An Efficient One-Pot, Four-Component Synthesis of {[(1*H*-1,2,3-Triazol-4-yl)methoxy]phenyl}-1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione Derivatives

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The 1-{[(1*H*-1,2,3-Triazol-4-yl)methoxy]phenyl}-1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione derivatives **5** were synthesized by a simple and efficient method, *i.e.*, by the four-component, one-pot condensation reaction of phthalohydrazide **4**, a (propargyloxy)benzaldehyde **1**, an active methylene compound **3** (malononitrile or ethyl cyanoacetate), and an azide **2** in the presence of $Cu(OAc)_2$/sodium L-ascorbate as catalyst and 1-methyl-1*H*-imidazolium trifluoroacetate ([Hmim](CF_3COO)) as an ionic-liquid medium in good to excellent yields (*Scheme 1*).

Introduction. – The term 'click chemistry', proposed in 2001 by *Sharpless* and co-workers [1], denotes a set of highly reliable and selective reactions for the rapid synthesis of useful compounds and combinatorial libraries. The characteristics of these reactions are simple reaction conditions, readily available starting materials and reagents, the use of benign or no solvent, simple product isolation, and high product yields [2].

The Cu^I-catalyzed reaction of terminal alkynes with organic azides *via Huisgen*'s 1,3-dipolar cycloaddition reaction to give regioselectively 1,4-disubstituted 1*H*-1,2,3-triazoles is one of the most useful examples of click chemistry [3][4]. The 1*H*-1,2,3-triazoles have become prominent heterocycles in medicinal [5], material [6], and biological [7] research. These compounds are stable and tolerate a variety of reaction conditions and functional groups. They also possess diverse biological activities including anti-HIV [8], anti-allergic [9], antifungal [10], antimicrobial [11], anti-asthmatic [12], and antiviral [13] properties.

The potential of click reactions can be further amplified by combining them with multicomponent reactions. Multicomponent reactions (MCRs) have stimulated substantial interest in organic chemistry because they provide useful products by the creation of several new bonds in a one-pot reaction; so it has been used in combinatorial chemistry and diversity-oriented synthesis [14].

The combination of a multicomponent reaction with a classical organic transformation has been shown to be a powerful strategy to yield complex structures in few synthetic steps [15]. The idea to use a MCR followed by a *Huisgen* copper catalyzed [3 + 2] reaction was first presented by *Ramachary* and *Barbas* [16]. Recently, a number of medicinally relevant heterocycles were synthesized *via* MCRs combined with a click

reaction, such as: sequential *Ugi*/intermolecular alkyne–azide cycloaddition (IAAC) [17], sequential *Van-Leusen*/alkyne–azide cycloaddition reactions [18], and the synthesis of triazolyl-substituted dihydropyrimidinone derivatives under microwave irradiation combining a *Biginelli* reaction with a Cu-catalyzed azide–alkyne cycloaddition (CuAAC) in separate steps [19]. However, examples of one-pot multicomponent click reactions with four or more components are scarce [16][20].

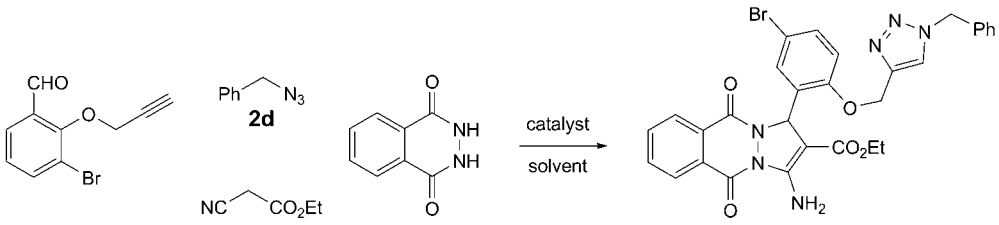
Heterocycles containing the pyrazole ring are important targets in synthetic and medicinal chemistry because this fragment is a key moiety in numerous biologically active compounds [21–24]. Similarly, pyrazolo[1,2-*b*]phthalazinedione derivatives were reported as anti-inflammatory, analgesic, antipyretic, and antihypoxant agents [25]. Recently, the synthesis of 1*H*-pyrazolo[1,2-*b*]phthalazinediones and 2*H*-indazolo[2,1-*b*]phthalazinetriones has been reported by *Bazgir* and co-workers *via* one-pot three-component reactions [26].

Results and Discussion. – In connection with our research program to find new and efficient methods for the synthesis of heterocyclic frameworks [27] and their linkage to 1*H*-1,2,3-triazole moieties *via* a *Huisgen* 1,3-dipolar cycloaddition [20], we describe the development of a powerful, reliable, and selective MCR for the synthesis of 1-{[(1*H*-1,2,3-triazol-4-yl)methoxy]phenyl}-1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione derivatives **5** as new compounds and for combinatorial libraries; *i.e.*, we designed a one-pot four-component reaction of a (propargyloxy)benzaldehyde (=(prop-2-yn-1-yloxy)-benzaldehyde) **1**, an azide **2**, an active methylene compound such as malononitrile (= propane-1,3-dinitrile; **3a**) or ethyl cyanoacetate (**3b**), and phthalohydrazide (=2,3-dihydrophthalazine-1,4-dione; **4**) in the presence of catalytic amounts of $Cu(OAc)_2$ (10 mol-%), sodium L-ascorbate (20 mol-%) as a reducing agent for Cu^{II}, and 1-methyl-1*H*-imidazolium trifluoroacetate ([Hmim](CF_3COO)) as an ionic liquid (IL) at 100° (*Scheme 1*).

