

obtained was recrystallized from water: yellow prisms, mp 129–130° dec, yield 6 g (9%).

*Anal.* Calcd for  $C_9H_{17}N_5O_3S_2$ : C, 35.19; H, 5.54; N, 22.80; S, 20.85; mol wt, 307. Found: C, 35.13; H, 5.62; N, 22.51; S, 21.28; mol wt, 285 (vapor-pressure osmometer, in  $H_2O$ ). Uv max ( $H_2O$ ) 281.5  $m\mu$  (br,  $\log \epsilon$  3.59), 343 (4.26); nmr ( $D_2O$ )  $\delta$  4.85 (s, 8,  $NH_4^+$ ), 4.13 (q, 2,  $CH_2$ ,  $J = 7$  cps), 1.28 (t, 3,  $CH_3$ ,  $J = 7$  cps).

The compound was methylated with dimethyl sulfate. Colorless needles of ethyl di(methylthio)methylenecyanoacetate were obtained. Recrystallization from methanol yielded 1.3 g (92%), mp 55–56°, undepressed by the addition of an authentic specimen.<sup>3</sup>

When the compound was treated with hydrogen peroxide (1%), colorless needles (8) of mp 223–224° were obtained. The product was recrystallized from pyridine–water.

*Anal.* Calcd for  $C_{12}H_{10}N_2O_4S_3$ : C, 42.15; H, 2.93; N, 8.19; S, 28.05; mol wt, 342. Found: C, 42.22; H, 3.00; N, 8.29; S, 27.99; mol wt, 326.7 (vapor-pressure osmometer, in acetone). Uv max (99% EtOH) 230  $m\mu$  ( $\log \epsilon$  4.37), 335 (4.35); ir (KBr) 2992, 2977 (m,  $\nu_{CH}$ ), 2220 (s,  $\nu_{CN}$ ), 1689 (sh,  $\nu_{CO}$ ), 1669, 1658  $cm^{-1}$  (vs,  $\nu_{C=C}$ ); ir ( $CHCl_3$ ) 2985 (m,  $\nu_{CH}$ ), 2200 (s,  $\nu_{CN}$ ), 1690 (sh,  $\nu_{CO}$ ), 1683  $cm^{-1}$  (s,  $\nu_{C=C}$ ); nmr ( $DMSO-d_6$ )  $\delta$  4.30 (q, 4,  $CH_2$ ,  $J = 7$  cps), 1.27 (t, 6,  $CH_3$ ,  $J = 7$  cps). The structure was tentatively designated 3,5-di(cyanocarbethoxymethylene)-1,2,4-trithiole (8). This trithiole was also obtained by treating ethyl di(sodiomer-capto)methylenecyanoacetate with hydrogen peroxide (5%).

**Preparation of 5-Amino-4-carbamoyl-1,2-dithiole-3-thione (9).**—Compound 7 (18 g, 0.09 mol) was dissolved in 100 ml of water. To this solution was added acetic acid (10 ml) and the solution was stirred at room temperature for 1 hr. The crude product was recrystallized from pyridine–water: yellow prisms, mp 247–248° dec (slow heating), ca. 258° dec (rapid heating), yield 8 g (45%). *Anal.* Calcd for  $C_4H_4N_2OS_3$ : C, 25.01; H, 2.10; N, 14.58; S, 49.95; mol wt, 192.09. Found: C, 25.31; H, 2.16; N, 14.47; S, 49.95; mol wt, 173.1 (vapor-pressure osmometer, in acetone). Uv max (99% EtOH) 240.5  $m\mu$  ( $\log \epsilon$  3.96), 286 (sh, 3.90), 314.5 (4.54), 364.5 (3.93); ir (KBr) 3220 (s), 3140 (w), 3020 (w,  $\nu_{NH_2}$ ), 1650 (sh,  $\nu_{CO}$ ), 1640 (vs,  $\delta_{NH_2}$ ), 1550  $cm^{-1}$  (vs,  $\nu_{C=O}$ ); nmr ( $DMSO-d_6$ )  $\delta$  10.35 (br, 2,  $CONH_2$ ), 8.70 (br, 2,  $NH_2$ ). The uv spectrum of 9 agreed with that reported by Mayer, *et al.*<sup>5</sup>

When 9 was treated with dimethyl sulfate, methyl carbamoyl-cyanodithioacetate (light yellow prisms, mp 233–234°)<sup>3</sup> and a small amount of sulfur were obtained.

