Synthesis, photophysical and antibacterial, larvicidal studies on triazolophanes with 5-nitroisophthalate functionality at the intraannular position

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Supporting Information

Content

General Considerations ...........................................................................................................S-1
General Procedure ....................................................................................................................S-2
Syntheses of precyclophanes, bis-bromide, bis-azides and triazolophanes
along with spectral data............................................................................................................S-3
NMR and Mass spectrum of Triazolophanes.........................................................................S-4
Antibacterial activity assay and images..................................................................................S-5
Molecular docking of triazolophanes......................................................................................S-6
Larvicidal activity photos........................................................................................................S-7
S-1

GENERAL CONSIDERATIONS:

All the melting points were determined by using Toshniwal melting point apparatus by open capillary tube method and were uncorrected. $^1$H and $^{13}$C NMR spectra were recorded on Bruker 300 MHz spectrometer with 75 MHz for $^{13}$C nucleus. The chemical shifts are reported in ppm ($\delta$) with TMS as internal standard and coupling constant ($J$) are expressed in Hz. MALDI-TOF mass spectrum on Voyager-DE PRO mass spectrometer using $\alpha$-cyano-4-hydroxycinnamic acid (CHCA) matrix and EI-MS spectra on JEOL DX-303 mass spectrometer. The FAB-MS spectra were recorded on a JEOL SX 102/DA-6000 mass spectrometer using a $p$-nitrobenzyl alcohol (NBA) matrix. Elemental analyses were performed on a Perkin-Elmer 240B elemental analyzer. Glass plates coated with silica gel-G (ACME) of about 0.25 mm thickness were used for TLC and visualized with iodine. Column chromatography was carried out with silica gel (ACME, 100-200 mesh). The organic extracts of crude products were dried over anhydrous magnesium sulphate or sodium sulphate.
Synthesis of Diprop-2-ynyl 5-nitroisophthalate 27 by Steglich Esterification (« two steps » acylation)

To a solution of propargyl alcohol (1.64 g, 26.7 mmol, 2.2 equiv.) and DMAP (3.0 equiv.) in dry CH₂Cl₂ (100 mL) was added slowly at 0°C the appropriate acyl chloride (3.0 g, 12 mmol, 1.0 equiv.). The solution was purged with nitrogen and stirred at room temperature for 24 h. The reaction was quenched with saturated aqueous sodium bicarbonate solution and the aqueous layer was extracted with CH₂Cl₂ (3 x 100 mL). The combined organic layer was washed with brine (2 x 100 mL), dried over anhydrous Na₂SO₄, filtered and concentrated in vacuo. The residue obtained was purified by column chromatography with Hexane: CHCl₃ (9:1) as a eluent to afford the precyclophane diyne 27 as white crystalline solid in 78% yield. Mp. 146 °C: ¹H NMR: (300 MHz, CDCl₃): δH 2.60 (t, 2H, J = 2.4 Hz); 5.02 (d, 4H, J = 2.4 Hz); 9.03 (s, 1H); 9.08 (s, 2H). ¹³C NMR: (75 MHz, CDCl₃): δC 53.6, 76.0, 77.4, 128.7, 131.9, 136.1, 148.5, 162.9. (ESI-MS) m/z 287 [M⁺]. Elemental Anal. Calcd for C₁₄H₉NO₆: C, 58.54; H, 3.16; N, 4.88%. Found: C, 58.51; H, 3.16; N, 4.84%.

General procedure for synthesis of bisbromides by O-alkylation (Procedure A)

A mixture of 1.0 equiv. of each of E-4-((4-nitrophenyl) diazenyl) benzene-1, 3-diol/Resorcinol/2,7-dihydroxynaphthalene/1,4-dihydroxybenzene and potassium carbonate (3.0 equiv.) in acetone (30 mL) was stirred for 15 minutes for at 60 °C. 1, 4-Dibromobutane (4.0 equiv.) was added to the reaction mixture and stirred at 60 °C for 7 h. After the completion of the reaction, the solvent was removed under reduced pressure and the residue was extracted with CHCl₃ (3 x 100 mL), washed with water (2 x 100
mL), brine (150 mL) and dried over anhydrous Na₂SO₄, filtered and concentrated in vacuo. The residue obtained was purified by column chromatography with the indicated eluent to afford the desired bisazide.

