10. N. Yoshida, K. Kitano, Y. Furukawa, T. Ogawa, S. Sugimori, Y. Goto, T. Isoyama, and K. Nigorikawa, Japanese Patent No. 186,045 EP; Chem. Abstr., 105, 181,666 (1986).
11. Kokai Tokyo Koho 60-25973 JP; Ref. Zh. Khim., 24N241P (1985).
12. Z. Arnold, J. Sauliova, and V. Krchnak, Coll. Czech. Chem. Commun., 38, 2633 (1973).
13. T. A. Kizner, M. A. Mikhaleva, and E. S. Serebryakova, Khim. Geterotsikl. Soedin. (in press).
14. W. Schäfer and H.-J. Deutscher, Z. Chem., 22, 447 (1982).
15. L. A. Karamysheva, E. I. Kovshev, and V. V. Titov, Zh. Org. Khim., 12, 1508 (1976).
16. G. Li, R. Yan, Y. Xiao, and W. Zhang, Huadong Huagong Xueyuan Xuebao, 11, 479 (1985); Chem. Abstr., 106, 130,999 (1987).
17. S. Patai (ed.), The Chemistry of Functional Groups. Suppl. A. The Chemistry of Double-Bonded Functional Groups, Wiley, London—New York (1977), Part 1, p. 112.
18. M. A. Mikhaleva, G. A. Kolesnichenko, and V. P. Mamaev, Izv. Sib. Otd., Akad. Nauk SSSR, Ser. Khim. Nauk, Vyp. 2, No. 5, 109 (1988).
19. D. Vorländer, Z. Phys. Chem., A126, 449 (1927).
20. H. Schubert, H.-J. Lorenz, R. Hoffmann, and F. Franke, Z. Chem., 6, 337 (1966).
21. H. Schubert and H. Zaschke, J. Prakt. Chem., 312, 494 (1970).
22. H. Zaschke, Wiss. Z. Univ. Halle, Math.-Naturwissensch. R, 29, 35 (1980).
23. H.-J. Hoffmann and P. Birner, J. Prakt. Chem., 327, 937 (1985).
24. H. Zaschke, J. Prakt. Chem., 317, 617 (1975).
25. G. Winter and H. Hartung, Mol. Cryst. Liq. Cryst., 149, 17 (1987).

SYNTHESIS OF 4-ALKYLTHIO-2-(o-HYDROXYPHENYL)-1,3,5-TRIAZINES BY RECYCLIZATION OF 4-OXO-1,3-BENZOXAZINE PERCHLORATES

Yu. I. Ryabukhin, O. B. Korzhavina, O. Yu. Ryabukhina,
A. G. Gasanov, and A. D. Garnovskii

UDC 547.867.2.07'491.8.
496.3:543.51'422

A method has been developed for synthesis of 4-alkylthio-2-(o-hydroxyphenyl)-1,3,5-triazines by treatment of 4-oxo-1,3-benzoxazine perchlorates with S-methyl, benzyl, and allyl-isothioureas.

sym-Triazines with different substituents in the 2-, 4-, and 6-positions have been little studied [1, 2]. These compounds (particularly the alkylthio derivatives) show high herbicidal activity [3] and the mono and di (o-hydroxyphenyl)triazines are used as highly efficient light stabilizers of polymers [4, 5] with specific spectral properties.

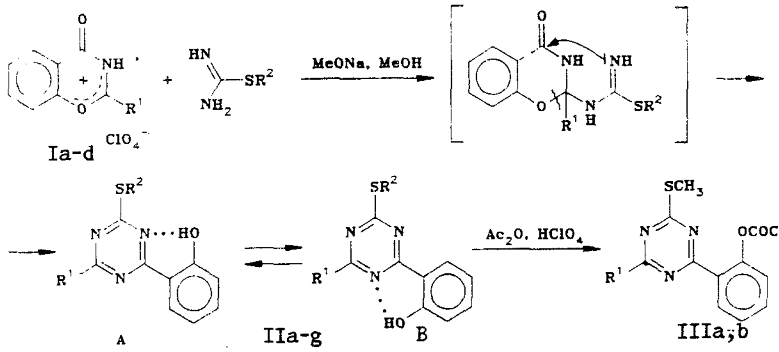
2,4-Dihydroxyphenyl-sym-triazines with alkyl(aryl) thio substituents are obtained by a Friedel—Crafts reaction of the chlorotriazines with resorcinol [4]. Mono(o-hydroxyphenyl)-triazines can be made either by fission of 2-(2-methylisoureido)- and 2-benzamido-4-oxo-1,3-benzoxazines with sodium methylate or thiophene [4] or by recyclization of 2-phenyl-4-oxo-1,3-benzoxazines with the S-alkyl-isothiourea [4, 6]. The latter method, however, is limited by the difficulty in obtaining benzoxazines, particularly the 2-alkyl derivatives which often cannot be prepared because of crotonic-type self-condensation [7, 8].

