Synthesis and structures of 4,6-disubstituted 2-(5-methyl-1,2,4-oxadiazol-3-yl)-1,3,5-triazines

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New 1,2,4-oxadiazolyl-1,3,5-triazines were synthesized from amidoximes derived from *sym*-triazine mononitriles. The structure of one of the resulting compounds was studied in detail by X-ray diffraction.

Key words: amidoximes of the *sym*-triazine series, 4,6-disubstituted 2-acetoxyamidino-1,3,5-triazines, 4,6-disubstituted 2-(5-methyl-1,2,4-oxadiazol-3-yl)-1,3,5-triazines, cyclization.

1,2,4-Oxadiazole and *sym*-triazine derivatives possess a wide spectrum of biological activities.[1—3] It was of interest to synthesize new compounds containing both these heterocycles.

We synthesized (Scheme 1) oxadiazolyltriazines **4** from nitriles **1**. Amidoximes **2a—i** were prepared by the reaction of nitriles **1** with a 20% excess of hydroxylamine in an water-ethanol solution.

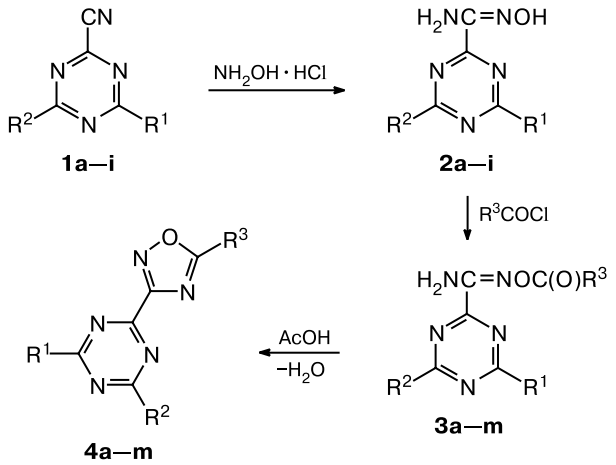
It is known[4,5] that the hydroxy group in aromatic amidoximes smoothly reacts with carboxylic acid anhydrides and chlorides to form the corresponding acylated derivatives. The reactions of compounds **2a—i** with acetyl and isobutyroyl chlorides, which were used in a 5% excess with respect to the stoichiometric amount, under mild conditions (solutions in anhydrous benzene, 5—20 °C) in the presence of an excess of pyridine produced acylated derivatives **3a—m**.

Refluxing of solutions of compounds **3a—m** in glacial acetic acid for 2—5 h smoothly afforded the corresponding substituted 1,2,4-oxadiazolyl-1,3,5-triazines **4a—m** in good yields.

The crystal structure of one of the resulting oxadiazolyl-1,3,5-triazines, *viz.*, compound **4d** containing the amino and diethylamino groups at positions 4 and 6 of the triazine ring, was established by X-ray diffraction study of a single crystal grown from ethanol. A projection of the crystal structure of compound **4d** is shown in Fig. 1. The interatomic distances and bond angles are given in Tables 1 and 2, respectively.

Molecule **4d** is virtually planar (see Fig. 1). The bond angles at the nitrogen atoms in the *sym*-triazine fragment (see Table 2) vary from 112.9(2)° (N(1)) to 121.6(2)° (N(4a)) and differ substantially from the bond angles at

Scheme 1



Compound	R^1	R^2
1a, 2a, 3a,b, 4a,b	morpholino	morpholino
1b, 2b, 3c, 4c	NMe_2	NMe_2
1c, 2c, 3d,e, 4d,e	NH_2	NEt_2
1d, 2d, 3f,g, 4f,g	EtNPh	EtNPh
1e, 2e, 3h,i, 4h,i	NH_2	NPh_2
1f, 2f, 3j, 4j	OMe	morpholino
1g, 2g, 3k, 4k	OMe	pyrrolidino
1h, 2h, 3l, 4l	OEt	NPh_2
1i, 2i, 3m, 4m	piperidino	piperidino

