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Article

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Pradeep Kumar, Trapti Aggarwal, and Akhilesh K. Verma

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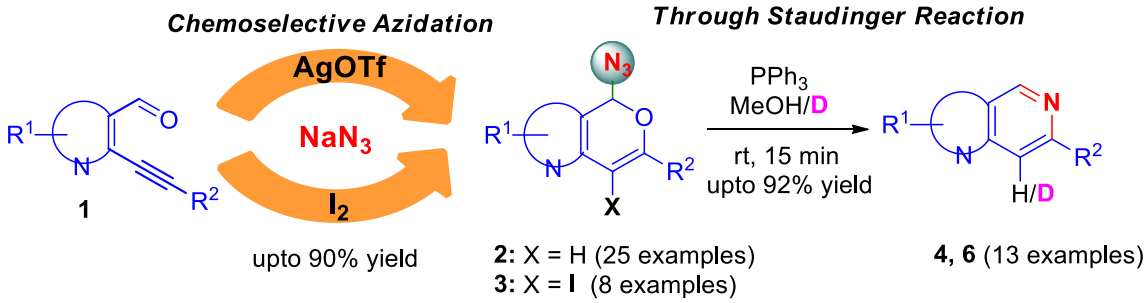
Chemoselective Azidation of *o*-Alkynylaldehydes over [3+2] Cycloaddition and Subsequent Staudinger Reaction: An Access to Benzonaphthyridines/Naphthyridines

*Pradeep Kumar, Trapti Aggarwal and Akhilesh K. Verma**

Synthetic Organic Chemistry Research Laboratory, Department of Chemistry,

University of Delhi, Delhi–110007, India

Email: averma@acbr.du.ac.in



ABSTRACT: An efficient tandem approach for the chemoselective synthesis of functionalized azido-pyranoquinolines and azido-iodo-pyranoquinolines via electrophilic cyclization of *o*-alkynylaldehydes in presence of sodium azide under mild reaction conditions has been described. The Mechanistic studies confirm the formation of azido-pyranoquinolines through nucleophilic attack of azide on pyrilium intermediate over [3+2] cycloaddition of azide on alkyne. The synthesized azido-pyranoquinolines were transformed into benzonaphthyridines via Staudinger reaction. The mechanistic pathway was supported

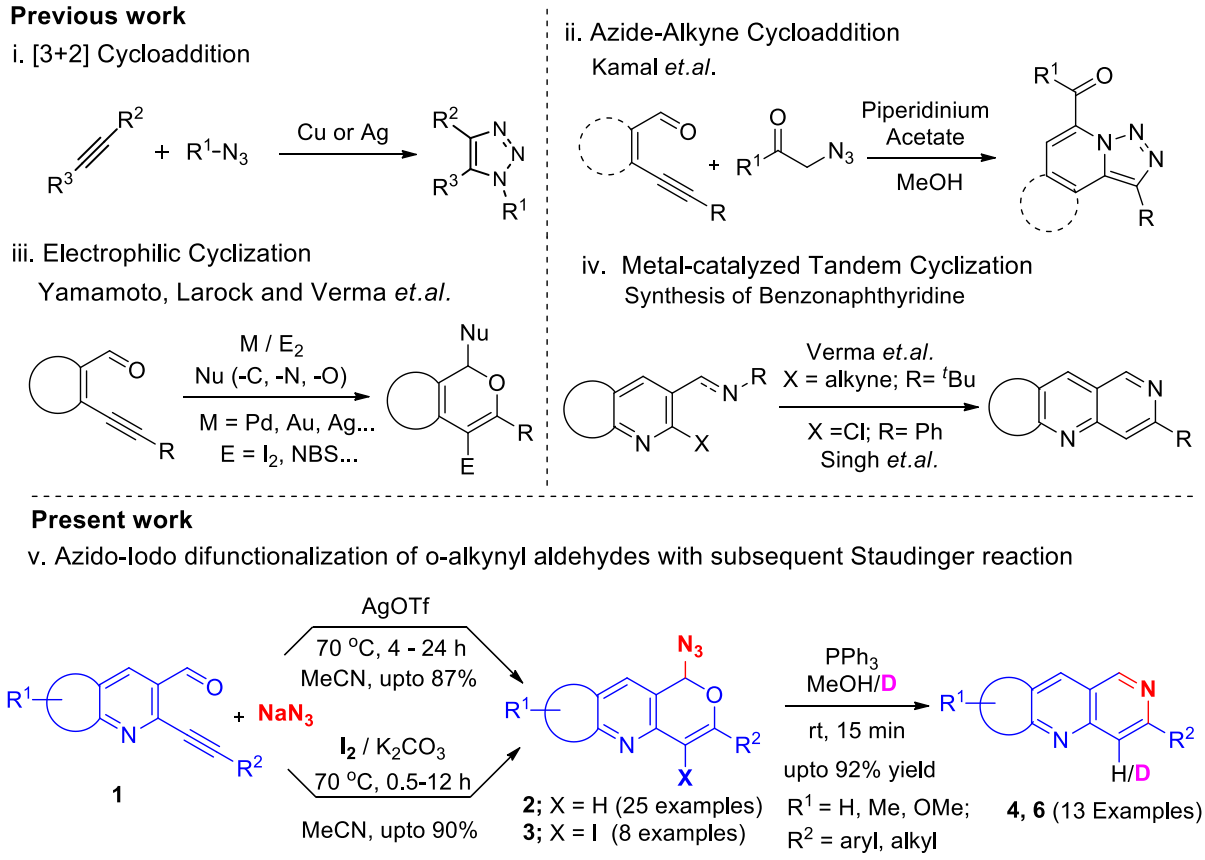
by deuterium labeling experiment and X-Ray crystallographic studies.

INTRODUCTION

In recent time, new perspectives have been developed for organic azides, and their synthesis has gained considerable attention due to their versatile use as an intermediate for the construction of *N*-containing molecules.[1] Synthetic utility of azides has been explicitly demonstrated by their implementation in azide−alkyne Huisgen cycloaddition[2a] and Staudinger ligation[2b] for chemical biology and drug discovery. Moreover, the incorporation of azide moiety in lead organic compounds accelerates their biological activities.[3] Despite an ample of azidation reactions,[4] strategy for selective azidation at carbonyl center remains challenging. Triazoles formation via [3+2] cycloaddition of azide with alkynes[5] and alkynyl aldehydes[6] has been well established (Scheme 1, i-ii). Electrophilic cyclization using metal-catalysts and nucleophiles has emerged as an efficient tool for the construction of heterocycles (Scheme 1, iii).[7] Although, implication of azide as an external nucleophile in the cyclization of *o*-alkynylaldehydes remains elusive.

Notably, the napthyridines core is associated with a wide range of biological activities including anticancer,[8a] anti-HIV-1,[8b] antimicrobial,[8c] and adrenoceptor blocking activities.[8d] Naphthyridines are also known to use as luminescence materials because of their structural properties.[8e] Previously, naphthyridine[9] derivatives were synthesized using metal-catalyzed tandem cyclization.[10a] Recently, Singh[10b] and our group[10c] have described the synthesis of benzonapthyridines using Pd-catalyzed arylation and cyclization, respectively (Scheme 1, iv). Owing to the pharmacological importance and in continuation of our ongoing research,[11] herein we have developed a facile chemoselective strategy for the synthesis of pyranoquinolines and benzonaphthyridines. We initiated our reaction with readily accessible *o*-alkynylaldehydes and sodium azide via electrophilic cyclization followed by concomitant Staudinger Reaction to afford the substituted napthyridines (Scheme 1, v).

Scheme 1. Previous Reports V/s Present Work.

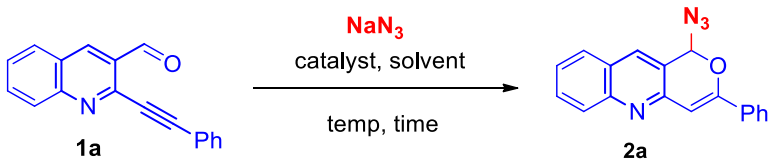


RESULTS AND DISCUSSION

We begin our preliminary observations with 2-(phenylethynyl)quinoline-3-carbaldehyde **1a** along with NaN_3 by using our previously reported conditions[11b] i.e. 10 mol % of $AgNO_3$ as a catalyst in H_2O at 80 °C; however, no progress in the reaction was observed after 1 h (Table 1, entry 1). Other solvents like DCE and toluene (entries 2 and 3) failed to provide the desired product. When MeOH was used as a solvent at 70 °C, it acts as strong nucleophile and formed 1-methoxy-3-phenyl-1*H*-isochromene exclusively in 70% yield instead of product **2a** (entry 4); however, MeCN failed to provide desired product with $AgNO_3$ (entry 5). The reaction with other silver salts like AgTFA and AgOAc (10 mol %) in MeCN afforded the desired product 2**a** in lower yield (entries 6 and 7). Use of AgOTf afforded the desired product **2a** in 76% yield in 6 h (entry 8). The yield of product remained same when the reaction

was run for 4 h (entry 9). Longer reaction time afforded the product in slightly lower yield (entry 10). While 5 mol % of AgOTf provided the product 2**a** in 56% yield (entry 11). Use of $TMSN_3$ as azide source gave product **2a** in diminished yield (entry 12), whereas TsN_3 found incompatible for the reaction (entry 13). When the amount of NaN_3 was decreased to 0.5 mmol, the product **2a** was obtained in 58% yield (entry 14). Other metal salts such as cobalt (II), copper (II), palladium (II), gold (I) and gold (III) with different counter ions were found inadequate (entry 12 –19). When the reaction was performed in the absence of catalyst and solvent, the desired product **2a** was not obtained in 24 h (entry 20). After screening various solvent and catalyst, it was found that the solvent and choice of silver salts was crucial for the formation of desired azido products.

