, 115.00, 114.80, 62.14 (C-7"), 55.63 (-O$\underline{C}H_2$), 51.54 (-OCH_3), 33.42 (C-9"); **HRMS** calcd. for $C_{25}H_{21}ClN_4O_3SH$: 493.1101; found $[M+H]^+$: 493.1112.

Acknowledgments

The authors acknowledge financial assistance from the University of Delhi under the Strengthening R & D Doctoral Research Programme. Y.K. is thankful to the University Grants Commission (UGC, Delhi, India) for providing a JRF (Junior Research Fellowship), SRF (Senior Research Fellowship) and also thankful to EMA-2 Experts III (Erasmus Mundus Action 2: Expert III) for providing a doctoral exchange scholarship.

References:

1. (a) A. K. Jain, A. Vaidya, V. Ravichandran, S. K. Kashaw, and R. K. Agrawal, *Bioorg. Med. Chem.* 2012, **20**, 3378; (b) A. Verma, and S. Saraf, *Eur. J. Med. Chem.* 2008, **43**, 897.

2. Z. Hongyu, S. Wu, S. Zhai, A. Liu, Y. Sun, R. Li, Y. Zhang, S. Ekins, P. W. Swaan, B. Fang, B. Zhangand, and B. Yan, *J. Med. Chem*. 2008, **51**, 1242.

3. (a) M. L. Barreca, J. Balzarini, A. Chimirri, De E. Clercq, L. De Luca, H. D. Höltje, M. Höltje, A. M. Monforte, P. Monforte, C. Pannecouque, A. Rao, and M. Zapalla, *J. Med. Chem.* 2002, **45**, 5410; (b) A. Rao, J. Balzarini, A. Carbone, A. Chimirri, E. De Clercq, A. M.

Monforte, P. Monforte, C. Pannecouque, and M. Zapallà, *Antivir. Res.* 2004, **63**, 79; (c) R. K. Rawal, R. Tripathi, S. B. Katti, C. Pannecouque, and E. De Clercq, *Bioorg. Med. Chem.* 2007, **15**, 3134.

4. V. R. Solomon, W. Haq, K. Srivastava, S. K. Puri, and S. B. Katti, *J. Med. Chem.* 2007, **50**, 394.

5. G. C. Kucukguzel, J. R. Shchullek, A. Kaocatepe, E. De Clercq, F. Sahinv, and M. Gulluce, *Eur. J. Med. Chem.* 2006, **41**, 353.

6. M. V. Diurno, O. Mazzoni, P. E. Calignano, F. Giorodano, and A. Bolognese, *J. Med. Chem.* 1992, **35**, 2910.

7. (a) Archana; V. K. Srivastava, A. Kumar, *Eur. J. Med. Chem*. 2002, **37**, 873; (b) C. Dwivedi, S. S. Gupta, and S. S. Parmar, *J. Med. Chem.* 1972, **15**, 553.

8. K. G. Desai, and K. R. Desai, *J. Sulfur Chemistry* 2006, **27**, 315.

9. C. M. Jackson, B. Blass, K. Coburn, L. Djandjighian, G. Fadayel, A. J. Fluxe, S. J. Hodson, J. M. Janusz, M. Murawsky, J. M. Ridgeway, R. E. White, and S. Wu, *Bioorg. Med. Chem. Lett*. 2007, **17**, 282.

10. V. S. Pore, M. A. Jagtap, S. G. Agalave, A. K. Pandey, M. I. Siddiqi, V. Kumar, and P. K. Shukla, *Med. Chem. Commun*., 2012, **3**, 484.

11. N. Pokhodylo, O. Shyyka, and V. Matiychuk, *Med. Chem. Res.,* 2014, **23**, 2426.

12. M. S. Costa, N. Boechat, E. A. Rangel, F. C. Silva, A. M. T. de Souza, C. R. Rodrigues, H. C. Castro, I. N. Junior, M. C. S. Lourenc¸, S. M. S. V. Wardell, and V. F. Ferreira, *Bioorg. Med. Chem.* 2006, **14**, 8644.

13. B. S. Holla, M. Mahalinga, M. S. Karthikeyan, B. Poojary, P. M. Akberali, and N. S. Kumari, *Eur. J. Med. Chem.* 2005, **40**, 1173.

14. (a) V. R. Solomon, C. Hu, and H. Lee, *Bioorg. Med. Chem.* 2009, **17**, 7585; (b) B. Meunier, *Acc. Chem. Res.* 2008, **41**, 69.

15. (a) D. Havrylyuk, L. Mosula, B. Zimenkovsky, O. Vasylenko, A. Gzella, and R. Lesyk, *Eur. J. Med. Chem.* 2010, **45**, 5012; (b) R. Lesyk, O. Vladzimirska, S. Holota, L. Zaprutko, and A. Gzella, *Eur. J. Med. Chem.* 2007, **42**, 641; (c) D. Havrylyuk, N. Kovach, B. Zimenkovsky, O. Vasylenko, and R. Lesyk, *Arch. Pharm. Chem. Life Sci.* 2011, **344**, 514; (d) L. Mosula, B. Zimenkovsky, D. Havrylyuk, A. V. Missir, I. C. Chirita, and R. Lesyk, *Farmacia* 2009, **57**, 321; (e) D. Kaminskyy, O. Vasylenko, D. Atamanyuk, A. Gzella, and R. Lesyk, R. *Synlett* 2011, **10**, 1385.