3a,c,d,f,h,j—m, 4a,c,d,f,h,j—m: R^3 = Me;
3b,e,g,i, 4b,e,g,i: R^3 = Pr^i

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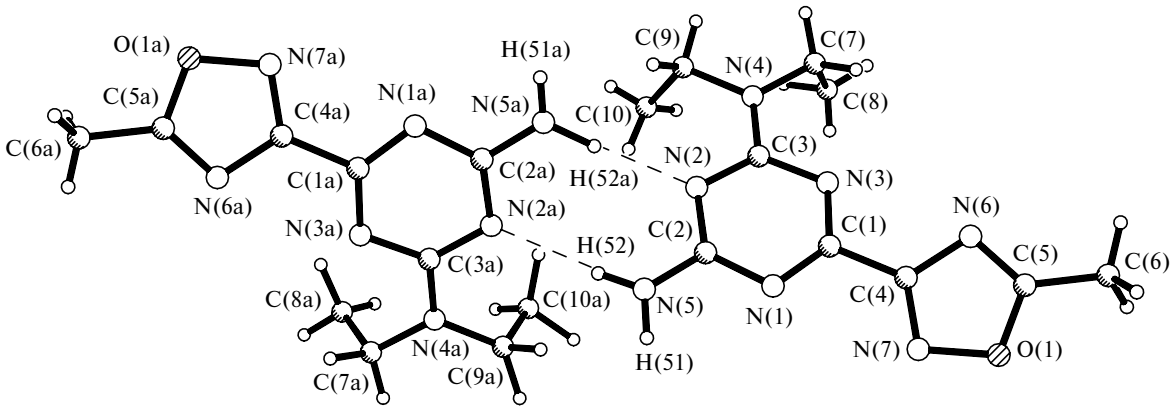

Fig. 1. Crystal structure of compound **4d**; the centrosymmetric dimers linked to each other by H bonds are shown.

Table 1. Interatomic distances in molecule **4d**

Bond	*d*/Å	Bond	*d*/Å
O(1)—C(5)	1.336(2)	O(1A)—C(5A)	1.335(2)
O(1)—N(7)	1.413(2)	O(1A)—N(7A)	1.414(2)
N(1)—C(1)	1.323(2)	N(1A)—C(1A)	1.323(2)
N(1)—C(2)	1.365(2)	N(1A)—C(2A)	1.355(2)
N(2)—C(2)	1.338(2)	N(2A)—C(2A)	1.341(2)
N(2)—C(3)	1.350(2)	N(2A)—C(3A)	1.348(2)
N(3)—C(1)	1.325(2)	N(3A)—C(1A)	1.326(2)
N(3)—C(3)	1.362(2)	N(3A)—C(3A)	1.358(2)
N(4)—C(3)	1.336(2)	N(4A)—C(3A)	1.339(2)
N(4)—C(9)	1.465(3)	N(4A)—C(9A)	1.457(3)
N(4)—C(7)	1.468(3)	N(4A)—C(7A)	1.465(3)
N(5)—C(2)	1.326(2)	N(5A)—C(2A)	1.333(2)
N(6)—C(5)	1.289(2)	N(6A)—C(5A)	1.292(2)
N(6)—C(4)	1.371(2)	N(6A)—C(4A)	1.369(2)
N(7)—C(4)	1.301(2)	N(7A)—C(4A)	1.291(2)
C(1)—C(4)	1.479(3)	C(1A)—C(4A)	1.485(3)
C(5)—C(6)	1.468(3)	C(5A)—C(6A)	1.488(3)
C(7)—C(8)	1.484(4)	C(7A)—C(8A)	1.503(4)
C(9)—C(10)	1.494(5)	C(9A)—C(10A)	1.461(6)

the carbon atoms, which vary from 124.6(2)° (C(3)) to 128.6(2)° (C(1)). In the oxadiazole fragments, the bond angles at the N(7) and N(7a) atoms are 103.0(2) and 103.2(2)°, respectively (see Table 2). The bond angles at the C(4) and C(5) atoms of the oxadiazole ring have close values (113.9(2) and 112.1(2)°, respectively). The crystal structure of compound **4d** consists of centrosymmetric dimers linked to each other by the hydrogen bonds between the N(2) and N(2a) atoms of the triazine ring and the H(52a) and H(52) atoms of the amine groups. The hydrogen bond lengths are 2.08(2) Å. The geometric parameters of molecules **4d** in the dimer are identical within the experimental error.