Table1. Optimization of Reaction Conditions[a]



Entry	Catalyst (mol %)	Solvent	temp(°C)/ time (h)	**2a** yield (%)[b]
1[11b]	$AgNO_3$(10)	H2O	80/1	NR
2	$AgNO_3$(10)	DCE	80/6	NR
3	$AgNO_3$(10)	Toluene	80/6	NR
4	$AgNO_3$(10)	MeOH	70/6	NR[c]
5	$AgNO_3$(10)	MeCN	70/6	NR
6	AgTFA (10)	MeCN	70/6	46
7	AgOAc (10)	MeCN	70/6	35
8	AgOTf (10)	MeCN	70/6	76
9	**AgOTf (10)**	**MeCN**	**70/4**	**76**

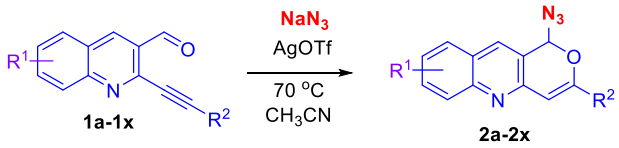
10	AgOTf (10)	MeCN	70/12	72
11	AgOTf (5)	MeCN	70/4	56
12	AgOTf (10)	MeCN	70/4	68[d]
13	AgOTf (10)	MeCN	70/4	NR[e]
14	AgOTf (1o)	MeCN	70/24	58[f]
15	$COCl_2$ (10)	MeCN	70/6	26
16	CuOAc (10)	MeCN	70/6	31
17	$PdCl_2$ (10)	MeCN	70/6	20
18	AuCl (10)	MeCN	70/6	35
19	$AuCl_3$ (10)	MeCN	70/6	28
20	-	-	70/24	NR

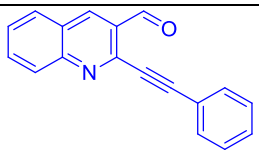
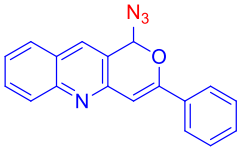
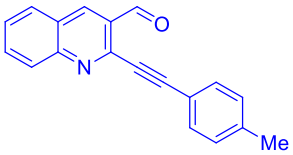
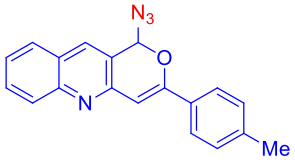
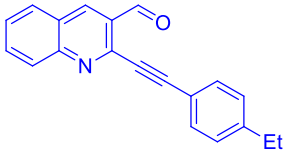
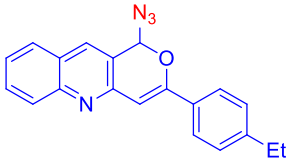
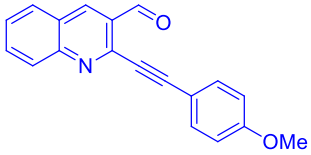
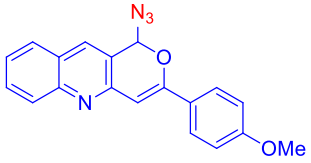
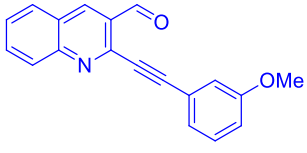
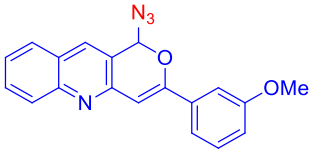
[a]Reactions were carried out using **1a** (0.5 mmol), NaN_3 (1.0 mmol.) in 2.0 mL of solvents. [b] Isolated yield. [c] Isochromene was obtained in 70% yield. [d] Using $TMSN_3$ (1.0 mmol). [e] Using TsN_3 (1.0 mmol). [f] 0.5 mmol of NaN_3 was used.

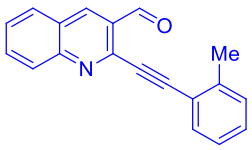
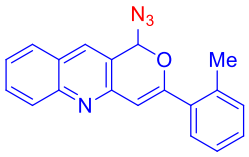
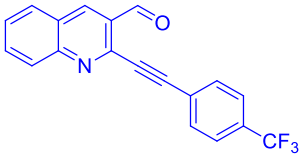
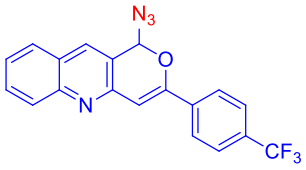
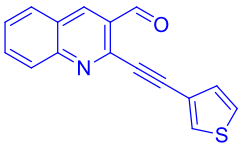
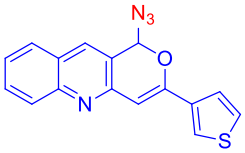
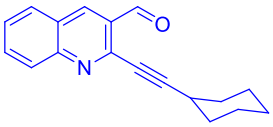
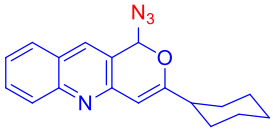
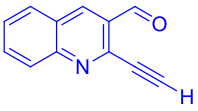
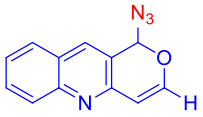
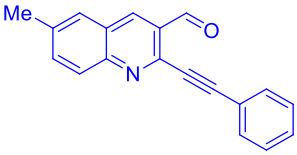
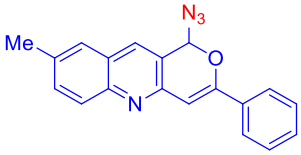
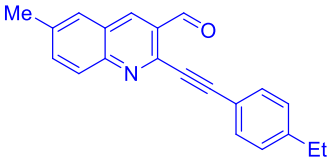
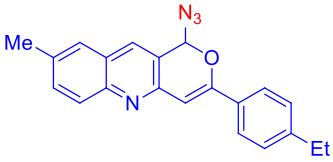
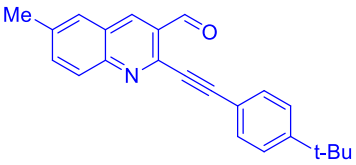
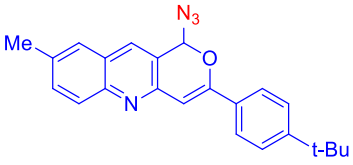
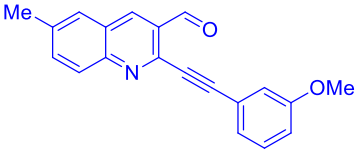
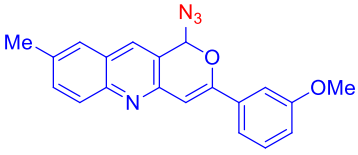
With optimal reaction condition, we next extended the scope of the reaction by utilizing a variety of substituted *o*-alkynylaldehyde having an electron-releasing, electron-withdrawing, hetero-aromatic and aliphatic group (Table 2). When phenyl substituted substrate 1a was reacted under standard condition, 76% yield of desired product 2a was obtained. Electron-releasing groups like -Me, -Et and -OMe at a distal end of the phenyl ring of alkyne afforded the corresponding products 2b–e in 74–84% yields, however, 2-(*o*-tolylethynyl)quinoline-3-carbaldehyde 1f provided the desired product 2f in slightly lower yield which might be due to the steric congestion. The substrate **1g** bearing an electron-withdrawing -CF3 group on para-position of the phenyl ring provided the products **2g** in 67% yield; whereas, thienyl substituted *o*-alkynylaldehyde **1h** provided the desired product **2h** in 72% yield. The reaction was successful with substrates having aliphatic alkynes **1i** and terminal alkyne **1j**. Further, the

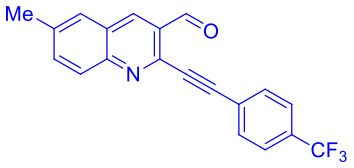
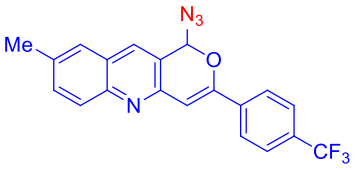
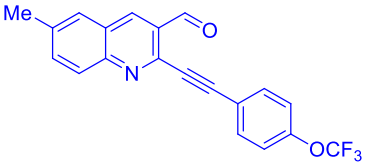
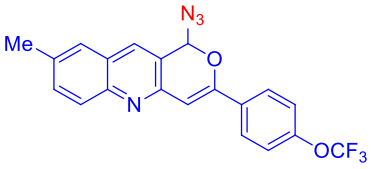
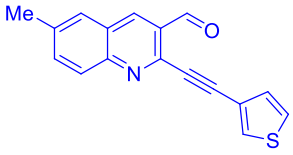
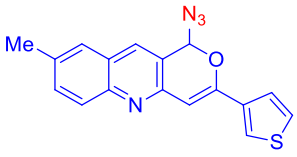
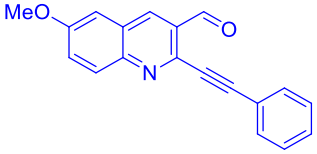
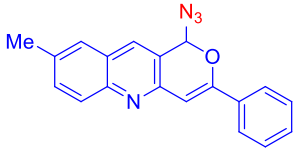
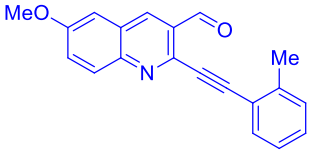
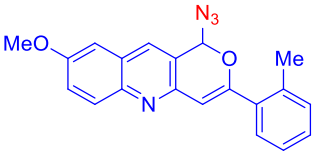
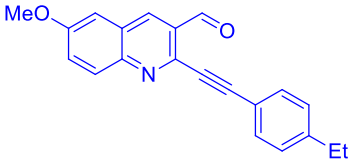
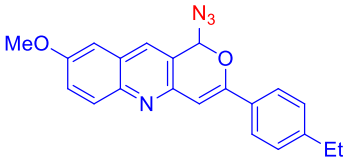
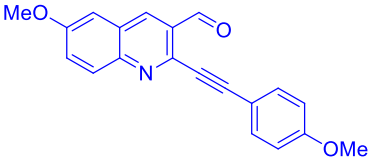
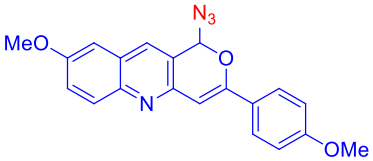
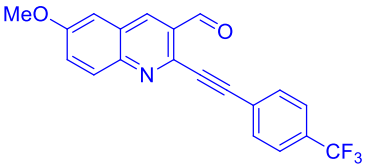
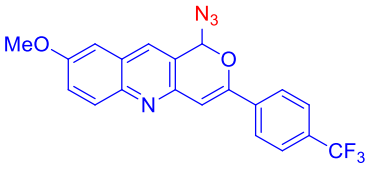
optimal protocol was utilized for substrates having 6-methyl and 6-methoxy-substituted alkynyl quinoline-3-carbaldehydes **1k**–**w** having a variety of electron-rich and electron-poor alkynes; the corresponding products 2**k**–**w** were obtained in 65-84% yields. The reaction was also compatible with substrate 2-((3,5-dimethoxyphenyl)ethynyl)-6-methoxy quinoline-3-carbaldehyde **1x** and afforded the desired product **2x** in 82% yield. The formations of desired azido-pyranoquinolines were confirmed by the spectroscopic studies and X-ray crystallographic data of product **2b**.

