Synthesis of Monocyclic Hydroperoxy- and Hydroxy-Substituted Sulfin- and Sulfonamides by Oxidation of 4,5-Dimethylisothiazolium Salts

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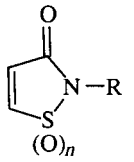
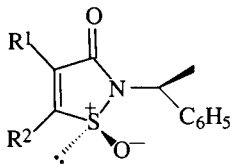
The isothiazolium salts **10**, easily accessible by cyclocondensation of the thiocyanates **8** with the anilines **9**, yielded with H_2O_2 as the oxidant the first stable hydroperoxides of the 2-aryl-2,3-dihydroisothiazole 1-oxides *rac-cis*-**13**, the 1,1-dioxides **15**, and their reduced 3-hydroxy derivatives *rac-cis*-**14** and **16**, respectively. The oxidation of **10** to new isothiazol-3(2*H*)-one 1,1-dioxides (**17**) is also described. For the first time, an aryl-bridged bis[isothiazolium salt] **11** was synthesized and oxidized.

Introduction. – Isothiazole derivatives **1** are recognized as substances that have biological activity in both medicinal and agrochemical fields [1–3]. The class of benzo-annelated isothiazole 1,1-dioxides, *e.g.*, the well-known saccharine, has been characterized and investigated quite well. These compounds show potent antibacterial, sedative-hypnotic, and anticonvulsant activities [3–5]. Extensive studies on the preparation of functionalized 1,2-dihydro-1λ^6-benzo[*d*]isothiazol-3-one 1,1-dioxides and toluene-2α-sultams have been carried out (for a review, see [5]). However, the number of studies on monocyclic, oxidized 2,3-dihydroisothiazole derivatives **2** and **3** is limited.

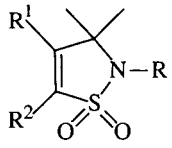
One of the earliest synthetic isothiazol-3(2*H*)-one derivatives were the 1-oxides **2** and the 1,1-dioxides **3** (R=H). The key step in their synthesis involves the oxidative cyclization of 4,5-dithiaoctanedioic acid diamides to **1** with either chlorine or sulfuryl chloride followed by oxidation [6]. This path is generally applicable [7–9], but the main difficulty is accessing the corresponding acyclic precursors. A general new route to the synthesis of *N*-substituted isothiazol-3(2*H*)-ones **1**, precursors of **2** and **3**, proceeds *via* trichloroacetic acid mediated ring closure of *N*-substituted (*Z*)-3-(benzylsulfinyl)propenamides [10].



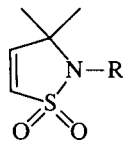
R = H, *t*-Bu, $C_6H_5CH_2$
1 *n* = 0
2 *n* = 1
3 *n* = 2



4a $R^1 = (CR^3{=}CH_2)$, R^2 = H
4b R^1 = Br, R^2 = H
4c $R^1 = R^2$ = H



5 R = H, CH_3, $C_6H_5CH_2$
$R^1 = NH_2$, OH
R^2 = H, CH_3, CN, subst. C_6H_5



6 R = H, $C_6H_5CH_2$

The homochiral isothiazol-3(2*H*)-one 1-oxides **4a**, synthesized *via Stille* coupling from **4b**, dimerize with high stereoselectivity *via* an unusual *exo*/*syn* transition state [11, 12]. An α-sulfinyl-substituted radical precursor, prepared by addition of phenyl selenol to **4c** in the presence of a catalytic amount of Et_3N, undergoes additions with (alk-2-enyl)tributyltin derivatives to give the corresponding 5-substituted isothiazol-3(2*H*)-one 1-oxides in excellent optical purity [13, 14].

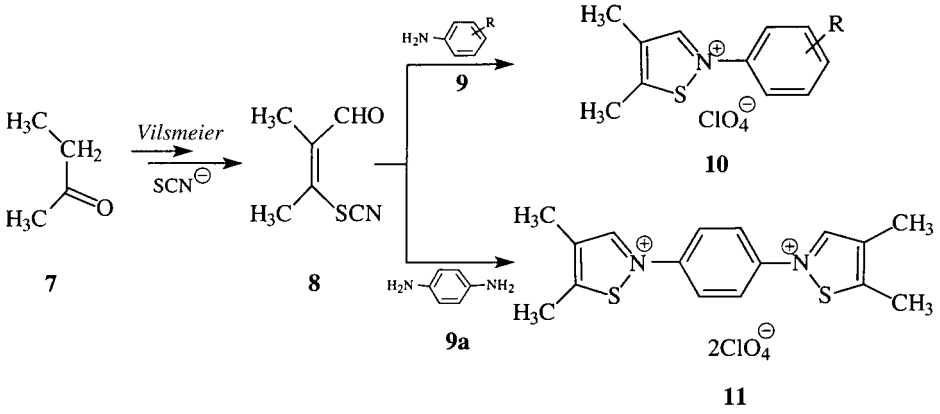
Oxidation at C(3) and S(1) of 3-unsubstituted isothiazoles with H_2O_2 in glacial AcOH is a convenient way to synthesize oxosultams of type **3** (R=H), which are alkyl-substituted in 4- or 5- or in both positions. The isothiazoles are accessible in only two steps from α-methylene ketones *via* (*Z*/*E*)-3-chloroalk-2-enales. The mechanism is not known yet; neither mono- nor bis-oxidized intermediates have been isolated so far [15]. The oxidation of 3-anilino-1-phenylprop-2-ene-1-thiones with H_2O_2 leads to the 2,5-diphenylisothiazol-3(2*H*)-one 1,1-dioxides **3** [16].

The synthesis and anti-HIV-1 activity of the first non-benzo-annelated 2,3-dihydroisothiazole 1,1-dioxides **5** (R^1=NH_2), lacking a 3-oxo group, has recently been described [17]. Compounds of type **5** (R^1=NH_2 or OH, R^2=arene) can be used as fungicides, herbicides, and pesticides [18]. Ring-closing metathesis (RCM) of vinylsulfonamide templates in the presence of *Grubbs* catalyst, providing the cyclic vinylsultams **6**, have also been described [19].

Here, we report a new approach to stable monocyclic 3-hydroperoxy- or 3-hydroxy-substituted isothiazole 1-oxides **13** and **14**, and sultams **15** and **16**, respectively. Furthermore, the synthesis of new monocyclic 4,5-dialkyl-2-phenyl-3-oxosultams **17** is described. With the presented method, these compounds are accessible on a preparative scale for the first time.

Results and Discussion. – *Vilsmeier* reaction of butan-2-one (**7**) and cyclo-condensation of the thiocyanates **8** with the anilines **9** gave the 4,5-dimethylisothiazolium salts **10b**–**j** according to our previously reported method (*Scheme 1*) [20]. The unknown 2-(4-nitrophenyl)isothiazolium salt **10j** can be prepared by a modified procedure from thiocyanate **8** and 4-nitroaniline (**9**). In the reaction of thiocyanates