**General procedure for the synthesis of bisazide (Procedure B)**

The dibromide (1.0 mmol, 1.0 equiv.) was dissolved in a mixture of acetone/water (4:1, 40 mL). NaN₃ (2.2 mmol, 2.2 equiv.) was added to the reaction mixture and then heated to 60 °C for 12 h. After completion of the reaction, the reaction mixture was cooled to room temperature, acetone was evaporated, to afford the crude product which was dissolved with CHCl₃ (3 x 100 mL) and washed with water (100 mL). The combined organic layer was washed with brine solution (2 x 50 mL) and dried with anhydrous sodium sulphate and filtered. The solvent was evaporated under vacuum and the residue was column chromatographed with the indicated eluent to give the desired azide.

**General procedure for the synthesis of cyclophane by Click reaction (Procedure C)**

To a solution of alkyne (1 equiv.) and bisazide (1.1 equiv.) in a mixture of THF/H₂O (3:1, 40 mL) was added sodium ascorbate (10 mol %) and CuSO₄·5H₂O (10 mol %). The reaction mixture was stirred at room temperature for 12 h. After completion of the reaction, the solvent was evaporated to give the crude product which was dissolved in CHCl₃ (150 mL) and washed with water (100 mL) and brine (150 mL), dried over anhydrous Na₂SO₄, filtered and concentrated to afforded the desired triazoles, purified by column chromatography (SiO₂) using the eluent as mentioned under each compound.
E-1-(2,4-Bis(4-bromobutoxy)phenyl)-2-(4-nitrophenyl) diazene 16:

Following the general procedure A, E-1-(2,4-bis(4-bromobutoxy)phenyl)-2-(4-nitrophenyl) diazene 16 was obtained as brick red solid from E-4-((4-nitrophenyl) diazenyl) benzene-1, 3-diol 11 (1.0 g, 3.86 mmol) and 1, 4- dibromobutane 26 (3.4 g, 15.74 mmol). Yield 69%; Mp: 104°C; $^1$H NMR: (300 MHz, CDCl$_3$): $\delta_H$ 1.95-2.2 (m, 8H); 3.51 (t, 2H, $J = 6.6$ Hz); 3.58 (t, 2H, $J = 6$ Hz); 4.09 (t, 2H, $J = 5.1$ Hz); 4.23 (t, 2H, $J = 5.1$ Hz); 6.54 (t, 2H, $J = 8.4$ Hz); 7.79 (d, 1H, $J = 8.7$ Hz); 7.96 (d, 2H, $J = 8.7$ Hz); 8.34 (d, 2H, $J = 9$ Hz). $^{13}$C NMR: (75 MHz, CDCl$_3$): $\delta_C$ 27.6, 27.7, 29.3, 29.8, 33.2, 33.5, 67.4, 68.7, 100.5, 106.9, 118.3, 123.1, 124.7, 137.1, 147.9, 156.5, 159.3, 164.4. (ESI-MS) $m/z$ 527[M$^+$. Elemental Anal. Calcd for C$_{20}$H$_{23}$Br$_2$N$_3$O$_4$: C, 45.39; H, 4.38; N, 7.94%. Found: C, 45.34; H, 4.31; N, 7.86%.

E-1-(2,4-Bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene21:
Following the general procedure B, E-1-(2,4-bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene 21 was obtained as red solid from (E)-1-(2,4-bis(4-bromobutoxy)phenyl)-2-(4-nitrophenyl) diazene 16 (1.0 g, 1.90 mmol) and sodium azide (0.5 g, 7.59 mmol). Yield 77%; Mp 72°C; $^1$H NMR: (300 MHz, CDCl$_3$): $\delta$H 1.72-1.98 (m, 8H); 3.32 (t, 2H, $J$ = 3 Hz); 3.36 (t, 2H, $J$ = 6.6 Hz); 4.01 (t, 2H, $J$ = 5.4 Hz); 4.14 (t, 2H, $J$ = 5.7 Hz); 6.46 (d, 2H, $J$ = 9 Hz); 7.72 (d, 1H, $J$ = 8.7 Hz); 7.86 (d, 2H, $J$ = 8.4 Hz); 8.26 (d, 2H, $J$ = 8.7 Hz). $^{13}$C NMR: (75 MHz, CDCl$_3$): $\delta$C 27.6, 27.7, 29.3, 29.8, 33.2, 33.5, 64.4, 68.8, 100.5, 106.9, 118.3, 123.1, 124.7, 137.0, 147.9, 156.5, 159.3, 164.4. (ESI-MS) $m/z$ 453[M$^+$]. Elemental Anal. Calcd for C$_{20}$H$_{23}$N$_9$O$_4$: C, 52.97; H, 5.11; N, 27.80%. Found: C, 52.89; H, 5.16; N, 27.71%.