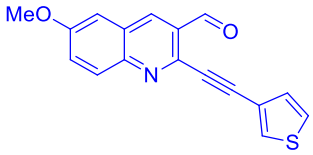
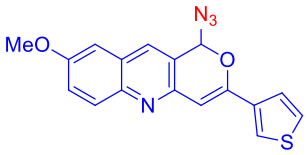
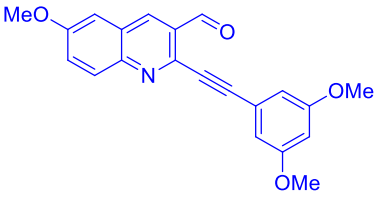
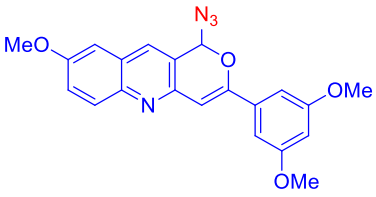
Table 2. Synthesis of Azidopyranoquinolines[a,b]



entry	*o*-alkynylaldehyde **(1)**		product (**2**)		yield (%)
1		**1a**		**2a**	76
2		**1b**		**2b**	80
3		**1c**		**2c**	80
4		**1d**		**2d**	84
5		**1e**		**2e**	74

6		**1f**		**2f**	64
7		**1g**		**2g**	67
8		**1h**		**2h**	72
9		**1i**		**2i**	65
10		**1j**		**2j**	60
11		**1k**		**2k**	80
12		**1l**		**2l**	82
13		**1m**		**2m**	83
14		**1n**		**2n**	78

15		**1o**		**2o**	70
16		**1p**		**2p**	68
17		**1q**		**2q**	75
18		**1r**		**2r**	81
19		**1s**		**2s**	65
20		**1t**		**2t**	84
21		**1u**		**2u**	87
22		**1v**		**2v**	72

23		**1w**		**2w**	79
24		**1x**		**2x**	82

[a]Reactions were carried out using optimal reaction conditions (Table 1 entry 11). [b]yield. [c] Reaction completed in 18 h. [d]Reaction completed in 24 h

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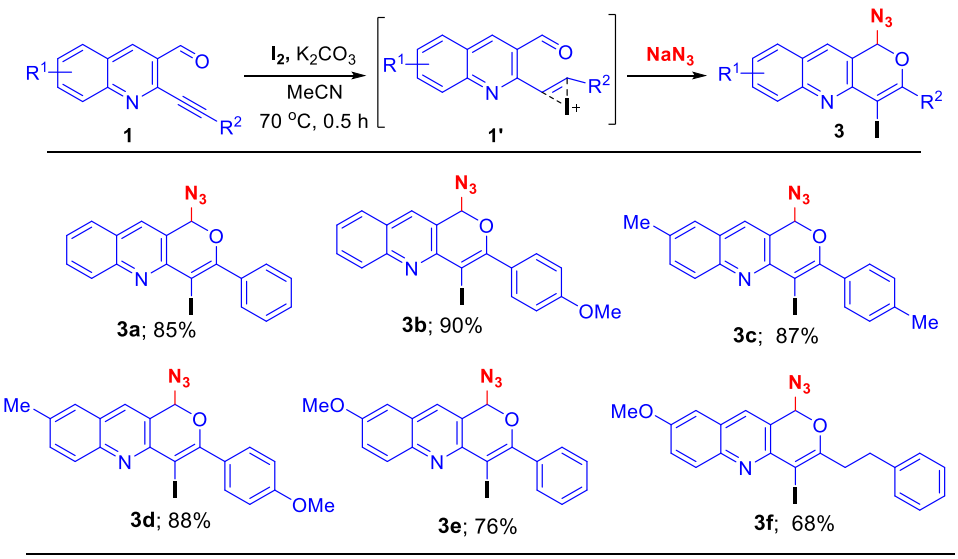
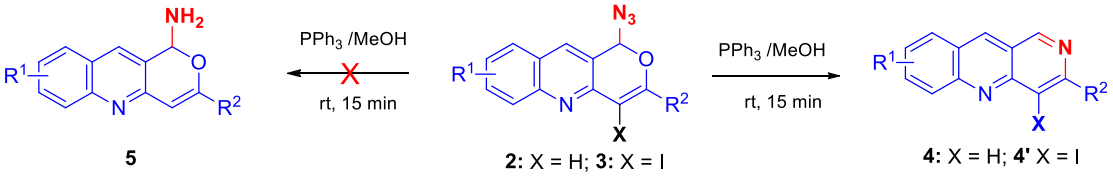
After obtaining successful results with metal-catalyzed cyclization, we next explored iodine-induced ring closure for the synthesis of substituted azido-iodo-pyranoquinolines **3a–f** from corresponding *o*-alkynyl aldehydes (Scheme 2). The reaction was preceded through the iodonium intermediate **1**' which subsequently cyclized through *6-endo dig* cyclization in the presence of sodium azide and molecular iodine afforded the desired product **3**. The phenyl and electron-rich substituted arenes afforded the substituted azido-Iodo products **3a-e** in 76-90% yield. The alkyl substituted **1y** was well tolerated and provided the product **3f** in moderate yield.

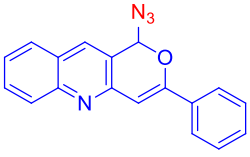
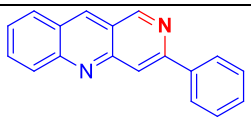
Scheme 2. Synthesis of Azido-Iodo-pyrano quinolines

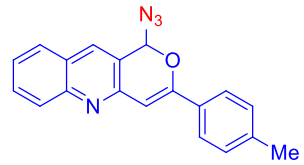
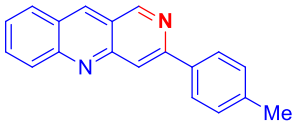
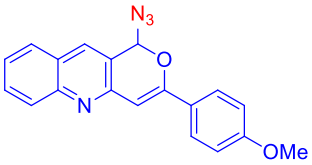
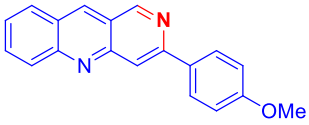
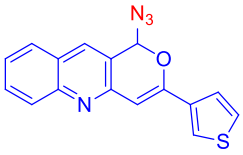
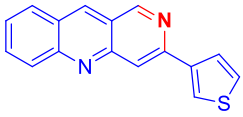
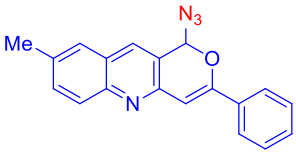
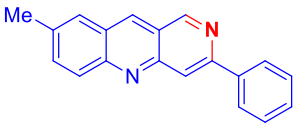
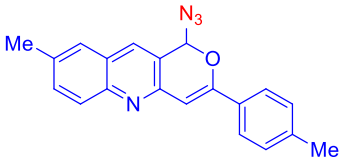
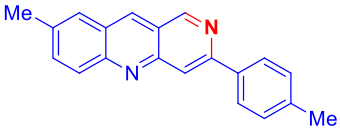
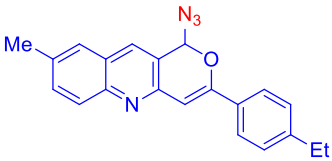
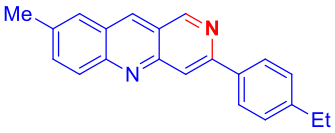
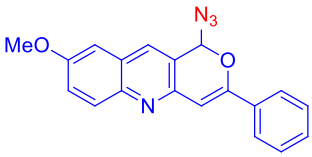
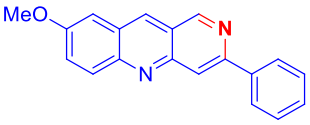
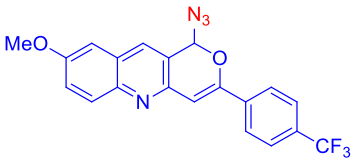
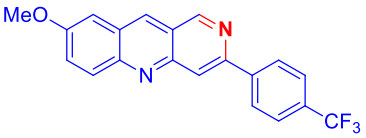
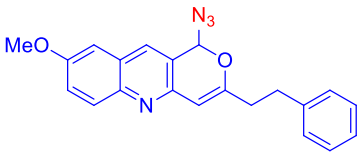
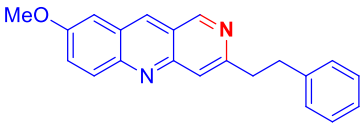


Next, we extended the utility of synthesized azido-pyranoquinolines/azido-iodopyrano quinolines via Staudinger reaction[12] (Table 3). When substrates **2** or **3** were treated with PPh3 in MeOH at room temperature, interestingly we obtained benzonapthyridines **4** exclusively instead of amino-pyranoquinolines **5/** iodo-benzonapthyridines **4'**. We have successfully explored the Staudinger reaction for the construction of biologically important functionalized benzonaphthyridines **4a-j** in good to excellent yield. The reaction proceeded smoothly with various electron-donating as well as electron-deficient substrates. The substrate **3f** having aliphatic substitution provided the targeted benzonapthyridine **4j** in 88% yield.

Table 3. Synthesis of Benzo-naphthyridines via Staudinger Reaction.[a]



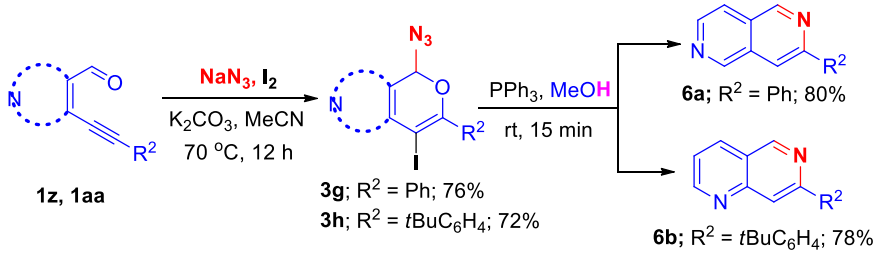
Entry	Substrate 2/ 3	Product 4	Yield %
1	 **2a**	 **4a**	90

2		**2b**		**4b**	88
3		**2d/3b**		**4c**	84/ 82
4		**2h**		**4d**	90
5		**2k**		**4e**	90
6		**3c**		**4f**	87
7		**2l**		**4g**	87
8		**2r**		**4h**	90/ 89
9		**2v**		**4i**	92
10		**3f**		**4j**	88

[a]Reactions were carried out using **2/ 3** (0.5mmol), PPh_3 (1.2 equiv.) in 2.0 mL of MeOH at rt for 15 mins. [b] Using **3** as substrate.