In initial experiments, (propargyloxy)benzaldehyde **1c**, benzyl azide (**2d**), ethyl cyanoacetate (**3b**), and phthalohydrazide (**4**) were chosen for the model reaction in the presence of various catalysts and solvents under heating conditions (*Table*). After preliminary screening of copper salts as the catalyst (*Table*, *Entries 1–3*), $Cu(OAc)_2 \cdot H_2O$ was selected as the best choice based on its higher efficiency, stability, and lower cost. To achieve suitable conditions for the above transformation according to our previous experiences, we investigated the reaction in various solvents such as EtOH, MeCN, and H_2O. In the presence of TsOH as a *Brönsted* acid catalyst, the reaction was very slow, and the product was obtained in low yield (*Table*, *Entries 4–6*). After several attempts, it was found that, by changing the solvent to [Hmim](CF_3COO) as an IL at 100°, the desired product **5h** was isolated in 78% yield (*Table*, *Entry 8*). It is noteworthy that compound **5h** was not produced at lower reaction temperature (60°) but compound **6h** was isolated in 90% yield instead. Therefore, it may be concluded that **6h** is the intermediate of the reaction, and that **6h** needs higher temperatures to react to the final product. To collaborate this hypothesis, compound **6h** was synthesized and treated with compound **4** in the presence of [Hmim](CF_3COO) at 100°; after 4 h, the desired product **5h** was obtained in 76% yield.

With this optimized procedure in hand, the scope of this four-component reaction was examined by using other (propargyloxy)benzaldehydes **1a–1e**, azides **2a–2e**,

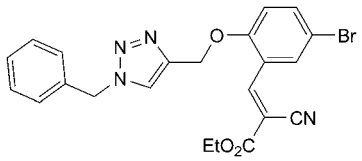
Table. *Optimization of the Reaction Conditions for the Model Reaction*[a])



1c **3b** **4** **5h**

Entry	Catalyst	Solvent	Yield [%] of **5h**
1	CuI	H_2O (reflux)	trace
2[b])	$CuSO_4$/NaAsc	H_2O (reflux)	trace
3[b])	$Cu(OAc)_2$/NaAsc	H_2O (reflux)	10
4[c])	$Cu(OAc)_2$/NaAsc/TsOH	EtOH (reflux)	20
5[c])	$Cu(OAc)_2$/NaAsc/TsOH	MeCN (reflux)	43
6[c])	$Cu(OAc)_2$/NaAsc/TsOH	H_2O (reflux)	53
7[d])	$Cu(OAc)_2$/NaAsc	[Hmim](CF_3COO) (60°)	trace
8[d])	$Cu(OAc)_2$/NaAsc	[Hmim](CF_3COO) (100°)	78

[a]) Reaction conditions: (propargyloxy)benzaldehyde **1c** (1 mmol), benzyl azide (**2d**; 1 mmol), ethyl cyanoacetate (**3b**; 1.2 mmol), phthalohydrazide (**4**; 1 mmol), catalyst (10 mol-%), solvent (10 ml), 4 h. [b]) Sodium L-ascorbate (NaAsc; 20 mol-%). [c]) NaAsc (20 mol-%), TsOH (10 mol-%). [d]) NaAsc (20 mol-%) and [Hmim](CF_3COO), (10 mol-%), under solvent-free conditions.



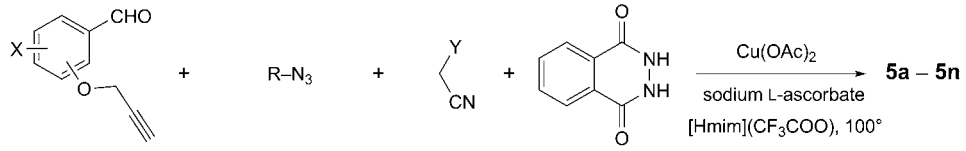
6h

malononitrile (**3a**) or ethyl cyanoacetate (**3b**), and phthalohydrazide (**4**) in the presence of catalytic amounts of $Cu(OAc)_2$ (10 mol-%), sodium L-ascorbate (20 mol-%), and [Hmim](CF_3COO) at 100° for 4 h. The results are summarized in *Scheme 1.* Generally, both electron-rich and electron-deficient (propargyloxy)benzaldehydes, bearing substituents at *ortho-* and *para*-position, afforded the products in high to excellent yields.

A reasonable mechanism for this four-component reaction involves initial formation of intermediate **6** by standard *Knoevenagel* condensation and click reaction of **1**, **2**, and the active methylene compounds **3** (*Scheme 2*). Then, the subsequent *Michael*-type addition of phthalohydrazide (**4**) would give the intermediate **7**, followed by cyclization to afford the corresponding product **5** (*Scheme 2*).