Scheme 1

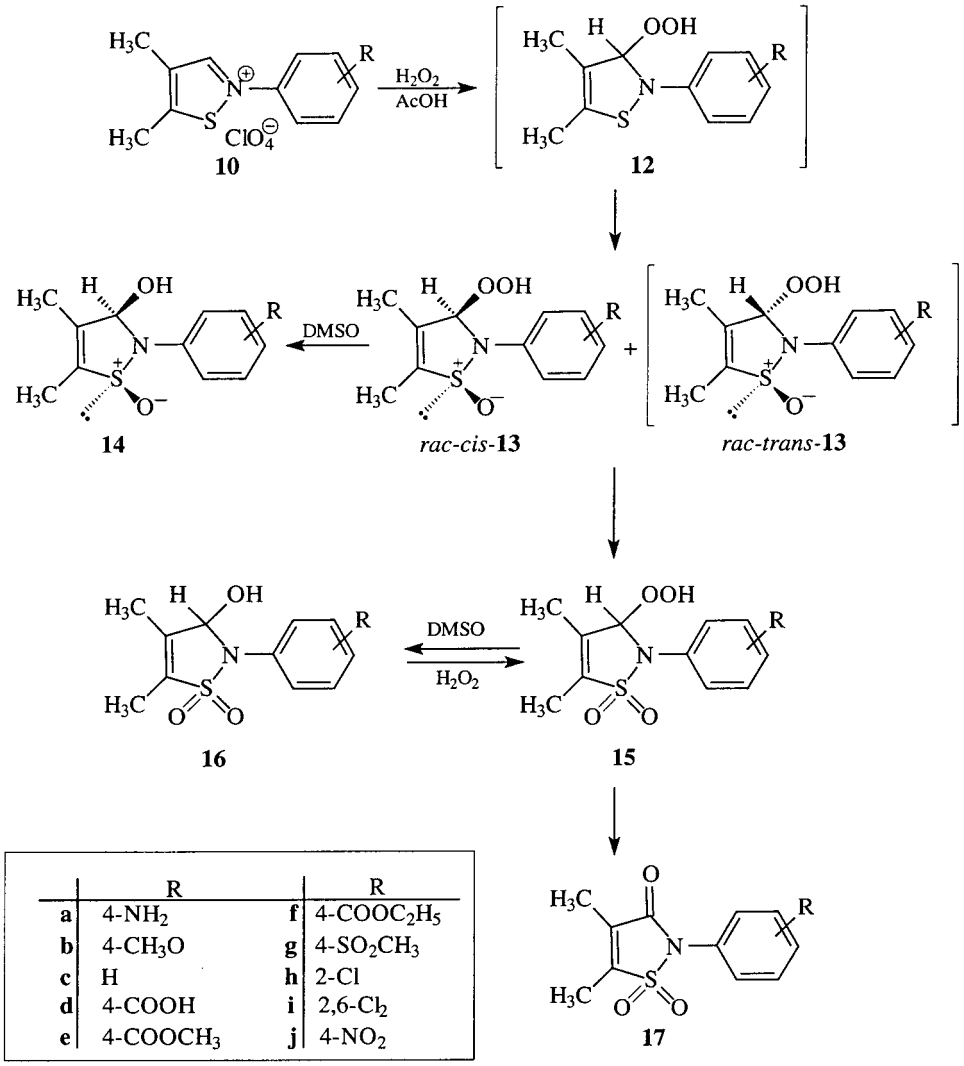


For specification of R, on *Scheme 2*

and benzene-1,4-diamine **9a**, we obtained a mixture of **10a** and **11**, which could not be purified by recrystallization, while **10b**–**j** were obtained in pure form. Surprisingly, when either the salts **10d** or **10e** were treated with the diamine **9a**, we isolated **10a** in more than 41% yield instead of the expected isomeric 2-(4-aminophenyl)-3,4-dimethylisothiazolium salt. We will report later on this so-called 'aniline exchange' reaction [21].

The oxidation of **10b**–**j** with H_2O_2 in AcOH at room temperature (45 h) gave the stable hydroperoxides **15b**–**j** as colorless crystals in moderate-to-good yields (30–87%, *Scheme 2*). The isolation of the corresponding precursors *rac-cis*-**13** was only possible in the case of acceptor-substituted salts, *e.g.*, *rac-cis*-**13d**–**f**,**j**, isolated after 3 h

Scheme 2



	R		R
a	4-NH_2	**f**	4-$COOC_2H_5$
b	4-CH_3O	**g**	4-SO_2CH_3
c	H	**h**	2-Cl
d	4-COOH	**i**	2,6-Cl_2
e	4-$COOCH_3$	**j**	4-NO_2

at room temperature in moderate yields (10–35%). Compound **13h** was not isolated at all, although detected by HPLC.

The structures of the compounds *rac-cis*-**13** and **15** were established by IR and NMR. Two absorption bands for the SO_2 group are characteristic for the 1,1-dioxides **15** at 1276–1300 and 1146–1172 cm^{-1} for the antisymmetric and symmetric vibrations, respectively. In the ^{1}H-NMR spectra of compounds **15**, the H–C(3) absorptions appear at 5.70–6.44 ppm, and in the ^{13}C-NMR spectra signals at 89.4–95.8 (C(3)), 132.8–136.1 (C(5)), and 137.4–140.2 ppm (C(4)) are typical. The 1-oxides *rac-cis*-**13** are characterized by a strong S–O absorption band at 1057–1060 cm^{-1}, by an ^{1}H-NMR signal at 5.69–6.29 ppm for H–C(3), and by ^{13}C-NMR signals at 98.3–98.9, 139.5–139.9, and 138.5–139.0 ppm, corresponding to C(3), C(4), and C(5), respectively.

We interprete the formation of the 1-oxides **13** as a two-step process. In the first step, nucleophilic attack of H_2O_2 at C(3) of **10** probably occurs in analogy to the mechanism proposed for bicyclic sultams [22]. A second attack of the oxidant at the S-atom then results in the formation of the *rac-cis*- and *rac-trans*-3-hydroperoxy compounds **13**. Until now, we have not managed to isolate *rac-trans*-**13**, although there was some evidence for their presence. Here, we present for the first time the synthesis of the stable, crystalline *rac-cis*-3-hydroxy isothiazole monoxides **14e**,**f**, formed by reduction of *rac-cis*-**13e**,**f** in the presence of DMSO. In the IR spectra of *rac-cis*-**14**, the typical sulfoxide absorptions are found at 1045–1058 cm^{-1}. In the ^{1}H-NMR spectrum, a *singlet* for H–C(3) appears at 5.89–5.91 ppm, and the ^{13}C-NMR signals were observed at 89.2–89.3, at 146.4, and at 136.4–136.8 ppm, corresponding to C(3), C(4), and C(5), respectively.

The assignment of the NMR signals of **14e** was achieved by NOE, COSY, HMQC, HMBC, and [(1,1)-ADEQUATE] measurements. The difference spectrum of **14e** showed an NOE effect between H–C(3) at 5.80 ppm and Me–C(4) at 1.94 ppm. The HMQC spectrum showed correlation signals between 1.94 and 12.16 ppm (Me–C(4)), 2.03 and 9.58 ppm (Me–C(5)), and between 5.80 and 88.5 ppm (H–C(3), C(3)), respectively. Unfortunately, to differentiate between C(4) and C(5) (141.0 *vs.* 135.1 ppm) was not possible by HMBC. Therefore, an [(1,1)-ADEQUATE] spectrum was recorded. The observed cross-peak at 229.5 ppm (sum of chemical shifts of C(3) and C(4)) clearly demonstrates that the ^{13}C-NMR absorption at 141.0 ppm corresponds to C(4). The assignment of the carbon shifts of the 2-aryl group was done analogously.

The *cis*-configuration of both *rac-cis*-**13e** and *rac-cis*-**14e** was confirmed by X-ray crystal-structure analysis (*Figs. 1* and *2*). In *rac-cis*-**13e**, N(1) protrudes by only 0.0017 Å from the plane defined by C(1), C(2), C(3), and S(1), *i.e.*, the isothiazole ring is approximately planar. The torsion angle between the isothiazole ring and the 2-aryl group is 17.5°.

The hydroxy-substituted isothiazole oxide *rac-cis*-**14e** showed two crystallographically distinct conformers **A** and **B** in a 1:1 ratio (*Fig. 2*), caused by different conformations of the Ph group. In conformer **B**, the aromatic ring is 9.1°, and in conformer **A** only 7.2°, out of plane with respect to the isothiazole ring. The isothiazole ring in **14e** is also approximately planar. The distance of N(1) in **A** from the plane C(1), C(2), C(3), S(1) is −0.06(8) Å, and that of N(2) in conformer **B** is 0.05(0) Å. Both *rac-cis* **13e** and *rac-cis* **14e** show intermolecular H-bonds between either the H-atom of the OOH group (**13e**) or OH group (**14e**) and the sulfoxide O-atom of a neighboring

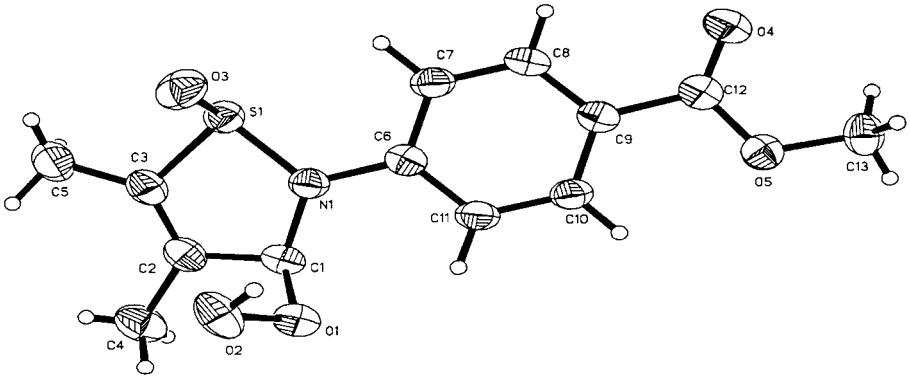


Fig. 1. *Structure of* rac-cis-**13e**

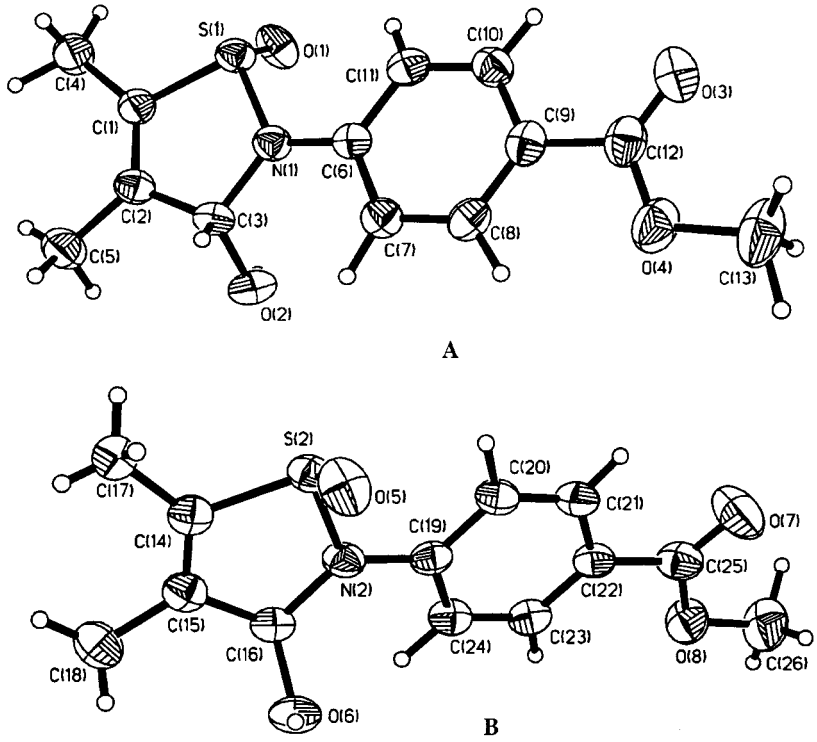


Fig. 2. *Structure of* rac-cis-**14e**

molecule. In contrast, the H-atom of the OH group in sultam **16e** forms the intermolecular H-bond with the O-atom of the ester function [23].