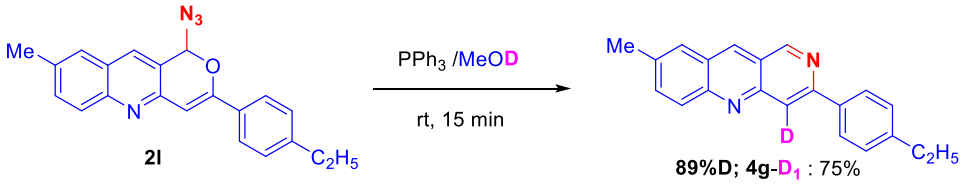
The scope of chemoselective azidation was next investigated with alkynyl-nicotinaldehyde 1z and 1aa for the synthesis of napthyridines 6. The reaction proceeded well and provided the desired 1,6 and 2,6 napthyridines 6a and 6b via electrophilic iodocyclization followed by Staudinger reaction in good yields (Scheme 3).

Scheme 3. Synthesis of 1,6 and 2,6-Naphthyridines from Azido-iodo-pyranopyridines



Further, we performed the deuterium labeling studies of azido-substrate 2l by using MeOD as a solvent, which showed that the deuterium was incorporated at the C-4 position in the benzonaphthyridine 4f-D1 (Scheme 4). This result supports the involvement of tautomerization step (v-vi) as described in the plausible mechanism (Scheme 7) for the synthesis of benzonapthyridine.

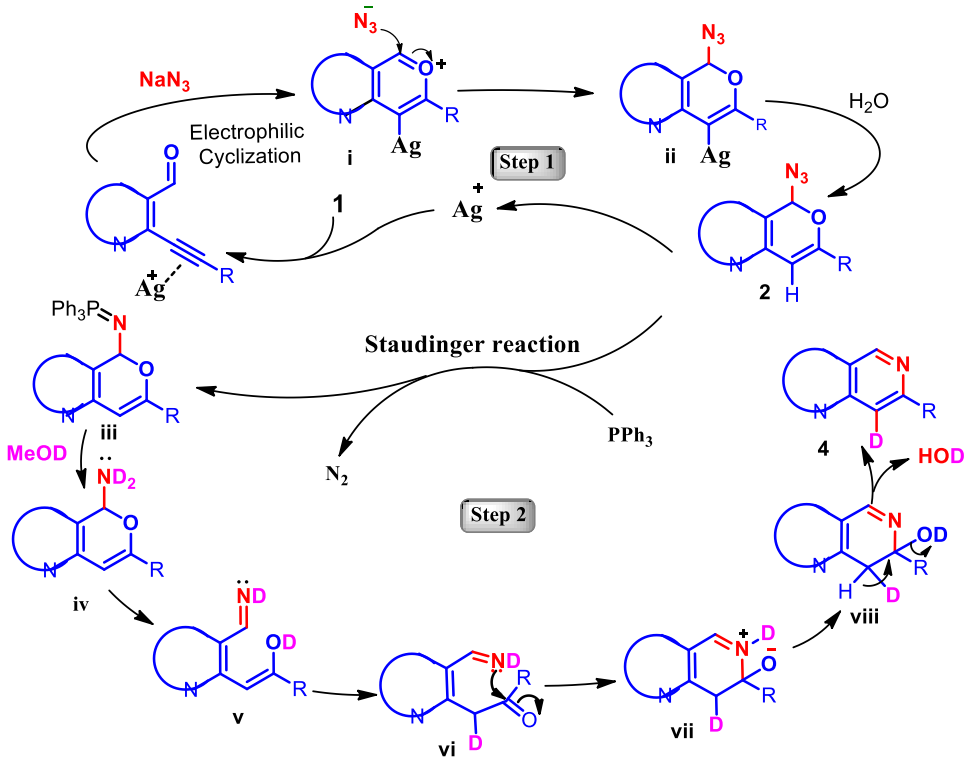
Scheme 4. Deuterium Labeling Studies



Based on the above observations, we proposed a mechanistic pathway for the reaction as described in scheme 5. It includes two steps; the first step involves the formation of azidopyranoquinolines **2** and the second step shows the direct conversion of azidopyrano quinolines **2**

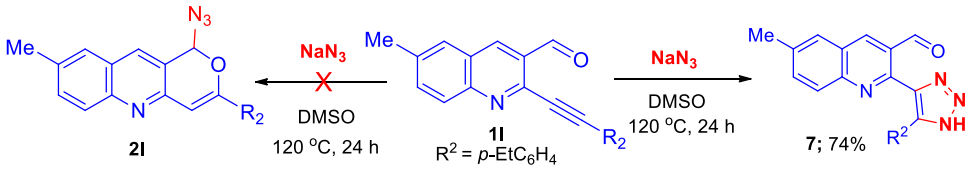
into benzonaphthyridines **4**. The first step of mechanistic cycle initiated by the coordination of silver metal to alkyne triple bond,[13] which triggers the attack of carbonyl oxygen to form oxonium ion via electrophilic cyclization **i**. Consequently, nucleophilic attack of azide followed by demetallation afforded the azidated product **2**.

Scheme 5. Proposed Reaction Mechanism



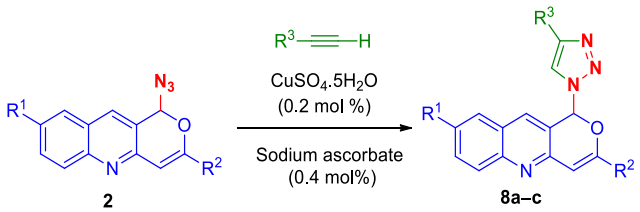
Next, the synthesis of benzonapthyridine was demonstrated in step 2 via formation of aza-ylide species[12] **iii** by using triphenylphosphine, which subsequently from unstable intermediate **iv** in the presence of MeOD. The instability and presence of nitrogen lone pair trigger the opening of pyran ring which immediately tautomerizes to give species **vi.**[14] Rapid intramolecular cyclization of species **vi** followed by aromatization leads to the generation of desired product **4**.

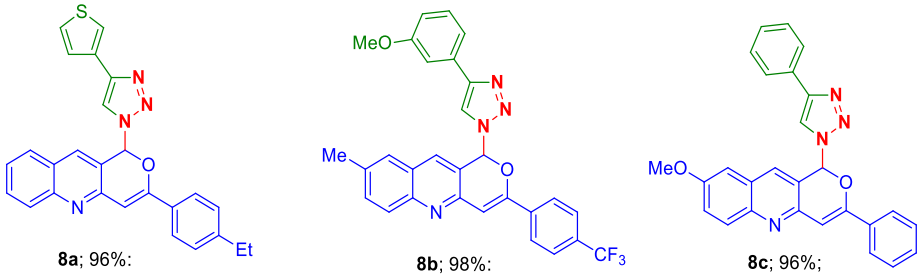
Scheme 6. Reaction of an Alkyne with Azide.



It was interesting to note that when the reaction was performed with substrate 1l in DMSO at 120 °C under the metal-free condition the triazole substituted aldehyde 7 was formed exclusively in 74% yields instead of azido-pyranoquinolines 2l (Scheme 6). This was probably due to the preferential [3+2] cycloaddition over alkyne activation in the absence of a metal catalyst.

Scheme 7. Synthesis of Trizolopyranoquinolines.





Next, we demonstrated the synthetic utility of the azidopyranoquinolines for the synthesis of trizolo pyranoquinolines via [3+2] cycloaddition (Scheme 7). The analogs of these compounds have been used to tag azide installation within the virus particles,[15a] nucleic acids[15b] and proteins from complex tissue lysates[15c] with virtually no background labeling. The trizolo-pyranoquinolines **8a-c** was synthesized in 96 to 98% yield using $CuSO_4.5H_2O$ as a catalyst.

CONCLUSION

In summary, we have demonstrated chemoselective azidation of *o*-alkynyl aldehydes via *6-endo dig* electrophilic cyclization over [3+2] cycloaddition reaction using the silver catalyst as well as

inexpensive iodine. Further, the synthesized azido-pyranoquinolines were elucidated under Staudinger reaction condition for the generation of benznaphthyridines and napthyridines via breaking of C-O bond and successive intramolecular N-C bond formation. In contrary, the metal-free condition afforded the trizolopyranoquinolines through [3+2] cycloaddition reaction. The deuterium incorporation in benzonaphthyridines confirmed the proposed mechanistic pathway. This chemistry is general and expected to find application in a variety of organic synthesis.

EXPERIMENTAL SECTION

The starting material 2-alkynylaldehydes required for synthesis were prepared by using our reported methodology. The structure and purity of known starting materials were confirmed by comparison of their physical and spectral data (^{1}H NMR and ^{13}C NMR) with those reported in literature.[17]

Characterization. ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded in $CDCl_3$/DMSO-d_6. Chemical shifts for protons and carbons are reported in ppm from tetramethylsilane and are referenced to the carbon resonance of the solvent. Data are reported as follows: chemical shift, multiplicity (s = singlet, br s = broad singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublet), coupling constants in Hertz and integration. High-resolution mass spectra were recorded on electrospray mass spectrometer. Crystal structure analysis was accomplished on single needles X-ray diffractometer. TLC analysis was performed on commercially prepared 60 F_{254} silica gel plates and visualized by either UV irradiation or by staining with I_2. All purchased chemicals were used as received. All melting points are uncorrected. All the HRMS are measured by Q-TOF B.05.01 (B5125).

General Procedure for the Synthesis of Azidopyranoquinolines (2a-x).

In an oven-dried reaction vial, 2-alkynyl-quinoline3-carbaldehyde (0.5 mmol) was dissolved in acetonitrile (2 mL), then NaN_3 (1.0 mmol) was added. Then, AgOTf (10 mol %) was added to the reaction mixture. The resulting reaction mixture was heated at 70 °C for 4–24 h. Progression of the reaction was monitored by TLC while noticing complete consumption of 2-alkynyl-quinoline3-carbaldehyde, the reaction was cool to room temperature. The reaction mixture was diluted water (15 mL) and washed with aqueous saturated brine solution, and then extracted with EtOAc. The combined organic layers were dried over Na_2SO_4, concentrated, and purified by column chromatography (: hexane: ethylacetate :: 90:10) to afford the corresponding product. All compounds were crystallized in DCM-Hexane.

1-Azido-3-phenyl-1H-pyrano[4,3-b]quinoline (***2a***). The product was obtained as light yellow crystals, (114.0 mg, 76% yield), mp 102–104 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, J = 8.3 Hz, 1H), 7.93 (s, 1H), 7.81–7.77 (m, 2H), 7.73 (d, J = 8.3 Hz, 1H), 7.67–7.63 (m, 1H), 7.44–7.35 (m, 4H), 6.89 (s, 1H), 6.72 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 149.11, 149.06, 133.0, 132.6, 130.7, 130.3, 128.8, 128.7, 128.0, 126.9, 126.1, 125.6, 120.8, 102.8, 88.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{12}N_4O$ 301.1089; found 301.1088.