The structures of the products **5a**–**5n** were characterized by their spectroscopic data. The ^{1}H-NMR spectra of compounds **5a**–**5n** in (D_6)DMSO consist of a characteristic due to the triazole H-atom in the region of δ 8.13–9.21. In addition,

Scheme 1. *One-Pot, Four-Component Synthesis of 1-[(Triazolylmethoxy)phenyl]-1*H*-pyrazolo[1,2-*b*]-phthalazine-5,10-dione Derivatives* **5a**–**5n**

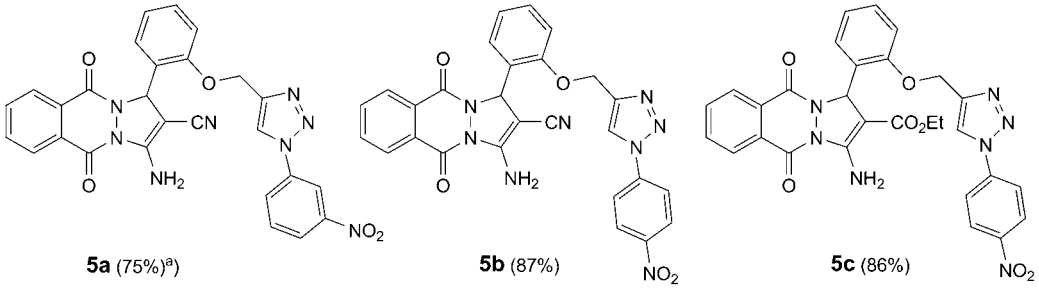


1a *ortho*, X = H
1b *para*, X = H
1c *ortho*, X = *m*-Br
1d *ortho*, X = *m*-NO_2
1e *para*, X = *m*-EtO

2a R = 3-NO_2-C_6H_4
2b R = 4-NO_2-C_6H_4
2a R = 3-F-Bn
2d R = Bn
2e R = 4-Cl-C_6H_4

3a Y = CN
3b Y = CO_2Et

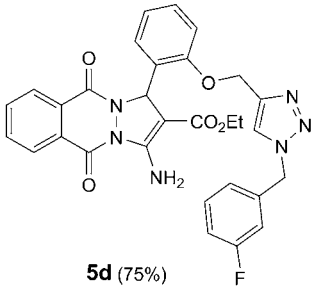
4



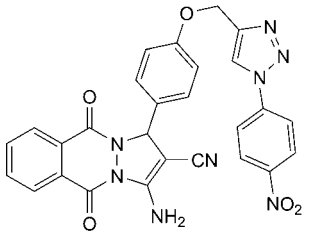
5a (75%)[a]

5b (87%)

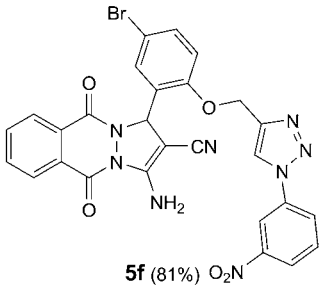
5c (86%)



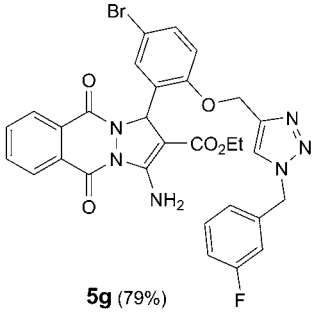
5d (75%)



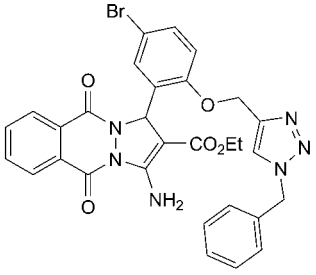
5e (92%)



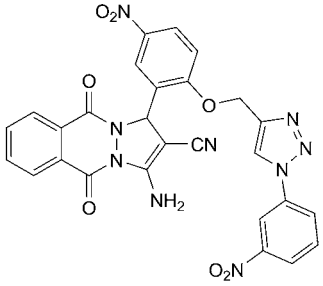
5f (81%)



5g (79%)



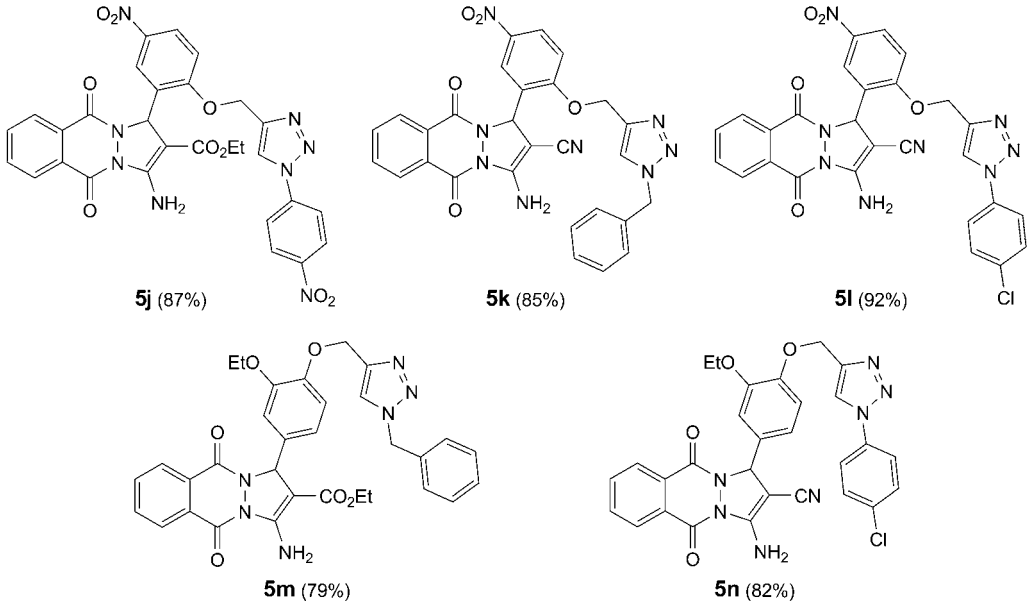
5h (78%)



