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Note

Oxidative regeneration of carbonyl compounds from their oximes using *in situ* generated superoxide

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Superoxide ion, generated *in situ* by the phase transfer reaction of potassium superoxide and 18-crown-6, brings about an easy oxidative regeneration of a variety of carbonyl compounds from their oximes under significantly mild reaction conditions at room temperature.

Keywords: Superoxide ion, 18-crown-6, oximes, carbonyl compounds, oxidative regeneration.

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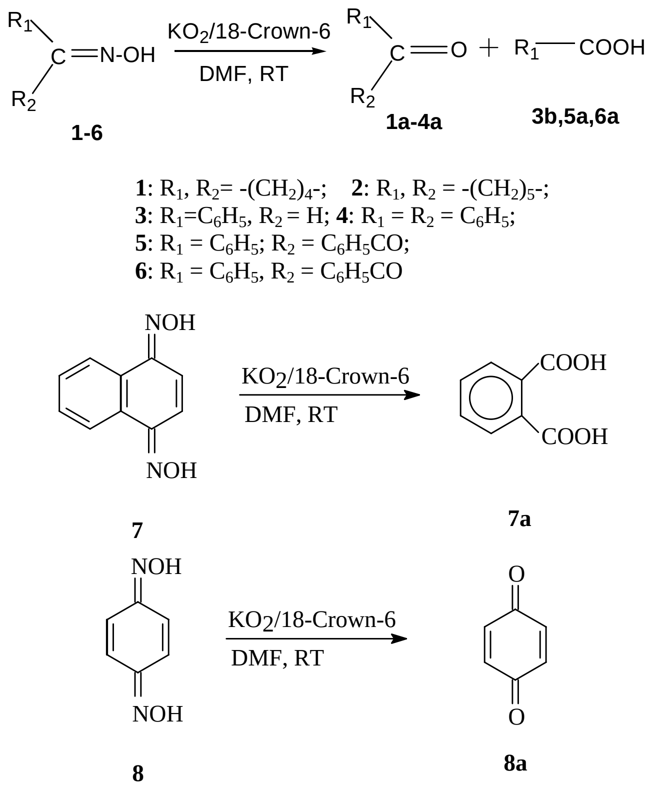
Regeneration of carbonyl compounds from their oxime derivatives under mild conditions is an important process in synthetic organic chemistry, which has aroused a growing interest in the development of mild and efficient methods[1-4]. Several chemical, electrochemical, biochemical and photochemical methods have been documented for the regeneration of carbonyl compounds from their oximes[5-16]. Liver cytochrome P_{450} is found to catalyze the oxidative cleavage of the C=N-OH bond of ketoximes, amidoximes and others[17,18]. Superoxide anion radical ($O_2^{-\cdot}$) reacts with arylamidoximes to afford selective formation of the corresponding benzamide and nitrogen oxides[19]. This P_{450} dependent oxidation of C=N-OH bonds is inhibited to a great extent by the addition of superoxide dismutase. This suggests the involvement of $O_2^{-\cdot}$ in the oxidation of oximes. To probe and substantiate the observation, it is worthwhile to investigate the reaction of *in situ* generated superoxide ion with compounds containing a C=N-OH bond.

In view of the above and as a part of our continued interest on superoxide research[20], this note reports herein the findings on the reactivity pattern of *in situ* generated $O_2^{-\cdot}$ with a number of oximes as model from the functional group perspective (**Scheme I**).