*1-Azido-3-(p-tolyl)-1H-pyrano[4,3-b]quinoline (**2b**).* The product was obtained as pale white needles, (122.46 mg, 78% yield), mp 120–122 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 8.3 Hz, 1H), 7.96 (s, 1H), 7.78–7.68 (m, 4H), 7.48–7.44 (m, 1H), 7.24 (d, J = 7.6 Hz, 2H), 6.90 (s, 1H), 6.75 (s, 1H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 149.3, 149.1, 140.7, 132.5, 130.6, 130.2, 129.4, 128.7, 128.0, 126.8, 126.0, 125.6, 120.8, 102.1, 88.3, 21.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O$ 315.1246; found 315.1238.

*1-Azido-3-(4-ethylphenyl)-1H-pyrano[4,3-b]quinolines (**2c**).* The product was obtained as pale yellow crystals, (131.20 mg, 80% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, J = 8.3 Hz, 1H), 7.95 (s, 1H), 7.75–7.72 (m, 3H), 7.68–7.64 (m, 1H), 7.44–7.41 7.43 (m, 1H), 7.23 (d, J = 7.6 Hz,

2H), 6.87 (s, 1H), 6.73 (s, 1H), 2.64 (q, *J* = 7.6 Hz, 2H), 1.20 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 149.3, 149.1, 147.0, 132.5, 130.7, 130.4, 128.8, 128.3, 128.0, 126.8, 126.0, 125.7, 120.8, 102.1, 88.3, 28.8, 15.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_4O$ 329.1402; found 329.1402.

*1-Azido-3-(4-methoxyphenyl)-1H-pyrano[4,3-b]quinolines (**2d**).* The product was obtained as light brown needles, (138.60 mg, 84% yield), mp 150–152 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.93 (s, 1H), 7.76–7.73 (m, 3H), 7.67–7.63 (m, 1H), 7.44–7.40 (m, 1H), 6.92 (dd, *J* = 8.7 and 1.8 Hz, 2H), 6.79 (s, 1H), 6.71 (s, 1H), 3.80 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.6, 155.0, 146.9, 145.1, 133.1, 131.3, 130.2, 130.1, 128.7, 127.9, 125.5, 123.3, 121.0, 105.7, 102.8, 88.3, 55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O_2$ 331.1195; found 331.1189.

*1-Azido-3-(3-methoxyphenyl)-1H-pyrano[4,3-b]quinolines (**2e**).* The product was obtained as yellow crystals, (122.10 mg, 74% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 8.3 Hz, 1H), 8.00 (s, 1H), 7.80 (d, *J* = 7.6 Hz, 1H), 7.74–7.69 (m, 1H), 7.50–7.44 (m, 2H), 7.35–7.33 (m, 2H), 6.98 (dd, *J* = 8.3 and 2.2 Hz, 1H), 6.94 (s, 1H), 6.78 (s, 1H), 3.85 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 155.6, 148.3, 147.6, 136.2, 134.5, 133.0, 131.9, 128.5, 126.9, 120.8, 118.2, 116.4, 110.6, 103.2, 88.4, 55.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O_2$ 331.1195; found 331.1203.

*1-Azido-3-(o-tolyl)-1H-pyrano[4,3-b]quinolines (**2f**).* The product was obtained as light yellow needles (100.48 mg, 64% yield), mp 115–117 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04–8.00 (m, 2H), 7.77 (d, *J* = 7.6 Hz, 1H), 7.71–7.67 (m, 1H), 7.50–7.44 (m, 2H), 7.31–7.26 (m, 1H), 7.22 (d, *J* = 6.8 Hz, 2H), 6.70 (s, 1H), 6.54 (s, 1H), 2.51 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.5, 150.2, 149.0, 141.0, 132.6, 131.1, 130.7, 129.8, 129.7, 129.6, 129.3, 128.1, 126.1, 125.9, 125.8, 121.2, 106.8, 88.7, 20.8; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O$ 315.1246; found 315.1238.

*1-Azido-3-(4-(trifluoromethyl)phenyl)-1H-pyrano[4,3-b]quinoline (**2g**).* The product was obtained as light yellow needles, (125.0 mg, 67% yield), mp 160–162 °C,^{1}H NMR (400 MHz, CDC_{l3}) δ 7.98 (d, *J*

= 8.3 Hz, 1H), 7.95 (s, 1H), 7.88 (d, *J* = 8.3 Hz, 2H), 7.74 (d, *J* = 8.3 Hz, 1H), 7.69–7.58 (m, 3H), 7.46–7.42 (m, 1H), 6.96 (s, 1H), 6.73 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.4, 149.1, 148.5, 136.3, 132.8, 130.9, 128.9, 128.0, 127.0, 126.5, 125.7 (q, *J* = 3.8 Hz, 1C), 120.8, 104.6, 88.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{11}F_3N_4O$ 369.0963; found 369.0962.

*1-Azido-3-(thiophen-3-yl)-1H-pyrano[4,3-b]quinoline (**2h**).* The product was obtained as pale yellow crystals, (110.16 mg, 72% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.3 Hz, 1H), 7.96 (s, 1H), 7.80–7.76 (m, 2H), 7.72–7.68 (m, 1H), 7.48–7.47 (m, 1H), 7.45–7.42 (m, 1H), 7.38–7.36 (m, 1H), 6.78 (s, 1H), 6.72 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.6, 149.1, 135.5, 132.6, 130.7, 128.8, 128.0, 126.8, 126.0, 124.9, 124.6, 120.8, 102.6, 88.2; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{10}N_4OS$ 307.0654; found 307.0648.

*1-Azido-3-cyclohexyl-1H-pyrano[4,3-b]quinolines (**2i**).* The product was obtained as light orange crystals, (99.45 mg, 65% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.3 Hz, 1H), 7.86 (s, 1H), 7.70 (d, *J* = 8.3 Hz, 1H), 7.64–7.61 (m, 1H), 7.41–7.37 (m, 1H), 6.51 (s, 1H), 6.12 (s, 1H), 2.25–2.19 (m, 1H), 1.98–1.93 (m, 2H), 1.79–1.76 (m, 2H), 1.37–1.26 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.9, 149.2, 148.8, 132.6, 130.5, 128.6, 127.9, 126.7, 125.7, 120.4, 101.5, 88.0, 42.4, 30.4, 26.0, 25.9; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{18}N_4O$ 307.1559; found 307.1565.

*1-Azido-1H-pyrano[4,3-b]quinoline (**2j**).* The product was obtained as light yellow crystals, (67.20 mg, 60% yield), mp 122–124 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.3 Hz, 1H), 7.91 (s, 1H), 7.74 (d, *J* = 8.3 Hz, 1H), 7.68–7.64 (m, 1H), 7.46–7.42 (m, 1H), 6.94 (d, *J* = 6.1 Hz, 1H), 6.55 (s, 1H), 6.29 (d, *J* = 6.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.6, 133.1, 130.7, 128.9, 128.0, 127.0, 126.3, 107.6, 87.9; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{12}H_8N_4O$ 225.0776; found 225.0784.

1-Azido-8-methyl-3-phenyl-1*H*-pyrano[4,3-*b*]quinoline ***(2k).*** The product was obtained as dark yellow crystals, (125.60 mg, 80% yield), mp 130–132 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89–7.86 (m, 2H),

7.81–7.78 (m, 2H), 7.51–7.48 (m, 2H), 7.41–7.35 (m, 3H), 6.88 (s, 1H), 6.71 (s, 1H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.7, 148.3, 147.7, 136.2, 133.1, 133.0, 131.9, 130.2, 128.7, 128.5, 127.0, 125.6, 120.8, 102.9, 88.4, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O$ 315.1246; found 315.1238.

1-Azido-3-(4-ethylphenyl)-8-methoxy-1H-pyrano[4,3-b]quinoline ***(2l).*** The product was obtained as white crystals, (140.22 mg, 82% yield), mp 158–160 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, J = 9.1 Hz, 1H), 7.82 (s, 1H), 7.71 (d, J = 8.3 Hz, 2H), 7.48–7.47 (m, 2H), 7.21 (d, J = 7.6 Hz, 2H), 6.83 (s, 1H), 6.68 (s, 1H), 2.63 (q, J = 7.6 Hz, 2H), 2.45 (s, 3H), 1.19 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 148.5, 147.6, 146.8, 136.0, 132.9, 131.9, 130.5, 128.4, 128.2, 126.9, 126.8, 125.6, 120.8, 102.2, 88.3, 28.8, 21.5, 15.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_4O$ 343.1559; found 343.1573.

1-Azido-3-(4-(tert-butyl)phenyl)-8-methyl-1H-pyrano[4,3-b]quinolines ***(2m).*** The product was obtained as light yellow needles, (153.55 mg, 83% yield), mp 168–170 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93–7.89 (m, 2H), 7.78 (d, J = 9.1 Hz, 2H), 7.55–7.53 (m, 2H), 7.47 (d, J = 8.3 Hz, 2H), 6.90 (s, 1H), 6.75 (s, 1H), 2.51 (s, 3H), 1.33 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 153.7, 148.5, 147.6, 136.0, 132.9, 131.9, 128.4, 126.9, 125.7, 125.4, 120.8, 102.2, 88.4, 22.6, 21.5, 14.1; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{23}H_{22}N_4O$ 371.1872; found 371.1869.

1-Azido-3-(3-methoxyphenyl)-8-methyl-1H-pyrano[4,3-b]quinoline ***(2n).*** The product was obtained as light yellow crystals, (134.16 mg, 78% yield), mp 138–140 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90–7.88 (m, 4H), 7.65 (d, J = 8.4 Hz, 2H), 7.53–7.51 (m, 2H), 6.96 (s, 1H), 6.75 (s, 1H), 3.90 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 155.6, 148.3, 147.6, 136.2, 134.5, 133.0, 131.9, 129.7, 128.5, 126.9, 120.8, 118.2, 116.4, 110.6, 103.2, 88.4, 55.2, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_4O_2$ 345.1352; found 345.1352.

1-Azido-8-methyl-3-(4-(trifluoromethoxy)phenyl)-1H-pyrano[4,3-b]quinolines ***(2o).*** The product was obtained as yellow crystals, (139.30 mg, 70% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89–7.87 (m, 2H), 7.82 (d, J = 8.3 Hz, 2H), 7.52–7.50 (m, 2H), 7.23 (d, J = 8.3 Hz, 2H), 6.87 (s, 1H), 6.72 (s, 1H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.2, 150.3, 147.8, 147.5, 136.4, 133.1, 132.0, 131.6, 128.4, 127.1, 126.9, 121.6, 120.9, 120.5, 119.1, 103.3, 88.3, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{13}F_3N_4O_2$ 399.1069; found 399.1077.

