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Reference Data

^{13}C NMR Assignments of Some Amidoximes, 1,2,4-Oxa(thia)diazole-5(4*H*)-ones (thiones) and 1,2,4-Oxadiazine-6(5*H*)-ones(thiones)

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ABSTRACT: ^{13}C NMR chemical shifts for some pyridyl-containing *N*-substituted amidoximes, 1,2,4-oxadiazoles and 1,2,4-oxadiazines bearing a thiocarbonyl group are reported. The chemical shift positions of the particular carbon atoms are discussed in view of literature knowledge and the effect of atoms or groups present.

KEYWORDS: NMR; ^{13}C NMR; amidoximes; oxadiazoles; oxadiazines

INTRODUCTION

Amidoximes and *N*-substituted amidoximes have been widely used in the synthesis of many heterocyclic compounds.[1–3] In particular, they and their derivatives have been reported to be used as drugs and to have considerable biological activity (antifungal, antibacterial and antitumoral).[4–10] Synthetic procedures for substituted amidoximes, oxadiazoles, oxadiazines and thiadiazoles have been reported previously.[11–16] To our knowledge, there is no report in the literature concerning ^{13}C NMR spectral studies of pyridyl-bearing *N*-substituted amidoximes, 1,2,4-oxadiazoles, thiadiazoles and oxadiazines. In this paper, ^{13}C NMR chemical shifts of the title compounds are reported.

EXPERIMENTAL

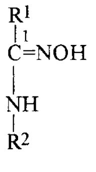
N-substituted amidoximes were synthesized by the action of primary amines on the corresponding hydroximoyl chlorides in methanol under reflux.[11,12] 1,2,4-oxadiazole-5(4*H*)-thiones **2a**–**h** were obtained by the reaction of corresponding amidoximes with thiophosgene.[14] 1,2,4-thiadiazole-5(4*H*)-ones **2i** and **j** are thermal rearrangement products of **2a** and **b**, respectively in diphenyl ether.[14–16] 1,2,4-Oxadizin-6(5*H*)-ones **3a**–**d** were obtained from the reaction of the corresponding amidoximes with chloroacetyl chloride.[13] Thiones **3e** and **f** were synthesized [13] from the oxadiazinones **3c** and **d**, respectively by thionation with P_2S_5. 1,2,4-Oxadiazoles **4a**–**c** were obtained by the action of chloroacetyl chloride on appropriate amidoximes.[13]

^{13}C NMR spectra were recorded on Varian XL-100 and JEOL FX-270 instrument operating at 25.2 and 67.8 MHz, respectively. Typical experimental conditions for running ^{13}C NMR spectra were as follows: sweep width, 5 kHz; pulse width, 16 μs; pulse delay, 0.6 s; acquisition time, 1 s; data points, 12K; and number of scans, 11.3K.

RESULTS AND DISCUSSION

The structures of the title compounds with atom labelling are presented in Fig. 1–4 and the ^{13}C NMR chemical shifts and signal assignments for the particular atoms are shown in Tables 1–4.

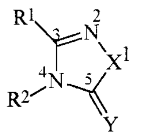
In the proton decoupled spectra of amidoximes **1a**–**f**, azomethine carbon signals appear between 148 and 154 ppm from TMS. These



1

	R1	R2
a	2-Pyridyl	Et
b	2-Pyridyl	n-Pr
c	2-Pyridyl	PhCH$_2$
d	3-Pyridyl	Me
e	3-Pyridyl	PhCH$_2$
f	4-Pyridyl	p-MeC$_6$H$_4$

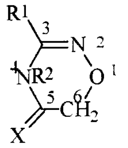
Figure 1. Structure of amidoximes **1a**–**f**.



2

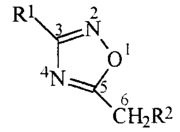
	X	Y	R1	R2
a	O	S	2-Pyridyl	Me
b	O	S	2-Pyridyl	Et
c	O	S	2-Pyridyl	n-Pr
d	O	S	3-Pyridyl	p-MeC$_6$H$_4$
e	O	S	4-Pyridyl	Me
f	O	S	4-Pyridyl	Et
g	O	S	4-Pyridyl	p-MeC$_6$H$_4$
h	O	S	Me	Ph
i	S	O	2-Pyridyl	Me
j	S	O	2-Pyridyl	Et

Figure 2. Structure of oxa(thia)diazole-5(4*H*)-ones(thiones) **2a**–**j**.



	X	R1	R2
a	O	Me	H
b	O	Ph	H
c	O	Ph	Me
d	O	Ph	Ph
e	S	Ph	Me
f	S	Ph	Ph

Figure 3. Structure of oxadiazine-6(5*H*)-ones (thiones) **3a**–**f**.



4

	R1	R2
a	Ph	Cl
b	Me	ON=C(NH$_2$)Me
c	Ph	ON=C(NH$_2$)Ph

Figure 4. Structure of 1,2,4-oxadiazoles **4a**–**c**.

