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Propargyl Hydrazides as a Useful Intermediate Leading to Pyrazoles via Certain Electrophiles

Kosuke Kiyokawa, Yukiteru Ito, Ryoma Kakehi, Takahiro Ogawa, Yusuke Goto, and Mitsuhiro Yoshimatsu*

Abstract: The reactions of propargyl hydrazides with certain electrophiles successfully led to the regioselective formation of various alkylated hydrazides. Reactions with electrophiles directly afforded the alkylated, chlorinated, brominated, and iodinated pyrazoles.

Introduction

Pyrazoles are one of the most important classes of nitrogen-containing heterocycles owing to their broad spectrum of biological activities and useful applications.[1] Typical pyrazole synthesis methods[2] are based on the condensation of hydrazines with more stable and easy–to–handle starting materials such as 1,3-diketones,[3] enones,[4] ynoes,[5] and enynes.[6] One recent trend is the one-pot synthesis[7] of the classical condensation reactions featuring three- and four-component coupling, intermolecular 1,3-dipolar cycloaddition, and [3+2] cycloaddition reactions. However, most of these approaches suffer from the formation of a mixture of regioisomers.[9]

Recently, we reported the regioselective synthesis of pyrazoles from propargyl alcohols with tosylhydrazine via the corresponding hydrazides, which were isolated by our original procedure.[10] Hydrazones have been reported to be a good tool for the synthesis of pyrazoles via intra and intermolecular cyclization reactions[11] with alkynes,[9] cyclobutanones,[12] and other substituted pyrazoles;[13-16] however, the corresponding hydrazides are much rarer than the corresponding hydrazones.[10,15] Continuing our study, we next focused on the modification of key intermediate propargyl hydrazides leading to some useful pyrazoles. The identification of suitable chemical processes for the hydrazides could easily lead to the discovery of convenient and regioselective synthetic methods for substituted pyrazoles. Herein, we report the direct synthesis of pyrazoles from propargyl hydrazides to control the reactions with electrophiles (Scheme 1).

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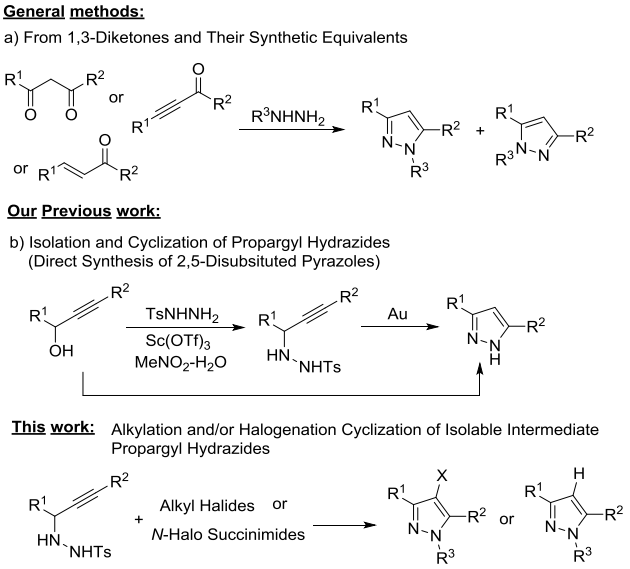
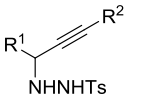


Scheme 1. Propargyl Hydrazines Leading to Some Substituted Pyrazoles.

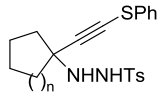
Results and Discussion

First, we conducted the base-promoted alkylation of propargyl tosyl hydrazines, which were easily prepared from the corresponding alcohols and *p*-tosyl hydrazide. We selected hydrazine **1a** and propargyl bromide as relatively reactive alkylating reagents for the screening of the alkylation of hydrazines. The results are shown in the Table of Supplement data.

Used Propargyl Hydrazides



1 (R^1=R^2=Ph); **2** (R^1=Ph; R^2=^{n}Bu);
3 (R^1=1-naphthyl; R^2=Ph);**4** (R^1=^{p}FC_6H_4; R^2=Ph);
5 (R^1=^{p}ClC_6H_4; R^2=nBu); **6** (R^1=pMeOC_6H_4; R^2=Ph);
7 (R^1=2-thienyl; R^2=^{n}Bu); **8** (R^1=1-naph; R^2=SPh);
9 (R^1=1,3-benzodioxol-5-yl; R^2=SPh);

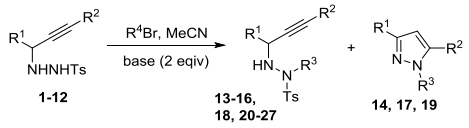


10 (n=1); **11** (n=2); **12** (n=3)

Having identified the appropriate reaction conditions, we investigated the scope of the alkylation of hydrazines. The results are summarized in Table 1. The reaction was typically completed within 10 min to 3 h at room temperature or 50 °C.

The reactions of **1** with some alkyl halides were first examined. Propargyl bromide (entry 1), allylic bromide (entry 3), bromoacetonitrile (entry 4), and methyl bromoacetates (entry 5) were tolerated under the base-promoted alkylation conditions to afford N^1-alkyl hydrazines **13a-d** in high yields. Interestingly, the use of amine bases yielded *N*-propargylpyrazole **14**, which was obtained through a one-pot alkylation–cyclization, accompanied by the expected alkylated product **13a** in low yield (entry 2). We next investigated the reactions of various hydrazides (R^1–R^2) with certain alkyl halides. The cyanomethylation of hydrazine **2** (R^2 = *n*-Bu) proceeded in good yield (entry 6). Interestingly, the addition of a small amount of 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) or heating at 50 °C resulted in the formation of *N*-cyanomethylpyrazoles **16-17**, and **19** (entries 7-8, 10) . Reactions of hydrazide bearing either electron-withdrawing or electron-donating groups at R^1 also provided **18** and **20-21** in excellent yields (entries 9 and 11-12). Hydrazine bearing a 2-thienyl group also reacted with similar alkyl halides (entries 13-14). Sulfur-substituted hydrazines (R^3 = SPh) successfully afford the alkylated products as almost pure products **23-27** (entries 15–19).

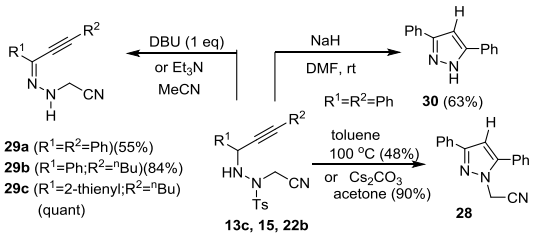
Table 1. Scope of base-promoted alkylation of hydrazides.



entry	Hydrazide	R^3	Temp (°C), time (h)	Products (%yields)
1	**1**	propargyl	rt, 0.17	**13a** (84)
2	**1**	propargyl	rt, 0.17	**14** (23)[a]
3	**1**	Allyl	50, 0.5	**13b** (85)
4	**1**	CH_2CN	rt, 2	**13c** (90)
5	**1**	CH_2CO_2Me	50, 0.5	**13d** (81)
6	**2**	CH_2CN	rt, 1	**15** (69)
7	**2**	CH_2CN	rt, 2	**16** (67)[a]
8	**3**	propargyl	50, 0.5	**17** (80)
9	**4**	allyl,	rt, 0.8	**18** (85)
10	**4**	CH_2CN	0.17	**19** (80)
11	**5**	CH_2CN	0.17	**20** (87)
12	**6**	$CH_2CO_2{}^tBu$	0.25	**21** (87)
13	**7**	allyl	rt, 0.67	**22a** (96)
14	**7**	CH_2CN	50, 0.17	**22b** (94)
15	**8**	propargyl	50, 3	**23** (86)
16	**9**	$CH_2CO_2{}^tBu$	rt, 0.25	**24** (96)
17	**10**	propargyl	50, 0.5	**25** (82)
18	**11**	CH_2CN	rt, 0.17	**26** (95)
19	**12**	propargyl	rt, 1	**27** (92)

[a] DBU was used as a base. [b] The reaction was examined for 1h at rt, and then for 2 h at 80 °C.

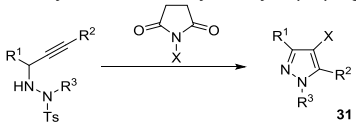
These results motivated a detailed study of the base-promoted alkylation of propargyl hydrazides. We performed some variations of the model reaction, as shown in Scheme 2. The reaction of *N*-alkylated hydrazide **13c** (R^1 = R^2 = Ph) under similar conditions more easily afforded *N*-cyanomethylpyrazole **14** in 90% yield. In particular, the thermal reaction of **13c** in toluene also afforded **28** in 48% yield. Conversely, reactions with amines such as DBU or triethylamine gave hydrazone **28a** through the detosylation and isomerization of **13c**. From this evidence and the previous insights in the base-promoted [3+2] cycloadditions,[9a,b,d,15a] we speculated that the base-promoted cyclization would proceed via a stepwise process. The first step is the base-promoted dehydrosulfonylation and isomerization to the corresponding hydrazones, which is supported by the isolation of some hydrazones **29b-29c**. Second, the cycloisomerization of propargyl hydrazones occurs under the thermal or base-catalyzed conditions. Otherwise, the treatment of **13c** with NaH in DMF afforded the decyanomethylated pyrazole **30**.



Scheme 2. Reactions of Propargyl Hydrazides with Other Bases.

We noted that the propargyl hydrazides easily form substituted pyrazoles under the base-promoted alkylation conditions. On this basis, we explored the reactions with halogenating agents as readily available electrophiles, and the results are listed in Table 2. The reaction of **13a** with *N*-chlorosuccinimide in dichloromethane (DCM) directly provided 4-chloropyrazole **31a** in 45% yield (entry 1 of Table 3). Reaction with *N*-bromosuccinimide quantitatively afforded the 4-bromo derivative **31b**. Iodocyclization also succeeded in the iodination–cycloaromatizations (entries 2 and 3). Recently, Wada and co-workers reported that the iodocyclization of propargyl hydrazides, prepared by the Mitsunobu reaction of the alcohol with diisopropyl azodicarboxylate (DIPA),[16b] afforded either 4-iodopyrazoles or 4-iodo-dihydropyrazoles by a useful switchable process. Comparing our halo-cyclization of *N*-tosyl propargyl hydrazides with the DIPA system, our method has strong potential to provide access to the pyrazole core because detosylation of hydrazides or hydrazones proceed much more easily than the decarboxylation of the DIPA system. We examined the substrate scope of the halo-cyclizations of tosyl hydrazides. The results are shown in entries 4–10 of Table 2.

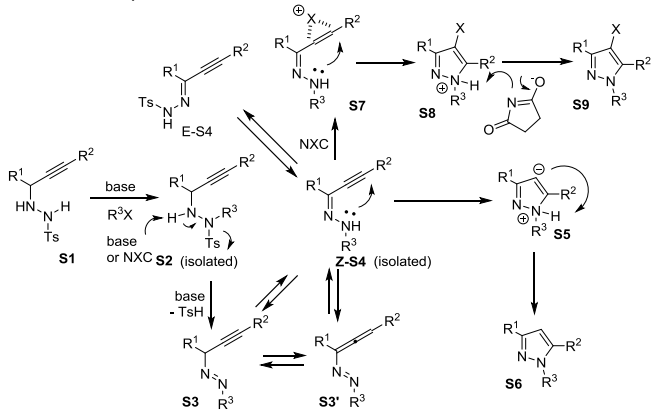
Table 2. Detosylative cyclization of 1-alkyl-1-tosyl-2-propargylhydrazines.