1-Azido-8-methyl-3-(4-(trifluoromethyl)phenyl)-1H-pyrano[4,3-b]quinolines ***(2p)***. The product was obtained as pale yellow crystals, (129.88 mg, 68% yield), mp 170–172 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90–7.88 (m, 4H), 7.65 (d, J = 8.3 Hz, 2H), 7.53 –7.51 (m, 2H), 6.96 (s, 1H), 6.75 (s, 1H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.9, 147.7, 147.6, 136.6, 136.4, 133.2, 132.1, 128.6, 127.1, 127.0, 125.7 (q, J = 3.8 Hz, 1C), 120.7, 104.6, 88.4, 21.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{13}F_3N_4O$ 383.1120; found 383.1132.

1-Azido-8-methyl-3-(thiophen-3-yl)-1H-pyrano[4,3-b]quinoline ***(2q)***. The product was obtained as pale white crystals, (120.0 mg, 75% yield), mp 135–137 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.3 Hz, 1H), 7.89 (s, 1H), 7.797–7.790 (m, 1H), 7.55–7.53 (m, 2H), 7.44–7.43 (m, 1H), 7.39–7.37 (m, 1H), 6.78 (s, 1H), 6.72 (s, 1H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.2, 148.2, 147.5, 136.1, 135.6, 133.0, 132.0, 128.3, 126.9, 126.7, 124.9, 124.5, 120.7, 102.5, 88.2, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{12}N_4OS$ 321.0810; found 321.0808.

1-Azido-8-methoxy-3-phenyl-1H-pyrano[4,3-b]quinolines ***(2r)***. The product was obtained as yellow crystals, (133.78 mg, 81% yield), mp 95–97 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 9.1 Hz, 1H), 7.88 (s, 1H). 7.84 (dd, J = 8.3 and 2.2 Hz, 2H), 7.46–7.41 (m, 3H), 7.37 (dd, J = 9.1 and 2.2 Hz, 1H), 7.07–7.06 (m, 1H), 6.92 (s, 1H), 6.75 (s, 1H), 3.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.6, 155.0, 146.9, 145.1, 133.1, 131.3, 130.2, 130.1, 128.7, 127.9, 125.5, 123.3, 121.0, 105.7, 102.8, 88.3,

55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_4O_2$ 331.1195; found 331.1189.

1-Azido-8-methoxy-3-(o-tolyl)-1H-pyrano[4,3-b]quinoline) ***(2s)***. The product was obtained as yellow needles, (111.8 mg, 65% yield), mp 98–100 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90–7.87 (m, 2H), 7.52–7.49 (m, 2H), 7.40–7.38 (m, 1H), 7.32–7.28 (m, 2H), 6.93–6.90 (m, 2H), 6.72 (s, 1H), 3.81 (s, 3H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 155.6, 148.3, 147.6, 136.2, 134.5, 133.0, 131.9, 129.7, 128.5, 126.9, 120.8, 118.2, 116.4, 110.6, 103.2, 88.4, 55.2, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_4O_2$ 345.1352; found 345.1352.

1-Azido-3-(4-ethylphenyl)-8-methoxy-1H-pyrano[4,3-b]quinolines ***(2t)***. The product was obtained as light yellow crystals, (150.36 mg, 84% yield), mp 106–108 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, J = 9.1 Hz, 1H), 7.83 (s, 1H), 7.70 (d, J = 7.6 Hz, 2H), 7.31 (d, J = 9.1 Hz, 1H), 7.22 (d, J = 8.3 Hz, 2H), 7.01 (s, 1H), 6.84 (s, 1H), 6.69 (s, 1H), 3.86 (s, 3H), 2.63 (q, J = 7.6 Hz, 2H), 1.20 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.5, 155.4, 147.0, 146.8, 131.4, 130.5, 130.0, 128.2, 127.8, 125.6, 123.3, 121.0, 105.8, 101.9, 88.3, 55.6, 28.8, 15.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_4O_2$ 359.1508; found 359.1506.

1-Azido-8-methoxy-3-(4-methoxyphenyl)-1H-pyrano[4,3-b] quinolines ***(2u)***. The product was obtained as light yellow crystals, (156.6 mg, 87% yield), mp 115–117 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, J = 9.1 Hz, 1H), 7.83 (s, 1H), 7.73 (d, J = 8.3 Hz, 2H), 7.31 (dd, J = 9.1 and 2.2 Hz, 1H), 7.01 (d, J = 3.0 Hz, 1H), 6.90 (d, J = 9.1 Hz, 2H), 6.79 (s, 1H), 6.68 (s, 1H), 3.85 (s, 3H), 3.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.1, 157.4, 155.2, 147.2, 132.2, 131.3, 129.9, 127.7, 127.2, 125.6, 123.3, 121.0, 114.1, 105.8, 100.9, 88.3, 55.6, 55.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_4O_3$ 361.1301; found 361.1292.

1-Azido-8-methoxy-3-(4-(trifluoromethyl)phenyl)-1H-pyrano[4,3-b]quinolone ***(2v)***. The product was obtained as pale white crystals, (143.2 mg, 72% yield), mp 118–120 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95–7.93 (m, 2H), 7.91–7.89 (m, 2H), 7.68 (d, J = 8.3 Hz, 2H), 7.39 (dd, J = 9.1 and 3.0 Hz, 1H), 7.07

(d, J = 2.2 Hz, 1H), 6.98 (s, 1H), 6.76 (s, 1H), 3.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.9, 153.3, 146.2, 145.2, 136.5, 131.3, 130.4, 128.1, 125.6 (q, J = 3.8 Hz, 1C), 123.6, 121.0, 105.7, 104.6, 88.4, 55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{13}F_3N_4O_2$ 399.1069; found 399.1077.

1-Azido-8-methoxy-3-(thiophen-3-yl)-1H-pyrano[4,3-b]quinolines ***(2w)***.The product was obtained as light yellow needles, (132.7 mg, 79% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, J = 9.1 Hz, 1H), 7.81 (s, 1H), 7.71 (s, 1H), 7.37–7.36 (m, 1H), 7.32–7.30 (m, 2H), 7.01 (d, J = 2.2 Hz, 1H), 6.70 (s, 1H), 6.65 (s, 1H), 3.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.5, 151.6, 146.8, 145.0, 135.6, 131.3, 130.1, 127.8, 126.7, 124.8, 124.2, 123.3, 121.0, 105.8, 102.5, 88.2, 55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{12}N_4O_2S$ 337.0759; found 337.0753.

1-Azido-3-(3,5-dimethoxyphenyl)-8-methoxy-1H-pyrano[4,3-b]quinolines ***(2x)***. The product was obtained as light yellow crystals, (159.89 mg, 82% yield), mp 102 –104 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, J = 9.1 Hz, 1H), 7.90 (s, 1H), 7.40 (dd, J = 9.1 and 2.7 Hz, 1H), 7.08 (d, J = 2.2 Hz, 1H), 7.01 (d, J = 2.2 Hz, 2H), 6.92 (s, 1H), 6.76 (s, 1H), 6.55–6.54 (m, 1H), 3.93 (s, 3H), 3.85 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9, 157.6, 154.8, 146.7, 145.1, 135.0, 131.3, 130.2, 127.9, 123.4, 121.1, 105.7, 103.4, 103.3, 102.7, 88.3, 55.6, 55.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_4O_4$ 391.1406; found 391.1403.

General Procedure for the synthesis of Azido-iodo-pyranoquinolines (3a-h).

In an oven-dried reaction vial, 2-alkynyl-quinoline3-carbaldehyde (0.5 mmol) was taken in acetonitrile (2 mL), then NaN_3 (2.0 equiv), K_2CO_3 (2.5 equiv) and molecular iodine (2.5 equiv) were added. The resulting reaction mixture was heated at 70 °C for 0.5 h. Progression of the reaction was monitored by TLC, while noticing complete consumption of 2-alkynyl-quinoline3-carbaldehyde, reaction was cool to room temperature. The solution was washed with saturated solution of $Na_2S_2O_3$ and then extracted with EtOAc. The combined organic layers were dried over Na_2SO_4, concentrated, and purified by column

chromatography (hexane: ethylacetate:: 98:2) to afford the corresponding product.

1-Azido-4-iodo-3-phenyl-1H-pyrano[4,3-b]quinoline ***(3a)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (180.62 mg, 85% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.14 (d, J = 8.3 Hz, 1H), 7.89 (s, 1H), 7.78 (d, J = 8.3 Hz 1H), 7.72–7.68 (m, 3H), 7.50–7.46 (m, 1H), 7.42–7.40 (m, 3H), 6.64 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.3, 148.9, 147.4, 135.8, 132.5, 130.7, 130.3, 130.2, 129.6, 128.0, 127.6, 127.3, 126.9, 120.2, 88.4, 78.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{11}IN_4O$ 427.0056; found 427.0029.

1-Azido-4-iodo-3-(4-methoxyphenyl)-1H-pyrano[4,3-b]quinoline ***(3b)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (205.20 mg, 90% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (d, J = 8.3 Hz, 1H), 7.93 (s, 1H), 7.84 (d, J = 8.3 Hz, 1H), 7.79–7.74 (m, 3H), 7.55–7.51 (m, 1H), 6.98 (d, J = 8.3 Hz, 2H), 6.68 (s, 1H), 3.87 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.1, 157.0, 148.9, 147.8, 132.3, 132.1, 130.7, 129.5, 127.9, 127.6, 127.2, 126.7, 120.3, 113.3, 88.3, 77.3, 55.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{13}IN_4O_2$ 457.0161; found 457.0158.

1-Azido-4-iodo-8-methyl-3-(p-tolyl)-1H-pyrano[4,3-b]quinoline ***(3c).*** The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (197.49 mg, 87% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 9.16 Hz, 1H), 7.75 (s, 1H), 7.60 (d, J = 8.3 Hz 2H), 7.51–7.49 (m, 2H), 7.20 (d, J = 7.6 Hz, 2H), 6.58 (s, 1H), 2.45 (s, 3H), 2.4 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.8, 147.5, 146.7, 140.5, 136.9, 132.95, 132.89, 131.7, 130.1, 129.2, 128.6, 127.2, 126.4, 120.1, 88.4, 78.0, 21.6, 21.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{15}IN_4O$ 454.0369; found 455.0365.