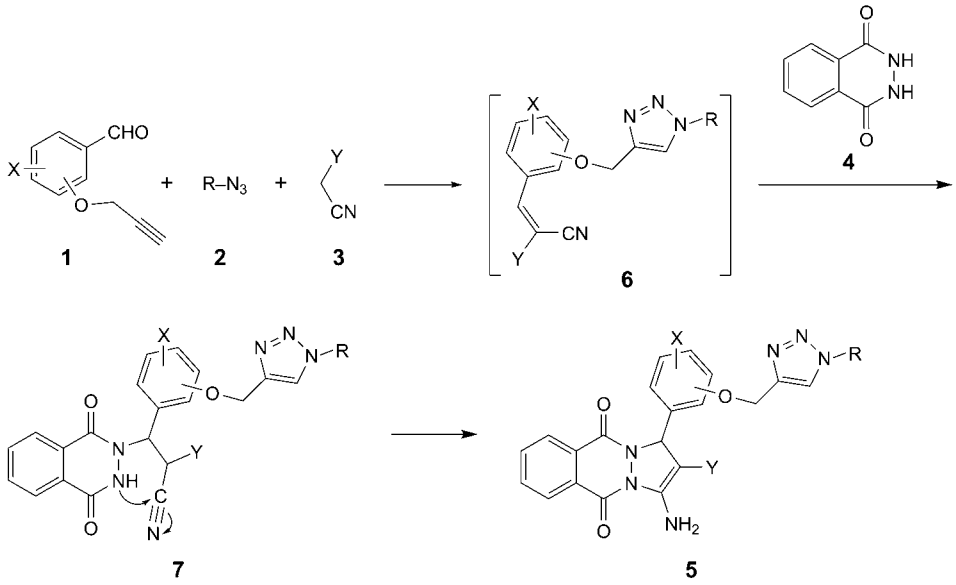
5i (91%)

[a]) Yield of isolated product based on phthalohydrazide (**4**)

Scheme 1 (cont.)



Scheme 2



the distinguished peak for H–C(1) of the 1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione moiety was observed at δ 6.01 – 6.42. Another characteristic feature of the ^{1}H-NMR spectra is the appearance of an *AB* signal at δ 4.95 – 5.64, which arises from the (triazol-4-yl)CH_2 unit.

Conclusion. – We have developed a highly efficient one-pot, four-component condensation strategy for the reaction of (propargyloxy)benzaldehydes, azides, malonitrile or ethyl cyanoacetate, and phthalohydrazide furnishing a class of 1-[(triazolylmethoxy)phenyl]-1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione derivatives in high yield. It is noteworthy that this domino reaction involved the formation of one C–C and four C–N bonds and of two heterocyclic scaffolds in a highly selective manner and could find wide applications in combinatorial chemistry, diversity-oriented synthesis, and drug discovery.

Financial support from the *Research Council of Shahid Beheshti University and the Catalyst Center of Excellence* (CCE) is gratefully acknowledged.

Experimental Part

General. The chemicals used in this work were obtained from *Fluka* and *Merck* and were used without purification. M.p.: *Electrothermal-9100* apparatus. IR Spectra: *Bomem-MB* FT-IR spectrophotometer; $\tilde{\nu}$ in cm^{-1}. ^{1}H-NMR Spectra: *Bruker-DRX-300-Avance* spectrometer; at 300 (^{1}H) and 75.5 MHz (^{13}C); in (D_6)DMSO; δ in ppm rel. to Me_4Si as internal standard, *J* in Hz. MS: *Finnigan-MAT-8430* mass spectrometer; ionization potential 70 eV; in *m/z* (rel. %). Elemental analyses: *VarioEL* instrument from *Elementar Analysensysteme GmbH*; CHNS mode.

*1-[(Triazolylmethoxy)phenyl]-1*H*-pyrazolo[1,2-*b*]phthalazine-5,10-dione Derivatives* **5***: General Procedure.* A (propargyloxy)benzaldehyde **1** (1.0 mmol), an azide **2** (1.0 mmol), an active methylene compound **3a** or **3b** (1.2 mmol), and phthalohydrazide (**4**; 1.0 mmol) in the presence of $Cu(OAc)_2$ (0.02 g, 10 mol-%), sodium L-ascorbate (0.04 g, 20 mol-%), and [Hmim](CF_3COO) (0.5 g) were mixed thoroughly and then stirred for 4 h at 100°. Then, NH_3 soln./H_2O 1:3 (30 ml) was added, the mixture stirred for 30 min, and then the solid filtered and washed with hot EtOH: pure product.

