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Note

Synthesis of 3-alkyl(aryl)-1-aryl-1,3-dihydro-2*H*-benzimidazole-2-thiones from 3-alkyl(aryl)-1-aryl-4-(α- and β-D-erythrofuranosyl)-1,3-dihydro-2*H*-imidazole-2-thiones

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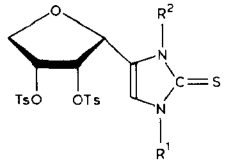
4-[(2*S*) and (2*R*)-2,5-dihydro-2-furyl]-1,3-dihydro-2*H*-imidazole-2-thiones (**5–8**) have been prepared[1] from α- and β-D-erythrofuranosyldihydroimidazole-2-thiones[2] by treatment of the corresponding 2′,3′-di-*O*-tosyl derivatives (**1–4**) with sodium iodide and zinc dust in *N*,*N*-dimethylformamide. Zinc was used to remove iodine as fast as it was formed, precluding iodination of the double bond[3] and thereby avoiding secondary reactions[4].

We now report on the treatment of **1–4** with sodium iodide in *N*,*N*-dimethylformamide without zinc. Unsaturated compounds were not formed (t.l.c.). The products, which had higher chromatographic mobilities, had elemental analyses and spectral data that accorded with the dihydrobenzimidazole-2-thione structures **9–11**.

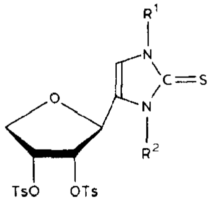
Compounds **9–11** had intense u.v. absorptions at 233–237 and 310–313 nm, in agreement with data reported[5] for 1,3-dihydro-2*H*-benzimidazole-2-thione (**12**), and i.r. bands in the region 730–750 cm^{-1}, characteristic of 1,2-disubstituted benzenes and observed[6] for heterocyclic compounds in which a benzene ring is fused to a five-membered ring. The ^{1}H-n.m.r. spectra also exhibited the characteristic pattern of *o*-disubstituted benzenes. The base peak was that for the molecular ion in the mass spectrum of **11**, which is characteristic of aromatic compounds, and the largest fragment peak corresponded to $M^+ - 1$. The structure of **11** has been confirmed by an X-ray crystallographic study[7].

Compound **11** was also prepared from the unsaturated compound **8** by heating at 100° for 1 h with iodine in *N*,*N*-dimethylformamide. This reaction suggests that the 2,5-dihydrofuryl compounds **5–8** may be intermediates in the synthesis of **9–11** from **1–4**.

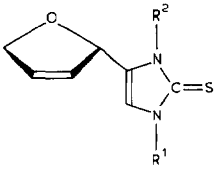
A possible mechanism for the synthesis of **11** from **8** involves the formation of the *E* and *Z* α,β-unsaturated epoxides (**14** and **15**) through the *trans*-di-iodide



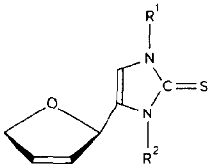
1 $R^1 = C_6H_4Me\text{-}p, R^2 = M$



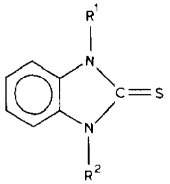
2 $R^1 = C_6H_4Me\text{-}p, R^2 = Me$
3 $R^1 = C_6H_4Me\text{-}p, R^2 = Ph$
4 $R^1 = C_6H_4OEt\text{-}p, R^2 = Ph$



5 $R^1 = C_6H_4Me\text{-}p, R^2 = Me$

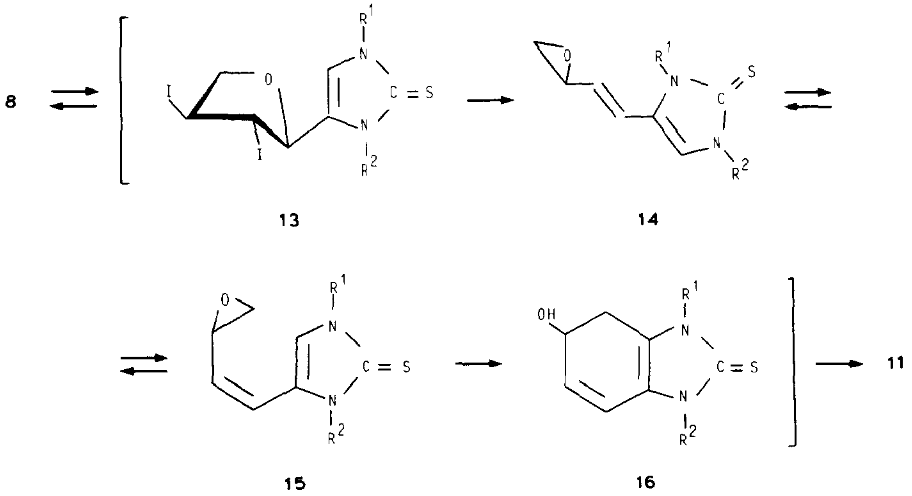


6 $R^1 = C_6H_4Me\text{-}p, R^2 = Me$
7 $R^1 = C_6H_4Me\text{-}p, R^2 = Ph$
8 $R^1 = C_6H_4OEt\text{-}p, R^2 = Ph$



9 $R^1 = C_6H_4Me\text{-}p, R^2 = Me$
10 $R^1 = C_6H_4Me\text{-}p, R^2 = Ph$
11 $R^1 = C_6H_4OEt\text{-}p, R^2 = Ph$
12 $R^1 = H, R^2 = H$

13[8] which, in the E_1 conformation, has I-2 and the ring-oxygen conveniently disposed for ring opening. The formation of epoxides from **8** can be considered as the allylic rearrangement of a cyclic ether, similar to the migration of an allylic benzyl ether in a methyl pyranoside derivative[9]. Finally, formation of a six-membered ring and loss of water leads to **11**. The stability of **11** determines the course of the reaction.