16. T. Srivastava, W. Haq, and S. B. Katti, *Tetrahedron* 2002, **58**, 7619.

17. R. K. Rawal, T. Srivastava, W. Haq, and S. B. Katti, *J. Chem. Res.* 2004, **5**, 368.

18. C. T. Sadashivaa, J. N. Narendra, S. Chandraa, C. V. Kavithaa, A. Thimmegowdab, M. N. Subhashc, and K. S. Rangappaa, *Eur. J. Med. Chem.* 2009, **44**, 4848.

19. S. K. Srivastava, and S. L. Srivastava, *J. Indian Chem. Soc.* 2002, **77**, 104.

20. R. C. Kumar, and D. Kumar, *J. Indian Chem. Soc.* 2002, **77**, 492.

21. X. Zhang, X. Li, D. Li, G. Qu, J. Wang, P. M. Loiseau, and X. Fan, *Bioorg. Med. Chem. Lett.* 2009, **19**, 6280.

22. V. Kanagarajana, J. Thanusua, and M. Gopalakrishnana, *Green Chem. Lett. Rev.* 2009, **2**, 161.

23. V. Gududuru, V. Nguyen, J. T. Dalton, and D. D. Miller, *Synlett* 2004, 2357.

24. E. Stephanie, A. Justus, J. C. Hodges, and M. W. Wilson, *Biotech. Bioeng.* 2000, **61**, 17.

25. (a) Q. Wang, T. R. Chan, R. Hilgraf, V. V. Fokin, K. B. Sharpless, and M. G. Finn, *J. Am. Chem. Soc.* 2003, **125**, 3192; (b) A. E. Speers, G. C. Adam, and B. F. Cravatt, *J. Am. Chem. Soc.* 2003, **125**, 4686; (c) J. C. Anderson, and P. G. Schultz, *J. Am. Chem. Soc.* 2003, **125**, 11782; (d) A. J. Link, and D. A. Tirrell, *J. Am. Chem. Soc.* 2003, **125**, 11164; (e) J. P. Collman, N. K. Devaraj, and C. E. D Chidsey, *Langmuir* 2004, **20**, 1051; (f) P. Wu, A. K. Feldman, A. K. Nugent, C. J. Hawker, A. Scheel, B. Voit, J. Pyun, J. M. J. Frechet, K. B. Sharpless, and V. V. Fokin, *Angew. Chem. Int. Ed.* 2004, **43**, 3928; (g). A. Michael, *J. Prakt. Chem*. 1893, **48**, 94; (h). A. Bertho, and F. Holder, *J. Prakt. Chem.* 1928, **119**, 189; (i). T. Curtius, and K. Raschig, *J. Prakt. Chem.* 1930, **125**, 466.

26. E. J. Hein, and V. V. Fokin, *Chem. Soc. Rev.* 2010, **39**, 1302.

27. P. Appukkuttan, W. Dehaen, V. V. Valery V. Fokin, and E. V. Van der Eycken, *Org. Lett*. 2004, **6**, 4223.

28. (a)Y. Kumar, V. Bahadur, A. K. Singh, V. S. Parmar, and B. K. Singh, *J. Indian Chem. Soc*. 2013, **90**, 1893; (b) Y. Kumar, V. Bahadur, A. K. Singh, V. S. Parmar, E. V. Van der Eycken, and B. K. Singh, *Beilstein J. Org. Chem.* 2014, **10**, 1413.

29 J. Thomas, J. John, N. Parekh, and W. Dehaen, *Angew. Chem. Int. Ed.* 2014*,* **53***,* 10155.

30. (a) O. C. Kappe, *Angew. Chem. Int. Ed.* 2004, *43*, 6250; (b) C. O. Kappe, and D. Dallinger, *Nat. Rev Drug. Disc.* 2006, **5**, 51; (c) A. K. Nagariya, A. K. Meena, Kiran; A. K. Yadav, U. S. Niranjan, A. K. Pathak, B. Singh, and M. M. Rao, *J. Phar. Res.* 2010, **3**, 575; (d) K. S. Jignasa, T. S. Ketan, S. P. Bhumika, and K. G. Anuradha, *Der Pharma Chemica.*

2010, **2**, 342; (e) A. Loupy, and L. Perreux, *Tetrahedron* 2001, **57**, 9199; (f) A. de la Hoz, A. Loupy, N. E. Leadbeater, J. R. Schmink, and T. A. Hamlin, *Microwaves in Organic Synthesis*, Willey-VCH, **1(3)**, 2013.

31. (a) A. Dömling, and I. Ugi, *Angew. Chem. Int. Ed.* 2000, **39**, 3168 (b) A. Dömling, *Chem. Rev.* 2006, *106*, 17; (c) M. Shriri, *Chem. Rev*. 2012, **112**, 3508; (d) D. J. Ramon, and M. Yus, *Angew. Chem. Int. Ed*. 2005, **44**, 1602. (e) B. Ganem, *Acc. Chem. Res.* 2009, **42**, 463; (f) L. ElKaı¨m, and L. Grimaud, *Mol. Diversity* 2010, **14**, 855; (g) E. Ruijter, R. Scheffelaar, and R. V. A. Orru, *Angew. Chem. Int. Ed.* 2011, **50**, 6234; (h) A. Dömling, W. Wang, and K. Wang, *Chem. Rev*. 2012, **112**, 3083.

32. M. Dabiri, P. Salehi, M. Bahramnejad, F. Sherafat, and M. Bararjanian, *Synth. Commun.* 2012, **42**, 3117.

33 V. Haridas, S. Sahu, and P.P.P. Kumar, *Tetrahedron Lett.* 2011, **52**, 6930.