To summarize, we synthesized new amidoximes of the 1,3,5-triazine series, performed their acylation, and carried out cyclization of acyloxyamidinotriazines accompanied by dehydration giving rise to previously unknown potentially biologically active connected 1,2,4-oxadiazolyl-1,3,5-triazines. The crystal structure of compound **4d** was established by X-ray diffraction.

Experimental

The IR spectra were recorded on a Specord-75 IR spectrophotometer in Nujol mulls. The ^{1}H NMR spectra were measured on a Bruker DRX-500 radiospectrometer in DMSO-d_6. The mass spectra were obtained on a Finnigan MAT INCOS50 instrument (ionizing radiation energy was 70 eV). Elemental analysis was carried out on a Carlo-Erba model 1106 analyzer. The progress of the reactions was monitored and the purities of the compounds were checked by TLC on Silufol UV-250 plates in a 1 : 1 acetone—hexane system.

X-ray diffraction study of 4-amino-6-diethylamino-2-(5-methyl-1,2,4-oxadiazol-3-yl)-1,3,5-triazine (4d). Crystals were grown from an ethanolic solution. The prismatic crystals belong to the triclinic system; the unit cell parameters: a = 10.027(2) Å, b =10.978(2) Å, c = 12.182(2) Å, α = 80.64(3)°, β = 77.50(3)°, γ = 76.83(3)°, Z = 4, d = 1.308 mg m^{-3}, V = 1265.6(4) Å^3, space group $P\bar{1}$. X-ray diffraction data were collected on an automated Enraf-Nonius CAD 4 diffractometer (β-filtered Mo-$K\alpha$ radiation) using the θ/2θ scanning technique. A total of 4085 reflections were measured, of which 1507 reflections were with $I > 2\delta(I)$. The structure of **4d** was solved by direct methods using the SHELXTL program package[6] and refined anisotropically (isotropically for H atoms) to R = 0.0308, R_w = 0.0743.

The starting mononitriles **1a—i** were prepared according to a procedure described earlier.[7] All reagents were purified by crystallization from an appropriate solvent or by fractional distillation immediately before use. The solvents were purified and dried according to known procedures.[8]

2-Hydroxyamidino-4,6-dimorpholino-1,3,5-triazine (2a). An aqueous solution (10 mL) containing hydroxylamine hydrochloride (4.3 mmol) and sodium hydrocarbonate (4.3 mmol) was allowed to stand until CO_2 bubbling ceased, after which 2-cyano-4,6-dimorpholino-1,3,5-triazine (**1a**) (3.6 mmol) and ethanol (20 mL) were successively added. The reaction mixture was refluxed for 2 h and cooled. The solvent was evaporated to dryness *in vacuo*, and the precipitate that formed was thoroughly washed with water and dried to a constant weight. After purifi-

Table 2. Bond angles in compound **4d**

Angle	ω/deg	Angle	ω/deg	Angle	ω/deg
C(5)—O(1)—N(7)	107.00(13)	N(7)—C(4)—N(6)	113.88(17)	N(1A)—C(1A)—N(3A)	127.91(18)
C(1)—N(1)—C(2)	112.89(15)	N(7)—C(4)—C(1)	122.33(17)	N(1A)—C(1A)—C(4A)	116.60(16)
C(2)—N(2)—C(3)	114.97(16)	N(6)—C(4)—C(1)	123.71(16)	N(3A)—C(1A)—C(4A)	115.45(17)
C(1)—N(3)—C(3)	113.50(15)	N(6)—C(5)—O(1)	112.13(17)	N(5A)—C(2A)—N(2A)	117.11(18)
C(3)—N(4)—C(9)	120.73(17)	N(6)—C(5)—C(6)	130.0(2)	N(5A)—C(2A)—N(1A)	117.55(18)
C(3)—N(4)—C(7)	121.15(17)	O(1)—C(5)—C(6)	117.92(18)	N(2A)—C(2A)—N(1A)	125.34(17)
C(9)—N(4)—C(7)	117.98(18)	N(4)—C(7)—C(8)	113.4(2)	N(4A)—C(3A)—N(2A)	118.68(17)
C(5)—N(6)—C(4)	103.95(16)	N(4)—C(9)—C(10)	113.9(3)	N(4A)—C(3A)—N(3A)	116.93(17)
C(4)—N(7)—O(1)	103.03(14)	C(5A)—O(1A)—(7A)	106.34(15)	N(2A)—C(3A)—N(3A)	124.40(16)
N(1)—C(1)—N(3)	128.60(17)	C(1A)—N(1A)—(2A)	113.39(16)	N(7A)—C(4A)—N(6A)	114.52(17)
N(1)—C(1)—C(4)	117.03(16)	C(2A)—N(2A)—(3A)	114.85(16)	N(7A)—C(4A)—C(1A)	122.68(17)
N(3)—C(1)—C(4)	114.35(16)	C(1A)—N(3A)—(3A)	113.74(16)	N(6A)—C(4A)—C(1A)	122.75(17)
N(5)—C(2)—N(2)	117.42(18)	C(3A)—N(4A)—(9A)	121.56(19)	N(6A)—C(5A)—O(1A)	112.74(18)
N(5)—C(2)—N(1)	117.20(17)	C(3A)—N(4A)—C(7A)	120.25(18)	N(6A)—C(5A)—C(6A)	129.8(2)
N(2)—C(2)—N(1)	125.38(17)	C(9A)—N(4A)—C(7A)	117.7(2)	O(1A)—C(5A)—C(6A)	117.5(2)
N(4)—C(3)—N(2)	118.00(16)	C(5A)—N(6A)—C(4A)	103.16(16)	N(4A)—C(7A)—C(8A)	113.6(2)
N(4)—C(3)—N(3)	117.49(17)	C(4A)—N(7A)—O(1A)	103.23(15)	N(4A)—C(9A)—(10A)	112.1(3)
N(2)—C(3)—N(3)	124.51(16)				

