Oxidation of Urazoles to Triazolinediones with Benzyltriphenylphosphonium Peroxymonosulfate under Solvent-Free Conditions

Abdol Reza Hajipour*, Shadpour E. Mallakpour,* and Hadi Adibi
Pharmaceutical Research Laboratory, College of Chemistry, Isfahan University of Technology, Isfahan 84156, IR Iran

(Received November 10, 2000; CL-001021)

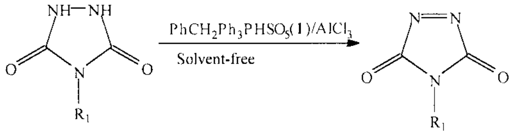
Benzyltriphenylphosphonium peroxymonosulfate ($PhCH_2Ph_3PHSO_5$) in the presence of $AlCl_3$ was used as an effective oxidizing reagent for the oxidation of urazoles to their corresponding triazolinediones in high yields under solvent-free conditions.

4-Substituted-1,2,4-triazoline-3,5-diones are notable for their ability to participate in a wide range of reactivity and reaction types, e. g. [4 + 2][1,2] and [2 + 2][3] cycloadditions, ene reactions,[4] electrophilic aromatic substitution,[5] dehydrogenating properties[6] and oxidation of alcohols to aldehydes and ketones.[7] The unusual reactivity that makes 1,2,4-triazoline-3,5-diones (**3**) of interest also makes them hard to prepare and purify. For example: 4-phenyl-1,2,4-triazoline-3,5-dione (**3a**) is an extremely reactive dienophile and enophile which is at least 1000 times more reactive than tetracyanoethylene in the Diels–Alder reaction with 2-chlorobutadiene and 2000 times more reactive than maleic anhydride.[1] All known methods of synthesis of these compounds require oxidation of the corresponding 1,2,4-triazolidine-3,5-diones (**2**), more commonly known as urazoles.

In recent years, a wide variety of reagents have been reported for this transformation,[8–11] but as far as we know this transformation is not so easy and is a tricky step because these compounds are very sensitive to the oxidizing agents and reaction conditions. However, most of the reported reagents produce by-products, which either destroy, or are difficult to remove from the sensitive triazolinediones.

Oxone® ($2KHSO_5·KHSO_4·K_2SO_4$) is an inexpensive, water-soluble and stable oxidizing reagent that is commercially available. In continuation of our ongoing program to develop environmentally benign methods using solid supports,[12] here we wish to report the oxidation of urazoles (**2**) to their corresponding triazolinediones (**3**) with benzyltriphenylphosphonium peroxymonosulfate (**1**) in the presence of $AlCl_3$ under solvent-free conditions. This reagent is readily prepared by the dropwise addition of an aqueous solution of oxone® ($2KHSO_5·KHSO_4·K_2SO_4$), to an aqueous solution of benzyltriphenylphosphonium chloride at room temperature.[13] Filtration and drying of the precipitates resulted in a white powder, which could be stored for months without losing its oxidation ability. The amounts of HSO_5^- in this reagent have been determined by an iodometric titration method.[14] The measurements are consistent with almost 99% by weight of active oxidizing agent. This reagent is quite soluble in methylene chloride, chloroform, acetone, and acetonitrile and insoluble in nonpolar solvents such as carbon tetrachloride, *n*-hexane, and ether.

At first, we decided to investigate the oxidation of 4-phenylurazole (**2a**) with this reagent under solvent-free conditions without catalyst, and observed that in the absence of catalyst the reaction does not proceed at all even with a higher molar ratio of the oxidant (1.2 mmol). For this aim, the catalytic effects of several Lewis acids such as $ZnCl_2$, $FeCl_6·6H_2O$, $BiCl_3$ and $AlCl_3$ were thoroughly investigated. Surprisingly, only $AlCl_3$ was found to be an effective catalyst during this investigation. The process in its entirely involves a simple mixing of benzyltriphenylphosphonium peroxymonosulfate ($PhCH_2Ph_3PHSO_5$) (**1**) and urazoles (**2**) in the presence of $AlCl_3$ (1 molar ratio) in a mortar and grinding the mixture for the time specified in Table 1 at room temperature. The yields of the reactions are high and the reaction times are exceedingly short (10–15 min). We tried the reaction of urazole (**2a**) with reagent (**1**) (1 mmol) in acetonitrile in the absence of Lewis acid at room temperature, and observed that the reaction did not complete after 60 min.



2a–f **3a–f**

Table 1. Oxidation of urazoles (**2**) to triazolinediones (**3**) with reagent (**1**) under solvent-free conditions[a,b]

Substrate	R_1	Product	Time /min	Yield[c] /%
2a	Ph	3a	10	94
2b	Cyclohexyl	3b	10	91
2c	*n*-Bu	3c	10	85
2d	$4\text{-Cl-}C_6H_4$	3d	12	80
2e	$4\text{-}NO_2\text{-}C_6H_4$	3e	15	85
2f	$4\text{-Cl}^-\ NH_3^+\text{-}C_6H_4$	3f	15	75

[a]Substrate/Oxidant/ $AlCl_3$ (1:1:1). [b]Confirmed by comparison with authentic samples.[8–11] [c]Yield of isolated pure products.

In summary, in this study we introduced a new methodology for the oxidation of different types of urazoles under solvent-free conditions. This method is superior to previously reported methods in terms of high yields, purity of products, facile work-up, cheaper and safer reagent and short reaction time.