Methyl 3,5-bis(4-bromobutoxy) benzoate 17:

Following the general procedure A, methyl 3,5-bis(4-bromobutoxy)benzoate 17 was obtained as colourless viscous liquid from methyl 3,5-dihydroxy benzoate 12 (1.0 g, 5.95 mmol) and 1, 4-dibromobutane 26 (5.14 g, 23.81 mmol). Yield 79%; $^1$H NMR: (300 MHz, CDCl$_3$): $\delta$H 1.87-2.01 (m, 8H); 3.40 (t, 4H, $J$ = 4.5 Hz); 3.82 (s, 3H); 3.94 (t, 4H, $J$ = 5.7 Hz); 6.54 (d, 1H, $J$ = 2.1 Hz); 7.09 (s, 2H). $^{13}$C NMR: (75 MHz, CDCl$_3$): $\delta$C 52.8,
75.4, 76.6, 129.8, 133.5, 164.8. (ESI-MS) m/z 436 [M⁺]. Elemental Anal. C_{16}H_{22}Br_{2}O_{4}
Calcd for: C, 43.86; H, 5.06%. Found: C, 43.78; H, 4.95%

**Methyl 3,5-bis(4-azidobutoxy)benzoate 22:**

Following the general procedure B, methyl 3,5-bis(4-azidobutoxy)benzoate 22 was obtained as colourless viscous liquid from methyl 3,5-bis(4-bromobutoxy)benzoate 17 (1.0 g, 2.30 mmol) and sodium azide (0.60 g, 9.23 mmol). Yield 79 %.

^1H NMR: (300 MHz, CDCl₃): δH 1.70-1.81 (m, 8H); 3.27 (t, 4H, J = 6.6 Hz); 3.81 (s, 3H); 3.92(t, 4H, J = 5.7 Hz); 6.54 (t, 1H, J = 1.8 Hz); 7.08 (d, 2H, J = 2.4 Hz).

^13C NMR: (75 MHz, CDCl₃): δC 25.8, 26.5, 51.2, 67.2, 101.5, 106.8, 129.9, 160.1 (ESI-MS) m/z 362 [M⁺]. Elemental Anal. Calcd for C_{16}H_{22}N_{6}O_{4}: C, 53.03; H, 6.12; N, 23.19%. Found: C, 52.93; H, 6.01; S, 23.09%.

**1,3-Bis(4-bromobutoxy)benzene 18:**

Following the general procedure A, 1, 3-bis (4-bromobutoxy) benzene 18 was obtained as white solid from resorcinol 13 (1.0 g, 9.09 mmol) and 1,4-dibromobutane 26 (7.85 g,
36.36 mmol). Yield 72%; Mp. 88 °C: $^1$H NMR: (300 MHz, CDCl$_3$): $\delta$H 1.89-1.97 (m, 4H); 2.02-2.11 (m, 4H); 3.49 (t, 4H, $J = 6.6$ Hz); 3.97 (t, 4H, $J = 6$ Hz); 6.64-6.50 (m, 3H); 7.16 (t, 1H, $J = 8.1$ Hz).$^{13}$C NMR: (75 MHz, CDCl$_3$): $\delta$C 27.9, 29.5, 33.4, 66.8, 101.5, 106.8, 129.9, 160.1. (ESI-MS) m/z 378 [M$^+$]. Elemental Anal. Calcd for C$_{14}$H$_{20}$Br$_2$O$_2$: C, 44.24; H, 5.30%. Found: C, 44.19; H, 5.39%.

1,3-Bis(4-azidobutoxy)benzene 23:

![Diagram of 1,3-Bis(4-azidobutoxy)benzene 23]

Following the general procedure B, 1, 3-bis (4-azidobutoxy) benzene 23 was obtained as colourless viscous liquid from 1, 3-bis (4-bromobutoxy) benzene 18 (1 g, 2.64 mmol) and sodium azide (0.69 g, 10.58 mmol). Yield 71%. $^1$H NMR: (300 MHz, CDCl$_3$): $\delta$H 1.76-1.88 (m, 8H); 3.36 (t, 4H, $J = 6.6$ Hz); 3.96 (t, 4H, $J = 5.4$ Hz); 6.44-6.50 (m, 3H); 7.16 (t, 1H, $J = 8.1$ Hz). $^{13}$C NMR: (75 MHz, CDCl$_3$): $\delta$C 25.8, 26.5, 51.2, 67.2, 101.5, 106.8, 129.9, 160.1. (ESI-MS) m/z 304 [M$^+$]. Elemental Anal. Calcd for C$_{14}$H$_{20}$N$_6$O$_2$: C, 55.25; H, 6.62; N, 27.61%. Found: C, 55.27; H, 6.55; N, 27.52%.

