A FACILE SYNTHESIS OF *N*-ARYLCYANOFORMAMIDOXIMES, 4-ARYL-3-CYANO-1,2,4-OXADIAZIN-5(6*H*)-ONES, 2-CYANOQUINAZOLINE-3-OXIDES, AND 2-CYANOQUINAZOLINES *VIA* 5-ARYLIMINO-4-CHLORO-5*H*-1,2,3-DITHIAZOLES

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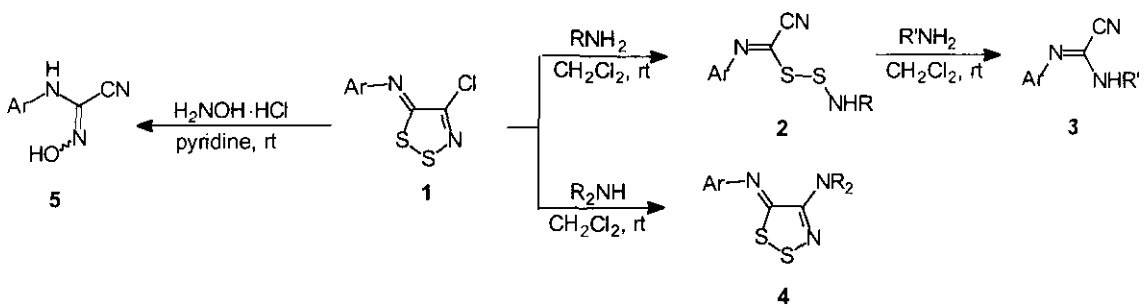
Abstract - The reaction of 5-arylimino-4-chloro-5*H*-1,2,3-dithiazoles with hydroxylamine hydrochloride in pyridine at room temperature gave *N*-arylcyanoformamidoximes, which were utilized as starting materials for the synthesis of 4-alkyl- (or aryl)-2-cyanoquinazolines and 4-aryl-3-cyano-1,2,4-oxadiazin-5(6*H*)-ones.

Recently much attention has been focused on exploring the synthetic utility of 5-arylimino-4-chloro-5*H*-1,2,3-dithiazoles (**1**)[1] which can be readily prepared from primary arylamines and 4,5-dichloro-5*H*-1,2,3-dithiazolium chloride (Appel's salt) in the presence of tertiary amine, mostly pyridine, in CH_2Cl_2 at room temperature.[2] Compounds (**1**) are attacked by primary and simple secondary alkylamines to give *N*-aryl-*N'*-alkylcyanoformamidines (**3**) *via* amino disulfides (**2**),[3] whereas treatment with bulky secondary alkylamines gave 5-arylimino-4-dialkylamino-5*H*-1,2,3-dithiazoles (**4**)[4] (Scheme 1).



Scheme 1

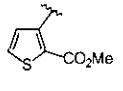
In a continuation of our ongoing project to develop the chemistry of **1**, compounds (**1**) were treated with hydroxylamine hydrochloride in pyridine at room temperature. The reactions proceeded smoothly to give

N-arylcyanoformamidoximes (**5**), which have received little attention in spite of extensive study on the synthesis and properties of amidoximes and related compounds.[5]

N-Phenylcyanoformamidoxime (**5a**) was reported to be prepared by treatment of chloroglyoxime with $SOCl_2$ in dry ether.[6] Later base catalyzed 1,2-migration of *N*-nitroso-areneaminoacetonitrile in MeOH was reported to give **5**.[7] However, the applicability of **5** has seldom been reported. Cyanoformamidoxime derivatives such as cyanoformamidoxime *O*-carbamate have been of biological interest because some of them have had significant use as acaracides, neumatocides, soil fungicides, and insecticides.[8]

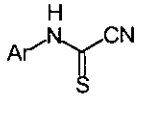
Table 1 shows yields and melting points of **5** prepared and reaction times.

Table 1. Reaction times and yields and melting points of *N*-arylcyanoformamidoximes **5** and 4-aryl-3-cyano-1,2,4-oxadiazin-5(6*H*)-ones (**12**)

	Ar	Time		Yield[a] (*E*/*Z*)	mp (decomp)	Time		Yield[a]	mp
		h		%	°C	min		%	°C
1a	Ph	3	**5a**	28 (1 : 10)	144-145[b]	10	**12a**	74	109-110[b]
1b	4-BrC_6H_4	15	**5b**	30 (1 : 7)	144-146[b]	10	**12b**	84	146-148[b]
1c	4-ClC_6H_4	3	**5c**	26 (1 : 7)	157-158[b]	10	**12c**	77[f]	124-125[b]
1d	2-$MeO_2CC_6H_4$	18	**5d**	84	184-186[c]	10	**12d**	73	85-86[b]
1e	4-$O_2NC_6H_4$	3	**5e**	54 (1 : 3)	168-170[c]	10	**12e**	59, 65[g]	158-159[d]
1f	2-$O_2NC_6H_4$	6	**5f**	47 (1 : 20)	121-122[b]	10	**12f**	70	99-100[b]
1g	3-$O_2NC_6H_4$	20	**5g**	54 (1 : 4)	143-144[b]	10	**12g**	61[h]	153-154[h]
1h	2-Me-4-$O_2NC_6H_3$	7	**5h**	79 (1 : 7)	156-158[b]	10	**12h**	56	Sticky
1i	2-Cl-5-$O_2NC_6H_3$	7	**5i**	40 (1 : 7)	126-128[b]	10	**12i**	67[i]	118-119[b]
1j		4	**5j**	83	176-177[b]	60	**12j**	10[j]	156-158[b]
1k	4-$MeC_6H_4SO_2$	24	**5k**	69 (1 : 3)	170-172[e]				

[a]Isolated yields. [b]Recrystallized from a mixture of CH_2Cl_2 and *n*-hexane. [c]Recrystallized from $CHCl_3$. [d]Recrystallized from EtOH. [e]Recrystallized form CH_2Cl_2. [f]Chloroacetic anhydride was used. [g]Triisopropylamine was used instead of TEA. [h]Compound (**5g**) was recoverd in 35% yield. [i]Compound (**5i**) was recovered in 12% yield. [j]Compound (**5j**) was recovered in 72% yield.

In addition to compounds (**5**), small amounts of sulfur and unknown mixtures were obtained. In the cases of the reactions of **1a**, **1b**, and **1c**, *N*-arylcyanothioformamides (**6a**) (5%), (**6b**) (36%), and (**6c**) (26%) were isolated.[9] No *N*-arylcyanothioformamide was isolated from the reactions with other dithiazoles (**1**)



6a, Ar = Ph
6b, Ar = 4-BrC_6H_4
6c, Ar = 4-ClC_6H_4
6d, Ar = 2-NCC_6H_4
6e, Ar = 4-$MeOC_6H_4$
6f, Ar = 4-Me-C(=N-OH)-C_6H_4

listed in Table 1. Interestingly, the reaction with **1l** (Ar = 2-NCC_6H_4) under the same conditions gave a complex mixture from which only **6d** (27%) was isolated.