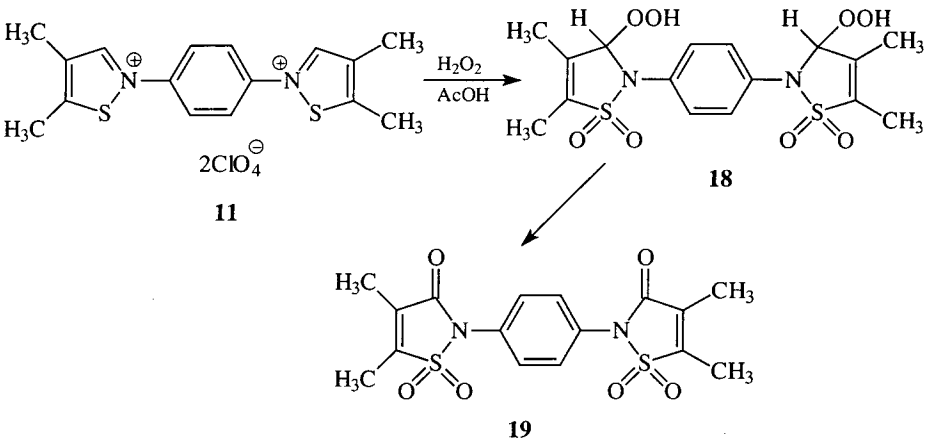
In contrast to the synthesis of substituted benzisothiazole 1,1-dioxides [22], it was not possible to obtain the corresponding sultams **16** by reduction of **15** with Na_2SO_3 in H_2O. However, we were able to synthesize the monocyclic sultams **16e**,**f** in the presence

of DMSO from the hydroperoxides **15e**,**f**. Characteristic for sultams of type **16** are the signals of C(3) in the ^{13}C-NMR spectra (83.0 ppm), and the signal of H–C(3) in the ^{1}H-NMR spectra (6.00–6.05 ppm). Thereby, the assignments of the ^{1}H and ^{13}C resonances of compounds **16** are based on the same NMR measurements as described above (see *Exper. Part*).

The 2-aryl-3-oxosultams **17b**,**c** and **17g–j** were obtained by oxidation of the corresponding precursors **10** with H_2O_2 in AcOH at 80°. Surprisingly, **17d–f** were received in good yields only by thermolysis of **15** in EtOH. Typical signals of this compounds are found in the ^{13}C-NMR spectra at 160.2–161.8 ppm (C=O) and in the IR spectra at 1274–1335 and at 1174–1179 cm^{-1} (SO_2). We have also found that, under the above reaction conditions, the NH_2 group of the phenyl ring in **10a** is being oxidized to a NO_2 group. Of course, **17j** can also be prepared by oxidation of the NO_2-substituted isothiazolium salt **10j**.

Finally, we investigated the oxidation of the bis(isothiazolium) salt **11** (*Scheme 3*). Depending on the reaction conditions, two compounds (**18** and **19**) were obtained. The bis(hydroperoxide) **18** displayed characteristic IR bands of the SO_2 group at both 1169 and 1287 cm^{-1}. Typical ^{13}C-NMR signals were found at 93.1, 138.5, and 134.5 ppm, corresponding to C(3), C(4), and C(5), respectively. The absorption of H–C(3) at 6.17 ppm is significant in the ^{1}H-NMR spectrum of **18**. Evidence for the bis[3-oxosultam] **19** was found in the IR-spectrum, in which the C=O resonance was observed at 1739 cm^{-1} and the SO_2 resonance at 1178 and 1332 cm^{-1}, respectively. The relevant ^{13}C-NMR data are: 161.7 ppm for C(3), 135.0 ppm for C(4), and 144.5 ppm for C(5).

Scheme 3



Conclusions. – In summary, the oxidation of isothiazolium salts of type **10** is a convenient new method for the synthesis of the hydroperoxy- or hydroxy-functionalized isothiazol-1-oxides *rac-ris*-**13**, **14** and the sultams **15**, **16**, respectively. Furthermore, an efficient route to the monocyclic 2-aryl-3-oxo-sultams **17** has been found by oxidation of the precursors **10** with H_2O_2 at 80°. For the first time, an aryl-bridged

bis[isothiazolium salt] (**11**) was prepared and oxidized. In the near future, the new compounds **13** and **15**, which bear a hydroperoxy substituent, will be used as oxidizing agents for organic compound containing heteroatoms such as S and P and for other applications [23].

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Experimental Part

General. M.p.: *Boetius* micro-melting-point apparatus; corrected. IR spectra: *Genesis FTIR Unicam Analytical System* (*ATI Mattson*); KBr pellets; values in cm^{-1}. UV/VIS spectra: *Beckman DU 650*; λ_{max} in nm (log ε). ^{1}H-NMR: *Varian Gemini-200* and *Varian Unity-400*; δ in ppm rel. to TMS as internal standard, *J* in Hz. ^{13}C-NMR spectra: 50 or 100 MHz, recorded on the above spectrometers. MS: *Quadrupole-MS VG 12-250*; 70 eV. Elemental analysis: *Heraeus CHNO Rapid Analyzer*.

1. *2-Aryl-4,5-dimethylisothiazolium Perchlorates* (**10**). The data of the salts **10b**,**c** are given in [20]. The other salts **10** were prepared according to [20].

2-(4-Aminophenyl)-4,5-dimethylisothiazolium Perchlorate (**10a**): 45%. Ochre crystals. M.p. 180–184°. IR: 1117*s* (O–Cl–O). UV (EtOH): 244.0 (3.90), 298.5 (3.39). ^{1}H-NMR ((D$_6$)DMSO): 2.27 (*s*, Me–C(4)); 2.70 (*s*, Me–C(5)); 6.68, 7.40 (*AA′BB′*, *J* = 10.1, 4 arom. H); 5.88 (br. *s*, NH_2); 9.25 (*s*, H–C(3)). ^{13}C-NMR ((D$_6$)DMSO): 11.7 (*Me*–C(4)); 14.1 (*Me*–C(5)); 115.0 (C(3′,5′)); 126.1 (C(2′,6′)); 133.8 (C(1′)); 134.6 (C(4)); 152.0 (C(4′)); 156.2 (C(3)); 165.8 (C(5)). EI-MS: 205 ([*M* – $HClO_4$]$^{+\bullet}$). Anal. calc. for $C_{11}H_{13}ClN_2O_4S$ (304.75): C 43.35, H 4.30, Cl 11.63, N 9.19, O 21.00; found: C 43.21, H 4.18, Cl 11.52, N 9.25, O 21.11.

2-(4-Carboxyphenyl)-4,5-dimethylisothiazolium Perchlorate (**10d**): 63%. Yellow crystals. M.p. 242–244°. IR: 1704*s* (C=O), 1100*s* (O–Cl–O). UV (EtOH): 248.5 (3.98), 296.0 (4.08). ^{1}H-NMR ((D$_6$)DMSO): 2.32 (*s*, Me–C(4)); 2.79 (*s*, Me–C(5)); 7.92, 8.18 (*AA′BB′*, *J* = 8.9, 4 arom. H); 9.58 (*s*, H–C(3)). ^{13}C-NMR ((D$_6$)DMSO): 11.7 (*Me*–C(4)); 14.1 (*Me*–C(5)); 124.0 (C(2′,6′)); 132.4 (C(3′,5′)); 133.8 (C(4′)); 134.7 (C(4)); 140.7 (C(1′)); 157.2 (C(3)); 167.0 (COOH); 169.7 (C(5)). EI-MS: 234 ([*M* – $HClO_4$]$^{+\bullet}$). Anal. calc. for $C_{12}H_{12}ClNO_6S$ (333.74): C 43.19, H 3.62, Cl 10.62, N 4.20, O 28.77, S 9.61; found: C 43.05, H 3.56, Cl 10.76, N 4.09, O 28.80, S 9.76.