Procedure for the Control Experiment: Preparation of **5h**. (Propargyloxy)benzaldehyde **1c** (2.0 mmol), azide **2d** (2.0 mmol), and ethyl cyanoacetate (**3b**; 2.4 mmol) in the presence of $Cu(OAc)_2$ (0.04 g, 10 mol-%), sodium L-ascorbate (0.08 g, 20 mol-%) in EtOH were mixed thoroughly and then stirred for 2 h at r.t. Then, NH_3 soln./H_2O 1:3 (30 ml) was added, the mixture stirred for 30 min, and the solid filtered and recrystallized from EtOH: pure **6h** in 90% yield.

Then, **6h** (1 mmol) was treated with phthalohydrazide (**4**; 1 mmol) in the presence of [Hmim](CF_3COO) (0.5 g) for 4 h at 100°. The solid was filtered and washed with hot EtOH: pure **5h** in 76% yield.

*3-Amino-5,10-dihydro-1-{2-{[1-(3-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5a**). Yield 0.40 g (75%). Pale green powder. M.p. 247 – 248°. IR (KBr): 3374, 3266, 2190, 1662, 1532, 1374, 1249. ^{1}H-NMR: 5.07 (*d*, *J* = 11.0, 1 H of CH_2); 5.17 (*d*, *J* = 11.0, 1 H of CH_2); 6.22 (*s*, CH); 6.99 (*t*, *J* = 7.0, 1 arom. H); 7.22 – 7.42 (*m*, 3 arom. H); 7.83 – 8.04 (*m*, 7 arom. H, NH_2); 8.33 – 8.38 (*m*, 2 arom. H); 8.65 (*s*, 1 arom. H); 8.77 (*s*, 1 H of triazole). ^{13}C-NMR: 60.3; 61.4; 113.0; 115.3; 116.6; 121.4; 123.5; 123.7; 126.7; 127.1; 127.4; 128.6; 128.7; 130.2; 132.0; 133.9; 135.0; 137.6; 144.0; 148.9; 151.5; 153.4; 156.0; 156.5. MS: 534 (5, M^+), 305 (30), 175 (36), 162 (100), 129 (36), 104 (80), 76 (45). Anal. calc. for $C_{27}H_{18}N_8O_5$ (534.48): C 60.67, H 3.39, N 20.96; found: C 60.71, H 3.31, N 20.88.

*3-Amino-5,10-dihydro-1-{2-{[1-(4-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5b**). Yield 0. 46 g (87%). Off-white powder. M.p. 246 – 248°. IR (KBr): 3370, 3278, 2190, 1662, 1522, 1374, 1277. ^{1}H-NMR: 5.08 (*d*, *J* = 11.3, CH); 5.18 (*d*, *J* =

11.3, CH); 6.23 (*s*, CH); 6.98–7.42 (*m*, 4 arom. H); 7.84–8.17 (*m*, 8 arom. H, NH_2); 8.49 (*d*, *J* = 8.5, 2 arom. H); 8.7 (*s*, 1 H of triazole). ^{13}C-NMR: 61.4; 64.3; 114.8; 115.0; 117.8; 118.9; 121.1; 123.7; 126.0; 127.1; 127.9; 129.1; 129.3; 130.4; 134.1; 134.9; 141.2; 147.1; 151.6; 154.1; 155.8; 158.1. MS: 534 (5, M^+), 331 (20), 239 (60), 162 (52), 129 (40), 104 (96), 76 (100). Anal. calc. for $C_{27}H_{18}N_8O_5$ (534.48): C 60.67, H 3.39, N 20.96; found: C 60.73, H 3.30, N 20.86.

*Ethyl 3-Amino-5,10-dihydro-1-{2-{[1-(4-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5c**). Yield 0.50 g (86%). Off-white powder. M.p. 145–147°. IR (KBr): 3375, 3285, 1698, 1659, 1642, 1534, 1385, 1277. ^{1}H-NMR: 1.02 (*t*, *J* = 7.0, Me); 3.94 (*m*, CH_2); 4.99 (*d*, *J* = 11.2, CH); 5.09 (*d*, *J* = 11.2, CH); 6.15 (*s*, CH); 6.95–7.49 (*m*, 6 arom. H, NH_2); 7.71–8.52 (*m*, 8 arom. H, NH_2); 8.70 (*s*, 1 H of triazole). ^{13}C-NMR: 14.3; 42.7; 59.8; 62.0; 114.1; 116.9; 120.9; 121.1; 127.8; 128.2; 130.9; 132.3; 133.6; 134.6; 144.5; 148.1; 150.0; 155.6; 156.6; 159.6; 167.2. MS: 581 (10, M^+), 175 (52), 162 (100), 104 (86), 76 (96). Anal. calc. for $C_{29}H_{23}N_7O_7$ (581.54): C 59.89, H 3.99, N 16.86; found: C 59.94, H 3.91, N 16.91.