It has been found that the reactions of **1** bearing an electron-donating group did not give **5**. For instance, the reaction of **1** having a 4-MeO group afforded the corresponding cyanothioformamide (**6e**) (33%),[9] and those of **1** having 2-HO and 2-Me groups gave sulfur and unknown mixtures without **6**. It has been observed that amidoximes are configurationally labile and amidoximes which are monosubstituted on the amide nitrogen generally form oximes with the *Z* configurations.[10] However, the stereochemistry around the C=N double bond of **5** is uncertain. A single crystal of **5** has not yet been obtained for X-Ray crystallography. The ^{1}H NMR spectra of **5a-k** indicate that compounds (**5**) exist in a single stereoisomer in $CDCl_3$, whereas **5a-c**, **5e-i** and **5k** exist in a mixture of *E*- and *Z*-isomers in DMSO-d_6. The assignment of the stereochemistry of **5** was made based on the relationship between the reported ^{1}H NMR spectral data observed from *E*- and *Z*-amidoximes.[11] That is, the N-H protons of *Z*-isomers appeared upfield compared with those of *E*-isomers, whereas the chemical shifts of the O-H protons of *E*- and *Z*-amidoximes showed an opposite tendency, probably due to hydrogen-bonding effects between the amino hydrogen and the oximino oxygen atoms. Based on this result, the *E*/*Z* ratios of **5** in DMSO-d_6 were determined. The results are summarized in parentheses in Table 1.

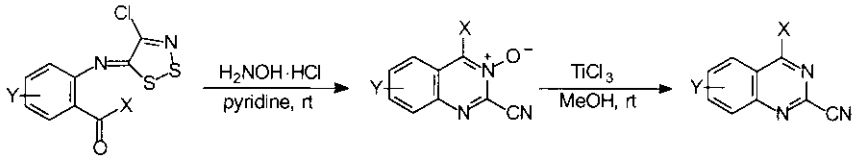
It is envisaged that the polarity of DMSO-d_6 causes the hydrogen bonding of *Z*-stereoisomer to break so that *E*-stereoisomer tends to be formed. In contrast, $CDCl_3$ which is nonpolar would not significantly influence the strength of the hydrogen-bond of *Z*-isomer. Consequently, only single isomer exists in $CDCl_3$.

When the aryl group of **1** has an acetyl or a benzoyl group at its *ortho* position, 2-cyanoquinazoline-3-oxides (**7**) were formed under the same conditions. Treatment of **7** with $TiCl_3$ according to the documented procedure gave 4-alkyl- and 4-aryl-2-cyanoquinazolines (**8**)[12] (Scheme 2). The results are summarized in Table 2.

Table 2. Reaction times, and yields of 2-cyanoquinazoline-3-oxides (**7**) and 2-cyanoquinazolines (**8**)

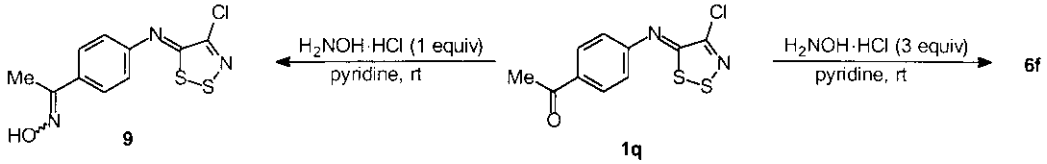
Compound	X	Y	Time	Yield[a]		mp (decomp)	Time	Yield[a]		mp
			h		%	°C	min		%	°C
1m	Me	H	72	**7a**	92	210-214[b]	40	**8a**	69	148-149[b] (lit.,[13] 145 – 147)
1n	Ph	H	24	**7b**	62	223-225[c]	60	**8b**	51	124-125[c] (lit.,[13] 127 – 129)
1o	Ph	5-Me	48	**7c**	41	190-192[b]	5	**8c**	51	156-158[b]
1p	Ph	4-Cl	72	**7d**	62	194-196[b]	5	**8d**	75	178-180[d]

[a]Isolated yields. [b]Recrystallized from a mixture of CH_2Cl_2 and *n*-hexane. [c]Recrystallized from EtOH. [d]Recrystallized from MeOH.



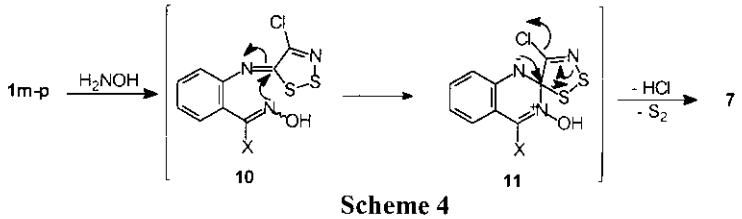
Scheme 2

In contrast, the reactions of compound (**1q**) (Ar = 4-$MeCOC_6H_4$) with 1 and 3 molar equivalents of hydroxylamine hydrochloride under the same conditions gave oxime (**9**) and cyanothioformamide (**6f**) in 82% and 36% yields, respectively (Scheme 3).



Scheme 3

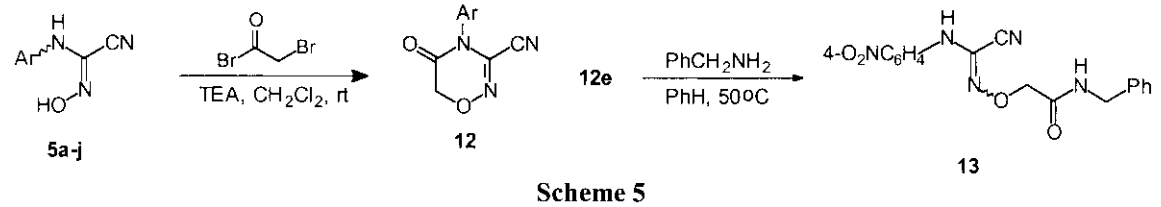
This result suggests that the non-bonding electrons on the oximino nitrogen of **10** attack C-5 of the dithiazole ring of **1** to give an intermediate (**11**), which extrudes S_2 concomitant with HCl, leading to **7** (Scheme 4).



Scheme 4

In the meantime, compounds (**5a-j**) were found to be useful starting materials for the synthesis of 4-aryl-3-cyano-1,2,4-oxadiazin-5(6*H*)-ones (**12**), which have never been reported in the literature although various 5,6-dihydro-4*H*-1,2,4-oxadizines[14] and 3-alkyl- and 3-aryl-4*H*-1,2,4-oxadizin-5(6*H*)-ones[15] have been prepared.

Treatment of **5a-j** with bromoacetyl bromide in the presence of triethylamine at room temperature gave **12** in good yields (Scheme 5). Compound (**5k**) was recovered quantitatively under the same reaction conditions. Reaction times and yields of **12** are summarized in Table 1.