1: R_1, R_2= -$(CH_2)_4$-; **2**: R_1, R_2 = -$(CH_2)_5$-;
3: R_1=C_6H_5, R_2 = H; **4**: R_1 = R_2 = C_6H_5;
5: R_1 = C_6H_5; R_2 = C_6H_5CO;
6: R_1 = C_6H_5, R_2 = C_6H_5CO

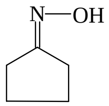
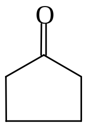
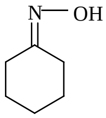
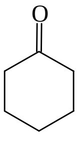
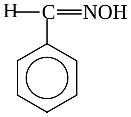
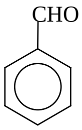
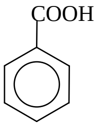
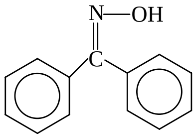
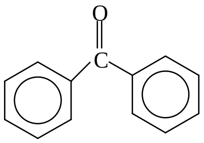
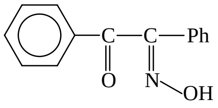
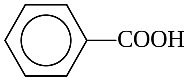
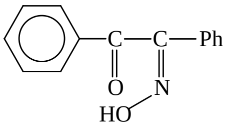
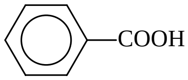
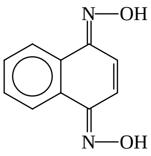
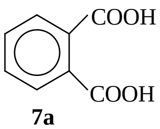
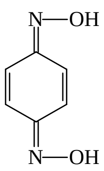
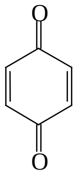
Scheme I

Superoxide ion was generated *in situ* by the phase transfer reaction of commercially available potassium superoxide and 18-crown-6, and was subsequently allowed to react with a variety of oximes such as cyclopentanone oxime **1**, cyclohexanone oxime **2**, benzaldehyde oxime **3**, benzophenone oxime **4**, α-benzilmonoxime **5**, β-benzilmonoxime **6**, 1,4-naphthaquinone dioxime **7** and *p*-benzoquinone dioxime **8**. **Table I** outlines the product(s) obtained along with their respective yields.

The molar ratio of the substrate, KO_2 and 18-crown-6 was taken to be 1:2:1. The reaction was conducted for 2-6 hr at room temperature under dry nitrogen atmosphere. The completion of the reaction was checked by TLC. The reaction mixture was then quenched and worked-up to isolate the product. The products were finally characterized based on their physical and spectral data reported in **Table II**.

The role of superoxide ion in the reaction is uncertain. However, it is assumed that the reaction is

Table I — Superoxide ion induced decomposition of oximes

Substrate	Product(s)	Yield* (%)	m.p./(b.p.)** (°C)	
			Obs.	Lit.
 **1**	 **1a**	43	129-30	130-31
 **2**	 **2a**	48	149-50	151-52
 **3**	 **3a**	52	180	178-79
	 **3b**	16	121	121-23
 **4**	 **4a**	84	47	48-49
 **5**	 **5a**	88	120	121-23
 **6**	 **6a**	79	119	121-23
 **7**	 **7a**	64	203	205
 **8**	 **8a**	61	111	113-15

*Isolated mass yield based on substrates **1-8**.

**Bracket indicates b.p., unbracked is m.p.

Table II — Spectral data of the products

Product	IR in cm^{-1}	^{1}H NMR (δ, ppm)
1a	472, 834, 960, 1153, 1408, 1455, 1746	1.8-2.4 (m, 8H, 4 × CH_2)
2a	908, 1119, 1222, 1312, 1339, 1450, 1715, 2863, 2938	1.6-2.1 (m, 6H, 3 × CH_2), 2.2-2.6 (t, 4H, 2 × CH_2)
3a	650, 689, 745, 828, 1204, 1311, 1584, 1597, 1702	7.8-8.4 (m, 5H, ArH), 9.7 (s, 1H, CHO)
3b/5a/6a	705, 936, 1294, 1325, 1455, 1580, 1690, 2500-3100	7.6-8.2 (m, 5H, ArH), 11.2 (s, 1H, COOH)
4a	638, 694, 705, 765, 1280, 1323, 1448, 1594, 1653	7.2-7.9 (m, 10H, ArH)
7a	896, 943, 1073, 1084, 1310, 1366, 15911, 1650, 1679	7.2-7.4 (m, 4H, ArH) 11.2 (s, 2H, COOH)
8a	740, 798, 906, 1071, 1283, 1404, 1586, 1682, 2894	6.8-7 (s, 4H, ArH)

initiated by hydrogen atom abstraction from the oxime. The resulting iminoxyl radical, after oxidation and hydrolysis, leads to the formation of the corresponding carbonyl compound.