**Registry No.**—Malononitrile, 109-77-3; carbon disulfide, 75-15-0; 1, 24571-55-9; 4, 24571-56-0; 4 (methylated), 24571-57-1; 6, 24571-58-2; 7, 24571-59-3; 7 (methylated), 17823-69-7; 8, 2631-93-8; 9, 5147-79-5; 10, 5147-74-0; 5, 24571-64-0.

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### Synthesis of 2-*t*-Butylaminobenzophenones and Benzaldehydes

ROBERT V. COOMBS AND GOETZ E. HARDTMANN

Sandoz Pharmaceuticals, Division of Sandoz-Wander, Inc., Hanover, New Jersey 07936

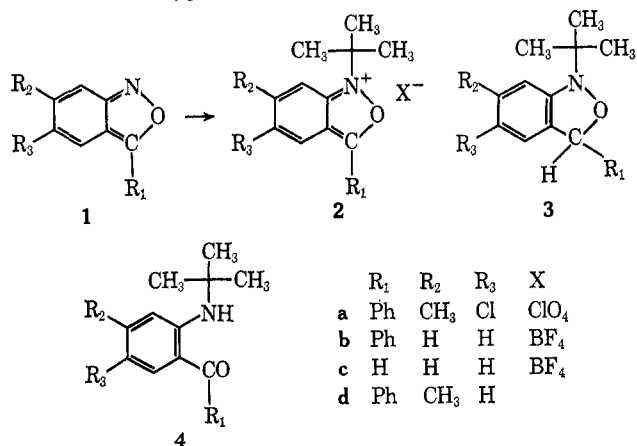
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During work on a program aimed at the synthesis of various 2(1H)-quinazolinones,<sup>1</sup> the need arose for monoalkylated 2-aminobenzophenones as interme-

diates. Although many monoalkyl derivatives can be prepared by standard procedures, attempts to extend these to the introduction of the *t*-butyl group led to very limited or no success. We now wish to report a novel route to these compounds which has been realized in excellent overall yield.

Whereas 3-phenyl-2,1-benzisoxazoles (1) are reduced completely by lithium aluminum hydride to 2-aminobenzhydrols,<sup>2</sup> less powerful reagents such as metal–acid combinations<sup>3,4</sup> or catalytic hydrogenation<sup>5,6</sup> give 2-aminobenzophenones. No intermediates retaining the heterocyclic ring were detected in these cases. Possibly then, formation of the quaternary salt from the benzisoxazole and subsequent reduction might yield alkylated aminobenzophenones, but the required salts had not previously been isolated.<sup>7</sup> The  $SN_1$  alkylation of substituted isoxazoles had been described,<sup>8</sup> however, and not only was the reaction particularly efficient with *t*-butyl alcohol but the perchlorate salts were readily isolable.

Application of this procedure to several 2,1-benzisoxazoles (1) gave the desired salts (2) in good yield. Addition of sodium borohydride to a suspension of the salt (*e.g.*, 2a) in ethanol led to rapid solution, and work-up yielded a colorless crystalline product identified from its spectral properties as the intermediate 1-*t*-butylbenzisoxazoline (3a). This compound proved to be surprisingly stable but it was noticed while determining the melting point that on continued heating the melt became an intense yellow which did not disappear on subsequent cooling. Spectral analysis of a sample of the yellow product isolated by chromatography showed that a thermal isomerization had occurred, the desired 2-*t*-butylaminobenzophenone (4a) having been cleanly formed. It was then found that this isomerization occurred in the three cases examined, heating the neat material at 160° for 4 hr being sufficient to effect better than 90% conversion.



The use of this sequence to prepare 2-*t*-butylaminobenzaldehyde (4c) in good yield is particularly interesting since 2-aminobenzaldehydes in general polymerize on contact with acid,<sup>9</sup> the presence of which is

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often unavoidable in other tertiary butylation procedures.