2,7-Bis(4-bromobutoxy)naphthalene 19:

![Diagram of 2,7-Bis(4-bromobutoxy)naphthalene 19]
Following the general procedure A, 2,7-bis(4-bromobutoxy)naphthalene 19 was obtained as white solid from naphthalene-2,7-diol 14 (1.0 g, 6.25 mmol) and 1,4-dibromobutane 26 (5.40 g, 25 mmol). Yield 78%; Mp. 106-111 °C: ¹H NMR: (300 MHz, CDCl₃): δ_H 1.85-2.02 (m, 8H); 3.41 (t, 4H, J = 6.3 Hz); 3.98 (t, 4H, J = 6 Hz); 6.86-6.93 (m, 4H); 7.55 (d, 2H, J = 8.7 Hz). ¹³C NMR: (75 MHz, CDCl₃): δ_C 26.9, 28.5, 32.5, 65.8, 105.0, 115.1, 123.2, 128.1, 134.8, 156.4. (ESI-MS) m/z 428 [M⁺]. Elemental Anal. Calcd for C₁₈H₂₂Br₂O₂: C, 50.26; H, 5.15%. Found: C, 50.18; H, 5.04%.

2,7-Bis(4-azidobutoxy)naphthalene 24:

Following the general procedure B, 2,7-bis(4-azidobutoxy)naphthalene 24 was obtained as white solid from 2,7-bis(4-bromobutoxy)naphthalene 19 (1.0 g, 2.33 mmol) and Sodium azide (0.61 g, 9.35 mmol). Yield 75 %; Mp.72 °C: ¹H NMR: (300 MHz, CDCl₃): δ_H 1.79-2.15 (m, 8H); 3.36 (t, 4H, J = 6.9 Hz); 4.06 (t, 4H, J = 5.7 Hz); 6.96-7.01(m, 4H); 7.64 (d, 2H, J = 8.7 Hz). ¹³C NMR: (75 MHz, CDCl₃): δ_C 25.8, 26.5, 51.2, 67.1, 106.0, 116.3, 124.4, 129.2, 135.9, 157.5. (ESI-MS) m/z 354 [M⁺]. Elemental Anal. Calcd for C₁₈H₂₂Br₂O₂: C, 61.00; H, 6.26; N, 23.71%. Found: C, 60.85; H, 6.32; N, 23.64%.

1, 4-Bis (4-bromobutoxy) benzene 20:
Following the general procedure A, 1, 4-bis (4-bromobutoxy) benzene 20 was obtained as crystalline white solid from the hydroquinone 15 (1.0 g, 9.09 mmol) and 1,4-dibromobutane 26 (7.85 g, 36.36 mmol). Yield 75%; Mp. 106-112 °C: \(^1\)H NMR: (300 MHz, CDCl\(_3\)): \(\delta\)H 1.88-2.11 (m, 8H); 3.48 (t, 4H, \(J = 6.3\) Hz); 3.93 (t, 4H, \(J = 6.3\) Hz); 6.80 (t, 4H, \(J = 3.3\) Hz). \(^{13}\)C NMR: (75 MHz, CDCl\(_3\)): \(\delta\)C 28.0, 29.5, 33.5, 67.4, 115.4, 153.0. (ESI-MS) \(m/z\) 378 [M\(^+\)]. Elemental Anal. Calcd for C\(_{14}\)H\(_{20}\)Br\(_2\)O\(_2\): C, 44.24; H, 5.30%. Found: C, 44.16; H, 5.36%.