1-Azido-4-iodo-3-(4-methoxyphenyl)-8-methyl-1H-pyrano[4,3-b] quinoline ***(3d)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (220.90 mg, 88% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, J = 9.16 Hz, 1H), 7.77 (s, 1H), 7.70 (d, J = 8.3 Hz, 2H), 7.53–7.51 (m, 2H), 6.91 (d, J = 8.3 Hz, 2H), 6.59 (s, 1H), 3.80 (s, 3H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.0, 156.5, 147.5, 147.0, 136.8, 133.0, 132.0, 131.7, 129.2, 127.9, 127.2, 126.5,

120.2, 113.2, 88.4, 76.7, 55.4, 21.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{15}IN_4O_2$ 471.0318; found 471.0310.

1-Azido-4-iodo-8-methoxy-3-phenyl-1H-pyrano[4,3-b]quinoline ***(3e)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (173.28 mg, 76% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, J = 9.1 Hz, 1H), 7.74 (s, 1H), 7.70–7.68 (m, 2H), 7.39–7.38 (m, 3H), 7.33 (dd, 9.5 and 3.0 Hz, 1H), 7.02–7.01 (m, 1H), 6.58 (s, 1H), 3.85 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.1, 156.1, 145.2, 145.0, 135.8, 131.1, 131.0, 130.2, 130.1, 128.4, 127.9, 123.4, 120.4, 105.1, 88.4, 78.5, 55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{13}IN_4O_2$ 457.0161; found 457.0158.

1-Azido-4-iodo-8-methoxy-3-phenethyl-1H-pyrano[4,3-b]quinoline ***(3f)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (164.56 mg, 68% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, J = 9.1 Hz, 1H), 7.64 (s, 1H), 7.28 (dd, 9.1 and 3.0 Hz, 1H), 7.23–7.22 (m, 4H), 7.15–7.13 (m, 1H), 6.96–6.95 (m, 1H), 6.38 (s, 1H), 381 (s, 3H), 3.08 – 2.92 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 157.8, 144.8, 144.3, 140.3, 130.93, 130.86, 128.5, 128.4, 128.1, 126.3, 123.2, 119.9, 105.2, 88.0, 78.9, 55.5, 39.7, 32.9, 29.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{17}IN_4O_2$ 485.0474; found 485.0467.

1-Azido-4-iodo-3-phenyl-1H-pyrano[4,3-c]pyridine ***(3g)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (142.50 mg, 76% yield), mp 140–142 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.75–8.73 (m, 1H), 7.75 (d, 9.1 Hz, 2H), 7.51 (d, 6.8 Hz, 1H), 7.28–7.25 (m, 1H), 6.98 (d, 8.3 Hz, 2H), 6.57 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.0, 155.4, 151.2, 148.5, 132.6, 132.0, 127.4, 122.5, 120.8, 113.3, 88.2, 75.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_9IN_4O$ 376.9899; found 376.9908.

5-Azido-7-(4-(tert-butyl)phenyl)-8-iodo-5H-pyrano[4,3-b]pyridine ***(3h)***. The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (155.52 mg, 72% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.74–8.72 (m, 1H), 7.73–7.70 (m, 2H), 7.51–7.47 (m, 3H), 7.26–7.24 (m, 1H),

6.55 (s, 1H), 1.36 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.8, 153.6, 151.2, 148.3, 132.6, 132.4, 130.0, 124.9, 122.6, 120.8, 88.2, 76.2, 34.9, 31.2; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{17}IN_4O$ 433.0525; found 433.0540.

General Procedure for the Synthesis of 3-phenylbenzo[*b*][1,6]naphthyridine (4a-j).

The 3-substituted Benzonaphthyridines were prepared from azido-pyrano[4,3-*b*]quinoline **2** (0.50 mmol) in 2ml of methanol in reaction vial. Then 1.2 equiv of PPh_3 was added to the reaction mixture and stirred for 0.5 h. The solid compound was precipitate and settles down. The completion of reaction was monitored by TLC and after completion the precipitate was filtered under vacuum and washed with hexane. Then, the final compound were crystallizes from chloroform.

3-Phenylbenzo[b][1,6]naphthyridine ***(4a)***. The product was obtained as yellow crystals, (115.20 mg, 90% yield), mp 190–192 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.53 (s, 1H), 8.89 (s, 1H), 8.36 (s, 1H), 8.18–8.16 (m, 3H), 8.00 (d, *J* = 8.3 Hz, 1H), 7.84–7.81 (m, 1H), 7.69–7.66 (m, 1H), 7.55–7.51 (m, 1H), 7.41–7.37 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.7, 138.8, 137.3, 133.4, 133.3 132.6, 130.5, 130.4, 129.2, 129.03, 128.9, 128.5, 128.4, 127.2, 126.4, 121.1; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{12}N_2$ 257.1079; found 257.1076.

3-(p-tolyl)Benzo[b][1,6]naphthyridine ***(4b)***. The product was obtained as light yellow crystals, (118.80 mg, 88% yield), mp 195–197 °C,^{1}H NMR (400 MHz, $CDCl_3$) 9.59 (s, 1H), 8.96 (s, 1H), 8.41 (s, 1H), 8.24 (d, *J* = 8.3 Hz, 1H), 8.15 (d, *J* = 7.6 Hz, 2H), 8.08 (d, *J* = 8.3 Hz, 1H), 77.50–7.46 (m, 1H), 7.62–7.58 (m, 1H), 7.36 (d, *J* = 7.6 Hz, 2H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.7, 150.8, 150.3, 139.3, 137.3, 136.1, 135.2, 133.3, 132.5, 130.4, 129.7, 129.0, 128.6, 127.1, 126.3, 115.9, 22.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_2$ 271.1235; found 271.1235.

3-(4-Methoxyphenyl)benzo[b][1,6]naphthyridine ***(4c)***. The product was obtained as pale yellow crystals, (120.12 mg, 84% yield), mp 188–190 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.56 (s, 1H), 8.92 (s, 1H), 8.34 (s, 1H), 8.23–8.19 (m, 3H), 8.05 (d, *J* = 8.3 Hz, 1H), 7.90–7.86 (m, 1H), 7.60–7.56 (m, 1H),

7.07 (d, *J* = 8.3 Hz, 2H), 3.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.7, 154.6, 153.6, 152.1, 150.5, 137.3, 133.3, 132.5, 131.4, 130.5, 129.3, 129.0, 128.5, 126.1, 120.9, 114.3, 55.4; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_2O$ 287.1184; found 287.1179.

*3-(Thiophen-3-yl)benzo[b][1,6]naphthyridine (**4d**).* The product was obtained as pale white crystals, (115.28 mg, 88% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.53 (s, 1H), 8.93 (s, 1H), 8.29 (s, 1H), 8.23 (d, *J* = 8.3 Hz, 1H), 8.20–8.19 (m, 1H), 8.06 (d, *J* = 8.3 Hz, 1H), 7.91–7.87 (m, 1H), 7.82–7.80 (m, 1H), 7.61–7.58 (m, 1H), 7.48–7.46 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.9, 152.1, 150.4, 150.0, 141.7, 137.4, 132.7, 129.3, 129.1, 126.9, 126.8, 126.3, 126.0, 124.8, 121.1, 115.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{10}N_2S$ 263.0643; found 263.0635.

*8-Methyl-3-phenylbenzo[b][1,6]naphthyridine (**4e**).* The product was obtained as yellow crystals, (121.50 mg, 90% yield), mp 220–222 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.50 (s, 1H), 8.77 (s, 1H), 8.35 (s, 1H), 8.17–8.15 (m, 2H), 8.08 (d, *J* = 9.1 Hz, 1H), 7.74 (s, 1H), 7.68–7.65 (m, 1H), 7.49–7.45 (m, 2H), 7.40–7.37 (m, 1H), 2.53 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.6, 153.5, 151.0, 149.9, 139.0, 136.4, 136.0, 135.6, 129.1, 129.0, 128.9, 127.2, 127.0, 121.3, 116.7, 21.8; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_2$ 271.1235; found 271.1235.

*8-Methyl-3-(p-tolyl)benzo[b][1,6]naphthyridine (**4f**).* The product was obtained as yellow crystals, (123.54 mg, 87% yield), mp 202–204 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.54 (s, 1H), 8.80 (s, 1H), 8.38 (s, 1H), 8.14–8.12 (m, 3H), 7.78 (s, 1H), 7.48–7.45 (m, 1H), 7.34 (d, *J* = 7.6 Hz, 2H), 2.59 (s, 3H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.5, 150.9, 149.8, 139.2, 136.3, 136.1, 135.6, 132.1, 132.0, 129.7, 128.9, 128.5, 128.4, 127.1, 121.2, 115.9, 21.7, 21.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_2$ 285.1392; found 285.1385.

*3-(4-Ethylphenyl)-8-methylbenzo[b][1,6]naphthyridine (**4g**).* The product was obtained as light yellow crystals, (129.63 mg, 87% yield), mp 190–192 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.49 (s, 1H), 8.76 (s,

1H), 8.33 (s, 1H), 8.10–8.06 (m, 3H), 7.74 (s, 1H), 7.66 (dd, *J* = 8.3 and 1.5 Hz, 1H), 7.31 (d , *J* = 8.3 Hz, 2H), 2.76 (q , *J* = 7.6 Hz, 2H), 2.53 (s, 3H). 1.24 (t , *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 154.6, 150.0, 148.6, 145.5, 143.2, 136.4, 136.3, 136.1, 135.6, 129.0, 128.5, 127.2, 127.1, 127.0, 118.9, 116.0, 28.7, 21.8, 15.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_2$ 299.1548; found 299.1541.

*8-Methyl-3-(p-tolyl)benzo[b][1,6]naphthyridine (**4h**).* The product was obtained as light yellow crystals, (128.70 mg, 90% yield), mp 98–100°C,^{1}H NMR (400 MHz, $CDCl_3$) *δ* 9.55 (s, 1H), 8.79 (s, 1H), 8.42 (s, 1H), 8.22 (d , *J* = 7.6 Hz, 2H), 8.14 (d , *J* = 9.1 Hz, 1H), 7.60–7.53 (m, 3H), 7.46 (d , *J* = 6.8 Hz, 1H), 7.22 (d , *J* = 2.3 Hz, 1H), 3.97 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 157.9, 154.0, 153.0, 149.3, 148.8, 138.9, 134.5, 130.8, 128.9, 128.07, 127.96, 127.1, 121.4, 116.9, 103.7, 55.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{14}N_2O$ 287.1184; found 287.1179.