cation by crystallization from ethanol, amidoxime **2a** was obtained in a yield of 0.9 g (80%).

Compounds **2b—i** were prepared under analogous conditions and crystallized from appropriate solvents.

The characteristics of compounds **2a—i** are given in Tables 3 and 4.

2-Acetoxyamidino-4,6-dimorpholino-1,3,5-triazine (3a). A solution of acetyl chloride (3.4 mmol) in anhydrous benzene (5 mL) was slowly (dropwise) added with vigorous stirring to a solution containing amidoxime **2a** (3.2 mmol), anhydrous benzene (10 mL), and pyridine (5 mL) at 5—10 °C. Then the reaction mixture was stirred at this temperature for 1 h and allowed to stand at room temperature for 12 h. The solvent was removed *in vacuo*, and the precipitate was repeatedly washed with water and purified by crystallization from acetonitrile. Compound **3a** was obtained in a yield of 0.85 g (75%).

Table 3. Characteristics of compounds **2**, **3**, and **4**

Compound	M.p./°C	Yield (%)	Found / Calculated (%)			Molecular formula	Molecular ion, m/z (I_{rel} (%))
			C	H	N		
2a	268—269	80	46.70 46.59	6.05 6.19	31.57 31.70	$C_{12}H_{19}N_7O_3$	309 (100)
2b	>225 (decomp.)	75	42.83 42.65	6.86 6.71	43.65 43.53	$C_8H_{15}N_7O$	225 (70)
2c	240—241	67	42.70 42.65	6.87 6.71	43.40 43.53	$C_8H_{15}N_7O$	225 (80)
2d	184—185	82	63.80 63.64	6.00 6.14	25.85 25.98	$C_{20}H_{23}N_7O$	377 (75)
2e	272—273	90	59.98 59.80	4.88 4.71	30.69 30.52	$C_{16}H_{15}N_7O$	321 (60)
2f	209—210	70	42.64 42.51	5.67 5.55	33.20 33.06	$C_9H_{14}N_6O_3$	254 (75)
2g	270—271	85	45.50 45.37	6.07 5.92	35.20 35.28	$C_9H_{14}N_6O_2$	238 (60)
2h	234—235	68	62.39 62.27	5.33 5.18	23.87 23.99	$C_{18}H_{18}N_6O_2$	350 (100)
2i	>220 (decomp.)	90	55.23 55.06	7.66 7.59	31.94 32.11	$C_{14}H_{23}N_7O$	305 (70)

(*to be continued*)

Table 3 (*continued*)