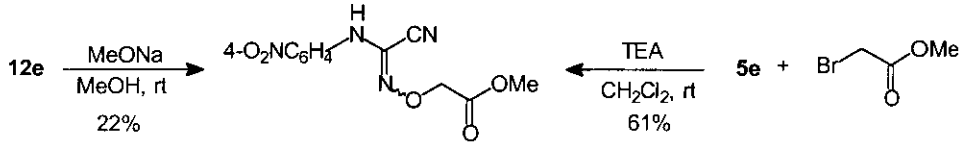
Scheme 5

The regiochemistry of **12** was determined based on the HMBC spectrum of **12a**, coupled with the

chemical transformation of **12e**. Most of compounds (**12**) exhibited carbonyl absorptions at 1731 to 1738 cm^{-1} except for **12d** and **12j**, which showed two absorptions at 1706 and 1744 cm^{-1}. The IR spectral data are of no useful in determining the regiochemistry of **12** in view of the carbonyl absorptions at 1705 - 1725 cm^{-1} and 1750 - 1776 cm^{-1} exhibited by 3-aryl-4*H*-1,2,4-oxadizin-5(6*H*)-one[15] and 4,5-dihydro-1,2,4-oxadiazin-6(5*H*)-one,[14] respectively. Similarly an indistinguishable tendency was found from the ^1H NMR spectral data. That is, the ^1H NMR spectral data of **12a-c**, **12e**, and **12g-j** exhibited a singlet at 4.72 to 4.79 ppm except for **12d** and **12f** which exhibited two singlets at 4.61 and 4.77, and 4.61 and 4.84 ppm, respectively. However, the chemical shifts exhibited by the former are close to 4.23 - 4.72 and 3.86 - 5.20 ppm, exhibited by 3-aryl-4*H*-1,2,4-oxadiazin-5(6*H*)-one and 4,5-dihydro-1,2,4-oxadiazin-6(5*H*)-one, respectively.

The HMBC spectrum of **12a** shows that the methylene protons at C-6 do not correlate with the quaternary carbon bonded to N-4. This result clearly indicates that the compound has a skeleton of 1,2,4-oxadiazin-5(6*H*)-one rather than 1,2,4-oxadiazin-6(5*H*)-one. Furthermore, treatment of **12e** with benzylamine in benzene at 50 °C gave *O*-alkylated cyanoformamidoxime (**13**) in 79% yield (Scheme 5). The ^1H NMR spectral data recorded in DMSO-d_6 suggest that **13** is a mixture of stereoisomers whose ratio is 1.8:1. More work has to be done for the assignment of the stereochemistry of **13**.

Similarly treatment of **12e** with MeONa in MeOH at room temperature gave *O*-alkylated cyanoformamidoxime (**14**) (22%), whose structure was identical with that obtained from the reaction of **5e** with methyl bromoacetate (Scheme 6).



Scheme 6

In conclusion, we demonstrated that 5-arylimino-4-chloro-5*H*-1,2,3-dithiazoles (**1**) are useful starting materials for the synthesis of *N*-arylcyanoformamidoximes (**5**) which can be utilized for the synthesis of 4-alkyl- (or aryl)-2-cyanoquinazolines (**8**) and 4-aryl-3-cyano-1,2,4-oxadiazin-5(6*H*)-ones (**12**).

EXPERIMENTAL

All melting points were determined on a Fisher-Johns melting point apparatus and are uncorrected. IR specta were obtained on a Shimadzu IR-470 IR spectrophotometer for samples of KBr pellets or thin films. ^1H NMR spectra were determined on a Bruker 300 MHz spectrometer using tetramethylsilane as internal standard; J values are given in Hz. MS spectra were obtained by electron impact at 70 eV. Elemental analyses were determined by the Korea Basic Science Institute. Column chromatography was

performed on silica gel (Merck, 70 – 230 mesh, ASTM). 5-Arylimino-4-chloro-5*H*-1,2,3-dithiazoles (1) were prepared according to the literature procedures.[2]

General Procedure for the Preparation of *N*-Arylcyanoformamidoximes (5). To a solution of 1 (0.4-0.5 mmol) in pyridine (5 mL) was added $H_2NOH{\cdot}HCl$ (56 – 70 mg, 0.8 – 1.0 mmol). The mixture was stirred for an appropriate time at rt, followed by neutralization with 5% HCl. The mixture was extracted with CH_2Cl_2 (25 mL x 3), which was dried over $MgSO_4$. Chromatography (3 x 10 cm) of the residue with *n*-hexane gave sulfur. Elution with a mixture of *n*-hexane and EtOAc (10:1) gave unknown mixtures. Elution with the same solvent mixture whose ratios were 5:1 and 2:1 gave **6** and **5**, respectively. Reaction time and yields and melting points of **5** are summarized in Table 1.

***N*-Phenylcyanoamidoximes (5a)**: ^{1}H NMR (DMSO-d_6, δ, ppm) 7.08 – 7.40 (5H, m, ArH of major and minor), 9.16 (1H, s, NH of major), 9.46 (1H, s, NH of minor), 11.28 (1H, s, OH of minor), 11.82 (1H, s, OH of major); IR (KBr) (υ, cm^{-1}) 3408, 3248, 2240, 1619, 1590, 1494, 1436, 1360, 976, 928, 745, 698; MS (EI) m/z 161 (M^+, 60%), 144 (100), 131 (18), 129 (12), 118 (15). *Anal.* Calcd for $C_8H_7N_3O$: C, 59.62; H, 4.38; N, 26.07. Found: C, 59.70; H, 4.41; N, 26.01.

***N*-(4-Bromophenyl)cyanoformamidoxime (5b)**: ^{1}H NMR ($CDCl_3$, δ, ppm) 6.99 (1H, s, NH), 7.09 (2H, d, J = 8.8 Hz, ArH), 7.51 (2H, d, J = 8.8 Hz, ArH), 8.51 (1H, s, OH); ^{1}H NMR (DMSO-d_6, δ, ppm) 7.14 (2H, d, J = 8.7 Hz, ArH of major), 7.34 (2H, d, J = 8.4 Hz, ArH of minor), 7.46 (2H, d, J = 8.4 Hz, ArH of minor), 7.51 (2H, d, J = 8.8 Hz, ArH of major), 9.31 (1H, s, NH of major), 9.65 (1H, s, NH of minor), 11.41 (1H, s, OH of minor), 12.0 (1H, s, OH of major); IR (KBr) (υ, cm^{-1}) 3360, 3152, 2224, 1634, 1578, 1482, 1355, 1066, 994, 928, 826, 778; MS (EI) m/z 222 (M^+ - 18, 98%), 196 (8), 170 (5), 155 (14), 143 (8), 117 (8). *Anal.* Calcd for $C_8H_6N_3OBr$: C, 40.03; H, 2.52; N, 17.50. Found: C, 40.06; H, 2.50; N, 17.50.

***N*-(4-Chlorophenyl)cyanoformamidoxime (5c)**: ^{1}H NMR ($CDCl_3$, δ, ppm) 6.94 (1H, s, NH), 7.14 (2H, d, J = 8.8 Hz, ArH), 7.36 (2H, d, J = 8.8 Hz, ArH), 8.09 (1H, s, OH); ^{1}H NMR (DMSO-d_6, δ, ppm) 7.21 (2H, d, J = 8.7 Hz, ArH of major and minor), 7.39 (2H, d, J = 8.8 Hz, ArH of major and minor), 9.29 (1H, s, NH of major), 9.62 (1H, s, NH of minor), 11.38 (1H, s, OH of minor), 11.93 (1H, s, OH of major); IR (KBr) (υ, cm^{-1}) 3368, 3152, 2232, 1634, 1586, 1486, 1406, 1358, 1068, 992, 930, 832; MS (EI) m/z 195 (M^+ , 31%), 178 (100), 165 (20), 152 (34), 138 (2), 127 (20). *Anal.* Calcd for $C_8H_6N_3OCl$: C, 49.12; H, 3.09; N, 21.48. Found: C, 49.23; H, 3.13; N, 21.38.