1,4-Bis(4-azidobutoxy)benzene 25:

Following the general procedure B, 1,4-bis(4-azidobutoxy)benzene 25 was obtained as colourless oily liquid from 1, 4-bis (4-bromobutoxy) benzene 20 (1.0 g, 2.64 mmol) and sodium azide (0.69 g, 10.58 mmol). Yield 81 %.\(^1\)H NMR: (300 MHz, CDCl\(_3\)): \(\delta\)H 1.74-1.84 (m, 8H); 3.33 (t, 4H, \(J = 6.3\) Hz); 3.90 (t, 4H, \(J = 5.4\) Hz); 6.81 (s, 4H). \(^{13}\)C NMR: (75 MHz, CDCl\(_3\)): \(\delta\)C 25.7, 26.6, 51.2, 67.8, 115.3, 153.0. (ESI-MS) \(m/z\) 304 [M\(^+\)]. Elemental Anal. Calcd for C\(_{14}\)H\(_{20}\)N\(_6\)O\(_2\): C, 55.25; H, 6.62; N, 27.61%. Found: C, 55.17; H, 6.52; N, 27.54%

Triazolophane 1:
Triazolophane 1 was synthesized as red solid in 32% yield from (E)-1-(2,4-bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene 21 (0.35 g, 0.77 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.2 g, 0.69 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). Mp: 148 °C. ¹H NMR: (300 MHz, CDCl₃); δH 1.85 (s, 4H); 2.10 (s, 4H); 4.05 (d, 4H, J = 33.9 Hz); 4.43 (s, 4H); 5.49 (s, 4H); 6.44 (s, 2H); 7.66 (s, 2H); 7.86 (s, 3H); 7.28 (d, 2H, J = 6.3 Hz); 8.84 (s, 1H); 8.96 (s, 2H). ¹³C NMR: (75 MHz, CDCl₃): δC 24.8, 26.4, 58.1, 66.5, 68.2, 100.6, 105.6, 117.4, 122.1, 123.2, 123.7, 127.7, 131.0, 134.9, 136.2, 141.4, 147.4, 155.3, 158.0, 162.7, 162.9. MS(ESI): m/z 741(M+H⁺). Elemental anal.calcd for C₃₄H₃₂N₁₀O₁₀: C, 55.13; H, 4.35 ;N, 18.91%. Found: C, 55.03; H, 4.42 ;N, 18.82%.

Triazolophane 2:
Triazolophane 2 was synthesized as yellow solid in 25% yield from methyl 3,5-bis(4-azidobutoxy)benzoate 22 (0.33 g, 0.82 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.83 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). 
Mp: 189 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.76-1.82 (m, 4H); 2.00-2.10 (m, 4H); 3.82 (s, 3H); 3.96 (t, 4H, J = 5.4 Hz); 4.38 (t, 4H, J = 7.5 Hz); 5.50 (s, 4H); 6.51 (s, 1H); 7.07 (d, 2H, J = 2.1 Hz); 7.65 (s, 2H); 8.87 (s, 1H); 8.98 (s, 2H). ¹³C NMR: (75 MHz, CDCl₃): δc 26.0, 27.7, 50.2, 52.3, 59.1, 67.4, 107.0, 107.9, 124.2, 128.7, 132.1, 132.2, 136.0, 142.2, 148.6, 159.5, 163.6, 166.9. MS(E1): m/z 649 [M⁺]. Elemental anal.calcd for C₃₀H₃₁N₇O₁₀: C, 55.47; H, 4.81; N,15.09%.Found: : C, 55.53 ; H, 4.73 ; N,15.18%.

Triazolophane 3:

Triazolophane 3 was synthesized as white solid in 38% yield from 1, 3-bis (4-azidobutoxy) benzene 23 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.83 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). 
Mp: 197 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.73-1.75 (m, 4H); 1.97-2.10 (m, 4H);
3.90 (t, 4H, J = 5.4 Hz); 4.38 (t, 4H, J = 7.2 Hz); 5.50 (s, 4H); 6.32 (s, 1H); 6.38 (d, 2H, J = 8.1 Hz); 7.08 (t, 1H, J = 7.5 Hz); 7.64 (s, 2H); 8.88 (s, 1H); 8.99 (s, 2H). ^13^C NMR: (75 MHz, CDCl\textsubscript{3}): δ c 25.8, 27.5, 108.6, 111.7, 115.4, 115.6, 124.3, 132.1, 136.4, 142.2, 152.8, 163.5. MS(E1): m/z 591 (M^+). Elemental anal. calcd for C\textsubscript{28}H\textsubscript{29}N\textsubscript{7}O\textsubscript{8}: C, 56.85%; H, 4.94%; N, 16.57%. Found: C, 56.78%; H, 4.89%; N, 16.49%.