*Ethyl 3-Amino-1-{2-{[1-[(3-fluorophenyl)methyl]-1*H*-1,2,3-triazol-4-yl}methoxy}phenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5d**). Yield 0.43 g (75%). Yellow powder. M.p. 195–197°. IR (KBr): 3424, 3311, 1700, 1665, 1643, 1291. ^{1}H-NMR: 1.01 (*t*, *J* = 7.0, Me); 3.95 (*m*, CH_2); 5.10 (*m*, CH_2); 5.61 (*m*, CH_2); 6.03 (*s*, CH); 6.91–7.41 (*m*, 9 arom. H); 7.70–8.32 (*m*, 6 arom. H (including triazole), NH_2). ^{13}C-NMR: 14.3; 52.9; 59.8; 62.0; 62.8; 113.3; 114.9; 116.5; 117.8; 118.9; 125.0; 126.5; 126.8; 127.1; 127.4; 127.9; 128.0; 128.6; 129.2; 132.3; 134.1; 134.9; 136.1; 142.4; 153.7; 154.0; 155.2; 155.8; 164.5. MS: 568 (5, M^+), 286 (28), 162 (88), 109 (100). Anal. calc. for $C_{30}H_{25}FN_6O_5$ (568.56): C 63.37, H 4.43, N 14.78; found: C 63.27, H 4.34, N 14.85.

*3-Amino-5,10-dihydro-1-{4-{[1-(4-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5e**). Yield 0.50 g (92%). Green powder. M.p. 189–191°. IR (KBr): 3370, 3278, 2190, 1662, 1519, 1377. ^{1}H-NMR: 4.78 (*s*, CH_2); 6.08 (*s*, CH); 6.94 (*s*, 2 arom. H); 7.38 (*s*, 2 arom. H); 7.94–8.23 (*m*, 10 arom. H, NH_2); 8.44 (*s*, 1 H of triazole). ^{13}C-NMR: 55.8; 62.9; 71.7; 115.1; 116.3; 116.6; 121.3; 122.3; 126.0; 126.9; 127.1; 127.7; 128.9; 133.8; 134.1; 135.1; 151.1; 158.1; 159.0; 160.8. MS: 534 (7, M^+), 162 (100), 109 (64). Anal. calc. for $C_{27}H_{18}N_8O_5$ (534.48): C 60.67, H 3.39, N 20.96; found: C 60.60, H 3.45, N 20.91.

*3-Amino-1-{5-bromo-2-{[1-(3-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5f**). Yield 0.49 g (81%). Brown powder. M.p. 154–155°. IR (KBr): 3409, 3232, 2185, 1695, 1663, 1525, 1367, 1295. ^{1}H-NMR: 4.72 (*s*, CH_2); 6.28 (*s*, CH); 7.03 (*s*, 1 arom. H); 7.22–7.68 (*m*, 4 arom. H, NH_2); 7.94–8.76 (*m*, 8 arom. H); 9.02 (*s*, 1 H of triazole). ^{13}C-NMR: 56.9; 59.9; 78.6; 113.5; 115.6; 121.1; 126.0; 127.1; 127.7; 128.8; 129.4; 131.2; 132.1; 133.4; 134.2; 135.0; 147.2; 151.8; 153.8; 154.5; 157.1. MS: 612 (10, M^+), 162 (100), 144 (44), 104 (72). Anal. calc. for $C_{27}H_{17}BrN_8O_5$ (613.38): C 52.87, H 2.79, N 18.27; found: C 52.77, H 2.75, N 18.34.

*Ethyl 3-Amino-1-{5-bromo-2-{[1-[(3-fluorophenyl)methyl])-1*H*-1,2,3-triazol-4-yl}methoxy}phenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5g**). Yield 0.51 g (79%). Yellow powder. M.p. 210–212°. IR (KBr): 3383, 3281, 1701, 1678, 1662. ^{1}H-NMR: 1.01 (*t*, *J* = 6.7, Me); 3.91 (*m*, CH_2); 4.90 (*d*, *J* = 10.9, CH); 5.00 (*d*, *J* = 10.9, CH); 5.57 (*d*, *J* = 15.2, CH); 5.65 (*d*, *J* = 15.2, CH); 6.14 (*s*, CH); 7.05–7.54 (*m*, 9 arom. H, NH_2); 7.87–8.06 (*m*, 4 arom. H); 8.13 (*s*, 1 H of triazole). ^{13}C-NMR: 14.5; 53.3; 59.0; 61.7; 62.0; 112.3; 115.0; 116.5; 125.0; 126.5; 126.8; 127.1; 127.4; 127.9; 128.0; 128.6; 129.2; 132.3; 134.1; 134.9; 136.1; 142.4; 153.7; 154.0; 155.2; 155.8; 164.5. MS: 647 (5, M^+), 162 (100), 109 (72). Anal. calc. for $C_{30}H_{24}BrFN_6O_5$ (647.45): C 55.65, H 3.74, N 12.98; found: C 55.75, H 3.66, N 12.91.