Compound	M.p./°C	Yield (%)	Found / Calculated (%)			Molecular formula	Molecular ion, m/z (I_{rel} (%))
			C	H	N		
3a	248—249	75	47.99 47.85	6.17 6.03	28.08 27.91	$C_{14}H_{21}N_7O_4$	351 (80)
3b	214—215	65	50.79 50.65	6.50 6.64	25.62 25.85	$C_{16}H_{25}N_7O_4$	379 (50)
3c	207—208	91	45.05 44.93	6.53 6.41	36.87 36.68	$C_{10}H_{17}N_7O_2$	267 (70)
3d	244—245	80	45.00 44.93	6.49 6.41	36.85 36.68	$C_{10}H_{17}N_7O_2$	267 (50)
3e	215—216	68	48.90 48.79	7.03 7.17	33.09 33.20	$C_{12}H_{21}N_7O_2$	295 (20)
3f	149—150	85	63.13 62.99	6.15 6.01	23.50 23.38	$C_{22}H_{25}N_7O_2$	419 (40)
3g	152—153	69	64.55 64.40	6.66 6.53	22.01 21.91	$C_{24}H_{29}N_7O_2$	447 (45)
3h	252—253	93	59.69 59.50	4.83 4.72	26.80 26.99	$C_{18}H_{17}N_7O_2$	363 (25)
3i	179—180	87	61.50 61.36	5.26 5.41	25.21 25.05	$C_{20}H_{21}N_7O_2$	391 (55)
3j	175—176	70	44.70 44.59	5.31 5.44	28.22 28.37	$C_{11}H_{16}N_6O_4$	296 (40)
3k	134—135	65	47.25 47.13	5.90 5.75	30.17 29.99	$C_{11}H_{16}N_6O_3$	280 (35)
3l	168—169	66	61.36 61.20	5.00 5.14	21.30 21.42	$C_{20}H_{20}N_6O_3$	392 (40)
3m	186—187	63	55.37 55.31	7.40 7.25	28.36 28.22	$C_{16}H_{25}N_7O_2$	347 (45)
4a	222—223	76	50.60 50.44	5.88 5.74	29.30 29.42	$C_{14}H_{19}N_7O_3$	333 (80)
4b	171—172	62	53.30 53.17	6.55 6.41	27.30 27.13	$C_{16}H_{23}N_7O_3$	361 (90)
4c	181—182	70	48.02 48.18	6.20 6.07	39.49 39.34	$C_{10}H_{15}N_7O$	249 (70)
4d	205—206	65	48.35 48.18	6.22 6.07	39.49 39.34	$C_{10}H_{15}N_7O$	249 (30)
4e	123—124	60	52.17 51.97	7.06 6.90	35.50 35.36	$C_{12}H_{19}N_7O$	277 (70)
4f	119—120	62	65.97 65.81	5.83 5.77	24.56 24.42	$C_{22}H_{23}N_7O$	401 (50)
4g	84—85	57	67.28 67.11	6.44 6.34	22.95 22.83	$C_{24}H_{27}N_7O$	429 (60)
4h	245—246	68	62.69 62.60	4.27 4.38	28.20 28.39	$C_{18}H_{15}N_7O$	345 (50)
4i	138—139	71	64.38 64.33	5.23 5.13	26.37 26.26	$C_{20}H_{19}N_7O$	373 (60)
4j	164—165	71	47.55 47.47	5.19 5.07	30.36 30.20	$C_{11}H_{14}N_6O_3$	278 (65)
4k	128—129	60	50.20 50.37	5.44 5.38	32.19 32.05	$C_{11}H_{14}N_6O_2$	262 (80)
4l	165—166	65	64.33 64.16	5.00 4.85	22.57 22.45	$C_{20}H_{18}N_6O_2$	374 (60)
4m	156—157	75	58.22 58.34	6.95 7.04	29.94 29.77	$C_{16}H_{23}N_7O$	329 (80)