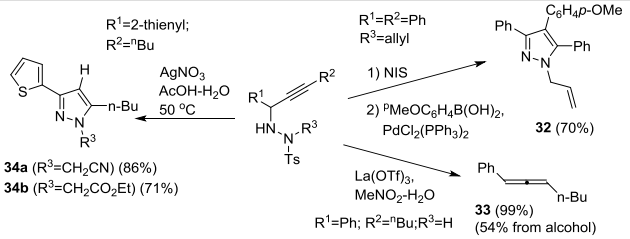
entry	R^1	R^2	R^3	time (h)	X	Products (%yields)
1	Ph	Ph	propargyl	18.5	Cl	**31a** (45)
2	Ph	Ph	propargyl	0.25	Br	**31b** (93)
3	Ph	Ph	propargyl	1	I	**31c** (82)
4	Ph	Ph	allyl	0.75	Br	**31d** (81)
5	Ph	Ph	allyl	0.5	I	**31e** (58)
6	Ph	Ph	CH_2CN	1.25	Br	**31f** (74)
7	Ph	Ph	CH_2CN	4	I	**31g** (67)
8	$^{\alpha}$Naph-	Ph	propargyl	40 min	Br	**31h** (97)
9	$^{p}FC_6H_4$	Ph	CN	2.5	Br	**31i** (61)
10	^{2}Thien-	Bu	allyl	0.25	I	**31j** (52)

From these studies, the proposed mechanism for the pyrazole formation of *N*-alkylated propargyl hydrazides are shown in Scheme 3. Alkylation reactions of **S1** easily gives **S2** under the basic conditions. Reactions under the high temperature and/or more basic conditions result in the formations of propargyl hydrazone **S4** through the dehydrosulfonylation-isomerization of hydrazine **S2** via either **S3** or **S3'** as mentioned above (Scheme 2). Intramolecular cyclization of **S4** would give the key intermediate **S5**. The subsequent inter- or intramolecular proton shift of the intermediate **S5** would give **S6**.[17] While, halogenation of **S2** with NXC would also provide the hydrazone **S4** by the similar pathway in the base-promoted alkylations. Electrophilic cyclization of *(Z)*-**S4** would proceed via the intermediate **S7** to give the cation **S8**.[5h] Deprotonation of **S8** provide the 4-halopyrazole **S9**.

Scheme 3. Proposed reaction mechanism.



Scheme 4. Transformation of 1-alkyl-1-tosyl-2-propargylhydrazides.



We performed the further transformation of propargyl hydrazides (Scheme 4). Halogenated pyrazoles underwent arylation to afford **32**. We also attempted the reactions with metal catalysts or Lewis acids. The reaction with Lewis acid underwent dehydrazination exclusively to afford allene **33**. Silver-catalyzed cyclizations in acetic acids successfully provided the *N*-alkylated pyrazoles **34a** and **34b** in high yields.

Conclusions

In summary, we have shown a regioselective synthesis of new propargyl hydrazides, *N*-alkylated propargyl hydrazones, and pyrazoles, respectively. Reactions of *N*-alkylated hydrazides with electrophiles such as NCS, NBS, and NIC easily underwent cyclization directly to give the 4-halopyrazoles. We are presently investigating the silver-catalyzed synthesis of pyrazoles, and further transformation of *N*-alkylated propargyl hydrazones. These results will be reported elsewhere.

Experimental Section

General Experimental Details

Dry solvents were purchased from commercial suppliers and used without further purification. Analytical thin-layer chromatography (TLC) was performed on glass plates coated with 0.25 mm Silicagel 60F254. Silicagel column chromatography was performed on Merck silica gel 60 (0.063-0.200 mm) and thin-layer chromatography (TLC) was performed on glass plates coated with Silicagel 60 PF254. IR spectra were recorded on JASCO FT/IR. NMR-spectra were recorded on a JEOL ECA 600 spectrometer at Gifu University. Chemical shifts are expressed in parts per million (ppm) with respect to tetramethylsilane as an internal standard. Splitting patterns are designated as follows: s, singlet; d, doublet; q, quartet. EI mass spectra (MS) were obtained using JEOL MS-700 spectrometer with direct-insertion probe at 70 eV. All high resolution mass determinations were obtained on the JMSD300 JMS 2000 on line system. Melting points apparatus were determined on a J-Science Lab. Micro melting point apparatus and uncorrected. Elemental analyses were performed at the Center of Instrumentation of Gifu University. All propargyl hydrazines **1-12** are prepared by the following known procedure.[10]

1. Alkylation of Propargyl Hydrazides.

2-(1,3-diphenylprop-2-yn-1-yl)-1-propargyl-p-toluenesulfonylhydrazine (13a).

Typical experimental procedure: To an acetonitrile (20.0 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (**1**) (1.00 g, 2.66 mmol) were added propargyl bromide (734 mg, 5.31 mmol) and cesium carbonate (63.2 mg, 3.19 mmol) at room temperature. The reaction mixture was stirred for 0.5 h at 50 ^{o}C and then poured into water (50 mL). The organic layer was separated and the aqueous layer was

extracted with AcOEt (20 mL × 2). The solvent was removed under reduced pressure. The residue was purified by column chromatography on silica gel eluting with AcOEt-*n*-hexane (1:20, then 1:10). 2-(1,3-Diphenylprop-2-yn-1-yl)-1-propargyl-1-(*p*-toluenesulfonyl)hydrazine (**13a**) (0.94 g, 85%) was obtained as a yellow oil.
IR (KBr, cm^{-1}) 3294, 3265, 3063, 3031, 2923, 2850, 2118, 1712, 1598, 1491, 1453, 1443, 1352, 1305, 1222, 1166, 1092, 1029, 917, 849, 815, 758, 694, 662, 580, 547, 527; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.05 (1H, t, *J*=2.3 Hz, acetylenic H), 2.40 (3H, s, Me), 3.91 (1H, d, *J* = 8.2 Hz, NH), 4.46 (1H, brd, *J* = 18.3 Hz, CH), 4.47 (1H, dd, *J* = 2.3 and 18.3 Hz, CH), 5.16 (1H, brd, *J* = 7.3 Hz, CH), 7.25 (2H, brd, *J* = 5.0 Hz, ArH), 7.26-7.38 (6H, m, ArH), 7.45-7.46 (2H, m, ArH), 7.60 (2H, d, *J* = 6.4 Hz, ArH), 7.83 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 40.3 (t), 56.9 (d), 75.3 (s), 76.8 (d), 86.7 (s), 87.8 (s), 122.5 (s), 128.2 (d × 2), 128.3 (d × 2), 128.4 (d × 2), 128.5 (d), 129.1 (d × 2), 129.2 (d × 2), 131.6 (d × 2), 133.6 (s), 137.2 (s), 144.0 (s); MS m/z 414 (M^+). Anal. Calcd for $C_{25}H_{22}N_2O_2S$: C, 72.44; H, 5.35; N, 6.76. Found: C, 72.55; H, 5.37; N, 6.73.

3,5-diphenyl-1-(2-propyn-1-yl)-*1H*-pyrazole (**14**), entry 2 in Table 1.[18]
The reaction of **1** (25 mg, 0.07 mmol), propargyl bromide (16 mg, 0.13 mmol), and DBU (20 mg, 0.13 mmol) in acetonitrile (0.50 mmol) was examined at 50 °C for 1.2 h. The workup procedure gave **14** (4.0 mg, 23%) as a yellow oil.
White powders (from *n*-hexane), mp 108-109 °C, IR (KBr, cm^{-1}) 3288, 3054, 2931, 1712, 1486, 1462, 1439, 1362, 1299, 785, 758, 696; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.44 (1H, t, *J* = 2..7 Hz, CH), 4.92 (2H, d, *J* = 2.7 Hz, CH_2), 6.64 (1H, s, ArH), 7.32 (1H, t, *J* = 7.6 Hz, ArH), 7.41 (2H, t, *J* = 7.6 Hz, ArH), 7.45 (1H, t, *J* = 7.6 Hz, ArH), 7.50 (2H, t, *J* = 6.9 Hz, ArH), 7.58 (2H, d, *J* = 6.9 Hz, ArH), 7.86 (2H, d, *J* = 7.5 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 39.8 (q), 73.6 (d), 78.4 (s), 103.7 (d), 125.8 (d × 2), 127.8 (d), 128.6 (d × 2), 128.8 (d × 2), 128.9 (d × 2), 130.1 (s), 133.1 (s), 145.1 (s), 151.5 (s); MS *m/z* 258 (M^+). Anal. Calcd for $C_{18}H_{14}N_2$: C, 83.69; H, 5.46; N, 10.84. Found: C, 83.46; H, 5.64; N, 10.77.

1-allyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (13b).
To an acetonitrile (10.0 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine **1** (500 mg, 1.33 mmol) were added allyl bromide (0.32 g, 2.66 mmol) and cesium carbonate (0.94 g, 2.66 mmol). The reaction mixture was stirred for 40 min and then poured into water (50.0 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was precipitated from hexane and filtered off to give 1-allyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13b**) (0.51 g, 92%) (pale yellow plates, mp 90-91 °C).
IR (KBr, cm^{-1}) 3281, 3064, 3032, 2925, 1712, 1598, 1490, 1453, 1443, 1353, 1304, 1289, 1166, 1091, 1028, 993, 921, 849, 815, 759, 693, 663, 549; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.41 (3H, s, Me), 3.75 (1H, s, NH), 4.13 (1H, dd, *J* = 6.3 and 14.9 Hz, CH), 4.25 (1H, dd, *J* = 8.0 and 14.9 Hz, CH), 5.01 (1H, s, CH), 5.21-5.24 (2H, m, CH_2), 5.56-5.63 (1H, m, CH), 7.27 (2H, d, *J* = 9.2 Hz, ArH), 7.31-7.35 (6H, m, ArH), 7.43-7.45 (2H, m, ArH), 7.48-7.49 (2H, m, ArH), 7.82 (2H, d, *J* = 8.0 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.5 (q), 53.3 (t), 56.9 (d), 86.4 (s), 88.2 (s), 122.2 (t), 122.7 (s), 128.3 (d), 128.3 (d × 4), 128.4 (d × 2), 128.5 (d), 128.7 (d × 2), 129.4 (d × 2), 131.0 (d), 131.6 (d × 2), 134.5 (s), 137.6 (s), 143.8 (s); MS m/z 261 (M^+ - Tos). Anal. Calcd for $C_{25}H_{24}N_2O_2S$: C, 72.09; H, 5.81; N, 6.73. Found: C, 71.89; H, 5.83; N, 6.56.

cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (13c).
To an acetonitrile (20.0 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine **1** (1.00 g, 2.66 mmol) were added bromoacetonitrile (478 mg, 3.98 mmol) and cesium carbonate (1.04 g, 3.19 mmol) at room temperature. The reaction mixture was stirred for 2 h and then poured into water (50.0 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. Cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (995 mg, 90%) was obtained as white powders (mp 96-101 °C).
IR (KBr, cm^{-1}) 3286, 3062, 3033, 2923, 2852, 2219, 1598, 1491, 1454, 1444, 1358, 1166, 1092, 848, 815, 758, 697, 662, 588, 548; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.43 (3H, s, Me), 3.88 (1H, d, *J* = 5.5 Hz, NH), 4.32 (1H, d, *J* = 7.9 Hz, CH), 4.61 (1H, d, *J* = 17.9 Hz, CH), 5.29 (1H, d, *J* = 5.5 Hz, CH), 7.33-7.40 (7H, m, ArH), 7.45-7.47 (2H, m, ArH), 7.56 (2H, brd, *J* = 6.9 Hz, ArH), 7.83 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.7 (q), 40.2 (t), 57.1 (d), 86.9 (s), 87.0 (s), 113.5 (s), 122.1 (s), 128.3 (d × 2), 128.4 (d × 2), 128.7 (d × 4), 128.8 (d × 2), 130.0 (d × 2), 131.7 (d × 2), 132.0 (s), 136.7 (s), 145.4 (s); MS m/z 414 (M^+ - 1). Anal. Calcd for $C_{24}H_{21}N_3O_2S$: C, 69.38; H, 5.09; N, 10.11. Found: C, 69.08; H, 5.10; N, 9.96.