2-[4-(Methoxycarbonyl)phenyl]-4,5-dimethylisothiazolium Perchlorate (**10e**): 86%. Yellow crystals. M.p. 207–209°. IR: 1722*s* (CO), 1112*s* (O–Cl–O). UV (EtOH): 256.0 (3.87), 295.0 (3.99). $C_{13}H_{14}ClNO_6S$ (347.77).

2-[4-(Ethoxycarbonyl]phenyl)-4,5-dimethylisothiazolium Perchlorate (**10f**): 66%. Yellow crystals. M.p. 165–167°. IR: 1714*s* (C=O), 1100*s* (O–Cl–O). UV (EtOH): 255.0 (3.94), 295.0 (4.05). $C_{14}H_{16}ClNO_6S$ (361.80).

4,5-Dimethyl-2-[4-(methylsulfonyl)phenyl]isothiazolium Perchlorate (**10g**): 90%. Yellow needles. M.p. 223–226°. IR: 1090*s* (O–Cl–O). UV (EtOH): 250.0 (3.82), 293.0 (3.91). ^{1}H-NMR ((D$_6$)DMSO): 2.34 (*s*, Me–C(4)); 2.81 (*s*, Me–C(5)); 3.32 (*s*, $MeSO_2$); 8.08, 8.22 (*AA′BB′*, *J* = 8.4, 4 arom. H); 9.59 (*s*, H–C(3)). ^{13}C-NMR ((D$_6$)DMSO): 10.9 (*Me*–C(4)); 13.4 (*Me*–C(5)); 43.3 ($MeSO_2$); 124.1 (C(2′,6′)); 129.4 (C(3′,5′)); 133.9 (C(4)); 140.3 (C(1′)); 142.6 (C(4′)); 156.5 (C(3)); 169.4 (C(5)). EI-MS: 267 ([*M* – $HClO_4$]$^{+\bullet}$). Anal. calc. for $C_{12}H_{14}ClNO_6S_2$ (367.82): C 39.18, H 3.84, Cl 9.64, N 3.81, O 26.10, S 17.43; found: C 38.99, H 3.99, Cl 9.44, N 4.00, O 26.30, S 17.56.

2-(2-Chlorophenyl)-4,5-dimethylisothiazolium Perchlorate (**10h**): 82%. Colorless crystals. M.p. 138–140°. IR: 1091*s* (O–Cl–O). UV (EtOH): 277.5 (3.88). ^{1}H-NMR ((D$_6$)DMSO): 2.38 (*s*, Me–C(4)); 2.85 (*s*, Me–C(5)); 7.80 (*m*, 4 arom. H); 9.43 (*s*, H–C(3)). ^{13}C-NMR ((D$_6$)DMSO): 11.0 (*Me*–C(4)); 13.6 (*Me*–C(5)); 114.5 (1 arom. C); 129.3, 129.7, 131.1 (3 arom. CH); 133.2 (1 arom. C); 133.7 (1 arom. CH); 134.0 (C(4)); 159.9 (C(3)); 171.5 (C(5)). Anal. calc. for $C_{11}H_{11}Cl_2O_4S$ (325.18): C 40.76, H 3.42, Cl 21.87, N 4.32, O 19.72, S 9.80; found: C 40.80, H 3.41, Cl 22.05, N 4.31, O 19.60, S 9.92.

2-(2,6-Dichlorophenyl)-4,5-dimethylisothiazolium Perchlorate (**10i**): 52%. Yellow crystals. M.p. 228–229°. IR: 1100*s* (O–Cl–O). UV (EtOH): 275.0 (3.90). ^{1}H-NMR ((D$_6$)DMSO): 2.36 (*s*, Me–C(4)); 2.86 (*s*, Me–C(5)); 7.71–7.88 (*m*, 3 arom. H); 9.43 (*s*, H–C(3)). ^{13}C-NMR ((D$_6$)DMSO): 11.6 (*Me*–C(4)); 14.6 (*Me*–C(5)); 130.5 (C(3′,5′)); 132.6, 133.9 (2 arom. C); 134.4 (C(4)); 135.1 (1 arom. CH); 161.0 (C(3)); 172.5 (C(5)). Anal. calc. for $C_{11}H_{10}Cl_3NO_4S$ (358.62): C 36.84, H 2.81, Cl 29.66, N 3.91, O 17.84, S 8.94; found: C 36.81, H 2.83, Cl 29.81, N 3.92, O 17.61, S 8.79.

4,5-Dimethyl-2-(4-nitrophenyl)isothiazolium Perchlorate (**10j**): 71%. Yellow crystals. M.p. 135–136°. IR: 1529*s* (NO_2); 1348*s* (NO_2); 1089*s* (O–Cl–O). UV (EtOH): 259.5 (3.40), 298.5 (3.37). ^{1}H-NMR ((D_6)DMSO): 2.38 (*s*, Me–C(4)); 2.85 (*s*, Me–C(5)); 8.13, 8.55 (*AA′BB′*, *J* = 9.1, 4 arom. H); 9.68 (*s*, H–C(3)). ^{13}C-NMR ((D_6)DMSO): 11.7 (*Me*–C(4)); 14.2 (*Me*–C(5)); 125.2 (C(2′,6′)); 126.6 (C(3′,5′)); 134.7 (C(4)); 141.9 (C(1′)); 149.5 (C(4′)); 157.4 (C(3)); 170.6 (C(5)). Anal. calc. for $C_{11}H_{11}ClN_2O_6S$ (334.73): C 39.47, H 3.31, Cl 10.59, N 8.37, O 28.68, S 9.58; found: C 39.41, H 3.45, Cl 10.74, N 8.47, O 28.58, S 9.43.

2,2′-[Benzene-1,4-diyl]bis[4,5-dimethylisothiazol-2-ium] Diperchlorate (**11**): 88%. Yellow solid. M.p. 170° (dec.). IR: 1091*s* (O–Cl–O). UV (EtOH): 249.5 (4.12), 336.0 (3.76), 386.5 (3.75). ^{1}H-NMR ((D_6)DMSO): 2.35 (*s*, 2 Me–C(4)); 2.81 (*s*, 2 Me–C(5)); 8.13 (*s*, 4 arom. H); 9.57 (*s*, 2 H–C(3)). ^{13}C-NMR ((D_6)DMSO): 10.9 (2 *Me*–C(4)); 13.3 (2 *Me*–C(5)); 125.2 (4 arom. CH); 133.8 (2 C(4)); 138.1 (2 arom. C); 156.6 (2 C(3)); 169.1 (2 C(5)). EI-MS: 300 ($[M - 2\,HClO_4]^{+\cdot}$). Anal. calc. for $C_{16}H_{18}Cl_2N_2O_8S_2$ (501.36): C 38.33, H 3.62, N 5.59, S 12.79; found: C 39.56, H 4.09, N 5.67, S 12.54.

2. *Aryl-Substituted 2,3-Dihydro-3-hydroperoxy-4,5-dimethylisothiazole 1-Oxides* (*rac-cis*-**13**). *General Procedure.* H_2O_2 (0.7 ml, 30%) was added to a stirred suspension of **10** (0.26 mmol) in AcOH (0.7 ml) at r.t. After 2–5 h, the starting material was dissolved and a colorless precipitate (*rac-cis*-**13**) was immediately filtered off to prevent oxidation to **15**. The crude products were washed with H_2O and recrystallized from EtOH.

cis-*4-(2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1-oxoisothiazol-2-yl)benzoic Acid* (*rac-cis*-**13d**): 10%. Colorless crystals. M.p. 175–178°. IR: 1689*s* (C=O), 1057*s* (S=O). ^{1}H-NMR ((D_6)acetone): 2.09 (*s*, Me–C(4′,5′)); 6.23 (*s*, H–C(3′)); 7.40, 8.02 (*AA′BB′*, *J* = 8.9, 4 arom. H); 11.11 (*s*, OOH). EI-MS: 265 ($[M - H_2O]^{+\cdot}$). Anal. calc. for $C_{12}H_{13}NO_5S$ (283.30): C 50.88, H 4.63, N 4,94, O 28.24, S 11.30; found: C 50.70, H 4.38, N 4.77, O 27.98, S 11.40.

*Methyl 4-(*cis-*2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1-oxoisothiazol-2-yl)benzoate* (*rac-cis*-**13e**): 20%. Colorless crystals. M.p. 134–136°. IR: 1711*s* (C=O), 1059*s* (S=O). ^{1}H-NMR ((D_6)acetone): 2.09 (*s*, Me–C(4′,5′)); 3.86 (*s*, MeO); 6.23 (*s*, H–C(3′)); 7.39, 7.99 (*AA′BB′*, *J* = 9.0, 4 arom. H); 11.10 (*s*, OOH). ^{13}C-NMR ((D_6)acetone): 10.6 (*Me*–C(5′)); 15.0 (*Me*–C(4′)); 52.8 (MeO); 98.9 (C(3′)); 117.2 (C(2,6)); 125.3 (C(4)); 132.3 (C(3,5)); 139.0 (C(5′)); 139.9 (C(4′)); 147.6 (C(1)); 167.5 (*C*OOMe). EI-MS: 279 ($[M - H_2O]^{+\cdot}$). Anal. calc. for $C_{13}H_{15}NO_5S$ (297.32): C 52.52, H 5.08, N 4.71, O 26.90, S 10.78; found: C 52.80, H 4.83, N 4.58, O 26.80, S 10.83.