***N*-(2-Methoxycarbonylphenyl)cyanoformamidoxime (5d)**: ^{1}H NMR (DMSO-d_6/$CDCl_3$, δ, ppm) 3.90

(3H, s, CH_3), 6.94 – 7.21 (1H, m, ArH), 7.49 – 7.62 (2H, m, ArH), 7.99 (1H, d, J = 8.0 Hz, ArH), 10.30 (1H, s, NH), 12.25 (1H, s, OH); IR (KBr) (υ, cm^{-1}) 3216, 3168, 2232, 1685, 1621, 1502, 1254, 1080, 989, 938, 749; MS (EI) m/z 219 (M^+, 13%), 203 (6), 187 (17), 170 (11), 157 (43), 144 (39). *Anal.* Calcd for $C_{10}H_9N_3O_3$: C, 54.79; H, 4.14; N, 19.17. Found: C, 54.62; H, 4.20; N, 19.02.

***N*-(4-Nitrophenyl)cyanoformamidoxime (5e)**: ^1H NMR ($CDCl_3$, δ, ppm) 7.32 (2H, d, J = 9.1 Hz, ArH), 8.02 (1H, s, NH), 8.28 (2H, d, J = 9.1 Hz, ArH); ^1H NMR (DMSO-d_6, δ, ppm) 7.34 (2H, d, J = 9.2 Hz, ArH of major), 7.58 (2H, d, J = 9.3 Hz, ArH of minor), 8.11 (2H, d, J = 9.2 Hz, ArH of minor), 8.18 (2H, d, J = 9.1 Hz, ArH of major), 9.21 (1H, s, NH of major), 9.84 (1H, s, NH of minor), 11.36 (1H, s, OH of minor); IR (KBr) (υ, cm^{-1}) 3320, 3200, 2232, 1627, 1587, 1501, 1328, 1296, 1106, 1006, 976, 846, 741, 702; MS (EI) m/z 190 (M^+ - 16, 100%), 174 (3), 160 (19), 117 (29), 108 (5). *Anal.* Calcd for $C_8H_6N_4O_3$: C, 46.61; H, 2.93; N, 27.18. Found: C, 46.59; H, 2.89; N, 27.22.

***N*-(2-Nitrophenyl)cyanoformamidoxime (5f)**: ^1H NMR ($CDCl_3$, δ, ppm) 7.23 – 7.26 (1H, m, ArH), 7.71 – 7.72 (2H, m, ArH), 8.26 (1H, d, J = 8.5 Hz, ArH), 8.44 (1H, s, NH), 9.97 (1H, s, OH); IR (KBr) (υ, cm^{-1}) 3328, 3087, 2238, 1607, 1507, 1452, 1356, 1282, 1001, 780, 745, 675; MS (EI) m/z 206 (M^+, 100%), 190 (20), 143 (61), 138 (29). *Anal.* Calcd for $C_8H_6N_4O_3$: C, 46.61; H, 2.93; N, 27.18. Found: C, 46.80; H, 2.87; N, 27.19.

***N*-(3-Nitrophenyl)cyanoformamidoxime (5g)**: ^1H NMR (DMSO-d_6, δ, ppm) 7.57 – 7.60 (2H, m, ArH of minor), 7.62 – 7.71 (2H, m, ArH of major), 7.80 – 7.82 (1H, m, ArH of minor), 7.89 – 7.93 (1H, m, ArH of major), 8.05 (1H, s, ArH of major), 8.46 (1H, s, ArH of minor), 9.67 (1H, s, NH of major), 10.06 (1H, s, NH of minor), 11.71 (1H, s, OH of minor), 12.21 (1H, s , OH of major); IR (KBr) (υ, cm^{-1}) 3328, 3184, 2240, 1690, 1622, 1523, 1341, 1011, 883, 794, 736; MS (EI) m/z 206 (M^+, 76%), 190 (58%), 189 (22), 188 (18), 176 (100), 174 (19). *Anal.* Calcd for $C_8H_6N_4O_3$: C, 46.61; H, 2.93; N, 27.18. Found: C, 46.75; H, 2.99; N, 27.05.

***N*-(2-Methyl-4-nitrophenyl)cyanoformamidoxime (5h)**: ^1H NMR ($CDCl_3$, δ, ppm) 2.44 (3H, s, CH_3), 6.79 (1H, br s, NH), 7.51 (1H, d, J = 9.6 Hz, ArH), 8.17 – 8.20 (3H, m, ArH and OH); ^1H NMR (DMSO-d_6, δ, ppm) 2.35 (3H, s, CH_3 of minor), 2.37 (3H, s, CH_3 of major), 7.31 (1H, d, J = 8.8 Hz, ArH of major), 7.56 (1H, d, J = 8.7 Hz, ArH of minor), 8.05 – 8.10 (1H, m, ArH of major), 8.05 – 8.10 (2H, ArH of minor), 8.14 (1H, s, ArH of major), 8.96 (1H, s, NH of major), 9.00 (1H, s, NH of minor), 12.14 (1H, s, OH of minor),12.25 (s, 1H, OH of major); IR (KBr) (υ, cm^{-1}) 3376, 3280, 2240, 1613, 1581, 1501, 1459, 1318, 1280, 998, 896, 822, 739. *Anal.* Calcd for $C_9H_8N_4O_3$: C, 49.09; H, 3.66; N, 25.44. Found: C, 49.15; H, 3.62; N, 25.52.

***N*-(2-Chloro-5-nitrophenyl)cyanoformamidoxime (5i)**: ^{1}H NMR (DMSO-d_6, δ, ppm) 7.77 (1H, d, J = 8.7 Hz, ArH of minor), 7.85 (1H, d, J = 8.8 Hz, ArH of major), 8.07 (1H, d, J = 8.8 Hz, ArH of major and minor), 8.14 (1H, s, ArH of major), 8.56 (1H, s, ArH of minor), 9.20 (1H, s, NH of major), 9.24 (1H, s, NH of minor), 12.05 (1H, s, OH of minor), 12.19 (1H, s, OH of major); IR (KBr) (υ, cm^{-1}) 3360, 3088, 2240, 1629, 1523, 1341, 1050, 1014, 992, 883, 736; MS (EI) m/z 224 (M^+ - 16, 100%), 207 (10), 189 (18), 179 (46), 151 (52). *Anal.* Calcd for $C_8H_5N_4O_3Cl$: C, 39.94; H, 2.09; N, 23.29. Found: C, 39.86; H, 2.12; N, 23.20.