methyl 4-(1,3-diphenylprop-2-yn-1-yl)-3-*p*-toluenesulfonylhydrazinylacetate (13d).
To an acetonitrile (2.0 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine **1** (100 mg, 0.27 mmol) were added methyl bromoacetate (121.9 mg, 0.80 mmol) and cesium carbonate (173.1 mg, 0.53 mmol) at room temperature. The reaction mixture was stirred for 10 min at 50 °C and then poured into water (50ml). The organic layer was separated and extracted with AcOEt (20mL × 2). The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (3:13). Methyl 4-(1,3-diphenylprop-2-yn-1-yl)-3-(p-toluenesulfonyl)hydrazinylacetate (**13d**) (97 mg, 81%) as white prisms (mp 73-75 °C, from $CHCl_3$-*n*-hexane).
IR (KBr, cm^{-1}) 3394, 3294, 3062, 3032, 2952, 1743, 1712, 1598, 1573, 1491, 1442, 1404, 1347, 1305, 1289, 1219, 1164, 1093, 853, 816, 759, 694, 660, 547; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.40 (3H, s, Me), 3.53 (3H, s, Me), 4.42 (1H, brd, *J* = 7.9 Hz, NH), 4.64-4.67 (2H, m, CH_2), 5.16 (1H, d, *J* = 7.6 Hz, CH), 7.27 (2H, d, *J* = 8.3 Hz, ArH), 7.31-7.36 (6H, m, ArH), 7.41-7.43 (2H, m, ArH), 7.53 (2H, d, *J* = 6.9 Hz, ArH), 7.79 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 50.7 (t), 52.0 (q), 56.5 (d), 86.7 (s), 88.0 (s), 122.4 (s), 128.2 (d × 2), 128.3 (d × 3), 128.4 (d × 4), 128.5 (d), 129.3 (d × 2), 131.5 (d × 2), 135.0 (s), 137.3 (s), 143.8 (s), 169.3 (s); MS m/z 448 (M^+), 292 (M^+-TsH). Anal. Calcd for $C_{25}H_{24}N_2O_4S$: C, 66.95; H, 5.39; N, 6.25. Found: C, 66.82; H, 5.46; N, 6.19.

1-cyanomethyl-2-(1-phenylhept-2-yn-1-yl)-*p*-toluensulfonylhydrazine (15).
To an acetonitrile (10.0 mL) solution of 2-(1-phenylhept-2-yn-1-yl)-*p*-toluenesulfonylhydrazine **2** (500 mg, 1.40 mmol) were added bromoacetonitrile (0.25 g, 2.10 mmol) and cesium carbonate (0.55 g, 1.70 mmol). The reaction mixture was stirred for 1 h at room temperature and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by the preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10) to give 1-cyanomethyl-2-(1-phenylhept-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**15**) (0.38 g, 69%) as white powders (mp 80-81 °C, from CH_2Cl_2-hexane).
IR (KBr, cm^{-1}) 3277, 2960, 2933, 2873, 2861, 1599, 1494, 1451, 1401, 1343, 1304, 1184, 1162, 1092, 919, 865, 836, 808, 743, 697, 661; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.92 (3H, t, *J* = 7.6 Hz, Me), 1.38-1.44 (2H, m, CH_2), 1.50-1.54 (2H, m, CH_2), 2.25 (2H, td, *J* = 2.0 and 6.9 Hz, CH_2), 2.44 (3H, s, CH_3), 3.74 (1H, d, *J* = 5.5 Hz, NH), 4.23 (1H, d, *J* = 17.9 Hz, CH_2), 4.57 (1H, d, *J* = 17.8 Hz, CH_2), 5.01 (1H, dt, *J* = 2.1 and 5.5 Hz, CH), 7.30-7.36 (5H, m, ArH), 7.47 (2H, d, *J* = 6.9 Hz, ArH), 7.81 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 18.5 (t), 21.6 (q), 22.0 (t), 30.6 (t), 40.1 (t), 56.6 (d), 77.9 (s), 87.9 (s), 113.5 (s), 128.2 (d×2), 128.5 (d), 128.6 (d × 2), 128.7 (d × 2), 129.9 (d × 2), 132.2 (s), 137.5 (s), 145.3 (s); MS m/z 394 (M^+ - 1), 396 (M^+-CN). Anal. Calcd for $C_{22}H_{25}N_3O_2S$: C, 66.81; H, 6.37; N, 10.62. Found: C, 66.58; H, 6.36; N, 10.58.

5-butyl-1-cyanomethyl-3-phenylpyrazole (16).
To an acetonitrile (1.0 mL) solution of 2-(1-phenylhept-2-yn-1-yl)-*p*-toluenesulfonylhydrazine **2** (30 mg, 0.80 mmol) were added bromoacetonitrile (29 mg, 0.24 mmol) and cesium carbonate (78 mg, 0.24 mmol) and DBU (2.4 mg, 0.02 mmol). The reaction mixture was stirred for 2 h. The workup procedure gave 5-butyl-1-cyanomethyl-3-phenylpyrazole (**16**)(13 mg, 67%) as a yellow oil.
IR (KBr, cm^{-1}) 3062, 2958, 2932, 2872, 2359, 1711, 1552, 1469, 1446, 1368, 1305, 1222, 1079, 958, 915, 768, 695; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.99 (3H, t, *J* = 6.8 Hz, Me), 1.46-1.49 (2H, m, CH_2), 1.71-1.76 (2H, m, CH_2), 2.69 (2H, t, *J* = 7.5 Hz, CH_2), 5.04 (2H, s, CH_2), 6.41 (1H, s, ArH), 7.31-7.33 (1H, m, ArH), 7.38-7.41 (2H, m, ArH), 7.75-7.77 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.7 (q), 22.3 (t), 25.2 (t), 30.4 (t), 37.2 (t), 103.2 (d), 114.0 (s), 125.6 (dx2), 128.1 (d), 128.6 (dx2), 132.7 (s), 145.2

(s), 152.1 (s); MS m/z 239 (M^+); high resolution mass calcd for $C_{15}H_{17}N_3$: 239.1422, found m/z 239.1427.

3-(1-naphthyl)-5-phenyl-1-propargyl-1*H*-pyrazole (17).
To an acetonitrile (1.0 mL) solution of 2-(1-naphthyl-3-phenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (**3**) (50 mg, 0.11 mmol) was added proprgyl bromide (27.8 mg, 0.23 mmol) and cesium carbonate (114 mg, 0.35 mmol) at room temperature. The reaction mixture was stirred for 1.5 h and then DBU (1.8 mg, 0.01 mmol) was added to the mixture. The whole was heated at 80 °C and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:20). 3-(naphthalene-1-yl)-5-phenyl-1-(2-propyn-1-yl)-*1H*-pyrazole (**17**) (27 mg, 80 %) was obtained as white powders.
mp 131-134 °C, IR (KBr, cm^{-1}) 3420, 3290, 3051, 2925, 1549, 1514, 1493, 1457, 1424, 1382, 1363, 1349, 1300, 1263, 1215, 1159, 1007, 937, 917, 800, 775, 760, 700; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.46 (1H, t, *J* = 2.8 Hz, CH), 5.01 (2H, d, *J* = 2.7 Hz, CH_2), 6.66 (1H, s, ArH),7.45-7.54 (6H, m, ArH), 7.65 (2H,d, *J* = 6.9 Hz, ArH), 7.76 (1H, d, *J* = 6.9 Hz, ArH), 7.86 (1H, d, *J* = 8.3 Hz, ArH), 7.89 (1H, d, *J* = 8.3 Hz, ArH), 8.61 (1H, d, *J* = 8.2 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 39.9 (t), 73.6 (d), 78.4 (s), 107.4 (d), 125.3 (d), 125.7 (d), 126.2 (d), 126.3 (d), 127.1 (d), 128.3 (d), 128.4 (d), 128.8 (d × 2), 128.9 (d), 128.9 (d × 2), 130.1(s), 131.2 (s), 131.4 (s), 134.0 (s), 144.4 (s), 151.2 (s); MS *m/z* 308 (M^+); high resolution mass calcd for $C_{22}H_{16}N_2$: 308.1313, found m/z 308.1344.

1-allyl-2-(1-*p*-fluorophenyl-3-phenylprop-2-ynyl)-*p*-toluenesulfonylhydrazine (18).
To an acetonitrile (1.0 mL) solution of 2-[1-(*p*-fluorophenyl)-3-phenylprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**4**) (50 mg, 0.13 mmol) was added to allyl bromide (46.0 mg, 0.38 mmol) and cesium carbonate (82.6 mg, 0.25 mmol) at room temperature. The reaction mixture was stirred for 50 min and poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 1-allyl-2-[1-(p-fuluorophenyl)-2-(3-phenylprop-2-yn-1-yl)]-*p*-toluenesulfonylhydrazine (**18**)(47 mg, 85 %) as pale yellow powders.
mp 61-64 °C, IR (KBr, cm^{-1}) 3284, 3067, 2923, 1712, 1601, 1508, 1491, 1443, 1352, 1305, 1294, 1223, 1166, 1092, 840, 815, 758, 692, 662, 585, 549; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.41 (3H, s, Me), 3.76 (1H, d, *J* = 6.9 Hz, CH), 4.14-4.23 (2H, m, CH_2), 5.07 (1H, d, *J* = 6.9 Hz, CH), 5.22-5.25 (2H, m, CH_2), 5.57-5.63 (1H, m, CH), 6.98-7.01 (2H, m, ArH), 7.26 (2H, d, *J* = 8.3 Hz, ArH), 7.31-7.34 (2H, m, ArH), 7.42-7.46 (5H, m, ArH), 7.78 (2H, d, *J* = 8.9 Hz, CH_2); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.5 (q), 53.3 (t), 56.1 (d), 86.6 (s), 87.9 (s), 115.1 (d), 115.3 (d), 122.2 (t), 122.4 (s), 128.4 (d × 2), 128.6 (d), 128.7 (d × 2), 129.4 (d × 2), 130.1 (d), 130.1 (d), 131.0 (d), 131.6 (d × 2), 133.4 (s), 134.4 (s), 144.0 (s), 162.6 (d, *J* = 247.1 Hz); MS m/z 279 (M^+ - TsH). Anal. Calcd for $C_{25}H_{23}FN_2O_2S$: C, 69.10; H, 5.34; N, 6.45. Found: C, 69.02; H, 5.28; N, 6.33.

1-cyanomethyl-3-(*p*-fluorophenyl)-5-phenyl-1*H*-pyrazole (19).
To an acetonitrile (5.0 mL) solution of 2-[1-(*p*-fluorophenyl)-3-phenylprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**4**) (0.20 g, 0.51 mmol) was added cesium carbonate (0.50 g, 1.52 mmol). The reaction mixture was refluxed for 0.5 h and then poured into water (50 mL). The workup procedure gave the titled compound **19** (0.11 g, 80%) as white powders.
mp 101-103 °C, IR (KBr, cm^{-1}) 3407, 3064, 2992, 2953, 2925, 2853, 2261, 1606, 1525, 1490, 1456, 1437, 1410, 1348, 1306, 1224, 1160, 1099, 908, 846, 817, 803, 781, 757, 697; ^{1}H NMR (600 MHz, $CDCl_3$) δ 5.02 (2H, s, CH2), 6.62 (1H, s, ArH), 7.10-7.14 (2H, m, ArH), 7.46-7.54 (5H, m, ArH), 7.80-7.83 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 37.9 (t), 104.4 (d), 114.4 (s), 115.6 (d), 115.7 (d), 127.5 (d), 127.7 (d), 128.7 (s), 128.8 (d × 2), 128.9 (s), 129.3 (d × 2), 129.6 (d), 146.1 (s), 151.8 (s), 162.9 (d, *J* = 247.1 Hz); MS m/z 277 (M^+). Anal. Calcd for $C_{17}H_{12}N_3F$: C, 73.63; H, 4.36; N, 15.15. Found: C, 73.47; H, 4.33; N, 15.31.