*Ethyl 4-(*cis-2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1-oxoisothiazol-2-yl)benzoate (*rac-cis*-**13f**): 15%. Colorless crystals. M.p. 138–141°. IR: 1712*s* (C=O), 1060*s* (S=O). ^{1}H-NMR ((D_6)acetone): 1.33 (*t*, *Me*CH_2O); 2.10 (*s*, Me–C(4′,5′)); 4.35 (*q*, MeC*H_2*O); 6.22 (*s*, H–C(3′)); 7.39, 8.01 (*AA′BB′*, *J* = 8.5, 4 arom. H); 11.10 (*s*, OOH). EI-MS: 293 ($[M - H_2O]^{+\cdot}$). Anal. calc. for $C_{14}H_{17}NO_5S$ (311.34): C 54.01, H 5.50, N 4.50, O 25.69, S 10.30; found: C 54.18, H 5.37, N 4.69, O 25.54, S 10.48.

cis-*2-(2,6-Dichlorophenyl)-2,3-dihydro-3-hydroperoxy-4,5-dimethylisothiazole 1-Oxide* (*rac-cis*-**13i**): 55%[1]). Colorless crystals. ^{1}H-NMR ((D_6)acetone): 2.09 (*s*, Me–C(4,5)); 5.69 (*s*, H–C(3)); 7.43–7.63 (*m*, 3 arom. H); 10.04 (*s*, OOH).

cis-*2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-2-(4-nitrophenyl)isothiazole 1-Oxide* (*rac-cis*-**13j**): 12%. Yellow crystals. M.p. 160–161°. IR: 1504*s* (NO_2), 1340*s* (NO_2), 1059*s* (S=O). ^{1}H-NMR ((D_6)acetone): 2.10 (*s*, Me–C(4,5)); 6.29 (*s*, H–C(3)); 7.49, 8.27 (*AA′BB′*, *J* = 9.3, 4 arom. H); 11.23 (*s*, OOH). ^{13}C-NMR ((D_6)acetone): 9.95 (*Me*–C(5)); 12.35 (*Me*–C(4)); 98.3 (C(3)); 116.8 (C(2′,6′)); 126.1 (C(3′,5′)); 138.5 (C(5)); 139.5 (C(4)); 143.3 (C(4′)); 148.6 (C(1′)). EI-MS: 266 ($[M - H_2O]^{+\cdot}$). Anal. calc. for $C_{11}H_{12}N_2O_5S$ (284.29): C 46.47, H 4.26, N 9.85, O 28.14, S 11.28; found: C 46.39, H 4.33, N 9.89, O 28.11, S 11.37.

3. *Aryl-Substituted 2,3-Dihydro-3-hydroxy-4,5-dimethylisothiazole 1-Oxides* (**14**). *General Procedure.* DMSO (2 ml) was added to **13**. After 2 h, the soln. was lyophilized, and the solid remainder was recrystallized from acetone.

*Methyl 4-(*cis-*2,3-dihydro-3-hydroxy-4,5-dimethyl-1-oxoisothiazol-2-yl)benzoate* (*rac-cis*-**14e**): 75%. Colorless crystals. M.p. 160–163°. IR: 1712*s* (C=O), 1276*s*, 1058*s* (S=O). ^{1}H-NMR ((D_6)DMSO): 1.94 (*s*, Me–C(4′)); 2.03 (*s*, Me–C(5′)); 3.84 (*s*, OMe); 5.80 (*s*, H–C(3′)); 7.36, 7.96 (*AA′BB′*, *J* = 9.0, 4 arom. H). ^{13}C-NMR ((D_6)DMSO): 9.58 (*Me*–C(5′)); 12.2 (*Me*–C(4′)); 51.8 (OMe); 88.5 (C(3′)); 115.3 (C(2,6)); 122.5 (C(4)); 130.8 (C(3,5)); 135.1 (C(5′)); 141.0 (C(4′)); 145.9 (C(1)); 166.0 (*C*OOMe). EI-MS: 281 ($M^{+\cdot}$). Anal. calc. for $C_{13}H_{15}NO_4S$ (281.33): C 55.50, H 5.37, N 4.98, O 22.75, S 11.40; found: C 55.37, H 5.08, N 5.11, O 22.32, S 11.73.

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[1]) Containing *ca.* 20% of **15i**.

*Ethyl 4-(*cis*-2,3-dihydro-3-hydroxy-4,5-dimethyl-1-oxoisothiazol-2-yl)benzoate* (*rac-cis*-**14f**): 76%. Colorless crystals. M.p. 135–137°. IR: 1702*s* (C=O), 1274*s*, 1045*s* (S=O). ^{1}H-NMR ((D$_6$)acetone): 1.35 (*t*, *Me*CH$_2$); 2.07 (*s*, Me–C(4′,5′)); 4.32 (*q*, MeC*H*$_2$); 5.89 (*s*, H–C(3′)); 7.49, 7.96 (*AA′BB′*, *J* = 9.0, 4 arom. H). ^{13}C-NMR ((D$_6$)acetone): 9.24 (*Me* – C(5′)); 11.78 (*Me* – C(4′)); 14.02 (OCH$_2$*Me*); 60.45 (O*C*H$_2$Me); 89.3 (C(3)); 115.6 (C(2,6)); 123.9 (C(4)); 131.1 (C(3,5)); 136.8 (C(5′)); 140.7 (C(4′)); 146.4 (C(1)); 165.8 (*C*OOEt). EI-MS: 295 ([*M*]$^{+\cdot}$). Anal. calc. for $C_{14}H_{17}NO_4S$ (295.35): C 56.93, H 5.80, N 4.74, O 21.67, S 10.85; found: C 56.81, H 5.73, N 4.95, O 21.52, S 10.94.

4. *Aryl-Substituted 2,3-Dihydro-3-hydroperoxy-4,5-dimethylisothiazole 1,1-Dioxides* (**15**). *General Procedure.* H_2O_2 (0.7 ml, 30%) was added at r.t. to a stirred suspension of **10** (0.26 mmol) in AcOH (0.7 ml). Precipitates formed during the reaction were not isolated. After 45 h, colorless crystals of **15b–j** were filtered off and recrystallized from EtOH.

2,3-Dihydro-3-hydroperoxy-2-(4-methoxyphenyl)-4,5-dimethylisothiazole 1,1-Dioxide (**15b**): 52%. Colorless crystals. M.p. 144–146°. IR: 1276*s* (SO$_2$), 1170*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 2.07 (*s*, Me–C(4,5)); 3.82 (*s*, OMe); 5.93 (*s*, H–C(3)); 6.98, 7.42 (*AA′BB′*, *J* = 9.0, 4 arom. H); 11.10 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 8.0 (*Me*–C(5)); 12.5 (*Me*–C(4)); 56.6 (OMe); 94.6 (C(3)); 116.0 (C(3′,5′)); 123.2 (C(1′)); 129.3 (C(2′,6′)); 134.7 (C(5)); 138.4 (C(4)); 160.0 (C(4′)). EI-MS: 267 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{12}H_{15}NO_5S$ (285.31): C 50.52, H 5.30, N 4.91, O 28.04, S 11.24; found: C 50.45, H 5.22, N 4.98, O 27.99, S 11.18.

2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1,1-dioxo-2-phenylisothiazole (**15c**): 57%. Colorless crystals. M.p. 145–147°. IR: 1280*s* (SO$_2$), 1169*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 2.07 (*s*, Me–C(4,5)); 6.17 (*s*, H–C(3)); 7.21–7.45 (*m*, 5 arom. H); 11.21 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 7.2 (*Me*–C(5)); 11.8 (*Me*–C(4)); 92.0 (C(3)); 123.2 (C(2′,6′)); 126.6 (C(4′)); 130.7 (C(3′,5′)); 134.0 (C(5)); 137.4 (C(1′)); 138.4 (C(4)). EI-MS: 237 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{11}H_{13}NO_4S$ (255.29): C 51.75, H 5.13, N 5.49, O 25.07, S 12.56; found: C 51.52, H 5.08, N 5.69, O 25.23, S 12.39.

4-(2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1,1-dioxoisothiazol-2-yl)benzoic Acid (**15d**): 51%. Colorless crystals. M.p. 185–188°. IR: 1690*s* (C=O), 1282*s* (SO$_2$), 1168*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 2.10 (*s*, Me–C(4′,5′)); 6.35 (*s*, H–C(3′)); 7.49, 8.05 (*AA′BB′*, *J* = 8.6, 4 arom. H); 11.36 (*s*, OOH). EI-MS: 281 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{12}H_{13}NO_6S$ (299.30): C 48.16, H 4.38, N 4.68, O 32.07, S 10.71; found: C 48.30, H 4.43, N 4.69, O 32.20, S 10.80.