***N*-(2-Methoxycarbonylthiophen-3-yl)cyanoformamidoxime (5j)**: ^{1}H NMR ($CDCl_3$, δ, ppm) 3.91 (3H, s, CH_3), 7.59 (1H, d, J = 5.6 Hz, =CH), 7.62 (1H, d, J = 5.6 Hz, =CH), 8.34 (1H, s, NH), 10.21 (1H, s, OH); IR (KBr) (υ, cm^{-1}) 3304, 3240, 1670, 1630, 1555, 1446, 1365, 1261, 1098, 979, 872, 768; MS (EI) m/z 225 (M^+, 58%), 209 (13), 193 (45), 163 (100), 150 (37), 136 (30), 125 (17). *Anal.* Calcd for $C_8H_7N_3O_3S$: C, 42.66; H, 3.13; N, 18.66; S, 14.24. Found: C, 42.80; H, 3.14; N, 18.58; S, 14.36.

***N*-(4-Tosyl)cyanoformamidoxime (5k)**: ^{1}H NMR (DMSO-d_6, δ, ppm) 2.40 (3H, s, CH_3 of major and minor), 7.45 (2H, d, J = 8.1 Hz, ArH of major and minor), 7.72 (2H, d, J = 8.3 Hz, ArH of minor), 7.78 (2H, d, J = 8.3 Hz, ArH of major), 12.55 (1H, br s, OH of major), 12.97 (1H, s, OH of minor); IR (KBr) (υ, cm^{-1}) 3584, 3376, 2224, 1629, 1584, 1389, 1283, 1258, 1136, 1085, 1037, 973, 870, 806, 758, 701, 666; FAB MS m/z 240 (M^+ + 1). *Anal.* Calcd for $C_9H_9N_3O_3S$: C, 45.18; H, 3.79; N, 17.56; S, 13.40. Found: C, 45.23; H, 3.68; N, 17.70; S, 13.28.

Reaction of 4-Chloro-5-(2-cyanophenylimino)-5*H*-1,2,3-dithiazole (1l) with Hydroxylamine Hydrochloride. Hydroxylamine hydrochloride (167 mg, 2.40 mmol) was added into a solution of **1l** (158 mg, 0.60 mmol) in pyridine (5 mL). The mixture was stirred at rt for 4 h and then worked up as usual. Chromatography (1.5 x 10 cm) of the reaction mixture with *n*-hexane gave sulfur (23 mg). Elution with a mixture of *n*-hexane and EtOAc (5 : 1) gave an unknown (12 mg) and *N*-(2-cyanophenyl)cyanothioformamide (**6d**) (30 mg, 27%): mp (decomp) 104 – 105 °C (CH_2Cl_2 – *n*-hexane); ^{1}H NMR (DMSO-d_6, δ, ppm) 7.54 (1H, t, J = 7.6 Hz, ArH), 7.63 (1H, t, J = 8.0 Hz, ArH), 7.81 (t, 1H, J = 7.6 Hz, ArH), 7.97 (d, 1H, J = 7.7 Hz, ArH); IR (KBr) (υ, cm^{-1}) 3184, 2992, 2240, 1360; MS (m/z) 160 (M^+ - 27, 100%). *Anal.* Calcd for $C_9H_5N_3S$: C, 57.74; H, 2.69; N, 22.44; S, 17.13. Found: C, 57.88; H, 2.75; N, 22.39; S, 17.25.

General Procedure for the Preparation of 2-Cyanoquinazoline-3-oxides 7. 2-Acyl- (or aroyl)phenyl-4-chloro-5*H*-1,2,3-dithiazoles (**1m-p**) (1.1–2.3 mmol) were treated with hydroxylamine hydrochloride

(174 – 229 mg, 2.5–3.3 mmol) in pyridine (5 mL) at rt according to the procedure described for the prepatation of **5**. Chromatography of the reaction mixture (3 x 8 cm) with *n*-hexane gave sulfur. Subsequent elution with a mixture of *n*-hexnae and EtOAc (1 : 2) gave **7**. Reaction times, yields and melting points of **7** are summarized in Table 2.

2-Cyano-4-methylquinazoline-3-oxide (7a): ^{1}H NMR (DMSO-d_6, δ, ppm) 2.79 (3H, s, CH_3), 7.89 - 7.93 (2H, m, ArH), 8.04 - 8.07 (1H, m, ArH), 8.20 - 8.23 (1H, m, ArH); IR (KBr) (υ, cm^{-1}) 1600, 1539, 1286, 1214, 1195, 1146, 773, 762, 707, 635; MS (EI) m/z 185 (M^+, 100), 169 (32), 168 (41), 159 (31), 141 (16), 128 (20), 116 (27). *Anal.* Calcd for $C_{10}H_7N_3O$: C, 64.86; H, 3.81; N, 22.69. Found: C, 64.77; H, 3.88; N, 22.73.

2-Cyano-4-phenylquinazoline-3-oxide (7b): ^{1}H NMR ($CDCl_3$, δ, ppm) 7.65 - 7.67 (6H, m, ArH), 7.74 (1H, t, J = 7.1 Hz, ArH), 7.86 (1H, t, J = 7.0 Hz, ArH), 8.13 (1H, d, J = 8.4 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1594, 1555, 1526, 1462, 1286, 1139, 774, 755, 694; MS (EI) m/z 247 (M^+, 26%), 246 (48), 231 (46), 230 (46), 218 (23), 177 (10), 151 (11). *Anal.* Calcd for $C_{15}H_9N_3O$: C, 72.87; H, 3.67; N, 16.99. Found: C, 73.19; H, 3.90; N, 17.15.

2-Cyano-7-methyl-4-phenylquinazoline-3-oxide (7c): ^{1}H NMR ($CDCl_3$, δ, ppm) 2.61 (3H, s, CH_3), 7.55 (2H, s, ArH), 7.64 (5H, s, ArH), 7.89 (1H, s, ArH); IR (KBr) (υ, cm^{-1}) 1606, 1523, 1315, 1274, 1037, 1014, 954, 752; MS (EI) m/z 261 (M^+, 10%), 260 (14), 245 (56), 244 (69), 231 (19), 230 (100). *Anal.* Calcd for $C_{16}H_{11}N_3O$: C, 73.55; H, 4.24; N, 16.08. Found: C, 73.68; H, 4.19; N, 15.92.

6-Chloro-2-cyano-4-phenylquinazoline-3-oxide (7d): ^{1}H NMR ($CDCl_3$, δ, ppm) 7.56 - 7.69 (6H, m, ArH), 7.75 - 7.78 (1H, m, ArH), 8.07 (1H, d, J = 8.95 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1590, 1520, 1466, 1283, 1178, 694; MS (EI) m/z 281 (M^+, 13%), 280 (15), 265 (60), 264 (90), 237 (11), 230 (100). *Anal.* Calcd for $C_{15}H_8N_3OCl$: C, 63.96; H, 2.86; N, 14.92. Found: C, 64.02; H, 2.89; N, 14.80.

General Procedure for the Preparation of 4-Alkyl- and 4-Aryl-2-cyanoquinazolines (8). Compounds (**8**) were prepared according to the literature procedures.[12] Reaction times, yields and melting points of (**8**) are summarized in Table 2.

2-Cyano-7-methyl-4-phenylquinazoline (8c): ^{1}H NMR ($CDCl_3$, δ, ppm) 2.67 (3H, s, CH_3), 7.58 - 7.67 (4H, m, ArH), 7.78 - 7.83 (2H, m, ArH), 7.98 (1H, s, ArH), 8.13 (1H, d, J = 8.6 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1610, 1546, 1520, 1472, 1392, 1331, 1030, 768, 691; MS (EI) m/z 245 (M^+, 53%), 244 (63), 230

(100). *Anal.* Calcd for $C_{16}H_{11}N_3$: C, 78.35; H, 4.52; N, 17.13. Found: C, 78.29; H, 4.52; N, 17.22.