1-cyanomethyl-2-[1-(*p*-chlorophenyl)hept-2-ynyl]-*p*-toluenesulfonylhydrazine (**20**)
To an acetonitrile (1.0 mL) solution of 2-[1-(*p*-chlorophenyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**5**) (50 mg, 0.13 mmol) was added bromoacetonitrile (31 mg, 0.26 mmol) and cesium carbonate (83 mg, 0.26 mmol) at room temperature. The reaction mixture was stirred at 50 °C for 10min and then poured into water (50 mL). The workup procedure gave 1-allyl-2-[1-(p-chlorophenyl)-hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**20**) (48 mg, 87 %) as white powders.
mp 80-84 °C, IR (KBr, cm^{-1}) 3285, 2959, 2931, 2872, 2355, 2333, 1712, 1597, 1489, 1462, 1408, 1360, 1222, 1166, 1092, 1016, 939, 814, 745; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.92 (3H, t, *J* = 7.6 Hz, Me), 1.37-1.44 (2H, m, CH_2), 1.49-1.53 (2H, m, CH_2), 2.25 (2H, dt, *J* = 2.1 and 6.9 Hz, CH_2), 2.44 (3H, s, CH_3), 3.76 (1H, d, *J* = 5.5 Hz, CH), 4.29 (1H, d, *J* = 17.9 Hz, CH), 4.56 (1H, d, *J* = 17.9 Hz, CH), 4.99 (1H, dd, *J* = 2.1 and 5.5 Hz, CH), 7.30 (2H, d, *J* = 8.2 Hz, ArH), 7.35 (2H, d, *J* = 8.3Hz, ArH), 7.40 (2H, d, *J* = 8.3 Hz, ArH), 7.80 (2H, d, *J* = 8.9 Hz, CH_2); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 18.4 (t), 21.6 (q), 22.0 (t), 30.5 (t), 40.1 (t), 55.9 (d), 77.5 (s), 88.4 (s), 113.4 (s), 128.6 (d × 2), 128.7 (d × 2), 129.6 (d × 2), 129.9 (d × 2), 131.9 (s), 134.3 (s), 136.0 (s), 145.4 (s); MS m/z 429 (M^+ - 1), 274 (M^+ - Ts). Anal. Calcd for $C_{22}H_{24}ClN_3O_2S$: C, 61.46; H, 5.63; N, 9.77. Found: C, 61.56; H, 5.59; N, 9.73.

t-butyl 2-[[2-(1-*p*-methoxyphenyl)-3-phenylprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazin-1-yl]acetate (21).
To an acetonitrile (1.0 mL) solution of 2-[1-(*p*-methoxypheny)-3-phenyllprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**6**) (50 mg, 0.12 mmol) was added *t*-butyl bromoacetete (48.0 mg, 0.25 mmol) and cesium carbonate (80.2 mg, 0.25 mmol) at room temperature. The reaction mixture was stirred at 50 °C for 0.25 h and then poured into water (50 mL). The workup procedure gave *t*-butyl 2-[2-[1-(*p*-methoxyphenyl)-3-phenylprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazin-1-ylacetate (**21**)(56 mg, 87 %) as a brown oil.
IR (KBr, cm^{-1}) 3301, 2979, 2934, 2838, 1734, 1610, 1599, 1586, 1511, 1491, 1457, 1443, 1395, 1368, 1346, 1304, 1251, 1164, 1093, 1034, 910, 814, 760, 693; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.31 (9H, s, *t*-Bu), 2.39 (3H, s, CH_3), 3.81 (3H, s, OCH_3), 4.36 (1H, brs, NH), 4.59 (1H, d, *J* = 18.6 Hz, CH), 4.76 (1H. d. *J* = 7.5 Hz, CH), 5.07 (1H, d, *J* = 7.5Hz, CH), 6.86 (2H, d, *J* = 8.9 Hz, CH_2), 7.25 (2H, d, *J* = 8.3 Hz, CH_2), 7.31-7.32 (3H, m, ArH), 7.41-7.43 (4H, m, ArH), 7.45 (2H, d, *J* = 8.2 Hz, ArH), 7.78 (2H, d, *J* = 8.2 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.5 (q), 27.8 (q × 3), 50.7 (t), 55.3 (q), 55.9 (d), 82.4 (s), 86.4 (s), 88.6 (s), 113.7 (d × 2), 122.6 (s), 128.3 (d × 2), 128.4 (d × 2), 128.5 (d), 129.2 (d × 2), 129.3 (d × 2), 129.7 (s), 131.6 (d × 2), 135.4 (s), 143.5 (s), 159.5 (s), 168.1 (s); MS m/z 364 (M^+ - TsH); high resolution mass calcd for $C_{29}H_{32}N_2O_5S$: 520.2031; found 519.2022.

1-allyl -2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22a**).
To an acetonitrile (5.0 mL) solution of 2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**7**) (200 mg, 0.55 mmol) was added allyl bromide (133.5 mg, 1.01 mmol) and cesium carbonate (215.7 mg, 0.66 mmol) at room temperature. The reaction mixture was stirred for 40 min and then poured into water (50 mL). The workup procedure gave 1-allyl -2-[1-(2-thienyl)-hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22a**) (213 mg, 96 %) as a yellow oil.
IR (KBr, cm^{-1}) 2959, 2934, 2862, 1712, 1598, 1465, 1436, 1353, 1230, 1167, 1092, 930, 815, 705, 666, 567, 517, 484, 462; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.92 (3H, t, *J* = 6.2 Hz, Me), 1.40-1.46 (2H, m, CH_2), 1.50-1.56 (2H, m, CH_2), 2.23-2.28 (2H, m, Me), 2.43 (3H, s, Me), 3.70 (1H, d, *J* = 6.9 Hz, CH), 4.12 (1H, dd, *J* = 6.2 and 15.1 Hz, CH), 4.19 (1H, dd, *J* = 8.2 and 15.1 Hz, CH), 4.98 (1H, brs, CH), 5.19-5.22 (2H, m, olefinic H), 5.54-5.61 (1H, m, olefinic H), 6.91 (1H, dd, *J* = 3.4 and 4.8 Hz, ArH), 7.05 (1H, dt, *J* = 3.5 and 1.3 Hz, ArH), 7.23-7.26 (1H, m, ArH), 7.29 (2H, d, *J* = 7.6 Hz, ArH), 7.85(2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 18.4 (t), 21.6 (q), 22.0 (t), 30.5 (t), 52.2 (d), 53.4(t) 78.8 (s), 86.5 (s), 122.2 (t), 125.9 (d), 126.4 (d × 2), 128.8 (d × 2), 129.4 (d × 2), 130.9 (d), 134.5 (s), 142.1 (s), 143.8 (s); MS m/z 247 (M^+ - TsH). Anal. Calcd for $C_{21}H_{26}N_2O_2S_2$: C, 62.66; H, 6.51; N, 6.96. Found: C, 62.77; H, 6.35; N, 6.97.

1-cyanomethyl-2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22b**).
To an acetonitrile (1.0 mL) solution of 2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazide (**7**) (50 mg, 0.14 mmol) was added bromoacetonitrile (33 mg, 0.28 mmol) and cesium carbonate (90.0 mg, 0.28 mmol) at room temperature. The reaction mixture was stirred at 50 °C for 10 min and then poured into water (50 mL). The workup procedure gave 1-cyanomethyl-2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22b**) (52 mg, 94%) as white powders.

mp 70-72 °C, IR (KBr, cm^{-1}) 2958, 2935, 2871, 1711, 1597, 1493, 1456, 1433, 1407, 1359, 1306, 1230, 1230, 1166, 1092, 815, 732, 707; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.92 (3H, t, *J* = 7.9 Hz, Me), 1.39-1.46 (2H, m, CH_2), 1.50-1.64 (2H, m, CH_2), 2.26 (2H, dt, *J* = 2.3 and 7.4 Hz, CH_2), 2.44 (3H, s, CH_3), 3.78 (1H, d, *J* = 6.3 Hz, NH), 4.35 (1H, d, *J* = 17.8 Hz, CH_2), 4.61 (1H, d, *J* = 18.3 Hz, CH), 5.21 (1H, d, *J* = 6.3Hz, CH), 6.94-6.96 (1H, m, ArH), 7.11 (1H, d, *J* = 3.4 Hz, ArH), 7.29 (1H, d, *J* = 5.1 Hz, ArH), 7.37 (2H, d, *J* = 8.0 Hz, ArH), 7.85 (2H, d, *J* = 8.0 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 18.3 (t), 21.6 (q), 21.9 (t), 30.4 (t), 40.0 (t), 52.2 (d), 77.3 (s), 87.5 (s), 113.4 (s), 126.4 (d), 126.6 (d), 126.8 (d), 128.9 (d × 2), 128.9 (d × 2), 131.9 (s), 141.0 (s), 145.3 (s); MS m/z 400 (M^+ - 1), 375 (M^+ - CN), 246 (M^+ - Ts). Anal. Calcd for $C_{20}H_{23}N_3O_2S_2$: C, 59.82; H, 5.77; N, 10.46. Found: C, 59.50; H, 5.60; N, 10.46.

2-(1-naphthyl-3-phenylsulfanylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (23).

To an acetonitrile (2.0 mL) solution of 2-(1-naphthyl-3-phenylsulfanylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (**8**) (100 mg, 0.22 mmol) were added propargyl bromide (90.4 mg, 0.65 mmol) and potassium carbonate (51.9 mg, 0.44 mmol) at room temperature. The reaction mixture was stirred for 3 h at 50 °C and poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:5). 2-(1-Naphthyl-3-phenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (**23**) (93 mg, 86%) was obtained as pale yellow plates (mp 105-107 °C, from $CHCl_3$-*n*-hexane).

IR (KBr, cm^{-1}) 3294, 3264, 3064, 2920, 2850, 2181, 2118, 1710, 1597, 1582, 1511, 1478, 1442, 1397, 1352, 1320, 1164, 1092, 1037, 1022, 940, 916, 871, 804, 780, 741, 687, 662, 586, 553; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.95 (1H, t, *J* = 2.8 Hz, acetylenic H), 2.27 (3H, s, Me), 3.85 (1H, d, *J* = 8.2 Hz, NH), 4.58 (1H, brd, *J* = 18.6 Hz, CH), 4.67 (1H, dd, *J* = 2.7 and 18.5 Hz, CH), 5.99 (1H, d, *J* = 8.2 Hz, CH), 7.07 (2H, d, *J* = 7.6 Hz, ArH), 7.21-7.23 (1H, m, ArH), 7.30-7.33 (2H, m, ArH), 7.41-7.44 (3H, m, ArH), 7.53-7.55 (1H, m, ArH), 7.63-7.66 (1H, m, ArH), 7.71 (2H, d, *J* = 8.2 Hz, ArH), 7.83-7.87 (3H, m, ArH), 8.62 (1H, d, *J* = 8.9 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.4 (q), 40.7 (t), 55.6 (d), 73.7 (s), 75.0 (s), 75.9 (d), 97.5 (s), 124.7 (d), 125.0 (d), 126.0 (d), 126.4 (d × 2), 126.5 (d), 126.7 (d × 2), 128.4 (d), 128.9 (d × 2), 129.1 (d × 2), 129.3 (d × 2), 129.7 (d), 131.2 (s), 131.9 (s), 132.0 (s), 133.1 (s), 133.8 (s), 143.9 (s); MS m/z 340 (M^+ – TsH). Anal. Calcd for $C_{29}H_{24}N_2O_2S_2$: C, 70.13; H, 4.87; N, 5.64. Found: C, 69.93; H, 4.84; N, 5.62.

t-butyl 2-[1-(1,3-benzodioxol-5-yl)-3-phenylsulfanylprop-2-ynyl]-*p*-toluenesulfonylhydrazin-1-ylacetate (24).

To an acetonitrile (3.0 mL) solution of 2-[1-(1,3-benzodioxol-5-yl)-3-phenylsulfanylprop-2-ynyl]-*p*-tosylhydrazine (**9**) (150 mg, 0.33 mmol) was added *t*-butyl bromoacetate (129 mg, 0.66 mmol) and cesium carbonate (216 mg, 0.66 mmol). The reaction mixture was stirred for 15 min. The workup procedure gave *t*-butyl 2-[1-(1,3-benzodioxol-5-yl)-3-phenylsulfanylprop-2-ynyl]-*p*-toluenesulfonylhydrazin-1-ylacetate (**24**) (181 mg, 96 %) as a yellow oil.

