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# Thiapyran Formation via an Unexpected Thioaldehyde Intermediate by the Thermal Decomposition of Phenacyl Sulfoxides Bearing Some Heterocycles

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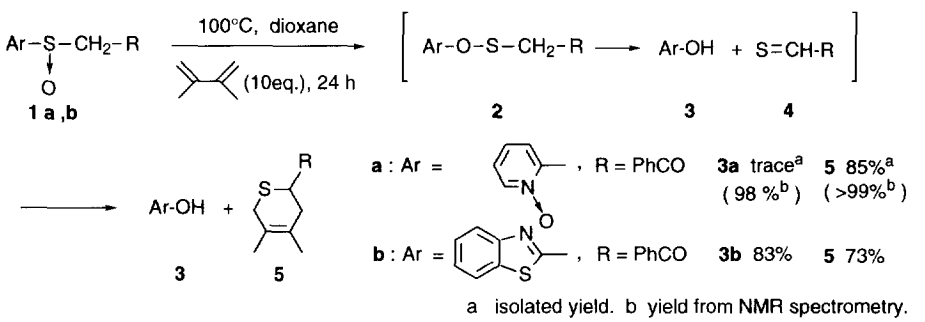
**Abstract**: Thermolysis of phenacyl sulfoxide bearing some nitrogen-containing heterocycles in the presence of 2,3-dimethyl-1,3-butadiene led to 6-benzoyl-5,6-dihydro-3,4-dimethyl-2*H*-thiapyran. This product was considered to be formed by the Diels-Alder reaction of the diene with thioaldehyde formed initially by the thermal decomposition of the sulfoxide. Copyright © 1996 Elsevier Science Ltd

Alkyl substituted sulfoxides having β-hydrogen are well known to undergo thermal decomposition by an Ei elimination mechanism, while other common sulfoxides are usually stable under thermal conditions. Meanwhile, in the fragmentation reaction of sulfoxides the mechanism has been proposed to go through rearrangement to sulfenic ester (RSOR') previously.[1] Quite recently, substantive evidence for the existence of a sulfenic ester in the reaction of certain sulfoxides has been demonstrated.[2] As a part of our continuing work, we have studied the thermal reaction of phenacyl sulfoxides bearing nitrogen-containing heterocycles and found a further example in which the intermediacy of the sulfenic ester would be involved.

N-Oxypyridyl phenacyl sulfoxide (**1a**) was heated in an inert solvent, such as dioxane, toluene or bromobenzene, at 120°C for 5 days in a sealed tube, expecting to detect the products derived from the sulfine which may be formed by the abstraction of the active α-hydrogen by the N-oxide group; however, the reaction only afforded a complex mixture of products. Then the thermal reaction of **1a** in dioxane was studied in a similar manner in the presence of 10 equivalent amount of 2,3-dimethyl-1,3-butadiene at 100°C for 24 hr in order to obtain the trapped adduct of sulfine.




a isolated yield. b yield from NMR spectrometry.

**Scheme 1**

In this case, unexpectedly, the isolated products were 6-benzoyl-5,6-dihydro-3,4-dimethyl-2*H*- thiapyran (**5**) and 2-hydroxy pyridine N-oxide (**3a**). Since the low isolated yield of **3a** by PLC would be due to its highly polar nature, the $^{1}$H NMR spectrometry of the crude reaction mixture was carried out to reveal that this reaction proceeds smoothly to give both **5** and **3a** almost quantitatively.