Table 4. Spectroscopic data for amidoximes **2**

Compound	IR, ν/cm^{-1}			^{1}H NMR, δ (*J*/Hz)	
	C=C, C=N, conj.	NH_2, OH	COC	=N—OH (s)	Other protons
2a	1500, 1550, 1655	3350, 3460	—	9.98	3.55—3.90 (m, 16 H, NCH_2, OCH_2); 5.35 (s, 2 H, NH_2)
2b	1520, 1535, 1650	3320, 3440	—	9.94	3.15 (s, 12 H, NMe_2); 5.33 (s, 2 H, NH_2)
2c	1510, 1570, 1670	3310, 3380, 3450	—	10.00	1.05—1.12 (t, 6 H, $CH_2\underline{Me}$, *J* = 8.2); 3.50—3.60 (q, 4 H, $C\underline{H}_2Me$, *J* = 7.1); 5.50 (s, 2 H, $\mathbf{N}\underline{H}_2CNOH$); 6.85 (br.s, 2 H, NH_2 in the triazine ring)
2d	1530, 1580, 1660	3360, 3480	—	10.12	1.00—1.15 (t, 6 H, $CH_2\underline{Me}$, *J* = 8.2); 3.80—4.00 (q, 4 H, $C\underline{H}_2Me$, *J* = 7.5); 5.32 (s, 2 H, NH_2 in the triazine ring); 7.15—7.40 (m, 10 H, H arom.)
2e	1525, 1550, 1675	3350, 3375, 3460	—	10.05	5.30 (s, 2 H, $\mathbf{N}\underline{H}_2CNOH$); 7.05 (br.s, 2 H, NH_2); 7.20—7.40 (m, 10 H, H arom.)
2f	1520, 1560, 1650	3340, 3470	1055, 1120	10.20	3.60—3.85 (m, 8 H, NCH_2, OCH_2); 3.95 (s, 3 H, OMe); 5.45 (br.s, 2 H, NH_2)
2g	1585, 1655	3380, 3445	1060, 1150	10.13	1.95—2.05 (m, 4 H, CH_2 of pyrrolidine); 3.50—3.65 (m, 4 H, NCH_2 of pyrrolidine); 3.90 (s, 3 H, OMe); 5.35 (s, 2 H, NH_2)
2h	1570, 1680	3370, 3490	1080, 1130	10.30	1.20—1.30 (t, 3 H, $OCH_2\underline{Me}$, *J* = 8.1); 4.20—4.30 (q, 2 H, $OC\underline{H}_2Me$, *J*= 7.2); 5.25 (s, 2 H, NH_2); 7.20—7.40 (m, 10 H, H arom.)
2i	1530, 1655	3390, 3485	—	9.90	1.50—1.75 (m, 12 H, CH_2 of piperidyl); 3.65—3.85 (m, 8 H, NCH_2); 5.30 (s, 2 H, NH_2)

Table 5. Spectroscopic characteristics of acylated amidoximes **3**

Compound	IR, ν/cm^{-1}				^{1}H NMR, δ (*J*/Hz)	
	C=C, C=N, conj.	NH_2	C=O	COC	NH_2	Other protons
3a	1550, 1600	3340	1750	—	6.70 (s)	2.05 (s, 3 H, COMe); 3.60—3.85 (m, 16 H, NCH_2, OCH_2)
3b	1540, 1590	3330	1740	—	6.65 (s)	1.00—1.15 (m, 6 H, $CH\underline{Me}_2$); 2.65—2.75 (m, 1 H, $C\underline{H}Me_2$); 3.60—3.85 (m, 16 H, NCH_2, OCH_2)
3c	1530, 1640	3350	1730	—	6.35 (s)	2.15 (s, 3 H, COMe); 3.20 (s, 12 H, NMe_2)
3d	1550, 1620	3380, 3470	1740	—	6.60 (s)	1.00—1.15 (t, 6 H, $CH_2\underline{Me}$, *J* = 8.3); 2.15 (s, 3 H, COMe); 3.50—3.65 (q, 4 H, $C\underline{H}_2Me$, *J* = 7.0)
3e	1555, 1620	3375, 3480	1740	—	6.55 (s)	1.05—1.20 (m, 12 H, $CH\underline{Me}_2$, $CH_2\underline{Me}$); 2.70—2.80 (m, 1 H, $C\underline{H}Me_2$); 3.50—3.65 (m, 4 H, $C\underline{H}_2Me$); 7.15 (br.s, 2 H, NH_2 in the triazine ring)
3f	1570, 1630	3380	1720	—	6.50 (br.s)	1.00—1.20 (t, 6 H, $CH_2\underline{Me}$, *J* = 8.3); 2.10 (s, 3 H, COMe); 3.75—3.95 (q, 4 H, $C\underline{H}_2Me$, *J* = 7.7); 7.15—7.45 (m, 10 H, H arom.)
3g	1575, 1640	3375	1730	—	6.53 (br.s)	0.95—1.25 (m, 12 H, $CH\underline{Me}_2$, $CH_2\underline{Me}$); 2.60—2.75 (m, 1 H, $C\underline{H}Me_2$); 3.80—4.00 (m, 4 H, $C\underline{H}_2Me$); 7.20—7.50 (m, 10 H, H arom.)
3h	1530, 1590, 1660	3360, 3380	1720	—	5.85 (s)	2.07 (s, 3 H, COMe); 6.80 (br.s, 2 H, NH_2 in the triazine ring); 7.20—7.50 (m, 10 H, H arom.)
3i	1560, 1600, 1670	3370, 3400	1720	—	5.95 (s)	1.05—1.25 (m, 6 H, $CH\underline{Me}_2$); 2.60—2.80 (m, 1 H, $C\underline{H}Me_2$); 6.90 (br.s, 2 H, NH_2 in the triazine ring); 7.25—7.50 (m, 10 H, H arom.)