IR (KBr, cm^{-1}) 3443, 3303, 2981, 2930, 1734, 1505, 1489, 1443, 1369, 1347, 1236, 1164, 1095, 1039, 926, 812, 743, 709, 690, 551; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.34 (9H, s, Me × 3), 2.40 (3H, s, CH_3), 4.42 (1H, d, *J* = 18.6 Hz, CH), 4.83 (1H, d, *J* = 6.9 Hz, CH), 5.07 (1H, d, *J* = 6.9 Hz, CH), 5.97 (2H, d, *J* = 1.4 Hz, CH_2), 6.75 (1H, d, *J* = 8.3 Hz, CH), 6.94 (1H, d, *J* = 7.5 Hz, ArH), 6.96 (1H, brs, ArH), 7.22-7.26 (3H, m, ArH), 7.33 (2H, t, *J* = 7.6 Hz, CH_2), 7.38-7.39 (2H, m, ArH), 7.76 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 27.9 (q × 3), 50.8 (t), 56.8 (d), 73.0 (s), 82.5 (s), 97.5 (s), 101.2 (t), 108.0 (d), 108.6 (d), 121.6 (d), 126.3 (d × 2), 126.7 (d), 128.4 (d × 2), 129.2 (d × 2), 129.3 (d × 2), 131.0 (s), 132.1 (s), 135.1 (s), 143.7 (s), 147.6 (s), 147.7 (s), 168.1 (s); MS m/z 410 (M^+ - TsH). Anal. Calcd for $C_{29}H_{30}N_2O_6S_2$: C, 61.47; H, 5.34; N, 4.94. Found: C, 61.19; H, 5.35; N, 4.96.

1-propargyl-2-[1-(phenylsulfanylethynyl)-1-cyclohexyl]-*p*-toluenesulfonylhydrazine (25).

To an acetonitrile (2.0 mL) solution of 2-[1-(phenylsulfanylethynyl)-1-cyclohexyl]-*p*-toluenesulfonylhydrazine (**10**) (50 mg, 0.12 mmol) were added propargyl bromide (59.4 mg, 0.50 mmol) and cesium carbonate (122.0 mg, 0.37 mmol) at room temperature. The reaction mixture was stirred for 1 h at 50 °C and poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 2-[1-phenylsulfanylethynylcyclohex-1-yl]-1-propargyl-*p*-toluenesulfonylhydrazine (**25**) (45 mg, 82%) as a pale yellow oil.

IR (KBr, cm^{-1}) 3295, 3257, 3062, 2935, 2895, 2856, 1712, 1620, 1598, 1583, 1479, 1442, 1355, 1167, 1146, 1091, 1058, 1023, 814, 804, 740, 688, 661, 587, 580, 549; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58-1.73 (10H, m, CH_2), 2.00 (1H, t, *J* = 2.0 Hz, acetylenic H), 2.41 (3H, s, Me), 3.72 (1H, s, CH), 4.68 (2H, d, *J* = 2.0 Hz, CH_2), 7.20-7.35 (6H, m, ArH), 7.38 (2H, d, *J* = 7.6 Hz, ArH), 7.90 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 22.4 (t × 2), 25.5 (t × 2), 39.8 (t), 41.2 (t), 57.2 (s), 70.9 (s), 74.9 (s), 76.3 (d), 102.5 (s), 126.1 (d × 2), 126.5 (d), 128.9 (d × 2), 129.1 (d × 2), 129.5 (d × 2), 132.6 (s), 133.6 (s), 143.8 (s); MS m/z 438 (M^+), 283 (M^+ – Ts). Anal. Calcd for $C_{24}H_{26}N_2O_2S_2$: C, 64.02; H, 5.93; N, 6.39. Found: C, 64.10; H, 5.92; N, 6.23.

1-cyanomethyl-2-[1-(phenylsulfanylethynyl)-1-cyclopentyl]-*p*-toluenesulfonylhydrazine (26).

To an acetonitrile (1.0 mL) solution of 2-(1-phenylsulfanylethynyl-1-cyclopentyl)-*p*-toluenesulfonylhydrazine (**11**) (50 mg, 0.13 mmol) were added bromoacetonitrile (96.5 mg, 0.34 mmol) and cesium carbonate (84.3 mg, 0.26 mmol) at room temperature. The reaction mixture was stirred for 10 min and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 1-cyanomethyl-2-(1-phenylsulfanylethynyl-1-cyclopentyl)-*p*-toluenesulfonylhydrazine (**26**) (52 mg, 95%) as a pale yellow oil.

IR (KBr, cm^{-1}) 3284, 2963, 2871, 1709, 1597, 1582, 1478, 1442, 1404, 1358, 1214, 1185, 1168, 1092, 1023, 815, 802, 741, 688, 661, 579, 552; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.79-2.11 (8H, m, CH_2), 2.42 (3H, s, Me), 3.18 (1H, s, NH), 4.85 (2H, s, CH_2), 7.23-7.35 (6H, m, ArH), 7.77 (2H, d, *J* = 8.2 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 23.7 (t × 2), 39.6 (t × 2), 63.0 (s), 70.8 (s), 102.3 (s), 112.9 (s), 126.3 (d × 2), 126.8 (d), 129.2 (d × 2), 129.4 (d × 2), 129.6 (d × 2), 131.8 (s), 132.0 (s), 145.1 (s); MS m/z 425 (M^+), 269 (M^+ – TsH); high resolution mass calcd for $C_{22}H_{23}N_3O_2S_2$: 425.1231, found: 425.1207.

2-(1-phenylsulfanylethynyl-1-cycloheptyl)-1-propargyl-*p*-toluenesulfonylhydrazine (27).

To an acetonitrile (1.0 mL) solution of 2-(1-phenylsulfanylethynyl-1-cycloheptyl)-*p*-toluenesulfonylhydrazine (**12**) (50 mg, 0.12 mmol) were added propargyl bromide (43.0 mg, 0.36 mmol) and cesium carbonate (78.6 mg, 0.24 mmol) at room temperature. The reaction mixture was stirred for 1 h and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt-*n*-hexane. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. 2-(1-Phenylsulfanylethynyl-1-cycloheptyl)-1-propargyl-*p*-toluenesulfonylhydrazine (**27**) (50 mg, 92%) was obtained without further purification.

IR (KBr, cm^{-1}) 3296, 3261, 3061, 2930, 2856, 1712, 1597, 1583, 1493, 1479, 1460, 1442, 1353, 1185, 1167, 1092, 1024, 814, 802, 739, 687, 661, 586, 557, 548; ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.64 (12H, m, CH_2), 2.01 (1H, t, *J* = 2.8 Hz, acetylenic H), 2.42 (3H, s, Me), 3.60 (1H, s, NH), 4.69 (2H, d, *J* = 2.8 Hz, CH_2), 7.19-7.22 (1H, m, ArH), 7.27 (2H, d, *J* = 8.2 Hz, ArH), 7.30-7.33 (2H, m, ArH), 7.37 (2H, d, *J* = 8.2 Hz, ArH), 7.80 (2H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 22.4 (t × 4), 29.1 (t × 2), 40.9 (t), 60.0 (s), 69.6 (s), 75.0 (s), 76.3 (d), 104.0 (s), 126.0 (d × 2), 126.5 (d), 128.9 (d × 2), 129.2 (d × 2), 129.5 (d × 2), 132.7 (s), 133.6 (s), 143.9 (s); MS m/z 452 (M^+), 296 (M^+ – TsH); high resolution mass calcd for $C_{25}H_{28}N_2O_2S_2$: 452.1592, found: 452.1577.

2. Experimental for Scheme 2.

2-(3,5-diphenyl-*1H*-pyrazol-1-yl)acetonitrile (**28**).[17]

Cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (42 mg, 0.10 mmol) in toluene (1.0 ml) was stirred at 100 °C for 1h. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 2-(3,5-Diphenyl-*1H*-pyrazol-1-yl)acetonitrile (**28**) (12 mg, 48%) as white powders.

Cesium carbonate (71 mg, 0.22 mmol) was added to an acetonitrile (1.0 mL) solution of **13c** (30 mg, 0.072 mmol). The reaction mixture was

stirred at 80 °C for 1 h and then poured into water. The workup procedure gave **28** (33 mg, 90%).
mp 108-109 °C, IR (KBr, cm^{-1}) 3061, 2923, 2851, 1709, 1553, 1487, 1462, 1441, 1415, 1364, 1301, 957, 917, 760, 690; ^{1}H NMR (600 MHz, $CDCl_3$) δ 5.03 (2H, s, CH_2), 6.07 (1H, s, ArH), 7.36 (1H, t, *J* = 7.6 Hz, ArH), 7.43 (2H, t, *J* = 7.6 Hz, ArH), 7.48-7.55 (5H, m, ArH), 7.84 (2H, dd, J = 1.4 and 7.6 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 37.9 (t), 104.7 (d), 114.4 (s), 125.8 (d × 2), 128.4 (d), 128.7 (d × 2), 128.8 (d × 2), 129.0 (s), 129.3 (d × 2), 129.6 (d), 134.4 (s); MS *m/z* 259 (M^+), 233 (M^+ - CN), 219 (M^+ - CH_2CN). Anal. Calcd for $C_{17}H_{13}N_3$: C, 78.74; H, 5.05; N, 16.20. Found: C, 78.54; H, 5.07; N, 15.98.

1,3-diphenylprop-2-ynone cyanomethylhydrazone (29a).
To a THF (1.0 mL) solution of 1-cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (50 g, 0.12 mmol) was added DBU (18 mg, 0.12 mmol) at room temperature. The reaction mixture was stirred for 1 h and then poured into water (50 mL). The workup procedure gave 1,3-diphenylprop-2-yn-1-one cyanomehylhydrazone (**29a**) (17 mg, 55%) as an orange powders.
mp 83-85 °C, IR (KBr, cm^{-1}) 3261, 3061, 1525, 1489, 1410, 1348, 1229, 1144, 1072, 1027, 1016, 916, 878, 850, 758, 687, 669, 628; ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.35 (2H, d, *J* = 5.5 Hz, CH_2), 6.48 (1H, brt, *J* = 5.5 Hz, NH), 7.34-7.46 (6H, m, ArH), 7.60 (2H, dd, *J* = 1.4 and 8.2 Hz, ArH), 7.90 (2H, dd, *J* = 1.4 and 8.2 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 39.0 (t), 78.3 (s), 103.6 (s), 117.1 (s), 121.0 (s), 125.9 (d × 2), 128.4 (d × 2), 128.7 (s), 129.0 (d), 129.9 (d), 131.7 (s), 132.0 (d×2), 135.0 (s); MS *m/z* 259 (M^+); high resolution mass calcd for $C_{17}H_{13}N_3$: 259.1109, found: 259.1087.

1-phenylhept-2-ynone cyanomethylhydrazone (29b).
To a dioxane (1.0 mL) solution of 1-cyanomethyl-2-(1-phenylhept-2-yn-1-yl)-1*p*-toluensulfonylhydrazine (**15**) (30 mg, 0.076 mmol) was added 1M Bu_4NF (0.23 mL in THF, 0.23 mmol) at room temperature. The reaction mixture was stirred for 2 h and then poured into water (50 mL). The workup procedure gave the titled compound **29b** (16 mg, 84%) as white powders and **16** (3 mg, 14%) as a yellow oil.
28b: IR (KBr, cm^{-1}) 3262, 3061, 2959, 2927, 2855, 2213, 1734, 1711, 1530, 1458, 1331, 1110, 1073, 918, 883, 768, 694; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.98 (3H, t, *J* = 7.4 Hz, Me), 1.48-1.55 (2H, m, CH_2), 1.65-1.70 (2H, m, CH_2), 2.58 (2H, t, *J* = 7.5 Hz, CH_2), 4.30 (2H, d, *J* = 5.7 Hz, CH_2), 6.32 (1H, t, *J* = 5.7 Hz, NH), 7.30-7.38 (3H, m, ArH), 7.83-7.84 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 19.3 (t), 22.1 (t), 30.4 (t), 38.8 (t), 70.8 (s), 106.1 (s), 117.2 (s), 125.9 (d × 2), 128.2 (d × 2), 128.8 (d), 132.5 (s), 135.3 (s); MS m/z 239 (M^+); high resolution mass calcd for $C_{15}H_{17}N_3$: 239.1422, found m/z 239.1408.