Methyl 4-(2,3-Dihydro-3-hydroperoxy-4,5-dimethylisothiazol-2-yl)benzoate (**15e**): 87%. Colorless crystals. M.p. 166–168°. IR: 1702*s* (C=O), 1279*s* (SO$_2$), 1147*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 2.10 (*s*, Me–C(4′,5′)); 3.87 (*s*, OMe); 6.35 (H–C(3)); 7.50, 8.04 (*AA′BB′*, *J* = 9.2, 4 arom. H); 11.36 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 6.5 (*Me*–C(5′)); 11.3 (*Me*–C(4′)); 51.6 (OMe); 90.2 (C(3′)); 117.9 (C(2,6)); 125.4 (C(4)); 130.8 (C(3,5)); 132.5 (C(5′)); 137.2 (C(4′)); 140.6 (C(1)); 166.1 (*C*OOMe). EI-MS: 295 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{13}H_{15}NO_6S$ (313.32): C 49.83, H 4.83, N 4.47, O 30.64, S 10.23; found: C 49.81, H 4.84, N 4.45, O 29.9, S 10.79.

Ethyl 4-(2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-1,1-dioxoisothiazol-2-yl)benzoate (**15f**). 70%. Colorless crystals. M.p. 153–155°. IR: 1702*s* (C=O), 1276*s* (SO$_2$), 1146*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 1.35 (*t*, CH$_2$*Me*); 2.10 (*s*, Me–C(4′,5′)); 4.34 (*q*, C*H*$_2$Me); 6.35 (*s*, H–C(3)); 7.51, 8.05 (*AA′BB′*, *J* = 9.2, 4 arom. H); 11.35 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 6.6 (*Me*–C(5′)); 11.4 (*Me*–C(4′)); 14.1 (OCH$_2$*Me*); 60.9 (O*C*H$_2$Me); 90.4 (C(3′)); 118.2 (C(2,6)); 126.0 (C(4)); 131.0 (C(3,5)); 132.8 (C(5′)); 137.4 (C(4′)); 140.7 (C(1)); 165.9 (*C*OOEt). EI-MS: 309 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{14}H_{17}NO_6S$ (327.35): C 51.37, H 5.23, N 4.28, O 29.32, S 9.79; found: C 51.30, H 5.25, N 4.19, O 29.01, S 9.89.

2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-2-[4-(methylsulfonyl)phenyl]isothiazole 1,1-Dioxide (**15g**): 68%. M.p. 168–171°. Colorless crystals. IR: 1300*s* (SO$_2$), 1150*s* (SO$_2$). ^{1}H-NMR (CDCl$_3$): 2.12 (*s*, Me–C(4)); 2.16 (*s*, Me–C(5)); 3.15 (*s*, SO$_2$Me); 6.42 (*s*, H–C(3)); 7.63, 8.00 (*AA′BB′*, *J* = 7.1, 4 arom. H). ^{13}C-NMR (CDCl$_3$): 5.8 (*Me*–C(5)); 10.6 (*Me*–C(4)); 43.2 (SO$_2$Me); 89.4 (C(3)); 117.5 (C(2′,6′)); 128.3 (C(3′,5′)); 131.9 (C(5)); 134.9 (1 arom. C); 136.6 (C(4)); 140.2 (1 arom. C). EI-MS: 315 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{12}H_{15}NO_6S_2$ (333.37): C 43.23, H 4.53, N 4.20, O 28.80, S 19.23; found: C 43.01, H 4.21, N 3.98, O 29.20, S 19.30.

2-(2-Chlorophenyl)-2,3-dihydro-3-hydroperoxy-4,5-dimethylisothiazole 1,1-Dioxide (**15h**): 30%. M.p. 121–125°. Colorless crystals. IR: 1290*s* (SO$_2$), 1170*s* (SO$_2$). ^{1}H-NMR (CDCl$_3$): 2.04 (*s*, Me–C(4)); 2.16 (*s*, Me–C(5)); 5.70 (*s*, H–C(3)); 7.39 (*m*, 2 arom. H); 7.54 (*m*, 2 arom. H). ^{13}C-NMR (CDCl$_3$): 8.2 (*Me*–C(5)); 12.4 (Me–C(4)); 95.0 (C(3)); 128.9 (1 arom. CH); 130.9 (1 arom. C); 131.4, 133.5, 134.4 (3 arom. CH) 136.1 (C(5)); 136.8 (1 arom. C); 138.3 (C(4)). EI-MS: 271 ([*M* – H$_2$O]$^{+\cdot}$). Anal. calc. for $C_{11}H_{12}ClN_2O_4S$ (289.74): C 45.60, H 4.17, Cl 12.24, N 4.83, O 22.09, S 11.07; found: C 45.52, H 3.98, Cl 12.11, N 4.67, O 22.21, S 11.27.

2-(2,6-Dichlorophenyl)-2,3-dihydro-3-hydroperoxy-4,5-dimethylisothiazole 1,1-Dioxide (**15i**): 50%. M.p. 207–209°. Colorless crystals. IR: 1288*s* (SO$_2$), 1172*s* (SO$_2$). ^{1}H-NMR ((D$_6$)acetone): 2.10 (*s*, Me–C(4,5)); 5.88 (*s*, H–C(3)); 7.44–7.64 (*m*, 3 arom. H); 10.83 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 8.3 (*Me*–C(5)); 12.9

(*Me*–C(4)); 95.8 (C(3)); 130.9, 131.2, 132.8 (3 arom. CH); 135.6 (C(5)); 137.4 (1 arom. C); 138.3 (C(4)); 141.0 (1 arom. C). EI-MS: 306 ($[M-H_2O]^{+\cdot}$). Anal. calc. for $C_{11}H_{11}Cl_2NO_4S$ (324.19): C 40.75, H 3.43, Cl 21.87, N 4.32, O 9.89, S 19.74; found: 41.07, H 3.70, Cl 21.62, N 4.45, O 10.01, S 19.70.

2,3-Dihydro-3-hydroperoxy-4,5-dimethyl-2-(4-nitrophenyl)isothiazole 1,1-Dioxide (**15j**): 50%. M.p. 165–168°. Yellow crystals. IR: 1511*s* (NO_2), 1344*s* (NO_2), 1296*s* (SO_2), 1147*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 2.12 (*s*, *Me*–C(4,5)); 6.44 (*s*, H–C(3)); 7.60, 8.32 (*AA′BB′*, *J* = 9.2, 4 arom. H). 10.83 (*s*, OOH). ^{13}C-NMR ((D$_6$)acetone): 7.11 (*Me*–C(5)); 11.9 (*Me*–C(4)); 90.7 (C(3)); 118.2 (C(2′,6′)); 125.8 (C(3′,5′)); 133.1 (C(5)); 137.9 (C(4)); 142.8 (C(1′)); 144.0 (C(4′)). EI-MS: 282 ($[M-H_2O]^{+\cdot}$). Anal. calc. for $C_{11}H_{12}NO_6S$ (300.29): C 43.99, H 4.03, N 9.33, O 31.97, S 10.68; found: C 43.82, H 4.09, N 9.45, O 32.04, S 10.51.

5. *Aryl-Substituted 2,3-Dihydro-3-hydroxy-4,5-dimethylisothiazole 1,1-Dioxides* (**16**). *General Procedure.* DMSO (2 ml) was added to **15** (0.5 mmol). After 2 h, the soln. was lyophilized and the remainder was recrystallized from acetone.

Methyl 4-(2,3-Dihydro-3-hydroxy-4,5-dimethyl-1,1-dioxoisothiazol-2-yl)benzoate (**16e**): 83%. Colorless crystals. M.p. 173–175°. IR: 1706*s* (C=O), 1280*s* (SO_2), 1168*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 2.08 (*s*, Me–C(4′,5′)); 3.87 (*s*, OMe); 6.00 (*s*, H–C(3)); 7.54, 8.03 (*AA′BB′*, *J* = 6.0, 4 arom. H). ^{13}C-NMR ((D$_6$)acetone): 7.6 (*Me*–C(5)); 12.6 (*Me*–C(4)); 52.8 (OMe); 83.0 (C(3′)); 118.6 (C(2,6)); 126.1 (C(4)); 131.6 (C(5′)); 132.1 (C(3,5)); 141.7 (C(1)); 142.1 (C(4′)); 167.4 (*C*OOMe). EI-MS: 297 ($M^{+\cdot}$). Anal. calc. for $C_{13}H_{15}NO_5S$ (297.32): C 52.52, H 5.08, N 4.71, O 26.91, S 10.78; found: C 51.95, H 5.03, N 4.78, O 27.04, S 10.52.