*Ethyl 3-Amino-1-{5-bromo-2-{[1-(phenylmethyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5h**). Yield 0.49 g (78%). White powder. M.p. 204–206°. IR (KBr): 3397, 3240, 1703, 1690, 1670, 1285. ^{1}H-NMR: 1.02 (br. *s*, Me); 3.92 (*m*, CH_2); 4.90 (*d*, *J* = 10.9, CH); 5.00 (*d*, *J* = 10.9, CH); 5.54 (*d*, *J* = 15.0, CH); 5.61 (*d*, *J* = 15.0, CH); 6.15 (*s*, CH); 7.06 (*d*, *J* = 8.3, 1 arom. H); 7.32–7.53 (*m*, 9 arom. H, NH_2); 7.87–8.02 (*m*, 4 arom. H); 8.16 (*s*, 1 H of triazole). ^{13}C-NMR: 14.4; 53.3; 59.0; 62.0; 79.9; 112.1; 114.9; 124.8; 127.0; 127.7; 128.5; 128.6; 128.8; 128.9; 129.2; 131.7; 133.9; 134.9; 136.3; 142.5; 150.7; 153.2; 155.5; 156.7; 164.5. MS: 628 (5, M^+), 144 (72), 91 (100). Anal. calc. for $C_{30}H_{25}BrN_6O_5$ (629.46): C 57.24, H 4.00, N 13.35; found: C 57.33, H 3.92, N 13.26.

*3-Amino-5,10-dihydro-1-{5-nitro-2-{[1-(3-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5i**). Yield 0.53 g (91%). Pale green powder. M.p.

212–214°. IR (KBr): 3369, 3300, 2190, 1691, 1662, 1528, 1369. ^{1}H-NMR: 5.27 (*d*, *J* = 11.3, CH); 5.36 (*d*, *J* = 11.3, CH); 6.42 (*s*, CH); 7.51 (*d*, *J* = 9.1, 1 arom. H); 7.78–8.49 (*m*, 10 arom. H, NH_2); 8.65 (*s*, 1 arom. H); 8.81 (*s*, 1 arom. H); 9.29 (*s*, 1 H of triazole). ^{13}C-NMR: 60.8; 62.5; 113.7; 115.4; 123.8; 124.0; 125.6; 126.3; 126.5; 126.8; 127.1; 127.2; 127.5; 128.4; 128.8; 129.2; 132.0; 134.0; 135.0; 137.5; 141.4; 148.9; 152.0; 153.7; 156.5; 161.1. MS: 579 (5, M^+), 175 (52), 162 (84), 104 (100), 76 (96). Anal. calc. for $C_{27}H_{17}N_9O_7$ (579.48): C 55.96, H 2.96, N 21.75; found: C 56.05, H 2.89, N 21.69.

*Ethyl 3-Amino-5,10-dihydro-1-{5-nitro-2-{[1-(4-nitrophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5j**). Yield 0.54 g (87%).Yellow powder. M.p. 241–243°. IR (KBr): 3375, 3304, 1705, 1697, 1667, 1522, 1359. ^{1}H-NMR: 1.24 (br. *s*, Me); 3.94 (*m*, CH_2); 5.65 (*s*, CH_2); 6.39 (*s*, CH); 7.19 (*d*, *J* = 9.1, 1 arom. H); 7.41–8.75 (*m*, 12 arom. H, NH_2); 8.99 (*s*, 1 H of triazole). ^{13}C-NMR: 14.2; 42.6; 61.8; 78.9; 120.2; 122.3; 123.4; 123.9; 127.8; 128.9; 129.5; 134.5; 135.5; 136.4; 140.1; 149.7; 150.1; 154.3; 155.6; 159.0; 166.8. MS: 626 (5, M^+), 162 (87), 144 (75), 91 (100). Anal. calc. for $C_{29}H_{22}N_8O_9$ (626.53): C 55.59, H 3.54, N 17.88; found: C 55.50, H 3.60, N 17.81.

*3-Amino-5,10-dihydro-1-{5-nitro-2-{[1-(phenylmethyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5k**). Yield 0.47 g (85%). Brown powder. M.p. 230–231°. IR (KBr): 3373, 3251, 2203, 1665, 1592, 1339, 1263. ^{1}H-NMR: 5.16 (*d*, *J* = 11.4, CH); 5.26 (*d*, *J* = 11.4, CH); 5.55 (*d*, *J* = 14.9, CH); 5.64 (*d*, *J* = 14.9, CH); 6.39 (*s*, CH), 7.30–7.47 (*m*, 6 arom. H); 7.9–8.28 (*m*, 8 arom. H, NH_2); 8.43 (*s*, 1 H of triazole). ^{13}C-NMR: 53.4; 58.9; 62.9; 113.6; 116.4; 125.1; 125.3; 126.3; 127.0; 127.3; 127.8; 128.5; 128.6; 129.0; 129.2; 134.2; 135.0; 136.2; 141.3; 141.7; 151.5; 153.8; 156.7; 161.2. MS: 548 (5, M^+), 162 (96), 144 (69), 104 (73), 91 (100). Anal. calc. for $C_{28}H_{20}N_8O_5$ (548.51): C 61.31, H 3.68, N 20.43; found: C 61.25, H 3.60, N 20.51.