Basic catalytic hydrogenolysis of the chlorine substituent in **4a** was unexceptional, leading to one further 2-*t*-butylaminobenzophenone, **4d**.

Further chemical transformations of the intermediate benzisoxazolium salts are under study.

### Experimental Section

Melting points were determined on a Thomas-Hoover capillary melting point apparatus and are not corrected. Infrared spectra were measured on a Model 457 Perkin-Elmer spectrophotometer in methylene chloride; nmr spectra in deuteriochloroform solution with tetramethylsilane as an internal standard, on a Varian A-60 instrument. Microanalyses were carried out in our analytical unit.<sup>10</sup>

**1-*t*-Butyl-5-chloro-6-methyl-3-phenyl-2,1-benzisoxazolium Perchlorate (2a).**—To a solution of 9 g (0.037 mol) of **1a** in 350 ml of nitromethane were added 3.2 g (0.042 mol) of *t*-butyl alcohol and 7 g (0.042 mol) of a 60% aqueous solution of perchloric acid. The resulting solution was left at room temperature for 60 hr and then diluted with 1000 ml of anhydrous ether. The crystalline precipitate so obtained was filtered off, dissolved in 50 ml of acetone, and reprecipitated by the addition of 250 ml of ether. There resulted 13 g (88%) of **2a**, mp 183–185°. Similarly prepared were **2b**, mp 142–145°, and **2c**, mp 132–134° dec.

**1-*t*-Butyl-5-chloro-6-methyl-3-phenyl-2,1-benzisoxazoline (3a).**—To a stirred suspension of 13.3 g (0.033 mol) of **2a** in 100 ml of ethanol at room temperature was added in several portions 1.5 g (0.04 mol) of sodium borohydride. After the addition was complete, the stirring was continued for a further 30 min by which time only a little fine crystalline precipitate was present in the reaction mixture. Water was then added slowly to give initially a clear solution followed by precipitation of the product. Isolation by filtration and recrystallization from aqueous ethanol gave 7.5 g (75%) of **3a**: mp 115–117°; nmr  $\delta$  1.32 (9 H, s, *t*-butyl), 2.34 (3 H, s, Ar-CH<sub>3</sub>), 6.32 (1 H, s, >CH), 6.81, 6.90 (2 H, 2 s, aromatic), 7.36 (5 H, s, phenyl). Similarly prepared were **3b** [mp 69–73°; nmr  $\delta$  1.32 (9 H, s, *t*-butyl), 6.41 (1 H, s, >CH), 6.85–7.25 (4 H, m, aromatic), 7.38 (5 H, s, phenyl)] and **3c** [oil, distilled (Kugelrohr; 0.2 mm, 90–100°); nmr  $\delta$  1.24 (9 H, s, *t*-butyl), 5.14 (2 H, s, -CH<sub>2</sub>-), 6.80–7.20 (4 H, m, aromatic)].

**2-*t*-Butylamino-5-chloro-4-methylbenzophenone (4a).**—Under an atmosphere of nitrogen, the melt from 11 g of **3a** was maintained at a temperature of 160° for 4 hr. The resulting liquid was cooled, diluted with 50 ml of CH<sub>2</sub>Cl<sub>2</sub>, and filtered through a short column of aluminum oxide. Further elution with CH<sub>2</sub>Cl<sub>2</sub> and evaporation of the yellow solution gave 9 g (82%) of **4a**: crystallized from pentane, mp 76–78°; ir 3.02 (NH), 6.18  $\mu$  (C=O); nmr  $\delta$  1.48 (9 H, s, *t*-butyl), 2.36 (3 H, s, Ar-CH<sub>3</sub>), 6.90 (1 H, s, aromatic), 7.32–7.70 (6 H, aromatic), 8.89 (1 H, D<sub>2</sub>O exchangeable, NH). Similarly prepared were **4b** [oil, distilled (Kugelrohr, 0.2 mm, 140–160°); nmr  $\delta$  1.50 (9 H, s, *t*-butyl), 6.49 (1 H, t, aromatic), 6.90–7.75 (8 H, aromatic), 8.85 (1 H, D<sub>2</sub>O exchangeable, NH)] and **4c** [oil, distilled (Kugelrohr, 0.2 mm, 100–130°) ir 3.05 (NH), 6.07  $\mu$  (C=O); nmr  $\delta$  1.43 (9 H, s, *t*-butyl), 6.45–7.50 (4 H, aromatic), 8.70 (1 H, D<sub>2</sub>O exchangeable, NH), 9.85 (1 H, s, -CHO)].