Urazoles were synthesized according to reported procedures.[1,4,5,10,11] The reagent (**1**) was prepared according to our previously reported procedures.[13] Yields refer to isolated pure products. The oxidation products were characterized by comparison of their spectral (IR, UV, ^{1}H-NMR) and physical data with the authentic samples.[8–11] All ^{1}H-NMR spectra were recorded at 90 MHz in CDCl$_3$ relative to TMS (0.00 ppm) and IR spectra were recorded on Shimadzu 435 IR spectrometer. All reactions were carried out under solvent-free conditions in a hood with strong ventilation.

Oxidation of 4-phenylurazole (**2a**) with reagent (**1**) to 4-phenyl-1,2,4-triazoline-3,5-dione (**3a**): A typical procedure: A mixture of 4-phenylurazole (1 mmol, 0.177 g) (**2a**), oxidizing agent (**1**) (1 mmol, 0.47 g) and AlCl$_3$ (1 mmol, 0.13 g) in a mortar was ground with a pestle for the time specified in Table 1 until a deep-red color appeared. When TLC showed complete disappearance of urazole, the mixture was extracted with CH$_2$Cl$_2$. Evaporation of the solvent gave 4-phenyl-1,2,4-triazoline-3,5-dione (**3a**). The yield was 0.17 g (94%) of crystalline red solid (**3a**), mp 170–174 °C (dec.) [Lit[10] mp 170–178 °C].

The authors are thankful of the Isfahan University of Technology (IUT), IR Iran for financial support.

References and Notes

1 a) S. E. Mallakpour and M. A. Zolfigol, *Indian J. Chem*., **34B**, 183 (1995). b) S. E. Mallakpour and M. A. Zolfigol, *Indian J. Chem*., **34B**, 302 (1995). c) S. E. Mallakpour and M. A. Zolfigol, *Indian J. Chem*., **37B**, 1001 (1998). d) S. E. Mallakpour and M. A. Zolfigol, *Indian J. Chem.,***38B**, 777 (1999).

2 G. Desimoni, G. Faita, P. P. Righetti, A. Sulcini, and D. Tsyganov, *Tetrahedron*, **50**, 1821 (1994).

3 a) J. H. Hall and G. Krishnan, *J. Org. Chem.*, **49**, 2498 (1984). b) J. H. Hall and M. L. Jones, *J. Org. Chem*., **48**, 822 (1983). c) G. A. Seymour and F. D. Green, *J. Am. Chem. Soc*., **102**, 6384 (1980).

4 a) S. E. Mallakpour, G. B. Butler, H. Aghabozorg, and G. Palanik, *J. Macromolecules*, **18**, 342 (1985). b) Y. C. Lai, S. E. Mallakpour, G. B. Butler, and G. Palanik, *J. Org. Chem*., **50**, 4378 (1985).

5 a) S. E. Mallakpour and G. B. Butler, *J. Polym. Sci., Polym. Chem. Ed.,* **27**, 217 (1989). b) S. E. Mallakpour and G. B. Butler, *J. Polym. Sci., Polym. Chem. Ed.,* **27**, 125 (1989). c) S. E. Mallakpour and G. B. Butler, *J. Polym.Sci., Polym. Chem. Ed.,* **25**, 2781 (1987).

6 T. Klindert and G. Seitz, *Synth. Commun*., **26**, 2587 (1996).

7 a) R. C. Cookson, I. D. R. Stevens, and C. T. Watts, *Chem. Commun*., **1966**, 744. b) D. W. Borhani and F. D. Green, *J. Org. Chem.,* **51**, 1563 (1986). c) T. Akasaka, H. Sonobe, R. Sato, and W. Ando, *Tetrahedron Lett*., **25**, 4757 (1984).

8 J. C. Stickler and W. H. Prikle, *J. Org. Chem*., **31**, 3444 (1966).

9 G. Read and N. R. Richardson, *J. Chem. Soc., Perkin Trans. 1,* **1996**, 167.

10 S. E. Mallakpour, *J. Chem. Education,* **69**, 238 (1992).

11 a) S. E. Mallakpour and M. A. Zolfigol, *J. Sci. I. R. Iran,* **4**, 199 (1993). b) M. A. Zolfigol and S. E. Mallakpour, *Synth. Commun.,* **29**, 4061 (1999).

12 a) A. R. Hajipour, S. E. Mallakpour, and Gh. Imanzadeh, *J. Chem. Res. (S)*, **1999**, 228. b) A. R. Hajipour, S. E. Mallakpour, and Gh. Imanzadeh, *Chem. Lett.,* **1999**, 99. c) A. R. Hajipour, *Indian J. Chem*., **36B**, 1069 (1997). d) A. R. Hajipour, I. M. Baltork, K. Nikbaght, and Gh. Imanzadeh, *Synth. Commun*., **29**, 1697 (1999). e) A. R. Hajipour and F. Islami, *Indian J. Chem*., **38B**, 461 (1999). f) A. R. Hajipour, S. E. Mallakpour, I. M. Baltork, and S. Khoee, *Chem. Lett.,* **2000**, 120. g) A. R. Hajipour, S. E. Mallakpour and S. Khoee, *Synlett,* **2000**, 740.

13 a) A. R. Hajipour, S. E. Mallakpour, and H. Adibi, *Chem. Lett.,* **2000,** 460. b) A. R. Hajipour, S. E. Mallakpour, and H. Adibi, *Phosphorus, Sulfur and Silicon*, **2000**, in press. c) A. R. Hajipour, S. E. Mallakpour, I. M. Baltork, and H. Adibi, *Phosphorus, Sulfur and Silicon*, **2000**, in press. d) A. R. Hajipour, S. E. Mallakpour, I. M. Baltork, and H. Adibi, *Synth. Commun*., **2000**, in press.

14 B. M. Trost and R. Braslau, *J. Org. Chem*., **53**, 532 (1988).