*3-Amino-1-{2-{[1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}-5-nitrophenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5l**). Yield 0.52 g (92%). Green solid. M.p. 260–262°. IR (KBr): 3375, 3297, 2195, 1678, 1662, 1270, 1100. ^{1}H-NMR: 5.31 (*m*, CH_2); 6.42 (*s*, CH); 7.48–7.93 (*m*, 10 arom. H, NH_2); 8.02 (*d*, *J* = 6.0, arom. H); 8.29 (*d*, *J* = 6.0, arom. H); 8.47 (*s*, arom. H); 8.59 (*s*, 1 H of triazole). ^{13}C-NMR: 62.1; 64.3; 113.4; 114.2; 117.7; 120.4; 122.3; 123.5; 127.2; 128.0; 129.1; 129.5; 130.3; 131.0; 133.5; 134.1; 134.9; 135.8; 144.7; 147.8; 148.3; 151.6; 154.2; 155.9. MS: 568 (5, M^+), 164 (20), 111 (44), 75 (56), 57 (56), 43 (100). Anal. calc. for $C_{27}H_{17}ClN_8O_5$ (568.93): C 57.00, H 3.01, N 19.70; found: C 56.90, H 2.92, N 19.75.

*Ethyl 3-Amino-1-{3-ethoxy-4-{[1-(phenylmethyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carboxylate* (**5m**). Yield 0.47 g (79%). Off-white powder. M.p. 212–214°. IR (KBr): 3381, 3285, 1710, 1685, 1673, 1285. ^{1}H-NMR: 1.02 (*t*, *J* = 7.0, Me); 1.24 (*t*, *J* = 7.1, Me); 3.36 (*q*, *J* = 6.9, CH_2); 3.94 (*q*, *J* = 6.6, CH_2); 5.07 (*s*, CH_2); 5.58 (*s*, CH_2); 6.02 (*s*, CH); 6.89–7.03 (*m*, 3 arom. H); 7.30–7.37 (*m*, 6 arom. H, NH_2); 7.76–8.22 (*m*, 5 arom. H); 8.25 (*s*, 1 H of triazole). ^{13}C-NMR: 14.7; 15.1; 53.2; 59.1; 62.3; 63.5; 64.4; 65.6; 114.5; 115.8; 122.3; 125.1; 127.1; 127.7; 128.4; 128.6; 129.2; 129.4; 136.5; 137.4; 140.1; 143.7; 147.7; 148.1; 155.5; 156.7; 164.5. MS: 594 (3, M^+), 164 (25), 144 (15), 91 (100). Anal. calc. for $C_{32}H_{30}N_6O_6$ (594.62): C 64.64, H 5.09, N 14.13; found: C 64.71, H 5.02, N 14.05.

*3-Amino-1-{4-{[1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl]methoxy}-3-ethoxyphenyl}-5,10-dihydro-5,10-dioxo-1*H*-pyrazolo[1,2-*b*]phthalazine-2-carbonitrile* (**5n**). Yield 0.47 g (82%). Yellow powder. M.p. 190–192°. IR (KBr): 3375, 3297, 2195, 1678, 1100. ^{1}H-NMR: 1.30 (*t*, *J* = 6.6, Me); 4.02(*q*, *J* = 6.6, CH_2); 5.21 (*s*, CH_2); 6.07 (*s*, CH); 6.97–7.68 (*m*, 9 arom. H, NH_2); 7.93–8.36 (*m*, 4 arom. H); 8.96 (*s*, 1 H of triazole). ^{13}C-NMR: 14.9; 15.1; 62.1; 64.4; 77.5; 113.7; 114.0; 114.5; 115.2; 122.3; 124.0; 125.1; 127.3; 130.4; 133.6; 135.7; 135.8; 143.5; 148.5; 153.5; 161.2. MS: 567 (3, M^+), 239 (20), 164 (20), 111 (44). Anal. calc. for $C_{29}H_{22}ClN_7O_4$ (567.98): C 61.32, H 3.90, N 17.26; found: C 61.25, H 3.98, N 17.17.

*Ethyl (2*E*)-3-{5-Bromo-2-{[1-(phenylmethyl)-1*H*-1,2,3-triazol-4-yl]methoxy}phenyl}-2-cyanoprop-2-enoate* (**6h**). Yield 0.4 g (90%). Yellow powder. M.p. 154–156°. IR (KBr): 2193, 1703, 1289. ^{1}H-NMR: 1.25 (*t*, *J* = 7.0, Me); 4.28 (*q*, *J* = 7.0, CH_2); 5.33 (*s*, CH_2); 5.62 (*s*, CH_2); 7.29–7.80 (*m*, 7 arom. H); 8.19 (*s*, 1 arom. H); 8.31 (*s*, CH), 8.39 (*s*, CH). ^{13}C-NMR: 14.4; 31.1; 53.3; 62.9; 104.5; 113.0; 115.7; 116.6; 122.8; 125.6; 128.3; 128.6; 129.2; 131.1; 136.4; 137.6; 142.5; 147.8; 157.2; 161.9. Anal. calc. for $C_{22}H_{19}BrN_4O_3$ (467.32): C 56.54, H 4.10, N 11.99; found: C 56.46, H 4.01, N 12.07.

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