**Triazolophane 4:**

![Triazolophane](image)

Triazolophane 4 was synthesized as pale yellow solid in 38% yield from 2,7-bis(4-azidobutoxy)naphthalene 24 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-ynylnitroisophthalate 27 (0.24 g, 0.86 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl\textsubscript{3}-MeOH (9:2). Mp: 253 °C. ^1^H NMR : (300 MHz, CDCl\textsubscript{3}): δ H 1.89 (t, 4H, J = 5.7 Hz); 2.16 (t, 4H, J = 6.3 Hz); 4.04 (t, 4H, J = 5.1 Hz); 4.48 (t, 4H, J = 6.6 Hz); 5.48 (s, 4H); 6.92 (d, 4H, J = 9.3 Hz); 7.58 (d, 2H, J = 8.4 Hz); 7.73 (s, 2H); 8.86 (s, 1H); 8.94 (s, 2H). ^13^C NMR: (75 MHz, CDCl\textsubscript{3}): δ c 25.5, 26.7, 49.9, 58.9, 66.7, 106.5, 115.8, 124.1, 124.2, 128.3, 128.9, 131.7, 135.4, 135.6, 142.0, 156.8, 163.4. MS(E1): m/z 641 [M^+]. Elemental anal. calcd for C\textsubscript{32}H\textsubscript{31}N\textsubscript{7}O\textsubscript{8}: C, 59.90%; H, 4.87%; N, 15.28%. Found: C, 59.83%; H, 4.75%; N, 15.17%.
Triazolophane 5:

Triazolophane 5 was synthesized as yellow solid in 32% yield from (E)-1-(2,4-bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene 25 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-yny1 5-nitroisophthalate 27 (0.24 g, 0.86 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:1). Mp: 238 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.76-1.85 (m, 4H); 2.03-2.12 (m, 4H); 3.93 (t, 4H, J = 5.4 Hz); 4.42 (t, 4H, J = 7.2 Hz); 5.56 (s, 4H); 6.69 (s, 4H); 7.73 (s, 2H); 8.97 (s, 1H); 9.01(d, 2H, J = 14.1 Hz). ¹³C NMR: (75 MHz, CDCl₃): δc 25.9, 27.6, 50.0, 59.3, 67.6, 115.4, 124.4, 128.6, 132.1, 136.2, 142.3, 148.4, 152.8, 163.6. MS(E1): m/z 591 [M⁺]. Elemental anal.calcd for C₂₈H₂₉N₇O₈: C, 56.85 ; H, 4.94 ; N,16.57%. Found: C, 56.71 ; H, 5.02 ; N,16.66%.

Triazolophane 6:
Triazolophane 6 was synthesized as red solid in 30% yield from (E)-1-(2,4-bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene 21 (0.35 g, 0.77 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.2 g, 0.69 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). Mp: 146 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.91-1.97 (m, 8H); 2.20-2.24 (m, 8H); 4.02 (t, 4H, J = 3.3 Hz); 4.16 (t, 4H, J = 6.6 Hz); 4.52 (d, 4H, J = 5.1 Hz); 4.56 (d, 4H, J = 7.2 Hz); 5.46 (d, 4H, J = 3.3 Hz); 5.53 (d, 4H, J = 7.5 Hz); 6.45 (t, 4H, J = 11.1 Hz); 7.60 (d, 1H, J = 9.6 Hz); 7.69 (d, 1H, J = 9 Hz); 7.74 (s, 1H); 7.78 (s, 4H); 7.85 (t, 3H, J = 7.8 Hz); 8.14 (d, 2H, J = 8.7 Hz); 8.84 (s, 2H); 8.93 (t, 4H, J = 21.6 Hz). ¹³C NMR: (75 MHz, CDCl₃): δc 26.0, 27.0, 59.0, 67.4, 68.7, 100.4, 106.9, 118.4, 123.0, 124.5, 124.7, 128.4, 132.1, 135.8, 137.0, 148.0, 148.3, 156.3, 159.0, 163.4, 164.0. MS(EI): m/z 1480 [M⁺]. Elemental anal.calcd for C₆₈H₆₄N₂₀O₂₀: C, 55.13;H, 4.35 ;N, 18.91%. Found: C, 55.01;H, 4.43 ;N, 18.78%.