**2-*t*-Butylamino-4-methylbenzophenone (4d).**—A solution of 1.7 g of **4a** in 100 ml of methanol containing 200 mg of KOH and 200 mg of 5% palladium on carbon was shaken under an atmosphere of hydrogen until 1 equiv had been taken up (ca. 12 hr). After filtration, evaporation of the solvent, and isolation of the organic material, there was obtained 1.3 g (87%) of **4d**: oil, distilled (Kugelrohr, 0.2 mm, 140–160°); nmr  $\delta$  1.48 (9 H, s, *t*-butyl), 2.28 (3 H, s, Ar-CH<sub>3</sub>), 6.26 (1 H, s, aromatic), 6.83 (1 H, s, aromatic), 7.27–7.70 (6 H, aromatic), 8.98 (1 H, D<sub>2</sub>O exchangeable, NH).

**Registry No.**—**2a**, 24806-54-0; **2b**, 24766-86-7; **2c**, 24766-87-8; **3a**, 24766-64-1; **3b**, 24766-65-2; **3c**, 24766-66-3; **4a**, 24766-67-4; **4b**, 24766-68-5; **4c**, 24766-69-6; **4d**, 24766-70-9.

(10) Satisfactory elemental analyses ( $\pm 0.3\%$  for C, H, and N or Cl) were reported for all compounds.

## Reaction of Electrophiles with Enolizable N-Hydrogen Ketimines

JOHN P. CHUPP

Monsanto Company, Agricultural Division, Research Department, St. Louis, Missouri 63166

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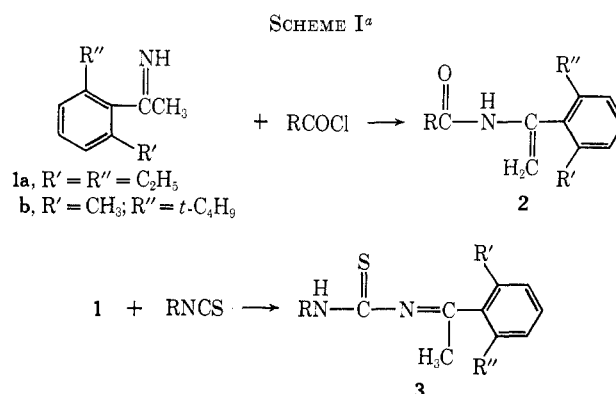
Recent investigations<sup>1</sup> have shown that electrophiles such as acyl chlorides, isocyanates, and isothiocyanates can react with N-substituted imines containing an enolizable proton to form, among other products, acylenamides, enureas, and enthioureas, respectively. The amount of enamide or urea obtained was shown to depend on both the electrophile and imine employed, as well as conditions of reaction.

In addition to the above products, it should be possible for N-hydrogen imines to alternatively react substitutively at nitrogen to form acylimine compounds. Earlier literature references<sup>2</sup> disclose the acylation of enolizable ketimine derivatives (Grignard complexes from acetophenone ketimines) to give such compounds. However, the structural assignments were shown to be incorrect, as later investigations<sup>3,4</sup> proved the materials to be enamides.

It is therefore a principal object of the present report to demonstrate that enolizable N-hydrogen ketimines can, in fact, under certain conditions, give acylimine derivatives with electrophiles such as acyl chlorides, isocyanates, and isothiocyanates.

Several representative N-hydrogen ketimines were prepared for investigation. Material **1** is derived from reaction of 2,6-dialkylbenzotrionitriles with an organometallic reagent, while **4**, **8**, and **9** are available by reaction of the respective ketone with ammonia in the presence of suitable reagents<sup>5</sup> or through an ammonolysis of the nitramine derivative.<sup>6</sup>

Reaction of **1** with acid chlorides invariably gave only **2**, while **3** was the product on reaction with isothiocyanates (Scheme I). In similar manner, **4** with acid



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