In our work the recyclization method of synthesis of the triazines is significantly modified by the introduction of the more reactive and readily available 4-oxo-1,3-benzoxazine perchlorates Ia-d [9-11] in the reaction with S-allylisothioureas. The possibility of using this method has previously been reported for the synthesis of 2-methylthio-4,6-di-(o-hydroxyphenyl)-sym-triazine [12].

As a result we have obtained the previously unknown 4-alkylthio-2-(o-hydroxyphenyl)-1,3,5-triazines IIa-g.

Physical and Organic Chemistry Research Institute, Rostov State University, Rostov-on-Don 344104. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 12, pp. 1658-1661, December, 1989. Original article submitted July 11, 1988.

0009-3122/89/2512-1381$12.50



I a $R^1=CH_3$, b $R^1=C_6H_5$, c $R^1=4\text{-}CH_3OC_6H_4$, d $R^1=CH=CHC_6H_5$; IIa–c $R^2=CH_3$, a $R^1=CH_3$, b $R^1=C_6H_5$, c $R^1=CH=CHC_6H_5$, II d, e $R^2=CH_2C_6H_5$, d $R^1=CH_3$, e $R^1=C_6H_5$, IIf, g $R^2=CH_2CH=CH_2$, f $R^1=C_6H_5$, g $R^1=4\text{-}CH_3OC_6H_4$, IIIa $R^1=CH_3$, b $R^1=C_6H_5$

Triazine synthesis was carried out by adding the perchlorate Ia-d to a suspension of a twofold excess of the S-alkylisothiourea salt and sodium methylate in methanol. The reaction mixture was held at room temperature or given a short reflux (up to 10 min).

The triazines II are colorless or light yellow (IIc,e,f) finely crystalline materials, soluble in polar organic solvents (alcohol, chloroform, DMF) and virtually insoluble in water. The yields and properties of the triazines are given in Table 1.

Formation of the triazine ring was confirmed by the IR spectra, which showed the absence of the carbonyl band consistent with opening and splitting of the benzoxazine ring. In the multiple bond region the bands of highest frequency (with medium intensity) are due to overall vibrations of the triazine and aromatic rings at 1620-1505 cm^{-1} (triazines in the crystalline state) or 1625-1480 cm^{-1} (solutions in CCl_4) (see Table 1). Bands at 1333-1127 cm^{-1} in the structure can be assigned to the stretching and deformation vibrations of the Ar–O and OH bonds, respectively. In the crystalline state the stretching vibration of the OH group appears as a low intensity, broad band in the region 3445-3190 cm^{-1}. In CCl_4 solution this absorption is shifted to the lower frequency of 3055-2980 cm^{-1} and appears as a broad band whose position and shape do not depend on concentration. Along with the shift of the phenolic proton NMR signal for the triazines II (Table 2) from 4.0-7.5 ppm (characteristic of free phenols [13, 14]) to 12.5-12.8 ppm, this points to a moderately strong intramolecular hydrogen bond between the phenolic hydroxyl and the triazine atom N_1 or N_3 (isomers A or B).

The presence of the phenolic hydroxyl in the synthesized molecules was confirmed by the violet or light brown (IIb, e-g, R^1 = Ar) coloration of alcoholic solutions with $FeCl_3$ and by their reaction with acetic anhydride under acidic catalysis conditions. The acetates IIIa, b thus formed did not show a phenolic reaction with alcoholic $FeCl_3$ and the bands due to the OH group in the IR spectrum are replaced by intense bands at 1755 and 1735 cm^{-1} due to the phenol esters [15]. In the NMR spectrum of acetate IIIb (Table 2) the phenolic proton signal is absent and a signal due to the $OCOCH_3$ methyl protons is observed at 2.2 ppm.

Triazines IIb, c were also synthesized [4] in 45 and 54% yields by reaction of S-methylisothiourea with 2-phenyl and 2-styryl-4-oxo-1,3-benzoxazines (obtained by deprotonation of the corresponding perchlorates Ib, d [9, 11]). Triazines IIa, b were obtained by treating N-acetyl- and N-benzoylsalicylamides with S-methylisothiourea but in less than 12% yields.

EXPERIMENTAL

IR spectra for all the triazines were recorded on an IR-75 instrument in the region 3700-700 cm^{-1} in Vaseline mull or as films prepared by evaporating CCl_4 solutions. Triazines IIa, b and IIIb were also recorded in CCl_4 in the concentration range 10^{-1} to 10^{-2} mole/liter with cd = const. The NMR spectra of triazine solutions were recorded on a Tesla BS-487C (80 MHz) at 20°C using HMDS as internal standard. The purity and identity of the triazines were monitored by TLC (Al_2O_3, $CHCl_3$).

