

NITRONATE ANIONS AS PRECURSORS OF HYDROXYNITRILIUM ION EQUIVALENTS
IN ELECTROPHILIC AROMATIC SUBSTITUTION - A NOVEL ROUTE TO OXIMES

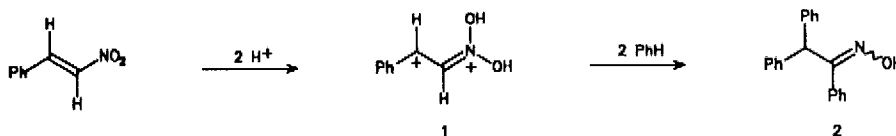
C. BERRIER, R. BRAHMI, H. CARREYRE, J.M. COUSTARD, J.C. JACQUESY*

Laboratoire de CHIMIE XII, associé au CNRS - Faculté des Sciences
40, avenue du Recteur Pineau - 86022 POITIERS Cedex (France)

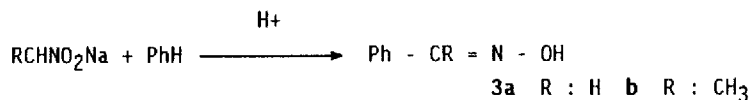
ABSTRACT - Nitronate salts $RCHNO_2Na$ react with aromatics ArH in acidic conditions to yield the corresponding oximes $Ar-CR=NOH$ via protonated nitronic acids.

Nitrocompounds are valuable intermediates and in the last decade the literature has intensively reviewed their preparative potential¹⁻⁷ in organic synthesis.

Generally nitrocompounds are weak bases, nitrobenzene and nitroalkanes being only monoprotinated in strong acids⁸. On the other hand it has been reported that nitronaphthalenes^{8d} and nitroolefins⁹⁻¹¹ are diprotinated in trifluoromethane-sulfonic acid (TfSA). The resulting dications react with benzene as illustrated below using β -nitrostyrene to yield diphenylacetophenoneoxime **2**.



We report in this paper that such a reaction can be extended to non conjugated nitroalkanes to yield oximes **3**, using the corresponding nitronate salts as the starting materials.



In a typical experiment sodium nitronate (10 mmoles) prepared according to Kornblum¹² is slowly added to a vigorously stirred cold ($0^\circ C$ or $-50^\circ C$) mixture of benzene (5 mmoles) and HF (10 ml). After 45 minutes and usual work-up, the products are isolated by column chromatography over SiO_2 .

Results obtained using sodium *aci*-nitromethane and sodium *aci*-nitroethane with various acids in the presence of benzene are reported in Table 1.

RCHNO ₂ Na	RCHNO ₂ Na/C ₆ H ₆ (molar ratio)	ACID	TEMP (°C)	PRODUCT ^c (yield %)
CH ₂ NO ₂ Na	0.2	HF	0	3a(35) ^a
CH ₂ NO ₂ Na	2	HF	0	3a(37) ^b
CH ₂ NO ₂ Na	2	HF	-50	3a(78) ^b
CH ₃ CHNO ₂ Na	0.2	HF	0	3b(16) ^a
CH ₃ CHNO ₂ Na	2	HF	0	3b(60) ^b
CH ₃ CHNO ₂ Na	2	HF	-50	3b(40) ^b
CH ₃ CHNO ₂ Na	0.07	H ₂ SO ₄	0	3b(13) ^a

TABLE 1

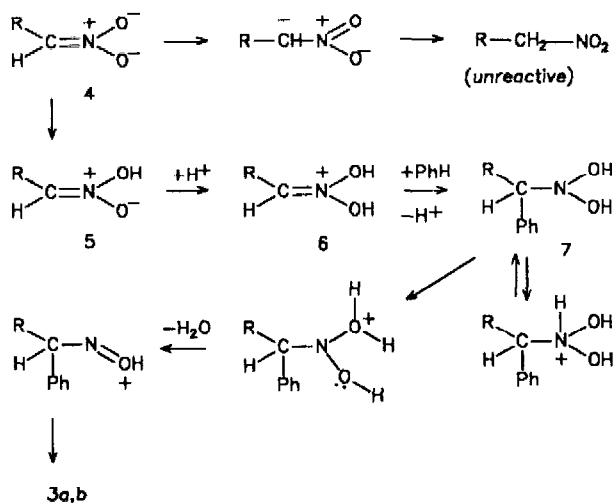
a : yield based on RNO₂Nab : yield based on C₆H₆

c : E+Z isomers

Results appear to be very sensitive to the nature of the nitronate salt, to RCHNO₂Na/C₆H₆ molar ratio, to temperature. The best yields (78 and 60% for 3a and 3b respectively) are obtained using hydrogen fluoride as the acid.