Ethyl 4-(2,3-Dihydro-3-hydroxy-4,5-dimethyl-1,1-dioxoisothiazol-2-yl)benzoate (**16f**): 87%. Colorless crystals. M.p. 156–158°. IR: 1703*s* (C=O), 1272*s* (SO_2), 1141*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 1.35 (*t*, CH_2*Me*); 2.07 (*s*, Me–C(4′,5′)); 4.33 (*q*, CH_2Me); 6.05 (*s*, H–C(3′)); 7.54, 8.04 (*AA′BB′*, *J* = 8.8, 4 arom. H). ^{13}C-NMR ((D$_6$)acetone): 7.6 (*Me*–C(5′)); 12.6 (*Me*–C(4′)); 15.3 (OCH_2*Me*); 61.9 (OCH_2Me); 83.0 (C(3′)); 118.7 (C(2,6)); 126.5 (C(4)); 132.1 (C(3,5)); 132.3 (C(5′)); 141.9 (C(1)); 142.1 (C(4′)); 166.9 (*C*OOEt). EI-MS: 311 ($M^{+\cdot}$). Anal. calc. for $C_{14}H_{17}NO_5S$ (311.35): C 54.01, H 5.50, N 4.50, O 25.69, S 10.30; found: C 54.20, H 5.73, N 4.32, O 25.40, S 10.21.

6. *Aryl-Substituted 2,3-Dihydro-4,5-dimethylisothiazol-3-one 1,1-Dioxides* (**17**). *Method A:* H_2O_2 (3 ml, 30%) was added to a suspension of **10** (0.86 mmol) in AcOH (8 ml). The soln. was stirred for 6–8 h at 80°. After cooling, the product was isolated by filtration and recrystallized from EtOH. *Method B:* A soln. of **15** (1 mmol) in EtOH (4 ml) was refluxed for 2 h. Then, 0.3 ml conc. HCl was added. After cooling, the product was isolated by filtration and recrystallized from EtOH.

2,3-Dihydro-2-(4-methoxyphenyl)-4,5-dimethylisothiazol-3-one 1,1-Dioxide (**17b**): 44% (A). Colorless crystals. M.p. 173–174°. IR: 1733*s* (C=O), 1319*s* (SO_2), 1172*s* (SO_2). UV (EtOH): 271.0 (3.34). ^{1}H-NMR ((D$_6$)DMSO): 2.08 (*s*, Me–C(4)); 2.32 (*s*, Me–C(5)); 3.86 (*s*, MeO); 7.16, 7.35 (*AA′BB′*, *J* = 9.0, 4 arom. H). ^{13}C-NMR ((D$_6$)DMSO): 8.4 (*Me*–C(5)); 9.7 (*Me*–C(4)); 56.3 (OMe); 116.0 (C(3′,5′)); 121.5 (C(1′)); 131.0 (C(2′,6′)); 134.1 (C(4)); 142.9 (C(5)); 161.0 (C(4′)); 161.2 (C(3)). EI-MS: 267 ($M^{+\cdot}$). Anal. calc. for $C_{12}H_{13}NO_4S$ (267.30). C 53.92, H 4.90, N 5.24, O 23.94, S 12.00; found: C 54.04, H 4.78, N 5.20, O 23.85, S 11.93.

2,3-Dihydro-4,5-dimethyl-2-phenylisothiazol-3-one 1,1-Dioxide (**17c**): 57% (A). Colorless crystals. M.p. 148–149°. IR: 1737*s* (C=O), 1323*s* (SO_2), 1174*s* (SO_2). UV (EtOH): 260.5 (3.06). ^{1}H-NMR ((D$_6$)acetone): 2.11 (*s*, Me–C(4)); 2.33 (*s*, Me–C(5)); 7.45–7.59 (*m*, 5 arom. H). ^{13}C-NMR ((D$_6$)acetone): 8.6 (*Me*–C(5)); 9.7 (*Me*–C(4)); 129.5 (C(2′,6′)); 131.0 (C(1′)); 131.2 (C(4′)); 131.5 (C(3′,5′)); 134.7 (C(4)); 144.4 (C(5)); 161.8 (C(3)). EI-MS: 236 ($M^{+\cdot}$). Anal. calc. for $C_{11}H_{11}NO_3S$ (237.27): C 55.68, H 4.67, N 5.90, O 20.23, S 13.51; found: C 55.50, H 4.89, N 5.77, O 20.60, S 13.63.

4-(2,3-Dihydro-4,5-dimethyl-1,1,3-trioxoisothiazol-2-yl)benzoic Acid (**17d**): 38% (B). Colorless needles. M.p. 235–238°. IR: 1740*s* (C=O), 1325*s* (SO_2), 1175*s* (SO_2). UV (EtOH): 268.5 (3.70). ^{1}H-NMR ((D$_6$)DMSO): 2.08 (*s*, Me–C(4′)); 2.33 (*s*, Me–C(5′)); 7.63, 8.15 (*AA′BB′*, *J* = 8.5, 4 arom. H); 13.27 (*s*, COOH). ^{13}C-NMR ((D$_6$)DMSO): 7.9 (*Me*–C(5′)); 9.3 (*Me*–C(4′)); 127.4 (C(2,6)); 131.1 (C(3,5)); 131.8 (C(4)); 133.6 (C(4′)); 133.9 (C(1)); 142.4 (C(5′)); 160.2 (C(3′)); 166.7 (COOH). EI-MS: 281 ($M^{+\cdot}$). Anal. calc. for $C_{12}H_{11}NO_5S$ (281.29): C 51.24, H 3.94, N 4.98, O 28.44, S 11.40; found: C 51.10, H 3.96, N 4.89, O 28.50, S 11.41.

Methyl 4-(2,3-Dihydro-4,5-dimethyl-1,1,3-trioxoisothiazol-2-yl)benzoate (**17e**): 51% (B). Colorless crystals. M.p. 97–99°. IR: 1740*s* (C=O), 1335*s* (SO_2), 1175*s* (SO_2). UV (EtOH): 273.5 (3.81). ^{1}H-NMR ((D$_6$)DMSO): 2.08 (*s*, Me–C(4′)); 2.32 (*s*, Me–C(5′)); 3.90 (*s*, OMe); 7.66, 8.16 (*AA′BB′*, *J* = 8.5, 4 arom. H). ^{13}C-NMR ((D$_6$)DMSO): 7.9 (*Me*–C(5′)); 9.3 (Me–C(4′)); 52.7 (OMe); 127.4 (C(2′,6′)); 130.4 (C(4)); 131.0 (C(3,5)); 133.4 (C(4′)); 134.0 (C(1)); 142.4 (C(5′)); 160.2 (C(3′)); 165.1 (*C*OOMe). EI-MS: 295 ($M^{+\cdot}$). Anal. calc. for $C_{13}H_{13}NO_5S$ (295.31): C 52.87, H 4.44; N 4.74, O 27.09, S 10.86; found: C 52.87, H 4.62, N 4.69, O 27.10, S 11.04.

Ethyl 4-(2,3-Dihydro-4,5-dimethyl-1,1,3-trioxoisothiazol-2-yl)benzoate (**17f**): 44% (B). Colorless crystals. M.p. 106–108°. IR: 1733*s* (C=O), 1330*s* (SO_2), 1177*s* (SO_2). UV (EtOH): 254.5 (3.69), 274.0 (3.59). ^{1}H-NMR ((D$_6$)DMSO): 1.35 (*m*, CH_2*Me*); 2.08 (*s*, Me–C(4′)); 2.32 (*s*, Me–C(5′)); 4.30–4.42 (*q*, CH_2Me); 7.66, 8.16 (*AA′BB′*, *J* = 8.5, 4 arom. H). ^{13}C-NMR ((D$_6$)DMSO): 7.9 (*Me*–C(5′)); 9.3 (*Me*–C(4′)); 14.4 (CH_2*Me*); 61.4 (CH_2Me); 127.4 (C(2,6)); 130.8 (C(4)); 131.0 (C(3,5)); 133.9 (C(4′)); 134.0 (C(1)); 142.4 (C(5′)); 160.2 (C(3′)); 165.1 (*C*OOEt). EI-MS: 309 ($M^{+\bullet}$). Anal. calc. for $C_{14}H_{15}NO_5S$ (309.14): C 54.36, H 4.89, N 4.53, O 25.86, S 10.37; found: C 54.03, H 4.69, N 4.43, O 25.70, S 10.22.

2,3-Dihydro-4,5-dimethyl-2-[4-(methylsulfonyl)phenyl]isothiazol-3-one 1,1-Dioxide (**17g**): 84%. Colorless crystals. M.p. 185–187°. IR: 1733*s* (C=O), 1335*s* (SO_2), 1179*s* (SO_2). UV (EtOH): 266.0 (2.84). ^{1}H-NMR ((D$_6$)acetone): 2.15 (*s*, Me–C(4)); 2.37 (*s*, Me–C(5)); 3.23 (*s*, SO_2Me); 7.82–8.16 (*AA′BB′*, *J* = 8.8, 4 arom. H). ^{13}C-NMR ((D$_6$)acetone): 8.6 (*Me*–C(5)); 9.8 (*Me*–C(4)); 44.9 (SO_2Me); 128.8, 130.5 (4 arom. CH); 135.1 (C(4)); 136.5 (C(1′)); 143.2 (C(5)); 144.5 (C(4′)); 161.9 (C(3)). EI-MS: 315 ($M^{+\bullet}$). Anal. calc. for $C_{12}H_{13}NO_5S_2$ (315.36): C 45.70, H 4.15, N 4.44, O 25.37, S 20.33; found: C 45.80, H 4.27, N 4.33, O 25.00, S 20.20.