*8-Methoxy-3-(4-(trifluoromethyl)phenyl)benzo[b][1,6]naphthyridine (**4i**).* The product was obtained as pale white crystals, (162.84 mg, 92% yield), mp 140–142 °C,^{1}H NMR (400 MHz, $CDCl_3$) *δ* 9.48 (s, 1H), 8.72 (s, 1H), 8.38 (s, 1H), 8.26 (d, *J* = 8.3 Hz, 2H), 8.08 (d, *J* = 9.1 Hz, 1H), 7.72 (d, *J* = 8.3 Hz, 2H), 7.53 (dd, *J* = 9.5 and 2.3 Hz, 1H), 7.15 (d, *J* = 3.0 Hz, 1H), 3.94 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 157.8, 154.2, 151.2, 149.4, 148.5, 142.3, 134.5, 130.9, 128.4, 128.2, 127.3, 125.8 (q, *J* = 3.8 Hz, 1C), 122.2, 121.7, 117.7, 103.6, 55.8; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{13}F_3N_2O$ 355.1058; found 355.1047.

*8-Methoxy-3-phenethylbenzo[b][1,6]naphthyridine (**4j**).* The product was obtained as light yellow crystals, (138.1 mg, 88% yield), mp 195–197 °C,^{1}H NMR (400 MHz, $CDCl_3$) *δ* 9.37 (s, 1H), 8.68 (s, 1H), 8.03 (d, *J* = 9.9 Hz, 1H), 7.69 (s, 1H), 7.49 (dd, *J* = 9.5 and 3.0 Hz, 1H), 7.21 – 7.19 (m, 5H), 7.13 (d, *J* = 3.0 Hz, 1H), 3.93 (s, 3H), 3.28 – 3.25(m, 2H), 315 – 3.11(m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 157.3, 156.7, 153.8, 148.9, 148.4, 141.4, 134.7, 132.9, 130.6, 129.7, 129.6, 127.9, 127.8, 125.9, 120.7,

118.7, 103.7, 55.7, 33.9, 35.7; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_2O$ 315.1497; found 315.1489.

General Procedure for the Synthesis of 4g-D1

The **3**-(4-Ethylphenyl)-8-methylbenzo[*b*][1,6]naphthyridine(**4g-D1**) was prepared from azido-pyrano[4,3-*b*]quinoline **3l** (0.50 mmol) in 2ml of deuterated methanol MeOD in reaction vial. Then 1.2 equiv of PPh_3 was added to the reaction mixture and stirred for 0.5 h. The solid compound was precipitate and settles down. After completion of the reaction, the precipitate was filtered under vacuum and washed with hexane. Then, the final compound was crystallizes from chloroform.

*3-(4-Ethylphenyl)-8-methylbenzo[b][1,6]naphthyridine (**4g-D1**).* The product was obtained as yellow crystals, (112.12 mg, 75% yield), mp 192–194 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.56–9.55 (m, 1H), 8.83 (s, 1H), 8.17–8.12 (m, 3H), 7.80 (s, 1H), 7.75–7.72 (m, 1H), 7.38 (d, J = 8.3 Hz, 2H), 7.26 (s, 1H), 2.74 (q , J = 7.6 Hz, 2H), 2.60 (s, 3H), 1.30 (dt , J = 7.6 and 2.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.5, 151.2, 151.0, 145.5, 136.6, 136.34, 136.26, 135.6, 129.0, 128.5, 127.4, 127.14, 127.08, 127.0, 119.6, 28.7, 21.8, 15.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{17}DN_2$ 300.1611; found 300.1611.

General Procedure for the Synthesis of Naphthyridines from azido-iodo-pyranopyridines (6a-b). The 3-substituted naphthyridines were prepared from azido-pyranopyridine **3** (0.50 mmol) in 2ml of methanol in reaction vial. Then 1.2 equiv of PPh_3 was added to the reaction mixture and stirred for 0.5 h. The solid compound was precipitate and settles down. The completion of reaction was monitored by TLC and after completion the precipitate was filtered under vacuum and washed with hexane. Then, the final compound were crystallizes from chloroform.

*3-Phenyl-2,6-naphthyridine (**6a**).* The product was obtained as light yellow crystals, (82.40 mg, 80% yield), mp 195–197 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 9.38 (s, 1H), 8.69 (s, 1H), 8.03 (d, J = 9.1Hz, 1H), 7.69 (s, 1H), 7.49(dd, J = 9.5 and 2.2 Hz, 1H), 7.20 – 7.19 (m, 3H), 7.14 – 7.13 (m, 1H), 7.12 –

7.10 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.3, 153.8, 144.5, 141.5, 134.6, 130.8, 128.5, 128.4, 127.83, 127.78, 126.0, 122.5; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_{10}N_2$ 207.0922; found 207.0933.

*7-(4-(tert-Butyl)phenyl)-1,6-naphthyridine (**6b**).* The product was obtained as yellow crystals (102.18 mg, 78%), mp 165–170 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.30 (s, 1H), 9.05–9.04 (m, 1H), 8.31 (s, 1H), 8.24 (d, *J* = 8.0 Hz, 1H), 8.10 (d, *J* = 8.8 Hz, 2H), 7.54 (d, *J* = 8.8 Hz, 2H), 7.45–7.42 (m, 1H), 1.36 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.0, 154.8, 152.5, 152.3, 151.2, 135.8, 135.4, 126.8, 125.8, 122.4, 121.8, 117.1, 34.6, 31.2; HRMS (EI-TOF) m/z: $[M]^+$ Calcd for $C_{18}H_{18}N_2$ 262.1470; found 262.1470.

General Procedure for the Synthesis of 1*H*-1, 2, 3-triazolyl Aldehydes 7.

1*H*-1,2,3-triazolyl aldehydes **7** was prepared by using 0.5 mmol of **1l** and 1.0 mmol of NaN_3in 2ml of DMSO in an oven dried vial and stir the reaction at 120 °C for 24 h. Progression of the reaction was monitored by TLC, while noticing complete consumption of substrate, reaction was cool to room temperature and after completion reaction mixture was diluted with H_2O and extracted with ethyl acetate (15ml x 3) and dried over $NaSO_4$. The compound was purified by column chromatography in 10% ethyl acetate/ hexane.

*2-(5-(4-ethylphenyl)-1H-1,2,3-triazol-4-yl)-6-methylquinoline-3-carbaldehyde (**7**).* The product was crystallised in DCM/ hexane and obtained as yellow solid, (126.54 mg, 74% yield), ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.97 (s, 1H), 8.70 (s, 1H), 8.08 (d, *J* = 9.1 Hz, 1H), 7.74 (s, 1H), 7.68 (d, *J* = 9.1 Hz, 1H), 7.44 (d, *J* = 8.3 Hz, 2H), 7.07 (d, *J* = 7.6 Hz, 2H), 2.61–2.55 (m, 5H), 1.17 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.1, 148.1, 145.2, 138.5, 137.5, 135.3, 129.0, 128.22, 128.16, 128.07, 128.0, 127.2, 127.0, 126.1, 28.6, 21.6, 15.2; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}N_4O$ 343.1559; found 343.1529.

General Procedure for the Synthesis of trizolopyranoquinolines (8a-c).

The triazolopyranoquinolines were prepared from 0.50 mmol of **3,** 1.2 equiv of alkynes, 0.2 mol % $CuSO_4.5H_2O$ and 0.4 mol% of sodium ascorbate in 2ml of THF: H_2O (3:1) in a oven dried vial and stirred at room temperature for 24 h. Reaction completion was monitored by TLC. After completion reaction was extracted with ethyl acetate (15ml x 3) and dried over $NaSO_4$.. The compound was purified by column chromatography in 10% ethyl acetate hexane. The highly fluorescent solid compound was obtained.

*3-(4-Ethylphenyl)-1-(4-(thiophen-3-yl)-1H-1,2,3-triazol-1-yl)-1H-pyrano[4,3-b]quinoline (**8a**)*. The product was obtained as light brown crystals, (209.28 mg, 96% yield), mp 202–204 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 8.3 Hz, 1H), 7.97 (s, 1H), 7.91 (s, 1H), 7.72–7.68 (m, 2H), 7.61 (d, J = 8.3 Hz, 2H), 7.528–7.524 (m, 1H), 7.46–7.42 (m, 1H),7.41–7.40 (m, 1H), 7.24–7.16 (m, 4H), 6.96 (s, 1H), 2.59 (q, J = 7.6 Hz, 2H), 1.16 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.8, 149.4, 149.2, 147.5, 146.8, 144.7, 134.1, 131.4, 131.1, 130.3, 129.8, 128.7, 128.3, 128.2, 126.9, 126.5, 126.4, 125.9, 125.6, 121.7, 119.4, 117.8, 101.4, 84.7, 28.8, 15.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{26}H_{20}N_4OS$ 437.1436; found 437.1438.

*1-(4-(3-Methoxyphenyl)-1H-1,2,3-triazol-1-yl)-8-methyl-3-(4-(trifluoromethoxy)phenyl)-1H-pyrano[4,3-b]quinoline (**8b**)*. The product was obtained as light yellow crystals, (259.70 mg, 98% yield), mp 168–170 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94–7.91 (m, 3H), 7.70 (d, J = 8.3 Hz, 2H), 7.55 (d, J = 8.3 Hz, 1H), 7.48 (s, 1H), 7.44 (s, 1H), 7.18–7.14 (m, 4H), 6.94 (s, 1H), 6.76–6.73 (m, 1H), 3.72 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 154.5, 150.6, 148.4, 148.0, 147.7, 137.0, 133.8, 133.5, 131.0, 129.8, 128.6, 127.4, 127.1, 127.0, 121.0, 119.0, 118.2, 118.1, 114.7, 110.6, 102.8, 84.7, 55.3, 21.6; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{29}H_{21}F_3N_4O_3$ 531.1644; found 531.1661.

8-Methoxy-3-phenyl-1-(4-phenyl-1H-1,2,3-triazol-1-yl)-1H-pyrano[4,3-b]quinoline (***8c***). The product was crystallised in DCM/ hexane and obtained as light yellow crystals, (205.20 mg, 95% yield), mp 168–170 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00–7.92 (m, 3H), 7.73–7.68 (m, 4H), 7.57 (s, 1H), 7.43–7.37 (m, 4H), 7.33–7.29 (m, 1H), 7.72–7.24 (m, 1H), 7.03–7.02 (m, 2H), 3.89 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.9, 155.3, 148.5, 146.6, 145.4, 132.6, 132.4, 130.4, 130.2, 129.7, 128.8, 128.7, 128.4, 128.0, 125.72, 125.66, 124.2, 119.6, 118.0, 105.6, 102.2, 84.8, 55.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{27}H_{20}N_4O_2$ 433.1665; found 433.1659.

ASSOCIATED CONTENT

Supporting Information

Electronic Supplementary Information (ESI) available: Data and spectral Copies of ^{1}H, ^{13}C NMR, and HRMS for target compounds. CCDC reference number for compound **3b** is 1520520.

AUTHOR INFORMATION

Corresponding Author

*E-mail: averma@acbr.du.ac.in

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