O-protonation of nitronate ion 4 yields nitronic acid 5 whereas the alternant C-protonation¹³ to the unreactive nitrocompound might be in part responsible for the modest yields observed in some experiments.

Our results can be accounted for by the nucleophilic addition of benzene occurring on protonated nitronic acids (N,N-dihydroxyiminium carbenium ions)^{6,13} followed by loss of water and tautomerization.



This new reaction is not limited to benzene and is effective to substitute activated aromatics. The results of conversion of toluene, phenol and anisole into the corresponding benzaldoximes using sodium salt of *aci*-nitromethane (molar ratio $\text{CH}_2\text{NO}_2\text{Na}$: substrate 2) in HF are reported in Table 2.

SUBSTRATE	TEMP (°C)	YIELD ^{a,b}	o/m/p)
Benzene	0	37	
	-50	78	
Toluene	0	34	62/0/38
	-50	70	61/0/39
Phenol	0	60	12/0/88
	-50	41	22/7/71
Anisole	0	28	25/3/72
	-50	57	33/2/65

TABLE 2

a : based on substrate

b : E+Z isomers

Except with phenol, oximes yields are highly improved when carrying out the reaction at low temperature and the observed regioselectivity is in agreement with an electrophilic aromatic substitution.

Nitrobenzene and aniline (which is probably deactivated by protonation) are unreactive.

In summary diprotonation of nitronate anion yields an electrophilic species equivalent to hydroxynitrilium ion ($\text{R} - \overset{+}{\text{C}} = \text{NOH} \longleftrightarrow \text{R} - \text{C} \equiv \overset{+}{\text{N}}\text{OH}$) in aromatic substitution. The reaction constitutes a novel synthetic method for oximes which are good intermediates to various functionalized compounds.

We thank CNRS for financial support.

REFERENCES

1. Seebach, D.; Colvin, E.W.; Lehr, F.; Waller, T. *Chimia* **1979**, *33*, 1.
2. Ono, N.; Kaji, A. *Synthesis*, **1986**, 693.
3. Rosini, G.; Ballini, R. *Synthesis*, **1988**, 833.
4. Fischer, R.H.; Weitz, H.M. *Synthesis*, **1980**, 693.
5. Yoshikoshi, A.; Miyashita, M. *Acc. Chem. Res.* **1985**, *18*, 284.
6. Barret, A.G.M.; Graboski, G.G. *Chem. Rev.* **1986**, *86*, 751.

7. Varna, R.S.; Kabalka, G.W. *Heterocycles*, **1986**, *24*, 2645.
8. a - Olah, G.A.; Kivovsky, T.E. *J. Am. Chem. Soc.* **1968**, *90*, 6461; b - Olah, G.A.; Fung, A.P.; Rawdah, T.N. *J. Org. Chem.* **1980**, *45*, 4149. c - Russel, D.G.; Senior, J.B. *Can. J. Chem.* **1980**, *58*, 22. d - Ohta, T.; Shudo, K.; Okamoto, T. *Tetrahedron Lett.* **1984**, 325.
9. a - Ohwada, T.; Ohta, T.; Shudo, K. *J. Am. Chem. Soc.* **1986**, *108*, 3029; b - Ohwada, T.; Itai, A.; Ohta, T.; Shudo, K. *J. Am. Chem. Soc.* **1987**, *109*, 7036.
10. Ohwada, T.; Ohta, T.; Shudo, K. *Tetrahedron*, **1987**, *43*, 297.
11. Okabe, K.; Ohwada, K.; Ohta, T.; Shudo, K. *J. Org. Chem.* **1989**, *54*, 733.
12. Kornblum, N.; Taylor, H.J. *J. Org. Chem.* **1963**, *28*, 1424.
13. Nielsen, A.T. in "*The chemistry of the nitro and nitroso group*", Part I (Ed. H. Feuer), Wiley Interscience, London, **1969**, p. 349.
14. Nucleophilic addition of water on protonated nitronic acids is a well-known route to aldehydes and ketones (Nef reaction), hydroxamic acids and carboxylic acids¹³.

(Received in France 30 July 1989)