6-Chloro-2-cyano-4-phenylquinazoline (8d): ^{1}H NMR ($CDCl_3$, δ, ppm) 7.59 - 7.67 (3H, m, ArH), 7.80 - 7.83 (2H, m, ArH), 7.90 - 8.02 (1H, m, ArH), 8.16 - 8.22 (2H, m, ArH); IR (KBr) (υ, cm^{-1}) 1594, 1542, 1507, 1472, 1373, 1338, 1072, 915, 835, 694; MS (EI) m/z 265 (M^+, 62%), 264 (85), 237 (12), 230 (100), 203 (15). *Anal.* Calcd for $C_{15}H_8N_3Cl$: C, 67.81; H, 3.03; N, 15.82. Found: C, 67.68; H, 2.98; N, 15.98.

Reaction of 5-(4-Acetylphenylimino)-4-chloro-5*H*-1,2,3-dithiazole (1q) with Hydroxylamine Hydrochloride. (i) To a solution of **1q** (299 mg, 1.10 mmol) in pyridine (5 mL) was added hydroxylamine hydrochloride (77 mg, 1.11 mmol). The mixture was stirred at rt for 24 h, followed by work-up as described in the general procedure for the preparation of compounds (**5**). Chromatography (3 x 15 cm) of the reaction mixture with CH_2Cl_2 as an eluent gave unreacted **1q** (32 mg, 11%). Subsequent elution with a mixture of EtOAc and *n*-hexane (1 : 1) gave 4-(4-chloro-5*H*-1,2,3-dithiazol-5-yl)iminoacetophenone oxime (**9**) (258 mg, 82%): mp 142 –144 °C (CH_2Cl_2 – *n*-hexane); ^{1}H NMR ($CDCl_3$, δ, ppm) 2.34 (3H, s, CH_3), 7.26 (2H, d, J = 8.6 Hz, ArH), 7.78 (2H, d, J = 8.6 Hz, ArH), 8.69 (1H, br s, OH); IR (KBr) (υ, cm^{-1}) 3232, 1600, 1565, 1488, 1453, 1398, 1363, 1299, 1226, 1174, 1123, 832. *Anal.* Calcd for $C_{10}H_8N_3OClS_2$: C, 42.03; H, 2.82; N, 14.70; S, 22.44. Found: C, 42.15; H, 2.75; N, 14.55; S, 22.60.

(ii) To a solution of **1q** (239 mg, 0.88 mmol) in pyridine (5 mL) was added hydroxylamine hydrochloride (184 mg, 2.65 mmol). The mixture was stirred at rt for 18 h and worked up as described in (i). Elution of the reaction mixture with a mixture of *n*-hexane and EtOAc (3 : 1) gave yellow solids, identified as *N*-(4-oximinoacetylphenyl)cyanothioformamide (**6f**): mp (decomp) 162 – 165 °C (EtOAc – *n*-hexane); ^{1}H NMR (DMSO-d_6, δ, ppm) 2.16 (3H, s, CH_3), 7.77 (2H, d, J = 8.9 Hz, ArH), 7.94 (2H, d, J = 8.8 Hz, ArH), 11.39 (1H, s, NH or OH), 13.55 (1H, s, NH or OH); IR (KBr) (υ, cm^{-1}) 3280, 2224, 1594, 1535, 1504, 1376, 1094, 1002, 915, 826; MS (EI) m/z 192 (M^+ - 27, 67%). *Anal.* Calcd for $C_{10}H_9N_3OS$: C, 54.78; H, 4.14; N, 19.16; S, 14.62. Found: C, 54.63; H, 4.07; N, 19.28; S, 14.48.

General Procedure for the Preparation of 4-Aryl-3-cyano-1,2,4-oxadiazin-5(6*H*)-ones (12). To a solution of **5** (0.3 – 0.7 mmol) and TEA (101 – 293 mg, 1.0 – 2.9 mmol) in CH_2Cl_2 (50 mL) was added dropwise a solution of bromoacetyl bromide (101 – 242 mg, 0.5 –1.2 mmol) for 10 min. The mixture was stirred for 10 min except for the reaction with **5j** (60 min) and quenched when no spot corresponding to **5** had been observed on TLC (EtOAc : *n*-hexane = 1 : 2). The mixture was washed with 1% HCl (30 mL), followed by drying over $MgSO_4$. Removal of the solvent *in vacuo* gave a residue, which was chromatographed on a silica gel column (70 – 230 mesh, 3 x 5 cm). Elution with CH_2Cl_2 gave **12**. Reaction times, yields and melting points of **12**, are summarized in Table 1.

3-Cyano-4-phenyl-1,2,4-dxadiazin-5(6*H*)-one (12a): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.73 (2H, s, CH_2), 7.28 – 7.34 (2H, m, ArH), 7.56 – 7.59 (3H, m, ArH); IR (KBr) (υ, cm^{-1}) 1734, 1571, 1347, 1315, 899, 762; MS (EI) m/z 201 (M^+, 67%), 173 (33), 172 (25), 116 (14), 105 (100), 91 (24). *Anal.* Calcd for $C_{10}H_7N_3O_2$: C, 59.70; H, 3.51; N, 20.89. Found: C, 59.85; H, 3.45; N, 20.80.

4-*Bromophenyl*-3-cyano-1,2,4-oxadiazin-5(6*H*)-one (12b): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.72 (2H, s, CH_2), 7.21 (2H, d, J = 8.8 Hz, ArH), 7.71 (2H, d, J = 8.8 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1738, 1574, 1341, 1302, 896, 819; MS (EI) m/z 279 (M^+, 71%), 251 (44), 223 (10), 183 (100), 171 (41). *Anal.* Calcd for $C_{10}H_6N_3OBr$: C, 42.88; H, 2.16; N, 15.00. Found: C, 42.70; H, 2.12; N, 15.13.

4-Chlorophenyl-3-cyano-1,2,4-oxadiazin-5(6*H*)-one (12c): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.72 (2H, s, CH_2), 7.27 (2H, d, J = 8.8 Hz, ArH), 7.56 (2H, d, J = 8.8 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1734, 1571, 1334, 1302, 896, 822; MS (EI) m/z 235 (M^+, 61%), 207 (33), 177 (16), 139 (100) . *Anal.* Calcd for $C_{10}H_6N_3O_2Cl$: C, 50.97; H, 2.57; N, 17.83. Found: C, 51.09; H, 2.53; N, 17.71.