1-(2-thienyl)hept-2-ynone cyanomethylhydrzone (29c).
DBU (38 mg, 0.25 mmol) was added to a dioxane (1.0 mL) solution of 1-cyanomethyl-2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22b**) (50 mg, 0.12 mmol). The reaction mixture was stirred for 0.5 h and then poured into water (50 mL). The workup procedure gave 1-(2-thienyl)hept-2-ynone cyanomethylhydrazone (**29c**)(32 mg, quant) as a yellow oil.
IR (KBr, cm^{-1}) 3262, 2958, 2933, 2871, 2360, 2219, 1709, 1519, 1457, 1435, 1455, 1329, 1231, 1155, 1092, 1038, 887, 833, 705; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.97 (3H, t, *J* = 7.4 Hz, Me), 1.43-1.55 (2H, m, CH_2), 1.65-1.88 (2H, m, CH_2), 2.55 (2H, t, *J* = 6.8 Hz, CH_2), 4.25 (2H, d, *J* = 5.5 Hz, CH_2), 6.19 (1H, t, *J* = 5.5 Hz, NH), 6.99 (1H, dd, *J* = 3.7 Hz, 5.0 Hz, ArH), 7.24 (1H, dd, *J* = 1.4 and 5.0 Hz, ArH), 7.31 (1H, dd, *J* = 1.0 and 3.7 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 19.2 (t), 22.0 (t), 30.2 (t), 38.7 (t), 70.0 (s), 104.8 (s), 117.1 (s), 126.3 (dx2), 126.4 (dx2), 126.9 (dx2), 128.5 (s), 140.0 (s); MS m/z 245 (M^+); high resolution mass calcd for $C_{13}H_{15}N_3S$: 245.0987, found m/z 245.0988.

3,5-diphenyl-*1H*-pyrazole (30).[10]
Sodium hydride (42 mg, 0.10 mmol) was added to a DMF (1.0 mL) solution of cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (42 g, 0.10 mmol) at 0 °C. The reaction mixture was stirred for 5 min and then poured into water (50 mL). The workup procedure gave 3,5-diphenyl-*1H*-pyrazole (**29**) (24 mg, 63%) as colorless prisms.

4.Halogenation and Cyclization of Propargyl Hydrazides.
4-chloro-3,5-diphenyl-1-propargyl-*1H*-pyrazole (31a).
N-Chlorosuccinimide (24.2 mg, 0.18 mmol) was added to a DCE (1.0 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (**13a**) (50 mg, 0.12 mmol) at room temperature. The reaction mixture was stirred for 18.5 h and poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was purified by preparative TLC on silica gel eluting with AcOEt-n-hexane (1:10). 4-Chloro-3,5-diphenyl-1-propargyl-1-1-pyrazole (**31a**) (16 mg, 45 %) was obtained as white powders.
mp 141 °C, IR (KBr, cm^{-1}) 3277, 3058, 2921, 2851, 1484, 1461, 1450, 1413, 1352, 1317, 1306, 1241, 1162, 1017, 990, 942, 916, 814, 771, 696, 678, 654, 611; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.42 (1H, t, *J* = 2.8 Hz, acetylenic H), 4.85 (2H, d, *J* = 2.8 Hz, CH_2), 7.37-7.39 (1H, m, ArH), 7.44-7.46 (2H, m, ArH), 7.50-7.58 (5H, m, ArH), 7.96-7.97 (2H, dd, *J* = 1.3 and 7.6 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 40.6 (t), 73.9 (d), 77.7 (s), 107.3 (s), 127.6 (d × 2), 127.7 (s), 128.3 (d), 128.4 (d × 2), 128.9 (d × 2), 129.5 (d), 129.8 (d × 2), 131.6 (s), 141.1 (s), 147.6 (s); MS m/z 291 (M^+-1), 257 (M^+ – Cl). Anal. Calcd for $C_{18}H_{13}ClN_2$: C, 73.85; H, 4.48; N, 9.57. Found: C, 73.57; H, 4.24; N, 9.38.

4-bromo-3,5-diphenyl-1-propargyl-*1H*-pyrazole (31b).
N-Bromosuccinimide (32.2 mg, 0.18 mmol) was added to a DCE (0.50 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (**13a**) (25 mg, 0.06 mmol) at room temperature. The reaction mixture was stirred for 15 min and then poured into water (50 mL). The workup procedure gave 4-bromo-3,5-diphenyl-1-propargyl-1*H*-pyrazole (**31b**)(19 mg, 93 %) as white powders.
White powders, mp 125-130 °C (dec), IR (KBr, cm^{-1}) 3294, 3065, 2920, 2851, 2358, 1709, 1606, 1537, 1515, 1480, 1456, 1354, 1302, 1232, 1213, 1176, 1156, 1073, 1059, 1043, 1032, 1013, 981, 817, 803, 769, 761, 698, 612, 601, 591, 571, 560, 519, 507; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.40 (1H, t, *J* = 2.8 Hz, acetylenic H), 4.84 (2H, d, *J* = 2.8 Hz, CH_2), 7.36-7.39 (1H, m, ArH), 7.44 (2H, t, *J* = 7.6 Hz, ArH), 7.50-7.56 (5H, m, ArH), 7.92-7.94 (2H, dd, *J* = 1.3 and 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 40.6 (t), 73.8 (d), 93.0 (s), 128.0 (d × 2), 128.3 (d × 2), 128.8 (d × 2), 129.6 (d), 130.0 (d × 2), 132.0 (s), 142.8 (s), 149.2 (s); MS m/z 336 (M^+), 257 (M^+ – Br); high resolution mass calcd for $C_{18}H_{13}BrN_2$: 336.0262; found 336.0230.

4-iodo-3,5-diphenyl-1-propargyl-*1H*-pyrazole (31c).
N-Iodosuccinimide (40.7 mg, 0.18 mmol) was added to a DCE (0.50 mL) solution of 2-(1,3-diphenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (**13a**) (25 mg, 0.06 mmol) at room temperature. The reaction mixture was stirred for 1 h and then poured into a 2% sodium thiosulfate solution (10 mL) and water (50 mL). The organic layer was separated and the aqueous layer was extracted with $CHCl_3$. The combined organic layer was dried over $MgSO_4$. The workup procedure gave 4-iodo-3,5-diphenyl-1-propargyl-1*H*-pyrazole (**31c**)(19 mg, 82 %) as a pale yellow oil.
A Yellow oil, IR (KBr, cm^{-1}) 3434, 3293, 3062, 2924, 2853, 1711, 1478, 1453, 1353, 1302, 1224, 1177, 1150, 974, 801, 765, 698, 672, 598; ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.39 (1H, t, *J* = 2.8 Hz, acetylenic H), 4.86 (2H, d, *J* = 2.7 Hz, CH_2), 7.38-7.40 (1H, m, ArH), 7.50-7.56 (4H, m, ArH), 7.89 (2H, d, *J* = 6.9 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 40.7 (t), 61.2 (s), 73.8 (d), 77.7 (s), 128.2 (d × 2), 128.3 (d), 128.5 (d × 2), 128.8 (d × 2), 129.4 (s), 129.6 (d), 130.3 (d × 2), 132.8 (s), 146.3 (s), 152.5 (s); MS m/z 384 (M^+), 257 (M^+ - I); high resolution mass calcd for $C_{18}H_{13}N_2I$: 384.0125; found 384.0098.

1-allyl-4-bromo-3,5-diphenyl-*1H*-pyrazole (31d).
N-Bromosuccinimide (573 mg, 3.22 mmol) was added to a DCE (9.0 mL) solution of 1-allyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13b**) (445 mg, 1.07 mmol) at room temperature. The reaction mixture was stirred for 50 min. The workup procedure gave 1-allyl-4-bromo-3,5-diphenyl-*1H*-pyrazole (**31d**)(295 mg, 81 %) as a pale yellow powders.
mp 53-55 °C (from CH_2Cl_2-*n*-hexane), IR (KBr, cm^{-1}) 3060, 3036, 2927, 2359, 2342, 1713, 1480, 1456, 1359, 1308, 1221, 1161, 981, 926, 771, 689, 606, 528; ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.70 (2H, dt, *J* = 1.4 and 5.5 Hz, CH_2), 5.01-5.04 (1H, m, olefinic H), 5.19 (1H, dd, *J* = 1.4 and 10.3 Hz, olefinic H), 5.94-6.00 (1H, m, olefinic H), 7.36-7.39 (1H, m, ArH), 7.43-7.52 (7H, m, ArH), 7.93-7.94 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 50.1 (t), 92.5 (s), 117.8 (t), 127.9 (d × 2), 128.1 (d), 128.3 (d × 2), 128.7 (d × 2), 128.8 (s), 129.4 (d), 130.0 (d × 2), 132.3 (s), 133.1 (d), 143.0 (s),

148.5 (s); MS 339 (M^+), 259 (M^+ – Br). Anal. Calcd for $C_{18}H_{15}BrN_2$: C, 63.73; H, 4.46; N, 8.26. Found: C, 63.69; H, 4.50; N, 8.27.

1-allyl-4-iodo-3,5-diphenyl-*1H*-pyrazole (31e).
N-Iodosuccinimide (81 mg, 0.36 mmol) was added to a DCE (1.0 mL) solution of 1-allyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13b**) (50 mg, 0.12 mmol) at room temperature. The reaction mixture was stirred at room temperature for 0.5 h. The workup procedure gave 1-allyl-4-iodo-3,5-diphenyl-1*H*-pyrazole (**31e**)(27 mg, 58 %) as pale yellow plates.
mp 135-140 ^oC, IR (KBr, cm^{-1}) 3062, 1712, 1475, 1453, 1352, 1308, 1222, 1154, 973, 915, 903, 698, 621, 610, 560, 518, 503; ^1H NMR (600 MHz, $CDCl_3$) δ 4.71 (2H, dd, *J* = 1.3 and 5.4 Hz, CH_2), 5.01 (1H, d, *J* = 17.2 Hz, olefinic H), 5.17 (1H, dd, *J* = 1.4 and 10.3 Hz, olefinic H), 5.92-5.97 (1H, m, olefinic H), 7.37-7.52 (8H, m, ArH), 7.89 (2H, d, *J* = 7.6 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 53.2 (t), 60.7 (s), 117.8 (t), 128.1 (d), 128.2 (d × 2), 128.4 (d × 2), 128.6 (d × 2), 129.4 (d), 130.0 (s), 130.2 (d × 2), 133.0 (s), 133.2 (d), 146.4 (s), 151.8 (s); MS m/z 386 (M^+), 258 (M^+ - I), 345 (M^+ - CH_2CN). Anal. Calcd for $C_{18}H_{15}N_2I$: C, 55.98; H, 3.91; N, 7.25. Found: C, 55.82; H, 3.89; N, 7.14.