2-(2-Hydroxyphenyl)-4-methylthio-6-methyl-1,3,5-triazine (IIa). S-Methylisothiourea sulfate (1.39 g, 5 mmoles) and then the benzoxazine perchlorate Ia (1.3 g, 5 mmoles) [9] were added to a solution of sodium methylate prepared from sodium (0.23 g, 10 mmoles) and methanol (10 ml). After 10 h the reaction mixture was poured onto ice and the precipitate filtered off, washed twice with water and dried (vacuum desiccator) over P_2O_5 to give 0.72 g of product with mp 88-89°C (from isobutanol).

TABLE 1. Data for 4-Alkylthio-2-(o-hydroxyphenyl)triazines

Compound	Empirical formula	Mp, °C†	IR Spectrum in Vaseline mull (or CCl_4), cm^{-1}			Yield, %
			OH	C=N and C=C arom	Ar—O and OH	
IIa	$C_{11}H_{11}N_3OS$	88...89	3425 (3055	1590 1535 1515 1625 1590 1525 1510	1310 1270 1250 1145 1305 1265 1245 1140)	62
IIb	$C_{16}H_{13}N_3OS$	146	3425 (2987	1620 1590 1530 1510 1593 1560 1480	1310 1250 1150 1333 1273 1147)	82
IIc	$C_{18}H_{15}N_3OS$	86...87	3210 (2980	1613 1580 1513 1500 1613 1573 1487	1300 1253 1160 1133 1307 1260 1153 1127)	57
IId	$C_{17}H_{15}N_3OS$	90...91	3190	1620 1598 1541 1523	1315 1280 1250 1160 1135	86
IIe	$C_{22}H_{17}N_3OS$	154...155	3425	1620 1590 1510	1325 1250 1170 1150	85
IIf	$C_{18}H_{15}N_3OS$	102...103	3445	1620 1588 1510	1310 1250 1240 1170	80
IIg	$C_{19}H_{17}N_3O_2S$	106...107	3395	1595 1515 1505	1315 1255 1175	48

---

*Molecular weights for IIa (233), IIf (321), and IIg (351) were determined by mass spectrometry on an MI-1305 (ionization energy 70 eV) in agreement with those calculated.

†Compounds IIa, b were recrystallized from isobutanol, IIc-f from isopropanol, and IIg from petroleum ether.

TABLE 2. ^1H NMR Spectra of Triazines II and III, δ, ppm*

Compound	S-alkyl protons	Aromatic protons	OH (1H, s)†	Other protons
IIa	2,51 (3H, s, CH_3)	6,8...8,4 (4H, m)	12,52	2,49 (3H, s, CH_3)
IIb	2,55 (3H, s, CH_3)	6,8...8,5 (9H, m)	12,81	—
IId	4,22 (2H, s, CH_2)	6,6...8,2 (9H, m)	—	2,42 (3H, s, CH_3)
IIe	3,94 (2H, s, CH_2)	6,8...8,5 (14H, m)	12,75	—
IIf	3,73 (2H, d, J=6 Hz, CH_2); 4,9...6,0 (3H, m, $CH{=}CH_2$)	6,7...8,3 (9H, m)	12,67	—
IIg	3,73 (2H, d, J=6 Hz, CH_2); 4,9...6,0 (3H, m, $CH{=}CH_2$)	6,6...8,3 (8H, m)	12,70	3,66 (3H, s, OCH_3)
IIIb	2,56 (3H, s, CH_3)	7,0...8,6 (9H, m)		2,20 (3H, s, $OCOCH_3$)

---

*Triazine IIa, b, e-g spectra recorded in $CDCl_3$, IId in CF_3COOH, IIIb in CCl_4.

†Phenolic proton signals disappeared upon deuteration.

Similar reactions of perchlorates Ia, b, d [9, 11] with S-methyl and S-benzylisothiourea gave the triazines IIb-e (see Table 1).

Elemental analytical data for C, H, N, and S agreed with that calculated.

4-(Allylthio)-2-(2-hydroxyphenyl)-6-phenyl-1,3,5-triazine (IIf). Perchlorate Ib [9] (1.62 g, 5 mmoles) was added to a suspension of S-allylisothiourea hydrobromide (1.97 g, 10 mmoles) in sodium methylate prepared from sodium (0.23 g) and methanol (10 ml), which had been heated to solution. The product was refluxed for 10 min, left for 12 h, and the precipitate formed was filtered off, washed twice with water, and dried over P_2O_5 to give 1.3 g of product with mp 102-103°C (from 2-propanol).