2,3-Dihydro-2-(2-chlorophenyl)-4,5-dimethylisothiazol-3-one 1,1-Dioxide (**17h**): 46% (A). Colorless crystals. M.p. 127–130°. IR: 1740*s* (C=O), 1330*s* (SO_2), 1180*s* (SO_2). ^{1}H-NMR ($CDCl_3$): 2.10 (*s*, Me–C(4)); 2.32 (*s*, Me–C(5)); 7.34–7.60 (*m*, 4 arom. H). ^{13}C-NMR ($CDCl_3$): 8.7 (*Me*–C(5)); 9.5 (*Me*–C(4)); 128.6 (2 arom. CH); 131.6 (1 arom. C); 132.3, 132.4 (2 arom. CH); 133.4 (1 arom. C); 135.5 (C(4)); 144.2 (C(5)); 160.1 (C(3)). EI-MS: 271 ($M^{+\bullet}$). Anal. calc. for $C_{11}H_{10}ClNO_3S$ (271.71): C 48.63, H 3.71, Cl 13.05, N 5.16, O 17.67, S 11.80; found: C 48.51, H 3.75, Cl 13.00, N 5.25, O 17.73, S 11.91.

2-(2,6-Dichlorophenyl)-2,3-dihydro-4,5-dimethylisothiazol-3-one 1,1-Dioxide (**17i**): 43% (A). Colorless crystals. M.p. 226–228°. IR: 1740*s* (C=O), 1320*s* (SO_2), 1180*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 2.16 (*s*, Me–C(4)); 2.39 (*s*, Me–C(5)); 7.52–7.68 (*m*, 3 arom. H). EI-MS: 305 ($M^{+\bullet}$). Anal. calc. for $C_{11}H_9Cl_2NO_3S$ (306.17): C 43.15, H 2.96, Cl 23.16, N 4.57, O 15.68, S 10.47; found: C 42.99, H 2.93, Cl 23.20, N 4.64, O 15.57, S 10.44.

2,3-Dihydro-4,5-dimethyl-2-(4-nitrophenyl)isothiazol-3-one 1,1-Dioxide (**17j**): 37% (A). Yellow powder. M.p. 160 (dec.). IR: 1738*s* (C=O), 1525*m* (NO_2), 1320*m* (NO_2), 1274*s* (SO_2), 1176*s* (SO_2). UV (EtOH): 276.5 (3.86), 340.5 (3.52). ^{1}H-NMR ((D$_6$)DMSO): 2.05 (*s*, Me–C(4)); 2.30 (*s*, Me–C(5)); 7.78, 8.42 (*AA′BB′*, *J* = 9.5, 4 arom. H). ^{13}C-NMR ((D$_6$)DMSO): 8.5 (Me–C(5)); 9.9 (Me–C(4)); 126.3 (C(2′,6′)); 128.4 (C(3′,5′)); 134.9 (C(4)); 136.5 (C(1′)); 143.0 (C(5)); 148.2 (C(4′)); 160.8 (C(3)). EI-MS: 282 ($M^{+\bullet}$). Anal. calc. for $C_{11}H_{10}N_2O_5S$ (282.27): C 46.80, H 3.57, N 9.93, O 28.34, S 11.36; found: C 46.56, H 3.46, N 9.75, O 28.59, S 11.47.

7. *2,2′-[benzene-1,4-diyl]bis[2,3-dihydro-3-hydroperoxy-4,5-dimethyl-1,1-dioxoisothiazole]* (**18**). H_2O_2 (0.7 ml, 30%) was added at r.t. to a stirred suspension of **11** (0.26 mmol) in AcOH (0.7 ml). After 24 h, colorless crystals of **18** were filtered off and recrystallized from EtOH: 25%. Colorless crystals. M.p. 160° (dec.). IR: 1287*s* (SO_2), 1169*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 2.08 (*s*, 2 Me–C(4,5)); 6.17 (*s*, 2 H–C(3)); 7.50 (*s*, 4 arom. H); 11.30 (*s*, 2 OOH). ^{13}C-NMR ((D$_6$)acetone): 7.91 (2 Me–C(5)); 12.5 (2 Me–C(4)); 93.1 (2 C(3)); 125.0 (4 arom. CH); 134.0 (2 arom. C); 134.5 (2 C(5)); 138.5 (2 C(4)). EI-MS: 395 ([M – 2 H_2O]$^{+\bullet}$). Anal. calc. for $C_{16}H_{20}N_2O_8S_2$ (432.46): C 44.44, H 4.66, N 6.48, O 29.60, S 14.83; found: C 44.28, H 4.79, N 6.37, O 29.65, S 14.68.

8. *2,2′-[Benzene-1,4-diyl]bis[2,3-dihydro-4,5-dimethyl-1,1,3-trioxoisothiazol-3-one]* (**19**). H_2O_2 (3 ml, 30%) was added to a suspension of **11** (0.86 mmol) in AcOH (8 ml). The soln. was stirred 6–8 h at 80°. After cooling, the product was filtered off and recrystallized from EtOH: 38%. Colorless crystals. M.p. 205–207°. IR: 1739*s* (C=O), 1332*s* (SO_2), 1178*s* (SO_2). ^{1}H-NMR ((D$_6$)acetone): 2.15 (*s*, 2 Me–C(4)); 2.37 (*s*, 2 Me–C(5)); 7.72 (*s*, 4 arom. H). ^{13}C-NMR ((D$_6$)acetone): 8.63 (2 *Me*–C(5)); 9.80 (2 *Me*–C(4)); 130.4 (4 arom. CH); 132.4 (2 arom. C); 135.0 (C(4)); 144.5 (C(5)); 161.7 (C(3)). EI-MS: 396 ($M^{+\bullet}$). Anal. calc. for $C_{16}H_{16}N_2O_6S_2$ (396.43): C 48.48, H 4.07, N 7.07, O 24.21, S 16.17; found: C 48.62, H 4.14, N 7.01, O 24.11, S 16.28.

9. *X-ray Crystal-Structure Analysis of* **13e** *and* **14e**. Crystals were obtained from acetone. The intensities were measured on a *Siemens SMART CCD* diffractometer. Data collection and cell refinement are listed in the *Table*. The structure was solved by direct methods with SHELXS-97 [24]. The refinement was done with SHELXL-97 [25].

10. *Supplementary Material.* Crystallographic data for the structural analyses have been deposited with the *Cambridge Crystallographic Data Centre*, CCDC Nos. 163008 for **13e** and 163009 for **14e**. Copies of the data can be obtained, free of charge, from CCDC, 12 Union Road, Cambridge, CB2 1EZ, UK (fax: +44-1233-336033; e-mail: deposit@ccdc.cam.ac.uk; internet: http://www.ccdc.cam.ac.uk).

Table. *Crystal Data of* **13e** *and* **14e**

	13e	**14e**
Empirical formula	$C_{13}H_{15}NO_5S$	$C_{13}H_{15}NO_4S$
Formula weight	297.32	281.33
Crystal color, habit	colorless, plates	colorless, prism
Crystal temp. [K]	220	213
Radiation, wavelength [Å]	MoK_α, 0.71073	MoK_α, 0.71073
Crystal dimensions [mm]	$0.30 \times 0.30 \times 0.10$	$0.40 \times 0.20 \times 0.06$
Crystal system	monoclinic	orthorhombic
Space group	$P2_1/c$	$Pca2(1)$
Z	4	8
Reflections for cell determination	2333	4517
2θ range for cell determination [°]	3–57	3–58
Unit-cell parameters a [Å]	16.133(5)	17.7346(18)
b [Å]	10.346(5) β[°] 93.139(5)	7.8334(8)
c [Å]	8.255(5)	19.236(2)
V [Å^3]	1375.8(11)	2672.3(5)
D [Mg/m^3]	1.435	1.398
Absorption coefficient μ [mm^{-1}]	0.254	0.252
Transmission factors (min, max)	0.9751; 0.9277	0.9851; 0.9161
Scan type	ω scan	ω scan
2θ(max) [°]	57.5	58
Total reflections measured	8348	26410
Symmetry-independent reflections	3259	6615
Reflections observed ($I > 2\theta(I)$)	2333	4517
Variables	238	463
Final R indices [$I > 2\theta(I)$]	$R_1 = 0.0443$ $\omega R_2 = 0.1142$	$R_1 = 0.0389$ $\omega R_2 = 0.0809$
R indices (all data)	$R_1 = 0.0706$ $\omega R_2 = 0.1344$	$R_1 = 0.0782$ $\omega R_2 = 0.0925$
$\Delta\rho$ (max, min) [e Å^{-3}]	0.699, −0.232	0.311, −0.250
Goodness of fit s	1.022	0,941

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