Experimental Section

Melting points were measured in open capillaries and are uncorrected. IR spectra were recorded on a JASCO FT/IR-5300 spectrophotometer. ^{1}H NMR spectra were run on a JEOL FT-NMR spectrometer FX-90Q using TMS as internal reference (chemical shifts in δ, ppm). Potassium superoxide and 18-crown-6 were procured from E. merck, Germany and were used as received. Dry DMF of Aldrich, USA was stored over molecular seives (4Å) prior to use. The substrate *p*-benzoquinone dioxime **8** was procured from Aldrich, USA, whereas the substrates **1**-**7** were prepared by the reaction of different carbonyl compounds and hydroxylamine hydrochloride adopting literature methods[21,22]. The other reagents used were of A.R. grade.

Preparation of oximes 1-3. General procedure

The corresponding carbonyl compound (0.025 mole) was mixed with an equivalent quantity of hydroxylamine hydrochloride (0.025 mole) in an aq. solution. To this was added an excess of aqueous $NaHCO_3$. The resulting oxime was extracted by ether, dried over anhyd sodium sulphate, filtered and the solvent removed with a rotary evaporator. The product was recyrstallised from water. Compound **1**: m.p. 55°C [lit 56.5°C]; **2**: m.p. 89°C [lit 89-90°C]; **3**: b.p. 118°C [lit 119°C]

α-Benzil monoxime 5

Benzil (4.2 g, 0.02 mole) was dissolved in ethanol (5 mL) and to it was added concentrated aqueous solution of hydroxylamine hydrochloride (1.75 g, 0.025 mole). The solution was cooled down to 5°C in an ice-bath followed by the addition of aqueous solution of 20% NaOH (5 mL) with stirring. After one and half hr, the mixture was diluted with water and then filtered off. The filtrate was acidified with gl. acetic acid to afford pinkish precipitate of α-benzilmonoxime **5**. The product was recyrstallised from aqueous ethanol. Yield: 2.5 g; m.p. 137° [lit. 137-38°C].

β-Benzil monoxime[23]

It was obtained from α-benzilmonoxime in benzene in the presence of animal charcoal. m.p. 112°C [lit. 113-114°C]

Reaction of *in situ* generated superoxide with oximes 1-8. General procedure

Potassium superoxide (1.13 g, 0.016 mole) was weighed in a dry capped specimen tube under dry nitrogen atmosphere and transferred into a two necked round bottom flask (150 mL) equipped with a nitrogen inlet and a double surface condenser guarded by $CaCl_2$ tube. The flask was degassed with dry nitrogen and to it were admitted anhydrous DMF (35 mL) and 18-crown-6 (0.008 mole). The mixture was stirred magnetically for about 15 min to facilitate the major dissolution of the solids. Oxime **1-8** (0.008 mole) was finally introduced and the stirring was continued at room temperature for 2-6 hr till the complete loss of starting material was indicated by TLC.

After the reaction was over, the mixture was successively treated with cold saturated aq. sodium chloride (20 mL) and saturated aq. sodium hydrogen carbonate (20 mL) and then extracted with ether (3×20 mL). The combined ethereal extract was washed with water, dried over anhydrous Na_2SO_4, filtered and evaporated to afford the product **1a-3a**, **4a** and **8a**. In case of substrates **3**/**5**/**6**/**7**, the aq. phase was acidified with hydrochloric acid and then extracted with ether (2 × 15 mL) to isolate the acidic products **3b** and **7a**.

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