Table 1. ^{13}C NMR chemical shifts[a] of azomethine carbons of amidoximes **1a**–**f**

	Compounds					
Atom	1a	1b	1c	1d	1e	1f
C-1	151.86	153.97	151.47	153.22	153.29	148.31

[a] In ppm referenced to TMS.

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Table 2. ^{13}C NMR chemical shifts^{a} of azomethine and thiocarbonyl carbons of oxa(thia)diazole-5(4*H*)-ones-(thiones) 2a–j

	Compound									
Atom	**2a**	**2b**	**2c**	**2d**	**2e**	**2f**	**2g**	**2h**	**2i**	**2j**
C-3	157.51	156.83	159.13	157.62	158.58	Unobserved	Unobserved	Unobserved	151.06	148.72
C-5	188.29	187.34	179.84	186.52	204.91	179.89	173.43	201.67	205.26	206.38

[a] In ppm referenced to TMS.

assignments are in accord with the values reported in the literature for oximes.[17–22]

In the spectra of 1,2,4-oxadiazole-5(4*H*)-thiones **2a**–**h**, azomethine carbons resonate at 148–159 ppm and thiocarbonyl carbons at 173–206 ppm (Fig. 2 and Table 2). The signal intensities of quaternary and thiocarbonyl carbons are generally low, and for **2f**–**h** azomethine carbon signals were not detected. In general, the replacement of a carbonyl by a thiocarbonyl results in a downfield shift.[19,22–25] For 1,2,4-thiadiazole-5(4*H*)-ones **2i** and **2j**, which are rearranged products of **2a** and **2b**, respectively, the carbonyl carbons appeared at downfield values. When the C=O is adjacent to a sulfur atom it causes a downfield shift of the carbonyl carbon. This effect operates also when a carbonyl is replaced by a thiocarbonyl group.[22] This may be due to the effect of the ring sulfur atom in the heterocycle.

In the ^{13}C NMR spectra of oxadiazin-6(5H)-ones **3a**–**d**, azomethine carbons, C-3, gave chemical shifts at 141–156 ppm. Carbonyl carbons, C-5, of **3a**–**5** appeared at 164–166 ppm and thiocarbonyl carbons, C-5, of **3e** and **f** at 153-–154 ppm (Fig. 3 and Table 3). In open-chain analogs of N—CX—S (X=O, S) bonding, it was reported[24] that there is a linear correlation for thiocarbonyl carbon chemical shift positions given by the equation $\delta(\mathrm{C{=}S}) = 1.45\delta(\mathrm{C{=}O}) - 46.5$ ppm. However, this would not be applicable for the title compounds. The upfield values of the carbonyl and thiocarbonyl carbons for the oxadiazine-5-ones (thiones) **3a**–**d** are interesting in comparison with those of oxadiazole-5-thiones **2a**–**h**.

Thiocarbonyl carbons of 1,2,4-oxadiazines **3e** and **f** appeared at upfield values. This may be reasoned by CH_2 insertion between the thiocarbonyl and oxygen. C-6 methylene carbons were observed at 66–75 ppm. Deshielding of the CH_2 carbons in **3e** and **f** can be attributed to the thiocarbonyl group in addition to the neighboring oxygen.

Table 3. ^{13}C NMR chemical shifts^{a} of 1,2,4-oxadiazine-6(5*H*)-ones(thiones) 3a–f

	Compound					
Atom	**3a**	**3b**	**3c**	**3d**	**3e**	**3f**
C-3	150.80	150.85	156.15	141.58	131.20	138.31
C-5	166.52	166.48	165.31	164.14	154.59	153.66
C-6	66.37	66.86	67.69	68.42	74.32	75.10

[a] In ppm referenced to TMS.

Table 4. ^{13}C NMR chemical shifts^{a} of 1,2,4-oxadiazoles 4a–c

	Compound		
Atom	**4a**	**4b**	**4c**
C-3	168.83	152.03	153.53
C-5	174.32	176.37	176.42
C-6	33.39	65.50	66.10
R^2C-1		167.19	Unobserved

[a] In ppm referenced to TMS.

In the case of 1,2,4-oxadiazoles, the C-3 ring carbons of 1,2,4-oxadiazole derivatives **4a**–**c** appear at 152–168 ppm (Fig. 4 and Table 4). The azomethine carbon C-3 of **4a** resonates at 168 ppm, which is more downfield with respect to those of **4b** and **c**. Similar chemical shifts have been reported for 1,2,4-oxadiazole derivatives.[26–30] Methylene carbons, C-6, have chemical shifts at 33 ppm for **4a** where a chlorine atom is bonded and at 65 ppm for **4b** and 66 ppm for **4c** where CH_2 is bonded to an electronegative oxygen atom. More deshielded values of the CH_2 carbons in **4b** and **c** can also be interpreted as the effect of the oxime moiety. The C-5 carbons, which are bonded to oxime moiety R^2 through CH_2 of **4b** and **c**, were observed as more deshielded relative to C-3. In the proton coupled spectra of **4a**–**c** the C-6 methylene carbons appeared as triplets. For **4b** the amidoxime methyl carbon and oxadiazole ring methyl carbon appeared as quadruplets.

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