4-(Allylthio)-2-(2-hydroxyphenyl)-6-(4-methoxyphenyl)-1,3,5-triazine (IIg) was obtained similarly from perchlorate IIc [10]. Chromatographic purification gave a 48% yield with R_f 0.69 (Al_2O_3, $CHCl_3$).

2-(2 Acetoxyphenyl)-4-methylthio-6-methyl-1,3,5-triazine (IIIa, $C_{13}H_{13}N_3O_2S$). Two drops of $HClO_4$ (70%) were added with stirring to a suspension of triazine IIa (1.16 g, 5 mmoles) in acetic anhydride (3 ml). The reaction mixture was heated to solution, left overnight, poured into water, neutralized by Na_2CO_3, and extracted with ether. The extract was dried with anhydrous $CaCl_2$ and the solvent evaporated to give the triazine (0.49 g, 36%) with mp 59-60°C (from water). IR spectrum: 1735 ($OCOCH_3$), 1620 and 1538 (C=N and $C{=}C_{arom}$), 1240 cm^{-1} (C—O).

2-(2-Acetoxyphenyl)-4-methylthio-6-phenyl-1,3,5-triazine (IIIb, $C_{18}H_{15}N_3O_2S$). Two drops of $HClO_4$ (70%) were added with stirring to a suspension of the triazine IIb (0.74 g, 2.5 mmoles) in acetic anhydride (3 ml). After 2 h the reaction mixture was poured into ice and the precipitate filtered, washed twice with water, and dried (P_2O_5) to give the product (0.67 g, 80%) with mp 94-95°C (from 2-propanol). IR spectrum (Vaseline mull): 1746 and 1733 ($OCOCH_3$), 1580, 1560, 1546, and 1493 (C=N and $C{=}C_{arom}$), 1333, 1220, 1186, and 1160 cm^{-1} (C–O).

IR spectrum (CCl_4): 1760 ($OCOCH_3$), 1587, 1560, and 1493 (C=N and $C{=}C_{arom}$), 1340, 1220, and 1173 cm^{-1} (C–O).

LITERATURE CITED

1. A. E. A. Porter, Comprehensive Organic Chemistry, D. Barton and W. D. Ollis (eds.), Vol. 8 [Russian translation], Khimiya, Moscow (1985), p. 189.
2. J. M. E. Quike, Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C. W. Rees (eds.), Vol. 3, Pergamon Press, Oxford (1984), p. 523.
3. N. N. Mel'nikov, Chemistry and Technology of Pesticides [Russian translation], Khimiya, Moscow (1974), p. 665.
4. H. Brunetti and C. E. Luthi, Helv. Chim. Acta, 55, 1566 (1972).
5. H. Brunetti, J. J. Peterli, and H. J. Heller, Swiss Patent 388,253; Chem. Abstr., 63, 13,484 (1965).
6. H. Brunetti, J. J. Peterli, and H. J. Heller, Swiss Patent 422,319; Chem. Abstr., 68, 79,141 (1968).
7. Yu. I. Ryabukhin, V. D. Karpenko, O. Yu. Ryabukhina, and G. N. Dorofeenko, Developments in the Chemistry of Nitrogen-Containing Heterocycles: Materials of the 2nd National Conference, Riga (1979), No. 2, p. 183.
8. D. S. Kemp, F. Vellacio, and H. Gilman, J. Org. Chem., 9, 1804 (1981).
9. Yu. I. Ryabukhin, V. V. Mezheritskii, and G. N. Dorofeenko, Khim. Geterotsikl. Soedin., No. 4, 460 (1975).
10. G. N. Dorofeenko, Yu. I. Ryabukhin, and V. V. Mezheritskii, Zh. Obshch. Khim., 45, 1860 (1975).
11. Yu. I. Ryabukhin, V. V. Mezheritskii, V. D. Karpenko, and G. N. Dorofeenko, Khim. Geterotsikl. Soedin., No. 9, 1184 (1975).
12. Yu. I. Ryabukhin, L. N. Faleeva, and V. G. Korobkova, Khim. Geterotsikl. Soedin., No. 3, 406 (1983).
13. A. V. Ioganssen, The Hydrogen Bond [Russian translation], Nauka, Moscow (1981), p. 112.
14. J. Emsley, J. Feeney, and L. Sutcliffe, High-Resolution Nuclear Magnetic Resonance Spectroscopy, Vol. 1 [Russian translation], Mir, Moscow (1968), p. 514.
15. L. Bellamy, Infrared Spectra of Molecules [Russian translation], IL, Moscow (1963), p. 262.