1-cyano-4-bromo-3,5-diphenyl-*1H*-pyrazole (31f).
To a DCM (1.0 mL) solution of cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (50 mg, 0.12 mmol) was added *N*-bromosuccinimide (64 mg, 0.36 mmol). The reaction mixture was stirred at room temperature for 1 h. The workup procedure gave 4-bromo-1-cyanomethyl-3,5-diphenyl-1*H*-pyrazole (**31f**)(34 mg, 74 %) as pale yellow plates.
A Yellow oil, IR (KBr, cm^{-1}) 3063, 2977, 2938, 1482, 1456, 1449, 1405, 1349, 1314, 1239, 1158, 1012, 982, 914, 814, 772, 761, 716, 700, 607; ^1H NMR (600 MHz, $CDCl_3$) δ 4.97 (2H, s, CH_2), 7.41-7.43 (1H, m, ArH), 7.46-7.51 (4H, m, ArH), 7.56-7.60 (3H, m, ArH), 7.92-7.94 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 38.6 (t), 94.3 (s), 113.9 (s), 127.2 (s), 127.9 (d × 2), 128.8 (d), 129.3 (d × 2), 129.8 (d × 2), 130.3 (d), 131.3 (s), 143.7 (s), 150.5 (s); MS m/z 338 (M^+), 258 (M^+ – Br). Anal. Calcd for $C_{17}H_{12}BrN_3$: C, 60.37; H, 3.58; N, 12.40. Found: C, 59.54; H, 3.63; N, 11.99.

1-cyanomethyl-4-iodo-3,5-diphenyl-1*H*-pyrazole (31g).
N-iodosuccinimide (81 mg, 0.36 mmol) was added to a DCE (1.0 mL) solution of cyanomethyl-2-(1,3-diphenylprop-2-yn-1-yl)-*p*-toluensulfonylhydrazine (**13c**) (50 mg, 0.12 mmol). The reaction mixture was stirred at 83 ^oC for 15 min. The workup procedure gave 1-cyanomethyl-4-iodo-3,5-diphenyl-1*H*-pyrazole (**31g**)(31 mg, 67 %) as pala yellow plates.
mp 135-140 ^oC, IR (KBr, cm^{-1})3437, 3063, 2927, 1709, 1479, 1454, 1351, 1306, 1228, 1178, 1151, 1075, 1031, 1011, 975, 919, 808, 764, 699; ^1H NMR (600 MHz, $CDCl_3$) δ 4.97 (2H, s, CH_2), 7.41-7.49 (5H, m, ArH), 7.56-7.60 (3H, m, ArH), 7.87-7.88 (2H, m, ArH) ; ^{13}C NMR (150 MHz, $CDCl_3$) δ 38.7 (t), 62.6 (s), 113.9 (s), 128.3 (d × 2), 128.4 (d × 2), 128.8 (d), 129.3 (d × 2), 130.0 (d × 2), 130.3 (d), 132.1 (s), 147.1 (s), 153.7 (s); MS m/z 385 (M^+), 258 (M^+ - I), 345 (M^+ - CH_2CN); high resolution mass calcd for $C_{17}H_{12}N_3I$: 385.0078; found 385.0085.

4-Bromo-3-naphtyl-5-phenyl-1-propargyl-*1H*-pyrazole (31h).
Preparation of 2-(1-naphthyl-3-phenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine.
To an acetonitrile (2.0 mL) solution of 2-(1-naphthyl-3-phenylprop-2-yn-1-yl)-1-(*p*-toluenesulfonyl)hydrazine (**3**) (97.0 mg, 0.70 mmol) and potassium carbonate (55.6 mg, 0.47 mmol). The reaction mixture was stirred for 3.5 h at 50 ^oC and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 2-(1-Naphthyl-3-phenylprop-2-yn-1-yl)-1-propargyl-1-(*p*-toluenesulfonyl)hydrazine (97 mg, 89%) was obtained as a yellow oil.
IR (KBr, cm^{-1}) 3285, 3260, 3064, 2922, 2851, 2118, 1711, 1598, 1511, 1491, 1442, 1398, 1350, 1320, 1264, 1165, 1092, 1036, 964, 915, 868, 804, 781, 759, 732, 692, 663, 585, 567, 547; ^1H NMR (600 MHz, $CDCl_3$) δ 1.96 (1H, t, *J* = 2.8 Hz, acetylenic H), 2.29 (3H, s, CH_3), 3.84 (1H, d, *J* = 9.6 Hz, NH), 4.76 (1H, d, *J* = 18.6 Hz, CH_2), 4.86 (1H, dd, *J* = 2.0 and 18.6 Hz, CH_2), 5.98 (1H, d, *J* = 9.0 Hz, CH), 7.06 (2H, d, *J* = 8.3 Hz, ArH), 7.34-7.36 (3H, m, ArH), 7.45-7.54 (4H, m, ArH), 7.66 (1H, t, *J* = 6.8 Hz, ArH), 7.72 (2H, d, *J* = 8.3 Hz, ArH), 7.86 (2H, t, *J* = 8.2 Hz, ArH), 7.95 (1H, d, *J* = 6.9 Hz, ArH), 8.68 (1H, d, *J* = 8.3 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.5 (q), 40.8 (t), 54.9 (d), 75.2 (s), 75.9 (s), 87.1 (s), 88.3 (s), 122.5 (s), 124.8 (d), 125.0 (d), 126.0 (d), 126.6 (d), 126.7 (d), 128.4 (d), 128.5 (d × 2), 128.6 (d), 128.9 (d × 2), 129.2 (d × 2), 129.6 (d), 131.4 (s), 131.6 (d × 2), 132.2 (s), 133.3 (s), 133.8 (s), 143.8 (s); MS m/z 464 (small M^+), 424 (M^+ – propargyl H). Anal. Calcd for $C_{29}H_{24}N_2O_2S$: 74.97; H, 5.21; N, 6.03. Found: C, 74.69; H, 5.31; N, 6.04.
N-Bromosuccinimide (29 mg, 0.16 mmol) was added to acetonitrile (1.0 mL) solution of 2-(1-naphthyl-3-phenylprop-2-yn-1-yl)-1-propargyl-*p*-toluenesulfonylhydrazine (50 mg, 0.05 mmol). The reaction mixture was stirred at room temperature for 40 min. The workup procedure gave 4-bromo-3-naphtyl-5-phenyl-1-propargyl-*1H*-pyrazole (**31h**)(16 mg, 97 %) as a yellow oil.
IR (KBr, cm^{-1}) 3293, 3059, 1710, 1515, 1490, 1454, 1382, 1356, 1302, 1220, 1155, 1081, 1052, 1012, 954, 805, 780, 763, 701, 655; ^1H NMR (600 MHz, $CDCl_3$) δ 2.45 (1H, d, *J* = 2.7 Hz, CH), 4.94 (2H, d, *J* = 2.7 Hz,CH_2), 7.51-7.59 (6H, m, ArH), 7.65 (2H, d, *J* = 6.9 Hz, ArH), 7.70 (1H, d, *J* = 6.2 Hz, ArH), 7.90-7.94 (2H, m, ArH), 8.10-8.12 (1H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 40.7 (t), 73.9 (d), 77.7 (s), 95.7 (s), 125.0 (d), 125.9 (d), 126.3 (d × 2), 128.2 (d), 128.6 (d), 128.9 (d × 2), 129.1 (d), 129.3 (s), 129.6 (d), 130.0 (d × 2), 131.8 (s), 133.7 (s), 142.2 (s), 149.7 (s); MS m/z 387 (M^+), 307(M^+ - Br); high resolution mass calcd for $C_{22}H_{15}BrN_2$: 386.0419, found m/z 386.0419.

4-bromo-1-cyanomethyl-3-*p*-fuluorophenyl-5-diphenyl-1*H*-pyrazole (31i).
Preparation of 1-cyanomethyl-1-(*p*-fluorophenyl)-2-(3-phenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine.
To an acetonitrile (1.0 mL) solution of 2-(1-fluorophenyl-3-phenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (50 mg, 0.13 mmol) were added bromoacetonitrile (30.4 mg, 0.26 mmol) and cesium carbonate (82.6 mg, 0.26 mmol) at room temperature. The reaction mixture was stirred for 10 min at 50 ^oC and poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10). 1-Cyanomethyl-2-[1-(p-fluorophenyl)-3-phenylprop-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (53 mg, 96%) as white powders (mp 79-81 ^oC, from *n*-hexane).
IR (KBr, cm^{-1}) 3286, 3058, 2987, 2923, 2853, 1711, 1604, 1509, 1492, 1443, 1413, 1359, 1306, 1296, 1224, 1186, 1166, 1092, 1017, 976, 840, 816, 759, 741, 731, 692, 660; ^1H NMR (600 MHz, $CDCl_3$) δ 2.45 (3H, s, Me), 3.87 (1H, d, *J* = 5.5 Hz, NH), 4.35 (1H, d, *J* = 17.9 Hz, CH), 4.61 (1H, d, *J* = 17.9 Hz, CH), 5.28 (1H, d, *J* = 5.5 Hz, CH), 7.07 (2H, d, *J* = 17.2 Hz, ArH), 7.34-7.38 (5H, m, ArH), 7.45-7.46 (2H, m, ArH), 7.53-7.55 (2H, m, ArH), 7.82 (2H, d, *J* = 8.2 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.6 (q), 40.2 (t), 56.3 (d), 86.6 (s), 87.2 (s), 113.4 (s), 115.5 (d), 115.6 (d), 121.9 (s), 128.4 (d × 2), 128.7 (d × 2), 128.9 (d), 130.0 (d × 2), 130.1 (d), 130.2 (d), 131.7 (d × 2), 131.9 (s), 132.6 (s), 145.5 (s), 162.8 (d, *J* = 274.4 Hz, ArH); MS m/z 433 (M^+), 277 (M^+ – TsH). Anal. Calcd for $C_{24}H_{20}FN_3O_2S$: C, 66.50; H, 4.65; N, 9.69. Found: C, 66.42; H, 4.78; N, 9.57.
N-Bromosuccinimide (61.6 mg, 0.35 mmol) was added to an acetonitrile (1.0 mL) solution of 1-cyanomethyl-1-(*p*-fluorophenyl)-2-(3-phenylprop-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (50 mg, 0.12 mmol). The reaction mixture was stirred at room temperature for 2.5 h. The workup procedure gave 4-bromo-1-cyanomethyl-3-(*p*-fuluorophenyl)-5-phenyl-1*H*-pyrazole (**31i**) (25 mg, 61 %) as white powders.
mp 107-114 ^oC, IR (KBr, cm^{-1}) 3431, 2927, 1709, 1607, 1527, 1508, 1484, 1449, 1361, 1298, 1233, 1160, 1096, 1014, 984, 919, 842, 799, 764, 732, 701, 595, 550; ^1H NMR (600 MHz, $CDCl_3$) δ 4.97 (2H, s, CH_2), 7.17 (2H, t, *J* = 8.2 Hz,CH_2), 7.49-7.51 (2H, m, ArH), 7.57-7.60 (3H, m, ArH), 7.91-7.94 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 38.6 (t), 91.2 (s), 113.8 (s), 115.4 (d), 115.5 (d), 127.1 (s), 129.4 (d × 2), 129.7 (d × 3), 129.8 (d), 130.3 (d), 143.7 (s), 149.6 (s), 162.2 (s), 163.9(s); MS m/z 356 (M^+), 276 (M^+ - Br). Anal. Calcd for $C_{17}H_{11}BrFN_3$: C, 57.32; H, 3.11; N, 11.80. Found: C, 57.14; H, 3.12; N, 11.74.