Triazolophane 7:

Triazolophane 7 was synthesized as pale yellow solid in 28% yield from methyl 3,5-bis(4-azidobutoxy)benzoate 22 (0.33 g, 0.82 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.83 mmol, 1 equiv.) by click reaction as per the procedure
C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). Mp: 120 °C. ³¹H NMR: (300 MHz, CDCl₃): δH 1.73-1.80 (m, 8H); 2.03-2.10 (m, 8H ); 3.80 (s, 6H); 3.91 (t, 8H, J = 7.2 Hz); 4.41 (t, 8H, J = 7.2 Hz); 5.45 (s, 8H); 6.47 (s, 2H); 7.01 (d, 4H, J = 2.1 Hz); 7.71 (s, 4H); 8.34 (s, 2H); 8.89 (s, 4H). ¹³C NMR: (75 MHz, CDCl₃): δc 26.2, 28.3, 49.1, 51.3, 58.1, 66.2, 105.5, 106.7, 123.2, 127.5, 131.0, 131.2, 134.9, 141.0, 147.3, 158.7, 162.5, 165.6. MS(EI): m/z 1298(M⁺). Elemental anal.calcd for C₆₀H₆₂N₁₄O₂₀: C, 55.47 ; H, 4.81 ; N,15.09%.Found: : C, 55.39 ; H, 4.74 ; N,14.97%.

**Triazolophane 8:**

Triazolophane 8 was synthesized as white solid in 30% yield from 1, 3-bis (4-azidobutoxy)benzene 23 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.83 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). Mp: 164 °C. ¹¹H NMR: (300 MHz, CDCl₃): δH 1.56 (t, 8H, J = 7.8 Hz); 1.73 (t, 8H, J = 6.9 Hz); 3.87 (t, 8H, J = 5.7 Hz); 4.40 (t, 8H, J = 6.9 Hz); 5.48 (d, 8H, J = 6.9 Hz); 6.28-6.36 (m, 6H); 7.03 (t, 2H, J = 8.4 Hz); 7.69 (s, 4H); 8.85 (s, 2H); 8.93 (d, 4H, J = 10.5 Hz). ¹³C NMR: (75 MHz, CDCl₃): δc 26.2, 28.3, 49.1, 58.1, 65.8, 100.5, 105.7, 113.1, 123.2,
127.5, 129.0, 131.2, 134.9, 138.2, 140.9, 147.4, 158.9, 162.6. MS(E1): m/z 1182(M⁺).
Elemental anal. calcd for C₅₆H₅₈N₁₄O₁₆: C, 56.85 ; H, 4.94 ; N, 16.57 %. Found: C, 59.73 ; H, 5.05 ; N, 16.56%.

**Triazolophane 9:**

Triazolophane 9 was synthesized as pale yellow solid in 25% yield from 2,7-bis(4-azidobutoxy)naphthalene 24 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.86 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2) Mp: 142 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.80 (t, 8H, J = 5.5 Hz); 2.11 (t, 8H, J = 6.2 Hz); 4.00 (t, 8H, J = 5.5 Hz); 4.41 (t, 8H, J = 6.3 Hz); 5.47 (s, 8H); 5.03 (d, 8H, J = 9.2 Hz); 7.57 (d, 4H, J = 8.1 Hz); 7.72 (s, 4H); 8.87 (s, 2H); 8.96 (s, 4H). ¹³C NMR: (75 MHz, CDCl₃): δc 25.5, 26.7, 49.9, 58.9, 66.7, 106.5, 115.8, 124.1, 124.2, 128.3, 128.9, 131.7, 135.4, 135.6, 142.0, 156.8, 163.4. MS(E1): m/z 1282 (M⁺). Elemental anal. calcd for C₆₄H₆₂N₁₄O₁₆: C, 59.90 ; H, 4.87 ; N, 15.28%. Found: C, 59.81 ; H, 4.95 ; N, 15.13%.
Triazolophane 10:

Triazolophane 10 was synthesized as yellow solid in 33% yield from (E)-1-(2,4-bis(4-azidobutoxy)phenyl)-2-(4-nitrophenyl) diazene 25 (0.28 g, 0.92 mmol, 1.1 equiv.) and diprop-2-ynyl 5-nitroisophthalate 27 (0.24 g, 0.86 mmol, 1 equiv.) by click reaction as per the procedure C, followed by purification from column using a mixture of CHCl₃-MeOH (9:2). Mp: 122 °C. ¹H NMR: (300 MHz, CDCl₃): δH 1.80 (s, 8H); 2.04-2.14 (m, 8H); 3.92 (t, 8H, J = 5.1 Hz); 4.47 (t, 8H, J = 7.2 Hz); 5.54 (d, 8H, J = 7.5 Hz); 6.75 (d, 8H, J = 7.8 Hz); 7.78 (s, 4H); 8.94 (d, 2H, J = 4.5 Hz); 9.01 (d, 4H, J = 14.1 Hz). ¹³C NMR: (75 MHz, CDCl₃): δc 26.3, 27.2, 50.2, 59.1, 67.4, 115.3, 124.3, 128.5, 132.2, 136.0, 141.8, 148.3, 152.9, 163.6. MS(EI): m/z 1182 (M⁺). Elemental anal.calcd for C₅₆H₅₈N₁₄O₁₆: C, 56.85 ; H, 4.94 ; N,16.57%.Found: C,56.76 ;H, 4.83 ;N,16.61%.
Figure 1: $^1$H NMR spectrum (300MHz, CDCl$_3$) of diprop-2-ynyl 5-nitroisophthalate 27
Figure 2: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of diprop-2yny1 5-nitroisophthalate 27
Figure 3: $^1$H NMR spectrum (300MHz, CDCl$_3$) of (E)-1-(2,4-bis(4-bromobutoxy)phenyl)-2-(4-nitrophenyl)diazene 16
Figure 4: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of (E)-1-(2,4-bis(4-bromobutoxy)phenyl)-2-(4-nitrophenyl)diazenediene 16
Figure 5: $^1$H NMR spectrum (300 MHz, CDCl$_3$) of Methyl 3,5-bis(4-azidobutoxy)benzoate 22
Figure 6: $^{13}$C NMR spectrum (75 MHz, CDCl$_3$) of Methyl 3, 5-bis(4-azidobutoxy)benzoate 22
Figure 7: $^1$H NMR spectrum (300MHz, CDCl$_3$) of 2,7-bis(4-bromobutoxy)naphthalene 19
Figure 8. $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of 2,7-bis(4-bromobutoxy)naphthalene 19
Figure 9: $^1$H NMR spectrum (300MHz, CDCl$_3$) of 2,7-bis(4-azidobutoxy)naphthalene 24
Figure 10: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of 2,7-bis(4-azidobutoxy)naphthalene 24
Figure 11: $^1$H NMR spectrum (300MHz, CDCl$_3$) of 1, 4-bis (4-bromobutoxy) benzene 20
Figure 12: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of 1, 4-bis (4-bromobutoxy) benzene
Figure 13: $^1$H NMR spectrum (300MHz, CDCl$_3$) of 1,4-bis(4-azidobutoxy)benzene 25
Figure 14: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of 1,4-bis(4-azidobutoxy)benzene 25
Figure 15: ESI mass spectrum of Triazolophane 1
Figure 16: ESI mass spectrum of Triazolophane 6
Figure 17: $^1$H NMR spectrum (300MHz, CDCl$_3$) of Triazolophane 2
Figure 18. $^{13}$C NMR spectrum (75 MHz, CDCl$_3$) of Triazolophane 2
Figure 19: Mass spectrum (EI) of Triazolophane 2
Figure 20: $^1$H NMR spectrum (300MHz, CDCl$_3$) of Triazolophane 7
Figure 21: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of Triazolophane 7
Figure 22: $^1$H NMR spectrum (300MHz, CDCl$_3$) of Triazolophane 4
Figure 23: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of Triazolophane 4
Figure 24: Mass spectrum (EI) of triazolophane 4
Figure 25: $^1$H NMR spectrum (300MHz, CDCl$_3$) of Triazolophane 5
Figure 26: $^{13}$C NMR spectrum (75MHz, CDCl$_3$) of Triazolophane 5
Antibacterial Activity

Microorganisms

Bacterial microorganisms such as *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhi* and *Escherichia coli* were stored in a refrigerator at the microbiology lab, from the Center for Advanced Studies in Botany, University of Madras, Chennai, India under *in vitro* conditions used for antimicrobial activity.

Reference and control:

Tetracycline and DMSO was chosen as the standard and reference compound for bacteria.

Well diffusion assay:

The all bacterial strains were maintained on nutrient agar (NA) consisting of the following (g/L): beef extract 10; yeast extract 20; peptone 10; NaCl 5; agar 15; distilled H$_2$O 1L; pH 7.2 in slants or petriplates at room temperature (28±2ºC). Effect of the compounds on the growth of human pathogens: the zone of inhibition was determined for compounds 1–10 by well diffusion assay (Riose et al., 1988). The compound at the concentration range of 10–30 μg/ml in 10% DMSO was used in this study with Cefotaxime as reference control. The zone of inhibition value was taken as the lowest concentration of compound that showed prominent inhibition of bacterial growth after 24 h of incubation at 37 ºC.
Molecular docking photos