After testing other pyridine derivatives without an N-oxide group as an aryl group, not only the N-oxide group but simple 2- and 4-pyridyl groups also were found to be useful in this reaction, though the yields of **5** were as low as 10% and 36%, respectively. However, other aryl groups such as phenyl, 4-nitrophenyl, 2,3,5,6-tetrafluorophenyl and thienyl groups did not afford the desired reaction. Other nitrogen-containing heterocyles, such as 2-pyrimidyl, and 2-benzothiazolyl groups were also found to be effective to afford good yields for the compound **5**. ( Scheme 1 )[3] The possibility of the formation of **5** derived from the S-oxide of **5** formed initially by trapping of sulfine with diene was tested by heating the S-oxide of **5** authentically prepared by the oxidation of **5**; however, this compound was observed to be stable under the same conditions. Therefore, the compound **5** was considered to be formed by the Diels-Alder reaction of 2,3-dimethyl-1,3-butadiene with thioaldehyde (**4**) formed initially by the thermal decomposition of the sulfoxide.[4]

In view of product formation, the only plausible mechanism for this reaction seems to go through sulfenic ester intermediate (**2**); however the direct detection of the intermediate (**2**) by NMR spectrometry was not successful, probably suggesting the rapid decomposition of the sulfenic ester intermediate (**2**) to products. In this reaction mechanism nitrogen-containing heteroaryl and benzoyl groups as well as the formation of stable hydroxy heteroaromatics would provide sufficient driving force for the rearrangement to the corresponding sulfenic ester (**2**).

We are now continuing further study to clarify the limitation and the detailed mechanism of this reaction, such as the kinetic measurements, determination of the substituent effect, $^{18}$O tracer experiments and other factors.

## REFERENCES AND NOTES


1. I. W. J. Still, In *The Chemistry of Sulfones and Sulfoxides*; S. Patai, Z. Rappaport, C. J. M. Stirling, Eds., John Wiley & Sons Ltd., New York, 1988; pp 873-887.; K. Kobayashi, K. Mutai, *Tetrahedron Lett* . **1981**, *22*, 5201.; A. G. Schultz, R. H. Schlessinger, *J. Chem. Soc., Chem. Commun.* **1970**, 1294.; N. Furukawa, T. Fujii, T. Kimura, H. Fujihara, *Chem. Lett*, **1994**, 1007.
2. T. Guo, W. S. Jenks, *J.Chem. Soc.*, **1995**, *60*, 5480.
3. A typical run is as follows: Benzothiazolyl phenacyl sulfoxide ( 100mg, 0.335mmol ) was dissolved in 3 mL of dioxane and into this solution freshly distilled 2,3-dimethyl-1,3- butadiene was added. This mixture in a 10 mL pyrex tube was degassed thoroughly *in vacuo* at dry ice-acetone temperature and the glass tube was sealed. Then the mixture was reacted at 100°C for 24 hrs. The reaction mixture was chromatographed on a silica gel preparative plate using 1:5 EtOAc-hexane to afford 57mg (73%) of **2** and 42mg of hydroxy benzothiazole (83%). Spectral data of **2**; $^{1}$H-NMR($CDCl_3$): δ 8.01–7.98 (m, 2H), 7.57-7.53 (m, 1H), 7.47-7.43 (m,2H), 4.49 (t, CH, 1H), 2.99 (bs, $CH_2$, 2H), 2.57-2.41 (m, $CH_2$, 2H), 1.74 (s, $CH_3$, 6H). $^{13}$C-NMR ($CDCl_3$): δ 195.6, 135.2, 133.0, 128.6, 128.5, 126.3, 122.6, 41.8, 32.7, 29.8, 20.1, 19.5. IR (neat): 2900, 1670 $cm^{-1}$. ; Anal. calcd for $C_{14}H_{16}OS$: C, 72.37; H, 6.94; N, 0.00%. Found: C, 72.28; H, 7.14; N, 0.00 %.
4. C. M. Bladon, I. E. G. Ferguson, G. W. Kirby, A. W. Lochead, and D. C. McDougall, *J. Chem. Soc., Perkin Trans. I.*, **1985**, 1541; E. Vedejs, T. H. Eberlein, D. J. Mazur, C. K. McClure, D. A. Perry, R. Ruggeri, E. Schwartz, J. S. Stults, D. L. VaRie, R. G. Wilde and S. Wittenberger, *J. Org. Chem.*, **51**, 1556, (1986)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