(*to be continued*)

Table 5 (*continued*)

Compound	IR, ν/cm^{-1}				^{1}H NMR, δ (*J*/Hz)	
	C=C, C=N, conj.	NH_2	C=O	COC	NH_2	Other protons
3j	1510, 1570, 1620	3350	1715	1050, 1130	6.45 (br.s)	2.20 (s, 3 H, COMe); 3.65—3.90 (m, 8 H, NCH_2, OCH_2); 3.95 (s, 3 H, OMe)
3k	1580, 1640	3375	1725	1055, 1145	6.30 (br.s)	1.90—2.00 (m, 4 H, CH_2 of pyrrolidine); 2.15 (s, 3 H, COMe); 3.55—3.70 (m, 4 H, NCH_2 of pyrrolidine); 3.90 (s, 3 H, OMe)
3l	1530, 1630	3380, 3500	1725	1050, 1120	6.47 (br.s)	1.25—1.35 (t, 3 H, $CH_2\underline{Me}$, *J* = 8.2); 2.20 (s, 3 H, COMe); 4.25—4.40 (q, 2 H, $C\underline{H}_2Me$, *J* = 7.3); 7.15—7.55 (m, 10 H, H arom.)
3m	1550, 1620	3400	1720	—	6.25 (s)	1.55—1.75 (m, 12 H, CH_2 of piperidine); 2.20 (s, 3 H, COMe); 3.65—3.90 (m, 8 H, NCH_2)

Table 6. Spectroscopic characteristics of oxadiazolyltriazines **4a—m**

Compound	IR, ν/cm^{-1}		^{1}H NMR, δ (*J*/Hz)	
	C=C, C=N, conj.	Other groups	Me (s)	Other protons
4a	1560, 1600	—	2.65	3.65—3.90 (m, 16 H, NCH_2, OCH_2)
4b	1510, 1580	—	—	1.31—1.40 (m, 6 H, $CH\underline{Me}_2$); 2.63—2.75 (m, 1 H, $C\underline{H}Me_2$); 3.60—3.85 (m, 16 H, NCH_2, OCH_2)
4c	1545, 1610	—	2.67	3.20 (s, 12 H, NMe_2)
4d	1570, 1620	3310 (NH_2)	2.65	1.07—1.15 (m, 6 H, $NCH_2\underline{Me}$); 3.50—3.62 (m, 4 H, NCH_2); 7.05, 7.20 (both s, 2 H each, NH_2 in the triazine ring)
4e	1530, 1600	3300	—	1.05—1.15 (m, 6 H, $NCH_2\underline{Me}$); 1.32—1.40 (m, 6 H, $CH\underline{Me}_2$); 2.60—2.70 (m, 1 H, $C\underline{H}Me_2$); 3.50—3.65 (m, 4 H, NCH_2); 7.10 (br.s, 2 H, NH_2 in the triazine ring)
4f	1580, 1610	—	2.65	1.05—1.25 (t, 6 H, $CH_2\underline{Me}$, *J* = 8.2); 3.80—4.00 (q, 4 H, $C\underline{H}_2Me$, *J* = 8.0); 7.20—7.50 (m, 10 H, H arom.)
4g	1570, 1600	—	—	1.05—1.25 (m, 6 H, $CH_2\underline{Me}$); 1.35—1.45 (m, 6 H, $CH\underline{Me}_2$); 2.65—2.75 (m, 1 H, $C\underline{H}Me_2$); 3.45—3.65 (m, 4 H, $C\underline{H}_2Me$); 7.20—7.50 (m, 10 H, H arom.)
4h	1545, 1600	3370 (br.s, NH_2)	2.61	7.23 (br.s, 2 H, NH_2 in the triazine ring); 7.25—7.50 (m, 10 H, H arom.)
4i	1550, 1640	3400 (NH_2)	—	1.25—1.40 (m, 6 H, $CH\underline{Me}_2$); 2.55—2.67 (m, 1 H, $C\underline{H}Me_2$); 7.10—7.40 (m, 10 H, H arom.); 7.15 (br.s, 2 H, NH_2 in the triazine ring)
4j	1500, 1550	1020, 1150 (COC)	2.60	3.60—3.85 (m, 8 H, NCH_2, OCH_2); 3.90 (s, 3 H, OMe)
4k	1540, 1580	1030, 1080 (COC)	2.70	1.90—2.05 (m, 4 H, CH_2 of pyrrolidine); 3.55—3.75 (m, 4 H, NCH_2 of pyrrolidine); 3.95 (s, 3 H, OMe)
4l	1575, 1590	1070, 1120 (COC)	2.60	1.20—1.30 (t, 3 H, $CH_2\underline{Me}$, *J* = 8.3); 4.20—4.35 (q, 2 H, $C\underline{H}_2Me$, *J* = 7.1); 7.20—7.45 (m, 10 H, H arom.);
4m	1560, 1620	—	2.65	1.55—1.75 (m, 12 H, CH_2 of piperidine); 3.70—3.90 (m, 8 H, NCH_2 of piperidine)