1-allyl-5-butyl-4-iodo-3-phenyl-*1H*-pyrazole (31j).
N-Iodosuccinimide (111 mg, 0.44 mmol) was added to DCM (1.0 mL) solution of 1-allyl-2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22a**) (66 mg, 0.16 mmol). The reaction mixture was stirred at room temperature for 0.25 h. The workup procedure gave 1-allyl-5-butyl-4-iodo-3-(2-thienyl)-1*H*-pyrazole (**31j**)(32 mg, 52 %) as white powders.

mp 30-31 °C, IR (KBr, cm^{-1}) 2956, 2930, 2365,2356, 2335, 1712, 1510, 1465, 1222, 1073, 919, 704, 609, 600, 593, 584, 505; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.96 (3H, t, *J* = 7.5 Hz, Me), 1.39-1.45 (2H, m, CH_2), 1.53-1.58 (2H, m, CH_2), 2.69 (2H, t, *J* = 8.3 Hz, CH_2), 4.77-4.78 (2H, m, CH_2), 5.08 (1H, brd, *J* = 17.2 Hz, olefinic H), 5.22 (1H, dd, *J* = 1.4 and 10.3 Hz, olefinic H), 5.96-6.01 (1H, m, olefinic H), 7.08 (1H, dd, *J* = 3.4 and 4.8 Hz, ArH), 7.29 (1H, dd, *J* = 1.4 and 4.1 Hz, ArH), 7.45 (1H, dd, *J* = 1.4 and 3.5 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.8 (q), 22.5 (t), 25.8 (t), 30.7 (t), 53.0 (t), 117.6 (t), 125.1 (d), 125.4 (d), 127.1 (d), 133.0 (d), 135.4 (s), 146.0 (s), 146.1 (s); MS m/z 372 (M^+), 245 (M^+ - I). Anal. Calcd for $C_{14}H_{17}N_2SI_2$: C, 45.17; H, 4.60; N, 7.52. Found: C, 45.07; H, 4.58; N, 7.38.

Transformation of 1-Alkyl-1-tosyl-2-propargylhydrazines to Functionalized Experimental for Scheme 4.

Suzuki coupling reaction of 31e.

To an ethanol (1.0 mL) solution of **31e** (50 mg, 0.15 mmol) was added *p*-methoxyphenylboronic acid (67 g, 0.44 mmol), potassium carbonate (102 mg, 0.74 mmol) in H_2O (0.50 mL) solution, and palladium bis(triphenylphosphine) dichloride (21 mg, 0.03 mmol). The reaction mixture was stirred at 80 °C for 2.5 h and then poured into water (50 mL). The workup procedure gave 1-allyl-4-(*p*-methoxyphenyl)-3,5-diphenylpyrazole (**32**)(38 mg, 70%) as a yellow oil.

IR (KBr, cm^{-1}) 3065, 2956, 2927, 2852, 2836, 1712, 1606, 1576, 1552, 1519, 1458, 1440, 1363, 1319, 1287, 1247, 1176, 1106, 1073, 1035, 974, 921, 839, 779, 699; ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.76 (3H, s, Me), 4.71 (2H, dt, *J*=1.4 and 16.9 Hz, olefinic H), 5.07 (1H, dd, *J*=1.4 and 10.1 Hz, olefinic H), 6.00-6.09 (1H, m, olefinic H), 6.71 (2H, d, J=8.7 Hz, ArH), 6.95 (2H, d, *J*=8.7 Hz, ArH), 7.24-7.27 (6H, m, ArH), 7.34-7.36 (2H, m, ArH), 7.48-7.50 (2H, m, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 52.3 (t), 55.0 (q), 113.5 (d × 2), 114.2 (d), 117.4 (t), 118.8 (s), 125.6 (s), 127.2 (d), 128.1 (d × 2), 128.2 (d × 2), 128.4 (d × 2), 128.5 (s), 130.3 (d × 2), 131.5 (d × 2), 133.6 (s), 133.8 (d), 142.1 (s), 148.8 (s), 158.1 (s); MS m/z 366 (M^+).

1-phenylhepta-1,2-diene (33).[19]

To a nitromethane (1.0 mL)-H_2O (0.20 mL) solution of 2-(1-phenylhept-2-yn-1-yl)-*p*-toluenesulfonylhydrazine (**2**) (50 mg, 0.14 mmol) were added tetrabutylammonium hydrogensulfate (4.8 mg, 0.014 mmol) and lanthanum triflate (8.2 mg, 0.014 mmol). The reaction mixture was refluxed for 0.5 h and poured into a sat. $NaHCO_3$ (30 mL) solution. The workup procedure gave the titled compound **32** (26 mg, 99%) as a yellow oil.

The titled compound **33** (25 mg, 54%) was also obtained by the direct reaction of 1-phenylhept-2-yn-1-ol (50 mg, 0.27 mmol), *p*-toluenesulfonyl hydrazine (0.15 g, 0.80 mmol), tetrabutylammonium hydrogensulfate (9.0 mg, 0.027 mmol), lanthanum triflate (16 mg, 0.027 mmol), and magnesium triflate (9.0 mg, 0.027 mmol).

silver nitrate catalyzed cyclization of propargyl hydrazides.

*2-[5-butyl- 3-(thiophen-2-yl)-1H-pyrazol-1-yl]acetate (**33a**).*

To a mixture of acetonitrile (0.60 mL) and acetic acid (0.30 mL) of cyanomethyl-2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (**22b**)(50 mg, 0.13 mmol) was added to a 0.1 M silver nitrate solution (0.1 ml, 0.025 mmol) and gold (I) chloride (1.4 mg, 0.0062 mmol) at room temperature. The reaction mixture was stirred for 0.5 h and then poured into water (50 mL). The organic layer was separated and the aqueous layer was extracted with AcOEt. The combined organic layer was washed with sat. $NaHCO_3$ (20 mL) and water (30 mL) and then dried over $MgSO_4$. The solvent was removed under reduced pressure. The residue was purified by preparative TLC on silica gel eluting with AcOEt-*n*-hexane (1:10) to give 2-[5-butyl-3-(thiophen-2-yl)-*1H*-pyrazol-1-yl]acetonitrile (**33a**)(19 mg, 86 %) as white powders (mp 108-109 °C).

White powders, mp 108-109 °C, IR (KBr, cm^{-1}) 3107, 3074, 2958, 2932, 2871, 1711, 1597, 1570, 1531, 1466, 1430, 1414, 1400, 1381, 1305, 1227, 1180, 1090, 1057, 916, 849, 799, 706; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.98 (3H, t, *J* = 7.6 Hz, Me), 1.44-1.49 (2H, m, CH_2), 1.69-1.74 (2H, m, CH_2), 2.66 (2H, t, *J* = 8.3 Hz, CH_2), 5.00 (2H, s, CH_2), 6.32 (1H, s, ArH), 7.05 (1H, dd, *J* = 3.5 and 4.5 Hz, ArH), 7.26 (1H, d, *J* = 4.6 Hz, ArH), 7.30 (1H, *J* = 2.7 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.7 (q), 22.3 (t), 25.1 (t), 30.2 (t), 37.1 (t), 103.2 (d), 113.8 (s), 124.2 (d), 124.9 (d), 127.4 (d), 135.8 (s), 145.4 (s), 147.4 (s); MS *m/z* 245 (M^+). Anal. Calcd for $C_{13}H_{15}N_3S$: C, 63.64; H, 6.16; N, 17.13. Found: C, 63.60; H, 6.15; N, 16.89.

ethyl 2-[5-butyl- 3-(thiophen-2-yl)-*1H*-pyrazol-1-yl]acetate (33b).

To an acetonitrile (1.0 mL) solution of 2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazide (**7**) (100 mg, 0.28 mmol) was added ethyl bromoacetate (46 mg, 0.28 mmol) and cesium carbonate (90.0 mg, 0.28 mmol) at room temperature. The reaction mixture was stirred at 50 °C for 10 min and then poured into water (50 mL). The workup procedure gave ethyl 2-[1-(2-thienyl)hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (61 mg, 99%) as white needles.

mp 49-50 °C, IR (KBr, cm^{-1}) 3302, 2959, 2930, 2862, 1739, 1599, 1458, 1402, 1344, 1305, 1292, 1213, 1164, 1094, 1021, 953, 815, 754, 708; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.91 (3H, t, *J* = 7.4 Hz, Me), 1.17 (3H, t, *J* = 7.5 Hz, Me), 1.37-1.44 (2H, m, CH_2), 1.47-1.53 (2H, m, CH_2), 2.23 (1H, dt, *J* = 1.7 and 5.1 Hz, CH_2), 2.41 (3H,s, CH_3), 3.99-4.11 (2H, m, CH_2), 4.40 (1H, d, *J* = 8.4 Hz, CH_2), 4.60-4.64 (2H, m, NH and CH), 5.06 (1H, d, *J* = 7.4 Hz, CH), 6.92 (1H, dd, *J* = 3.4 and 5.1 Hz, ArH), 7.06 (1H, d, *J* = 3.4 Hz, ArH), 7.25 (1H, dd, *J* = 1.1 and 5.1 Hz, ArH), 7.29 (2H, d, *J* = 8.0 Hz, ArH), 7.82 (2H, d, *J* = 8.6 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.5 (q), 13.9 (q), 18.3 (t), 21.5 (q), 21.9 (t), 30.4 (t), 50.5 (t), 51.9 (d), 61.2 (t), 78.8 (s), 86.8 (s), 125.9 (d), 126.2 (d), 126.4 (d), 128.5 (d × 2), 129.2 (d × 2), 134.9 (s), 142.0 (s), 143.7 (s), 168.9 (s); MS m/z 449 (small M^+), 292 (M^+ - TsOH). Anal. Calcd for $C_{22}H_{28}N_2O_4S_2$: C, 58.90; H, 6.29; N, 6.24. Found: C, 58.83; H, 6.31; N, 6.25.

To an acetonitrile (0.60 mL)-acetic acid (0.30 mL) mixture of ethyl-2-[1-(2-thienyl)-hept-2-yn-1-yl]-*p*-toluenesulfonylhydrazine (50 mg, 0.11 mmol) was added to a 0.1 M silver nitrate (0.1 ml, 0.022 mmol) solution at room temperature. The reaction mixture was stirred at 50 °C for 5 h and then poured into water (50 mL). The workup procedure gave ethyl 2-[5-butyl-3-(thiophen-2-yl)-*1H*-pyrazol-1-yl]acetate (**33b**)(23 mg, 71 %) as a yellow oil.

IR (KBr, cm^{-1}) 2958, 2932, 2871, 2360, 2337, 1754, 1712, 1568, 1531, 1467, 1377, 1311, 1264, 1209, 1024, 849, 701; ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.95 (3H, t, *J* = 7.6 Hz, Me), 1.27 (3H, t, *J* = 7.6 Hz, Me), 1.40-1.46 (2H, m, CH_2), 1.64-1.76 (2H, m, CH_2), 2.53 (2H, t, *J* = 7.6 Hz, CH_2), 4.21-4.24 (2H, m, CH_2), 4.85 (2H, s, CH_2), 6.30 (1H, s, ArH), 7.02 (1H, dd, *J* = 3.5 and 4.8 Hz, ArH), 7.21 (1H, d, *J* = 6.2 Hz, ArH), 7.28 (1H, d, *J* = 3.4 Hz, ArH); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.8 (q), 14.1 (t), 22.3 (t), 25.1 (t), 30.2 (t), 50.6 (t), 61.7 (t), 102.1 (d), 123.5 (d), 124.2 (d), 127.3 (d), 136.8 (s), 145.5 (s), 146.3 (s), 167.8 (s); MS *m/z* 292 (M^+), 263 (M^+ - Et), 219 (M^+ - CO_2Et). Anal. Calcd for $C_{15}H_{20}N_2O_2S$: C, 61.62; H, 6.89; N, 9.58. Found: C, 61.55; H, 6.88; N, 9.24.

Keywords: Hydrazines • Propargyl • Pyrazoles • Alkylation • Halogenation

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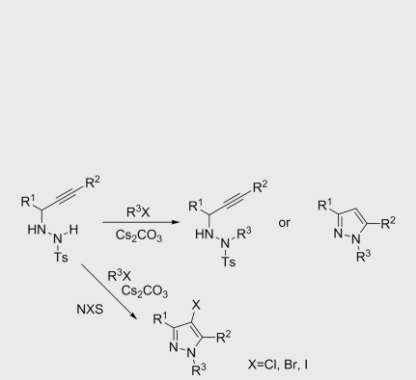

Key Topic*

*Kosuke Kiyokawa, Yukiteru Ito, Ryoma Kakehi, Takahiro Ogawa, Yusuke Goto and Prof. Dr. Mitsuhiro Yoshimatsu**

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Propargyl Hydrazides as a Useful Intermediate Leading to Pyrrazoles via Certain Electrophiles.

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