3-Cyano-4-(2-methoxycarbonylphenyl)-1,2,4-oxadiazin-5(6*H*)-one (12d): ^{1}H NMR ($CDCl_3$, δ, ppm) 3.91 (3H, s, OCH_3), 4.61 (1H, d, J = 15.1 Hz, CH), 4.77 (1H, d, J = 15.1 Hz, CH), 7.38-7.41 (1H, m, ArH), 7.64 – 7.76 (2H, m, ArH), 8.23 – 8.26 (1H, m, ArH); IR (KBr) (υ, cm^{-1}) 1744, 1706, 1574, 1331, 1286, 1251, 1120, 896, 755; MS (EI) m/z 259 (M^+, 29%), 228 (18), 202 (11), 178 (13), 172 (15), 170 (33), 151 (12), 148 (13), 146 (59), 144 (48), 119 (100). *Anal.* Calcd for $C_{12}H_9N_3O_4$: C, 55.60; H, 3.50; N, 16.21. Found: C, 55.49; H, 3.57; N, 16.34.

3-Cyano-4-(4-nitrophenyl)-1,2,4-oxadiazin-5(6*H*)-one (12e): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.77 (2H, s, CH_2), 7.56 (2H, d, J = 9.0 Hz, ArH), 8.45 (2H, d, J = 9.0 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1731, 1568, 1517, 1488, 1347, 1302, 1053, 986, 854; MS (EI) m/z 246 (M^+, 37%), 218 (68), 217 (37), 150 (100). *Anal.* Calcd for $C_{10}H_6N_4O_4$: C, 48.79; H, 2.46; N, 22.76. Found: C, 48.90; H, 2.51; N, 22.62.

3-Cyano-4-(2-nitrophenyl)-1,2,4-oxadiazin-5(6*H*)-one (12f): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.61 (1H, d, J = 15.4 Hz, CH), 4.84 (1H, d, J = 15.4 Hz, CH), 7.52 (1H, d, J = 7.7 Hz, ArH), 7.80 – 7.93 (2H, m, ArH), 8.36 (1H, d, J = 8.1 Hz, ArH); IR (KBr) (υ, cm^{-1}) 1744, 1584, 1475, 1344, 1293, 1201, 986, 899; MS (EI) m/z 246 (M^+, 62%), 201 (84), 200 (99), 173 (33), 143 (85), 90 (100). *Anal.* Calcd for $C_{10}H_6N_4O_4$: C, 48.79; H, 2.46; N, 22.76. Found: C, 48.83; H, 2.44; N, 22.68.

3-Cyano-4-(3-nitrophenyl)-1,2,4-oxadiazin-5(6*H*)-one (12g): ^{1}H NMR ($CDCl_3$, δ, ppm) 4.76 (2H, s,

CH_2), 7.67 (1H, d, J = 7.2 Hz, ArH), 7.80 (1H, t, J = 8.3 Hz, ArH), 8.25 (1H, s, ArH), 8.43 (1H, d, J = 7.4 Hz, ArH); IR (KBr) (υ, cm^{-1}) 2240, 1731, 1578, 1523, 1347, 1309, 986, 906, 678; MS (EI) m/z 246 (M^+, 25%), 218 (54), 217 (32), 150 (100). *Anal.* Calcd for $C_{10}H_6N_4O_4$: C, 48.79; H, 2.46; N, 22.76. Found: C, 48.70; H, 2.39; N, 22.77.

3-Cyano-4-(2-methyl-4-nitrophenyl)-1,2,4-oxadiazin-5(6*H*)-one (12h): ^1H NMR ($CDCl_3$, δ, ppm) 2.38 (3H, s, CH_3), 4.77 (2H, d, J = 5.1 Hz, CH_2), 7.47 (1H, d, J = 8.6 Hz, ArH), 8.26 (1H, d, J = 8.6 Hz, ArH), 8.31 (1H, s, ArH); IR (KBr) (υ, cm^{-1}) 2240, 1738, 1574, 1520, 1344, 1312, 989, 752; MS (EI) m/z 260 (M^+, 50%), 232 (32), 233 (46), 230 (81), 164 (100). *Anal.* Calcd for $C_{11}H_8N_4O_4$: C, 50.78; H, 3.10; N, 21.53. Found: C, 50.85; H, 3.09; N, 21.61.

4-(2-Chloro-5-nitrophenyl)-3-cyano-1,2,4-oxadiazin-5(6*H*)-one (12i): ^1H NMR ($CDCl_3$, δ, ppm) 4.79 (2H, s, CH_2), 7.86 (1H, d, J = 9.0 Hz, ArH), 8.35 (1H, s, ArH), 8.43 (1H, d, J = 9.0 Hz, ArH); IR (KBr) (υ, cm^{-1}) 2240, 1741, 1597, 1574, 1523, 1341, 1312, 1293, 992, 736; MS (EI) m/z 280 (M^+, 13%), 253 (11), 252 (28), 251 (26), 245 (43), 184 (100). *Anal.* Calcd for $C_{10}H_5N_4O_4Cl$: C, 42.80; H, 1.80; N, 19.96. Found: C, 42.83; H, 1.86; N, 19.92.

Methyl 3-(3-cyano-5-oxo-1,2,4-oxadiazin-4-yl)thiophenecarboxylate (12j): ^1H NMR ($CDCl_3$, δ, ppm) 3.92 (3H, s, OCH_3), 4.71 (2H, d, J = 9.1 Hz, CH_2), 7.16 (1H, d, J = 5.3 Hz, =CH), 7.72 (1H, d, J = 5.3 Hz, =CH); IR (KBr) (υ, cm^{-1}) 1747, 1696, 1581, 1530, 1434, 1306, 1267, 867, 774; MS (EI) m/z 265 (M^+, 54%), 234 (14), 176 (35), 152 (46), 125 (100). *Anal.* Calcd for $C_{10}H_7N_3O_4S$: C, 45.28; H, 2.66; N, 15.84; S, 12.09. Found: C, 45.37; H, 2.60; N, 15.89; S, 12.22.

Reaction of 12e with Benzylamine. To a solution of **12e** (12 mg, 0.46 mmol) in benzene (50 mL) was added benzylamine (490 mg, 4.57 mmol). The mixture was heated at 50 °C for 5 min and then cooled to rt. The solids formed (60 mg) which were identified as *N*-(4-nitrophenyl)cyanoformamidoximes (**13**) were filtered. Removal of the solvent from the filtrate gave a residue which was chromatographed on a silica gel column (70 – 230 mesh, 1.5 x 2.0 cm) with a mixture of *n*-hexane and EtOAc (2 : 1) as an eluent to give a mixture of steroisomer of **13** whose ratio was 1.8 : 1. The major stereoisomer of **13**: ^1H NMR (DMSO-d_6, δ, ppm) 4.38 (2H, d, J = 6.1 Hz, CH_2), 4.70 (2H, s, CH_2), 7.20 – 7.33 (5H, m, ArH), 7.45 (2H, d, J = 9.2 Hz, ArH), 8.26 (2H, d, J = 9.2 Hz, ArH), 8.51 (1H, s, NH), 10.27 (1H, br s, NH). The minor stereoisomer of **13**: ^1H NMR(DMSO-d_6, δ, ppm) 4.35 (2H, d, J = 6.2 Hz, CH_2), 4.66 (2H, s, CH_2), 7.20 – 7.33 (5H, m, ArH), 7.59 (2H, d, J = 9.3 Hz, ArH), 8.16 (2H, d, J = 9.3 Hz, ArH), 10.57 (1H, br s, NH); IR (KBr) (υ, cm^{-1}) of **13**: 3379, 3136, 1654, 1610, 1587, 1570, 1328, 1072, 1008, 912, 848. *Anal.* Calcd for

$C_{17}H_{15}N_5O_4$: C, 57.79; H, 4.28; N, 19.82. Found: C, 57.87; H, 4.21; N, 19.90.