Compounds **3c,d,f,h,j—m** were synthesized analogously. Compounds **3b,e,g,i** were prepared with the use of isobutyroyl chloride.

The spectroscopic characteristics of compounds **3a—m** are given in Table 5.

2-(5-Methyl-1,2,4-oxadiazol-3-yl)-4,6-dimorpholino-1,3,5-triazine (4a). A solution of compound **3a** (1.4 mmol) in glacial acetic acid (10 mL) was refluxed for 2.5 h. Then the acetic acid was concentrated to dryness under reduced pressure. The ground dry residue was washed on a filter with water until neutral and

then dried to a constant weight *in vacuo* at 56 °C. After purification by crystallization from ethanol, oxadiazolyltriazine **4a** was obtained in a yield of 0.36 g (76%).

Compounds **4b—m** were synthesized analogously.

The spectroscopic characteristics of compounds **4a—m** are given in Table 6.

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References

1. A. G. Tyrkov, *Izv. Vuzov, Ser. Khim. i Khim. Tekh.* [*Proceedings of Universities: Chemistry and Chemical Technology*], 2003, **46**, No. 5, 3 (in Russian).
2. L. A. Kayukova, I. S. Zhumadil´daeva, and S. G. Klepikova, *Izv. Min. Nauki—Akad. Nauk Resp. Kazakhstan, Ser. Khim.* [*Bull. Min. Sci. Nat. Acad. Sci. Republic of Kazakhstan, Div. Chem. Sci.*], 2000, No. 4, 41 (in Russian).
3. G. M. Pogosyan, V. A. Pankratov, V. N. Zaplishnyi, and S. G. Matsoyan, *Politriaziny* [*Polytriazines*], Izd-vo AN Arm. SSR, 1987, 614 pp. (in Russian).
4. *Methoden der organischen Chemie*, Houben-Weyl, Georg Thieme Verlag, Stuttgart, 1955, 944 p.
5. L. A. Kayukova, *Khim. Geterotsikl. Soedin.*, 2003, 253 [*Chem. Heterocycl. Compd.*, 2003 (Engl. Transl.)].
6. G. M. Sheldrick, *Computational Crystallography*, Oxford Univ. Press, Oxford, 1982, 506 p.
7. A. A. Chesnyuk, S. N. Mikhaylichenko, V. S. Zavodnov, and V. N. Zaplishnyi, *Khim. Geterotsikl. Soedin.*, 2002, 197 [*Chem. Heterocycl. Compd.*, 2002 (Engl. Transl.)].
8. A. Gordon and R. Ford, *The Chemist´s Companion*, New York—London—Sydney—Toronto, 1972, 545 p.

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