13 **14**

15 **16**

The present study provides a new route for the synthesis of benzoheterocycles from *C*-erythrofuranosylheterocycles as well as from *C*-2,5-dihydrofurylheterocycles.

EXPERIMENTAL

General. — Melting points are uncorrected. T.l.c. was performed on silica gel HF_{254} (Merck), using chloroform and detection with iodine vapour or u.v. light (254 nm). Column chromatography was conducted on silica gel 60 (Merck, 70–230 mesh). ^{1}H-N.m.r. spectra were recorded for solutions in $CDCl_3$ at 90 MHz with a Bruker HX-90-E spectrometer. The e.i. mass spectrum was recorded at 70 eV with a Hewlett–Packard 5930A spectrometer.

*3-Alkyl(aryl)-1-aryl-1,3-dihydro-2*H*-benzimidazole-2-thiones* (**9–11**). — A suspension of **1–4** (1 g, 1.62–1.41 mmol) and sodium iodide (0.6 g, 4.0 mmol) in *N,N*-dimethylformamide (10 mL) was stirred at 130° for 10 h and then cooled. Chloroform (50 mL) was added, and the mixture was washed with water (4 × 25 mL), dried (Na_2SO_4), and concentrated to dryness. The resulting syrup was purified by column chromatography, using a hexane–ether gradient. The compounds were recrystallised from ethanol.

1,3-Dihydro-3-methyl-1-*p*-tolyl-2*H*-benzimidazole-2-thione (**9**; 0.154 g, 37%), obtained from **1**, had m.p. 168–169°, R_F 0.66; λ_{max}^{EtOH} 200, 237, and 340 nm (ε_{mM} 34.0, 25.1, and 28.1); ν_{max}^{KBr} 1600, 1579, 1570, 1510, 1475, 740, and 633 cm^{-1}. ^{1}H-N.m.r. data: δ 7.39 (s, 4 H, *p*-tolyl), 7.34–6.92 (m, 4 H), 3.88 (s, 3 H, NMe), and 2.47 (s, 3 H, tolyl Me).

Anal. Calc. for $C_{15}H_{14}N_2S$: C, 70.83; H, 5.55; N, 11.01; S, 12.61. Found: C, 70.93; H, 5.50; N, 10.88; S, 12.90.

The same product (0.128 g, 31%) was also obtained from **2**.

1,3-Dihydro-3-phenyl-1-*p*-tolyl-2*H*-benzimidazole-2-thione (**10**; 0.188 g, 40%), obtained from **3**, had m.p. 153–154°, R_F 0.81; λ_{max}^{EtOH} 200, 234, and 313 nm (ε_{mM} 41.0, 27.1, and 23.8); ν_{max}^{KBr} 1608, 1590, 1515, 1498, 1476, 748, and 700 cm^{-1}. ^{1}H-N.m.r. data: δ 7.57 (s, 5 H, Ph), 7.43 (s, 4 H), and 2.45 (s, 3 H, tolyl Me).

Anal. Calc. for $C_{20}H_{16}N_2S$: C, 75.91; H, 5.10; N, 8.85; S, 10.13. Found: C, 75.74; H, 4.94; N, 8.95; S, 10.41.

1,3-Dihydro-1-*p*-ethoxyphenyl-3-phenyl-2*H*-benzimidazole-2-thione (**11**; 0.111 g, 23%), obtained from **4**, had m.p. 179–180°, R_F 0.72; λ_{max}^{EtOH} 200, 233, and 313 nm (ε_{mM} 40.0, 27.4, and 20.0); ν_{max}^{KBr} 1600, 1585, 1502, 1490, 1467, 743, and 692 cm^{-1}. ^{1}H-N.m.r. data: δ 7.49 (s, 5 H, Ph), 7.43–6.93 (m, *p*-ethoxyphenyl), 7.13–6.85 (m, 4 H), 4.03 (q, 2 H, *J* 7.0 Hz), and 1.37 (t, 3 H, *J* 7.0 Hz). Mass spectrum: *m/z* 348 (8%), 347 (27), 346 (100, M^{+}), 345 (99), 317 (53, M − Et), 288 (16, M − NCS), 225 (26, M − $EtOC_6H_4$), 224 (16, M − EtOPh), 167 (13, M − $EtOC_6H_4NCS$), 77 (39, Ph).

Anal. Calc. for $C_{21}H_{18}N_2OS$: C, 72.80; H, 5.23; N, 8.08; S, 9.25. Found: C, 72.79; H, 5.23; N, 7.95; S, 9.51.

Compound **11** was also obtained by heating a solution of **8** (0.05 g, 0.137 mmol) and iodine (0.035 g, 0.137 mmol) in *N,N*-dimethylformamide (1 mL) at 100° for 1 h. After cooling, the solution was concentrated. Preparative t.l.c. of the residue and crystallisation from methanol gave **11** (0.010 g, 19%).

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