Reaction of 12e with Sodium Methoxide. Compound (**12e**) (111 mg, 0.45 mmol) was added into the solution of NaOMe in MeOH, *in situ* preperated by treatment of Na (10 mg, 0.44 mmol) with absolute MeOH (10 mL). The color of the solution turn red. Water (20 mL) was added to the mixture when the spot corresponding to **12e** had disappeared on TLC (CH_2Cl_2). The mixture was extracted with CH_2Cl_2 (25 mL x 3). Evaporation of the solvent gave *O*-methoxycarbonlymethyl-*N*-(4-nitrophenyl)cyanoformamidoxime (**14**) (28 mg, 22%); mp 122 –123 °C (CH_2Cl_2 – *n*-hexane); ^{1}H NMR ($CDCl_3$, δ, ppm) 3.84 (3H, s,CH_3), 4.80 (2H, s, CH_2). 7.34 (2H, d, *J* =9.1 Hz, ArH), 7.72 (1H, s, NH), 8.28 (2H, d, *J* = 9.1 Hz, ArH); IR (KBr) (υ, cm^{-1}) 3280, 2224, 1734, 1613, 1587, 1504, 1328, 1226, 1082, 851, 592; MS (EI) m/z 278 (M^+, 100%), 251 (13), 219 (19), 189 (44), 174 (40), 150 937), 143 (91). *Anal.* Calcd for $C_{11}H_{10}N_4O_5$: C, 47.49; H, 3.62; N, 20.14. Found: C, 47.38; H, 3.62; N, 20.20.

The reddish aqueous layer was neutralized with 1% HCl, followed by extraction with CH_2Cl_2 (25 mL x 3). Evaporation of the solvent gave *N*-(4-nitrophenyl)cyanoformamidoximyl-*O*-acetic acid (**15**) (42 mg, 35%); ^{1}H NMR ($CDCl_3$, δ, ppm) 4.85 (2H, s, CH_2), 7.34 (2H, d, *J* = 9.1 Hz, ArH), 7.50 (1H, s, NH or OH), 8.28 (2H, d, *J* = 9.1 Hz, ArH); IR (neat) (υ, cm^{-1}) 3296, 2240, 1728, 1610, 1587, 1507,1331, 1091, 1024. *Anal.* Calcd for $C_{10}H_8N_4O_5$: C, 57.79; H, 4.28; N, 19.82. Found: C, 57.87; H, 4.21; N, 19.90.

Reaction of 5e with Methyl Bromoacetate. To a solution of **5e** (125 mg, 0.61 mmol) in CH_2Cl_2 (50 mL) was added triethylamine (290 mg, 2.87 mmol), followed by addition of methyl bromoacetate (178 mg, 1.16 mmol). The mixture was stirred at rt for 24 h. After 1% HCl (50 mL) was added, the mixture was extracted with CH_2Cl_2 (30 mL x 3). The extracts were dried over $MgSO_4$. Removal of the solvent gave a residue, which was chromatographed (silica gel, 1.5 x 5 cm) with CH_2Cl_2 to give **14** (104 mg, 61%) and unreacted **5e** (20 mg, 16 %).

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REFERENCES AND NOTES

1. K. Kim, *Sulfur Reports,* 1998, **21**, 147.
2. R. Appel, H. Jassen, M. Siray, and F. Knoch, *Chem. Ber.*, 1985, **118**, 1632.
3. H. Lee and K. Kim, *J. Org. Chem.*, 1993, **58**, 7001.
4. H. Lee, K. Kim, D. Whang, and K. Kim, *J. Org. Chem.*, 1994, **59**, 6179.

5. F. Eloy and R. Lenaers, *Chem. Rev.*, 1962, **62**, 155.
6. W. Steinkopf and B. Jurgens, *J. Prakt. Chem.*, 1919, **83**, 453.
7. H. U. Daeniker, *Helv. Chim. Acta*, 1964, **47**, 33; H. Feuer and P. M. Pivawer, *J. Org. Chem.*, 1966, **31**, 3152.
8. H. U. Brechbuehler and K. Gubler, Ger. Offen. 1,937,476, 1970 (*Chem.Abstr.*, 1970, **72**, 110 833).
9. B. Kumelj and M. Tišler, *Vestnik Sloven kemi društva.* 1958, **5**, 69 (*Chem. Abstr.*, 1960, **54**, 22 426); CIBA Ltd. Neth. Appl. 6500321, 1965; Swiss Appl. Jan. 13, 1964 (*Chem, Abstr.*, 1966, **64**, 9 634). For the mechanism of the formations of **6**, refer to ref.3.
10. O. Exner, V. Jehlicka, A. Dondoni, and A. C. Boicelli, *J. Chem. Soc., Perkin Trans. II*, 1974, 567; A. Dondoni, L. Lunazzi, P. Giorgiaani, and D. Macciantelli, *J. Org. Chem.*, 1975, **40**, 2979; K. J. Dignam and A. F. Hegarty, *J. Chem. Soc., Chem. Commun.*, 1976, 862; K. J. Dignam and A. F. Hegarty, *J. Chem. Soc., Perkin Trans. II*, 1979, 1437.
11. K. –H. Wunsch and A. J. Boulton, In *Advances in Heterocyclic Chemistry*, ed. by A. R. Katritzky and A. J. Boulton, Academic Press, New York, 1967, pp, 277 – 379; D. M. Fink and B. E. Kurys, *Tetrhedron Lett.*, 1996, **37**, 995.
12. J. M. McCall and R. E. TenBrink, *Synthesis*, 1975, 335.
13. A. Miyashita, T. Kawashima, C. Iijima, and T. Higashino, *Heterocycles*, 1992, **33**, 211; T. Higashino, T. Amano, Y. Tamura, N. Katsumata, Y. Washizu, T. Ono, and E. Hayashi, *Chem. Pharm. Bull.*, 1972, **20**, 1874.
14. K. Takacs, K. Harsanyi, and K. I. Ajzert, *Chem. Ber.*, 1975, **108**, 1911; P. Rajagopalan and C. N. Talaty, *J. Am. Chem. Soc.*, 1966, **88**, 5048.
15. A. A. Santilli and A. C. Scotese, *J. Heterocycl. Chem.*, 1979, **16**, 213; A. G. Hussein, M. M. El-Abaselah, and W. S. Sabri, *J. Heterocycl. Chem.*, 1984, **21**, 455; A. Q. Hussein, *Heterocycles*, 1987, **26**, 163; K. I. Ajzert and K. Takács, *Chem. Ber.*, 1984, **117**, 2999; L. Ürögdi, L. Kisfaludy, Á. Patthy, E. Moravcsik, H. Tüdös, Z. Tegyei, and L. Ötvös, *J. Heterocycl. Chem.*, 1989, **26**, 129; H. N. Weller, A. V. Miller, K. E. J. Dickinson, S. A. Hedberg, C. L. Delaney, R. P. Serafino, and S. Moreland, *Heterocycles*, 1993, **36**, 1027.

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